Final

Integrated Natural Resource Management Plan Appendices

Joint Base Pearl Harbor-Hickam

Pearl Harbor Naval Complex
Naval Magazine Pearl Harbor Lualualei and West Loch Branches, Naval Computer and Telecommunications Area Master Station Pacific Wahiawa, Naval Radio Transmitter Facility Lualualei, and Navy-retained Lands at Kalaeloa
Hickam Air Force Base

O‘ahu, State of Hawai‘i

Commander, Navy Region Hawaii
September 2011

Final

Integrated Natural Resource Management Plan Appendices

Joint Base Pearl Harbor-Hickam

Pearl Harbor Naval Complex
Naval Magazine Pearl Harbor Lualualei and West Loch Branches,
Naval Computer and Telecommunications Area Master Station Pacific Wahiawa, Naval Radio Transmitter Facility Lualualei, and
Navy-retained Lands at Kalaeloa
Hickam Air Force Base
O‘ahu, State of Hawai‘i

Prepared for:
Commander, Navy Region Hawaii
Pearl Harbor, Hawai‘i 96860

Prepared by:
Helber Hastert & Fee Planners, Inc.
733 Bishop Street, Suite 2590
Honolulu, HI 96813

September 2011

CONTENTS

APPENDIX A
PHNC PLANT AND ANIMAL SURVEYS

A1 – PEARL HARBOR COASTAL ZONE BOTANICAL SURVEY (NAVFAC PAC 2006B)

This page is intentionally left blank.

PEARL HARBOR COASTAL ZONE
Botanical Survey

INTRODUCTION

Comprehensive botanical surveys in the Pearl Harbor coastal zone were most recently conducted in 2000 for the Pearl Harbor INRMP (Char, 2000). The survey report identified this community as a mangrove community and covered both the immediate coastal areas and those inland from the mangroves using a walk-through survey method.

For this 2007 INRMP, survey updates were conducted at Waipio and Pearl City Peninsula, along with the addition of Laulaunui Island. Complete species lists were not compiled again for this update, rather, walk through surveys were conducted to update any changes in the vegetation due to development, invasive species or other factors and further search for rare, threatened and endangered species.

METHODS

All available literature and survey reports were reviewed before surveys were conducted. Areas that had been described as having the most intact native vegetation were targeted with a walk-through survey method. Notes were taken on species composition, associations, and distribution. Photos were also taken of all communities and individual species for report use and future identification. Any plants that could not be identified in the field were photographed and collected for off-site identification using several field guides.

RESULTS and DISCUSSION

General: As described by Char (2000), the coastal zone of Pearl Harbor is primarily covered by thick mangrove forest. Interestingly, the coastal areas at the tip of Waipio Peninsula had very little mangrove; instead milo (*Thespesia populnea*) and kiawe (*Prosopis pallida)* forest dominated. No new species were found to add to Char's surveys completed in 2000. Table 1 provides a dominant species list for those observed on Laulaunui Island.

Mangrove (*Rhizophora mangle*) was first introduced on the island of Molokai in 1902, primarily for the purpose of stabilizing coastal mud flats (Allen 1998). This species is now well established in Hawaii, and is found on nearly all of the major islands. At least five other species of mangroves or associated species were introduced to Hawaii in the early 1900s, and while none has thrived to the degree of *R. mangle*, at least two have established self-maintaining populations (*Bruguiera gymnorrhiza* and *Conocarpus erectus*). Mangroves are highly regarded in most parts of the tropics for the ecosystem services they provide, but in Hawaii they are viewed as invasive, and their negative ecological and economic impacts are well reported. Known negative impacts include reduction in wetland habitat quality for endangered waterbirds, colonization of habitats to the detriment of native species (e.g. coastal forests, anchialine pools), overgrowing native

Hawaiian archaeological sites, and causing drainage and aesthetic problems. In non-Navy areas of Pearl Harbor such as Pouhala Marsh, mangrove thickets have also been reported to provide refuge for drug related crimes (Honolulu Advertiser 2005).

Positive impacts of mangrove appear to be few, but include uses of local importance, such as providing habitat for coastal fish, collection of flowers for lei, as well as some ecological services attributed to mangroves elsewhere, such as sediment retention and organic matter export.

While complete eradication of mangrove in Pearl Harbor is not realistic, it would be prudent for the Navy to continue supporting mangrove removal at Pouhala Marsh and Pearl Harbor National Wildlife Refuge to restore native plants and wetland habitat for protected waterbird species. Additionally, areas such as the tip of Waipio Peninsula where mangrove is not dominant would be good areas for habitat restoration projects.

Laulaunui Island:

A botanical survey was conducted on Laulaunui Island on March 29, 2006. Background research revealed that the island was not only used by native Hawaiians and the U. S. military, but was also used by the University of Hawaii as a primate research facility. Concrete foundations and oyster middens are remaining evidence of this history.

The limestone island, which is located in the West Loch of Pearl Harbor, contains similar vegetation to the surrounding coastal areas of West Loch and Pearl City Peninsula. A large portion of the island is a Hawaiian fish pond which is surrounded by thick, impenetrable mangrove forest. Other than mangrove, the predominant canopy species is kiawe. The ground cover is comprised primarily of thick beds of indigenous `ilima (*Sida fallax*) (Photo 1), however, this shows evidence of being overtaken by the very invasive golden crown beard (*Verbesina enceloides*) (Photo 2). Pa`u o hi`iaka (*Jacquemontia ovalifolia*), is the other native, ground cover that was found (Photo 3). Non-native ground cover included lion's ear (*Leonotis nepetifolia*), coral berry (*Ravina humilis*), *Boerhavia coccinea,* and ivy gourd (*Coccina grandis*). The non-native sourbush (*P. carolinensis)*, India fleabane (*Pluchea indica*) and koa haole (*Leucaena leucocephala*) were the most common shrubs observed.

No rare, threatened or endangered species were found at Laulaunui Island. It was somewhat surprising to not find other native coastal species such as milo or hau (*Hibiscus tiliaceus*), however, it is assumed that the small size of the island has allowed the mangrove to take over the natives more completely than the larger, adjacent peninsulas.

Waipio Peninsula: Waipio Peninsula was found as described by Char in 2000. The natural areas are weed-dominated with dirt and gravel rounds throughout. The roads appear to be used by the military for training as a tank caravan was staged at the ramp at the end of the peninsula.

One interesting observation is the dominance of native milo and non-native kiawe instead of mangrove on the tip of the peninsula. A large portion of Waipio Peninsula was developed into the Waipio Soccer Park, which is landscaped and mowed.

Pearl City Peninsula: Pearl City Peninsula was found as described by Char in 2000. The natural areas are highly disturbed and weed dominated; many abandoned and run-down buildings can be found throughout the area. A bridge over Waiawa Stream provides access to the western side of the peninsula. Upstream, where salinity levels are lower, the stream is lined with typical riparian vegetation, including hau (Photo 4), India fleabane and California grass (*Brachiaria mutica*) (Photo 5).

The northeastern corner of the peninsula, east of Lehua Avenue was interesting as the inshore areas were milo dominated with a hau and naupaka (*Scaveloa sericea*) understory (photo 6). Evidence was also found in this area of milo harvest (photo 7). This is not condoned on U. S. Navy property and should be actively discouraged in the future.

Access to Pearl City Peninsula was privatized on 2 October 2006, unlocking the gates and allowing access onto the natural areas to the public. It is too early to observe any impact from this action, however, it is recommended that additional signs be posted at the USFWS NWR to discourage disturbance.

REFERENCES

Allen, James. 1998. Mangroves as Alien Species: The Case of Hawaii. *Global Ecology and Biogeography Letters*, Vol. 7, No. 1, Biodiversity and Function of Mangrove Ecosystems, pp. 61-71

Char, W. 2000. Botanical Survey Mangrove Community in Pearl Harbor, Pearl Harbor, HI. Prepared for Helbert, Hastert and Fee.

Honolulu Advertiser. October 16, 2005. "Waipahu 10th graders study marsh up close".

Wagner, W.L., D. R. Herbst and S. H. Sohmer. 1999. Manual of the Flowering Plants of Hawaii, revised edition, two volumes. University of Hawaii Press and Bishop Museum Press, Honolulu, Bishop Museum Special Publication; 97.

Whistler, W. Arthur. 1995. Wayside Plants of the Islands: A Guide to the lowland flora of the Pacific Islands. Published by Isle Botanica, Honolulu Hawaii.

Table 1 – Laulaunui Island plant list

SCIENTIFIC NAME	COMMON NAME	STATUS
Abutilon grandiflorum	Hairy abutilon	Alien
Boerhavia coccinea	No common name	Alien
Cechrus ciliaris	Bufflegrass	Alien
Chamesyce prostrata	Prostrate spurge	Alien
Chloris barbata	Swollen fingergrass	Alien
Coccina grandis	Ivy Gourd	Alien
Digitaria sp.		Alien
Jacquemontia ovalifolia	Pa'uohi'iaka	Indigenous
Leonotis nepetifolia	Lions ear	Alien
Leuceana leucocephala	Koa haole	Alien
Pluchea carolinensis	Sourbush	Alien
Pluchea indica	India fleabane	Alien
Portulaca pilosa	No common name	Alien
Prosopis pallida	Kiawe	Alien
Ravina humilis	Coral berry	Alien
Rhizophora mangle	Mangrove	Alien
Sida fallax	Ilima	Indigenous
Verbesina enceloides	Golden crownbeard	Alien
Thespesia populnea	Milo	Indigenous
Youngia japonica	Oriental hawksbeard	Alien

Photo 1 – Ilima (*Sida fallax*) at Laulaunui Island

Photo 2 – Golden crown beard (*Verbesina enceloides*) at Laulaunui Island

Photo 3 – Native Pa`u o hi`ika (*Jacquemontia ovalifolia*) at Laualunui Island

Photo 4 – Hau (*Hibiscus tiliaceus*) at Pearl City Peninsula

Photo 5 – Waiawa Stream where it bisects Pearl City Peninsula

Photo 6 – Milo (*Thespesia populnea*) coastal forest at Pearl City Peninsula

Photo 7 – Milo (*Thespesia populnea*) harvest at Pearl City Peninsula

A2 – RED HILL FUEL STORAGE AREA FLEET INDUSTRIAL SUPPLY CENTER BOTANICAL SURVEY 2006 (NAVFAC PAC 2006I)

This page is intentionally left blank.

RED HILL FUEL STORAGE AREA
FLEET INDUSTRIAL SUPPLY CENTER
Botanical Survey
2006

INTRODUCTION

The Navy-owned property known as Red Hill Fuel Storage Area is located on a ridge that separates Halawa from Moanalua Valley. The facility contains underground fuel storage to supply the Pacific Fleet. Most of the vegetation found on this installation is typical of other lowland areas on Oahu, with most of the site covered by koa haole scrub with only common native species. This is consistent with the conditions that were found by Char in 2000 during the most recent botanical survey of this parcel.

Complete species lists were not compiled again for this update, rather, walk through surveys were conducted to further search for rare, threatened and endangered species, and to update any changes in the vegetation due to development, invasive species or other factors. The majority of the survey was spent on the ridge above the water tower to investigate the reported erosion and to explore the native forest that had been described.

METHODS

All available literature and prior survey reports were reviewed before field surveys were conducted. Areas that had been described as having the most intact natural areas were targeted with a walk-through survey method – developed and landscaped areas were not surveyed. Notes were taken on species composition, associations, and distribution. Photos were also taken of all communities and many individual species for report use and future field studies. Any plants that could not be identified in the field were photographed and collected for off-site identification using several field guides.

RESULTS AND DISCUSSION

Table 1 provides a dominant species list for Red Hill Fuel Storage Area.

The 2000 survey classified the vegetation into five vegetation types – koa haole scrub, mixed grass/shrub, Christmas berry scrub, waiawi scrub, and ruderal. This current survey may have extended to a slightly higher elevation up the ridgeline than the 2000 survey, however, a sixth vegetation type was found which should be added – lowland mesic shrubland (see photo 1).

The lowland mesic shrubland was observed along the ridgeline trail above the watertower, going mauka towards the electrical tower, at a higher elevation than the mixed grassland/shrub. In this area, the vegetation quickly became predominantly native forest with an ohia (*Meterosideros polymorpha*) (Photo 3) and koa (*Acacia koa*) overstory, and a`ali`i (*Dodonaea viscosa*), sandalwood (*Santalatum freycinetianum*) (photo 2), alahe`e (*Canthium odoratum*), akia (*Wikstroemia oahuensis*) (Photo 5) and pukiawe (*Styphelia* *tameiameiae*) (Photo 6) as the dominant mid canopy species. The ground cover in this area contained a large thickets of ulei (*Osteomeles anthyllidifolia*) (Photo 4), among several species of non-native grass. There was also an abundance of the native vine huehue (*Cocculus orbiculatus*) (Photo 7). These species are fairly common at this elevation, however, native species should be protected from unnecessary development.

Koa haole scrub covers the most area at Red Hill and occurs on gently sloping to somewhat steep slopes. Other than the dominant koa haole, frequent Chinese banyan (Ficus microcarpa) and silk oak (*Grevillia robusta*) are also found. The ground cover is primarily guinea grass (*Panicum maximum*) with smaller patches of Chinese violet (*Asystasia gangetica*). Native species such as kumuniu fern (*Doryopteris decipiens*), peperomia (*Peperomia leptostachya*) and spurflower (*Plectranthus perviforis*) were observed on the rocky outcroppings that are also found along the slopes.

Mixed grass/shrub vegetation is found on the ridgetop on the less steep areas above the housing area. The grasslands of guinea grass, molasses grass, natal redtop and beardgrass (among others) are patchy, with frequent koa haole, waiawi, and Christmas berry (*Schinus terebinthifolius*) scattered throughout. This vegetation type is found adjacent to the lowland mesic shrubland with some overlap of native tree/shrub species, including koa, alahe`e, aali`i and akia. These conditions are the same as observed by Char in 2000.

Waiawi scrub is dominated by the yellow fruited variety of the strawberry guava (*Psidium cattleianum* var *littorale*). There is a fair amount of overlap between this vegetation type and the mixed grass/shrubland described above. This vegetation type was also observed in the same condition as described by Char.

Ruderal vegetation continues to be found along the paved and unpaved roads at Red Hill. It is comprised of non-native grasses and herbaceous species. This vegetation type is also currently the same as described by Char.

Erosion has been a concern at Red Hill in the past, particularly during times of drought. In May 2005, three Navy biologists conducted a site visit to the area to assess existing condition of erosion on the ridge at Red Hill. They only observed one large area of erosion past the water tanks. Their assessment was that despite poor conditions in the past, the area was improving and that natural revegetation was occurring. They recommended monitoring the area to assure that the vegetation continued to fill in. During this survey in the fall of 2006, several large areas were observed where erosion was an issue. They were in the same general vicinity as what was described in 2005. One of the largest areas observed is shown in Photo 7. This area shows no signs of new vegetation growth occurring in the bare area. It is recommended that effort be made to revegetate this area with native groundcover species (ulei, a`ali`i, pukiawe, iliahi) as it is unlikely to do so without human intervention.

Table 1 - Dominant native species found on upper ridge at Red Hill

SCIENTIFIC NAME	COMMON NAME	FAMILY	STATUS
Acacia koa	Koa	Fabaceae	Endemic
Canthium odoratum	Alahe`e	Rubiaceae	Indigenous
Cocculus orbiculatus	Huehue	Menispermaceae	Indigenous
Diospyros sandwicensis	Lama	Ebenaceae	Indigenous
Dodonaea viscosa	`Aali`i	Sapindaceae	Indigenous
Meterosideros polymorpha	`Ohia	Myrtaceae	Endemic
Osteomeles anthyllidifolia	Ulei	Rosaceae	Indigenous
Santalum freycinetianum	`Iliahi, sandalwood	Santalaceae	Endemic
Styphelia tameiameiae	Pukiawe	Epacridaceae	Indigenous
Wikstroemia oahuensis	`Akia	Thymelaeaceae	Endemic

Photo 1 – Native forest along ridgeline (shows ulei, sandalwood, ohia)

Photo 2 - Sandalwood (*Santalum elipticum*) shrub species

Photo 3 – Ohia (*Meterosideros polymorpha*) canopy species

Photo 4 – Ulei (*Osteomeles anthyllidifolia*) predominant ground cover

Photo 5 – `Akia (*Wikstroemia oahuensis*), shrub species

Photo 6 – Pukiawe (*Styphelia tameiameiae*) shrub species

Photo 6 – Huehue (*Cocculus orbiculatus*) vine

Photo 7 – erosion scar

A3 – WAIAWA WATERSHED BOTANICAL SURVEY (NAVFAC PAC 2006J)

This page is intentionally left blank.

WAIAWA WATERSHED
Botanical Survey
2006

INTRODUCTION

The Navy-owned property known as Waiawa watershed lies in the lower portion of Waiawa Valley near Pearl City Industrial Park. It is bisected by Waiawa and Waimano Streams, which join together at the makai edge of the parcel (Photo 1). The stream banks provide most of the forested area of the 75-acre parcel. The rest of the property is koa haole scrub, non-native grassland and ruderal vegetation. This is consistent with the conditions that were found by Char in 2000 during the most recent botanical survey of this parcel.

Complete species lists were not compiled again for this update, rather, walk through surveys were conducted to further search for rare, threatened and endangered species, and to update any changes in the vegetation due to development, invasive species or other factors.

METHODS

All available literature and prior survey reports were reviewed before field surveys were conducted. Areas that had been described as having the most intact natural areas were targeted with a walk-through survey method – developed and landscaped areas were not surveyed. Notes were taken on species composition, associations, and distribution. Photos were also taken of all communities and many individual species for report use and future field studies. Any plants that could not be identified in the field were photographed and collected for off-site identification using several field guides.

RESULTS AND DISCUSSION

Table 1 provides a dominant species list for Waiawa Watershed. As described by Char (2000), there are five major vegetation types found on the Waiawa Watershed parcel – koa haole scrub, ruderal, java plum mixed forest, guinea grass grassland and savanna. The guinea grass and savanna were found to be virtually identical.

All five areas are dominated by non-native plants. The koa haole scrub has a virtually impenetrable guinea grass groundcover, making it very difficult to traverse. The scrub is found from the bisecting road up to the property line at the ridge top and contains java plum (*Syzgium cumini*), kiawe (*Prosopis pallida*) and Chinese banyan (*Ficus microcarpa*). The rocky outcroppings on the upper areas of the hillside still have remnant native plants scattered throughout the koa haole. Native plants observed in this area are a`ali`i (*Dodonea viscosa*), pili (*Heteropogon contortus*), `ala`ala wai nui (*Peperomia leptostachya*) (Photo 2) and `uhaloa (*Waltheria indica*), allowing for some insight into the possible forest composition prior to the introduction of invasive species such as koa haole and guinea grass.

The java plum mixed forest along the stream banks was also found as described by Char (Photo 3). The mid and understory were sparse, as is typical with this type of forest. No native species were observed along the stream. Prior reports have discussed evidence of homeless camps, however, none was noted during this visit. Steep banks lined some narrow sections of the streambed (Photo 4), providing shelter for birds. This area should be provided as a recreation area to military families as it provides an unusually peaceful and aesthetically pleasing stream environment for walks and fishing which is easily accessible from the Pearl Harbor area.

The species composition of the ruderal vegetation is different on either side of the road – scrub forest with plants such as macaranga (*Macaranga tanarius*) and Victorian box (*Pittosporum undulatum*) (Photo 5) understory are found on the stream side and guinea grass leading upslope on the cliff side. All species are common in this type of non-native dominant habitat.

Table 1 - Dominant species list for Waiawa Watershed

SCIENTIFIC NAME	COMMON NAME	FAMILY	STREAMBED	HILLSIDE and RUDERAL	STATUS
Acacia confusa	Formosan koa	Cucurbitaceae	X		Alien
Acacia farnesiana	Klu	Fabaceae		X	Alien
Aleurites moluccana	Kukui	Euphorbiaceae	X		Alien
Brachiaria mutica	California grass	Poaceae		X	Alien
Calyptocarpus vialis	Calyptocarpus	Asteraceae	X		Alien
Chamaesyce hypericifolia	Graceful spurge	Euphorbiaceae	X		Alien
Chloris barbata	Swollen fingergrass	Poaceae	X		Alien
Chromolaena odorata	None	Asteraceae		X	Alien
Clusia rosea	Autograph tree	Clusiaceae	X		Alien
Cordyline terminalis	Ti	Agavaceae	X		Alien
Dodoaea viscosa	A`ali`i	Sapindaceae		X	Indigenous
Ficus macrocarpa	Chinese banyan	Moraceae		X	Alien
Filicum decipiens	Fern tree	Sapindaceae	X		Alien
Grevillea robusta	Silk oak	Proteaceae		X	Alien
Heteropogon contortus	Pili grass	Poaceae		X	
Hibiscus tiliaceus	Hau			X	Indigenous
Ipomoea cairica	Ivy leaved morning glory	Convolvulaceae	X		Alien
Jacquemontia ovalifolia	Pa`u o hi`iaka	Convolvulacea			Indigenous
Lantana camara	Lantana	Verbenaceae	X		Alien
Leucaena leucocephala	Haole koa	Fabaceae	X		Alien
Macaranga tanarius	Macaranga	Euphorbiaceae		X	Alien
Mangifera indica	Mango	Anacardiaceae	X		Alien

Murraya paniculata	Mock orange	Rutaceae	X	X	Alien
Ochna kerkii	Mickey mouse plant	Ochnaceae	X		Alien
Oplismenus compositus	Basket grass	Poaceae	X		Alien
Opuntia ficus-indica	Prickly pear cactus	Cactaceae	X		Alien
Passiflora foetida	Passionfruit	Passifloraceae	X		Alien
Panicum maximum	Guinea grass	Poaceae	X		Alien
Peperomia leptostachya	`Ala`ala wai nui	Piperaceae		X	Indigenous
Pilea microphylla	Rockweed	Urticacea	X		Alien
Pithecellobium dulce	Manila tamarind	Pithecellobium	X		Alien
Pittosporum undulatum	Victorian box	Pittosporaceae		X	Alien
Pluchea carolinensis	Sourbush	Asteraceae		X	Alien
Pluchea indica	India fleabane	Asteraceae		X	Alien
Portulaca oleracea	Pigweed	Portulacaceae		X	Alien
Prosopis pallida	Kiawe	Fabaceae		X	Alien
Psidium cattleianum	Strawberry guava	Myrtaceae	X		Alien
Ravina humilis	Coral berry	Phytolaccaceae	X	X	Alien
Ricinus communis	Castor bean	Euphorbiaceae	X		Alien
Samanea saman	Monkeypod	Fabaceae	X		Alien
Schefflera actinophylla	Octopus tree	Araliaceae	X		Alien
Schinus terebinthifolius	Christmas berry	Anacardiaceae	X	X	Alien
Senna surattensis	Kolomona	Fabaceae		X	Alien
Sida fallax	`Ilima	Malvaceae		X	Indigenous
Solanum americanum	Popolo	Solanaceae		X	Indigenous
Solanum torvum	Prickly solanum	Solanaceae		X	Alien
Spathodea campanulata	African tulip	Bignoniaceae	X		Alien
Stachytarpheta jamaicensis	Jamaican vervain	Verbenaceae	X		Alien
Syzygium cumini	Java plum	Myrtaceae	X		Alien
Waltheria indica	Uhaloa	Sterculiaceae		X	Indigenous

Photo 1 – Waiwa Watershed streambed

Photo 2 – Native `ala`ala wai nui (*Peperomia leptostachya*) on hillside of Waiawa Watershed.

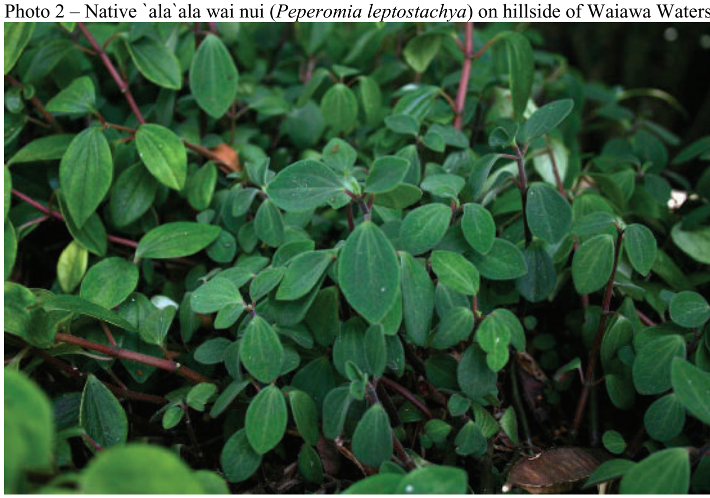


Photo 3 – Java plum mixed forest

Photo 4 - Steep, narrow stream bank

Photo 5 – Victoria box (*Pittosporum undulatum*) along roadside

A4 – BOTANICAL SURVEY OF MANGROVE COMMUNITY IN PEARL HARBOR, PEARL HARBOR, O‘AHU (CHAR 2000C)

This page is intentionally left blank.

BOTANICAL SURVEY

MANGROVE COMMUNITY IN PEARL HARBOR

PEARL HARBOR, O‘AHU

by

Winona P. Char

CHAR & ASSOCIATES
Botanical Consultants
Honolulu, Hawai'i

Prepared for:

HELBER HASTERT & FEE

March 2000

Contents

INTRODUCTION

The mangrove *(Rhizophora mangle)* community or vegetation type is the dominant plant community along the shoreline of Pearl Harbor. Mangrove, for the most part, has replaced the original, low growing native vegetation composed of various sedges and herbaceous species. Where it is native, mangrove has a number of beneficial aspects which includes retention of sediments, absorption of pollutants, stabilization of shorelines, and providing a nursery ground for various fish and invertebrate species. In Hawaii, however, mangrove is not native and is viewed as an invasive species by natural resources managers. It has dramatically altered the ecology of the coastal zone in Hawaii. Ecosystem impacts include high levels of organic inputs from leaf and propagule production, alteration of water flow patterns, and invasion of wetlands resulting in fewer open, shallow marshland and mudflat habitats utilized by endangered Hawaiian waterbirds. Dense mangrove thickets also adversely impact important Hawaiian archaeological sites such as fishponds by causing deterioration of these structures.

Field studies to inventory the mangrove community on Navy-owned lands in Pearl Harbor were conducted on 21 and 22 December 1999, and 07 January 2000 by two botanists. The areas surveyed included the Okiokiolepe Fishpond at Naval Magazine Lualualei, West Loch Branch, and Loko Paaiau Fishpond at McGrew Point, and the shoreline around Waipio Peninsula and Pearl City Peninsula. The vegetation types adjacent to the mangrove communities were also surveyed since they may also be impacted by mangrove clearing and other management activities. For example, kiawe *(Prosopis pallida)* forest immediately adjoins the mangrove communities around the two fishponds, while extensive areas with pickleweed *(Batis maritima)* marsh are found on Pearl City Peninsula. The primary objectives of the field studies were to:

1) Provide a description of the vegetation along the shoreline and fishponds;
2) Inventory the flora; and
3) Search for threatened and endangered species as well as species of concern.

SURVEY METHODS

Prior to undertaking the field studies, a search was made of the pertinent literature to familiarize the principal investigator with other botanical studies conducted in the area. Topographic maps as well as recent colored, aerial photographs were examined to determine vegetation cover patterns, terrain characteristics, access, boundaries and reference points. The most recent National Wetlands Inventory (NWI) for Pearl Harbor was also examined for locations of wetlands. The classification system it uses, however, does not identify the dominant plant cover. Whenever possible we attempted to link the NWI code with recognized vegetation types.

A walk-through survey method was used. Notes were made on plant associations and distribution, substrate types, topography, exposure, disturbances, etc. Plant identifications were made in the field; plants that could not be positively identified were collected for later determination in the herbarium, and for comparison with the recent, taxonomic literature.

MANGROVE IN PEARL HARBOR

The American or red mangrove *(Rhizophora mangle)* is a large shrub to medium-size tree up to 40 feet (12 meters) tall with conspicuous stilt roots. The plants often form impenetrable thickets. The fruit is greenish brown, leathery, pendent, 0.75 to 1.25 inches (2 to 3 centimeters) long, and one-seeded. The seed germinates within the fruit while still attached to the parent plant, a condition termed vivipary. The spindle to club-shaped hypocotyl ("young root") is about a foot (0.3 meter) long. Mangrove is native to Florida, the West Indies, and South America. The reddish, fine-grained, very hard wood is used for charcoal, fuel, fences, and buildings. The bark, which contains 20 to 30% tannins, is used for dyes (Neal 1965; Wagner *et al.* 1990).

Mangrove was introduced by the American Sugar Company in 1902 to hold soil in mudflats on southwestern Molokai (Degener 1940). Since then, it has spread to all of the main Hawaiian Islands except Niihau.

Mangroves have been found in Pearl Harbor since 1917, but the steep-sided shoreline provided little suitable habitat for colonization. Mechanical harvesting of sugar cane in the mid-1940s led to increased sedimentation inputs causing the formation of deltas at the mouth of Pearl Harbor streams. With the formation of these deltas, the mangrove population increased dramatically within Pearl Harbor (Bishop Museum 2000). Mangrove has been successful because there are few native plants which colonize mudflats and there are no mangrove predators (herbivores and insects) and diseases in Hawaii (Guilbeaux and Mejia-Chang 1999).

Prior to Western contact, the vegetation along the Pearl Harbor shoreline probably consisted mostly of kaluha *(Bolboschoenus maritimus),* a sedge 12 to 60 inches (30 to 150 centimeters) tall, and 'akulikuli or sea purslane *(Sesuvium portulacastrum),* a succulent

mat-forming herb. Patches of kipukai or seaside heliotrope *(Heliotropium curassavicum)* were probably locally abundant. These plants would be found in saline or fresh water, on mudflats, and in marshes. Streams, springs, and fresh to brackish water wetlands supported 'aki'akai or great bulrush *(Schoenoplectus lacustris).* Few native flowering plants were found in the lowest portions of the intertidal zone, although there may have been patches of ditchgrass or widgeon grass *(Ruppia maritima),* an aquatic flowering plant. The lowest portion of the intertidal zone was occupied primarily by algae, fungi, and sessile animals (Bishop Museum 2000).

After Western contact, several introduced species became common to abundant components of the vegetation around Pearl Harbor, but these were primarily low growing species such as California grass *(Brachiaria mutica)* and pickleweed *(Batis maritima).* During the 1930s, Hosaka (1937) described thick patches of pickleweed, a low woody much-branched shrub with fleshy, cylindrical leaves, growing along the West Loch shoreline among the 'akulikuli and kaluha.

The rapid spread of mangrove within Pearl Harbor following increased sedimentation inputs in the mid-1940s has dramatically altered the ecology of the shoreline. Open, low vegetation dominated by various sedges, herbs, and small shrubs has been replaced by dense, woody, monospecific stands of mangrove.

Other changes include degradation of water quality to severe modifications of habitats. The native ecosystem nutrient cycle has been modified by the alteration of water flow patterns and high levels of organic inputs from leaf and propagule production. In areas with restricted water flow, high nutrient inputs are the suspected cause for reduction in dissolved oxygen and water quality. Mangroves are also associated with offensive odor production (Guilbeaux and Mejia-Chang 1999). The few remaining fishponds in the Pearl Harbor area have been damaged by the mangrove thickets. Mangroves, if left unchecked, can also fill in drainage canals and streams.

The loss of mudflats and shallow water, inshore habitats by mangrove invasion is one of the factors involved in the population decline of endangered Hawaiian waterbirds such as the Ae'o or Hawaiian Stilt. The optimal nesting and foraging habitats for most of these Hawaiian waterbirds are the shallowly flooded marshes and exposed mudflats. Mangroves may also adversely impact these endangered waterbirds by providing habitat for some predators including the native 'Auku'u or Black-crowned Night Heron, and the introduced Cattle Egret, black rat, and Indian mongoose.

MANGROVE COMMUNITY AND ADJACENT VEGETATION TYPES

On the undeveloped areas along the shoreline with estuarine, intertidal habitats, mangrove is the dominant plant cover. Other plant communities are found adjacent to and inland of the dense mangrove thickets. Pickleweed marsh is found in low-lying areas behind the mangrove. Kiawe forest abuts the two fishponds and also occurs as a narrow band along the shorelines of the West Loch Branch magazine and the lower half of Waipio Peninsula. Koa haole scrub is found inland of the mangroves on the western portion of the Pearl City Peninsula. Because these adjacent plant communities or vegetation types would also be impacted by mangrove clearing and management, they were also included in the survey. The NWI code for these vegetation types is presented in parenthesis in the discussion that follows.

Mangrove Community (E2FO3N, E2SS3N)

Along the undeveloped portions of the Pearl Harbor shoreline, mangroves occur in relatively sheltered, shallow water where there are diurnal and seasonal fluctuations of flooding and salinity. These are areas with mudflats, embayments, at the mouth of streams, and around fishponds. The plants form dense stands from 20 to 40 feet (6 to 12 meters) tall; in some of the more sheltered, inland areas the trees may reach 50 to 60 feet (15 to 18 meters) in height. Under the mangroves, there is only a dense carpet of leaf litter and propagules, and exposed substrate, usually mud or coral and shell rubble.

Other species occur here in very small numbers and are found along the margins of the mangrove thickets where there is more sunlight available and less competition from the aggressive mangrove plants. Along the outer walls of Loko Paaiau Fishpond at McGrew Point, there are scattered trees of milo *(Thespesia populnea)* and small patches of pickleweed. On the inland side of most mangrove thickets a few kiawe and milo trees are usually found. Along Waiawa Stream where the salinity levels are lower, scattered thickets of hau *(Hibiscus tiliaceus),* shrubs of Indian pluchea *(Pluchea indica),* and mats of California grass *(Brachiaria mutica)* are found. The mangrove cover begins to thin out further up the stream.

Pickleweed Marsh (E2EM1N, E2EM1P, PEM1Kx)

Pickleweed *(Batis maritima),* native to coastal regions of tropical and subtropical America and the Galapagos Islands (Wagner *et al*. 1990), was first observed by Hillebrand in 1859

in the salt marshes near Honolulu (Hillebrand 1888). In the 1930s, Hosaka (1937) described thick patches of pickleweed along the West Loch shoreline growing among the 'akulikuli and kaluha sedge. Before the rapid expansion of mangrove, pickleweed was the most abundant vegetation type in the Pearl Harbor area (Char & Balakrishnan 1979).

Pickleweed prefers the same physiographic areas as mangrove, that is, estuarine situations with shallow waters. Because of its low growth form, pickleweed is quickly shaded out by the taller mangrove. Today, there are only a few remnant patches of pickle-weed (E2EMIN, E2EMIP), squeezed inland by the advancing mangrove thickets.

Dense mats of pickleweed can also be found along the margins of ponds (PEI4lKx) on the National Wildlife Refuges at Pearl City Peninsula and along the West Loch shoreline. These are non-tidal wetlands that were excavated and are artificially flooded.

Pickleweed forms a thick mat which may be 3 feet (1 meter) high in places. Like the mangrove community, there are few other plants found within the solid mats of pickleweed. Along the peripheries of the pickleweed marsh, Indian pluchea shrubs form dense thickets. In some places along the margins of the marsh, there are open areas with exposed soil; there is usually a fine film of salt on the soil surface. These areas support scattered plants of pickleweed, swollen fingergrass *(Chloris barbata),* Australian saltbush *(Atriplex semibaccata), Leptochloa uninervia,* and *Trianthema portulacastrum.*

Kiawe Forest (E2FO3P)

Kiawe forest occurs along parts of the West Loch Branch magazine and lower Waipio Peninsula on coral outcrop. The shoreline in these areas drops off steeply into deeper waters. Mangrove does not occur nor is very sparse in these areas where the shoreline is steep-sided.

The kiawe trees in most places form a closed-canopy forest; that is, the branches of the trees interlock and canopy cover is greater than 6O%. In some places on the coral outcrops facing the ocean, there are a few patches of 'ohelo kai *(Lycium sandwicense),* an indigenous spreading shrub with red, succulent berries belonging to the tomato family. Most of the plants associated with the kiawe forest, however, are introduced or alien species. Koa haole shrubs *(Leucaena leucocephala)* and clumps of buffelgrass *(Cenchrus ciliaris)* and Guinea grass *(Panicum maximum)* are common.

A variant of the kiawe forest (not on NWI map) is found inland of the mangrove community at Loko Paaiau Fishpond. It occurs as a narrow band between the mangroves and the park. Kiawe comprises about 50% or more of the tree cover while trees such as 'opiuma *(Pithcellobium dulce),* monkeypod *(Samanea saman),* milo, and coconut *(Cocos nucifera)* make up the remaining tree cover. Shrubs of koa haole, Christmas berry *(Schinus terebinthifolius),* and Indian pluchea are common to abundant.

Koa Haole Scrub

This vegetation type is not on the NWI maps as koa haole is not considered a wetland indicator species in Hawaii (Reed 1997). Koa haole is found directly inland of the mangrove community in some places on Waipio Peninsula and Pearl City Peninsula. Mangrove removal and management has been proposed for the areas around Walker Bay on Waipio Peninsula and the mouth of Waiawa Stream on Pearl City Peninsula. Koa haole scrub abuts the two sites and may be impacted by these activities.

Around Walker Bay, koa haole scrub occurs as a narrow band between the mangrove community and the overgrown cane fields. Koa haole shrubs are from 5 to 12 feet (1.5 to 4 meters) tall. In places, some of the shrubs have died back due to heavy psyllid infestation; the psyllid is a sap-sucking insect that attacks the shoots and young leaves. Robust clumps of Guinea grass, 3 to 4 feet (1 to 1.2 meters) tall, form a dense cover between the shrubs. Kiawe occurs as scattered individuals or small stands of trees. Other species observed in the koa haole scrub include Chinese violet *(Asystasia gangetica),* castor bean *(Ricinus communis),* koali çawa *(Ipomoea indica),* sourbush *(Pluchea carolinensis),* and Indian pluchea.

On Pearl City Peninsula, koa haole scrub is found bordering the mangrove community along both sides of Waiawa Stream. Along the east side of the stream, near the mouth, is a small embayment that is overgrown with mangrove. An area of open water within the mangrove thicket can be seen on the aerial photograph. In this area, the koa haole scrub is more open and low, 4 to 6 feet (1.2 to 2 meters) tall, with scattered kiawe tees. Shrubs of Indian pluchea are common. Ground cover is primarily Guinea grass and scattered patches of pitted beardgrass *(Bothriochloa pertusa),* Australian saltbush, and swollen fingergrass. There are also patches of bare, reddish-brown colored soil; these can easily be picked up on the aerial photograph.

DISCUSSION AND MANAGEMENT RECOMMENDATIONS

The shoreline vegetation on the undeveloped portions of Navy-owned lands at West Loch, Waipio Peninsula, Pearl City Peninsula, and McGrew Point is dominated by introduced species. Dense mangrove stands cover the estuarine intertidal areas. Pickleweed marsh is found in low lying areas inland of the mangrove community. Steep-sided shoreline areas support kiawe forest. In some places, a narrow band of koa haole scrub is found on the dry land behind the mangrove community.

A few native species can be found in the vegetation along the shoreline. These include 'ohelo kai *(Lycium sandwicense),* koali çawa *(Ipomoea indica),* beach naupaka or naupaka kahakai *(Scaevola sericea),* çilima *(Sida fallax),* 'uhaloa *(Waltheria indica),* and popolo *(Solanum americanum).* All of these plants are indigenous, that is, they are native to the Hawaiian Islands and elsewhere. All of the plants observed during this survey can be found in similar lowland habitats throughout Hawaii. None of the plants is a threatened and endangered species or a species of concern (U.S. Fish and Wildlife Service 1999). Botanical studies of the West Loch Branch magazine (Char and Balakrishnan 1979) and of the Waipio and Pearl City peninsulas (Traverse Group, Inc. 1991) have recorded similar findings.

While mangroves are considered to be ecologically important and valued in most coastal areas of the world, in Hawaii their value and ecological role are questionable. They are not native to Hawaii and there are adverse impacts related to mangrove establishment. Some of these negative aspects have been discussed in the earlier section of this report (see “Mangrove in Pearl Harbor”).

Management Recommendations

The complete eradication of mangrove from Navy-owned lands around Pearl Harbor is not feasible. Estimates for mangrove removal range from $100,000 to $400,000 per hectare (2.5 acres) and, even after successful removal of the adult trees, the area cleared is plagued by rapid and continued recolonization by mangrove propagules (Gauilbeaux and Mejia-Chang 1999). Given funding limitations, it would be better to focus on management strategies for the long-term control of mangroves at sensitive sites. This is the approach employed by the National Park Service at Hawaii Volcanoes National Park in their “Special Ecological Areas (SEA)” program.

Priority sites are areas of cultural value and ecological importance. Mangrove should be removed from the fishpond on Laulaunui Island in West Loch, Okiokiolepe Fishpond, and Loko Paaiau Fishpond. Restoration of Loko Paaiau Fishpond at McGrew Point could also include a Hawaiian civic club or a community group as it is easily accessible to the public. The band of kiawe forest adjacent to the mangrove and pond should also be removed. Some of the larger trees can be incorporated into the landscaping and the area grassed over. This would enlarge the existing park area and provide a clear view of the fishpond and harbor.

The U.S. Fish and Wildlife Service has recommended that the mangrove be removed around Walker Bay on Waipio Peninsula to provide shallow, open water habitat for endangered Hawaiian waterbirds. The small embayment at the mouth of Waiawa Stream is another site where mangrove could also be removed. If mangrove is removed, it is recommended that native sedges such as kaluha be planted on the mudflats. Milo trees and mats of 'akulikuli can be planted along the water's edge. This vegetation cover would decrease the movement of sediments into deeper waters and provide food and cover for foraging waterbirds.

The Navy should also consider working with the U.S. Fish and Wildlife Service in the long-term maintenance of the wildlife refuge at Pearl City Peninsula. This could be as simple as rounding up a group of volunteers to remove pickleweed and other vegetation from the refuge on a regular basis.

LITERATURE CITED

Bishop Museum. 2000. Biodiversity of freshwater and estuarine communities in lower Pearl Harbor, Oahu, Hawaii with observations on introduced species. Prepared for U.S. Navy, Department of Defense Legacy Project No. 106.

Char, W.P. and N. Balakrishnan. 1979. 'Ewa Plains botanical survey. Prepared for the U.S. Fish and Wildlife Service. Contract No. 14-16-0001-78171.

Degener, 0. 1940. Flora Hawaiiensis, family 269. *Rhizophora mangle*. Published privately, 2pp. Reprinted 1946.

Evenhuis, N.L. and S.E. Miller, eds. 1995-1998. Records of the Hawaii Biological Survey. Bishop Museum Occasional Papers Nos. 41 to 56.

Evenhuis, N.L. and L.G. Eldredge, eds. 1999. Records of the Hawaii Biological Survey. Bishop Museum Occasional Papers Nos. 58 to 59.

Guilbeaux, M.D. and M. Mejia-Chang. 1999. Invasive mangroves in Hawaii: GIS and physiological studies. Hawaiian Botanical Society Newsletter 37(4): 57-66.

Hillebrand, W. 1888. Flora of the Hawaiian Islands. Published privately. Reprinted 1981, Lubrecht & Cramer, Monticello, N.Y.

Hosaka, E.Y. 1937. Ecological and floristic studies in Kipapa Gulch, Oahu. Bishop Museum Occasional Papers 13: 175-232.

Neal, M.C. 1965. In gardens of Hawaii. Bishop Museum Press, Honolulu. Bishop Museum Special Publication 50.

Reed, P. B., Jr. 1996. National list of plant species that occur in wetlands. U.S. Fish and Wildlife Service, Washington, D.C.

Traverse Group, Inc. 1991. Natural resources management plan, Pearl Harbor Complex. Prepared for the U.S. Navy. Contract No. N62742-86-C-0538.

U.S. Fish and Wildlife Service. 1999. U.S. Fish and Wildlife Service species list, plants. March 23, 1999. Pacific Islands Ecoregion Office, Honolulu, HI.

Wagner, W.L., D.R. Herbst, and S.H. Sohmer. 1990. Manual of the flowering plants of Hawaii. 2 vols. University of Hawaii Press and Bishop Museum Press, Honolulu. Bishop Museum Special Publication 83.

PLANT SPECIES LIST -- Mangrove Community, Pearl Harbor

The following checklist is an inventory of all the plants observed during the field studies. The plant names are arranged alphabetically by families within each of two groups: Dicots, and Monocots. The taxonomy and nomenclature of the flowering plants, Dicots and Monocots, follow Wagner *et al.* (1990). The few recent name changes for the flowering plants are those reported in the Hawaii Biological Survey series (Evenhuis and Miller, eds. 1995-1998; Evenhuis and Eldredge, eds. 1999).

For each species, the following information is provided:

1. Scientific name with author citation.
2. Common English and/or Hawaiian name(s), when known.
3. Biogeographic status. The following symbols are used:
   - I = indigenous = native to the Hawaiian Islands and also elsewhere.
   - I? = questionably indigenous = data not clear if dispersal by natural or human-related mechanisms, but weight of evidence suggests probably indigenous.
   - P = Polynesian = plants originally of Polynesian introduction prior to Western contact, that is, Cook's discovery of the Hawaiian Islands in 1778.
   - X = introduced or alien = all those plants brought to the Hawaiian Islands by humans, intentionally or accidentally, after Western contact.
   - X? = questionably introduced = date of introduction unclear or very early; may be indigenous or of Polynesian origin.
4. Presence (+) or absence (-) of a particular species within each of four vegetation types recognized on the project site (see text for discussion):

   - m = Mangrove Community
   - p = Pickleweed Marsh
   - k = Kiawe Forest
   - s = Koa Haole Scrub

Scientific name	Common name	Status	Vegetation Type m	p	k	s
FLOWERING PLANTS						
DICOTS						
ACANTHACEAE (Acanthus family)						
Asystasia gangetica (L.) T. Anderson	Chinese violet, coromandel	X	-	-	+	+
AIZOACEAE (Fir-marigold family)						
Trianthema portulacastrum L.		X	-	+	+	-
AMARANTHACEAE (Amaranth family)						
Achryanthes aspera L.		X	-	-	+	-
Alternanthera pungens Kunth	khaki weed	X	-	+	-	-
ANACARDIACEAE (Mango family)						
Schinus terebinthifolius Raddi	Christmas berry	X	-	-	+	-
ASTERACEAE (Daisy family)						
Calyptocarpus vialis Less.		X	-	-	+	-
Pluchea carolinensis (Jacq.) G. Don	sourbush, pluchea	X	-	+	+	+
Pluchea X fosbergii Cooperr. & Galang	pluchea hybrid	X	+	-	-	-
Pluchea indica (L.) Less.	Indian fleabane, Indian pluchea	X	+	+	+	+
Sonchus oleraceus L.	sowthistle, pualele	X	-	+	+	-
BATIDACEAE (Saltwort family)						
Batis maritima L.	pickleweed	X	+	+	+	-
CHENOPODIACEAE (Goosefoot family)						
Atriplex semibaccata R. Br.	Australian saltbush	X	-	+	+	+

Scientific name	Common name	Status	Vegetation Type m	p	k	s
CONVOLVULACEAE (Morning glory family)						
Ipomoea indica (J. Burm.) Merr.	koali çawa, koali ‘awahia	I	-	-	-	+
Merremia aegyptia (L.) Urb.	hairy merremia, koali kua hulu	X?	-	-	-	+
EUPHORBIACEAE (Spurge family)						
Ricinus communis L.	castor bean, koli	X	-	+	-	+
FABACEAE (Pea family)						
Crotalaria incana L.	fuzzy rattlepod, kukaehoki	X	-	-	-	+
Desmanthus pernambucanus (L.) Thellung	virgate mimosa, slender mimosa	X	-	-	+	-
Leucaena leucocephala (Lam.) de Wit	koa haole	X	-	-	+	+
Pithecellobium dulce (Roxb.) Benth.	‘opiuma	X	-	-	+	-
Prosopis pallida (Humb. & Bonpl. ex Willd.) Kunth	kiawe, algaroba	X	+	+	+	+
Samanea saman (Jacq.) Merr.	monkeypod	X	-	-	+	-
Senna surattensis (N.L. Burm.) H. Irwin & Barneby	kolomona, kalamona	X	-	-	+	-
GOODENIACEAE (Goodenia family)						
Scaevola sericea Vahl	naupaka kahakai, naupaka, beach naupaka	I	-	-	+	-
LAMIACEAE (Mint family)						
Leonotis nepetifolia (L.) R. Br.	lion’s ear	X	-	-	-	+
MALVACEAE (Mallow family)						
Hibiscus tiliaceus L.	hau	I?	+	-	-	-
Malvastrum coromandelianum (L.) Garcke	false mallow	X	-	-	+	-
Sida ciliaris L.		X	-	-	+	-
Sida fallax Walp.	‘ilima	I	-	-	+	+
Thespesia populnea (L.) Sol. ex Correa	milo	I?	+	+	+	+

Scientific name	Common name	Status	Vegetation Type m	p	k	s
RHIZOPHORACEAE (Mangrove family)						
Rhizophora mangle L.	American mangrove, red mangrove	X	+	+	-	-
SOLANACEAE (Nightshade family)						
Lycium sandwicense A. Gray	‘ohelo kai, ‘ae’ae	I	-	-	+	-
Solanum americanum Mill.	popolo, glossy nightshade	I?	-	+	+	+
STERCULIACEAE (Cacao family)						
Waltheria indica L.	‘uhaloa, hi’aloa, kanakaloa	I?	-	-	+	-
TILIACEAE (Linden family)						
Triumfetta semitriloba Jacq.	Sacramento bur	X	-	-	+	-
MONOCOTS						
ARECACEAE (Palm family)						
Cocos nucifera L.	coconut, niu	P	+	-	+	-
Phoenix sp.	date palm	X	-	-	+	-
POACEAE (Grass family)						
Bothriochloa pertusa (L.) A. Camus	pitted beardgrass	X	-	-	+	+
Brachiaria mutica (Forssk.) Stapf	California grass	X	+	+	-	-
Cenchrus ciliaris L.	buffelgrass	X	-	-	+	-
Chloris barbata (L.) Sw.	swollen fingergrass, mau’u lei	X	-	+	+	+
Cynodon dactylon (L.) Pers.	Bermuda grass, manienie	X	-	+	-	-
Digitaria insularis (L.) Mez. ex Ekman	sourgrass	X	-	-	+	-
Leptochloa uninervia (K. Presl.) Hitchc. & Chase	leptochloa	X	-	+	-	-
Panicum maximum Jacq.	Guinea grass	X	+	+	+	+
Pennisetum purpureum Schumach.	Napier grass, elephant grass	X	+	-	-	-
Setaria verticillata (L.) P. Beauv.	bristly foxtail, mau’u pilipili	X	-	-	+	+
Sporobolus pyramidatus (Lam.) Hitchc.		X	-	+	-	-

A5 – BOTANICAL SURVEY OF MAKALAPA CRATER NAVAL STATION PEARL HARBOR, O‘AHU (CHAR 1999)

This page is intentionally left blank.

BOTANICAL SURVEY

MAKALAPA CRATER

NAVAL STATION PEARL HARBOR, O‘AHU

by

Winona P. Char

CHAR & ASSOCIATES
Botanical Consultants
Honolulu, Hawai‘i

Prepared for: **HELBER HASTERT & FEE**

January 1999

CONTENTS

INTRODUCTION

Makalapa Crater is one of the few areas on the Naval Station which has not been developed and still has some remaining natural resources. A survey of the botanical resources found at Makalapa Crater was conducted on 04 January 1999 for the Integrated Natural Resources Management Plan (INRMP), Naval Station Pearl harbor. The survey team consisted of two botanists.

The primary objectives of the survey were to:

1) prepare a description of the vegetation on the site;
2) inventory the flora; and
3) search for threatened and endangered species as well as species of concern.

SURVEY METHODS

Prior to the field studies, a search was made of the botanical literature pertinent to the general area. Soil maps and a colored aerial photograph were examined to determine vegetation cover patterns, terrain characteristics, access, boundaries, and reference points.

A walk-through survey method was used. Notes were made on plant associations and distribution, topography, drainage, substrate types, past and present disturbances, etc. Species which could not be positively identified were collected for later determination in the herbarium, and for comparison with the most recent taxonomic literature.

DESCRIPTION OF THE VEGETATION

An inventory of all the plant species found on the Makalapa Crater site is presented in the checklist at the end of the report.

Kiawe *(Prosopis pallida)* is the dominant plant cover on the site. On the north and east portions of the crater, the kiawe trees form a closed-canopy forest (tree cover greater than 60%) with the trees 40 to 50 feet (12 to 15 meters) tall. Scattered through this older kiawe forest are several other tree species. These include large trees of wild date palm *(Phoenix sylvestris),* monkeypod *(Samanea saman),* ‘opiuma *(Pithecellobium dulce),* sebesten plum *(Cordia dichotoma),* and yellow poinciana *(Peltophorum inerme).* In places, the sebesten plum has formed small stands of trees 15 to 20 feet (5 to 6 meters) tall; seedlings are abundant in these areas. The understory vegetation consists of scattered shrubs of koa haole *(Leucaena leucocephala),* 10 to 12 feet (3 to 4 meters) tall, and dense tufts of Guinea grass *(Panicum maximum)* and green panicgrass *(Panicum maximum* var. *trichoglume),* 2 to 3 feet (0.6 to 1 meter) tall.

On the south and west portions of the crater, the kiawe forest is open and the trees are 10 to 20 feet (3 to 6 meters) tall. This area appears to have been more recently disturbed, and the colored aerial photograph of the crater taken some years back shows more open, grassy spots; most of these now support young kiawe and ʻopiuma trees. Along the southern boundary, ʻopiuma trees are locally abundant forming rather large stands of trees, 15 to 20 feet (5 to 6 meters) tall. Thickets of koa haole shrubs are also common. In the more open areas, buffel grass *(Cenchrus ciliaris)* forms a dense mat between the woody components.

A few overgrown trails and dirt roads are found around the crater or cross through the open kiawe forest. These overgrown areas support mostly weedy annual plants such as hairy spurge *(Chamaesyce hirta),* coat buttons *(Tridax procumbens), Boerhavia coccinea,* swollen fingergrass *(Chloris barbata),* sowthistle *(Sonchus oleraceus),* and false mallow *(Malvastrum coromandelianum). Sida ciliaris,* a recently introduced weed with procumbent stems, is locally common along the overgrown crushed coral-lined road which parallels the highway.

There are a few low-lying spots which support pickleweed *(Batis maritima)* and California grass *(Brachiaria mutica);* both are wetland indicator species. The crater once supported a pond and wetland vegetation, but it has been greatly modified and its hydrology altered. Dredge material was pumped into the crater, in places 30 to 40 feet (9 to 12 meters) deep, during the construction of the naval facilities (pers. comm. B. Ching, COE). Rubble piles from demolished buildings are found on the site. Large concrete slabs, twisted rebars, chunks of asphalt paving, loose piles of boulders, tires, large pieces of rusted metal, etc., make surveying difficult.

DISCUSSION AND RECOMMENDATIONS

The vegetation within the Makalapa Crater area is dominated by introduced or alien species such as kiawe, koa haole, and buffel grass, which are typically found in disturbed, lowland sites throughout the islands. Only three native species occur on the site. These are the kauna'oa or native dodder *(Cuscuta sandwichiana),* ʻ*ilima (Sida*

fallax), and popolo *(Solanum americanum).* The kaunaʻoa is endemic, that is, it is native only to the Hawaiian Islands; the ʻilima and popolo are indigenous, that is, they are native to the islands and elsewhere.

None of the plants is a threatened or endangered species, nor is any plant a species of concern (U.S. Fish and Wildlife Service 1997). All of the plants can be found in similar environmental habitats throughout the Hawaiian Islands.

The remaining undeveloped portions of the crater would make an excellent recreational area, i.e. community gardens, jogging and bike trails, wooded park and picnic areas, but costs for cleaning out the tons of rubble may be prohibitive.

LITERATURE CITED

Evenhuis, N.L. and S.E. Miller, eds. 1995-1998. Records of the Hawaii Biological Survey. Bishop Museum Occasional Papers Nos. 41-56.

U.S. Fish and Wildlife Service, 1997. U.S. Fish and Wildlife Service species list, plants. September 25, 1997. Pacific Islands Ecoregion Office, Honolulu, HI.

Wagner, W.L., D.R. Herbst, and S.H. Sohmer. 1990. Manual of the flowering plants of Hawai'i. 2 vols. University of Hawai'i Press and B.P. Bishop Museum Press, Honolulu. B.P. Bishop Museum Special Publication 83.

PLANT SPECIES LIST

The following checklist is an inventory of all the plant species observed on the project site during the field studies. The plant names are arranged alphabetically by families within each of two groups: Dicots and Monocots. The taxonomy and nomenclature of the flowering plants follow those reported in the Hawaii Biological Survey series (Evenhuis and Miller, eds., 1995-1998).

For each species, the following information is provided:

1. Scientific name with author citation.
2. Common English and/or Hawaiian name(s), when known.
3. Biogeographic status. The following symbols are used:
   - E = endemic = native only to the Hawaiian Islands.
   - I = indigenous = native to the Hawaiian Islands and also elsewhere.
   - I? = questionably indigenous = data not clear if dispersal by natural or human-related meachisms, but weight of evidence suggests probably indigenous.
   - P? = questionably Polynesian = may be a Polynesian introduction, or possibly introduced in historical times (after 1778, Cook's discovery of the Hawaiian Islands).
   - X = introduced or alien = all those plants brought to the Hawaiian islands by humans, intentionally or accidentally, after Western contact (1778).
   - X? = questionably introduced = dates of introduction unclear; could possibly be indigenous or perhaps of Polynesian introduction.

Scientific name	Common name	Status
DICOTS		
ACANTHACEAE (Acanthus family)		
Asystasia gangetica (L.) T. Anderson	Chinese violet, coromandel	X
AIZOACEAE (Fir-marigold family)		
Trianthema portulacastrum L.		X
AMARANTHACEAE (Amaranth family)		
Alternanthera pungens Kunth	khaki weed	X
Amaranthus viridis L.	slender amaranth, pakai	X
ANACARDIACEAE (Mango family)		
Schinus terebinthifolius Raddi	Christmas berry	X
ARALIACEAE (Ginseng family)		
Schefflera actinophylla (Endl.) Harms	octopus tree, umbrella tree	X
ASTERACEAE (Daisy family)		
Ageratum conyzoides L.	maile hohono	X
Calyptocarpus vialis Less.	heirba de cabello	X
Pluchea carolinensis (Jacq.) G. Don	pluchea, sourbush	X
Pluchea indica (L.) Less.	Indian pluchea	X
Sonchus oleraceus L.	pualele, sowthistle	X
Tridax procumbens L.	coat buttons	X
BATIDACEAE (Saltwort family)		
Batis maritima L.	pickleweed, ‘akulikuli kai	X
BIGNONIACEAE (Bignonia family)		
Spathodea campanulata P. Beauv.	African tulip tree	X
Tabebuia pentaphylla (L.) Hemsl.	pink tecoma	X
BORAGINACEAE (Heliotrope family)		
Cordia dichotoma Forst. f.	sebesten plum	X
Heliotropium procumbens var. depressum (Cham.) Fosb.		X

Scientific name	Common name	Status
BRASSICACEAE (Mustard family)		
Lepidium oblongum Small		X
CONVOLVULACEAE (Morning glory family)		
Ipomoea obscura (L.) Ker-Gawl.	field bindweed	X
Ipomoea ochracea (Lindl.) G. Don		X
Ipomoea triloba L.	little bell, pink bindweed	X
Merremia aegyptia (L.) Urb.	hairy merremia, koali kua hulu	X?
CUCURBITACEAE (Gourd family)		
Coccinia grandis (L.) Voigt	coccinia, ivy gourd	X
Cucurbita pepo L.	pumpkin	X
Momordica charantia L.	wild bittermelon	X
CUSCUTACEAE (Dodder family)		
Cuscuta sandwichiana Choisy	kauna‘oa	E
EUPHORBIACEAE (Spurge family)		
Chamaecyse hirta (L.) Millsp.	hairy spurge, garden spurge	X
Chamaesyce prostrata (Aiton) Small	prostrate spurge	X
Ricinus communis L.	castor bean, koli	X
FABACEAE (Pea family)		
Acacia farnesiana (L.) Willd.	klu	X
Canavalia cathartica Thouars	maunaloa	X
Crotalaria pallida Aiton	smooth rattlepod, pikakani	X
Desmanthus pernambucanus (L.) Thellung	slender mimosa	X
Leucaena leucocephala (Lam.) de Wit	koa haole	X
Macroptilium latyroides (L.) Urb.	wild bean, cow pea	X
Medicago rugosa Desr.		X
Neonotonia wightii (Wight & Arn.) Lackey		X
Peltophorum inerme (Roxb.) Naves	yellow poinciana	X
Pithecellobium dulce (Roxb.) Benth.	‘opiuma	X
Prosopis pallida (Humb. & Bonpl. ex Willd.) Kunth	kiawe	X

Scientific name	Common name	Status
Samanea saman (Jacq.) Merr.	monkeypod	X
Senna septemtrionalis (Viv.) H. Irwin & Barneby	kolomona	X
MALVACEAE (Mallow family)		
Abutilon grandifolium (Willd.) Sweet	hairy abutilon, maʻo	X
Malvastrum coromandelianum (L.) Garcke	false mallow, hauuoi	X
Sida ciliaris L.		X
Sida fallax Walp.	çilima	I
MORACEAE (Mulberry family)		
Ficus lyrata Warb.		X
Ficus microcarpa L.f.	Chinese banyan, Malayan banyan	X
MYRTACEAE (Myrtle family)		
Syzygium cumini (L.) Skeels	Java plum	X
NYCTAGINACEAE (Four-o'clock family)		
Boerhavia coccinea Mill.		X
OXALIDACEAE (Wood sorrel family)		
Oxalis corniculata L.	yellow wood sorrel, ʻihi ʻai	P?
PASSIFLORACEAE (Passion flower family)		
Passiflora foetida L.	running pop, pohapoha	X
PHYTOLACCACEAE (Pokeweed family)		
Rivina humilis L.	coral berr, rouge plant	X
POLYGONACEAE (Buckwheat family)		
Antigonon leptopus Hook & Arnott	Mexican creeper, chain-of-hearts	X
PORTULACACEAE (Purslane family)		
Portulaca oleracea L.	pigweed, çakulikuli kula, çihi	X
Portulaca pilosa L.		X

Scientific name	Common name	Status
RUTACEAE (Citrus family)		
Murraya paniculata (L.) Jack	mock orange	X
SAPOTACEAE (Sapodilla family)		
Chrysophyllum oliviforme L.	satin leaf, caimitillo	X
SOLANACEAE (Nightshade family)		
Solanum americanum Mill.	popolo	I?
Solanum lycopersicum var. cerasiforme (Dunal) Spooner, Anderson & Jansen	currant tomato, wild tomato	X
MONOCOTS		
AGAVACEAE (Sisal family)		
Sansevieria trifasciata var. laurentii (de Wild.) N.E. Brown	bowstring hemp	X
Sansevieria zeylanica Willd.		X
ARECACEAE (Palm family)		
Phoenix sylvestris (L.) Roxb.	wild date palm	X
Roystonea sp.		X
CYPERACEAE (Sedge family)		
Cyperus alternifolius ssp. flabelliformis (Rottb.) Kukenth.	umbrella plant, ʻahuʻawa haole	X
POACEAE (Grass family)		
Brachiaria mutica (Forssk.) Stapf	California grass, Para grass	X
Cenchrus ciliaris L.	buffel grass	X
Chloris barbata (L.) Sw.	swollen fingergrass	X
Cynodon dactylon (L.) Pers.	Bermuda grass, manienie	X
Dactyloctenium aegyptium (L.) Willd.	beach wiregrass	X
Eleusine indica (L.) Gaertn.	wiregrass, goosegrass	X
Eragrostis amabilis (L.) Wight & Arnott	lovegrass	X
Eragrostis cilianensis (All.) Link	stinkgrass	X
Panicum maximum Jacq.	Guinea grass	X
Panicum maximum var. trichoglume Eyles ex Robyns	green panicgrass	X

A6 – BOTANICAL SURVEY OF RED HILL FUEL STORAGE AREA
FLEET INDUSTRIAL SUPPLY CENTER
PEARL HARBOR, O‘AHU
(CHAR 2000A)

This page is intentionally left blank.

BOTANICAL SURVEY

RED HILL FUEL STORAGE AREA
FLEET AND INDUSTRIAL SUPPLY CENTER
PEARL HARBOR, O'AHU

by

Winona P. Char

CHAR & ASSOCIATES
Botanical Consultants
Honolulu, Hawai'i

Prepared for:

HELBER HASTERT & FEE

January 2000

CONTENTS

INTRODUCTION

The Red Hill Fuel Storage Area is located on a long volcanic ridge between South Halawa and Moanalua Valleys. In 1938, the Navy realized the need for an underground fuel facility to supply its battleships and aircraft carriers. The Red Hill area was deep enough to fit the tanks and still have enough room at the top to protect it against bombings or sabotage. Twenty tanks, each 250 feet (75 meters) tall and 100 feet (30 meters) in diameter, were carved out of solid rock and the project completed in 2 years and 8 months. Red Hill was named a National Historic Civil Engineering Landmark in 1995. The fuel storage facility is still in use today, constantly monitored for leaks, and sends fuel to Pearl Harbor and Hickam Air Force Base.

The vegetation on the site is typical of most lowland habitats on 0’ahu with much of the site dominated by koa haole scrub and other introduced plants. The vegetation along the ridge top has largely recovered from past construction activities, but there are eroded areas mainly associated with the fuel storage vents.

A survey to update the 1986 botanical survey by Hawaiian Agronomics, Inc., was made on 06 January 2000: a team of two botanists was used. The 1986 study covered only the area on the south slopes and ridge top (Moanalua Valley side), from above the ball field to about 715 feet (216 meters) elevation. The present study included most of the area on the north slopes as well as the ridge top and south slopes. The primary objectives of the study were to:

1) provide a description of the vegetation on the site;
2) inventory the flora; and
3) search for threatened and endangered species as well as species of concern.

SURVEY METHODS

Prior to undertaking the field studies, a search was made of the pertinent literature to familiarize the principal investigator with other studies conducted in the general area. Topographic maps as well as a recent, colored aerial photograph were studied to determine vegetation cover patterns, terrain characteristics, access, boundaries, and reference points.

A walk-through survey was made of the undeveloped areas; no studies were conducted for the landscaped area around the water tanks or other structures. The paved and unpaved roads provided the primary access onto most of the site. The north slopes are very steep and binocular observation was used in many places. Notes were made on plant associations and distribution, substrate types, drainage, exposure, past and present disturbances, topography, etc. Plant identifications were made in the field; plants which could not be positively identified were collected for later determination in the herbarium, and for comparison with the recent taxonomic literature.

DESCRIPTION OF THE VEGETATION

Five major vegetation types are recognized on the Red Hill Fuel Storage Area. Koa haole scrub covers the most area and occurs on gently sloping to somewhat steep slopes. An open, mixed scrub composed of various grasses and scattered small clumps of koa haole, waiawi, and several other shrubs and small trees occurs on the somewhat broad and gently sloping ridge top. The southeast slopes on the Moanalua Valley side support dense thickets of Christmas berry shrubs, while the steeper slopes on the northeast (Halawa Valley side) are covered by an open waiawi scrub. Ruderal vegetation composed primarily of weedy, mostly annual, plants is found as a narrow band along the paved and unpaved roads.

An inventory of all the plants observed during the field studies is presented in the checklist at the end of the report.

Koa Haole Scrub

On the more gently sloping portions of the storage area, especially on the lower eastern half of the site, the koa haole shrubs *(Leucaena leucocephala)* form a tall, dense cover up to 20 feet (6 meters) tal**l**. In these more protected areas and with somewhat deeper soil, the ground cover is primarily Guinea grass *(Panicum maximum)* with smaller localized patches of Chinese violet *(Asystasia gangetica).* On the more steeply sloping, exposed areas, koa haole cover is more open and the shrubs 10 to 15 feet (3 to 5 meters) tall. On some slopes above Icarus Road, there are dense patches of Guinea grass with scattered, low koa shrubs, 4 to 6 feet (1 to 2 meters) tall; these areas appear to have been disturbed in the past.

Scattered throughout the koa haole scrub are small stands of trees, 20 to 40 feet (6 to 12 meters) tall. There are some rather large Chinese banyan trees *(Ficus microcarpa)*

and trees of silk oak *(Grevillea robusta)* are abundant. Other trees occurring here in smaller numbers include Chinaberry *(Melia azedarach),* octopus tree *(Schefflera actinophylla),* autograph tree *(Clusia rosea),* and Java plum *(Syzygium cumini).*

Numerous rock outcroppings are found along the slopes, especially on the Halawa Valley side. These provide habitat for ferns such as the native kumuniu *(Doryopteris decipeins),* lichens (mostly *Parmelia* species), a native peperomia *(Peperomia leptostachya),* and the native spurflower *(Plectranthus parviflorus).*

Mixed Grass/Shrub Vegetation

This vegetation type is found on the ridge top on the more gently sloping areas. In the 1986 Hawaiian Agronomics, Inc., study, the vegetation type in this area was mapped as “grassland,” composed of various grass species and scattered shrubs. The present study finds that much of the open grassy sections have since been colonized by shrubs such as koa haole, waiawi *(Psidium cattleianum* var. *littorale),* lantana *(Lantana camara)* and Christmas berry *(Schinus terebinthifolius),* and a few trees of Java plum and silk oak. The woody components now comprise about 40 to 50% of the plant cover, while the grasses cover about 50 to 60% of the area. Shrub height ranges between 6 to 15 feet (2 to 5 meters), while the trees are from 20 to 25 feet (6 to 8 meters) tall.

The grass cover is variable with large, robust clumps of Guinea grass, 6 to 7 feet (1.8 to 2 meters) tall, found mainly along the dirt road. Scattered mats and clumps of golden beardgrass or pilipili-’ula *(Chrysopogon aciculatus),* molasses grass *(Melinis minutiflora),* Natal redtop *(Melinis repens),* pitted beardgrass *(Bothriochloa pertusa),* and broomsedge *(Andropogon virginicus)* tend to occur on the areas with more exposed soil. Several herbaceous species and small shrubs or subshrubs are locally common; these include Spanish clover *(Desmodium incanum),* ‘uhaloa *(Waltheria indica),* partridge pea *(Chamaecrista nictitans),* and Jamaica vervain *(Stachytarpheta jamaicensis).*

Besides ‘uhaloa and golden beardgrass, a few other native species are also associated with the mixed grass/shrub vegetation type. ‘Ulei *(Osteomeles anthyllidifolia),* a shrubby member of the rose family which forms low woody tangles 3 to 5 feet (1 to 1.5 meters) high, is common on the ridge top. A few koa trees *(Acacia koa)* are found at about the 700-foot (212-meter) elevation, near the mauka boundary. Shrubs of ‘akia *(Wikstroemia oahuensis),* alahe’e *(Psydrax odoratum),* and ‘a’ali’i *(Dodonaea viscosa)* are also found on the mauka portion of the ridge, past the water tanks. Huehue vines *(Cocculus orbiculatus)* are uncommon.

Christmas Berry Scrub

This vegetation type is found on the lower slopes facing Moanalua Valley. The Christmas berry shrubs form dense thickets excluding most other plants. Christmas berry is known to be allelopathic, that is, it produces compounds in its leaves and roots which restrict the germination and growth of other plant species (Smith 1985; Stone *et al.* 1992).

As a result, there are few other plants found in the understory. Other species tend to occur along the margins of the Christmas berry scrub or where there are openings in the scrub such as on rocky outcroppings or eroded areas. California grass *(Brachiaria mutica)* is locally abundant in the area where the mixed grass/ shrub vegetation type interfaces the Christmas berry scrub. Openings in the Christmas berry scrub support shrubs of koa haole, sourbush *(Pluchea carolinensis)* and strawberry guava *(Psidium cattleianum),* and a few trees of Java plum, Chinese banyan, and silk oak.

Waiawi Scrub

Waiawi *(Psidium cattleianum* var. *littorale)* is a solitary, large shrub to small tree, and, unlike strawberry guava, does not form dense stands which often sucker at the base. This yellow-fruited variety of strawberry guava from tropical America has ellipsoidobconical (football-shaped) fruits and is common to abundant on the upper, mauka slopes facing South Halawa Valley.

Waiawi scrub is open, often sharing some of the same components found in the adjoining mixed grass/shrub vegetation type. Christmas berry shrubs are common to occasional throughout the waiawi scrub, while koa haole and small stands of silk oak trees are more numerous along the lower boundaries of this vegetation type. The open areas between the shrubs support a mix of grasses and smaller shrubs and herbs. Low clumps of ‘ulei and a few ‘a’ali’i shrubs are occasionally found in the open areas along the slopes.

Ruderal Vegetation

Ruderal or weedy roadside vegetation occurs along the paved and unpaved roads throughout the storage facility. In many places, these roadside areas are periodically

maintained. It occurs as a narrow band, 3 to 6 feet (1 to 2 meters) wide, and is too small to map at the scale used in this study.

Ruderal vegetation consists largely of annual herbaceous species and various grasses. On this site, the most commonly occurring grasses are Bermuda grass *(Cynodon dactylon),* Guinea grass, Indian dropseed *(Sporobolus diander),* and lovegrass *(Eragrostis amabilis).* Three perennial herbs which form large, low mats alongside the roads are creeping indigo *(Indigofera spicata), Heliotropium procumbens* var. *depressum,* and *Sida ciliaris.* A number of the weedy annuals are seasonal and occur in larger numbers or only during the wetter months; these include common mouse-ear chickweed *(Cerastium fontanum),* Australian brass buttons *(Cotula australis),* oriental hawksbeard *(Youngia japonica),* purple cudweed *(Gamachaeta purpurea),* and artillery plant *(Pilea microphylla).*

DISCUSSION AND RECOMMENDATIONS

Portions of the Red Hill Fuel Storage Area were extensively disturbed during the construction of the underground storage tanks, but the vegetation has reestablished itself throughout most of the disturbed sections. Prior to the Navy’s use of Red Hill, the property may have been used for grazing cattle (The Traverse Group, Inc. 1991).

Introduced or alien plants are the dominant components in each of the five vegetation types recognized on the site. Much of the site is covered by koa haole scrub with smaller areas on the mauka slopes covered by Christmas berry scrub and waiawi scrub. The vegetation on the ridge top is composed of a mixture of various grass and shrub species. In some places, there are remnant patches of grasses such as pangola grass *(Digitaria pentzii),* St. Augustine grass *(Stenotaphrum secundatum),* and Bermuda grass which were probably planted there during the revegetation efforts following construction of the fuel tanks. Ruderal vegetation occupies only a small area along the roadsides.

A total of 125 plant species were inventoried on the fuel storage area. Of these, 110 (88%) are introduced; one (1%) is thought to be of Polynesian introduction; and 14 (11%) are native. Eleven of the native species are indigenous, that is, they are native to the Hawaiian Islands and elsewhere. Three are endemic, that is, they are native only to the Hawaiian Islands. The endemic plants are the kumuniu fern *(Doryopteris decipiens),* koa *(Acacia koa),* and ‘akia shrub *(Wikstroemia oahuensis).* None of the plants found during this study or the earlier Hawaiian Agronomics study is a threatened and endangered species or a species of concern (U.S. Fish and Wildlife Service 1999).

The earlier studies for the management of the natural resources on this site (Hawaiian Agronomics, Inc. 1986; The Traverse Group, Inc. 1991) recommended that the vegetation not be disturbed and left intact. The existing plant cover prevents soil loss and provides watershed protection.

Over the years, plant cover has reclaimed most of the disturbed areas along the ridge top, but there are still places with bare soil, especially around the vents near the water tanks. These eroded portions should be replanted if funding becomes available; Bermuda grass was recommended in the 1991 study.

LITERATURE CITED

Evenhuis, N.L. and S.E. Miller, eds. 1995-1999. Records of the Hawaii Biological Survey. Bishop Museum Occasional Papers. Nos. 41-60.

Hawaiian Agronomics, Inc. 1986. Final report for flora, fauna and water resources survey of the Pearl Harbor Area Facilities, Hawaii—Red Hill Fuel Storage Area. Naval Facilities Engineering Command, Pearl Harbor, Hawaii.

Lamoureux, C.H. 1988. Draft checklist of Hawaiian pteridophytes, “Kupukupu 0 Hawai’i Ne’i.” Lyon Arboretum, University of Hawai’i, Manoa.

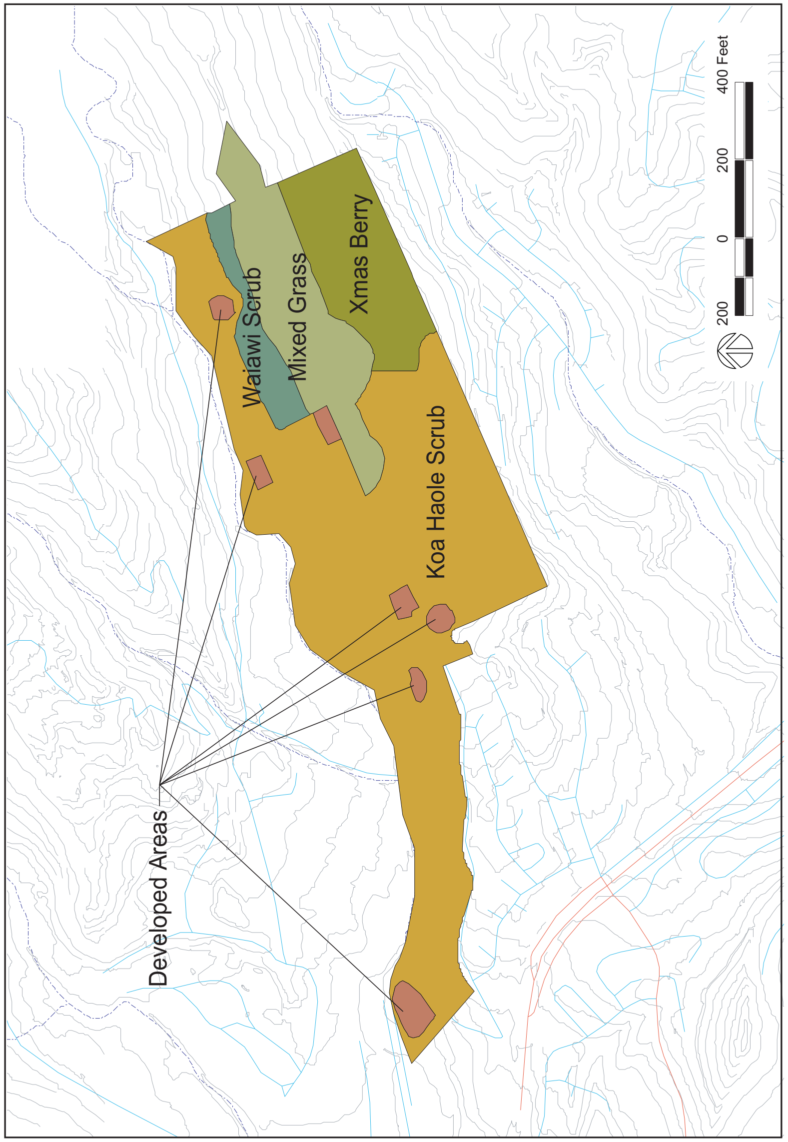
Smith, C.W. 1985. Impact of alien plants on Hawai’i’ s native biota. In: Hawai’i’s terrestrial ecosystems: preservation and management, eds. C.P. Stone and J.M. Scott, pp. 180-250. University of Hawai’i Cooperative Nationa1 Park Resources Studies Unit. University of Hawai’i Press, Honolulu.

Stone, C.P., C.W. Smith, and J.T. Tunison, eds. 1992. Alien plant invasions in native ecosystems of Hawai’i: management and research. University of Hawai’i Cooperative National Park Resources Studies Unit. University of Hawai’i Press, Honolulu.

The Traverse Group, Inc. 1991. Natural resources management plan, Pearl Harbor Complex. Contract No. N62742-86-C-0538.

U.S. Fish and Wildlife Service. 1999. U.S. Fish and Wildlife Service species list, plants. March 23, 1999. Pacific Islands Ecoregion Office, Honolulu, HI.

Wagner, W.L., D.R. Herbst, and S.H. Sohmer. 1990. Manual of the flowering plants of Hawai’i. 2 vols. University of Hawai’i Press and Bishop Museum Press, Honolulu. Bishop Museum Special Publication 83.



Red Hill Vegetation
Pearl Harbor INRMP

PLANT SPECIES LIST

The following checklist is an inventory of the plants observed during the field studies. The plant names are arranged alphabetically by families within each of three groups: Ferns, Dicots, and Monocots. The taxonomy and nomenclature of the Ferns follow Lamoureux (1988), while the flowering plants, Dicots and Monocots, are in accordance with Wagner *et al.* (1990). The few recent name changes for the flowering plants follow those reported in the Hawaii Biological Survey series (Evenhuis and Miller, 1995-1999). An asterisk (*) before a plant name indicates that the species was found during this study but not in the earlier studies (Hawaiian Agronomics, Inc. 1986; The Traverse Group, Inc. 1991).

For each species, the following information is provided:

1. Scientific name with author citation.
2. Common English and/or Hawaiian name(s), when known.
3. Biogeographic status. The following symbols are used:

E = endemic = native only to the Hawaiian Islands.

I = indigenous = native to the Hawaiian Islands and also elsewhere.

I? = questionably indigenous = data not clear if dispersal by natural or human-related mechanisms, but weight of evidence suggests probably indigenous.

P = Polynesian = plants originally of Polynesian introduction prior to Western contact, that is, Cook's discovery of the Hawaiian Islands in 1778.

P? = questionably Polynesian = may be a Polynesian introduction or possibly introduced in historical times (shortly after 1778).

X = introduced or alien = all those plants brought to the Hawaiian Islands by humans, intentionally or accidentally, after Western contact.

X? = questionably introduced = date of introduction unclear or very early, could possibly be indigenous or perhaps of Polynesian introduction.

4. Presence (+) or absence (-) of a particular species within each of five vegetation types recognized within the study area (see text for discussion):

k = Koa Haole Scrub

m = Mixed Grass/Shrub Vegetation

c = Christmas Berry Scrub

w = Waiawi Scrub

r = Ruderal Vegetation

Scientific name	Common name	Status	Vegetation Type k	m	c	w	r
FERNS							
LINDSAEACEAE (Lace fern family)							
*Sphenomeris chinensis (L.) Maxon	pala'a, pala pala'a	I	-	+	-	+	-
NEPHROLEPIDACEAE (Swordfern family)							
Nephrolepis multiflora (Roxb.) Jarrett ex Morton	hairy swordfern, ʻokupukupu	X	-	+	-	-	-
POLYPODIACEAE (Common fern family)							
*Phlebodium aureum (L.) J. Sm.	laua'e haole	X	+	-	-	-	-
*Phymatosorus scolopendria (Burm.) Pic.-Ser.	maile-scented fern, laua'e	X	+	-	-	-	-
SINOPTERIDACEAE (Cliffbrake family)							
*Doryopteris decipiens (Hook) J. Sm.	kumuniu, ʻiwa'iwa	E	+	-	-	-	-
*Pellaea viridis (Forsk.) Prantl	cliffbrake	X	+	-	-	-	-
FLOWERING PLANTS							
DICOTS							
ACANTHACEAE (Acanthus family)							
Asystasia gangetica (L.) T. Anderson	Chinese violet, coromandel	X	+	-	-	-	+
ANACARDIACEAE (Mango family)							
Schinus terebinthifolius Raddi	Christmas berry	X	+	+	+	+	+

Scientific name	Common name	Status	Vegetation Type k	m	c	w	r
APIACEAE (Parsley family)							
Centella asiatica (L.) Urb.	Asiatic pennywort, pohe kula	X	-	+	-	-	+
ARALIACEAE (Ginseng family)							
Schefflera actinophylla (Endl.) Harms	octopus tree	X	+	+	-	-	-
ASTERACEAE (Daisy family)							
*Ageratum conyzoides L.	maile hohono	X	+	-	-	-	+
Bidens pilosa L.	Spanish needle, ki, ki nehe	X	-	+	-	-	+
Calyptocarpus vialis Less.		X	-	-	-	-	+
*Cotula australis (Sieber ex Spreng.) J.D. Hook.	Australian brass buttons	X	-	-	-	-	+
Cyanthillium cinereum (L.) H. Rob.	little ironweed	X	-	+	-	-	-
Emilia fosbergii Nicolson	pualele	X	+	+	-	+	+
*Gamachaeta purpurea (L.) Cabr.	purple cudweed	X	-	-	-	-	+
Pluchea carolinensis (Jacq.) G. Don	sourbush, pluchea	X	+	+	+	+	+
Pluchea indica (L.) Less.	Indian fleabane	X	-	-	-	-	+
Sonchus oleraceus L.	sowthistle, pualele	X	+	+	-	+	-
Tridax procumbens L.	coat buttons	X	-	-	-	-	+
*Youngia japonica (L.) DC	oriental hawskbeard	X	-	-	-	-	+
BIGNONIACEAE (Bignonia family)							
Macfadyena unguis-cati (L.) A. Gray	cat's-claw climber	X	+	-	-	-	-
*Spathodea campanulata P. Beauv.	African tulip tree	X	+	-	-	-	-
Tabebuia pentaphylla (L.) Hemsl.	pink tecoma	X	+	-	-	-	-
BORAGINACEAE (Borage family)							
Heliotropium procumbens var. depressum (Cham.) Fosb.		X	-	-	-	-	+

			Vegetation Type				
Scientific name	Common name	Status	k	m	c	w	r
BUDDLEIACEAE (Butterfly bush family)							
Buddleia asiatica Lour.	dog tail, huelo ‘ilio	X	-	+	-	-	+
CACTACEAE (Cactus family)							
*Opuntia ficus-indica (L.) Mill.	panini, papipi	X	+	-	-	-	-
CARYOPHYLLACEAE (Pink family)							
*Cerastium fontanum ssp. triviale (Link) Jalas	common mouse-ear chickweed	X	-	-	-	-	+
CASUARINACEAE (She-oak family)							
Casuarina sp.	ironwood	X	-	+	-	-	-
CLUSIACEAE (Mangosteen family)							
*Clusia rosea Jacq.	autograph tree, copey, Scotch attorney	X	+	-	-	-	-
CONVOLVULACEAE (Morning glory family)							
*Ipomoea cairica (L.) Sweet	koali	X?	+	-	-	-	-
*Ipomoea obscura (L.) Ker-Gawl.	field bindweed	X	-	-	-	-	+
Ipomoea triloba L.	little bell	X	-	-	-	-	+
CUCURBITACEAE (Gourd family)							
*Coccinia grandis (L.) Voigt	ivy gourd, coccinia	X	+	-	-	-	-
EUPHORBIACEAE (Spurge family)							
Chamaesyce hirta (L.) Millsp.	hairy spurge, garden spurge	X	-	+	-	+	+
Chamaesyce hypericifolia (L.) Millsp.	graceful spurge	X	-	+	-	-	+
*Chamaesyce prostrata (Aiton) Small	prostrate spurge	X	-	-	-	-	+
*Euphorbia cyathophora J.A. Murray	wild poinsettia	X	-	+	-	-	-

Scientific name	Common name	Status	Vegetation Type k	m	c	w	r
FABACEAE (Pea family)							
Acacia confusa Merr.	Formosan koa	X	-	+	-	-	-
*Acacia farnesiana (L.) Willd.	klu	X	+	-	-	-	-
Acacia koa A. Gray	koa	E	-	+	-	-	-
*Alysicarpus vaginalis (L.) DC	alysicarpus	X	-	-	-	-	+
Chamaecrista nictitans (L.) Moench	partridge pea, lauki	X	-	+	-	+	+
Crotalaria pallida Aiton	smooth rattlebox, pikakani	X	-	+	-	+	+
Desmanthus pernambucanus (L.) Thellung	virgate mimosa	X	-	+	-	+	+
Desmodium incanum DC	Spanish clover, ka'imi	X	-	+	+	+	+
*Desmodium tortuosum (Sw.) DC	Florida beggarweed	X	-	-	-	-	+
Desmodium triflorum (L.) DC	three-flowered beggarweed	X	-	+	-	+	+
*Indigofera spicata Forssk.	creeping indigo	X	-	-	-	-	+
Indigofera suffruticosa Mill.	indigo, 'iniko	X	+	+	-	+	-
Leucaena leucocephala (Lam.) de Wit	koa haole	X	+	+	+	+	+
Mimosa pudica var. unijuga (Duchass. & Walp.) Griseb.	sensitive plant, sleeping grass, pua hilahila	X	-	+	-	+	+
Willd.) Kunth	kiawe	X	+	-	-	-	-
Samanea saman (Jacq.) Merr.	monkeypod	X	+	-	-	-	-
*Senna pendula (Humb. & Bonpl. ex Willd.) H. Irwin & Barneby		X	-	+	-	-	-
Senna surattensis (N.L. Burm.) H. Irwin & Barneby	kolomona, kalamona	X	+	-	-	-	-
LAMIACEAE (Mint family)							
*Hyptis pectinata (L.) Poit.	comb hyptis	X	+	-	+	+	-
*Plectranthus parviflorus Willd.	spurflower, 'ala'ala wai nui pua ki	I	+	-	-	-	-
-							
MALVACEAE (Mallow family)							
*Malvastrum coromandelianum (L.) Garcke	false mallow	X	-	-	-	-	+

			Vegetation Type				
Scientific name	Common name	Status	k	m	c	w	r
*Sida ciliaris L.		X	-	-	-	-	+
*Sida rhombifolia L.	Cuba jute	X	-	-	-	-	+
MELIACEAE (Mahogany family)							
*Melia azedarach L.	Chinaberry, pride of India, ‘inia	X	+	-	-	+	-
MENISPERMACEAE (Moonseed family)							
*Cocculus orbiculatus (L.) DC	huehue, hue	I	-	+	-	-	-
MORACEAE (Mulberry family)							
Ficus microcarpa L.f.	Chinese banyan	X	+	+	+	-	-
MYRTACEAE (Myrtle family)							
Psidium cattleianum Sabine	strawberry guava	X	+	+	+	+	+
Psidium cattleianum var. litorale (Raddi) Fosb.	waiawi	X	+	+	+	+	-
Psidium guajava L.	guava, kuawa	X	+	+	-	+	-
Syzygium cumini (L.) Skeels	Java plum	X	+	+	-	+	-
OXALIDACEAE (Wood sorrel family)							
*Oxalis corniculata L.	yellow wood sorrel, ‘ihi ‘ai	P?	-	-	-	-	+
PASSIFLORACEAE (Passion flower family)							
Passiflora edulis forma flavicarpa Degener	liliko’i	X	-	+	-	-	-
Passiflora foetida L.	running pop, pohapoha	X	+	+	+	-	-
Passiflora suberosa L.	huehue haole	X	+	+	+	+	-
PHYTOLACCACEAE (Pokeweed family)							
*Rivina humilis L.	coral berry	X	+	-	-	-	-

Scientific name	Common name	Status	Vegetation Type k	m	c	w	r	
PIPERACEAE (Pepper family)								
*Peperomia leptostachya Hook & Arnott	‘ala’ala wai nui	I	+	-	-	-	-	
PORTULACACEAE (Purslane family)								
Portulaca oleracea L.	pigweed, ‘akulikuli kula, ’ihi	X	-	+	-	-	+	Por
PROTEACEAE (Protea family)								
Grevillea robusta A. Cunn. ex R. Br.	silk oak, ‘oka kalika	X	+	+	+	+	-	
ROSACEAE (Rose family)								
Osteomeles anthyllidifolia (Sm.) Lindl.	‘ulei, u’ulei	I	-	+	-	+	-	
RUBIACEAE (Coffee family)								
Paederia foetida L.	maili-pilau	X	-	-	+	-	-	
Psydrax odoratum (G. Forster) Seem	alahe’e, walahe’e	I	-	+	-	-	-	
Spermacoce assurgens Ruiz & Pav.	buttonweed	X	-	+	-	-	+	
SAPINDACEAE (Soapberry family)								
Dodonaea viscosa Jacq.	‘a’ali’i	I	+	+	+	+	-	
SOLANACEAE (Nightshade family)								
*Solanum lycopersicum var. cerasiforme (Dunal) Spooner, Anderson & Jansen	currant tomato, wild tomato	X	+	-	-	-	+	
STERCULIACEAE (Cacao family)								
Waltheria indica L.	‘uhaloa, hi’aloa, kanakaloa	I?	-	+	-	+	+	
THYMELAEACEAE (‘Akia family)								
*Wikstroemia oahuensis (A. Gray) Rock	‘akia	E	-	+	-	-	-	

Scientific name	Common name	Status	Vegetation Type k	m	c	w	r
URTICACEAE (Nettle family)							
*Pilea microphylla (L.) Liebm.	artillery plant	X	-	-	-	-	+
VERBENACEAE (Verbena family)							
Lantana camara L.	lantana, lakana	X	+	+	+	+	-
Stachytarpheta jamaicensis (L.) Vahl	Jamaica vervain, owi, oi	X	-	+	-	-	+
Stachytarpheta urticifolia (Salisb.) Sims	nettle-leaved vervain, owi, oi	X	+	+	+	+	+
MONOCOTS							
ARECACEAE (Palm family)							
Phoenix sylvestris (L.) Roxb.	wild date palm	X	+	-	-	-	-
CYPERACEAE (Sedge family)							
*Cyperus gracilis R. Br.	McCoy grass	X	-	-	-	-	+
ORCHIDACEAE (Orchid family)							
*Arundina graminifolia (D. Don) Hochr.	bamboo orchid	X	-	+	-	-	-
Spathoglottis plicata Blume	Philippine ground orchid, Malayan ground orchid	X	-	+	-	+	-
POACEAE (Grass family)							
Andropogon virginicus L.	broomsedge	X	-	+	-	+	-
Axonopus fissifolius (Raddi) Kuhlm.	narrow-leaved carpetgrass	X	-	+	-	+	+
Bothriochloa pertusa (L.) A. Camus	pitted beardgrass	X	-	+	-	-	+
Brachiaria mutica (Forssk.) Stapf	California grass	X	+	-	+	+	-
Cenchrus echinatus L.	common sandbur, ‘ume ‘alu	X	-	-	-	-	+
Chloris barbata (L.) Sw,	swollen fingergrass, mau’u lei	X	+	+	-	-	+
Chloris divaricata R. Br.	stargrass	X	-	-	-	-	+

Scientific name	Common name	Status	Vegetation Type k	m	c	w	r
Chrysopogon aciculatus (Retz.) Trin.	golden beardgrass, pilipili'ula	I?	-	+	-	+	+
Cynodon dactylon (L.) Pers.	Bermuda grass, manienie	X	-	+	-	+	+
*Dactyloctenium aegyptium (L.) Willd.	beach wiregrass	X	-	-	-	-	+
Dichanthium sp.		X	-	+	-	-	+
*Digitaria ciliaris (Retz.) Koeler	Henry's crabgrass	X	-	-	-	-	+
Digitaria insularis (L.) Mez ex Ekman	sourgrass	X	-	+	-	-	-
Digitaria setigera Roth	kukaepua'a, itchy crabgrass	I?	-	-	+	-	-
*Ehrhata sp.		X	-	-	-	-	+
Eleusine indica (L.) Gaertn.	wiregrass, goosegrass	X	-	-	-	-	+
Eragrostis amabilis (L.) Wight & Arnott	lovegrass	X	-	-	-	-	+
Eragrostis sp.		X	-	-	-	-	+
Melinis repens (Willd.) Zizka	Natal redtop, Natal grass	X	+	+	+	+	+
Panicum maximum Jacq.	Guinea grass	X	+	+	+	+	+
*Paspalum fimbriatum Kunth	Panama paspalum, fimbriate paspalum	X	-	-	-	-	+
Paspalum scrobiculatum L.	ricegrass, mau'u, laiki	I?	-	+	-	+	+
Pennisetum polystachion (L.) Schult.	feathery pennisetum	X	-	+	-	-	-
Pennisetum purpureum Schumach.	napier grass, elephant grass	X	-	+	-	-	-
Setaria gracilis Kunth	yellow foxtail, perrenial foxtail, mau'u Kaleponi	X	-	+	-	-	+
*Sporobolus diander (Retz.) P. Beauv.	Indian dropseed	X	-	-	-	-	+
Sporobolus indicus (L.) R. Br.	Indian dropseed, rattail grass	X	-	-	-	-	+
Stenotaphrum secundatum (Walt.) Ktze.	St. Augustine grass	X	-	+	-	-	+
*Themeda villosa (Poir.) A. Camus	Lyon's grass	X	-	+	-	-	-

A7 – BOTANICAL SURVEY OF WAIAWA WATERSHED PUBLIC WORKS CENTER PEARL HARBOR, O‘AHU (CHAR 2000B)

This page is intentionally left blank.

BOTANICAL SURVEY

WAIAWA WATERSHED
PUBLIC WORKS CENTER PEARL HARBOR, O'AHU

by

Winona P. Char

CHAR & ASSOCIATES
Botanical Consultants
Honolulu, Hawai'i

Prepared for:

HELBER HASTERT & FEE

January 2000

CONTENTS

INTRODUCTION

The Waiawa Watershed consists of approximately 75 acres (30 hectares) of land located in the lower reaches of Waiawa Valley, adjacent to the Pearl City Industrial Park. Steep gulch walls characterize the east and west portions of the site. The more or less gently sloping valley floor consists of an alluvial terrace into which the Waiawa Stream has cut a channel 10 to 15 feet (3 to 5 meters) lower. Waimano Stream joins Waiawa Stream on the southern portion of the property.

Field studies were made on 02 December 1999 to assess the botanical resources on the site and also to update the plant inventory list compiled during the earlier flora study by Hawaiian Agronomics, Inc. in 1986. The survey team consisted of two botanists. The primary objectives of the field survey were to:

1) prepare a general description of the vegetation on the site;
2) inventory the flora; and
3) search for threatened and endangered species as well as species of concern.

SURVEY METHODS

Prior to undertaking the field studies, a search was made of the pertinent literature to familiarize the principal investigator with other botanical studies conducted in the area. Topographic maps as well as a recent, colored aerial photograph were examined to determine vegetation cover patterns, terrain characteristics, access, boundaries, and reference points.

A walk-through survey method was used on the undeveloped portions of the site; no studies were conducted for the landscaped area around the pumping station. Notes were made on plant associations and distribution, substrate types, drainage, exposure, past and present disturbances, topography, etc. Plant identifications were made in the field; plants that could not be positively identified were collected for later determination in the herbarium, and for comparison with the most recent taxonomic literature.

DESCRIPTION OF THE VEGETATION

Five major vegetation types are recognized on the Waiawa Watershed parcel. The steep gulch walls with numerous rock outcroppings support low statured koa haole scrub. A taller, more dense type of koa haole scrub is found at the base of the steep walls and along the valley floor. On the eastern slopes, below the Pacific Palisades subdivision, a savanna vegetation composed of dense Guinea grass and scattered trees and shrubs is found. Dense forests composed primarily of Java plum, along with several other tree species in smaller numbers, occur along the sides of both streams. The valley floor also supports smaller areas dominated by Guinea grass grasslands and ruderal vegetation, which occurs as a narrow, weedy band along the paved and unpaved roads.

An inventory of the plant species found in each of these vegetation types is presented in the checklist at the end of the report. A vegetation map is also found at the end of the report; the ruderal vegetation was not mappable at this scale.

Koa Haole Scrub

This vegetation covers the most area on the study site, roughly 44 acres (17.6 hectares). Two variants of the koa haole scrub are recognized on the Waiawa Watershed property. On the steep walls, the koa haole shrubs *(Leucaena leucocephala)* form an open-canopied, low-statured scrub, 3 to 10 feet (1 to 3 meters) tall. A few widely scattered trees of Java plum *(Syzygium cumini)*, kiawe *(Prosopis pallida)*, ‘opiuma *(Pithecellobium dulce)*, and Chinese banyan *(Ficus microcarpa)* are found on the steep walls. Guinea grass *(Panicum maximum)* forms a somewhat dense cover between the woody elements on the west wall, while a mix of Guinea grass and sourgrass *(Digitaria insularis)* patches is more typical of the east wall. Rocky outcrops are numerous and support a number of different species, especially during the wetter months from about November through March. Plants of *Portulaca pilosa,* maile hohono *(Ageratum conyzoides),* pigweed *(Portulaca oleracea),* ‘uhaloa *(Waltheria indica),* and cliffbrake fern *(Pellaea viridis)* are locally common and form good-sized patches. Other plants associated with these outcroppings include periwinkle *(Catharanthus roseus),* Natal redtop grass *(Melinis repens),* lantana *(Lantana camara),* klu *(Acacia farnesiana),* Chinese violet *(Asystasia gangetica),* comb hyptis *(Hyptis pectinata),* and coat buttons *(Tridax procumbens).* Native species associated with these rocky areas are pili grass *(Heteropogon contortus),* ‘a’ali’i *(Dodonaea viscosa),* popolo *(Solanum americanum),* ‘ala’ala wai nui *(Peperomia leptostachya),* and ‘uhaloa.

Tall koa haole scrub, 12 to 20 feet (4 to 6 meters) high, is found on the valley floor in areas with deeper soil and in some places at the base of the steep gulch walls. Guinea grass forms a very dense cover, up to 8 feet (2.5 meters) tall, between the

shrubs. This type of koa haole scrub is found where several rows of large, U-shaped concrete forms are stored. Tall koa haole shrubs and a few scattered trees are found between the concrete forms, while dense Guinea grass mats occupy the area between the rows. This “storage area” is easily identified on the colored aerial photographs of the site.

Java Plum/Mixed Forest

This vegetation type covers roughly 23 acres (9.2 hectares) of the study site and is found on the valley floor bordering the streams. Java plum is the most abundant tree, especially closer to the stream banks. Other tree species which occur here in smaller numbers as scattered individuals or small stands of trees include macaranga *(Macaranga tanarius),* albizia *(Paraserianthes falcataria),* mango *(Mangifera indica),* octopus tree *(Schefflera actinophylla),* African tulip *(Spathodea campanulata),* monkeypod *(Samanea saman),* and Chinese banyan. Tree height varies from 40 to 60 feet (12 to 18 meters) and the canopy cover is closed (tree canopy cover greater than 60%).

The understory is deeply shaded and supports saplings of the tree species mentioned above as well as shrubs of guava *(Psidium guajava)* and koa haole. Ground cover is patchy and consists of seedlings of the woody components and more shade-tolerant species such as basketgrass *(Oplismenus hirtellus),* coral berry *(Rivina humilis),* blechnum fern *(Blechnum occidentale),* and hairy sword-fern *(Nephrolepis multiflora).*

A number of species more commonly used as landscape plantings or ornamentals have escaped cultivation, probably from the nearby subdivision, and have established small populations within the Java plum/mixed forest areas. These include asparagus fern *(Asparagus setaceus),* rabbit’s foot fern *(Davallia fejeensis),* allspice *(Pimenta dioica),* Mickey Mouse plant *(Ochna thomasiana),* mock orange *(Murraya paniculata),* Victorian box *(Pittosporum undulatum),* and fern tree *(Filicium decipiens).* A few of the Victorian box and fern trees are 25 to 30 feet (8 to 11 meters) tall.

Guinea Grass Grassland

This vegetation type covers about 3 acres (1.2 hectares) of the Waiawa site and is found on the valley floor adjacent to the paved road. It appears to have been bulldozed in the past and there are low mounds of soil in a more recently disturbed area. Guinea grass forms robust clumps, 4 to 6 feet (1 to 2 meters) tall; grass cover is 90 to 95%.

There are a few koa haole shrubs scattered through the grassland, but these tend to occur along the margins of the grassland where it interfaces the koa haole scrub vegetation type.

On the more recently disturbed area by the mounds of soil, grass cover is about 50%. A number of weedy species occur here. These include fuzzy rattlepod *(Crotalaria incana),* spiny amaranth *(Amaranthus spinosus), Trianthema portulacastrum,* castor bean *(Ricinus communis),* Spanish needle *(Bidens pilosa),* Jimson weed *(Datura stramonium)* and lion's ear *(Leonotis nepetifolia).* A few mounds are composed of crushed coral and/or sand and soil; these support a few native species: pa'uohi'iaka *(Jacquemontia ovalifolia* ssp. *sandwicensis),* ilima *(Sida fallax),* 'uhaloa, and kukaepua'a *(Digitaria setigera).*

Savanna

This vegetation type is found on the east slopes below the Pacific Palisades subdivision and covers about 5 acres (2 hectares). It consists of scattered individuals and small clumps of trees and shrubs, about 5% to 20% cover, in a dense matrix of Guinea grass. In some places sourgrass may be common.

The most frequently observed woody components are koa haole, guava, Christmas berry *(Schinus terebinthifolius),* silk oak, and Java plum. Where the Guinea grass cover is sparser, there are patches of Natal redtop grass, pluchea *(Pluchea carolinensis),* lantana, indigo *(Indigofera suffruticosa),* virgate mimosa *(Desmanthus pernambucanus),* and swollen fingergrass *(Chloris barbata).*

Ruderal Vegetation

The ruderal or roadside vegetation occupies only a small area within the Waiawa site where it occurs as a narrow band along the paved and unpaved roads on the undeveloped areas. A number of weedy species associated with this vegetation type are either confined to or are much more abundant here. The vegetation along the roadsides may occasionally be cut back or subject to vehicular traffic.

Ruderal vegetation is composed of a mixture of several grass species and weedy, mostly annual, herbaceous species with no one species dominating. Among the grasses, the most frequently observed are Guinea grass, pitted beardgrass *(Bothriochloa pertusa),* swollen fingergrass, Hilo grass *(Paspalum conjugatum),*

Bermuda grass *(Cynodon dactylon),* and wiregrass *(Eleusine indica).* Herbaceous species include several of the spurges *(Chamaesyce* spp.), nodeweed *(Synedrella nodeflora),* coat buttons, partridge pea *(Chamaecrista nictitans),* creeping indigo *(Indigofera spicata),* and comb hyptis.

DISCUSSION AND RECOMMENDATIONS

Five vegetation types are recognized on the Waiawa Watershed site. All of them are dominated by introduced or alien plant species; introduced species are all those plants which were brought to the Hawaiian Islands by humans, intentionally or accidentally, after Western contact (Cook's discovery of the islands in 1778). Of a total of 162 plant species inventoried on the site, 148 (91.4%) are introduced; 3 (1.8%) are originally of Polynesian introduction; and 11 (6.8%) are native. Of the natives, 10 are indigenous, that is, they are native to the Hawaiian Islands and elsewhere, and one is endemic, that is, it is native only to these islands. The indigenous species are the pakahakaha fern *(Pleopeltis thunbergiana),* koali *(Ipomoea indica),* 'ilima *(Sida fallax),* 'ala'ala wai nui *(Peperomia leptostachya),* pili grass *(Heteropogon contortus),* popolo *(Solanum americanum),* kukaepua'a *(Digitaria setigera),* 'a'ali'i *(Dodonaea viscosa),* mau u laiki *(Paspalum scrobiculatum),* and 'uhaloa *(Waltheria americana).* Pa'uohi'iaka *(Jacquemontia ovalifolia* ssp. *sandwicensis)* is the one endemic species.

None of the plants found during this field study or noted in the earlier flora studies (Hawaiian Agronomics, Inc. 1986; The Traverse Group, Inc. 1991) is a threatened and endangered species or a species of concern (U.S. Fish and Wildlife Service 1999). No sensitive native plant dominated communities exist on the site. This is not surprising as most lowland habitats in the islands, especially on the island of O'ahu, have been extensively disturbed by humans and their activities, beginning with the arrival of the early Polynesians (Cuddihy and Stone 1990). A botanical survey (Char 1994) of the former sugar cane lands and gulches to the west and north of the Waiawa Watershed property for the Gentry Waiawa project recorded similar findings.

There are no specific plans at present for the use or development of the site. If some future use of the site should occur, then the impacts to the vegetation would not be significant as it is dominated by introduced plant species. However, the Java plum/ mixed forest which lines the sides of the streams should not be removed. These forested areas provide a good control for soil erosion; the streams are subject to flash-flooding and can quickly overflow their banks. The forested areas immediately adjacent to the stream have been classified as palustrine-forested wetland-broadleafed evergreen-temporary (The Traverse Group, Inc. 1991). A buffer zone 50 feet (15 meters) wide should be maintained along the stream channels to preserve the forested areas.

LITERATURE CITED

Char, W.P. (Char & Associates). 1994. Botanical survey, Gentry Waiawa project (±1,250 acres), ‘Ewa District, island of O’ahu. Prepared for Gentry Hawaii, Ltd. January 1994.

Cuddihy, L.W. and C.P. Stone. 1990. Alteration of native Hawaiian Vegetation: effects of humans, their activities and introductions. Cooperative National Park Resources Studies Unit, University of Hawai’i, Manoa.

Evenhuis, N.S. and S.E. Miller, eds. 1995-1999. Records of the Hawaii Biological Survey. Bishop Museum Occasional Papers. Nos. 41-57.

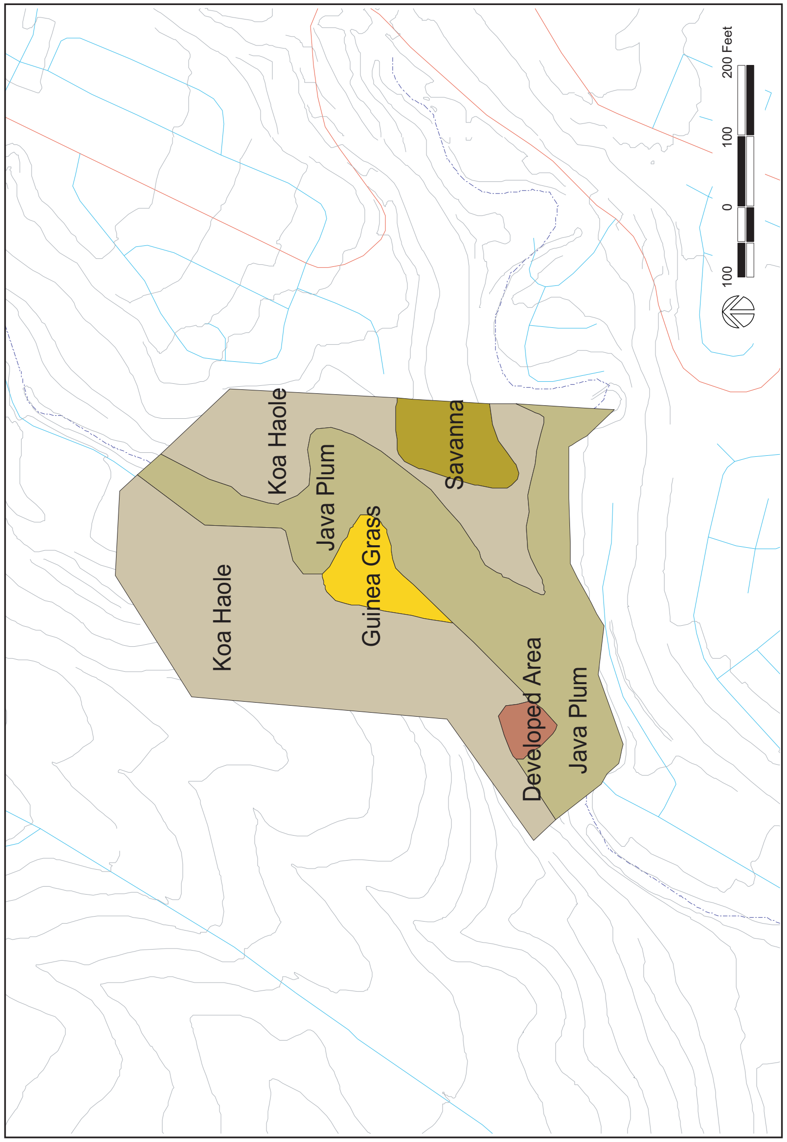
Hawaiian Agronomics, Inc. 1986. Final report for flora, fauna and water resources of the Pearl Harbor Area Facilities, Hawaii - Waiawa Water Pumping Facility. Naval Facilities Engineering Command, Pearl Harbor, Hawaii.

Lamoureux, C.H. 1988. Checklist of Hawaiian pteridophytes, “Kupukupu O Hawai’i Ne’i.” Lyon Arboretum, University of Hawai’i, Manoa.

The Traverse Group, Inc. 1991. Natural resources management plan, Pearl Harbor Complex, Hawaii. Contract No. N62742-86-C-0538.

U.S. Fish and Wildlife Service. 1999. U.S. Fish and Wildlife Service species list, plants. March 23, 1999. Pacific Islands Ecoregion Office, Honolulu, HI.

Wagner, W.L., D.R. Herbst, and S.H. Sohmer. 1990. Manual of the flowering plants of Hawai’i. 2 vols. University of Hawai’i Press and B.P. Bishop Museum Press, Honolulu. B.P. Bishop Museum Special Publication 83.



Waiawa Watershed Vegetation Types

Pearl Harbor INRMP

PLANT SPECIES LIST

The following checklist is an inventory of the plants found on the Waiawa Watershed study site. The plant names are arranged alphabetically by families within each of three groups: Ferns, Dicots, and Monocots. The taxonomy and nomenclature of the Ferns follow Lamoureux (1988), while the flowering plants, Dicots and Monocots, are in accordance with Wagner *et al.* (1990). The few recent name changes for the flowering plants follow those reported in the Hawaii Biological Survey series (Evenhuis and Miller, 1995-1999). An asterisk (*) before a plant name indicates that the species was found during this study but not in the earlier studies (Hawaiian Agronomics, Inc. 1986; The Traverse Group, Inc. 1991).

For each species, the following information is provided:

1. Scientific name with author citation.
2. Common English and/or Hawaiian name(s), when known.
3. Biogeographic status. The following symbols are used:

E = endemic = native only to the Hawaiian Islands.

I = indigenous = native to the Hawaiian Islands and also elsewhere.

I? = questionably indigenous = data not clear if dispersal by natural or human-related mechanisms, but weight of evidence suggests probably indigenous.

P = Polynesian = plants originally of Polynesian introduction prior to Western contact, that is, Cook's discovery of the Hawaiian Islands in 1778.

P? = questionably Polynesian = may be a Polynesian introduction or possibly introduced in historical times (shortly after 1778).

X = introduced or alien = all those plants brought to the Hawaiian Islands by humans, intentionally or accidentally, after Western contact.

X? = questionably introduced = date of introduction unclear or very early, could possibly be indigenous or perhaps of Polynesian introduction.

4. Presence (+) or absence (-) of a particular species within each of five vegetation types recognized within the study area (see text for discussion):

k = Koa Haole Scrub
j = Java Plum/Mixed Forest
g = Guinea Grass Grassland
s = Savanna
r = Ruderal Vegetation

Scientific name	Common name	Status	Vegetation Type k	j	g	s	r
FERNS							
BLECHNACEAE (Blechnum family)							
Blechnum occidentale L.	blechnum	X	-	+	-	-	-
DAVALLIACEAE (Rabbit's foot fern family)							
*Davallia fejeensis Hook.	rabbit's foot fern	X	-	+	-	-	-
NEPHROLEPIDACEAE (Swordfern family)							
Nephrolepis multiflora (Roxb.) Jarrett ex Morton	hairy swordfern, 'okupukupu	X	-	+	-	-	-
POLYPODIACEAE (Common fern family)							
Phymatosorus scolopendria (Burm.) Pic.-Ser.	maile-scented fern, laua'e	X	-	+	-	-	-
*Pleopeltis thunbergiana Kaulf.	pakahakaha, 'ekaha 'akolea	I	-	+	-	-	-
SINOPTERIDACEAE (Cliffbrake family)							
Pellaea viridis (Forsk.) Prantl	cliffbrake	X	+	-	-	-	-
THELYPTERIDACEAE (Wood-fern family)							
Christella parasitica (L.) Levl.	wood-fern	X	-	+	-	-	-
FLOWERING PLANTS							
DICOTS							
ACANTHACEAE (Acanthus family)							
Asystasia gangetica (L.) T. Anderson	Chinese violet, coromandel	X	+	-	+	-	-

Scientific name	Common name	Status	Vegetation Type k	j	g	s	r
AIZOACEAE (Fir-marigold family)							
*Trianthema portulacastrum L.		X	-	-	+	-	-
AMARANTHACEAE (Amaranth family)							
Achryanthes aspera L.		X	-	+	-	-	+
Alternanthera pungens Kunth	khaki weed	X	-	-	-	-	+
*Alternanthera sessilis (L.) DC	sessile joyweed	X	-	-	-	-	+
Amaranthus spinosus L.	spiny amaranth, pakai kuku	X	-	-	+	-	-
Amaranthus viridus L.	slender amaranth, pakai	X	+	-	-	-	-
ANACARDIACEAE (Mango family)							
Mangifera indica L.	mango, manako	X	-	+	-	-	-
Schinus terebinthifolius Raddi	Christmas berry	X	+	+	-	+	-
APOCYNACEAE (Dogbane family)							
*Catharanthus roseus (L.) G. Don	Periwinkle	X	+	-	-	-	-
ARALIACEAE (Ginseng family)							
Schefflera actinophylla (Endl.) Harms	octopus tree, umbrella tree	X	-	+	-	-	-
ASTERACEAE (Daisy family)							
Ageratum riparia (Regel) R. King & H. Robinson	Hamakua pamakani	X	-	+	-	-	-
*Ageratum conyzoides L.	maile hohono	X	+	-	-	-	-
Bidens pilosa L.	Spanish needle, ki, ki nehe	X	-	-	+	-	+
Calyptocarpus vialis Less.	hierba del cabello	X	-	-	-	-	+
Cyanthillium cinereum (L.) H. Rob.	little ironweed	X	-	-	-	-	+
*Emilia fosbergii Nicolson	flora’s paintbrush, pualele	X	+	-	-	-	+
Erechtites valerianifolia (Wolf) DC	fireweed	X	-	-	+	-	-
*Flaveria trinervia (Spreng.) C. Mohr	flaveria	X	-	-	+	-	-

Scientific name	Common name	Status	Vegetation Type k	j	g	s	r
Pluchea carolinensis (Jacq.) G. Don	pluchea, sourbush	X	+	-	-	+	+
Pluchea indica (L.) Less.	Indian fleabane	X	-	+	+	-	-
*Sonchus oleraceus L.	sowthistle, pualele	X	-	-	-	-	+
Spagneticola trilobata (L.) Pruski	wedelia	X	-	+	-	-	-
Synedrella nodiflora (L.) Gaertn.	nodeweed	X	-	-	-	-	+
Tridax procumbens L.	coat buttons	X	+	-	-	-	+
BIGNONIACEAE (Bignonia family)							
*Spathodea campanulata P. Beauv.	African tulip tree	X	-	+	-	-	-
BORAGINACEAE (Borage family)							
*Ehretia acuminata R. Br.	ehretia	X	-	+	-	-	-
*Heliotropium procumbens var. depressum (Cham.) Fosb.		X	-	-	+	-	+
BUDDLEIACEAE (Butterfly bush family)							
Buddleia asiatica Lour.	dog tail, huelo ʻilio	X	-	+	-	-	-
CACTACEAE (Cactus family)							
Opuntia ficus-indica (L.) Mill.	panini, papipi	X	+	-	-	-	-
CARICACEAE (Papaya family)							
Carica papaya L.	papaya, mikana	X	-	+	-	-	-
CLUSIACEAE (Mangosteen family)							
*Clusia rosea Jacq.	autograph tree, copey, Scotch attorney	X	+	+	-	-	-

Scientific name	Common name	Status	Vegetation Type k	j	g	s	r
CONVOLVULACEAE (Morning glory family)							
Ipomoea alba L.	moonflower, koali pehu	X	-	+	-	-	-
Ipomoea cairica (L.) Sweet	koali	X?	+	-	+	+	-
Ipomoea indica (J. Burm.) Merr.	koali ‘awa, koali ‘awahia	I	-	-	+	-	-
Ipomoea obscura (L.) Ker-Gawl.	field bindweed	X	-	+	+	-	+
*Ipomoea ochracea (Lindl.) G. Don		X	+	-	-	-	-
*Ipomoea triloba L.	little bell	X	-	-	+	-	+
*Jacquemontia ovalifolia ssp. sandwicensis (A. Gray) K. Robertson	pa’uohi’iaka	E	-	-	+	-	-
*Merremia aegyptia (L.) Urb.	hairy merremia, koali kua hulu	X?	-	-	+	-	-
CUCURBITACEAE (Gourd family)							
*Coccinia grandis (L.) Voigt	ivy gourd	X	+	-	+	-	+
Momordica charantia L.	wild bittermelon	X	+	-	-	-	-
EUPHORBIACEAE (Spurge family)							
Aleurites moluccana (L.) Willd.	kukui, tutui	P	-	+	-	-	-
Chamaesyce hirta (L.) Millsp.	hairy spurge, garden spurge	X	+	-	-	-	+
Chamaesyce hypericifolia (L.) Millsp.	graceful spurge	X	-	-	+	-	+
Chamaesyce hyssopifolia (L.) Small		X	-	-	+	-	-
Chamaesyce prostrata (Aiton) Small	prostrate spurge	X	-	-	-	-	+
*Euphorbia heterophylla L.	Mexican fireweed, kaliko	X	-	-	+	-	-
Macaranga tanarius (L.) Mull. Arg.	macaranga	X	-	+	-	-	-
Phyllanthus debilis Klein ex Willd.	niruri	X	+	-	+	-	-
Ricinus communis L.	castor bean, koli	X	-	-	+	-	-

Scientific name	Common name	Status	Vegetation Type k	j	g	s	r
FABACEAE (Pea family)							
Acacia farnesiana (L.) Willd.	klu	X	+	-	-	+	-
Caesalpinia decapetala (Roth) Alston	cat's claw, wait-a-bit, Mysore thorn, puakelekino	X	-	+	-	-	-
Canavalia sp.		X	-	+	-	-	-
Chamaecrista nictitans (L.) Moench	partridge pea, lauki	X	+	+	+	+	+
Crotalaria incana L.	fuzzy rattlepod, kukaehoki	X	-	-	+	-	-
Crotalaria pallida Aiton	smooth rattlebox, pikakani	X	-	-	-	-	+
Desmanthus pernambucanus (L.) Thellung	virgate mimosa	X	+	-	+	+	+
Desmodium incanum DC	Spanish clover, ka'imi	X	-	+	-	-	-
*Desmodium tortuosum (Sw.) DC	Florida beggarweed	X	-	-	-	-	+
Desmodium triflorum (L.) DC	three-flowered beggarweed	X	-	-	-	-	+
*Indigofera spicata Forssk.	creeping indigo	X	-	-	+	-	+
Indigofera suffruticosa Mill.	indigo, 'iniko	X	+	-	+	+	-
Leucaena leucocephala (Lam.) de Wit	koa haole	X	+	+	+	+	+
Macroptilium atropurpureum (DC) Urban		X	-	-	-	-	+
Macroptilium latyroides (L.) Urb.	wild bean, cowpea	X	-	-	+	-	-
Mimosa pudica var. unijuga (Duchass. & Walp.) Griseb.	sensitive plant, sleeping grass, pua hilahila	X	-	-	+	-	+
*Neonotonia wightii (Wight & Arn.) Lackey		X	-	-	+	-	-
*Paraserianthes falcataria (L.) I. Nielsen	albizia	X	-	+	-	-	-
Pithecellobium dulce (Roxb.) Benth.	'opiuma	X	+	+	-	-	-
Prosopis pallida (Humb. & Bonpl. ex Willd.) Kunth	kiawe, algaroba	X	+	-	-	-	-
Samanea saman (Jacq.) Merr.	monkeypod	X	-	+	-	-	-
Senna pendula (Humb. & Bonpl. ex Willd.) H. Irwin & Barneby		X	-	+	-	-	-
Senna surattensis (N.L. Burm.) H. Irwin & Barneby	kolomona, kalamona	X	-	+	-	-	-

Scientific name	Common name	Status	Vegetation Type k	j	g	s	r
LAMIACEAE (Mint family)							
Hyptis pectinata (L.) Poit.	comb hyptis	X	+	-	+	+	-
*Leonotis nepetifolia (L.) R. Br.	lion's ear	X	-	-	+	-	-
*Stachys arvensis L.	staggerweed	X	-	-	-	-	+
MALVACEAE (Mallow family)							
Malvastrum coromandelianum (L.) Garcke	false mallow, cheeseweed	X	-	-	+	-	+
*Sida ciliaris L.		X	-	-	-	-	+
*Sida fallax Walp.	'ilima	I	-	-	+	-	-
MELASTOMATACEAE (Melastome family)							
Clidemia hirta (L.) D. Don	Koster's curse, clidemia	X	-	+	-	-	-
MELIACEAE (Mahogany family)							
*Melia azedarach L.	Chinaberry, pride of India, 'inia	X	+	+	-	-	-
MORACEAE (Mulberry family)							
Ficus microcarpa L. fil.	Chinese banyan	X	+	+	-	-	-
MYRTACEAE (Myrtle family)							
*Pimenta dioica (L.) Merr.	allspice	X	-	+	-	-	-
Psidium guajava L.	guava, kuawa	X	+	+	-	+	-
Syzygium cumini (L.) Skeels	Java plum	X	+	+	-	+	-
OCHNACEAE (Ochna family)							
*Ochna thomasiana Engl. & Gileg	Mickey Mouse Plant	X	-	+	-	-	-
OXALIDACEAE (Wood sorrel family)							
Oxalis corniculata L.	yellow wood sorrel, 'ihi 'ai	P?	-	-	-	-	+

Scientific name	Common name	Status	Vegetation Type k	j	g	s	r	
PASSIFLORACEAE (Passion flower family)								
Passiflora edulis forma flavicarpa Degener	liliko'i	X	+	+	-	-	-	
Passiflora foetida L.	running pop, pohapoha	X	+	-	-	-	-	
Passiflora laurifolia L.	yellow granadilla	X	-	+	-	-	-	
Passiflora suberosa L.	huehue haole	X	-	+	-	-	-	
PHYTOLACCACEAE (Pokeweed family)								
*Rivina humilis L.	coral berry	X	-	+	-	-	-	
PIPERACEAE (Pepper family)								
Peperomia leptostachya Hook & Arnott	'ala'ala wai nui	I	+	-	-	-	-	
PITTOSPORACEAE (Pittosporum family)								
*Pittosporum undulatum Venten.	Victorian box, orange pittosporum	X	-	+	-	-	-	
PORTULACACEAE (Purslane family)								
Portulaca oleracea L.	pigweed, 'akulikuli kula, 'ihi	X	+	-	-	-	+	Por
*Talinum paniculatum (Jacq.) Gaertn.	jewels of Opar	X	-	-	-	-	+	
PROTEACEAE (Protea family)								
Grevillea robusta A. Cunn. ex R. Br.	silk oak, 'oka kalika	X	+	-	-	+	-	
RUBIACEAE (Coffee family)								
Paederia foetida L.	maili pilau	X	-	+	-	-	-	
Spermacoce assurgens Ruiz & Pav.	buttonweed	X	-	-	-	-	+	
RUTACEAE (Citrus family)								
Citrus aurantifolia (Christm.) Swingle	lime	X	-	+	-	-	-	
*Murraya paniculata (L.) Jack	mock orange	X	-	+	-	-	-	

Scientific name	Common name	Status	Vegetation Type k	j	g	s	r
SAPINDACEAE (Soapberry family)							
Dodonaea viscosa Jacq.	‘a’ali’i	I	+	-	-	-	-
Filicium decipiens (Wight & Arnott) Thwaites ex J.D. Hook.	fern tree	X	-	+	-	-	-
SAPOTACEAE (Sapodilla fmily)							
Bumelia buxifolia Willd. ex HBK	bumelia	X	-	+	-	-	-
SOLANACEAE (Nightshade family)							
Capsicum frutescens L.	chili peppe, nioi	X	+	-	-	-	-
*Datura stramonium L.	Jimson weed, la’au hano	X	-	-	+	-	-
Solanum americanum Mill.	popolo, glossy nightshade	I?	+	-	-	-	-
Solanum seaforthianum Andr.	blue potato vine	X	+	+	+	-	-
STERCULIACEAE (Cacao family)							
Waltheria indica L.	‘uhaloa, hi’aloa, kanakaloa	I?	+	-	+	-	-
URTICACEAE (Nettle family)							
*Pilea microphylla (L.) Liebm.	artillery plant	X	+	-	-	-	-
VERBENACEAE (Verbena family)							
Citharexylum caudatum L.	fiddleweed	X	-	+	-	-	-
Lantana camara L.	lantana, lakana	X	+	-	-	+	-
Stachytarpheta dichotoma (Ruiz & Pav.) Vahl	owi, oi	X	-	+	-	-	-
Stachytarpheta jamaicensis (L.) Vahl	Jamaica vervain, owi, oi	X	+	-	+	-	-

Scientific name	Common name	Status	Vegetation Type k	j	g	s	r
MONOCOTS							
AGAVACEAE (Agave family)							
Cordyline fruticosa (L.) A. Chev.	ti, ki	P	-	+	-	-	-
COMMELINACEAE (Spiderwort family)							
Commelina diffusa N.L. Burm.	honohono	X	-	-	+	+	-
CYPERACEAE (Sedge family)							
*Cyperus alternifolius ssp. flabelliformis (Rottb.) Kukenth.	umbrella plant, ‘ahu’awa haole	X	-	+	-	-	-
*Cyperus gracilis R. Br.	McCoy grass	X	-	-	-	-	+
*Cyperus rotundus L.	nutgrass, nut sedge	X	-	-	+	-	-
Kyllinga brevifolia Rottb.	green kyllinga, kili’o’opu	X	-	+	-	-	-
Kyllinga nemoralis (J.R. Forster & G. Forster) Dandy ex Hutchinson & Dalziel	white kyllinga, kili’o’opu	X	-	-	-	-	+
LILIACEAE (Lily family)							
Aloe vera L.	aloe	X	+	-	-	-	-
*Asparagus setaceus (Kunth) Jessop	asparagus fern	X	+	+	-	-	-
POACEAE (Grass family)							
Andropogon virginicus L.	broomsedge	X	+	-	-	-	+
Bothriochloa pertusa (L.) A. Camus	pitted beardgrass	X	-	-	+	-	+
Brachiaria mutica (Forssk.) Stapf	California grass	X	+	+	-	-	+
*Brachiaria subquadripara (Trin.) Hitchc.		X	-	-	+	-	+
*Cenchrus ciliaris L.	buffelgrass	X	-	-	+	-	-
*Cenchrus echinatus L.	common sandbur, ‘ume ‘alu	X	-	-	+	-	-

Scientific name	Common name	Status	Vegetation Type k	j	g	s	r
Chloris barbata (L.) Sw,	swollen fingergrass, mau'u lei	X	-	-	+	+	+
Chloris divaricata R. Br.	stargrass	X	-	-	-	-	+
*Chloris radiata (L.) Sw.	radiate fingergrass	X	+	-	-	-	+
Coix lachryma-jobi L.	Job's tears	X	-	+	-	-	-
Cynodon dactylon (L.) Pers.	Bermuda grass, manienie	X	-	-	+	-	+
Dichanthium aristatum (Poir.) Hubb.	Wilder grass	X	-	-	-	-	+
Digitaria ciliaris (Retz.) Koeler	Henry's crabgrass	X	-	+	-	-	-
Digitaria insularis (L.) Mez ex Ekman	sourgrass	X	+	+	+	+	+
Digitaria setigera Roth	kukaepua'a, itchy crabgrass	I?	-	-	+	-	-
Eleusine indica (L.) Gaertn.	wiregrass, goosegrass	X	-	-	+	-	+
Eragrostis amabilis (L.) Wight & Arnott	lovegrass	X	-	-	-	-	+
Eragrostis cilianensis (All.) Link	stinkgrass	X	-	-	+	-	-
Heteropogon contortus (L.) P. Beauv. ex Roem. & Schult.	pili, pili grass	I?	+	-	-	-	-
Melinis repens (Willd.) Zizka	Natal redtop, Natal grass	X	+	-	+	+	-
Oplismenus hirtellus (L.) P. Beauv.	basket grass, honohono kukui	X	-	+	-	-	-
Panicum maximum Jacq.	Guinea grass	X	+	+	+	+	+
Paspalum conjugatum Bergius	Hilo grass, mau'u Hilo	X	-	+	-	-	+
Paspalum scrobiculatum L.	ricegrass, mau'u laiki	I?	-	+	-	-	-
Sacciolepis indica (L.) Chase	Glenwood grass	X	-	+	-	-	-
Setaria verticillata (L.) P. Beauv.	bristly foxtail, mau'u pilipili	X	-	-	+	-	-
Sporobolus indicus (L.) R. Br.	Indian dropseed	X	-	-	-	-	+

A8 – O‘AHU BIRD SURVEYS
(NAVFAC PAC 2006A)

This page is intentionally left blank.

INTRODUCTION

This report provides the results of bird surveys conducted to assist with the updates of the October 2001 Integrated Natural Resources Management Plan (INRMP) for Pearl Harbor, the November 2001 INRMP for Naval Computer and Telecommunication Area Master Station Pacific, and the November 2001 INRMP for NAVMAG Pearl Harbor into an Oahu Complex INRMP. Installations or facilities included within this report are; Pearl Harbor Naval Complex (including, Makalapa Crater, Pearl City Peninsula, Red Hill Fuel Storage Facility, and Waiawa Watershed), Naval Magazine West Loch Branch (includes Waipio Peninsula and Laulaunui Island), and Navy-retained lands at Kalaeloa (former Naval Air Station (NAS) Barbers Point).

SITE DESCRIPTIONS

Pearl Harbor Naval Complex

- Makalapa Crater

Makalapa Crater is an approximately 180 acre (73 hectare) area that was once used as a freshwater fish pond by Hawaiians (Fig. 1). The crater has since been filled and a section of the interior has remained undeveloped. The dominant vegetation type within Makalapa Crater is kiawe (*Prosopis pallida*) scrub.

- Pearl City Peninsula

Pearl City Peninsula (PCP) is an extensively developed area comprised largely of military housing. In areas of un-improved land, the vegetation is dominated by pickleweed (*Batis maritima*), kiawe, weedy scrub or koa haole (*Leucaena leucocephala*) scrub. Along Pearl Harbor waters, the vegetation is dominated by red mangrove (*Rhizophora mangle)*, milo (*Thespesia populnea*) and pickleweed. There is a non-operational sewage treatment plant on the property with standing water in the old retention ponds. The Waiawa Unit of the Pearl Harbor National Wildlife Refuge wetland is located within the Pearl City Peninsula (Fig. 2).

- Red Hill Fuel Storage Area, Fleet and Industrial Supply Center (FISC)

Red Hill Fuel Storage Area is a 226 acre (91.5 hectare) parcel in south-central Oahu and is the Navy's main fuel storage facility (Fig. 3). The facility includes a ridge with elevations between 270 and 715 feet (82.3 and 218 meters). Because of the steep topography, there is limited access to areas of the parcel. The dominant vegetation on Red Hill is koa haole scrub along with areas of strawberry guava (*Psidium cattleianum*) dominated scrub. Along the ridge-top, grassland-type

Figure 1. Makalapa Crater

Figure 2. Pearl City Peninsula

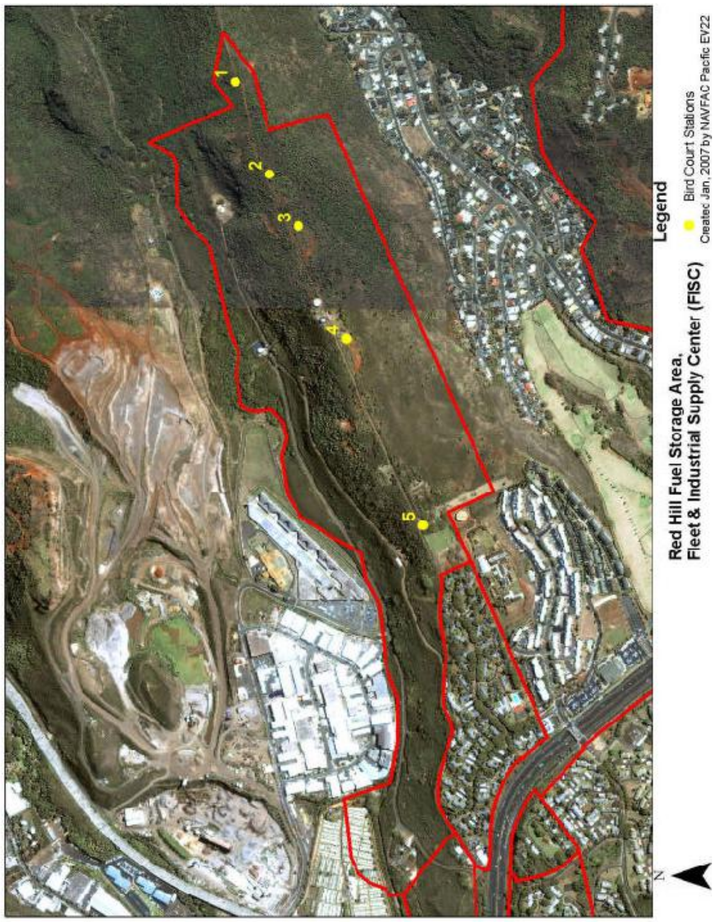


Figure 3. Red Hill Fuel Storage Area

vegetation is alongside the road and in patches along the top of the ridge. Further down the slopes on the Moanalua Valley side Christmas berry (*Schinus terebinthifolius*) scrub dominates (Hawaiian Agronomics 1985a).

- Waiawa Watershed

Waiawa watershed is an approximately 75-acre (30.4 hectare) area in the lower reaches of the Waiawa Valley of south-central Oahu (Fig. 4) and is the Navy's primary source of potable water. The elevation of the parcel is between 100 and 425 feet (30.5 and 129.5 meters) and lies along the west bank of Waiawa Stream. The parcel is a flat valley bordered by steep gulch walls. The majority of the area is covered with koa haole and mixed shrub habitat and tall, non-native forest habitat (largely Java plum (*Syzygium cumini*) along the stream. Within the facility, there is a small grassland area (primarily composed of Guinea grass (*Panicum maximum*).

NAVMAG Pearl Harbor West Loch Branch

- NAVMAG West Loch

NAVMAG West Loch consists of approximately 2,670 acres (1,081 hectares) on the coastal plain (part of the limestone Ewa plain) of southwest Oahu (Fig. 5). The topography is relatively flat, except for the occasional sinkhole. The vegetation of West Loch is primarily kiawe, kiawe/koa haole scrub and grassland (primarily Guinea grass).

- Waipio Peninsula and Laulaunui Island

Waipio Peninsula and Laulaunui Island cover 1,412 acres (571 hectares) of the NAVMAG Pearl Harbor area (Fig. 5). The topography of Waipio Peninsula is flat or gently sloping, primarily because much of the soil is fill material. The vegetation on Waipio Peninsula is largely kiawe/koa haole scrub with mangrove on the coastal margins of Pearl Harbor.

Laulaunui Island has an area of approximately 10 acres (4 hectares) with elevations ranging from sea level to approximately 20 feet (6 meters) (Jensen & Head 1997). The island is comprised of coral limestone and the vegetation is dominated by mangrove and kiawe with an understory of koa haole, ualoa (*Waltheria indica*), ilima (*Sida fallax*), lantana (*Lantana camara*) and non-native grasses.

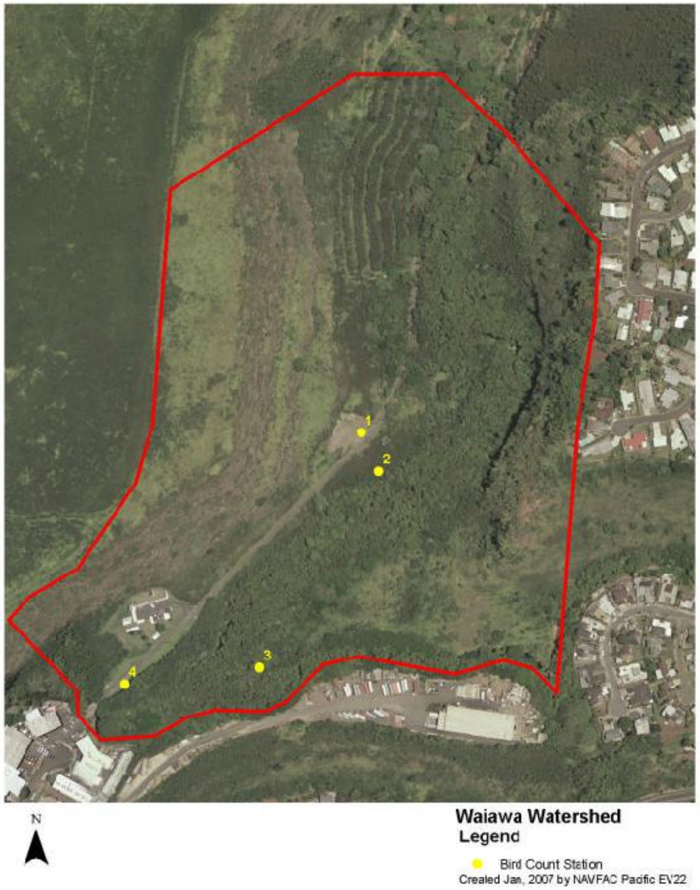


Figure 4. Waiawa Watershed

Figure 5. NAVMAG Pearl Harbor West Loch Branch

Navy-retained Lands at Kalaeloa (former NAS Barbers Point)

Kalaeloa is located on the southwest coast of Oahu on the Ewa Plain (Fig. 6). The facility was identified as excess to Navy's needs under Base Realignment and Closure (BRAC) review in 1999. Only Navy-retained parcels were surveyed.

- Golf Course and Stables

According to the 1988 Natural Resources Management Plan, Naval Air Station Barbers Point (TGI 1988), the golf course and stable area lies on filled land. The total acreage of the area is approximately 346 acres (140 hectares). The stables were built in the 1950s using the already in-place WWII-era bombproof revetments. The stable area has since become incorporated (1993) as the Barbers Point Riding Club. Members may rent stables and practice horsemanship. It is the home of the equestrian competition portion of the Aloha State Games. The Barbers Point Golf course was constructed in 1966 and is an active military golf course. The stables area is characterized by patches of kiawe scrub and the golf course is extensively landscaped and maintained for esthetic and golf course purposes.

- Nimitz Beach Park and Cottages and White Plains Beach Park and Cottages

The Nimitz and White Plains Beach Parks and Cottages are areas with cottages managed by Morale, Welfare, and Recreation (MWR). Active duty and reservist military, DOD civilians, AAFES employees and their respective retirees may rent these. White Plains Beach Park and Cottages consists of approximately 17 acres (6.9 hectares) and Nimitz is approximately 22 acres (8.9 hectares). The area can be described as beach strand (i.e., naupaka (*Scaevola sericea*), pickle weed and akulikuli (*Sesuvium portulacastrum*) with kiawe/koa haole scrub above the berm.

- Biosolids Treatment Facility

The Biosolids Treatment Facility is an approximately 74 acre (29.9 hectare) area on the west end of the runway at Kalaeloa. The treatment facility combines two waste streams (biosolids and greenwaste) into an environmentally friendly compost used on military property. Most of the land is improved with patches of kiawe/koa haole scrub.

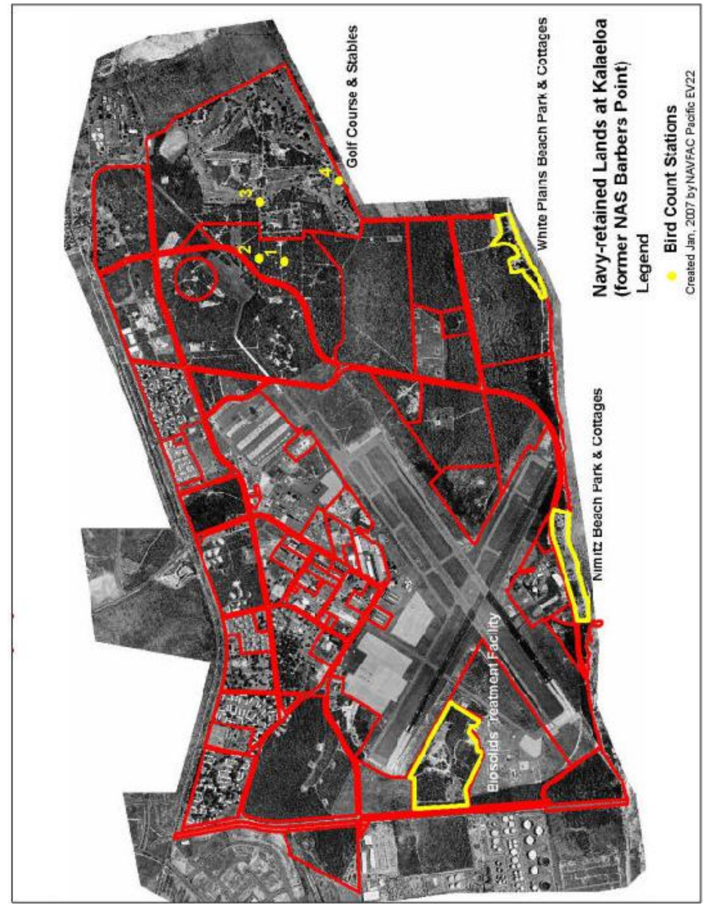


Figure 6. Navy-retained Lands at Kalaeloa (former NAS Barbers Point)

SURVEY METHODOLOGY

The majority of the surveys were conducted following the Hawaiian Forest Bird Survey methods. These methods use the variable circular-plot (VCP) method (Reynolds et al. 1980) where all birds observed or heard during the count period were recorded and the type of observation (aural, visual or both) was noted. Additionally, at first detection the distance to the bird was estimated. Birds observed flying over the count station but not landing in the area were determined not to be using the habit and were not counted. Each count was conducted for 8 minutes. The sizes, shapes and habitats of the Navy installations affected the manner in which the point count stations (for the VCP method) were determined. Therefore, all point count stations are not randomly placed, however stations were set up at least 492 feet (150 meters) apart and an attempt was made to place stations in different habitat types.

Exceptions to the above methodology were the Nimitz and White Plains beach parks and cottages and the Biosolids Treatment Facility. At these locations an abbreviated timed species count was conducted where are all positively identified species were recorded within a period of one hour. The VCP method was not used in these areas because they are small and are comprised primarily of improved lands.

The results of the surveys were not analyzed using the Distance program (used with VCP method) to estimate the densities of bird species observed. The minimum number of sightings required for an adequate analysis was not achieved. Therefore relative abundance (RA) was calculated using:

RA = total number of species X/total number of all birds recorded.

RESULTS & DISCUSSION

All of the bird surveys for this report were conducted within the Pearl Harbor area. The overall five most abundant species (calculated from relative abundance) are Japanese white-eyes, common waxbills, spotted doves, zebra doves, and red-vented bulbuls. In general, when comparing the results from the previous surveys conducted within the Pearl Harbor area on Navy lands, the bird species that are most common have not changed. These are typically non-native passerine-type species. The only exception to this is the Pacific golden plover. When they are in residence, they may be one of the most abundant species observed. The results for each area surveyed follow. Table 36 (located at the end of the report) contains all bird species observed during all surveys conducted on Navy lands within this report. This includes survey information collected by the U.S. Fish and Wildlife Service at the Pearl Harbor National

Wildlife Refuge from 2001 through 2006. Appendix A provides the results for the calculated relative abundance.

<u>Pearl Harbor Naval Complex</u>

- <u>Makalapa Crater</u>

The most commonly observed birds during the 2000 survey (Bruner 2000) were zebra doves, red-vented bulbuls, Japanese white-eyes, house finches, and common waxbills. In 2006, a total of 16 species were observed during the survey. The most abundant birds recorded were common waxbills, zebra doves, and red-vented bulbuls.

- <u>Pearl City Peninsula</u>

During the 2000 survey (Bruner 2000) a total of 26 species were observed and the most abundant species recorded were Pacific golden plovers, zebra doves, northern mockingbirds, Japanese white-eyes, house finches and common waxbills. A total of 14 species were recorded during the 2006 survey. The three most abundant species recorded were Japanese white-eyes, red-vented bulbuls, and spotted doves.

- <u>Red Hill Fuel Storage Area</u>

Hawaiian Agronomics (1986a) recorded a total of thirteen species of birds at Red Hill. The three most abundant species observed during the 1985 survey were red-vented bulbuls, Japanese white-eyes, and house finches. In 2006, a total of 10 species were observed. The survey occurred on a day of gusting winds (up to approximately 20 mph), therefore there is a high probability that all species using the habitat on the ridge top were not recorded. The most abundant species recorded were red-vented bulbuls, Japanese white-eyes, red-whiskered bulbuls and common mynas (the latter two were the same relative abundance).

- <u>Waiawa Watershed</u>

A total of fifteen species of birds were recorded in 1985 within Waiawa Watershed (Hawaiian Agronomics 1986a). The three most abundant bird species were Japanese white-eyes, red-vented bulbuls and zebra doves. During the 2000 survey (Bruner 2000) a total of 20 species were recorded. The most abundant species were red-vented bulbuls, Japanese white-eyes, and house finches. During the March 2006 surveys there was 100% cloud cover and with occasional sprinkles. Additionally, there had been relatively heavy or constant rains for at least the prior three weeks. The river was flowing and full, but not at flood stage when the surveys were conducted, but had been higher during the prior weeks. Thus fewer birds were observed. Surveys were conducted again in June. A total of 17 species of birds were observed during the 2006 surveys. The most abundant species recorded were Japanese white-eyes, zebra doves and house sparrows.

NAVMAG Pearl Harbor West Loch Branch

- NAVMAG West Loch

A total of 21 bird species were observed during the surveys in 1985. The three most abundant species observed recorded were Pacific golden plovers, zebra doves and Japanese white-eyes (Hawaiian Agronomics 1986c). A total of 18 species were recorded during the 2006 survey. The most abundant species recorded were spotted doves, gray francolins, Pacific golden plovers (the latter two have equal relative abundances) and zebra doves. The numerous gray francolins around the magazine were observed with chicks.

- Waipio Peninsula and Laulaunui Island

A total of 15 species were recorded for this area. The most abundant species were common waxbills, spotted doves and Japanese white-eyes. The only native species observed was the Pacific golden plover. In November, 2005 an osprey was observed flying over Pearl Harbor while NAVFAC Pacific biologists were traveling to survey Laulaunui Island.

Navy-retained Lands at Kalaeloa (former NAS Barbers Point)

The total number of species recorded at NAS Barbers Point in 1984 was twenty-two. This survey covered all of NAS Barbers Point at that time. The three most abundant species observed during the surveys were zebra doves, Japanese white-eyes, and northern cardinals (Botanical Consultants 1984).

- Golf Course and Stables

The most commonly observed species during the 2006 survey were red-crested cardinals, zebra doves and red-vented bulbuls. The most abundant species recorded in this area were red-crested cardinals, zebra doves and red-vented bulbuls.

- Nimitz Beach Park and Cottages and White Plains Beach Park and Cottages

A timed species account occurred at this area and a total of 15 species were recorded. A notable observation was the large flock of jungle fowl (chickens) observed within these areas.

- Biosolids Treatment Facility

A timed species account occurred at this area and a total of 16 species were recorded. However, birds that were observed at all times while traversing the property were (in no particular order); red-vented bulbuls, Japanese white-eyes, northern cardinals, spotted doves and zebra doves.

SPECIES DISCUSSION

The majority of Navy lands on Oahu are dominated by non-native bird species. The following is a brief discussion of commonly recorded native and non-native species found on Navy lands.

Each species has a table associated with it, reflecting the year when that species was recorded. The 1984 survey was conducted at the Barbers Point Naval Air Station. The 1985 studies were conducted at Waiawa Watershed, Red Hill Fuel Storage Facility, and at NAVMAG West Loch. The 2000 surveys were conducted at Makalapa Crater, Pearl City Peninsula, Red Hill and Waiawa Watershed.

The abbreviations in the table are defined below:

PHNC = Pearl Harbor Naval Complex
- **MC** = Makalapa Crater
- **PCP** = Pearl City Peninsula
- **RH** = Red Hill
- **WW** = Waiawa Watershed

NAVMAG = NAVMAG Pearl Harbor West Loch Branch
- **WL** = NAVMAG Westloch
- **WP** = Waipio Peninsula & Laulaunui Island

NRL = Navy-retained Lands at Kalaeloa (former NAS Barbers Point)
- **GC&S** = Golf Course and Stables
- **N&WP** = Nimitz and White Plains Beaches
- **BTF** = Biosolids Treatment Facility

Cattle egret (*Bubulcus ibis*)

Cattle egrets were imported in 1959 from Florida to control insects that pestered cattle (Berger 1972). They are common in many habitats around Oahu and may be seen foraging for insects behind lawnmowers on most installations.

Table 1. Locations of cattle egrets recorded during the 1985, 2000 and 2006 surveys (Botanical Consultants 1984; Hawaiian Agronomics 1986a; Hawaiian Agronomics 1986c; Bruner 2000).

	PHNC				**NAVMAG**		**NRL**		
Year	MC	PCP	RH	WW	WL	WPL	GC&S	N&WP	BTF
1984							x	x	x
1985					x				
2000	x	x		x					
2006	x	x			x	x			x

Black-crowned night heron (*Nycticorax nycticorax*)

Black-crowned night herons are considered indigenous in Hawaii. While they were not recorded during the 1985 survey, the person working at the pump house at Waiawa Watershed reported seeing black-crowned night herons (Hawaiian Agronomics 1986a).

Figure 7. Black-crowned night heron.

Table 2. Locations of black-crowned night herons recorded during the 1985, 2000 and 2006 surveys (Botanical Consultants 1984; Hawaiian Agronomics 1986a; Hawaiian Agronomics 1986c; Bruner 2000).

	PHNC				**NAVMAG**		**NRL**		
Year	MC	PCP	RH	WW	WL	WPL	GC&S	N&WP	BTF
1984							x	x	x
1985									x
2000		x		x	x				
2006		x			x	x	x	x	x

Pacific golden plover (*Pluvialis fulva*)

Pacific golden plovers are a medium-sized plover that, during the winter months, occupy upland and coastal habitats in the Hawaiian Islands (Johnson & Conners 1996). They leave Hawaii in April to migrate to Alaska to breed and return to Hawaii in August (Hawaii Audubon Society 2005). These plovers can be observed at many locations in Hawaii, especially in areas with mowed grass. Plovers were, most likely, not observed during the 2006 surveys at PCP and Waiawa Watershed because the survey was conducted in June and July, when plovers have not yet returned from Alaska.

Figure 8. Pacific golden plover.

Table 3. Locations of Pacific golden plovers recorded during the 1985, 2000 and 2006 surveys (Botanical Consultants 1984; Hawaiian Agronomics 1986a; Hawaiian Agronomics 1986b; Hawaiian Agronomics 1986c; Bruner 2000).

	PHNC				**NAVMAG**		**NRL**		
Year	MC	PCP	RH	WW	WL	WPL	GC&S	N&WP	BTF
1984							x	x	x
1985			x	x	x		x	x	x
2000	x	x	x	x					
2006	x				x	x	x	x	x

Black-necked stilt (*Himantopus mexicanus*)

Basic life history information for Hawaiian black-necked stilts is provided in Pepi, 2006. In 2006, the stilts were at the old, non-operational, water retention ponds (Fig. 2), which are not far from the Waiawa Unit of the Pearl Harbor National Wildlife Refuge. Juveniles and adults were observed there and it looked like the stilts may have nested at the site. Stilts were also observed at the retention ponds on NAVMAG Westloch.

Figure 9. Hawaiian black-necked stilt.

Table 4. Locations of black-necked stilts recorded during the 1985, 2000 and 2006 surveys (Bruner 2000).

	PHNC				**NAVMAG**		**NRL**		
Year	MC	PCP	RH	WW	WL	WPL	GC&S	N&WP	BTF
1984									
1985									
2000		x							
2006		x			x		x		x

Ruddy turnstone (*Arenaria interpres*)

Ruddy turnstones are considered an abundant winter visitor to Hawaii (Hawaii Audubon Society 2005). Although ruddy turnstones were not observed during the 2006 survey, they most likely utilize the beach habitat along all shores of the Pearl Harbor area and at Kalaeloa.

Table 5. Locations of ruddy turnstones recorded during the 1985, 2000 and 2006 surveys (Botanical Consultants 1984; Bruner 2000).

	PHNC				NAVMAG		NRL		
Year	MC	PCP	RH	WW	WL	WPL	GC&S	N&WP	BTF
1984							x	x	x
1985									
2000		x							
2006					x				

Wandering tattler (*Heteroscelus incanus*)

Wandering tattlers are another common winter visitor to Hawaii. They arrive by August and stay until late April or early May (Hawaii Audubon Society 2005).

Table 6. Locations of wandering tattlers recorded during the 1985, 2000 and 2006 surveys (Botanical Consultants 1984; Bruner 2000).

	PHNC				NAVMAG		NRL		
Year	MC	PCP	RH	WW	WL	WPL	GC&S	N&WP	BTF
1984									
1985									
2000				x					
2006								x	

<u>Pueo or short-eared owl (*Asio flammeus*)</u>

The short-eared owl is one of the world's most widely distributed medium-sized owls. The species in Hawaii is believed to have originated from Alaskan stock (Wiggens 2006).

Table 7. Locations of pueo recorded during the 1984, 1985, 2000 and 2006 surveys (Hawaiian Agronomics 1986c).

	PHNC				**NAVMAG**		**NRL**		
Year	MC	PCP	RH	WW	WL	WPL	GC&S	N&WP	BTF
1984									
1985						x			
2000									
2006						x			

<u>Barn owl (*Tyto alba*)</u>

Barn owls were first released in Hawaii in 1958 from California with the hope that they would control the rat populations in the sugarcane fields (Berger 1972).

Table 8. Locations of barn owls recorded during the 1984, 1985, 2000 and 2006 surveys (Botanical Consultants 1984).

	PHNC				**NAVMAG**		**NRL**		
Year	MC	PCP	RH	WW	WL	WPL	GC&S	N&WP	BTF
1984							x	x	x
1985									
2000									
2006									

<u>Gray francolin (*Francolinus pondicerianus*)</u>

Gray francolins were introduced to Hawaii from India in 1958 (Hawaii Audubon Society 2005). "Hawaii's Birds" (2005) states that this species is found at Diamond Head and Lualualei Valley. While gray francolins are still observed within Lualualei Valley, they are also observed around Pearl Harbor (including within the Pearl Harbor National Wildlife Refuge).

Table 9. Locations of gray francolins recorded during the 1984, 1985, 2000 and 2006 surveys.

	PHNC				**NAVMAG**		**NRL**		
Year	MC	PCP	RH	WW	WL	WPL	GC&S	N&WP	BTF
1984									
1985									
2000									
2006					x	x	x	x	x

<u>Ring-necked pheasant (*Phasianus colchicus*)</u>

This game bird was first introduced in Hawaii in 1865 (Berger 1972; Hawaiian Agronomics 1986c) for hunting.

Table 10. Locations of ring-necked pheasants recorded during the 1984, 1985, 2000 and 2006 surveys (Hawaiian Agronomics 1986c; Bruner 2000).

	PHNC				NAVMAG		NRL		
Year	MC	PCP	RH	WW	WL	WPL	GC&S	N&WP	BTF
1984									
1985					x				
2000									
2006		x				x			

<u>Red junglefowl (*Gallus gallus*)</u>

Red junglefowl (also called moa or chickens) are commonly observed throughout Oahu. They can be sighted in both town and country.

Figure 10. Red junglefowl.

Table 11. Locations of red junglefowl recorded during the 1984, 1985, 2000 and 2006 surveys (Hawaiian Agronomics 1986c; Bruner 2000).

	PHNC				NAVMAG		NRL		
Year	MC	PCP	RH	WW	WL	WPL	GC&S	N&WP	BTF
1984									
1985									
2000									
2006	x			x			x	x	

<u>Rock dove (*Columbia livia*)</u>

Rock doves (also called common pigeon) were first introduced to Hawaii in 1796 (Berger 1972). They are typically observed in flocks around populated areas.

Table 12. Locations of rock doves recorded during the 1984, 1985, 2000 and 2006 surveys (Bruner 2000).

	PHNC				NAVMAG		NRL		
Year	MC	PCP	RH	WW	WL	WPL	GC&S	N&WP	BTF
1984									
1985									
2000		x							
2006		x		x					

<u>Spotted dove (*Streptopelia chinensis*)</u>

The exact date of when spotted doves were introduced to Hawaii is unknown. However, it is believed to have been introduced from eastern Asia early during European colonization (Berger 1972).

Table 13. Locations of spotted doves recorded during the 1984, 1985, 2000 and 2006 surveys (Botanical Consultants 1984; Hawaiian Agronomics 1986a; Hawaiian Agronomics 1986b; Hawaiian Agronomics 1986c; Bruner 2000).

	PHNC				**NAVMAG**		**NRL**		
Year	MC	PCP	RH	WW	WL	WPL	GC&S	N&WP	BTF
1984							x	x	x
1985			x	x	x				
2000	x	x	x	x					
2006	x	x	x	x	x	x	x		x

<u>Zebra dove (*Geopelia striata*)</u>

It is thought that zebra doves were introduced around 1922 from Malaysia (Berger 1972). They are ubiquitous around the island of Oahu.

Figure 11. Zebra dove.

Table 14. Locations of ruddy turnstones recorded during the 1985, 2000 and 2006 surveys (Botanical Consultants 1984; Hawaiian Agronomics 1986a; Hawaiian Agronomics 1986b; Hawaiian Agronomics 1986c; Bruner 2000).

	PHNC				**NAVMAG**		**NRL**		
Year	MC	PCP	RH	WW	WL	WPL	GC&S	N&WP	BTF
1984							x	x	x
1985			x	x	x				
2000	x	x	x	x					
2006	x	x	x	x	x	x	x	x	x

<u>Eurasian skylark (*Alauda arvensis*)</u>

Eurasian skylarks were introduced from England in 1865 (Berger 1972). They typically occur on the dry, leeward side of the island, but have been observed at Kaneohe Marine Corps Base (Pratt 2003).

Table 15. Locations of Eurasian skylarks recorded during the 1984, 1985, 2000 and 2006 surveys (Hawaiian Agronomics 1986c; Bruner 2000).

	PHNC				NAVMAG		NRL		
Year	MC	PCP	RH	WW	WL	WPL	GC&S	N&WP	BTF
1984									
1985					x				
2000		x							
2006									x

<u>Red-billed leiothrix (*Leiothrix lutea*)</u>

Red-billed leiothrix were first brought into the state during the 1910's (Berger 1972). In the past, they had declined markedly, but have since increased in numbers and have been recorded around Waipio (Pratt 2003).

Table 16. Locations of red-billed leiothrix recorded during the 1984, 1985, 2000 and 2006 surveys (Bruner 2000).

	PHNC				NAVMAG		NRL		
Year	MC	PCP	RH	WW	WL	WPL	GC&S	N&WP	BTF
1984									
1985									
2000			x	x					
2006				x					

<u>Red-whiskered bulbul (*Pycnonotus jocusus*)</u>

Although this species was prohibited from being imported to the state, it was imported illegally in 1965 (Berger 1972). According to Pratt (2003), the numbers and spread of red-whiskered bulbuls has grown.

Figure 12. Red-whiskered bulbul.

Table 17. Locations of red-whiskered bulbuls recorded during the 1984, 1985, 2000 and 2006 surveys (Bruner 2000).

	PHNC				NAVMAG		NRL		
Year	MC	PCP	RH	WW	WL	WPL	GC&S	N&WP	BTF
1984									
1985									
2000			x	x					
2006			x	x		x	x		

<u>Red-vented bulbul (*Pycnonotus cafer*)</u>

There is no record of when or how red-vented bulbuls were introduced to Hawaii. However, this species was first observed in 1966 during bird counts (Berger 1972).

Figure 13. Red-vented bulbul.

Table 18. Locations of red-vented bulbuls recorded during the 1984, 1985, 2000 and 2006 surveys (Botanical Consultants 1984; Hawaiian Agronomics 1986a; Hawaiian Agronomics 1986b; Hawaiian Agronomics 1986c; Bruner 2000).

	PHNC				NAVMAG		NRL		
Year	MC	PCP	RH	WW	WL	WPL	GC&S	N&WP	BTF
1984							x	x	x
1985			x	x	x				
2000	x	x	x	x					
2006	x	x	x	x	x	x	x	x	x

<u>Northern mockingbird (*Mimus polyglottos*)</u>

Northern mockingbirds are native to the Americas and they were first released on Oahu in 1931 (Berger 1972). They are recorded in small numbers around the state (Pratt 2003).

Table 19. Locations of northern mocking birds recorded during the 1984, 1985, 2000 and 2006 surveys (Botanical Consultants 1984; Hawaiian Agronomics 1986b; Hawaiian Agronomics 1986c; Bruner 2000).

	PHNC				**NAVMAG**		**NRL**		
Year	MC	PCP	RH	WW	WL	WPL	GC&S	N&WP	BTF
1984							x	x	x
1985			x		x				
2000		x	x						
2006							x	x	

<u>White-rumped shama (*Copsychus malabaricus*)</u>

White-rumped shamas were first introduced to Oahu in 1940 (Berger 1972).

Table 20. Locations of white-rumped shamas recorded during the 1984, 1985, 2000 and 2006 surveys (Botanical Consultants 1984; Hawaiian Agronomics 1986a; Hawaiian Agronomics 1986b; Hawaiian Agronomics 1986c; Bruner 2000).

	PHNC				**NAVMAG**		**NRL**		
Year	MC	PCP	RH	WW	WL	WPL	GC&S	N&WP	BTF
1984							x	x	x
1985			x	x	x				
2000		x	x	x					
2006		x		x	x		x	x	x

<u>Japanese bush warbler (*Cettia diphone*)</u>

Japanese bush warblers were first introduced in 1929 (Berger 1972) and are somewhat common in small numbers in forested habitats.

Table 21. Locations of Japanese bush warblers recorded during the 1984, 1985, 2000 and 2006 surveys (Bruner 2000).

	PHNC				**NAVMAG**		**NRL**		
Year	MC	PCP	RH	WW	WL	WPL	GC&S	N&WP	BTF
1984									
1985									
2000	x	x	x	x					
2006			x	x					

<u>Common myna (*Acridotheres tristis*)</u>

According to Berger (1972), mynas were introduced in 1865 from India. They are most commonly observed within populated areas.

Figure 14. Common myna.

Table 22. Locations of common mynas recorded during the 1984, 1985, 2000 and 2006 surveys (Botanical Consultants 1984; Hawaiian Agronomics 1986a; Hawaiian Agronomics 1986b; Bruner 2000).

	PHNC				**NAVMAG**		**NRL**		
Year	MC	PCP	RH	WW	WL	WPL	GC&S	N&WP	BTF
1984							x	x	x
1985			x	x					
2000	x	x	x	x					
2006	x	x	x	x	x	x	x	x	

Japanese white-eye (*Zosterops japonicus*)

Japanese white-eyes were, apparently, first imported from Japan in 1929 (Berger 1972). They are common in a wide range of habitats and within populated areas.

Figure 15. Japanese white-eye.

Table 23. Locations of Japanese white-eyes recorded during the 1984, 1985, 2000 and 2006 surveys (Botanical Consultants 1984; Hawaiian Agronomics 1986a; Hawaiian Agronomics 1986b; Hawaiian Agronomics 1986c; Bruner 2000).

	PHNC				**NAVMAG**		**NRL**		
Year	MC	PCP	RH	WW	WL	WPL	GC&S	N&WP	BTF
1984							x	x	x
1985			x	x	x				
2000	x	x	x	x					
2006	x	x	x	x	x	x	x	x	x

Northern cardinal (*Cardinalis cardinalis*)

Northern cardinals were introduced from the United States between 1929 and 1931 (Berger 1972). They can now be found in a variety of habitats and populated areas.

Figure 16. Northern cardinal.

Table 24. Locations of northern cardinals recorded during the 1984, 1985, 2000 and 2006 surveys (Botanical Consultants 1984; Hawaiian Agronomics 1986a; Hawaiian Agronomics 1986b; Hawaiian Agronomics 1986c; Bruner 2000).

	PHNC				**NAVMAG**		**NRL**		
Year	MC	PCP	RH	WW	WL	WPL	GC&S	N&WP	BTF
1984							x	x	x
1985			x	x	x				
2000	x	x	x	x					
2006	x	x	x	x	x	x	x	x	x

Red-crested cardinal (*Paroaria coronata*)

Red-crested cardinals are native to parts of South America and were first released in Hawaii in 1928 (Berger 1972). They may often be seen in populated areas and in kiawe scrub on Oahu.

Figure 17. Red-crested cardinal.

Table 25. Locations of red-crested cardinals recorded during the 1984, 1985, 2000 and 2006 surveys (Botanical Consultants 1984; Hawaiian Agronomics 1986a; Hawaiian Agronomics 1986b; Hawaiian Agronomics 1986c; Bruner 2000).

	PHNC				**NAVMAG**		**NRL**		
Year	MC	PCP	RH	WW	WL	WPL	GC&S	N&WP	BTF
1984							x	x	x
1985			x	x	x				
2000	x	x	x	x					
2006	x	x	x	x	x	x	x	x	x

House finch (*Carpodacus mexicanus*)

House finches are thought to have been introduced prior to 1870 from San Francisco (Berger 1972). They are quite common in populated areas.

Figure 18. House finch.

Table 26. Locations of house finches recorded during the 1984, 1985, 2000 and 2006 surveys (Botanical Consultants 1984; Hawaiian Agronomics 1986a; Hawaiian Agronomics 1986b; Hawaiian Agronomics 1986c; Bruner 2000).

	PHNC				**NAVMAG**		**NRL**		
Year	MC	PCP	RH	WW	WL	WPL	GC&S	N&WP	BTF
1984							x	x	x
1985			x	x	x				
2000	x	x	x	x					
2006	x	x	x	x		x	x		

Saffron finch (*Sicalis flaveola*)

Berger (1972) listed saffron finches as known to be escaped, but not established. He reported that the species was recorded during Oahu Christmas counts in the late 1960's. According to the 2002-2003 Christmas count, a small number of saffron finches were observed within the Waipio survey area (Pratt 2003).

Figure 19. Saffron finch.

Table 27. Locations of saffron finches recorded during the 1984, 1985, 2000 and 2006 surveys (Bruner 2000).

	PHNC				**NAVMAG**		**NRL**		
Year	MC	PCP	RH	WW	WL	WPL	GC&S	N&WP	BTF
1984									
1985									
2000		x	x						
2006	x		x				x		

House sparrow (*Passer domesticus*)

House sparrows were introduced to Hawaii in 1871 from New Zealand (Berger 1972). They are quite common in populated areas.

Table 28. Locations of house sparrows recorded during the 1984, 1985, 2000 and 2006 surveys (Botanical Consultants 1984; Bruner 2000).

	PHNC				**NAVMAG**		**NRL**		
Year	MC	PCP	RH	WW	WL	WPL	GC&S	N&WP	BTF
1984							x	x	x
1985									
2000	x	x	x	x					
2006	x			x	x			x	x

Yellow-fronted canary (*Serinus mozambicus*)

Yellow-fronted canaries were introduced to Hawaii in the late 1960's (Hawaii Audubon Society 2005). During the 2002-2003 Christmas count, a small number of yellow-fronted canaries were observed within the Honolulu survey area (Pratt 2003).

Table 29. Locations of red-vented bulbuls recorded during the 1984, 1985, 2000 and 2006 surveys.

	PHNC				**NAVMAG**		**NRL**		
Year	MC	PCP	RH	WW	WL	WPL	GC&S	N&WP	BTF
1984									
1985									
2000									
2006	x					x			

Common waxbill (*Estrilda astrild*)

"Hawaii's Birds" states that common waxbills were first identified in the late 1970's (Hawaii Audubon Society 2005). They were counted only on Oahu during the 2002-2003 Christmas count (Pratt 2003).

Figure 20. Common waxbill.

Table 30. Locations of common waxbills recorded during the 1984, 1985, 2000 and 2006 surveys (Botanical Consultants 1984; Bruner 2000).

	PHNC				**NAVMAG**		**NRL**		
Year	MC	PCP	RH	WW	WL	WPL	GC&S	N&WP	BTF
1984							x	x	x
1985									
2000	x	x	x	x			x	x	x
2006	x	x		x	x	x	x	x	x

Orange-cheeked waxbill (*Estrilda melpoda*)

Orange-cheeked waxbills were first recorded on Oahu in 1965 (Berger 1972). They appear to be decreasing in numbers around the Pearl Harbor area as none were observed during the 2000 or 2006 surveys. Additionally, a small number of birds were recorded within the Honolulu survey area during the 2002-2003 Christmas count (Pratt 2003).

Table 31. Locations of orange-cheeked waxbills recorded during the 1984, 1985, 2000 and 2006 surveys (Botanical Consultants 1984; Hawaiian Agronomics 1986a; Hawaiian Agronomics 1986c; Bruner 2000).

	PHNC				**NAVMAG**		**NRL**		
Year	MC	PCP	RH	WW	WL	WPL	GC&S	N&WP	BTF
1984							x	x	x
1985				x	x				
2000									
2006									

<u>Red avadavat (*Amandava amandava*)</u>

Red avadavats (formerly known as strawberry finches) were most likely introduced between 1900 and 1910 (Berger 1972). They were recorded in small numbers during the 2002-2003 Christmas count (Pratt 2003).

Table 32. Locations of red avadavats recorded during the 1984, 1985, 2000 and 2006 surveys (Hawaiian Agronomics 1986c; Bruner 2000).

	PHNC				**NAVMAG**		**NRL**		
Year	MC	PCP	RH	WW	WL	WPL	GC&S	N&WP	BTF
1984									
1985					x				
2000		x		x					
2006					x	x			

<u>Nutmeg mannikin (*Lonchura punctulata*)</u>

Nutmeg mannikins were introduced to Hawaii around 1865 (Berger 1972). They were recorded in small numbers on Oahu during the 2002-2003 Christmas count (Pratt 2003).

Table 33. Locations of nutmeg mannikins recorded during the 1984, 1985, 2000 and 2006 surveys (Botanical Consultants 1984; Hawaiian Agronomics 1986a; Hawaiian Agronomics 1986b; Hawaiian Agronomics 1986c; Bruner 2000).

	PHNC				**NAVMAG**		**NRL**		
Year	MC	PCP	RH	WW	WL	WPL	GC&S	N&WP	BTF
1984							x	x	x
1985			x	x	x				
2000		x		x					
2006	x			x			x		x

<u>Chestnut mannikin (*Lonchura malacca*)</u>

Chestnut manikins were first reported as established at West Loch, Pearl Harbor in 1959 (Berger 1972). It is thought that they were first introduced between 1936 and 1941 due to the pet trade.

Figure 21. Chestnut mannikin.

Table 34. Locations of chestnut mannikins recorded during the 1984, 1985, 2000 and 2006 surveys (Botanical Consultants 1984; Hawaiian Agronomics 1986a; Hawaiian Agronomics 1986b; Hawaiian Agronomics 1986c; Bruner 2000).

	PHNC				**NAVMAG**		**NRL**		
Year	MC	PCP	RH	WW	WL	WPL	GC&S	N&WP	BTF
1984							x	x	x
1985			x	x	x				
2000		x							
2006					x			x	

<u>Java sparrow (*Padda oryzivora*)</u>

Java sparrows may have been introduced in 1865 (Berger 1972) from Java. They appear to be most commonly observed within populated areas.

Table 35. Locations of java sparrows recorded during the 1984, 1985, 2000 and 2006 surveys (Hawaiian Agronomics 1986a; Hawaiian Agronomics 1986b; Hawaiian Agronomics 1986c; Bruner 2000).

	PHNC				**NAVMAG**		**NRL**		
Year	MC	PCP	RH	WW	WL	WPL	GC&S	N&WP	BTF
1984									
1985				x	x				
2000	x	x	x						
2006	x								

WAIAWA AND HONOULIULI UNITS OF THE PEARL HARBOR NATIONAL WILDLIFE REFUGE (USFWS 2006)

The Pearl Harbor National Wildlife Refuge (NWR) is managed by the U.S. Fish and Wildlife Service (USFWS) and consists of two units, the Waiawa and Honouliuli units (Figs. 2 & 5). The primary mission of the NWR is the management of Hawaii's four endangered waterbirds: the Hawaiian coot, moorhen, stilt and duck. Secondarily, and consistent with this management, benefits are also realized for a variety of migrant waterbirds.

Wetlands within the NWR are primarily managed by manipulating the water level and controlling vegetation. Water levels are varied to control or foster certain plant species throughout most of the year, particularly during waterbird nesting seasons. Water levels are maintained at a relatively high level through the fall and winter. This is to provide a relatively constant water level suitable for Hawaiian coot and Hawaiian moorhen nesting. Nesting by these species tends to subside around February and water levels are normally lowered to accommodate Hawaiian stilt nesting, stilt nest on open flats as opposed to over open water. During stilt nesting season (February through July or August), water levels are fluctuated or "pulsed" to maintain nesting, foraging, and chick rearing habitat for stilts. Water level management is also a means of producing a variety of invertebrates and plants utilized by Hawaii's four endangered waterbirds for food, nesting, thermal cover, and protection from predators.

Water levels are regulated utilizing a simple yet effective water control structure. The addition or removal of wooden flash boards either allows the release or retention of water in a given water impoundment. Water conservation is constantly practiced on this NWR. Whenever possible, rainfall is utilized for water management. Wells are used to augment rainfall production during periods when rainfall by itself is not adequate to maintain water levels at desired heights.

Upon completion of stilt nesting and chick fledging in August, one of the two water impoundments is de-watered and mechanical vegetation control is achieved using small tractors and mowers. By late September or early October, the goal is to have habitat work completed and to begin re-flooding the impoundment. The mechanical vegetation removal allows creation of vegetation interspersion, variety in vegetative structure, thinning of vegetation, and control of plants less desirable to waterbirds.

A predator control program is operational yearlong. Fencing, live traps and Diphacinone bait stations are used in the program. The targeted species are mongoose, rats, and other feral animals; all of which will kill birds and destroy eggs.

During the fall and winter, portions of the shallow water and mudflat areas are maintained for migratory waterbirds that come from various parts of the world to winter in Hawaii. This habitat provides feeding, loafing, and protected habitat during their stay. These migrants generally return to their breeding grounds around April.

Honouliuli Unit

The Honouliuli unit is approximately 36.6 acres (14.8 hectares) and consists of two water impoundments. One impoundment is 4.8 acres (1.9 hectares) and the other is 13.8 acres (5.6 hectares). The remainder of the unit is comprised of shoreline and upland habitat. The salinity of the water in the impoundments is typically 4-6 parts per thousand (ppt).

Figure 23. One of the impoundments at the Honouliuli Unit of the PH NWR.

The two most numerous endangered waterbirds using the refuge are the Hawaiian coot and Hawaiian stilt. Hawaiian moorhen and Hawaiian duck occur, but in lower numbers. All four species successfully breed and rear young there. In recent years, between 50 to70 Hawaiian stilts have been fledged from the site annually. Hawaiian coot production has remained around 100 to 150 young per year. Hawaiian ducks are difficult to separate from the Hawaiian duck x mallard hybrids; therefore, no accurate production data is available. Due to the low numbers of Hawaiian moorhen occupying the refuge, production ranges from just about 2 to 4 per year.

Water is provided by a slightly brackish well on the refuge, and flow is controlled by a mechanical timer. Salinity in the impoundments can be varied by adding or restricting inflow of harbor water. Salinity is also used as a vegetation control tool.

Prescribed burning is a desirable management tool, but due to weather patterns and the close proximity of residential homes in the area this is not an option on this unit.

<u>Waiawa Unit</u>

The Waiawa unit is approximately 24.5 acres (9.9 hectares) and consists of two water impoundments. One impoundment is 6.8 acres (2.8 hectares) and the other is 13.8 acres (5.6 hectares). The remainder of the unit comprises both shoreline and upland habitat. The salinity of the water in the impoundments is often near that of sea water (~35 ppt) and can be allowed to become hypersaline.

A project to remove approximately 5 acres (2.0 hectares) of dense tangled red mangrove from the shoreline was completed by USFWS in 2006. The project was aimed at restoring the shoreline to a more natural condition and improving the suitability for fish and other native coastal native species.

Figure 24. The Waiawa Unit of the PH NWR. The far side of the picture is the area where the red mangrove removal occurred.

The two most numerous endangered waterbirds using the refuge are the Hawaiian stilt and Hawaiian coot, with the stilts being the most numerous. Hawaiian moorhen and Hawaiian duck occur, but in lower numbers. Successful breeding and rearing of young occurs here. Water salinity plays an important role in species numbers and diversity on this unit.

In recent years between 10 and 27 Hawaiian stilt have been fledged from the site annually. The number of Hawaiian coot is lower than at the Honouliuli unit with about 6 to 10 produced per year. Hawaiian ducks are difficult to separate from the Hawaiian duck x mallard hybrids, so no accurate production data is available. Hawaiian moorhen production ranges from about 4 to 10 per year due to the low numbers of this species occupying the refuge.
Water is provided to the refuge ponds by a new brackish (~ 7 ppt salinity) water well on the refuge. Water flow is controlled by a mechanical timer which allows water to flow into the impoundments to be set to a specific rate and flow time per day. Salinity in the impoundments is higher than at Honouliuli because of the encroachment of harbor water. Salinity is used very successfully as a vegetation management tool at this unit. However, the salinity also limits plant diversity and structure.

RECOMMENDATIONS

<u>Bird Surveys</u>

It is recommended that annual bird surveys occur at discreet (or defined) areas throughout the Pearl Harbor Area. Establish survey points where access will be relatively easy.

It appears Hawaiian stilts may have nested at the non-operational sewage treatment plant water retainment ponds. They should be monitored or surveyed during the nesting season.

LITERATURE CITED

Berger, Andrew J. 1972. Hawaiian bird life. The University Press of Hawaii. Honolulu. 270 pp.

Botanical Consultants. 1984. Flora and fauna report of Naval Air Station, Barbers Point, Oahu, Hawaii. U.S. Navy Contract N62742-84-C-0082

Bruner, Phillip L. 2000. Survey of the avifauna and feral mammals for the Integrated Natural Resources Management Plan for Naval Station (NAVSTA), Public Works Center (PWC) and Fleet and Industrial Supply Center (FISC) Pearl Harbor

Hawaii Audubon Society. 2005. Hawaii's birds. Hawaii Audubon Society. Honolulu. 141 pp.

Hawaiian Agronomics. 1986a. Final report for flora, fauna and water resources surveys of the Pearl Harbor area facilities, Hawaii, Waiawa Water Pumping Facility (Contract N6274285C0137). Hawaiian Agronomics (International), Inc.

Hawaiian Agronomics. 1986b. Final report for flora, fauna and water resources of the Pearl Harbor area facilities, Hawaii, Red Hill Fuel Storage Area (Contract N6274285C0137). Hawaiian Agronomics (International), Inc.

Hawaiian Agronomics. 1986c. Final report for flora, fauna and water resources of the Pearl Harbor area facilities, Hawaii, Naval Magazine, Lualualei, West Loch Branch (Contract N6274285C0137). Hawaiian Agronomics (International), Inc.

Jensen, Peter M. and James Head. 1997. Archaeological reconnaissance survey Naval Magazine Lualualei NAVMAG-West Loch, Lands of Pu'uloa, Honouliuli, Waikele, and Waipi'o District of 'Ewa, Island of O'ahu. Contract No. N62742-93-D-0502. Report 1547.1-121296

Johnson, O. W., and P. G. Connors. 1996. American Golden-Plover (*Pluvialis dominica*), Pacific Golden-Plover (*Pluvialis fulva*). *In* The Birds of North America, No. 201–202 (A. Poole and F. Gill, eds.). The Academy of Natural Sciences, Philadelphia, and The American Ornithologists' Union, Washington, D.C.

Pepi, Vanessa. E. 2006. Report on waterbirds using Niuli'i Ponds within the Niuli'i Wildlife Refuge, Naval and Computer Telecommunications Area Master Station Pacific, Radio Transmitting Facility, Lualualei, Oahu, Hawaii.

Pratt, Thane K. 2003. Christmas Bird Count No. 103: Hawaii/Pacific Islands 2002-2003. 'Elepaio 63(5): 35-40.

Reynolds, R. T., J. M. Scott and R. A. Nussbaum. 1980. A variable circular-plot method for estimating bird numbers. Condor 82(3): 309-313

The Traverse Group, Inc. (TGI). 1988. Natural Resources Management Plan Naval Air Station Barbers Point.

USFWS. 2006. PH Mgt Info to Vanessa 20060906.doc

Wiggins, D. A. (2006). Short-eared Owl (*Asio flammeus*). The Birds of North America Online (A. Poole, Ed.). Ithaca: Cornell Laboratory of Ornithology

Table 36. Species of birds observed at Makalapa Crater (MC), Pearl City Peninsula (PCP), Red Hill (RH), Waiawa Watershed (WW), NAVMAG Westloch (WL), Waipio Peninsula (WP), Navy-retained Lands at Kalaeloa (NRL), Pearl Harbor National Wildlife Refuge Honouliuli and Waiawa Units (PHNWR).

Common Name	Scientific Name	MC	PCP	RH	WW	WL	WP	NRL	PHNWR
California gull	*Larus californicuas*								*
ring-billed gull	*Larus delawarensis*								*
laughing gull	*Larus atricilla*								*
Bonaparte's gull	*Larus philadelphia*								*
Franklin's gull	*Larus pipixcan*								*
Caspian tern	*Sterna caspia*								*
least tern	*Sterna antillarum*								*
white tern	*Gygis alba*								*
great frigatebird	*Fregata minor*								*
red junglefowl	*Gallus gallus*	*			*			*	
mallard	*Anas platyrhynchos*								*
Hawaiian duck	*Anas wyvilliana*								
koloa/mallard hybrid	*Anas spp.*							*	*
Eurasian wigeon	*Anas penelope*								*
American wigeon	*Anas americana*								*
American green-winged teal	*Anas crecca (carolinensis)*								*
green-winged teal	*Anas crecca*								*
garganey	*Anas querquedula*								*
blue-winged teal	*Anas discors*								*
cinnamon teal	*Anas cyanoptera*								*
northern shoveler	*Anas clypeata*								*
northern pintail	*Anas acuta*								*
domestic duck - non mallard	*Anas spp.*								*
lesser scaup	*Aythya affinis*								*
ring-necked duck	*Aythya collaris*								*
bufflehead	*Bucephala albeola*								*
greater white-fronted goose	*Anser albifrons*								*
white-faced ibis	*Plegadis chihi*								*
cattle egret	*Bubulcus ibis*	*	*			*	*	*	*
black-crowned night heron	*Nycticorax nycticorax*		*			*	*		*
Hawaiian moorhen	*Gallinula chloropus*								*
Hawaiian coot	*Fulica alai*								*
Wilson's phalarope	*Phalaropus tricolor*								*
Hawaiian stilt	*Himantopus mexicanus*		*			*		*	*
common snipe	*Gallinago gallinago*								*
long-billed dowitcher	*Limnodromus scolopaceus*								*
stilt sandpiper	*Calidris himantopus*								*
red knot	*Calidris canutus*								*

Table 36 cont.

Common Name	Scientific Name	MC	PCP	RH	WW	WL	WP	NRL	PHNWR
sharp-tailed sandpiper	*Calidris acuminata*								*
pectoral sandpiper	*Calidris melanotos*								*
least sandpiper	*Calidris minutilla*								*
dunlin	*Calidris alpina*								*
curlew sandpiper	*Calidris ferruginea*								*
sanderling	*Calidris alba*								*
bar-tailed godwit	*Limosa lapponica*								*
black-tailed godwit	*Limosa limosa*								*
marsh sandpiper	*Tringa stagnatilis*								*
greater yellowlegs	*Tringa melanoleuca*								*
lesser yellowlegs	*Tringa flavipes*								*
wandering tattler	*Heteroscelus incanus*							*	*
ruff	*Philomachus pugnax*								*
black-bellied plover	*Pluvialis squatarola*								*
Pacific golden plover	*Pluvialis fulva*	*				*	*	*	*
semi-palmated plover	*Charadrius semipalmatus*								*
ruddy turnstone	*Arenaria interpres*					*			*
ring-necked pheasant	*Phasianus colchicus*						*		*
gray francolin	*Francolinus pondicerianus*					*	*	*	*
Erckel's francolin	*Francolinus erkelli*								*
peregrine falcon	*Falco peregrinus*								*
osprey	*Pandion haliaetus*						*		*
barn owl	*Tyto alba*								
Hawaiian owl	*Asio flammeus*						*		*
rock dove	*Columba livia*		*		*				
spotted dove	*Streptopelia chinensis*	*	*	*	*	*	*	*	
zebra dove	*Geopelia striata*	*	*	*	*	*	*	*	
mourning dove	*Zenaida macroura*								*
Eurasian sky lark	*Aluda arvensis*							*	
red-vented bulbul	*Pycnonotus cafer*	*	*		*	*	*	*	
red-whiskered bulbul	*Pycnonotus jocosus*			*	*		*	*	
Japanese bush warbler	*Cettia diphone*				*				
red-billed leiothrix	*Leiothrix lutea*				*				
white-rumped shama	*Copsychus malabaricus*		*		*	*		*	
northern mockingbird	*Mimus polyglottus*							*	
common myna	*Acridotheres tristis*	*	*	*	*	*	*	*	
Japanese white-eye	*Zosterops japonicus*	*	*	*	*	*	*	*	
northern cardinal	*Cardinalis cardinalis*	*	*	*	*	*	*	*	
red-crested cardinal	*Paroaria coronata*	*	*	*	*	*		*	
saffron finch	*Sicalis flaveola*	*		*				*	
house finch	*Carpodacus mexicanus*	*	*	*	*		*	*	
house sparrow	*Passer domesticus*				*			*	

Table 36 cont.

Common Name	Scientific Name	MC	PCP	RH	WW	WL	WP	NRL	PHNWR
yellow-fronted canary	*Serinus mozambicus*	*					*		
common waxbill	*Estrilda astrild*	*	*		*	*	*	*	
orange-cheeked waxbill	*Estrilda melpoda*								
red avadavat	*Amandava amandava*					*	*		
warbling silverbill	*Lonchura malabarica*					*			
chestnut mannikin	*Lonchura malacca*					*		*	
nutmeg mannikin	*Lonchura punctulata*	*			*			*	
Java sparrow	*Padda oryzivora*	*							

Appendix A. Calculated Relative Abundances

Makalapa Crater		
Common Name	**Scientific Name**	**Calculated Relative Abundance**
cattle egret	*Bubulcus ibis*	0.0152
Pacific golden plover	*Pluvialis fulva*	0.0076
spotted dove	*Streptopelia chinensis*	0.0152
zebra dove	*Geopelia striata*	0.1667
red-vented bulbul	*Pycnonotus cafer*	0.1136
common myna	*Acridotheres tristis*	0.0758
Japanese white-eye	*Zosterops japonicus*	0.0682
northern cardinal	*Cardinalis cardinalis*	0.0379
red-crested cardinal	*Paroaria coronata*	0.1061
house finch	*Carpodacus mexicanus*	0.0758
saffron finch	*Sicalis flaveola*	0.0076
yellow-fronted canary	*Serinus mozambicus*	0.0227
common waxbill	*Estrilda astrild*	0.1970
Java sparrow	*Padda oryzivora*	0.0758
nutmeg mannikin	*Lonchura punctulata*	0.0152

Pearl City Peninsula		
Common Name	**Scientific Name**	**Calculated Relative Abundance**
cattle egret	*Bubulcus ibis*	0.0673
black-crowned night heron	*Nycticorax nycticorax*	0.0096
black-necked stilt	*Himantopus mexicanus*	0.0769
rock dove	*Columba livia*	0.0865
spotted dove	*Streptopelia chinensis*	0.0865
zebra dove	*Geopelia striata*	0.0769
red-vented bulbul	*Pycnonotus cafer*	0.2019
white-rumped shama	*Copsychus malabaricus*	0.0096
common myna	*Acridotheres tristis*	0.0288
Japanese white-eye	*Zosterops japonicus*	0.2115
northern cardinal	*Cardinalis cardinalis*	0.0481
red-crested cardinal	*Paroaria coronata*	0.0288
house finch	*Carpodacus mexicanus*	0.0577
common waxbill	*Estrilda astrild*	0.0096

Redhill		
Common Name	Scientific Name	Calculated Relative Abundance
spotted dove	*Streptopelia chinensis*	0.0250
zebra dove	*Geopelia striata*	0.0500
red-vented bulbul	*Pycnonotus cafer*	0.2750
red-whiskered bulbul	*Pycnonotus jocosus*	0.1250
common myna	*Acridotheres tristis*	0.1250
Japanese white-eye	*Zosterops japonicus*	0.2500
northern cardinal	*Cardinalis cardinalis*	0.0250
red-crested cardinal	*Paroaria coronata*	0.0750
saffron finch	*Sicalis flaveola*	0.0250
house finch	*Carpodacus mexicanus*	0.0250

Waiawa Watershed		
Common Name	Scientific Name	Calculated Relative Abundance
spotted dove	*Streptopelia chinensis*	0.1149
rock dove	*Columba livia*	0.0230
zebra dove	*Geopelia striata*	0.1264
red-vented bulbul	*Pycnonotus cafer*	0.0766
red-whiskered bulbul	*Pycnonotus jocosus*	0.0690
Japanese bush warbler	*Cettia diphone*	0.0307
white-rumped shama	*Copsychus malabaricus*	0.0268
red-billed leiothrix	*Leiothrix lutea*	0.0536
red junglefowl	*Gallus gallus*	0.0038
common myna	*Acridotheres tristis*	0.0115
Japanese white-eye	*Zosterops japonicus*	0.1877
northern cardinal	*Cardinalis cardinalis*	0.0192
red-crested cardinal	*Paroaria coronata*	0.0038
house finch	*Carpodacus mexicanus*	0.0192
house sparrow	*Passer domesticus*	0.1188
common waxbill	*Estrilda astrild*	0.1111
nutmeg mannikin	*Lonchura punctulata*	0.0038

NAVMAG Westloch		
Common Name	Scientific Name	Calculated Relative Abundance
ruddy turnstone	Arenaria interpres	0.0090
cattle egret	Bubulcus ibis	0.0270
black-crowned night heron	Nycticorax nycticorax	0.0090
Hawaiian stilt	Himantopus mexicanus	0.0270
Pacific golden plover	Pluvialis fulva	0.1532
gray francolin	Francolinus pondicerianus	0.1532
spotted dove	Streptopelia chinensis	0.1622
zebra dove	Geopelia striata	0.1351
red-vented bulbul	Pycnonotus cafer	0.1081
white-rumped shama	Copsychus malabaricus	0.0180
common myna	Acridotheres tristis	0.0270
Japanese white-eye	Zosterops japonicus	0.1622
northern cardinal	Cardinalis cardinalis	0.0631
red-crested cardinal	Paroaria coronata	0.0270
common waxbill	Estrilda astrild	0.0360
red avadavat	Amandava amandava	0.0090
warbling silverbill	Lonchura malabarica	0.0090
chestnut mannikin	Lonchura malacca	0.0090

Waipio Peninsula		
Common Name	Scientific Name	Calculated Relative Abundance
ring-necked pheasant	*Phasianus colchicus*	0.0164
gray francolin	*Francolinus pondicerianus*	0.0437
barn owl	*Tyto alba*	0.0055
spotted dove	*Streptopelia chinensis*	0.2240
zebra dove	*Geopelia striata*	0.0437
red-vented bulbul	*Pycnonotus cafer*	0.0328
red-whiskered bulbul	*Pycnonotus jocosus*	0.0055
common myna	*Acridotheres tristis*	0.0055
Japanese white-eye	*Zosterops japonicus*	0.2131
northern cardinal	*Cardinalis cardinalis*	0.0383
red-crested cardinal	*Paroaria coronata*	0.0546
house finch	*Carpodacus mexicanus*	0.0164
yellow-fronted canary	*Serinus mozambicus*	0.0055
common waxbill	*Estrilda astrild*	0.2842
red avadavat	*Amandava amandava*	0.0109

Golf Course & Stable Area		
Common Name	**Scientific Name**	**Calculated Relative Abundance**
gray francolin	*Francolinus pondicerianus*	0.0313
red junglefowl	*Gallus gallus*	0.0469
Pacific golden plover	*Pluvialis fulva*	0.0156
spotted dove	*Streptopelia chinensis*	0.0703
zebra dove	*Geopelia striata*	0.1328
red-vented bulbul	*Pycnonotus cafer*	0.1250
white-rumped shama	*Copsychus malabaricus*	0.0156
northern mockingbird	*Mimus polyglottus*	0.0078
common myna	*Acridotheres tristis*	0.1016
Japanese white-eye	*Zosterops japonicus*	0.1172
northern cardinal	*Cardinalis cardinalis*	0.0703
red-crested cardinal	*Paroaria coronata*	0.1406
house finch	*Carpodacus mexicanus*	0.0781
common waxbill	*Estrilda astrild*	0.0469

Pearl Harbor Wide	
Common Name	**Calculated Relative Abundance**
ruddy turnstone	0.0010
cattle egret	0.0125
black-crowned night heron	0.0021
Hawaiian stilt	0.0115
Pacific golden plover	0.0042
ring-necked pheasant	0.0031
gray francolin	0.0303
moa	0.0063
spotted dove	0.1148
rock dove	0.0157
zebra dove	0.1096
red-vented bulbul	0.1054
red-whiskered bulbul	0.0251
Japanese bush warbler	0.0084
white-rumped shama	0.0125
red-billed leiothrix	0.0146
red junglefowl	0.0010
northern mockingbird	0.0010
common myna	0.0397
Japanese white-eye	0.1691
northern cardinal	0.0407
red-crested cardinal	0.0365
house finch	0.0365
saffron finch	0.0021
house sparrow	0.0324
yellow-fronted canary	0.0042
common waxbill	0.1232
nutmeg mannikin	0.0031
red avadavat	0.0031
warbling silverbill	0.0010
chestnut mannikin	0.0010
Java sparrow	0.0104

A9 – O‘AHU HERPETOLOGICAL AND MAMMAL SURVEYS (NAVFAC PAC 2006D)

This page is intentionally left blank.

Introduction

Herpetological and mammal surveys were performed on Navy lands on Oahu during February - December 2006. The surveys were performed for the update of the base Integrated Natural Resources Management Plan.

Mammal Sampling

Methods

Small mammals were sampled by trap lines of Victor Snap traps. Traps were set up and baited in the afternoon and checked the following morning. Traps were set on the ground and also 1-1.5 meters off ground by wiring to trees. Traps were baited with dried squid and peanut butter. Trap spacing was 15-20 meters. The abundance was expressed as the number of rats captured divided by the number of trapping nights to yield a capture percentage. One trap set for one night equals one trap night. So, 20 traps set for one night equals 20 trapping nights and 20 traps set for 2 nights equals 40 traps nights etc. Four rats captured on 20 trapping nights yields a catch rate of 0.20 (20%): 4/20= 0.20.

Mammals and mammal sign were also observed opportunistically during other surveys or when setting up the trap lines.

Sampled areas include: the forested area at Makalapa, Waiawa watershed, Waipio peninsula, Red hill area and 2 sites at the Naval Magazine at Lualualei: the Niulii ponds area and the upper slopes of Lualualei valley.

Results

A total of 406 trapping nights were performed for the small mammal sampling. The only rat species captured was the black rat, *Rattus rattus*. In addition to this, 4 house mice, *Mus musculus* were captured at the Niulii ponds site and one Mongoose was captured at Makalapa. See chart 1. for species captured and the capture rates.

Feral cats, *Felis catus*, and mongoose, *Herpestes auropunctatus*, were observed on all the sites sampled, except the upper elevations at Lualualei. Both species were considered very abundant at the sites where they occurred. It was beyond the scope of this study to determine absolute numbers for these species.

Feral pigs, *Sus scrofa*, or their sign were observed at Waiawa, Lualualei and the Red hill area. Feral pigs were considered abundant at each site. Again, it was not possible to determine absolute population numbers for the species.

We also have a report (Joel Lau pers. comm.) of feral goats, *Capra hircus*, in the upper elevations of the Lualualei valley.

Chart 1.

Small mammal trapping rates

Area sampled	Off ground traps	Ground traps	Total catch rate
Makalapa	0	*Rattus* – 0.17 Mongoose – 0.08	*Rattus* - .09 Mongoose - .04
Waiawa	0	*Rattus* – 0.05	*Rattus* – 0.025
Waipio	0	0	0
Lualualei	*Rattus* - 0.07	*Rattus* - 0.08	0.075
Niulii ponds	*Rattus* – 0.04	*Mus* – 0.16	*Rattus* – 0.02 *Mus* – 0.08

Discussion

Rats

Only one species of rat was documented, *Rattus rattus*. Rat numbers appear to be low at all areas sampled. We did experience trap interference with ground traps, presumably from mongoose. This was especially evident at Waipio peninsula. So, while we did not capture rats at Waipio we feel that they undoubtedly occur there. Due to trap interference, the rat densities could be higher than what the trap rates indicate.

Areas of special concern are Niulii ponds and the upper elevations of Lualualei both of which have endangered species. Lualualei has elepaio and Niulii ponds has moorhens, Hawaiian coots, and Hawaiian stilts. The elepaio sub-population at Lualualei however, appears to consist of only 4-6 individuals and all are male (Vogt, 2006). Rats are known threats to elepaio populations (Vanderwerf and Smith, 2002) and if there are breeding pairs of elepaio at Lualualei then rat control is warranted. At this time such does not appear to be the case.

Carnivores: Feral Cats and Mongoose

Feral cats, and mongoose, were abundant at all sites with the exception of the upper elevations at Lualualei. The impacts of cats and mongoose on island species are well documented, however at most of these sites native species are not present. The exception is the Niulii pond area and mongoose control is being performed there by U.S. Depart of Agriculture, Wildlife Services.

Ungulates: Feral Pigs and Feral Goats

Feral pigs and goats can have devastating effects on Pacific island native plants (Williamson 1996). However control or eradication of these ungulates is difficult in Hawaii for logistic and political reasons. Without fencing to stop immigration feral ungulate control can be an almost futile endeavor. Also both species are very popular for

sport hunting in Hawaii although goats are less popular than pigs. Goats are also easier to eradicate than pigs due to their diurnal activities, herding behavior and grazing habits. Goat control was performed at Lualualei in 2001. However because the area is not fenced, we now have reports of goats coming back.

Management Recommendations

Rats

At this time we do not recommend rat control on any Navy lands on Oahu. Given the difficulties of rat control and the paucity of native species we do not feel that rat control is a worthwhile endeavor at this time.

Carnivores: Feral Cats and Mongoose

Mongoose control at Niulii ponds should continue. These ponds are important for native wetland birds and should be protected. At this time large scale control of feral cats and mongoose on Oahu Navy lands is too difficult without a barrier to prevent immigration.

Ungulates: Feral Pigs and Feral Goats

At this time we recommend that no management actions be taken for feral pigs. Without fencing feral pigs are too difficult to control. We do recommend that the feral goat situation at Lualualei be investigated. If goats are documented there, control/eradication should be implemented.

Reptile and Amphibian Sampling

Methods

Reptiles were sampled with adhesive glue boards (sticky traps) set on the ground and stapled to the trunks of trees. Captured reptiles (lizards) were identified and removed with vegetable oil and released at the point of capture. Sticky traps were set for day and night time sampling.

Reptiles were also sampled by walking timed transects during the day.

These types of sampling give presence or absence data and a very broad indication of abundance. They do not give absolute numbers or fine scale indices of abundance.

Areas sampled include: the upper elevations of Lualualei valley and Niulii ponds at the Naval Magazine, Makalapa, Waiawa watershed, Waipio peninsula, Pearl City peninsula.

Results:

The following species were documented at the following sites.

House Gecko, *Hemidactylus frenatus*: All sites.
Mourning Gecko, *Lepidodactylus lugubrus*: All sites.
Indo-Pacific Gecko, *Hemidactylus garnotii*: Waiawa watershed.
Cane Toad, Bufo murinus: Niulii ponds.

H. frenatus and *L lugubrus* were abundant at all sites and *H garnotii* was abundant at Waiawa.

Cane toads, *Bugo murinus* and Red eared slider turtles, *Trachemys scripta* have been observed at the Niulii ponds (Pepi pers. comm..).
.

Discussion:

Ground skinks and *Anolis* sp. were not documented. These species are abundant on other areas of Oahu (McKeown, 1996) and were expected to be documented on Navy lands. It is thought that *Anolis* sp. do occur on Navy lands but in urban areas around human structures or habitations (F. Kraus pers. comm.). These areas were not surveyed well as this is a plan for the natural resource areas. While skink species are common on Oahu their distribution is spotty and is restricted to wet and humid areas (F. Kraus pers. comm.). The areas surveyed for this plan, were drier and less humid and may have not been optimal ground skink habitat.

None of the documented species are considered to be native although *L. lugubrus* and *H. garnotii* may have arrived with the first Polynesian canoes (McKeown, 1996). All were considered to be abundant where they occur.

At present, reptile and amphibian diversity on Oahu Navy lands is low.

Management Recommendations:

There are no management recommendations for reptiles and amphibians at this time.

References

Brennan, M., Moller, H., and J. P. Parkes. 1993. Indices of density of feral goats in a grassland/forest habitat, Marlborough, New Zealand. New Zealand Journal of Ecology (1993) 17(2): 103-106.

Dowding, J. E., and E. C. Murphy. 2001. The impact of predation by introduced mammals on endemic shorebirds in New Zealand: a conservation perspective. Biological Conservation 99: 47-64.

Mckeown Sean. 1996. Reptiles and Amphibians in the Hawaiian islands. Diamonhead Publishing Inc. 172 pp.

Mcneill, J.R. 1994. Of rats and men: a synoptic environmental history of the island pacific. Journal of World History. Vol. 5 No. 2 pp 299-347.

Nowak, Ronald M. 1999. Walker's mammals of the world. Sixth edition. The Johns Hopkins University Press. Baltimore and London.

VanderWerf, E. A. and D.G. Smith. 2002. Effects of alien rodent control on demography of the O'ahu 'Elepaio, an endangered Hawaiian forest bird. Pacific Conservation Biology 8:83-81.

Williamson, M. 1996. Biological invasions. Chapman and Hall. 244 pp.

A10 – WAIAWA STREAM AQUATIC SPECIES SURVEY (NAVFAC PAC 2007C)

This page is intentionally left blank.

Waiawa Stream Aquatic Species Survey
23 June 2007
Cory Campora, NAVFAC Pacific

Introduction

NAVFAC Pacific Natural Resources entomologist, Cory Campora, and NAVFAC Pacific Environmental employee Dennis Habecker surveyed the portion of Waiawa stream that flows over Navy property On 23 June 2006. This included the length of the stream from where it passes under the road leading to the pump station up to where it crosses onto private land (approximately 1.5 km). The primary purpose of the survey was to determine if native Hawaiian damselflies (*Megalagrion* sp.) were present in this area.

Methods

Observations on the presence/absence of adult damselflies were made along the stream bed at 50 meter intervals and at all major pool areas (the stream was not flowing at the time of the survey and consisted of intermittent pools of various sizes and depths). Three to Five samples were taken from each major pool with a D-frame aquatic net and inspected on-site for damselfly nymphs. All aquatic organisms observed in pools were recorded.

Figure 1. Waiawa Stream on 23 June 2003, showing dry bed and small pool.

Results

All aquatic animal species observed in Waiawa Stream on this survey are listed in Table 1.

No adult or immature damselflies were observed or caught in portion of Waiawa stream that flows over Navy-owned land. The only member of the Odonata (order of insects comprised of dragonflies and damselflies) found in this portion of the stream was the dragonfly *Pantala flavescens*. An adult *P. flavescens* was seen flying above the stream bed, and an immature nymph was caught in one of the pools. This species is indigenous to Hawaii and is commonly found around ponds, slow moving streams, and temporary pools.

Table 1. Aquatic animal species observed in Waiawa Stream on 23 June 2007

Species	Common Name	Origin
Pantala flavescens	Wandering glider (dragonfly)	indigenous
*Awaous guamensis**	O'opu nakea	indigenous
Clarias fuscus	Chinese catfish	alien
Poeciliidae spp.	Topminnows	alien
Bufo marinus	Cane toad tadpole	alien
Rana catesbeiana	Bullfrog tadpole	alien
Macrobrachium lar	Tahitian prawn	alien

*Observed in a large pool just above the Navy property line.

The only other species seen that is indigenous to Hawaii was *Awaous guamensis*, or 'o'opu nakea. This fish represents Hawaii's largest native 'o'opu, or goby. It is not considered endemic to Hawaii, however, because it also occurs elsewhere in the pacific. The pool in which the goby seen during this survey (see Figures 2 and 3) was located did not occur on Navy property – it was located approximately 50 meters above the Navy property line. Notwithstanding the absence of *A. guamensis* in the Navy portion of Waiawa Stream, it is certainly logical to assume that, during times of higher water, this species is found in some areas of the stream that flow over Navy land. At the very least, it travels down through the Navy portion of the stream to spawn. Two individuals were seen in the pool.

Figure 2.

'O'opu nakea (Awaous guamensis) in Waiawa Stream.

Figure 3. Large pool in just beyond Navy property line that contained 'O'opu nakea.

Recommendations

Although the Navy owned portion of Waiawa Stream was not found to harbor native Hawaiian damselflies, it doe provide habitat for an indigenous dragonfly and a native fish species. It is therefore recommended that this portion of the stream be retained in its natural state, and that no land development be pursued that would alter the quality of the stream or degrade the streamside habitat.

Figure 4. Tadpoles of *Bufo marinus* and poeciliid minnows in Waiawa Stream.

Figure 5. A Tahitian prawn, or giant freshwater shrimp, in Waiawa Stream.

A11 – SURVEY OF AVIFAUNA AND FERAL MAMMALS FOR THE INTEGRATED NATURAL RESOURCES MANAGEMENT PLAN FOR NAVAL STATION (NAVSTA), PUBLIC WORKS CENTER (PWC), AND FLEET INDUSTRIAL SUPPLY CENTER (FISC) PEARL HARBOR (BRUNER 2000A)

This page is intentionally left blank.

SURVEY OF THE AVIFAUNA AND FERAL MAMMALS FOR THE INTEGRATED NATURAL RESOURCES MANAGEMENT PLAN FOR NAVAL STATION (NAVSTA), PUBLIC WORKS CENTER (PWC) AND FLEET AND INDUSTRIAL SUPPLY CENTER (FISC) PEARL HARBOR

Prepared for

Helber Hastert and Fee

Phillip L. Bruner
Assistant Professor of Biology
Director, Museum of Natural History
BYU-Hawaii
Environmental Consultant Faunal (Bird & Mammal) Surveys

17 January 2000

CONTENTS

Introduction

The purpose of this report is to summarize the findings of bird and mammal field surveys conducted for Naval Station (NAVSTA), Public Works Center (PWC) and Fleet and Industrial Supply Center (FISC) Pearl Harbor. The surveys were conducted at the main Pearl Harbor Complex, Pearl City Peninsula, Waiawa Watershed and Red Hill Fuel Farm during November and December 1999. Also included are references to pertinent literature and unpublished reports.

The objectives of the field survey and literature review were to:

1- Document what bird and mammal species actually occur on these sites. Note what other birds and mammals potentially could occur in this area given the types of habitat available.

2- Provide some baseline data on the relative abundance of each species at each site.

3- Note the presence or likely occurrence of any native fauna, particularly those that are listed as “Endangered” or “Threatened”.

4- Determine the location of any special or unique resources important to native fauna.

Site Descriptions

Pearl Harbor Complex: Shoreline

This area includes the shoreline around the harbor. Mangrove and Kiawe are the dominant trees. Along the river drainages Milo and Java Plum are common trees. Wildlife refuges and fishponds can be found in the complex.

Pearl City Peninsula:

Kiawe and other introduced trees dominate this site. Large areas are open grass/brush habitat can also be found. Residential property and paved areas also occur on the peninsula. Mangrove and Milo occur along stream drainages and portions of the shoreline. The Pearl City Unit of the Pearl Harbor National Wildlife Refuge is also a part of this area. This unit is also known as the Waiawa Unit.

Waiawa Watershed:

Riparian habitat along Waiawa Stream is dominated by Java Plum and other introduced trees. Residential, industrial and agricultural properties surround the site.

Red Hill Fuel Farm:

Introduced trees characterize this property. Residential, industrial and State forest lands adjoin the site. The stream drainage is a chanelized cement ditch.

Study Methods

Pearl Harbor Complex: Shoreline

On 18 November 1999 the entire shoreline was surveyed from a boat and by walking into accessible sites with wetland habitat. Streams and fish ponds were also investigated using the boat.

Figure One shows the location of eight sites more closely examined. These areas had the greatest potential for foraging waterbirds.

Pearl City Peninsula:

This area was surveyed along the shoreline on 18 November 1999. A driving and walking visit was also conducted on 7 December 1999. All habitats were sampled on the surveys.

Waiawa Watershed:

A walking survey of this site was conducted on 2 December 1999. A night of heavy rain preceding the survey created very high water in the stream. The steep valley walls were surveyed by binoculars.

Red Hill Fuel Farm:

This site was visited on 28, 30 December 1999 and 6 January 2000. The survey was conducted on foot and by car along existing roads.

A checklist of species either heard or seen at each site was kept. Estimates of relative abundance were also noted. Published and unpublished reports of birds known from similar habitat on Oahu were also consulted in order to acquire a better perspective of the possible fauna that could occur in this region and their potential relative abundance (Pratt et al. 1987; Hawaii Audubon Society 1993; Bruner 1984, 1989a, 1989b, 1991, 1992; Pyle 1993, 1996, 1999, 2000). Observations of feral mammals were limited to visual sightings and evidence in the form of scats and tracks. No attempts were made to trap mammals in order to obtain data on their relative abundance and distribution. Such an effort was not possible nor necessary within the scope and time constraints of these field surveys.

Scientific names of birds and mammals used in this report follow those given in Pyle (1997) and Honacki et al. (1982). These sources give the currently accepted taxonomy for birds and mammals covered in this report.

Results and Discussion

Pearl Harbor Complex: Shoreline

This site was surveyed on 10 November 1998 and 18 November 1999. The focus on the shoreline survey of Pearl Harbor was to examine habitats suitable for foraging waterbirds and shorebirds. No attempt to list or estimate the relative abundance of introduced birds was made in this area. Eight sites were examined as actual or potential habitats for waterbirds (Fig. 1). Only three of the eight sites contained birds at the time of the survey. Site Two (Waiawa Stream) had four Koloa (Anas wyvilliana) and one Black-crowned Night-Heron (Nycticorax nycticorax). Site Four (Walker Bay) contained two Black-necked Stilt (Himantopus mexicanus). Site Seven (Pearl Harbor National Wildlife Refuge) had 15 Black-necked Stilt and 12 Hawaiian Coot (Fulica alai).

The habitats at these sites included rocky shorelines with mangrove thickets, stream drainages with a mixture of introduced trees and grass, and remnant fishponds lined with mangrove and rocky shorelines. Surprisingly few waterbirds were seen on the survey of the Pearl Harbor shoreline. Perhaps a survey at dusk might record more Black-crowned Night-Heron. Black-necked Stilt habitat was limited. The majority of the shoreline is either too thick with vegetation or the slope too steep to provide shallow areas suitable for wading birds like stilts. In addition, migratory shorebirds such as Wandering Tattler (Heteroscelus incanus), Ruddy Turnstone (Arenaria interpres) and Pacific Golden-Plover (Pluvialis fulva) were not recorded on the survey. These common migrants likely forage at the few accessible rocky beaches around the harbor. The Koloa ducks found at the Waiawa Stream mouth were the only waterfowl recorded on the Pearl Harbor shoreline survey. No waterbirds or shorebirds were observed in the remnant fishponds. Pouhala Marsh and West Loch Shores

Park also provide shorebird habitat but are not part of the study area and were not examined on this survey. Data on Pouhala Marsh are available through Job Progress Reports of the Division of Forestry and Wildlife, State of Hawaii. Additional data on birds can be had by consulting Bruner 1984, 1989a, 1989b.

Pearl City Peninsula:

This area was examined as part of the shoreline survey on 18 November 1999 and on a separate visit on 7 December 1999. Table One gives the findings of these surveys. The 1991 Natural Resource Management Plan (NRMP) and Bruner 1991 provide additional data on portions of this area and are included in Table One. That information, however, is nearly ten years old. More recent data on waterbirds and shorebirds are available in the Job Progress Reports of the State of Hawaii Division of Forestry and Wildlife which survey wetlands on Oahu on a bi-annual basis. Pyle (1993, 1996, 1999) gives the findings of Hawaii Audubon Society Christmas Counts which includes the Pearl City Peninsula under the Waipio Count portion of his reports. The stream drainages, lawns and wildlife refuges provide important habitats for waterbirds and shorebirds. Lawn areas contain territorial Pacific Golden-Plover. This species is the most common winter migrant in Hawaii and has been studied intensely over this last two decades (Johnson et al. 1981, Johnson and Johnson 1983, Johnson et al. 1989, Hawaii Audubon Society 1993).

Waiawa Watershed:

This site was visited on 2 December 1999. Table Two gives the findings of the survey of this area. Data from the 1991 NRMP and Bruner 1992 provide additional information, however, these data are nearly ten years old. The Job Progress Reports of the Division of Forestry and Wildlife bi-annual waterbird surveys and Pyle (1999) give more recent data. The information in these sources comes from the Waiawa area but not the Navy's lands. Nevertheless their findings compliment those obtained on this current study of the Waiawa watershed.

Red Hill Fuel Farm:

Three visits to this site (28, 30 December 1999, 6 January 2000) provided an adequate accounting of the species present on the property. Table Three gives the data of this survey plus that contained in the 1991 NRMP report. The 1991 NRMP data came from a 1986 report and are thus more than ten years old. Nevertheless they provide comparison of past and present species composition and abundance at this site.

Taxonomic Notes

The 1991 NRMP contains common and scientific names that have changed since that time. The Lesser Golden-Plover (Pluvialis dominica) is now called the Pacific Golden-Plover (Pluvialis fulva). The Common Barn Owl is now called the Barn owl. The Hawaii population of the American Coot (Fulica americana) is now recognized as specifically distinct and is called the Hawaiian Coot (Fulica alai). The Strawberry Finch/Red Munia is now called the Red Avadavat.

Mammals:

Small Indian Mongoose (Herpestes auropunctatus) was recorded at Waiawa Watershed, Red Hill Fuel Farm and Pearl City Peninsula. Mongoose are abundant on Oahu, particularly in low elevation second growth vegetation and agricultural lands. Feral cats (Felis catus) are also abundant in urban and non-urban habitats. Cats were seen at Pearl City Peninsula and Red Hill Fuel Farm but not at Waiawa Watershed. Cats and mongoose are significant bird

predators. No feral dogs were observed. Rats and mice were likewise not seen but undoubtedly occur at all of the sites. The endangered Hawaiian Hoary Bat (Lasiurus cinereus semotus) occurs in low numbers on Oahu (Tomich 1986; Kepler and Scott 1990). Jacobs (1991, 1993) and Reynolds et al. (1998) provide additional information on this species. No bats were found on the surveys conducted for this report.

Conclusions

Pearl Harbor Complex: Shoreline

Few waterbirds and shorebirds were seen on the surveys of the shoreline surrounding Pearl Harbor. The primary reason for this was the limited areas with suitable foraging habitat for these species. The banks along most of the shoreline are steep and the water too deep for wading birds like stilt or migratory shorebirds. Large sections of the shoreline are covered in a dense tangle of mangrove trees which also restricts shallow water access to waders. The few areas with waterbirds were stream mouths or established wildlife refuges. Disturbance from human activity such as fishing and boating did not seem to be much of a problem. Little activity of this sort was noted on the survey. Water depth and shoreline access seem to be the major limiting factors on waterbird and shorebird activity around the shoreline of Pearl Harbor. It might be possible to enhance several sections of the shoreline for waterbirds and shorebirds. This might entail removal of some mangrove where the banks have a gentle slope and shallow areas for wading can be exposed. It does not make sense to remove mangrove from steep banks since these areas have water too deep for waders. The mangrove also helps to stabilize the shoreline against wave erosion. The restoration of the remnant fishponds might improve waterbird habitat if the landward side of the pond's shoreline were cleared of vegetation to allow wader access. Black-crowned Night-Herons and stilts would use this habitat. Migratory shorebirds would also benefit by the exposed shoreline.

Pearl City Peninsula:

This area was surveyed by boat along the shoreline as well as by walking and driving portions of the interior of the peninsula. The Pearl City Unit (also known as the Waiawa Unit) of the Pearl Harbor National Wildlife Refuge contains the most valuable waterbird habitat on the peninsula. Lawns and other open areas also provide habitat for migrants such as Pacific Golden-Plover and Ruddy Turnstone. The typical mix of introduced species were seen on this survey. Some of the shoreline fronting the refuge might be improved by careful clearing of some vegetation to create wading opportunities. This would need to be an ongoing endeavor due to the robust growth habits of mangrove and other shoreline vegetation.

Waiawa Watershed:

The stream provides foraging habitat for Black-crowned Night Herons. The forested habitat along the stream and up the slopes of the valley host a wide variety of introduced birds. The limited access to this site, despite being surrounded by industrial and residential/agricultural lands, makes this property a small oasis for birds. Not only were many species tallied, but their numbers were also robust. This site should probably be left in its present condition. More public access would not enhance the site for birds.

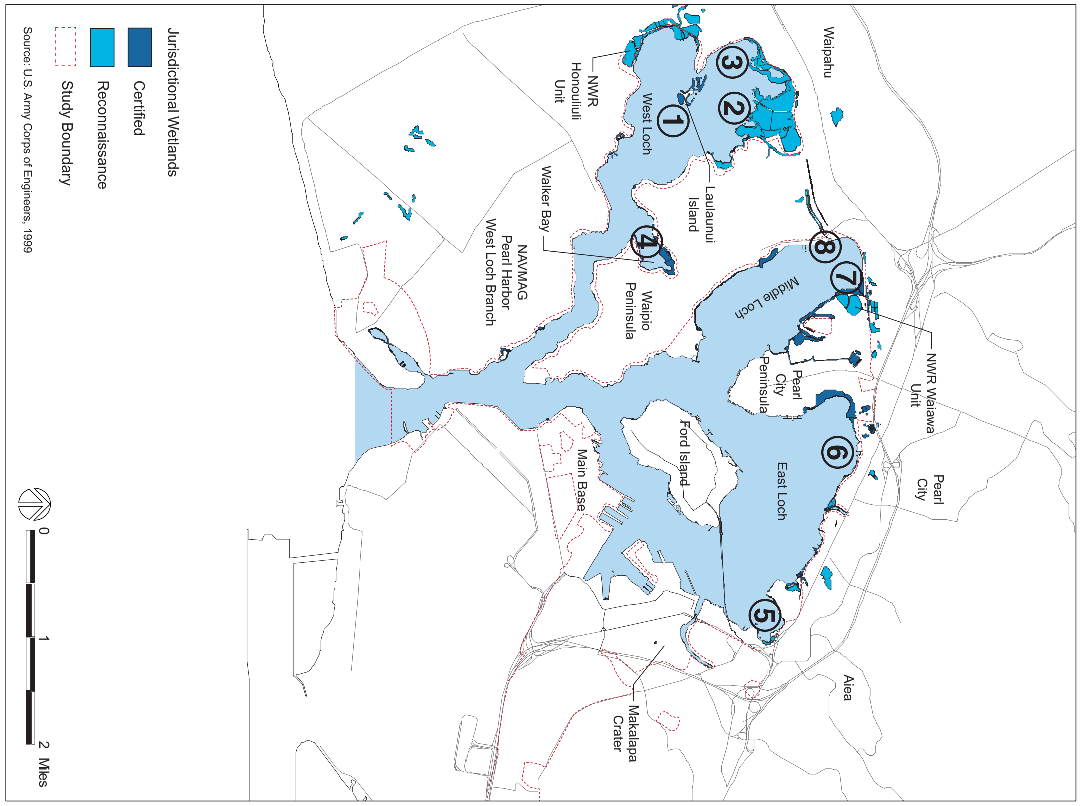
Red Hill Fuel Farm:

The steep topography of this site limits access except along the existing roads. The forest seemed less diversified than Waiawa Watershed and the

stream has been reduced to a cement lined ditch. Nevertheless there was a reasonable array of introduced birds recorded on the surveys. The elevation and vegetation were not appropriate for native forest birds. The Pacific Golden-Plover was the only migrant recorded. The removal of the introduced trees along the ridge line and their replacement with native species such as Koa could improve the forest and might in time make the area more attractive. Whether or not this would ever result in native birds such as the Oahu Amakihi (Hemignathus chloris) foraging at this site remains to be seen.

Mammals:

The typical array of introduced mammals were recorded on the surveys. More detailed information could be had by trapping. The time and effort required to conduct a trapping program was not justified for these sites. The endangered Hawaiian Hoary Bat was not recorded. The limited number of recent sightings on Oahu would suggest that this species occurrence at the sites covered by this report would be infrequent at best.



Avifauna Survey Sites **Figure 1**

(Survey Dates: November 10 & 18, 1999)

Table 1: Pearl City Peninsula Bird Species

Birds recorded on 1999 surveys of the shoreline and interior portions of Pearl City Peninsula. Relative abundance estimates are based on the following scale: Abundant = 25+, Common = 15-25, Uncommon = 5-14, Rare = less than 5. Species also listed in the 1991 Natural Resources Management Plan and or in Bruner 1991 are noted with an *.

Common Name	Scientific Name	Relative Abundance Estimate
Cattle Egret*	Bubulcus ibis	C
Black-crowned Night-Heron*	Nycticorax nycticorax	R
Ring-necked Pheasant	Phasianus colchicus	R
Pacific Golden-Plover*	Pluvialis fulva	A
Black-necked Stilt*	Himantopus mexicanus	R
Ruddy Turnstone*	Arenaria interpres	C
Rock Dove*	Columba livia	U
Spotted Dove*	Streptopelia chinensis	C
Zebra Dove*	Geopelia striata	A
Sky Lark	Alauda arvensis	U
Red-vented Bulbul*	Pycnonotus cafer	A
Japanese Bush-Warbler	Cettia diphone	U
White-rumped Shama	Copsychus malabaricus	R
Northern Mockingbird*	Mimus polyglottos	U
Common Myna*	Acridotheres tristis	A
Japanese White-eye*	Zosterops japonicus	A
Northern Cardinal*	Cardinalis cardinalis	C
Red-crested Cardinal*	Paroaria coronata	C
Saffron Finch	Sicalis flaveola	R
House Finch*	Carpodacus mexicanus	A
House Sparrow*	Passer domesticus	C
Common Waxbill*	Estrilda astrild	A

TABLE 1 (cont.)

Common Name	Scientific Name	Relative Abundance Estimate
Red Avadavat*	Amandava amandava	R
Nutmeg Mannikin*	Lonchura punctulata	C
Chestnut Mannikin*	Lonchura malacca	R
Java Sparrow	Padda oryzivora	C

Table 2: Waiawa Watershed Bird Species

Birds recorded on 1999 survey of Waiawa Watershed. Relative abundance estimates are based on the following scale: Abundant = 25+, Common = 15-25, Uncommon = 5-14, Rare = less than 5. Species also listed in the 1991 Natural Resources Management Plan and or in Bruner 1992 are noted with an *.

Common Name	Scientific Name	Relative Abundance Estimate
Cattle Egret*	Bubulcus ibis	R
Black-crowned Night-Heron*	Nycticorax nycticorax	R
Pacific Golden-Plover*	Pluvialis fulva	R
Wandering Tattler	Heteroscelus incanus	R
Spotted Dove*	Streptopelia chinensis	C
Zebra Dove*	Geopelia striata	C
Red-vented Bulbul*	Pycnonotus cafer	A
Red-whiskered Bulbul	Pycnonotus jocosus	C
Japanese Bush-Warbler*	Cettia diphone	U
White-rumped Shama*	Copsychus malabaricus	C
Red-billed Leiothrix	Leiothrix lutea	C
Common Myna*	Acridotheres tristis	C
Japanese White-eye*	Zosterops japonicus	A
Northern Cardinal*	Cardinalis cardinalis	C
Red-crested Cardinal*	Paroaria coronata	C
House Finch*	Carpodacus mexicanus	A
House Sparrow*	Passer domesticus	R
Common Waxbill*	Estrilda astrild	C
Red Avadavat*	Amandava amandava	R
Nutmeg Mannikin*	Lonchura punctulata	U

Table 3: Red Hill Fuel Annex Bird Species

Birds recorded on 1999 and 2000 surveys of Red Hill Fuel Farm. Relative abundance estimates are based on the following scale: Abundant = 25+, Common = 15-25, Uncommon = 5-14, Rare = less than 5. Species noted on the 1991 Natural Resources Management Plan are noted with an *.

Common Name	Scientific Name	Relative Abundance Estimate
Pacific Golden-Plover*	Pluvialis fulva	U
Spotted Dove*	Streptopelia chinensis	A
Zebra Dove*	Geopelia striata	C
Red-vented Bulbul*	Pycnonotus cafer	A
Red-whiskered Bulbul	Pycnonotus jocosus	C
Japanese Bush-Warbler	Cettia diphone	U
White-rumped Shama*	Copsychus malabaricus	U
Red-billed Leiothrix	Leiothrix lutea	R
Northern Mockingbird*	Mimus polyglottos	R
Common Myna*	Acridotheres tristis	C
Japanese White-eye*	Zosterops japonicus	A
Northern Cardinal*	Cardinalis cardinalis	C
Red-crested Cardinal*	Paroaria coronata	C
Saffron Finch	Sicalis flaveola	R
House Finch*	Carpodacus mexicanus	A
House Sparrow	Passer domesticus	U
Common Waxbill	Estrilda astrild	C
Java Sparrow	Padda oryzivora	C

Sources Cited

Bruner, P.L. 1984. Avifaunal and feral mammal survey for the proposed Ford Island Causeway, Oahu. Unpubl. Ms. Prep. For Belt Collins and Associates. Honolulu.

________ 1989a. Survey of the avifauna and feral mammals at Ford Island, Pearl Harbor, Oahu. Unpubl. Ms. Prep. For Belt Collins and Associates. Honolulu.

________1989b. Survey of the avifauna and feral mammals at Waimalu, Oahu. Unpubl. Ms. Prep. For Group 70 Ltd. Honolulu.

________1991. Survey of the avifauna and feral mammals at the proposed US Navy SURTASS site, Pearl City Peninsula, Oahu. Unpubl. Ms. Prep. For Belt Collins and Associates. Honolulu.

________1992. Survey of the avifauna and feral mammals of Waiawa wetlands, Oahu. Unpubl. Ms. Prep. For Helber Hastert and Fee. Honolulu.

Hawaii Audubon Society. 1993. Hawaii's birds. Fourth Edition. Hawaii Audubon Society. Honolulu.

Honacki, J.H., K.E. Kinman and J.W. Koeppl ed. 1982. Mammal species of the world: a taxonomic and geographic reference. Allen Press Inc., and the Association of Systematic Collections. Lawrence, Kansas.

Jacobs, D.S. 1991. The distribution and abundance of the endangered Hawaiian Hoary Bat (Lasiurus cinereus semotus), on the island of Hawaii. Unpubl. report submitted to University of Hawaii, Department of Zoology.

________ 1993. Foraging behavior of the endangered Hawaiian Hoary Bat (Lasiurus cinereus semotus). Final Report to U.S. Fish and Wildlife Service. Grant No. 14-48-0001-92570.

Johnson, O.W., P.M. Johnson and P.L Bruner. 1981. Wintering behavior and site-faithfulness of Golden-Plovers on Oahu. 'Elepaio 41 (12): 123-130.

Johnson, O.W., P.M. Johnson. 1983. Plumage-molt-age relationships in "over-summering" and migratory Lesser Golden-Plovers. Condor 85:460-419.

Johnson, O.W., M.L. Morton, P.L Bruner and P.M. Johnson. 1989. Winter range fat cyclicity in Pacific Golden-Plovers (Pluvialis fulva) and predicted migratory flight ranges. Condor 91:156-177.

Kepler, C.B. and J.M. Scott. 1990. Notes on distribution and behavior of the endangered Hawaiian Hoary Bat (Lasiurus cinereus semotus). ‘Elepaio 50 (7):59-64.

Pratt, H.D., P.L. Bruner and D.G. Berrett. 1987. A field guide to the birds of Hawaii and the tropical Pacific. Princeton University Press. Princeton, New Jersey.

Pyle, R.L. 1993. Hawaii Christmas Bird Counts – 1995. ‘Elepaio 53 (5):31-35.

_______ 1996. Christmas Bird Count – 1995. ‘Elepaio 56 (8):57-58.

_______1997. Checklist of the birds of Hawaii – 1997. ‘Elepaio 57 (9):153-157.

_______1999-2000. Christmas Bird Counts – 1998: Regional summary for Hawaii and Pacific Islands. ‘Elepaio 59 (9):81-85.

Reynolds, M.H., B.M.B. Nielsen and J.D. Jacobi. 1998. Surveys of the Hawaiian Hoary Bat in the district of Puna, Hawaii Island. ‘Elepaio 57 (9):153-157.

TGI The Traverse Group, Inc. 1991. Natural Resources Management Plan Pearl Harbor Complex. Prepared for the Department of the Navy. Unpubl. report. Contract #N62742-86-C-0538.

Tomich, P.Q. 1986. Mammals in Hawaii. Bishop Museum Press. Honolulu.

A12 – SURVEY OF AVIFAUNA AND FERAL MAMMALS FOR THE INTEGRATED NATURAL RESOURCES MANAGEMENT PLAN FOR NAVAL STATION PEARL HARBOR, MAKALAPA CRATER, O‘AHU (BRUNER 1999B)

This page is intentionally left blank.

SURVEY OF THE AVIFAUNA AND FERAL MAMMALS FOR THE INTEGRATED NATURAL RESOURCES MANAGEMENT PLAN FOR NAVAL STATION PEARL HARBOR, MAKALAPA CRATER, OAHU

Prepared for:

Helber Hastert and Fee

Phillip L. Bruner
Assistant Professor of Biology
Director, Museum of Natural History
BYU-Hawaii
Environmental Consultant Faunal (Bird & Mammal) Surveys

20 January 1999

CONTENTS

INTRODUCTION

The purpose of this report is to summarize the findings of a bird and mammal field survey conducted on 16 December 1998 at Makalapa Crater, Oahu (Fig. 1). Also included are references to pertinent literature and unpublished reports.

The objectives of the field survey were to:

1- Document what bird and mammal species actually occur on the property. Note what other birds and mammals potentially could occur in this area.

2- Provide some baseline data on the relative abundance of each species.

3- Note the presence or likely occurrence of any native fauna, particularly those that are listed as "Endangered" or "Threatened".

4- Determine if the property contains any special or unique resources that if lost or altered by development might result in a significant impact on the native fauna in this region of the island.

SITE DESCRIPTION

Second-growth, introduced vegetation dominates this property. Kiawe trees with an understory of grass cover most of the site. Some low-lying areas contain Indian Pluchea (a wetland indicator species) and may flood during heavy prolonged rains. The property is surrounded on all sides by urbanized habitats. The crater shows clear evidence of past human modification. Although the vegetation has grown over the material that was dumped at this site, it is still possible to find metal, concrete and land fill throughout the property.

Weather during the survey period was clear and calm, but noise from adjoining highways made the detection of bird vocalizations more difficult.

STUDY METHODS

The property was surveyed on 16 December 1998. The site was walked and all habitats were investigated. Field observations were focused in the early morning hours when birds are more active.

A checklist of species either heard or seen was kept. An attempt to record numbers of individuals of each species was hampered by traffic noise. The relative abundance data given in Table 1 are likely underestimated. Published and unpublished reports of similar bird habitat on Oahu were also consulted in order to acquire a better perspective of the possible fauna that could occur in this region and their potential relative abundance (Pratt et al. 1987; Hawaii Audubon Society 1993; Bruner 1991, 1995; Pyle 1993, 1996). Observations of feral mammals were limited to visual sightings and evidence in the form of scats and tracks. No attempts were made to trap mammals in order to obtain data on their relative abundance and distribution. Such an effort was not possible or necessary within the time constraints of the field survey.

Scientific names of birds and mammals used in this report follow those given in Checklist of the Birds of Hawaii (Pyle 1997) and Mammal Species of the World (Honacki et al. 1982).

RESULTS AND DISCUSSION

Resident Endemic (Native) Birds:

No native landbirds were recorded on the survey. Given the location, elevation and type of habitats available at this site, the absence of native landbirds was not unexpected. The Short-eared Owl or Pueo (Asio flammeus sandwichensis) forages in agricultural fields and pastures as well as in lowland and upland forested habitat (Hawaii Audubon Society 1993). This species is rare on Oahu and is listed as endangered by the State of Hawaii. I

have seen Pueo near Ewa Beach in 1998 but I know of no records for Makalapa Crater. Although this species was not recorded on this survey, it could forage in this area. Pueo nest on the ground and prefer tall grass. If any owls are seen in this area they are more likely to be the introduced Barn Owl (Tyto alba).

Migratory Indigenous (Native) Birds:

Migratory shorebirds winter in Hawaii between the months of August through May. Some juveniles will stay over the summer months as well (Johnson et al. 1981, 1983, 1989). The most abundant shorebird species that winters in Hawaii is the Pacific Golden-Plover (Pluvialis fulva). Plover forage in open areas such as mud flats, lawns, pastures, plowed agricultural fields and roadsides. Plover are extremely site-faithful and most establish winter foraging territories that they defend vigorously. Such behavior makes it possible to accurately census the plover population in a particular area. These populations likewise remain relatively stable over many years (Johnson et al. 1989). A total of four plover were recorded on the survey. These birds were seen on lawn habitats at the edge of the site. Plover are not listed as endangered or threatened.

Resident Indigenous (Native) Seabirds:

No seabirds were recorded, nor would any be expected at this location. Predators such as dogs, cats and the Small Indian Mongoose (Herpestes auropunctatus), along with human disturbance inhibit seabird nesting at all but a few isolated locations on the main Hawaiian Islands (Hawaii Audubon Society 1993).

Resident (Native) Waterbirds:

No wetland habitat suitable for waterbirds to forage in was found on this property. Heavy prolonged rains could flood low lying sections at the center of the crater but the dense vegetation would make it difficult for waterbirds to access the area and forage efficiently.

Exotic (Introduced) Birds:

A total of 12 species of exotic birds were recorded during the course of the field survey. This list compares favorably with that obtained on nearby lands by Bruner (1991, 1995). Table 1 shows the relative abundance of each species. In addition to these species, other exotic birds which potentially could occur on the property include: Barn Owl (Tyto alba), Northern Mockingbird (Mimus polyglottus), White-rumped Shama (Copsychus malabaricus) and Red Avadavat (Amandava amandava) (Pratt et al. 1987; Hawaii Audubon Society 1993; Bruner 1991, 1995; Pyle 1993, 1996).

Feral Mammals:

One Small Indian Mongoose (Herpestes auropunctatus) was recorded on the survey. Cat (Felix catus) tracks were also seen. Records of the endemic and endangered Hawaiian Hoary Bat (Lasiurus cinereus semotus) on Oahu are limited (Tomich 1986; Kepler and Scott 1990). No bats were seen on this survey. This species is known to roost solitarily in trees and forages for flying insects using echolocation (Jacobs 1993). They use a variety of habitats including native forest, ranchlands, ponds and bays as well as urban areas (Jacobs 1991). The life history of this species is not well known. The most recent work on this species on the Big Island has yielded some new insights into their behavior (Reynolds et al. 1998).

CONCLUSION

A short field survey can only provide a limited view of the wildlife that may use the site. The number of species and their relative abundance may vary throughout the year due to resource (food, water) availability and reproductive success. Species that are migratory will only be an important part of the faunal picture at certain times during the year. Exotic

species sometimes prosper for a time, only to later disappear or become a less significant part of the faunal community (Williams 1987, Moulton 1990). Thus only long-term studies can provide a comprehensive view of the bird and mammal populations in a particular area. However, some general conclusions related to bird and mammal activity at this site can be made. Below is a summary of the findings of this survey.

1- The site was surveyed by walking. Census data were probably on the low side due to ambient noise from surrounding areas that reduced the detectability of vocalizing birds.

2- No native resident birds were tallied on the survey. The native owl (Pueo) occurs in this region but was not recorded on this survey. They are listed as endangered by the State of Hawaii.

3- The migratory Pacific Golden-Plover was present on this site. Plover are not endangered or threatened.

4- The list of exotic birds recorded on the survey (Table 1) was typical for this region of Oahu and compared favorably with the data obtained by Bruner from nearby properties and reports from Christmas Bird Counts by Hawaii Audubon Society as reported by Pyle.

5- Small Indian Mongoose and cats were recorded at this site. Rats (Rattus sp.) and mice (Mus musculus) probably occur in this area although not observed on this survey. The endangered Hawaiian Hoary Bat was not seen. This species is rare on Oahu.

6- This property has been significantly altered by introduced vegetation and land filling. No unusual or unexpected species were recorded nor were there any unique or special resources important to native wildlife. Disturbed second growth land is common in this region of Oahu.

Table 1: Exotic species of birds recorded at Makalapa Crater, Oahu.

COMMON NAME	SCIENTIFIC NAME	RELATIVE ABUNDANCE
Spotted Dove	Streptopelia chinensis	U
Zebra dove	Geopelia striata	C
Red-vented Bulbul	Pycnonotus cafer	C
Japanese Bush-warbler	Cettia diphone	R
Common Myna	Acridotheres tristis	U
Japanese White-eye	Zosterops japonicus	C
Northern Cardinal	Cardinalis cardinalis	U
Red-crested Cardinal	Paroaria coronata	U
House Finch	Carpodacus mexicanus	C
Common Waxbill	Estrilda astrild	C
House Sparrow	Passer domesticus	R
Java Sparrow	Padda oryzivora	U

KEY TO TABLE 1
Relative abundance = Number of times observed during the survey
A = Abundant (avg. 10+)
C = Common (avg. 5-10)
U = Uncommon (less than 5)
R = Recorded (seen or heard only once)

SOURCES CITED

Bruner, P.L. 1991. Survey of the avifauna and feral mammals at the proposed US Navy SURTASS site, Pearl City Peninsula, Oahu. Unpubl. ms. Prep. for Belt Collins and Associates, Honolulu.

_________1995. Faunal survey report for Manana and Pearl City Junction mixed use development, Pearl City, Oahu. Unpubl. ms. Prep. for PKF Hawaii.

Hawaii Audubon Society. 1993. Hawaii's Birds. Fourth Edition. Hawaii Audubon Society, Honolulu.

Honacki, J.H., K.E. Kinman and J.W. Koeppl ed. 1982. Mammal species of the world: a taxonomic and geographic reference. Allen Press Inc., and the Association of Systematic Collections, Lawrence, Kansas.

Jacobs, D.S. 1993. The distribution and abundance of the endangered Hawaiian Bat (Lasiurus cinereus semotus), on the island of Hawaii. Unpubl. report submitted to University of Hawaii, Department of Zoology. 16 pp.

________1993. Foraging behavior of the endangered Hawaiian Hoary Bat (Lasiurus cinereus semotus). Final Report to U.S. Fish and Wildlife Service. Grant No. 14-48-0001-92570.

Johnson., O.W., P.M. Johnson and P.L. Bruner. 1981. Wintering behavior and site-faithfulness of Golden-Plovers on Oahu. 'Elepaio 41 (12):123-130.

Johnson, O.W., and P.M. Johnson. 1993. Plumage-molt-age relationships in "over- summering" and migratory Lesser Golden-Plovers. Condor 85:406-419.

Johnson, O.W., M.L. Morton, P.L. Bruner and P.M. Johnson. 1989. Winter range fat cyclicity in Pacific Golden-Plovers (Pluvialis fulva) and predicted migratory flight ranges. Condor 91:156-177.

Kepler, C.B., and J.M. Scott. 1990. Notes on distribution and behavior of the endangered Hawaiian Hoary Bat (Lasiurus cinereus semotus). 'Elepaio 50(7):59-64.

Moulton, M.P., S.L. Pimm and M.W. Krissinger. 1990. Nutmeg Mannikin (Lonchura punctulata): a comparison of abundance in Oahu vs Maui sugarcane fields, evidence for competitive exclusion? 'Elepaio 50(10):83-85.

Pratt, H.D., P.L. Bruner and D.G. Berrett. 1987. A field guide to the birds of Hawaii and the Tropical Pacific. Princeton Univ. Press.

Pyle, R.L. 1993. Hawaii Christmas Bird Counts -- 1995. Elepaio 53(5):31-35

1996. Christmas Bird Count - 1995. Elepaio 56(8):57-58.

______1997. Checklist of the birds of Hawaii - 1997. Elepaio 57F7):129-138.

Reynolds, M.H., B.M.B. Nielsen, and J.D. Jacobi. 1998. Surveys of the Hawaiian Hoary Bat in the district of Puna, Hawaii Island. 'Elepaio 57(9):153-157.

Tomich, P.Q. 1986. Mammals in Hawaii. Bishop Museum Press. Honolulu.

Williams, R.N. 1987. Alien Birds on Oahu 1944-1985. 'Elepaio 47(9):87-92

A13 – WETLANDS SURVEY OF PEARL HARBOR (NAVFAC PAC 2007)

FINAL

Pearl Harbor Wetlands Inventory

November 30, 2007

FINAL

Pearl Harbor Wetlands Inventory

November 30, 2007

Prepared For:

Naval Facilities Engineering Command, Pacific
EV2 Environmental Planning
258 Makalapa Drive
Suite 100
Pearl Harbor, Hawai'i 96860-3134

Prepared By:

AECOS, Inc.
45-939 Kamehameha Highway
Suite 104
Kāne'ōhe, Hawai'i 96744-3221

and

Wil Chee - Planning, Inc.
1018 Palm Drive
Honolulu, Hawai'i 96814

Contract No. N62742-06-D-1869, Task Order No. 0001

Table of Contents

Chapter 6 (continued)

Introduction

Report Organization

The previous inventory of wetlands in Pearl Harbor (ACOE, 1999) provided a descriptive overview of wetlands arranged by “segments” that divided the Pearl Harbor coastline in clockwise order from the west side of the Pearl Harbor entrance channel (Pu'uloa) to the east side of the channel (Fort Kamehameha). Here, we follow a similar sequencing for the Pearl Harbor wetland descriptions. However, we utilize different segment boundaries in order to better balance the amount of text and to better collate wetlands on Navy property versus those not on Navy property. The following “segments” are used in this report:

Chapter 1. Iroquois Point Lagoon to Honouliuli NWR (Navy wetlands)
Chapter 2. West Loch (north and west shore)
Chapter 3. Waipi'o Peninsula (Navy wetlands)
Chapter 4. Middle Loch and Pearl City Peninsula (Navy wetlands)
Chapter 5. North Shore of East Loch: Waiau to Kalauao Stream
Chapter 6. East Loch (east shore) and Ford Island (Navy wetlands)

The introduction to this report presents definitions for wetlands and a general discussion of wetlands that occur in the Pearl Harbor area. Approach and methodologies used in the report are discussed at length. Much of the discussion that follows attempts to clarify wetland definitions as they pertain to features in and around Pearl Harbor. While what is and is not a wetland should logically be at the heart of the scope-of-work for this project report, in the final analyses, the question is really peripheral to establishing legal responsibility for respecting and caring for aquatic habitats on Navy property. In essence, nearly all natural aquatic environments in and around Pearl Harbor are encompassed by Clean Water Act definitions of “special aquatic sites” (Federal Register, 1980) and therefore are jurisdictional.[1]

Previous Reports ~ In addition to the ACOE, 1999 inventory of Pearl Harbor wetlands, a series of separate reports (for example, Brunner, 1999; Char, 2000) covering various lands under Navy jurisdiction were prepared as appendices to the Pearl Harbor Integrated Natural Resources Management Plan (PHINRMP; Helber Hastert & Fee, 2001) and the INRMP for the Naval Magazine Pearl Harbor (NAVFACENGCOM, 2001). These sources and several earlier wetland inventory reports (Ahuimanu Productions, 1977; Elliott & Hall, 1977) added to

[1] Useful in clarifying federal jurisdiction in aquatic environments is knowledge of the six categories of “special aquatic sites” listed by EPA (Federal Register, 1980): 1) sanctuaries and refuges, 2) wetlands, 3) mudflats, 4) vegetated shallows, 5) coral reefs, and 6) riffle and pool complexes in streams. All are subject to provisions of the Clean Water Act.

the natural resources knowledge base of Pearl Harbor and included discussion of wetland resources. *AECOS* Inc., an environmental consulting firm, has been active in the Pearl Harbor area for over 20 years, preparing environmental reports which have covered specific wetland and stream resources in the area (*AECOS*, 1986, 1988b, 1994, 1996, 1999, 2000, 2001a, 2001b, 2002a, 2005). A bibliography of pertinent references is provided at the end of this Introduction.

Significant in terms of its completeness as an inventory of the flora and fauna of aquatic environments around Pearl Harbor is the Pearl Harbor Biodiversity Project funded by the U.S. Navy. The two phases of this project covered investigations of marine organisms (Phase I, 1995-1997, Coles, et al., 1997, 1999) and estuarine and freshwater organisms from the mouths of streams discharging into the harbor (Phase II, 1997-1998, Englund, et al., 2000). In the present report we only utilize sampling location descriptions as applicable to wetland features, and do not provide biota results from the biodiversity project reports.

Wetlands Classification

The most straight-forward definitions of "wetland" are those similarly expressed by Cowardin, et al. (1979): "Wetlands are lands transitional between terrestrial and aquatic systems where the water table is usually at or near the surface or the land is covered by shallow water" and Mitsch & Gosselink (1986): an environment "...at the interface between truly terrestrial ecosystems and truly aquatic systems making them different from each yet highly dependent on both." The Cowardin, et al. definition, used by U.S. Fish and Wildlife Service (USFWS), is part of a classification system developed for wetlands and deep water habitats of the United States. A somewhat more restricted definition[2] is that issued jointly by the U.S. Army Corps of Engineers (ACOE; Federal Register, 1982) and the U.S. Environmental Protection Agency (EPA; Federal Register, 1980):

> wetlands are "those areas that are inundated or saturated by surface or ground water at a frequency and duration sufficient to support, and that under normal circumstances do support, a prevalence of vegetation typically adapted to life in saturated soil conditions.

[2] USFWS definition is broader in scope for the reason that it is part of a classification system of aquatic habitats that includes wetlands. Although possibly in rare cases within the Pearl Harbor area the USFWS definition would apply to a habitat not regarded as jurisdictional and subject to EPA and ACOE authority, in the vast majority if not all of cases, habitats classified by USFWS (Cowardin, et al;. 1979) would be jurisdictional for the reason that federal jurisdiction pertains to "waters of the U.S." (Federal Register, 1982) which include many other aquatic habitats in addition to just wetlands as defined by ACOE (1987).

The ACOE manual (1987, p. 14-15) for delineating wetlands amplifies on the definition above, but also briefly covers definitions, diagnostic characteristics, and technical approach for the identification and delineation of deepwater aquatic habitats and non-wetlands. Although the ACOE manual serves as the technical basis for delineating wetlands (by which is meant establishing a jurisdictional boundary defining a wetland's limits), it does not provide a classification of wetlands. The USFWS system presented in Cowardin, et al. (1979) classifies wetlands and other aquatic habitats, and is therefore of considerable value in a general inventory such as presented in this report.

Aquatic Environment Classification ~ The USFWS classification system is hierarchical, at the highest level consisting of five "systems" (Cowardin, et al., 1979, p. 5): Marine, Estuarine, Riverine, Lacustrine, and Palustrine.

The **Marine System** pertains to intertidal and subtidal aquatic habitat off the ocean shore. In the area covered by the present survey, this would only be shoreline and fringing reef habitats outside of the mouth of Pearl Harbor (see Chapters 1 and 6).

The **Estuarine System** in the USFWS classification covers deepwater tidal and adjacent tidal wetlands within a basin semi-enclosed by land and having marine water that is at least occasionally diluted by freshwater runoff. This definition would apply to Pearl Harbor itself.

The **Riverine System** includes all wetlands and deepwater habitats confined to a channel, excluding 1) wetlands dominated by emergent vegetation and 2) habitats with ocean-derived salts in excess of 0.5 ppt.

The **Lacustrine System** encompasses lakes and ponds: aquatic environments confined in a natural or man-made basin and either lacking emergent aquatic vegetation or the vegetation is 30% or less of the area of the feature. The Lacustrine System includes all freshwater bodies of water over 20 ac (8 ha) in area, or smaller features if 1) all or part of the margin is an active wave-formed or bedrock shoreline, or 2) the deepest part of the basin exceeds 6.6 ft (2 m).

The **Palustrine System** covers vegetated aquatic environments developing in association with freshwater sources. In the USFWS classification (Cowardin, et al. 1979), these are fresh water wetlands (salinity less than 0.5 ppt) with emergent vegetation, but including open water areas 1) lacking vegetation if less than 20 ac (8 ha) in area, 2) lacking a bedrock or active wave-formed shoreline, and 3) less than 6 ft (2m) deep in the deepest part. Thus, most freshwater ponds in the Pearl Harbor area would be included in the palustrine system.

National Wetland Inventory ~ The National Wetland Inventory (NWI) covering areas of Pearl Harbor was very recently updated (mid-2007) using EarthData 2005 imagery (Elaine Blok, USFWS, pers. comm). The previous inventory coincided with the ACOE (1999) survey of wetlands in the area. The 1999 update process utilized aerial photographs dated September 1992 and included field work conducted in 1998-99 (Helber Hastert & Fee, 2001). The most recent update was undertaken in early 2007 with revisions to the wetland maps appearing on-line in late July 2007 (USFWS, 2007). Methodology and summary data have yet to be reported.

The NWI utilizes the system of classification developed by Cowardin, et al. (1979) described above and includes wetlands and other jurisdictional waters—that is, not just vegetated wetlands as defined by the Army Corps (ACOE, 1987). Thus, all waters (estuaries and tidal waters) in Pearl Harbor are classified in the NWI system maintained by the USFWS, including the permanently submerged waters of the lochs and all tidally influenced areas along the shore. The statement in Helber Hastert & Fee (2001) that "[b]ecause of the [USFWS] more liberal definition of wetland….the NWI maps include areas that are not considered 'jurisdictional' wetlands subject to federal laws and regulations" is not entirely true. Deep waters and tidal lands (and streams) are jurisdictional in the same sense that ACOE certified wetlands are jurisdictional.

The NWI maps (URL: http://wetlandsfws.er.usgs.gov/wtlnds/launch.html) are a valuable source of information about the occurrence of wetlands in different areas, so the 1999 maps (later compared with the 2007 maps) were regularly consulted to locate wetlands around Pearl Harbor. Our experiences in this regard are discussed throughout the text of the report, including suggestions for classification using the Cowardin system where reclassification is indicated by our field observations[3]. The last NWI Wetland classification summary is provided here as Table 1 from the Pearl Harbor INRMP. Note that the large area of "permanently flooded estuarine wetland" reflects the fact that in the Cowardin system, all Pearl Harbor subtidal waters are counted, whereas vegetated, intertidal areas (e.g., mangrove) are mostly in the "other" category. Presently, no updated accounting based on the 2007 NWI mapping effort is available from USFWS.

[3] Our experience after visiting nearly all of the sites around Pearl Harbor is that many if not most were assigned incorrect classification codes in 1999, These shortcomings have been corrected in many cases in the latest (2007) version, although we still disagree with many code assignments made in 2007. In the text, we provide the 2007 NWI code assignments and, where we disagree, our suggested code assignments for each wetland feature discussed. The coding scheme from USFWS is presented as Appendix A following the References Cited in this report.

Table 1. NWI Wetland classification of Pearl Harbor
(after Greenhorne & O'Mara, 1999)

Wetland Type	Area (acres)	Area (hectares)
Estuarine		
Permanently flooded	4,758.5	1,925.7
Other	367.8	148.8
Palustrine	72.9	29.5
Riverine	8.1	3.3
Total	**5,207.3**	**2,107.3**

The ACOE (1999) summary of wetlands in Pearl Harbor from their field and mapping efforts concluded there were 456.41 ac (184.7 ha) of wetlands, classifiable as 288.40 ac (116.7 ha) of mangrove wetlands, 81.99 ac (33.2 ha) of "other coastal" wetlands, 13.77 ac (5.6 ha) of "stream" wetlands, and 72.25 ac (29.2 ha) of "other freshwater" wetlands. With respect to freshwater aquatic features (palustrine and riverine systems), the NWI and ACOE accountings are similar.

Pearl Harbor Wetlands

The formation of Pearl Harbor—how it came to be in its present day configuration viewed over geological time—is complex but well covered in various texts (see Stearns, 1966; MacDonald, et al., 1983; drawings in ACOE, 1999 after Stearns) and need not be repeated here. While events over hundreds of thousands of years established the general lay of the land, wetlands extant along and behind the modern shore are much more recently formed and owe their existence to several basic features of the Pearl Harbor basin. One is the "great Pearl Harbor springs, with a discharge of almost 230 million liters per day (earlier in the [last] century discharge averaged about 300 million liters per day)…" (MacDonald, et al., 1983, p. 236). These springs issue directly from Ko'olau lava rock not far inland from the shore (Fig. 1) and have been regarded as the largest and most significant complex of springs in the Hawaiian Islands, contributing some 70% of the fresh water flowing into Pearl Harbor (Englund, et al., 2000).

Pearl Harbor is a large estuarine feature on the south coast of the Island of O'ahu fed by several streams and numerous freshwater springs. The basin represents drowned valleys that now comprise the lochs and is somewhat unusual in the convergence of these broad shallow valleys into a single, narrow outlet (most valley or fluvial features tend to broaden downslope). It has been said that the "…Pearl Harbor spring, coastal wetland, and riverine systems represent an ecologically important and unique natural resource and formerly contained a significant endemic fish and invertebrate fauna" (Titcomb, 1972 cited in Englund, et al., 2000). These areas are now dominated by introduced species. Excluding terrestrial arthropods found in riparian areas (also surveyed), 192 aquatic species have now been identified in the lower reaches of Pearl Harbor streams and wetlands. Introduced species were 47% of the species recorded, while only 33% were native (endemic or indigenous) and the balance (20%) undetermined (Englund, et al., 2000).

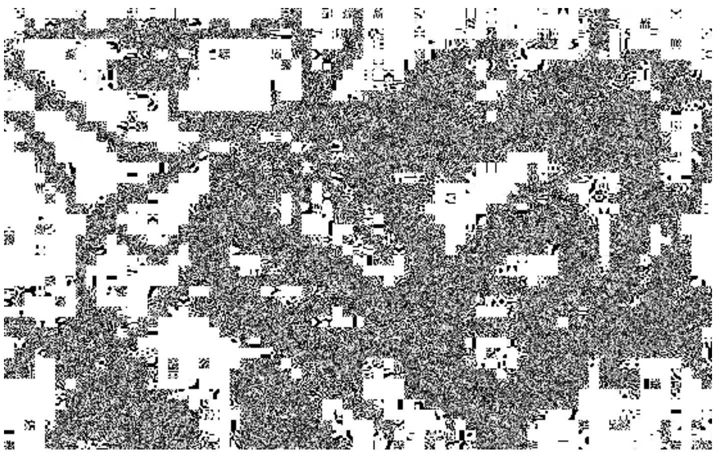


Figure 1. Historic map of the major Pearl Harbor springs in 1935 (after Stearns and Vasvik, 1935 from Englund et al, 2000).

Estuarine Wetlands ~ Prior to use of the "harbor" as a military asset, the original basin of Pearl Harbor was quite shallow throughout and the shoreline lined by Hawaiian fishponds (and prior to the arrival of the early Polynesians, probably lined by extensive wetlands). Dredging for harbor development greatly altered the bathymetry and must have likewise changed the relationship between land runoff and tidal exchange, causing the entire feature to become less brackish and more saline. Consequently, many former wetlands that were inhabited by native marsh vegetation tolerant of some saltiness (plants such as *makai* and *kaluhā*) found the increasingly marine nature of the shallows unsuitable and subsequently disappeared. Exposed barren tidal flats and abandoned fishponds provided habitat for species of introduced plants, two of which have become especially prominent: pickleweed (*Batis maritima*; see page

17) and American or red mangrove (*Rhizophora mangle*; see page 14)[4]. The requirements of these two species now define the extent of coastal or saline vegetated wetlands in Pearl Harbor (as well as in many other locations in the Islands, such as Kāneʻohe Bay and much of the south shore of Molokaʻi).

So prominent are pickleweed and mangrove in the coastal wetlands of Pearl Harbor, that only the physical nature of the shoreline itself influences which type of wetland will be present in any given location: an *ʻākulikuli kai* (Hawaiian name for *Batis maritima*) tidal flat or a mangrove swamp. In as much as propagules generated by the abundant mangrove trees reach all tidal shoreline areas, only physical factors that tend to discourage establishment of young mangroves determine the eventual fate of progressive vegetation development. As with any tidal shore, there are sections of generally low slope and sediment deposition and sections of steeper banks of rock or other hard material (such as concrete). Modifications to the shore and nearshore—dredging, placement of revetments and other structures—influence the physiography of the shore, as has occurred in most areas of Pearl Harbor, beginning with the ancient Hawaiians constructing rock walls to define fishponds. Another influencing factor is the discharge of sediments from upland drainages, a process that was greatly accelerated with the coming of western-style agriculture (sugar cane and pineapple) and a likely reduction in the freshwater flux as upland streams and lowland springs were tapped to service the agricultural fields (the first artesian well developed in Hawaiʻi was drilled at Honoʻuliʻuli in 1879; MacDonald, Abbott, and Peterson, 1983). The point to be made is that the very nature of Pearl Harbor has changed significantly over the last century and a half and the introduction of various "aggressive" alien plants is only part of the story. These plants are viewed as aggressive because they easily out-compete other (native) plants for physical space, but the advantages they have in this competition are more than genetic; more than the simple sum of characteristics they possess. The very nature of the physical environment changed, a circumstance that placed the native inhabitants at a disadvantage, if not alone accounting for their demise.

The difference in nature of the shore and subsequent wetland development is clearly illustrated by the peninsula at West Loch Shoreline Park. This feature is a finger of lava rock that extends into West Loch. The dominant Trade winds, blowing from the northeast to east, set-up waves across the upper end of West

[4] *Batis maritima* was first recorded at Sand Island by Hillebrand (1888) in 1859 and first noted present in Pearl Harbor by Hosaka (1937) in West Loch; however, Englund, et al. (2000) displays a photograph on the cover showing pickleweed in the Harbor (Kukona Fishpond, Waiau) in 1911. *Rhizophora mangle* was first introduced on Molokai in 1902 (Degener, 1940) and noted in Pearl Harbor as early as 1917 (Wester, 1981).

Loch that erode the north shore of the peninsula (Fig. 2a). The south-facing shore is more sheltered and consequently, depositional. The gradual transition to deeper water across a shallow, low-sloping tidal flat or beach is one quite suitable for emergent plants tolerant of the salinity regime. Consequently, the south shore is one of wetlands vegetated either by *'akulikuli kai* or mangrove (Fig. 2b).

The following stages were described by Egler (1939) as representing typical succession of many Hawaiian intertidal flats: (1) original native communities of Widgeon Grass (*Ruppia maritima*), various species of algae, and sessile organisms, (2) introduction of Pickleweed (*Batis maritima*) and subsequent development of pure meadows, (3) introduction and spread of Red Mangrove (*Rhizophora mangle*), (4) extirpation of indigenous *Hau* (*Hibiscus tiliaceus*) forests by mangrove forests, and (5) the eventual displacement of pickleweed meadows by mangrove forests.

There can be no doubt that pickleweed and red mangrove compete with each other for space along much of the shoreline, having similar preference for shallow tide flats. Char (2000) noted recently that "…before the rapid expansion of mangrove, pickleweed was the most abundant vegetation type in the Pearl Harbor area (Char & Balakrishnan, 1979). She points out that in this competition, red mangrove typically succeeds in shading out low growing pickleweed shrubs, and dominates an area pretty much to the exclusion of all other plant species. It may not be the case that all areas presently dominated by pickleweed will eventually succession into mangrove forest. Experience at Nu'upia Ponds (AECOS, 1985b) on the Mōkapu Peninsula (windward O'ahu) demonstrates that pickleweed has a greater tolerance for hyperhaline conditions where mangrove either cannot establish or clearly struggle once established. Further, pickleweed grows in the upper intertidal and, in some cases, out onto adjacent uplands or semi-isolated basins where red mangrove cannot invade. These reasons may explain, in part, the observation by Char (2000) of pickleweed flats "squeezed inland by the advancing [mangrove] thickets."

Mangrove expansion in Pearl Harbor is largely seaward, leaving in some cases more open flats behind the original colonization "shore" that seasonal hyperhalinity or other factors prevent mangrove propagules from successfully establishing. Of course, caught behind a wall of mangrove, such flats may be relatively short-lived if subjected to sediment deposition from the land. Such

Figure 2: a) North side of peninsula at West Loch Community Park showing upland vegetation reaching to the exposed, basalt rock shore (no wetlands are present here). b) South side of peninsula showing mixed *'akulikuli kai*/red mangrove wetland across a gently sloped shore.

isolated flats, if subjected to regular inputs of freshwater have the potential for developing into palustrine wetlands, a few examples of which are found around Pearl Harbor. If the isolated depressions lack significant freshwater (as runoff, stream input, or groundwater), the proximity to haline waters of the harbor (with typically brackish groundwater) create salt flats supporting pickleweed and no or minimal mangrove growth. Accumulation of salts in the soil can reach a point where even pickleweed cannot continue to grow (Fig. 3; see also Fig. 3-05[5] and p. 17), and the central depression of these shallow basins will be barren of vegetation. This sets up a situation, known as a playa, where the soils (flocculated by salts) are easily moved by winds when dry, and the basin persists or enlarges as sediment is blown away during the dry season.

Figure 3. Playa formation beside the old Pearl City WWTP. Salt encrusted, bare soil in foreground is depressed relative to the flat behind overgrown with pickleweed, but the soil too salty to support even pickleweed.

Palustrine Wetlands ~ Palustrine wetlands are associated with sources of fresh water—around Pearl Harbor these would be the extensive springs that issue not far inland along the northern shores of the lochs. Palustrine wetlands

[5] The reference to Fig. 3-05 means Figure 05 in Chapter 3 of this report.

also may be associated with streams. Riverine wetlands are rare or not present in the survey area for the reason that definitions do not allow for them even though both the NWI (Greenhorne & O'Mara, 1999) and ACOE (1999) appear to conclude that there are some present—respectively, 8.1 and 13.8 ac (or 3.3 and 5.6 ha, respectively; see Table 1 and text following). By definition (Cowardin, et al., 1979), Riverine System habitats are characterized by freshwater and no emergent vegetation (that is, not wetlands by the ACOE definition). Larger streams flowing into Pearl Harbor are estuarine in the lower reaches, so the Riverine System would only apply to stream channels *upstream* of the estuaries. Stream associated wetlands registered by the ACOE (1999) study must be Palustrine Systems under the NWI definition. On the other hand, streams and even small drainage ditches draining uplands are classified as Riverine in the NWI (2007)—around Pearl Harbor, however, always upstream of a lowland, estuarine stream or ditch segment.

Coastal wetlands in Hawai'i have been subjected to substantial changes as a consequence of, among other factors, invasion by introduced mangrove and/or pickleweed. Although these plants are limited to tidal and estuarine waters, freshwater wetlands have also been impacted by introduced plant species, particularly the aggressive para grass (or California grass; *Urochloa mutica*). As well, both great bulrush (*Schoenoplectrus californicus*) and common cattail (*Typha latifolia*) are introduced species now widely distributed in palustrine wetlands around the islands. As a result of these invaders, the floristic structure of impacted wetlands has been altered, although the oft cited concept (e.g., Wilson and Loomis, 1967) that encroachment of vegetation results in terrestrialization, or an eventual shrinkage in wetland area, is not well supported by studies (Mitsch and Gosselink, 1986). If anything, open waters are gradually transformed into wetlands, which can remain as wetland bogs for centuries. Losses in wetland area are most likely the result of direct human interventions: adding fill material or altering hydrology by draining or diverting.

Invasion by California grass can alter the relative abundance of other wetland plants present, but the primary impact and the one of greatest concern is the gradual diminution of open water habitat utilized by waterbirds (Oceanit, 2006). Thus, this plant and several others (for example, water hyacinth, Kariba weed, and cattail; see AML, 2004) are not so much threats to "wetlands" as defined by the ACOE (1987) but to open ponds and bare mudflats that serve as important endangered species habitats in Hawai'i. In an ironic sense, by occupying wet areas previously not supportive of native emergent vegetation, these invasive plants actually increase the area occupied by ACOE defined wetlands.

ACOE Wetland Designations ~ Various systems are in use for designating or indicating a particular wetland. Preferred, for common acceptance and general ease of use, are place names. However, for small features or wetlands that are perhaps only a small part of a larger named feature, place names may not be all that helpful. In the ACOE (1999) report on the wetlands of Pearl Harbor, a ten digit number was assigned to each wetland feature. In as much as this report is an update of that 1999 report, it is desirable to retain the Corps' numbering system if for no other reason than to provide a means of cross-referencing the wetland descriptions. Although the 1999 report does not much utilize wetland ID numbers in the text, the maps that were developed do. The attributes of the ten digit number are explained this way in the metadata table provided (punctuation added):

> A numbering system developed by the Corps and used to uniquely identify wetlands in the Hawaiian Islands. Each wetland is given a ten digit number (ABCDEFGHIJ); digits CDE represent a specific wetland delineation project; digits FG represent subprojects or segments within a project; digits HIJ is a numerical number assigned to a specific wetland for a specific segment within a specific project.

Although digit pair "AB" is not explained, presumably it could represent the island or part of an island within the Hawaiian chain. For all of the wetlands described in the ACOE report, this value is 21; the specific project descriptor is always 001. The "FG" code appears to represent the segment of Pearl Harbor shore (varies from 01 to 12). Thus, only these last 5 digits ("FGHIJ") are needed to uniquely designate a place within the scope of this project. For the reason that a few digits is much easier to read than a 10-digit number, we represent the ACOE system throughout our text as follows:

..3165 is 2100103165 (larger of the Honouliuli Unit ponds at Pearl Harbor National Wildlife Refuge or PHNWR)

.12007 is 2100112007 (a subsegment of the shore of Ford Island; not used in the ACOE text, but may appear in the 1999 data base; not used in this report)

Note first that the segment ("3" in the first sample above) refers to the 1999 system and not the segments utilized herein (which we define as chapters in our text). ACOE segments beyond 9 require addition of another digit in our simplified presentation, but these are segments on the east side of Pearl Harbor and on Ford Island where there are no wetlands (see Chapter 6).

Although we have adopted the numbering system developed by the ACOE for their 1999 survey and use it extensively throughout the text, it must be noted that in many cases the reason for subdividing a wetland are obscure to us; they possibly served an accounting function of some use to the 1999 survey. The

result is that there are a good deal more uniquely numbered wetlands than seems necessary, while wetlands that were missed or parts of wetlands that truly are ecologically distinct from adjacent but not uniquely numbered areas have had to be assigned numbers by us. Where new numbers are needed, we have assigned unused numbers from series representing nearby wetlands.

Wetland Delineation

"Wetland delineation" refers to the process of establishing a wetland boundary, usually for legal purposes, utilizing methodologies described in the *Corps of Engineers Wetlands Delineation Manual* (also herein as "the manual"; ACOE, 1987). A wetland boundary separates a wetland (as defined by EPA/ACOE) from non-wetlands: uplands and deep water habitats. In all cases, it is the boundary between wetland and upland that is of greatest interest. The boundary between wetland and deep water habitats is, from the perspective of the ACOE manual, the outer edge of emergent vegetation.[6] Obviously, for open waters within a wetland, there is some minimal size that would be considered simply part of the wetland and not "deepwater aquatic habitat", but this minimal size is not defined in the manual. In the USFWS system (Cowardin, et al., 1979) open waters of over 20 ac (8 ha) are classified in the Lacustrine System; but smaller ponds are lacustrine only if certain other physical conditions pertain (see p. 3 above).

The manual allows for considerable flexibility in methodology for establishing a boundary between wetland and upland, but requires that in most cases all three of the following must be present on the wetland side: 1) hydrology (i.e., water or a source of water), 2) wetland vegetation (an assemblage of plant species indicative of wetland conditions), and 3) wetland soil (a defined hydric soil type or certain redoximorphic properties indicative of inundation). Moving outward, a bounding point for the wetland becomes that point where any one of these characteristics ceases to be present. It is generally sufficient to establish that a feature is a wetland as defined by the manual, understand what specific characteristics provide field evidence of the bounding line, and delineate along that line. In conducting an inventory, it is far too time consuming to establish bounding points by sampling vegetation and soil at multiple places inside and outside of a suspected wetland. Field observation and marking on good aerial photograph can be used to delineate a wetland for inventory purposes, while a more careful placement of the line would be needed where a project in the design phase requires fairly precise mapping to either avoid or establish and quantify wetland encroachment. In the latter case, it is standard practice to

[6] Technically, deepwater aquatic habitats have at least one of the following: 1) permanently inundated and lacking rooted, emergent vegetation, 2) bottom a sediment not a soil and does not support rooted emergent or woody plants, or 3) permanently inundated at depths >6.6 ft (2 m).

place stakes or flags along the delineated boundary and have these located by land survey.

In the present case, it seemed clear that the ACOE inventory in 1999 (ACOE, 1999) was essentially an inventory approach, and we have followed in that same vein. Satellite images and field or ground-truthing were combined to establish probable wetland boundaries. Attempts to utilize a GPS unit in the field to create a shape file representative of a wetland boundary were generally frustrated by poor or no reception in densely forested areas (either at the edge of the mangrove or in an adjacent upland *kiawe* forest). Further, it was not practical to plot the outer, open water edge by GPS either, and both boundaries are clearly evident in the photographs anyway. The resulting shape files created from photographs and field notes, superimposed on georeference satellite images, are incorporated herein as an attachment at the end of this report.

We deviate in one respect that bears mentioning, although in truth the impact on results is nil for Pearl Harbor wetlands. The manual requires that wetland status of plants be obtained from a specific source, namely Reed (1988). However, that source is out of date and a better (although unofficial) source is that of Puttock and Imada (2004), which we use in this report.

Regulatory Issues ~ Since 1999, two Supreme Court decisions—*Solid Waste Agency of Northern Cook County v. U.S. Army Corps of Engineers*, widely known as the SWANCC case and *Rapanos v. United States*—have thrown into question the interpretations by EPA and ACOE of Clean Water Act jurisdiction or coverage (ELI, 2007). The resulting shift and uncertainty in regulatory authority complicates the delineation process, although again the impact on Navy wetlands in and around Pearl Harbor is not substantive. Clarification of ACOE policy in light of the Supreme Court decisions is now available (ACOE, 2007, EPA/ACOE, 2007).

At the center of Clean Water Act issues (CWA, Section 404) are interpretation of the term "waters of the United States" (33 CFR § 1362(7)) from which flows the regulatory authority of both EPA (40 CFR Part) and ACOE (33 CFR Part 38). Thus, "waters of the U.S." are also called "jurisdictional waters." It is possible to utilize any wetland definition to map an area as a wetland. The National Wetland Inventory (NWI) follows USFWS definitions for this purpose. For CWA purposes, the ACOE manual (ACOE, 1987) applies, but if the feature is not "waters of the United States," ACOE jurisdiction does not apply. The distinction between wetlands and "waters of the U.S." is important for another reason: many more aquatic environments are jurisdictional than just those delineated as wetlands. And this distinction applies two different ways: 1) a delineated

boundary typically divides wetland from upland or at least from non-wetland; and 2) aquatic features that fail to satisfy the requirement of a wetland by the ACOE definition, might still be jurisdictional.

In all cases discussed in this report, ultimate authority for establishing jurisdiction over a particular feature rests with the Army (ACOE), not with the preparers of this text. However, at least since *SWANCC* (2001) and *Rapanos* (2006), ACOE authority over wetlands and other waters previously claimed as jurisdictional under CWA has been reduced. Because ACOE jurisdictional authority is in flux, we have retained, in our descriptive chapters, all previously inventoried wetland features (ACOE, 1999; USFWS, 1999). While presenting our position on the likely regulatory status of all these aquatic features, we have provided descriptions and some level of mapping, whether jurisdictional or not, as a conservative approach.

Table 2 summarizes the current policies of the Army Corps in establishing jurisdiction over various aquatic features. *Traditional Navigable Waters* are "[a]ll waters which are currently used, or were used in the past, or may be susceptible to use in interstate or foreign commerce, including all waters which are subject to the ebb and flow of the tide." (33 CFR § 328.3(a)(1); 40 CFR § 230.3(s)(1).

Note that where the Corps must decide jurisdiction based upon a "significant nexus with traditional navigable water," the process can become very involved.

The State of Hawai'i regulates state waters, which are defined as "all waters, fresh, brackish, or salt around and within the State, including, but not limited to, coastal waters, streams, rivers, drainage ditches, ponds, reservoirs, canals, ground waters, and lakes ... including wetlands." Wetlands are defined by the state using the ACOE manual (see HAR §11-54-1).

The primary regulations the State of Hawai'i uses to protect wetlands is the CWA Section 401 permitting program. Section 401 requires that applicants for a federal permit also receive a Water Quality Certification (WQC) that indicates that the proposed project will not violate local water quality standards. If a federal permit is not required (for example, a project does not involve jurisdictional waters), then a Hawai'i WQC is not required. However, the Department of Health - Clean Water Branch (HDOH-CWB) has the authority to protect existing uses and the level of water quality under the water quality antidegradation policy (HAR §11-54-1.1). The antidegradation policy applies to all waters (including wetlands) in Hawai'i, whether or not they fall under federal jurisdiction.

Table 2. Summary of Key Points (from EPA/ACOE, 2007)

[illegible]

Note: "Agencies" refers to U.S. Army Corps of Engineers (ACOE) and U.S. Environmental Protection Agency (EPA).

Mangrove Wetlands ~ The following is taken from AECOS (2006, p. 12):

> Mangrove ecosystems, or mangals, are a type of coastal wetland, defined in the National Wetlands Inventory (Cowardin, et al., 1979) as haline estuarine intertidal forested and shrub wetland. Wetlands are among the most important ecosystems on Earth (Mitsch and Gosselink, 1993), are protected by international treaties as well as federal law (Clean Water Act), and are managed in the US under a "no net loss" policy. Throughout their natural distribution, mangals provide coastal shoreline protection, reduce nearshore water pollution, provide a forestry and fishery resource, and act as a refuge for wildlife. Even in Hawai'i, mangrove forests may benefit the marine environment by providing habitat for many animal species (many non-native), removing and sequestering dissolved nutrients from water, and holding back sediments derived [from] land run-off.

The red mangrove (*Rhizophora mangle*) is an obligate wetland plant (Reed, 1988; Puttock and Imada, 2003) from tropical America, described as aggressive-invasive in Erickson & Puttock (2006). Although there are two species of mangrove established in Hawai'i, only *R. mangal* is widespread. The other species (*Bruguiera sexangula*) is uncommon and found only on O'ahu (Erickson & Puttock, 2006). No occurrences of *B. sexangula* were noted during our surveys (nor was it reported in ACOE, 1999), but differentiating this species from *R. mangal* does require paying careful attention to each tree (*B. sexangula* has knee roots and lacks the prop roots of *R. mangal*; Fig. 4), so distribution of *Bruguiera* in Pearl Harbor remains unknown to us.

Figure 4. Red mangrove growing along a creek in Wai'au. This view from beneath the canopy shows the extensive prop-root growth of youthful trees. Note numerous mangrove seedlings on opposite bank.

Although an obligate wetland species, it is not clear that any growth of mangrove along the shore of Pearl Harbor, even though assigned a wetland identification number by ACOE (1999), is actually wetland. Soils may be presumed hydric, but are not necessarily present in many situations. To wit, (ACOE, 1999, p. 49): "...mangroves of themselves do not constitute a regulatory wetland." Mangroves occur in waters of the U.S., but sometimes in situations which are not wetlands: on rock and coarse sand and gravel shorelines, and the banks of streams and other channels wherever seedlings are carried and take root. As pointed out in their 1999 report, once "…there is a buildup of sediment caused by mangrove encroachment, the stream or shoreline may change from a waterway to a wetland." Much like the difficulty of differentiating a small pond from an open water part of a wetland, there is no sharp point at which an area of mangrove growth becomes a wetland by this approach. The manual (ACOE, 1987, p. 54) allows that if the dominant vegetation has an indicator status of obligate, the soil (or sediment) is presumed to be hydric requiring no further inspection. It is mute on the point of whether there must be a soil or sediment present. Mangroves are not just dominant species where they grow, but typically the only vegetation present of any consequence (see Fig. 4), an exception sometimes being pickleweed (see p. 20), also an obligate wetland species.

In this report, we have generally tried to describe as "mangal"—a term meaning a mangrove forest—areas of mangrove growth that clearly are wetlands. These are stands of several to many trees in all directions with a buildup of organic-rich soil/sediment on the forest floor (see *AECOS*, 2006 for a practical example differentiating mangroves from mangal in Kāneʻohe Bay). We are more circumspect about the many narrow but in some places continuous bands of mangrove shrubs along rocky shores, gravel beaches (Fig. 5), or man-made estuarine channels in Pearl Harbor. It is evident from the text that the Corps delineators in 1999 were aware of such a distinction, although were conservative on the side of designating more such growths as wetlands than might stand to careful scrutiny. The most recent version of the NWI (USFWS, 2007) appears to define all occurrences of mangrove as wetlands under the Cowardin, et al. classification system (see p. 3, above), in some cases apparently differentiating between mangroves growing as shrubs and mangroves growing as trees, although we are unable to find any consistency in the application of one code over another.

We suggest that the classification of mangrove dominated habitat following Cowardin, et al. (1979)[7] is E2FO3N: estuarine intertidal broad-leaved evergreen forested, regularly flooded wetland. Where mangrove growth is sparse and the plants are shrubs less than 6 m in height, the NWI coding could be E2SS3N: estuarine intertidal broad-leaved evergreen scrub-shrub, regularly flooded wetland. Such areas are usually not counted by us as wetlands and the same coding might apply to intertidal pickleweed flats (a shrub; see p. 20). Any area identified as a mangal by our definition would be coded, E2FO3N.

[7] Cowardin, et al. (1979) does not actually provide the codes used by the NWI. These were developed later and have been subject to additions/modifications over time. Our Appendix A summarizes the coding as presently provided by the NWI website.

Figure 5. Red mangrove establishing on a gravel beach shoreline presently occupied above by pickleweed that will, over time, be overgrown or isolated behind a mangal (*AECOS*, 2006).

Almost without exception, any area of mangrove growth in Pearl Harbor is jurisdictional, whether a "wetland" as defined by ACOE (1987) or not. Consequently, we have not shown as wetlands on our delineation maps what appear to us to be isolated growths of red mangrove and not mangal, or channels and other soft-sediment sites where mangrove has been recently removed. In the latter case, this is not to imply that the site was wetland and is now not wetland simply as a result of removal of the wetland indicator plant. The manual describes methods for delineating wetlands where the vegetation has been altered by recent human activity. In all cases, these locations have reverted (or presumably will) to either mudflat (a special aquatic site) or unvegetated tidal channel. Whether maintenance is planned to keep them mangrove free or mangroves do recolonize, our pragmatic view is that at the time of this survey they were no different than shallow tidal waters that have yet to be covered by mangrove growth, identical in status to a shrinking central pond (non-wetland) of a former Hawaiian fishpond gradually being overgrown by mangrove.

Delineations of mangal in our survey have been accomplished mostly by using aerial photographs in the field to "establish" the wetland boundary. In most cases, mangrove trees can be easily distinguished in satellite images. This approach has proven necessary because GPS equipment provides generally low accuracy (or no reading) for positions under the dense canopy of the mangal, and as well under the canopy of *kiawe*, a typical vegetation type of the upland bordering a mangal.

Because mangrove in Hawai'i is "a landscape-altering species' (Erickson & Puttock, 2006, p. 128), local ACOE policy with respect to permits is to support removal of alien mangrove in the Hawaiian Islands, a sensible approach because a mangrove-denuded area may cease to be a wetland by definition but does not lose its status as jurisdictional waters of the U.S. A surprising amount of mangal—well-established mangrove forest—and isolated mangrove shrubs were removed from Pearl Harbor shores during the period of our field efforts (September 2006 to July 2007).

Pickleweed Wetlands ~ Pickleweed or *'ākulikuli kai* (*Batis maritima*) is a small maritime shrub, one of only two species in the genus and in the Family Bataceae. *B. maritima* was first noted growing in a salt marsh at what is now Sand Island on O'ahu by Hillebrand in 1859 (Wagner, et al., 1990). The species is native to the Americas.

The common name refers to organs resembling small pickles in which the young flowers are initially enclosed. Pickleweed is listed as an obligate wetland species in both Reed (1988) and Puttock and Imada (2004), and its growth is pretty much restricted to marine and estuarine upper shorelines areas. It is described as aggressive-invasive in Erickson & Puttock (2006). On the lower shore, pickleweed is limited by lack of tolerance to lengthy immersion, therefore advancing only just into the upper intertidal. On the upper shore or inland along estuaries, pickleweed is also limited to saline conditions, and its presence can be used to infer saline influence beyond that afforded by brackish water. The grass, *Paspalum virginicum*, usually replaces pickleweed where conditions are not quite saline enough for the latter.

Pickleweed is an excellent indicator of isolated or semi-isolated saline wetlands (Fig. 6) and thus a potential indicator of the reach of the highest tides, the latter being an important jurisdictional marker. Because pickleweed can exhibit scrambling growth, the upper edge of the plants is not necessarily at the

extreme of either tidal reach or wetland conditions. In drier parts of the island, a saline tidal flat may have, along its border, a significant incursion of perhaps several meters by pickleweed into the surrounding upland. Further, the plant will not tolerate salinity extremes of evaporative saline basins. The lowest part of such basins (where the most salts are deposited) can be barren of all vegetation (Fig. 3, above), although are part of the wetland and likely tidal but irregularly flooded.

Figure 6. Pickleweed dominating a saline channel on the Pearl City Peninsula near the old Pearl City WWTP.

Pickleweed establishes along the shore in areas of quiet waters, especially where the substratum is sediment. This plant could dominate most of the Pearl Harbor shore, but for its intolerance of deep shade. Once mangrove becomes established on the same shore, the pickleweed is gradually edged out by the much taller growth of the mangrove (Fig. 7; see also Figs. 5 and 2b, above). Mangrove propagules initially establish in slightly deeper water, running out in front of the pickleweed shore. This sometimes results in a mangal with a pocket of pickleweed along the landward edge where an irregularly flooded basin exists.

Figure 7. An interior area of pickleweed, south of West Loch Community Park, being slowly invaded by American mangrove (scattered shrubs on left and solid tree growth on right and background).

We suggest that the best classification of pickleweed dominated habitat using Cowardin, et al. (1979) is E2SS3P: estuarine intertidal broad-leaved evergreen scrub-shrub, irregularly flooded wetland. Of course, some areas of pickleweed may be regularly flooded (E2SS3N). By definition (Cowardin, et al., 1979, p. 29), *irregularly flooded* pertains to "tidal water [that] floods the land surface less often than daily." However, the distinction between "daily" and "less often than daily" is difficult to make at the upper end of the intertidal zone where (as in the Hawaiian Islands) the tides are mixed semidiurnal and have a spring/neap tide cycle. The distinction between regularly and irregularly flooded cannot be made based on aerial photographs, requiring that either careful observations be made within the vegetation type over time or stadial surveys be conducted across the area. Irregular flooding intervals would be those limited to certain spring tides, spring tides at certain times of the year, or tides in concert with high groundwater levels, as in the wet season.

California Grass Wetlands ~ California or Para grass (*Urochloa mutica*; synonyms: *Brachiaria mutica* and *Panicum muticum*) is a sprawling perennial herb (grass) with stems that can reach 6 m (18 ft) in length. The native origin of this plant is unknown (tropical Africa is suggested in Erickson & Puttock, 2006), but it was first recorded on O'ahu in 1924 (Wagner, et al., 1990). It grows in areas of high soil moisture and is listed as facultative wetland (FACW) in Reed (1988) and Puttock and Imada (2004). On the wetter windward sides of the island, its presence is not a certain indication of a wetland, but on the drier leeward coast, its presence nearly always merits investigation for potential wetland conditions.

Figure 8. A somewhat unusual situation of a palustrine wetland dominated by California grass (foreground), the grass growing up into red mangrove at a palustrine/estuarine boundary.

California grass is particularly important in wetland ecology on O'ahu for the reason that its rapid growth after establishment can result in the loss of native wetland vegetation and open water areas important to waterfowl. The plant does not grow in deep water (or very well in shallow water for that matter), and may be limited in that regard, but its long, sprawling stems grow out over the water surface, advancing across each season's accumulation of dead stems to form a thick, floating mat that eventually obscures the open water. Even large ponds, if not flushed by seasonal freshets, can be covered in a few years. This species is described as aggressive-invasive by Erickson & Puttock (2006) and is a potent threat to all palustrine systems around Pearl Harbor.

California grass grows within a range of situations, some neither wetland nor aquatic environment of any kind. We suggest that the classification of a California grass dominated wetland using Cowardin, et al. (1979) is PEM1C: palustrine emergent herbaceous vegetation, seasonally flooded wetland or PEM1H if in an area permanently flooded (where California grass is overgrowing from the margins).

Abbreviations

Although most abbreviations are explained where first introduced in the text, this report is intended as a reference document that might not be read from front to back. The following abbreviations may be encountered without explanation:

ACOE - U.S. Army Corps of Engineers
AECOS - Not an acronym; *AECOS*, Inc.
DA - Department of the Army (as in DA Permit No...., an ACOE permit).
DLNR - Department of Land and Natural Resources (state agency)
DO - Dissolved oxygen; also DO Sat: the percentage of oxygen dissolved in water relative to the maximum theoretical amount given the salinity and temperature of the water
C&C - City and County of Honolulu
CFR - Code of Federal Regulations
E - First order (system) NWI code for estuarine (see Cowardin, et al., 1979)
HECO - Hawaiian Electric Company
ID - ACOE (1999) wetland surveys numbering system; in this report the given 4-digit number should be preceded by 210010 to yield the complete ACOE (1999) reference
INRMP - Integrated Natural Resources Management Plan
M - First order (system) NWI code for marine (see Cowardin, et al., 1979)
NAVMAG - Naval Magazine
NWI - National Wetlands Inventory (USFWS)
NWR - National Wildlife Refuge
OR&L - Oahu Railroad and Land Co.; historical entity
P - First order (system) NWI code for palustrine (see Cowardin, et al., 1979); a freshwater wetland
PACNAVFACENGCOM - Pacific Naval Facilities Engineering Command (NAVFAC Pacific)
PH - Pearl Harbor
PHNWR - Pearl Harbor National Wetland Refuge
pH - Unit of measure of the acidity of a water sample
R - First order (system) NWI code for riverine (see Cowardin, et al., 1979)
USFWS - U.S. Fish and Wildlife Service (federal agency)
USGS - U.S. Geological Service (federal agency)

Hawaiian Words

A number of Hawaiian words are used widely in common speech and technical writing in the Hawaiian Islands (including common names of many plants). These words appear in italics in the text and are defined here. Hawaiian place names are not italicized or explained further (with one exception in the list below).

ʻaeʻae	*Bacopa monnieri*, a native wetland plant
ʻākulikuli	*Sesuvium portulacastrum*
ʻākulikuli kai	*Batis maritima* or pickleweed, a non-native wetland plant
ʻEwa	Place name on Oʻahu west of Pearl Harbor, but frequently used to indicate direction on leeward Oʻahu; i.e., to the west (towards *ʻEwa*)
hau	*Hibiscus tiliaceus*
kalo	Taro (*Colocasia esculenta*)
kaluhā -	*Bolboschoenus maritimus*, a native bulrush
kiawe	*Prosopis pallida*; a non-native algaroba tree
koa haole	*Leucaena leucocephala*
loʻi	A pond field for growing *kalo*
loko	- A (typically) estuarine or freshwater pond
makahā	The sluice gate of a fishpond
makai	- Direction towards the sea, towards the coast
mauka	Direction towards the mountains, inland
muliwai	Broadly: estuarine; but more specifically a natural pond at the mouth of an intermittent stream held behind a beach

Bibliography and References Cited

AECOS, Inc. 1983. Hydrological patterns and water quality of the Nu'upia Ponds, Marine Corps Air Station, Kaneohe Bay, Island of O'ahu, Hawai'i. Prep. for U.S. Fish and Wildlife Service, Honolulu. AECOS No. 374: 120 pp.

______. 1985a. Environmental assessment for a proposed watercress development project at Waiawa, O'ahu. Prep. for Landsend, Inc., Honolulu. AECOS No. 438A: 54 pp.

______. 1985b. Biological surveys in the Nu'upia Ponds Wildlife Management Area in association with the November 1984 opening of the Pa'akai/Kailua Bay Channel. Prep. for Naval Facilities Engineering Command, MCAS. *AECOS* No. 424: 81 pp.

______. 1986. Final environmental impact statement for a proposed watercress development project at Waiawa, O'ahu. Kailua, AECOS, Inc.**:** 60 p.

______. 1988a. Dredged material testing for maintenance of Waimalu Stream, Waimalu, Hawaii, AECOS, Inc., Kailua.

______. 1988b. Environmental assessment of the upper estuarine reach of Wailani Stream (Kahu Channel), Waipahu, Oahu, Hawaii. Prep. for Gerald Park, Urban Planner, Honolulu. AECOS No. 521: 9 pp.

______. 1994. An Environmental Reconnaissance Survey of Lower Waiau Stream, Pearl City, O'ahu, AECOS Inc., Kailua**:** 12 pp.

______. 1996. Final report and water quality assessment: Waimano drainage reconstruction, Pearl City, O'ahu, AECOS, Inc., Kailua**:** 25 pp.

______. 1998. Dredged material testing for maintenance of Waimalu Stream, Waimalu, Oahu, Hawaii (Bioassay and bioaccumulation testing). Prep. for M & E Pacific. 52 pp.

______. 1999. Biological reconnaissance survey of Halawa Stream mouth for Kamehameha Highway widening project, AECOS, Inc., Kailua. *AECOS* No. 932**:** 11 pp.

______. 2000. Biological resources survey for the Leeward Bikeway environmental assessment. Prep. for EarthTech, Inc., Honolulu. AECOS, Inc, Kaneʻohe. AECOS No. 942: 35 pp.

AECOS, Inc. 2001a. A wetland boundary determination for the Waipahu Ash Landfill Closure, Waipahu, O'ahu. *AECOS* Inc., AECOS No. 987A**:** 14 pp.

______. 2001b. Aquatic resources survey for the HECO Waiau Power Generating Station on East Loch of Pearl Harbor, O`ahu, AECOS Inc., Kaneohe, AECOS No. 961A: 16 pp.

______. 2002a. Aquatic resources survey for the HECO Waiau Power Generating Station on East Loch of Pearl Harbor, O'ahu. *AECOS* No. 961A: 14 pp.

______. 2002b. untitled letter report (a field reconnaissance survey for the U.S. Army Corps of Engineers' project entitled "Environmental Assessment for FY03 MCA PN 52201 Logistic Support Vessel (LSV) Facility, Pearl Harbor, Oahu, Hawaii"). Prep. for Wil Chee Planning. AECOS No. 999: 5 pp.

______. 2004. Water quality and biological survey of Waimano Stream at Pacific Palisades Wastewater Pump Station, Aiea, O`ahu. Prep. for: Engineering Concepts. 11 pp.

______. 2005. Water quality and biological survey of Kahu Channel tributary at Waipi'o Point, 'Ewa, O`ahu. Prep. for: Engineering Concepts. 13 pp.

______. 2006. Feasibility study for mangrove removal along the south Kāne'ohe Bay shoreline, Marine Corps Base Hawaii, Kāne'ohe, O'ahu, Hawai'i. Prep. for MCBH Environmental Department. *AECOS* No. 1107B: 89 pp.

______. 2007. Terrestrial and aquatic resources inventory and impacts assessment along lower Kapakahi Stream, Waipahu, O'ahu, Hawai'i. Prep. for Environmental Planning Solutions, LLC, Honolulu. *AECOS* No. 1136: 11 pp.

'Ahahui Mālama i ka Lōkahi (AML). 2004. Studies relevant to restoration efforts in Kawai Nui Marsh. Prep. for Kailua Bay Advisory Council (KBAC) by AECOS Consultants and 'Ahahui Mālama i ka Lōkahi.

Ahuimanu Productions. 1977. An ornithological survey of Hawaiian wetlands. 130 pp.

Allen, J. A. 1998. Mangroves as alien species: the case of Hawaii. *Global Ecology and Biogeography Letters*. 7: 61-71.

B-K Dynamics Inc. 1972. Marine environmental impact analysis, Waiau Power Plant, B-K Dynamics, Inc.**:** 47 pp.

Belt Collins Hawaii. 1998. Final Environmental Impact Statement for Waipio Peninsula Soccer Park, Conceptual Master Plan. Prep. for City & County of Honolulu, Dept. Design and Construction. 229 pp.

Bruner, P. 1992. Survey of the avifauna and feral mammals of Waiawa wetlands, Oahu. Prep. for Helber Hastert & Fee. 13 pp.

______. 1996. Migratory shorebird, resident waterbird and seabird survey of Fort Kamehameha wetlands and offshore islets. Final Environmental Impact Statement, outfall replacement for wastewater treatment plant at Fort Kamehameha, Navy Public Works Center, Pearl Harbor, Hawaii. App. V**:** 7 pp.

______. 1999. Survey of the avifauna and feral mammals for the Integrated Natural Resources Management Plan for Naval Station Pearl Harbor, Makalapa Crater, Oahu. Prep. for Helber Hastert & Fee, Honolulu. 9 pp.

______. 2000. Survey of the avifauna and feral mammals for the Integrated Natural Resources Management Plan for Naval Station (NAVSTA), Public Works Center (PWC), and Fleet and Industrial Supply Center (FISC) Pearl Harbor. Prep. for Helber Hastert & Fee, Honolulu. 16 pp.

Bryan, E. H. 1935. *Hawaiian Nature Notes*. Honolulu Star-Bulletin, Ltd. 285 pp.

Char, W. 1993. Botanical survey, Waiawa wetlands study, Pearl City Peninsula, Island of O'ahu. Prep. for Helber Hastert & Fee, Planners by Char & Assoc. 16 pp.

______. 2000. Botanical survey, mangrove community in Pearl Harbor, Pearl Harbor O'ahu. Prep. For Helber Hastert & Fee, Honolulu by Char & Assoc. 14 pp.

______ and N. Balakrishnan. 1979. 'Ewa Plains botanical survey. Prep. for U.S. Dept. Interior, Fish and Wildlife Service. University of Hawaii, Department of Botany. Contract No. 14-16-0001-78171: 119 pp.

Clark, J. R. K. 2002. *Hawai'i Place Names. Shores, Beaches, and Surf Sites*. The University Press of Hawaii, Honolulu. 413 pp.

Coles, S. L. 1979. A description of the wetlands adjacent to the Waiau Generating Station, Oahu, Hawaii, and a history of its land utilization, Hawaiian Electric Co., Inc., Honolulu: 34 pp.

Coles, S. L., R. C. DeFelice, L. G. Eldredge, and J. T. Carlton. 1997. Biodiversity of marine communities in Pearl Harbor, Oahu, Hawaii with observations on introduced exotic species. Bishop Museum Tech. Rept. 76 pp.

______, ______, ______, and ______. 1999. Historical and recent introduction of nonindigenous marine species into Pearl Harbor, Oahu, Hawaiian Islands. *Mar. Biol.*, 235: 147-158.

Cowardin, L. M., V. Carter, F. C. Golet, and E. T. LaRoe. 1979. *Classification of wetlands and deepwater habitats of the United States.* Washington, D.C., U. S. Fish and Wildlife Service. (See URL: http://www.fws.gov/nwi/MapCodesLegend.pdf)

David, R. 2001. A survey of avian and terrestrial mammalian species for the HECO fuel pipeline: Barbers Point to Waiau Project, Oahu, Hawaii.

Dollar, S. and R. Brock. Undated. Pearl Harbor Integrated Natural Resources Management Plan. Marine and fishery resources. Prep. for Helber Hastert & Fee, Honolulu.

Ducks Unlimited Inc. 1998. Environmental and enhancement plan for Pouhala Marsh, Oahu, Hawaii. Prep. for Hawaii Division of Forestry and Wildlife, U.S. Fish and Wildlife Service, and City and County of Honolulu. Ducks Unlimited, Inc., Rancho Cordova, Calif.

Earth Tech Inc. 1999. Closure/post-closure plan, Waipahu Ash Landfill, O`ahu, Hawai`i. Draft (60%), Earth Tech, Honolulu: 30 pp.

Elliott, M. E. and E. M. Hall. 1977. Wetlands and wetland vegetation of Hawaii: 344 pp.

Engineers Surveyors Hawaii and Environmental Planning Services (ESH and EPS). 2003. Final environmental assessment - Waimalu Stream dredging, City & County of Honolulu, Hawaii. Prep. for: City and County of Honolulu.

Engilis, A., Jr. 1988. Surveys and inventories of water-birds in the State of Hawaii, a ten-year trend analysis. Unpbl. Pitt. Robs. report W-18-R-12, R-III-A.

Englund, R. A. 2002. The loss of native biodiversity and continuing non-indigenous species introductions in freshwater, estuarine, and wetland communities of Pearl Harbor, Oahu, Hawaiian Islands. *Estuaries*, 25(3): 418-430.

Englund, R. A., D. J. Preston, S. L. Coles, L. G. Eldredge, K. Arakaki, R. Wolff. 2000. Biodiversity of freshwater and estuarine communities in lower Pearl Harbor, Oahu, Hawaii with observations on introduced species. Dept. of Defense Legacy Proj. No. 106.

Environmental Law Institute (ELI). 2007. The Clean Water Act Jurisdictional Handbook. 2007 Edition. Environmental Law Institute, Washington, DC. 77 pp.

Erickson, T. A. and C. F. Puttock. 2006. *Hawai`i Wetland Field Guide: an ecological and identification guide to wetlands and wetland plants of the Hawaiian Islands.* Honolulu, U.S. Environmental Protection Agency. 293 pp.

Federal Register. 1980. “40 CFR Part 230: Section 404(b) (1) Guidelines for Specification of Disposal Sites for Dredged or Fill Material.” U.S. Govt. Printing Office, Washington, DC. *Federal Register*, 45(249): 85352-85353.

______. 1982. “Title 33: Navigation and Navigable Waters; Chapter II, Regulatory Programs of the Corps of Engineers.” U.S. Govt. Printing Office, Washington, DC. *Federal Register*, 47(138): 31810.

Freeman, W. 1993. Revised total maximum daily load estimates for six water quality limited segments of O`ahu, Hawaii, Pacific Environmental Research.

Geographic Decision Systems International, and E. P. Dashiell (GDSI). 1994. State definition and delineation of watersheds. Prep. for State of Hawaii, Office of State Planning, Coastal Zone Management Program. Geographic Decision Systems International.

Greenhorne & O’Mara, Inc. 1999. Wetland mapping report for the United States Navy. Updated National Wetland Inventory, cited in Helber Hastert & Fee (2001).

Guinther, E. B. 2003. Assessment of wetland conditions on Parcel TMK: 9-7-19: 38 in Waiau, Central Oahu. AECOS Consultants No. AC035: 5 pp.

______ and R. David. 2001. Biological survey, Iroquois Pt/Puuloa Housing Area, PHNC, Pearl _Harbor, O`ahu, Hawai`i, AECOS Inc., Kailua and Rana Productions, Ltd., Kailua-Kona**:** 11 pp.

Guinther, E. and J. C. McCain. 1987. Preliminary assessment of the biological impact of the May 13, 1987 fuel spill on the mangrove environment in Middle Loch, Pearl Harbor, Hawaii. AECOS, Inc.**:** 28 pp.

______ and K. Laing. 2006. Marine resources survey for proposed improvements at Pu'uloa Lagoon, Iroquois Point Housing, Pearl Harbor, O'ahu. Prep. for Hunt Building. AECOS Consultants No. AC041A: 16 pp.

Hawaii Cooperative Park Service Unit. 1990. Hawaii stream assessment. A preliminary appraisal of Hawaii's stream resources. Prep. for State of Hawaii, Commission on Water Resource Management. National Park Service, Hawaii Cooperative Park Service Unit, Rept. No. **R84**: 294 pp.

Helber Hastert & Fee, Planners. 1994. Final report. Waiawa floodplain feasibility study, Pearl Harbor, Oahu, Hawaii. 36 pp + appendices.

______. 2001. Pearl Harbor Naval Complex, Integrated Natural Resources Management Plan. Final. Prep. for Commander Navy Region Hawaii, Dept. of the Navy. 202 pp. + appendices.

Henderson, R. S. 1991. Bioassay and bioaccumulation tests on dredged material from Pearl Harbor (Foxtrot 5 Pier & offshore improvements, Project P-332A), Environmental Sciences Division, Naval Ocean Systems Center**:** 20 pp.

Hosaka, E. Y. 1937. Ecological and floristic studies in Kipapa Gulch, Oahu. *Bishop Museum Occ. Pap.*, 13: 175-232.

Land Study Bureau (LSB). 1963. Detailed land classification - Island of Oahu. LSB Bull. No. 3: 141 pp. [collection of 1951-1954 USACOE aerial photographs of Oahu].

Marine Research Consultants. 1998. Assessment of the biotic communities on the proposed alignments for the Fort Kamehameha sewage outfall extension. Final Environmental Impact Statement, outfall replacement for wastewater treatment plant at Fort Kamehameha, Navy Public Works Center, Pearl Harbor, Hawaii, Marine Research Consultants, Honolulu**:** 14 pp.

Microsoft Corp. 2006-7. Satellite images at URL: http://maps.live.com last visited on November 1, 2007.

Mitsch, W. J., and J. G. Gosselink. 1986. *Wetlands*. Van Nostrand Reinhold. 539 pp.

Nance, T. 1998. Effect of the proposed use of the WP-18 pump station on Waikele Stream and West Loch. Consultants report prepared by Tom Nance Water Resource Engineering. 39 pp.

Naval Facilities Engineering Command (NAVFACENGCOM). 2001. NAVMAG Pearl Harbor, Integrated Natural Resources Management Plan (INRMP), Naval Magazine Pearl Harbor. Prep. for Commander, Navy Region Hawaii, Dept. of the Navy. Natural Resources Branch, Pacific Division, NAVFACENGCOM.

Nichols, W. D., P. J. Shade and C. D. Hunt. 1997. Summary of the Oahu, Hawaii, regional aquifer-system analysis. *U.S. Geological Survey Professional Paper,* 1412-A: 61 pp.

Nishida, G. M. and C. T. Imada. 1997. A reconnaissance survey of the plants and animals of Pouhala Marsh, Pearl Harbor, Oahu. Report to Ducks Unlimited, Inc. Bishop Museum, Hawaii Biological Survey. 15 pp.

Oceanit Laboratories Inc. 2006. Kawai Nui Marsh invasive aquatic plant study. Final report. Kawai Nui Marsh, Kailua, O'ahu. Prep. for U.S. Army Corps of Engineers. 94 pp.

Paul H. Rosendahl, Ph D., Inc. (PHRI). 1993. Archaeological inventory survey, Waiawa Floodplain Feasibility Study project area. Land of Manana, Ewa District, Island of Oahu. Prep. for Helber Hastert & Fee, Planners. Rept. 1307-101493.

Puttock, C. F. and C. Imada. 2004. Wetland status list for Hawaiian plants. Final report for U.S. Fish and Wildlife Service, Honolulu.

Rapanos. 2006. *Rapanos v. United States* and *Carabell v. United States* (consoilidated). 126 Sup. Crt. 2208 (2006).

Reed, P. B. J. 1988. National list of plant species that occur in wetlands: Hawaii (Region H), U.S. Fish & Wildlife Service, Washington, DC. Biol. Rept. 88 (26.13)**:** 88 pp.

Scott, D. A. 1993. A Directory of Wetlands in Oceania. The International Waterfowl and Wetlands Research Bureau (IWRB) Asian Wetland Bureau (AWB).

Shallenberger, R. J. 1977. An ornithological survey of Hawaiian wetlands, Ahuimanu Productions, Honolulu: Part 1 - 131; Part II - 406.

South Carolina Department of Natural Resources (SCDNR). Undated. Website URL: http://www.dnr.sc.gov/cgi-bin/wetlands/nwidecoder (last visited October 2007).

Stearns, H. T. and K. N. Vaksvik. 1935. Geology and ground-water resources of the island of Oahu, Hawaii. Territory of Hawaii, Department of Public Lands, Division of Hydrography, Bulletin 1: 479 pp.

Stemmermann, L. 1981. A Guide to Pacific Wetland Plants. Honolulu, U.S. Army Corps of Engineers, Honolulu District.

Sterling, Elspeth P. and Catherine C. Summers. 1978. *Sites of Oahu*. Dept. of Anthropology, Dept. of Education, Bernice P. Bishop Museum. 352 pp.

SWANCC. 2001. *Solid Waste Agency of Northern Cook County v. U.S. Army Corps of Engineers*, 531 U.S. 159 (2001).

U.S. Army Corps of Engineers (ACOE). 1987. Corps of Engineers Wetlands Delineation Manual. Vicksberg, Mississippi, Environmental Laboratory, Dept. of the Army, Waterways Experiment Station, Corps of Engineers.

______. 1999. Wetlands of Pearl Harbor, Pearl Harbor, Oahu, Hawaii. U.S. Army Engineer District, Honolulu. 70 pp.

______. 2007. Regulatory Guidance Letter: Practices for documenting jurisdiction under Sections 9 & 10 of the Rivers & Harbors Act (RHA) of 1899 and Section 404 of the Clean Water Act (CWA). RGL No. 07.01, June 5, 2007.

U.S. Environmental Protection Agency and U.S. Army Corps of Engineers (EPA/ACOE). 2007. Appendix A. Memorandum Re: Clean Water Act Jurisdiction following the U.S. Supreme Court's Decision in *Rapanos v. United States & Carabell v. United States*. B. J. Grumblers, U.S. EPA and J. P. Woodley, Jr., Dept. of the Army. July 5, 2007. 12 pp.

U.S. Fish and Wildlife Service (USFWS). 1999. Wetlands Online Mapper (NWI). (URL: http://wetlandsfws.er.usgs.gov/wtlnds/launch.html, last visited in June 2007). (Maps were formerly available at http://www.fws.gov/pacific islands/wnwr/opearlnwr.html).

U.S. Fish and Wildlife Service (USFWS). Wetlands Online Mapper (NWI). (URL: http://wetlandsfws.er.usgs.gov/ wtlnds/launch.html (last visited October 2007).

______. National Wetlands Inventory (NWI) Wetlands and Deepwater Habitats Classification, Map Legend. PDF chart, 2 pp. (URL: http://www.fws.gov/nwi/ MapCodesLegend.pdf (last visited October 9, 2007).

Visher, F.N. and J.F. Mink. 1964. Ground-water resources in southern Oahu, Hawaii. *Geological Survey Water-Supply Paper*, 1778: 133 pp.

Wagner, W.L., D. R. Herbst, and S.H. Sohmer. 1990. *Manual of the Flowering Plants of Hawai'i*. University of Hawaii Press, Honolulu, Hawaii. 1854 pp.

Wester, L. 1981. Introduction and spread of mangroves in the Hawaiian Islands. *Association of Pacific Coast Geographers Yearbook*, 43:125-137.

Wil Chee - Planning Inc. 1999. Draft Environmental Assessment for the Waipahu Ash Landfill Closure, Waipahu, O`ahu, Hawai`i, Tax Map Key: 9-3-02: 2, 27, por. 9, 1 and 28. Wil Chee - Planning, Inc., Honolulu: 30 pp.

Whistler, A. 1998. Botanical survey of the proposed Waipi'o Peninsula Sports Complex Site, Honolulu. Prep. for Belt Collins Hawai'i, Honolulu. 23 pp.

Wilcox, Bruce, Eric B. Guinther, Kristin N. Duin, and Hilary Maybaum. 1998. Mokapu: manual for watershed health and water quality. Prep. for Environmental Dept., MCBH-KB.

Wilson, C. L. and W. E. Loomis. 1967. *Botany*. Holt, Reinhart and Winston, New York. 626 pp.

Young, S. 1999. Hawai`i wetland management policy, Aura Consulting: 25 pp.

APPENDIX A. Wetlands and Deepwater Habitats Classification Key to Codes

WETLANDS AND DEEPWATER HABITATS CLASSIFICATION

SYSTEM: M - MARINE

SUBSYSTEM: 1 - SUBTIDAL

CLASS	RB – ROCK BOTTOM	UB – UNCONSOLIDATED BOTTOM	AB – AQUATIC BED	RF - REEF	OW - *OPEN WATER/ Unknown Bottom*
Subclass	1 Bedrock 2 Rubble	1 Cobble-Gravel 2 Sand 3 Mud 4 Organic	1 Algal 3 Rooted Vascular 5 *Unknown Submergent*	1 Coral 3 Worm	

SUBSYSTEM: 2 - INTERTIDAL

CLASS	AB – AQUATIC BED	RF– REEF	RS – ROCKY SHORE	US - UNCONSOLIDATED SHORE
Subclass	1 Algal 3 Rooted Vascular 5 *Unknown Submergent*	1 Coral 3 Worm	1 Bedrock 2 Rubble	1 Cobble-Gravel 2 Sand 3 Mud 4 Organic

SYSTEM: E - ESTUARINE

SUBSYSTEM: 1 - SUBTIDAL

CLASS	RB - ROCK BOTTOM	UB – UNCONSOLIDATED BOTTOM	AB – AQUATIC BED	RF – REEF	OW - *OPEN WATER/ Unknown Bottom*
Subclass	1 Bedrock 2. Rubble	1 Cobble-Gravel 2 Sand 3 Mud 4 Organic	1 Algal 3 Rooted Vascular 4 Floating Vascular 5 *Unknown Submergent* 6 *Unknown Surface*	1 Mollusc 2 Worm	

SUBSYSTEM: 2 - INTERTIDAL

CLASS	AB – AQUATIC BED	RF– REEF	SB – STREAMBED	RS - ROCKY SHORE	US – UNCONSOLIDATED SHORE	EM -EMERGENT	SS – SCRUB-SHRUB	FO – FORESTED
Subclass	1 Algal 3 Rooted Vascular 4 Floating Vascular 5 *Unknown Submergent* 6 *Unknown Surface*	1 Mollusc 2 Worm	1 Cobble Gravel 2 Sand 3 Mud 4 Organic	1 Bedrock 2 Rubble	1 Cobble-Gravel 2 Sand 3 Mud 4 Organic	1 Persistent 2 Nonpersistent	1 Broad-Leaved Deciduous 2 Needle-Leaved Deciduous 3 Broad-Leaved Evergreen 4 Needle-Leaved Evergreen 5 Dead 6 *Deciduous* 7 *Evergreen*	1 Broad-Leaved Deciduous 2 Needle-Leaved Deciduous 3 Broad-Leaved Evergreen 4 Needle-Leaved Evergreen 5 Dead 6 *Deciduous* 7 *Evergreen*

SYSTEM: R - RIVERINE

SUBSYSTEM: 1 – TIDAL; 2 – LOWER PERENNIAL; 3 – UPPER PERENNIAL; 4 – INTERMITTENT; 5 – *UNKNOWN PERENNIAL*

CLASS	RB – ROCK BOTTOM	UB – UNCONSOLIDATED BOTTOM	*SB – STREAMBED	AB – AQUATIC BED	RS – ROCKY SHORE	US – UNCONSOLIDATED SHORE	**EM – EMERGENT	OW – *OPEN WATER/ Unknown Bottom*
Subclass	1 Bedrock 2 Rubble	1 Cobble-Gravel 2 Sand 3 Mud 4 Organic	1 Bedrock 2 Rubble 3 Cobble Gravel 4 Sand 5 Mud 6 Organic 7 Vegetated	1 Algal 2 Aquatic Moss 3 Rooted Vascular 4 Floating Vascular 5 *Unknown Submergent* 6 *Unknown Surface*	1 Bedrock 2 Rubble	1 Cobble-Gravel 2 Sand 3 Mud 4 Organic 5 Vegetated	2 Nonpersistent	

* STREAMBED is limited to TIDAL and INTERMITTENT SUBSYSTEMS, and comprises the only CLASS in the INTERMITTENT SUBSYSTEM.
** EMERGENT is limited to TIDAL and LOWER PERENNIAL SUBSYSTEMS.

Classification of Wetlands and Deepwater Habitats of the United States
Cowardin ET AL. 1979 as modified for National Wetland Inventory Mapping Convention

WETLANDS AND DEEPWATER HABITATS CLASSIFICATION

SYSTEM: L- LACUSTRINE

SUBSYSTEM: 1 - LIMNETIC

CLASS	RB – ROCK BOTTOM	UB – UNCONSOLIDATED BOTTOM	AB – AQUATIC BED	OW – *OPEN WATER/ Unknown Bottom*
Subclass	1 Bedrock 2. Rubble	1 Cobble-Gravel 2 Sand 3 Mud 4 Organic	1 Algal 2 Aquatic Moss 3 Rooted Vascular 4 Floating Vascular 5 *Unknown Submergent* 6 *Unknown Surface*	

SUBSYSTEM: 2 - LITTORAL

CLASS	RB – ROCK BOTTOM	UB – UNCONSOLIDATED BOTTOM	AB – AQUATIC BED	RS – ROCKY SHORE	US – UNCONSOLIDATED SHORE	EM – EMERGENT	OW – *OPEN WATER/ Unknown Bottom*
Subclass	1 Bedrock 2. Rubble	1 Cobble-Gravel 2 Sand 3 Mud 4 Organic	1 Algal 2 Aquatic Moss 3 Rooted Vascular 4 Floating Vascular 5 *Unknown Submergent* 6 *Unknown Surface*	1 Bedrock 2. Rubble	1 Cobble-Gravel 2 Sand 3 Mud 4 Organic 5 Vegetated	2 Nonpersistent	

SYSTEM: P - PALUSTRINE

CLASS	RB – ROCK BOTTOM	UB – UNCONSOLIDATED BOTTOM	AB – AQUATIC BED	US – UNCONSOLIDATED SHORE	ML – MOSS-LICHEN	EM – EMERGENT	SS – SCRUB-SHRUB	FO – FORESTED	OW – *OPEN WATER/ Unknown Bottom*
Subclass	1 Bedrock 2. Rubble	1 Cobble-Gravel 2 Sand 3 Mud 4 Organic	1 Algal 2 Aquatic Moss 3 Rooted Vascular 4 Floating Vascular 5 *Unknown Submergent* 6 *Unknown Surface*	1 Cobble-Gravel 2 Sand 3 Mud 4 Organic 5 Vegetated	1 Moss 2 Lichen	1 Persistent 2 Nonpersistent	1 Broad-Leaved Deciduous 2 Needle-Leaved Deciduous 3 Broad-Leaved Evergreen 4 Needle-Leaved Evergreen 5 Dead 6 *Deciduous* 7 *Evergreen*	1 Broad-Leaved Deciduous 2 Needle-Leaved Deciduous 3 Broad-Leaved Evergreen 4 Needle-Leaved Evergreen 5 Dead 6 *Deciduous* 7 *Evergreen*	

MODIFIERS

In order to more adequately describe the wetland and deepwater habitats one or more of the water regime, water chemistry, soil, or special modifiers may be applied at the class or lower level in the hierarchy. The farmed modifier may also be applied to the ecological system.

WATER REGIME

Non-Tidal

- A Temporarily Flooded
- B Saturated
- C Seasonally Flooded
- D *Seasonally Flooded/ Well Drained*
- E *Seasonally Flooded/ Saturated*
- F Semipermanently Flooded
- G Intermittently Exposed
- H Permanently Flooded
- J Intermittently Flooded
- K Artificially Flooded
- W Intermittently Flooded/Temporary
- Y Saturated/Semipermanent/ Seasonal
- Z Intermittently Exposed/Permanent
- U *Unknown*

Tidal

- K *Artificially Flooded*
- L Subtidal
- M Irregularly Exposed
- N Regularly Flooded
- P Irregularly Flooded
- *S Temporary-Tidal
- *R Seasonal-Tidal
- *T Semipermanent-Tidal
- *V Permanent-Tidal
- U *Unknown*

*These water regimes are only used in tidally influenced, freshwater systems.

WATER CHEMISTRY

Coastal Halinity

- 1 Hyperhaline
- 2 Euthaline
- 3 Mixohaline *(Brackish)*
- 4 Polyhaline
- 5 Mesohaline
- 6 Oligohaline
- 0 Fresh

Inland Salinity

- 7 Hypersaline
- 8 Eusaline
- 9 Mixosaline
- 0 Fresh

pH Modifiers for all Fresh Water

- a Acid
- t Circumneutral
- i Alkaline

SOIL

- g Organic
- n Mineral

SPECIAL MODIFIERS

- b *Beaver*
- d *Partially Drained/Ditched*
- f Farmed
- h *Diked/Impounded*
- r Artificial Substrate
- s *Spoil*
- x Excavated

NOTE: Italicized terms were added for mapping by the National Wetlands Inventory program.

Chapter 1

Puuloa Rifle Range and Iroquois Point Lagoon to Honouliuli Unit, PHNWR

The lands west of the entrance channel to Pearl Harbor are known as Puʻuloa. Navy property in this area includes the Puuloa Rifle Range (on the south shore of Oʻahu in the ʻEwa District, the adjacent Iroquois Point Housing directly west of the entrance channel, and Naval Magazine Pearl Harbor (NAVMAGPH), West Loch Branch, extending along the west side of Pearl Harbor all the way to Honoʻuliʻuli. The Honouliuli Unit of the Pearl Harbor National Wetland Refuge (PHNWR) is located at the western end of Navy property just inland from the south shore of West Loch. All of this area is geologically part of the ʻEwa Plain, an ancient coral reef formation that developed during the late Pleistocene, with the upper portion probably representing the +7.5 m Waimanalo Stand of the sea. Thus, the shoreline in this area tends to rise abruptly and limestone rock and soils are present from the shore inland. Pearl Harbor locations covered in this chapter correspond to most of ACOE (1999) PH Segments 1 and 2.

Puuloa Rifle Range

No wetlands or inland water bodies are known from the Puuloa Rifle Range parcel. The facility borders a beach along the ocean shore.

Iroquois Point Housing Lagoons

Within the Iroquois Point Housing are two man-made lagoon basins connected by pipe culverts beneath 106th Avenue; the larger eastern or outer lagoon opens onto the entrance channel of Pearl Harbor midway between Iroquois Point and Hammer Point. The outer lagoon is used as a yacht basin; the channel connecting to Pearl Harbor is deep enough to accommodate small boat and sailing yachts (Fig. 1-01). The following description of the lagoons is taken from *AECOS* (2006, p. 2):

> Iroquois Point is owned by the U.S. Navy and has been the site of Naval Housing until recently leased to Hunt Building Company, Ltd. (Hunt). The housing and associated infrastructure at Iroquois Point dates from 1959 and the early 1960s[1]. The housing area was developed in an area of mostly kiawe

[1] ACOE (1999) shows two aerial photographs obtained from R.M. Towill Corp: One (dated September 1950) shows what appears to be a large area of cleared land in and around the area later occupied by the lagoons, and the other (dated June 13, 1962) shows the completed Naval housing area and lagoons.

trees (*Prosopis pallida*) and koa-haole (*Leucaena leucocephala*) scrub. The lagoons were then a large depressed area in the midst of the forest, one that probably held shallow water features part of the year, and was a salt flat the remainder of the time. Presumably, this environment was something like that of the Nu'upia Ponds on Marine Corps Base Hawaii at Kane`ohe Bay (see AECOS, 1983, 1985; Wilcox, et al., 1998).

Figure 1-01. The outer lagoon at Iroquois Point Housing is a yacht basin. The shoreline is a man-made revetment of boulders.

In Hawaiian times, this place was part of the 'ili (land division) of Pu'uloa and was known for an offshore fish trap called Pakuli built on the reef off Hammer Point at the mouth of Pearl Harbor (Bryan, 1935; Sterling and Summers, 1978). A commercial salt works was established inland after the 'ili of Pu'uloa was purchased by Isaac Montgomery in 1849, producing salt into the early 1900's (Clark, 2002). During and after the Second World War, development of various facilities along the shore of Pearl Harbor was encroaching southward into this area as Pearl Harbor Navy Base expanded. By the 1950s, it appears that the interior depression (location of the former salt works) was no longer connected to the Pearl Harbor entrance channel (interpretations from aerial photo in LSB, 1963). The present-day lagoon was dredged from the depression area, and the steepness of the banks suggests fill from dredging (and perhaps

These photos do not conflict with the LSB (1963) source, as the aerial photographs in that document are from the mid-1950s.

other sources) was used to raise the level of the ground on which the housing project was then built around the lagoon. At this time, two "separate" ponds were formed with a narrow connection between them. A road was placed across the connection, and water exchange maintained through large culverts beneath the road.

The previous (ACOE, 1999) description of this "wetland" (ID ..2231, ..2232. 2333 through ..2338) was that of a lagoon with a dense growth of mangrove along the shore, nearly completely surrounding the inner lagoon and the innermost part of the eastern or outer lagoon. Likewise, Guinther & David (2001) noted "[a]round the margin of the lagoon, the vegetation is dominated by kiawe, red mangrove (*Rhizophora mangle*), and low-growing pickleweed (*Batis maritima*)."

Figure 1-02. Removal of mangroves underway along shore of the inner lagoon at Iroquois Point Housing in June 2004. Trees were cut by hand in the water, then lifted out with a crane on the shore. Original shoreline here is placed (mostly limestone) boulders (see Fig. SP1-01).

In 2004, permission was obtained from the ACOE for Hunt Building Company, Ltd. to remove the mangroves from the area (Fig. 1-02). In areas of dense mangrove growth, the trees had essentially isolated the housing units from use of the lagoon (e.g., the inner lagoon was not even visible from adjacent housing units) and large amounts of flotsam was collecting at the shoreline among the prop roots of the mangrove (also noted by ACOE, 1999). A biological resources assessment document (*AECOS*, 2006b) was prepared to accompany the application by Hunt Building Company, Ltd. to add cabanas on pilings in the lagoon as part of their efforts to enhance amenities at Iroquois Point Housing. The resources assessment document includes a description and photographs of the marine life inhabiting the essentially marine lagoon environment. A very brief description of the biota of the lagoons is found in Guinther & David (2001).

Observations on the aquatic biota of the lagoons were made on September 1, 2006. Observations were limited to several shoreline areas on each lagoon (corresponding to ID ..2232, ..2233, ..2234, and ..2235; results are given in Table 1-01). The lagoons were visited again on September 15 (3 PM) and salinity measurements taken, yielding 33 ppt for the inner lagoon and 34 ppt for the outer lagoon (close to seawater salinity). The predicted high tide on that date (at Bishop Point, Pearl Harbor) was 2.1 ft at about noon.

Establishing the "wetland" status of the lagoons at Iroquois Point Housing is difficult. Clearly most of the area is not wetland as defined by the ACOE (ACOE, 1987). This aquatic feature is a man-made basin, the substratum at the shore is mostly boulder revetment, and the vegetation is not hydric (although modified from a narrow margin of mangrove growth in many areas). However, in some shoreline sections, the land does slope gradually into the subtidal, and wetland indicator plants (e.g., pickleweed) are or could become established (see Fig. 1-03). The lagoons have an open connection to the ocean (via the Pearl Harbor entrance channel), are tidal, and therefore are—down from the high tide line—jurisdictional waters.

The NWI designation (USFWS, 2007) for this area is E1UBL (the lagoon) and E2FO3N: estuarine, intertidal, broad-leaved evergreen forested, regularly flooded wetland, for the no longer existing mangrove at the shore. A better coding would be E1UBHx, reflecting the estuarine subtidal nature (coded E1), the sedimentary bottom (UB), and the fact that the lagoons are permanently flooded and excavated or man-made (Hx). The shoreline areas of rock revetment become E2RSNx.

Naval Magazine Pearl Harbor, West Loch Branch

Directly north of Iroquois Point Housing is Naval Magazine Pearl Harbor, West Loch Branch (NAVMAGPH). Nearly all of the shoreline north from the mouth of the Iroquois Point Lagoons, along the west side of the Pearl Harbor entrance channel and the long southwest shore leading to West Loch, is a sea cliff of variable height (between 3 and 18 ft or 1 and 5 m; see SP1-02) eroded into the

ancient coral reef formation of the ʻEwa Plain. In many places, docks (many now abandoned) line the shore. Gently sloping shoreline and or shallow mud flat areas are rare, in part because no streams enter Pearl Harbor in this area: the nature of the coastline is erosional rather than depositional, in contrast to the northern parts of Pearl Harbor where many streams draining central Oʻahu contribute sediment loads to deltas building out from the shore.

Figure 1-03. The shore of the inner lagoon near the community center. In some areas the shore is not armored and the fill is eroding. The resulting broad intertidal and subtidal shallows encourages aquatic plants such as pickleweed and mangrove seedlings as seen here.

Interior areas of NAVMAGPH are thought not to have any wetlands (ACOE, 1999) and we would concur that inland wetlands would be very unlikely given the nature (geology and land use) of the area. At the shoreline, mangrove growth is scattered, mostly concentrated in small inlets or coves or similar protected situations. On NAVMAGPH, there are five areas of well established mangal (described below), where the trees have reached good size, and formed a stand more than one tree deep. These stands are all subject to tidal rise and fall and therefore constitute jurisdictional waters, although the outer edges may lack hydric soil or even sediment development. In nearly all places visited, the land side, or transition to upland boundary, is evident by a break in the slope (in some cases a cliff; see Fig. 1-04) and/or a deposit of flotsam, although the mangrove canopy may hang out over the upland by several meters.

At NAVMAGPH, the wetlands are typically surrounded by a *kiawe* forest or savannah of variable tree density (although in undisturbed or undeveloped locations, typically of closed canopy), with an undergrowth of buffel grass or Guinea grass. *Milo* trees are common near some wetland boundaries and *koa haole* scrub occurs typically further back from the wetlands or mixed with *kiawe*. The diversity of plants growing close to or at the wetland margin (see Table 1-02) is generally low because these areas have not been disturbed for a long time, and the vegetation has come to be dominated by just a few species.

Figure 1-04. Cliff shoreline section (here only 2-3 m high) near Nichols Point, NAVMAGPH. Pickleweed on right covers a cliff face, while young mangroves cling to rocks at base of cliff and *kiawe* trees overhang this non-wetland shore (see also photo SP1-06).

Loko ʻOkiʻokiolepe ~ Loko ʻOkiʻokiolepe (ID ..2206) is an ancient Hawaiian fish pond located at the shore near the NAVMAGPH road intersection of G Avenue and 15th Street. The margins of the pond are so completely overgrown with mangrove, that evidence of a pond wall is nearly completely obscured and

the open, middle of the pond glimpsed only through dense tree growth. Evidence can be seen in aerial photographs of openings at either end of the outer wall, but these are becoming obscured by mangrove growth. The growth of *Rhizophora* is so dense that, with only minor exceptions of some *Batis*, no other plants are present within the wetland. Most of the interior edge of the pond is marked by a low escarpment, generally less than 1 m (2+ ft) high of limestone outcrops, or a clear transition from a sloping shore dominated by buffelgrass (in areas where the canopy is open), *kiawe*, and *milo* into the arching mangrove prop roots. *Batis* occurs in scattered open areas on the north side among the *kiawe* where it is growing well above the wetland boundary.

This pond was one of the study sites visited by Char (2000), although no site specific information is provided in her report. Dollar & Brock (undated) include a brief description (presumably from the same time period) which found the outer wall intact although partially collapsed, and, like nearly the entire enclosed pond, covered by mangrove. The INRMP for NAVMAG Pearl Harbor (NAVFACENGCOM, 2001, p. 3-18) describes the pond thusly:

> The pond has been identified as being of historic importance because it is one of a few fishponds left in Pearl Harbor where many had existed in the past. It is also considered significant in that it [the wall] was constructed of stacked coral blocks rather than of basaltic stone, the latter being the more common method of constructing fishponds in the Hawaiian Islands. The pond wall is 656 feet (200 meters) long and encloses an area of approximately 4.5 acres (1.8 hectares).

Beyond the north end of the pond is a low cliff around 2 m (or 5-6 ft) high and an inlet, with mangroves clinging to the rocky shore below the cliff. The shoreline north (to Loko Pamoku) and south (to the entrance of Iroquois Point lagoons) of Loko ʻOkiʻokiolepe is a low cliff supporting mostly kiawe above the shore, with only scattered, small mangrove trees established at the water's edge.

The NWI (USFWS, 2007) designation of Loko ʻOkiʻokiolepe is E2SS3N (estuarine, intertidal, broad-leaved evergreen scrub-shrub, regularly flooded) wetland, which is inaccurate and the E2FO3P (estuarine, intertidal, broad-leaved evergreen forested, irregularly flooded) applied to an adjacent mangal is better with the exception that "regularly flooded" would be more correct (i.e., E2FO3N) for tidal mangal. The central open pond is coded E2ABM (estuarine, intertidal, aquatic bed, irregularly exposed), aligning it ecologically with the shallows in front of the pond, which may or may not be precisely correct.

Loko Pamoku ~ The Army Corps report (ACOE, 1999, p. 17-18) provides this description of Loko Pamoku (ID ..2207):

> This is a smaller pond than Loko Okiokiolepe. It is accessed by going down G Avenue headed towards Waipahu and taking a right turn onto a dirt road just past the secured bunkers. This fishpond is also colonized by mangroves with patches of pickleweed behind it.

Figure 1-05. Boundary between wetland and upland (north edge of Loko Pamoku on old fill) with mangrove trunks on left and in background and kiawe trees growing on upland. Note intermixing of canopy.

We surveyed a feature fitting the description along the shore northwest of ʻOkiʻokiolepe and north of a very imposing area of secured bunkers along G Avenue just south of the NAVMAGPH Restricted Area. Physical evidence relating to whether or not this feature is an ancient fishpond is gone. The feature consists of two mangrove choked inlets separated by a narrow shoreline belt of mangrove below a low cliff. No outer pond wall is evident. On the north side, it appears fill was deposited in the pond or up to the pond edge (Fig. 1-05).

Within each cove or inlet, wetlands are entirely covered by red mangrove, and the margins are much as described above for Loko ʻOkiʻokiolepe. Several patches of pickleweed occur inland of the mangrove surrounded by the *kiawe* forest, but these seem to be clearly upland sites. The NWI designation (USFWS, 2007) for this area of the shore is E2FO3N: estuarine, intertidal, broad-leaved evergreen forest, regularly flooded wetland, which is correct. The open "pond" at the front is E2ABN (estuarine, intertidal, regularly flooded aquatic bed; see Loko ʻOkiʻokiolepe discussion, above). A large area along this coast (redrawn since USFWS, 1999) is coded E2FO3P (implying an irregularly flooded mangal), which is in fact mostly a *kiawe* forest above a cliff at the shoreline and not an environment that floods.

Shoreline Mangrove and Mangal Wetlands ~ In addition to the two named fishponds, at least three clusters of mangroves represent wetlands along the shore in the northern part of NAVMAGPH (accessed through the northern gate at the end of Iroquois Pt. Road). Several, presently distinct clusters of mangrove growth at the shore and two mangrove islets form a mangal off the former officers club on Arizona Loop. These mangal features (IDs ..2208 through ..2211) lie at the base of a high (5-6 m or 15-18 ft) cliff (and the islets lie just off the shoreline mangal). As with the fishponds, these wetland features are entirely dominated (essentially, defined) by red mangrove, and the landward boundary between the mangrove and uplands is sharp.

The outer wall of an enclosed cove or fishpond (ID ..2213) was constructed of large concrete pieces (old concrete pilings) laid end to end to form a wall roughly 1 meter (3 ft) above the high tide level and roughly 1.7 m (5 ft across), with at least one control-type opening or *makahā*. Nearly the entire pond is covered by a growth of red mangrove, although aerial photographs and ACOE (1999, Fig. 10) show an interior open pond. Because of the mangrove growth, the concrete wall could not be accessed all the way across to the carefully engineered concrete walkway (Fig. 1-06) that surrounds the east and south sides of an open water area at the north end of this same cove. But the entire area was clearly modified to create what seems to be a recreational swimming area: the concrete walkway wall is reached by a well-constructed and rather formal looking stairway that leads down from the former Nichols Point officers housing area at the end of B Avenue. The wall extending northwest from the south end of the cove is less exacting in its construction (see photo SP1-03), yet still appears to have been used as a walkway as well as a barrier enclosing a portion of the cove. A shelf (former road or graded shore) lies along the inland margin, where the land rises abruptly, but not as a cliff, lending credence to the idea that this feature was a cove modified for recreational use. ACOE (1999) regarded the shoreline modifications as undocumented with respect to their files.

An expanded shoreline mangal (ID ..2214; with one small mangrove islet) lies off the north side of Nichols Point. The wetland begins at the base of a moderately high cliff and extends, with only red mangrove, a variable distance out from the shore. Scattered occurrences of mangrove occur along the shore to the west of Nichols Point. Behind the shore is Navy land leased to others for farming and located outside the NAVMAGPH fence. This area was not accessed for the present survey.

Figure 1-06. Portion of the south wall of an enclosed swimming area at Nichols Point. Mangroves are destroying this potentially significant historical feature.

All of the shoreline mangrove wetlands described above are now indicated on NWI maps (USFWS, 2007). These mangals are all coded E2SS3N (estuarine intertidal broad-leaved evergreen scrub-shrub, regularly flooded) in the northwest part of NAVMAGPH. In our interpretation, only E2FO3N could be applied to such mature mangrove areas. Further, open areas in the so-called "swimming pool" area are not coded at all as were similar habitats at Loko ʻOkiʻokiolepe and Loko Pamoko. One area mapped as E2FO3N is upland, covered by *kiawe* forest with a cliff at the shore.

Honouliuli Unit, Pearl Harbor National Wildlife Refuge

The Honouliuli Unit of the Pearl Harbor National Wildlife Refuge (PHNWR) is located behind the southwestern shore of West Loch, Pearl Harbor. The refuge encompasses an area of 37 acres (15 ha) divided into two shallow ponds (ID ..3164 and ..3165), with a drainage ditch (ID ...3158) between them (see photo SP1-04 and SP1-05). The refuge is managed by the U.S. Fish & Wildlife Service under a cooperative agreement with the U.S. Navy, which owns the land.

The two ponds are managed as fresh water wetlands (USFWS at URL: http://www.fws.gov/pacificislands/wnwr/opearlnwr.html). Much of the vegetation in the NWR is actively managed, as are water levels in the ponds; therefore the diversity of wetland plants is far greater than observed in wetlands elsewhere around Pearl Harbor (see Table 1-02). Native plants are planted or encouraged and no one species is allowed to become dominant across the wetland.

As a managed wildlife refuge, wetland conditions are maintained to particularly encourage listed (endangered or threatened) waterfowl. Large numbers of Hawaiian stilt and Hawaiian coot were observed, along with other birds (Table 1-01). The NAVMAG Pearl Harbor INRMP (NAVFACENGCOM, 2001) contains additional information on this wildlife refuge.

National Wetland Inventory maps for the PHNWR, Honouliuli Unit are provided at the NWI website (USFWS, 2007). The refuge ponds are classified differently: PABHx: palustrine, aquatic bed, permanently flooded, excavated for the western pond and PEM1/USCx: palustrine persistent emergent vegetation seasonally flooded/unconsolidated shore, excavated for the eastern pond. Offshore areas are correctly identified as E1UBL: Estuarine subtidal unconsolidated bottom (i.e., a mud or sand-bottomed estuary). The central drainage ditch between the ponds is coded E1UBLx, essentially an excavated subtidal feature. Curiously, a moderately large area immediately to the east of PHNWR is classified PSS3C: palustrine, broad-leaved evergreen scrub-shrub, seasonally flooded. We believe this corresponds to a small hill within the refuge fenceline.

Beyond the wildlife refuge, the shoreline turns northward across the mouth of Honoʻuliʻuli Valley, where the coast becomes mixed erosional/depositional in nature, with a consequent increase in aerial extent of conditions favoring mangal formation. This part of Pearl Harbor (upper West Loch) is discussed in Chapter 2.

Tables 1-01 and 1-02 summarize biological observations (fauna and flora, respectively) made in 2006 at various wetlands located in the upper East Loch area. Table 1-03 summarizes differences between what was reported for this area as present and surveyed in 1999 (ACOE, 1999) and our 2006-7 observations.

Table 1-01. Aquatic biota listing for Iroquois Point to PHNWR (Honouliuli Unit).

Species listed by family	Common name	Notes	Wetland ID No. 2334 (a)	2206 (b)	3164	3165
	INVERTEBRATES					
MOLLUSCA, BIVALVIA						
OSTREIDAE						
Crassostrea virginica	Amer. oyster		A			
MOLLUSCA, GASTROPODA						
THIARIDAE						
Melanoides tuberculata	Red-rimmed Melania					A
ARTHROPODA, CRUSTACEA						
CHTHAMALIDAE						
Chthamalus proteus	Caribbean barnacle		C			
GRAPSIDAE						
Metopograpsus thukuhar	*'alamihi*		O			
ARTHROPODA, INSECTA						
DIPTERA						
CULICIDAE						
Indet.	(mosquito larvae)					
ODONATA						
AESHNIDAE						
Anax junius	Green darner					U
LIBELLULIDAE						
Crocothemis servillia	Scarlet skimmer					C
Orthemus ferruginea	Roseate skimmer					O
Pantala flavescens	Globe skimmer					R
Tramea lacerata	Black					C

Table 1-01. Aquatic biota listing for Iroquois Point to PHNWR (Honouliuli Unit).

Species listed by family	Common name	Notes	Wetland ID No. 2334 (a)	2206 (b)	3164	3165
	saddlebags					
COENAGRIONIDAE						
Ischnura ramburii	Rambur's damselfly					O
	VERTEBRATES					
PISCES (fishes)						
CICHLIDAE						
Sarotherodon melanotheron	black-chin tilapia					A
KUHLIIDAE						
Kuhlia xenura	*aholehole*		C			C
MUGILIDAE						
Mugil cephalis	*'ama'ama*		C			
POECILIIDAE						
Gambusia affinis	mosquitofish		O			C
SPHYRAENIDAE						
Sphyraena helleri	barracuda		R			
AMPHIBIA						
RANIDAE						
Rana catesbeiana	American bullfrog					R
AVES (birds)						
ANATIDAE						
Anas platyrhynchos	mallard					C
ARDEIDAE						
Bulbucus ibis	cattle egret		U			O
Nycticorax nycticorax hoactili	black-crowned night heron, *auku'u*					U
CHARADRIIDAE						
Pluvialis fulva	*kolea*		R			A
RALLIDAE						
Fulica alai	*'alae keokeo*					A
RECURVIROSTRIDAE						
Himantopus mexicanus	*ae'o*					A

Table 1-01. Aquatic biota listing for Iroquois Point to PHNWR (Honouliuli Unit).

Species listed by family	Common name	Notes	Wetland ID No. .2334 (a)	.2206 (b)	.3164	.3165
knudseni						
SCOLOPACIDAE						
Arenaria interpres	*'akekeke*					C
Calidris alba	*hunakai*					O

KEY TO SYMBOLS USED IN TABLE: 1-01

Abundance categories:

- R – Rare – only one or two individuals seen.
- U – Uncommon – several to a dozen individuals observed.
- O – Occasional – regularly encountered, but in small numbers.
- C – Common - Seen everywhere, although generally not in large numbers.
- A – Abundant – found in large numbers and widely distributed.
- P – Present – noted as occurring, but quantitative information lacking.

Table 1-02. Flora listing for Iroquois Point to PHNWR (Honouliuli Unit) wetlands.

Species listed by family	Common name	Notes	Wetland ID No. .2334 (a)	.2206	.2207	.2208	.3164 (b)
AIZOACEAE							
Sesuvium portulacastrum	*'ākulikuli*	(2)					R
Trianthema portulacastrum	---	(1)					U
AMARANTHACEAE							
Achyranthes aspera	---	(1)					R
Alternanthera pungens	khaki weed	(1)	R				
Amaranthus spinosus	spiny amaranth	(1)					R
Amaranthus viridis	slender amaranth	(1)	R				
ASTERACEAE							
Calyptocarpus vialis	---	(1)	U				
Pluchea	sourbush	(1)			U	U	

Table 1-02. Flora listing for Iroquois Point to PHNWR (Honouliuli Unit) wetlands.

Species listed by family	Common name	Notes	Wetland ID No. .2334 (a)	.2206	.2207	.2208	.3164 (b)
carolinensis							
Pluchea indica	Indian fleabane	(2)	U				A
Pluchea X fosbergii	fleabane hybrid	(1)			U		R
Verbesina enceliodes						U	
BATACEAE							
Batis maritima	*'ākulikuli kai*		O	O	O	U	C
BORAGINACEAE							
Heliotropum curassavicum	seaside heliotrope	(1)	U				C
CHENOPODIACEAE							
Atriplex semibaccata	Aust. saltbush	(1)				U	C
CONVOLVULACEAE							
Jacquemontia ovalifolia	*pa'u-o-hi'iaka*	(1)					O
Ipomoea cairica	*koali'ai*	(1)					U
CUCURBITACEAE							
Coccinia grandis	*ivy gourd*	(1)			U		
CYPERACEAE							
Bolboschoenus maritimus	*kaluhā*						A
Cyperus rotundus	nut sedge	(1)					O
Mariscus javanicus	*'ahu'awa*						O
EUPHORBIACEAE							
Chamaesyce hirta	garden spurge	(1)	U				U
Chamaesyce hypericifolia	graceful spurge	(1)	U				U
Chamaesyce prostrata	prostrate spurge	(1)	U				
Phyllanthus debilis	---	(1)	U				

Table 1-02. Flora listing for Iroquois Point to PHNWR (Honouliuli Unit) wetlands.

Species listed by family	Common name	Notes	Wetland ID No. .2334 (a)	.2206	.2207	.2208	.3164 (b)
FABACEAE							
Desmanthus virgatus	virgate mimosa	(1)		U			O
Indigofera spicata	*creeping indigo*	(1)					U
Leucaena leucocephala	*koa haole*	(1)		U			O
Pithecellobium dulce	*'opiuma*	(1)					R
Prosopis pallida	*kiawe*	(1)	O	A	A	C	U
Samanea saman	monkeypod	(1)	R				
MALVACEAE							
Sida ciliaris	---	(1)					U
Sida fallax	*'ilima*	(1)			O		
Sida spinosa	prickly sida	(1)					U
Thespesia populnea	*milo*	(1)	O	C	C		
NYCTAGINACEAE							
Boerhavia coccinea	false *alena*	(1)	R				U
PASSIFLORACEAE							
Passiflora foetida	love-in-the-mist	(1)		O			O
POACEAE							
Cenchrus ciliaris	buffel grass	(1)		A		A	U
Chloris radiata	plushgrass	(1)					C
Cynodon dactylon	Bermuda grass	(1)	C				A
Eleusine indica	wiregrass	(1)					U
Leptochloa uninervia	sprangletop						C
Paspalum vaginatum	seashore paspalum						C
Sporobolis virginicus	seashore rushgrass	(1)					U
Sporobolis diander	---	(1)					U
Urochloa maxima	Guinea grass	(1)			A		O
PORTULACACEAE							

Table 1-02. Flora listing for Iroquois Point to PHNWR (Honouliuli Unit) wetlands.

Species listed by family	Common name	Notes	Wetland ID No. .2334 (a)	.2206	.2207	.2208	.3164 (b)
Portulaca oleracea	pigweed	(1)					
RHIZOPHORACEAE							
Rhizophora mangle	red mangrove		O	A	A	A	U
SCROPHULARIACEAE							
Bacopa monnieri	*'ae'ae*						A
SOLANACEAE							
Solanum americanum	*popolo*		R				
TYPHACEAE							
Typha latifolia	cattail						C

Notes:
(a) The listing for ..2334 includes ..2332, ..2333 and ..2335.
(b) The listing for ..3164 includes ..3165 and ..3158.
(1) Typically not a vegetation of wetlands, but growing around margin.
(2) Marginal wetland vegetation member; more typically growing at edge of wetland, but sometimes in wetland.

Table 1-03. Summary of Changes since 1999

Site	Description	Change since 1999	Wetland ID
Golf course ponds	Eight ponds surveyed, none discussed*	More ponds exist; no ponds surveyed in 2006.	..1197 - ..1204
Puuloa Rifle Range	no wetlands	no change.	n/a
Iroquois Point Lagoons	Man-made marine ponds with fill (rock or eroding) shore	Mangroves removed; minimal or no wetlands present.	..2231- ..2338
Loko ʻOkiʻokiolepe	Mangal within pond	Mangrove expanding.	**..2206**
Loko Pamoku	Mangal within pond	Mangrove expanding.	**..2207**
Unnamed mangal	Shoreline mangal	Mangrove expanding.	**..2208 - ..2212**
Unnamed pond	Mangal within pond	Mangrove expanding.	**..2213**
Unnamed mangal	Shoreline mangal	Not seen in 1999.	**..2214**
PHNWR, Honouliuli	Refuge wetlands	No change in size or status.	**..3158. ..3164, ..3165**

Following are supplemental photographs (SP) for Chapter 1.

SP1-01 (right): Area of removed mangrove trees at Iroquois Point Housing (same location as shown in Fig. 1-02), with community improvements underway in September 2006).

SP1-02 (left): Typical NAVMAGPH cliffed shoreline with a forest of *kiawe* (*Prosopis pallida*) growing above the cliff line.

SP1-03 (left): Wall structure across the front of the southern end of a pond at Nichols Point. This feature is deep inside a mangrove forest.

SP1-04 (right): The central drainage ditch at Honoʻuliʻuli Unit of the Pearl Harbor NWR. The shoreline mangal on West Loch is seen across the back.

SP1-05 (left): Larger of the two ponds at Honoʻuliʻuli Unit of the Pearl Harbor NWR. The open nature and diversity of wetland plants in a managed system such as this, is in sharp contrast with the low diversity and excessive alien plant growth of most unmanaged wetlands around Pearl Harbor.

SP1-06 (above): Nichols Point. Composite photograph showing mangrove growing at base of cliff shore (left) with *kiawe* immediately above. Islet of limestone rock offshore on right is oddly not colonized by mangrove, perhaps lacking any surrounding shallows for propagules to gain purchase.

Chapter 2

West Loch Shoreline

West Loch is the westernmost of the three major divisions of Pearl Harbor. The western shore borders an area of extensive recent housing developments in what used to be agricultural lands surrounding Hono'uli'uli. Navy property in the upper Loch is limited to an offshore islet and a former fishpond known as Laulaunui and the east side of the Loch (Waipi'o Peninsula; covered in Chap. 3). Inland of the lower west shore is a shallow valley or coastal lowland around Hono'uli'uli Stream. Much of this low ground is occupied by a City and County of Honolulu municipal golf course where remnant water bodies and wetlands are present between areas of fill. This area also includes the West Loch Shoreline Park (accessed off Laulaunui Street) which incorporates all of the coastal wetlands still extant in the area. The Honouliuli Unit of the Pearl Harbor National Wetland Refuge (PHNWR; discussed in Chap. 1) is located at the southern end of this western shore. The areas encompassed in Chapter 2 correspond to most of ACOE (1999), Segment 3.

Geologically, much of this coastal segment is alluvial material eroded onto the limestone 'Ewa Plain, an ancient coral reef formation formed during a Pleistocene high stand of the sea. Thus, the shoreline in this area tends to rise abruptly and limestone materials are present behind the shore beneath a mantle of lateritic alluvium.

West Loch Shoreline Park

The low area around the mouth of Hono'uli'uli Stream was at one time a shallow inlet or perhaps a broad tidal flat that extended inland up the stream as an extensive wetland feature fed by numerous springs that issued from the edge of the low escarpment at the edge of the 'Ewa Plain. The once extensive coastal wetland was partially cut off from West Loch by the Oahu Railroad & Land Company (OR&L) right-of-way (r-o-w) running between the 'Ewa Plantation at 'Ewa, passing around Pearl Harbor, and then on to Honolulu Harbor. Although the stream itself was bridged, the berm supporting the railway physically divided the wetland, partially isolating ponds and lowlands on the west from the Pearl Harbor shore on the east. The OR&L berm (TMK: 9-10-17:044; owned by the State of Hawai'i and now an energy corridor) supports a bikeway/jogging path in the park (although the paved bikeway goes inland around Ka'auku'u Fishpond).

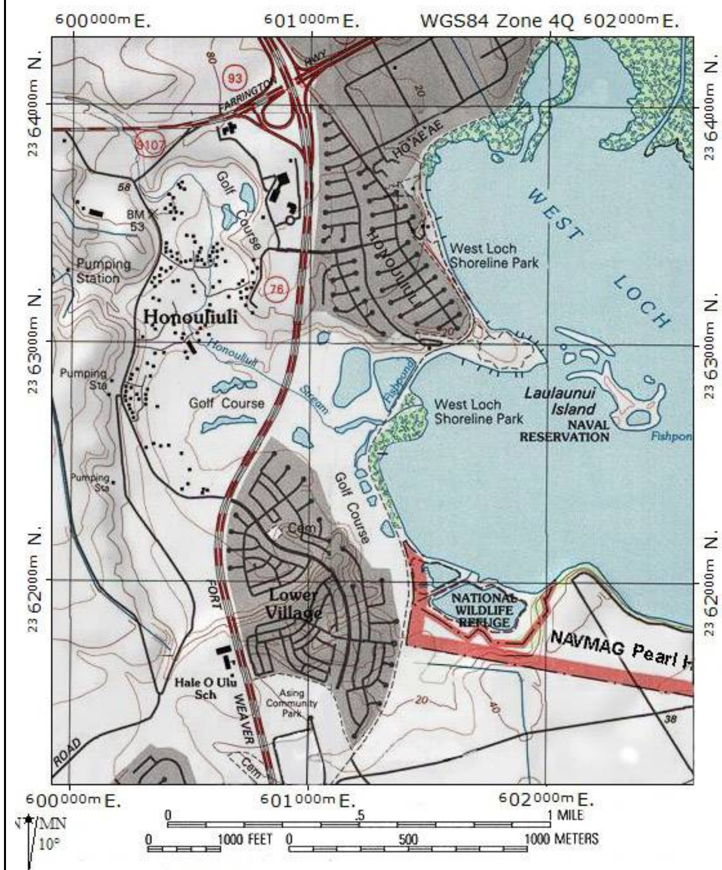


Figure 2-01. Place names and topographic map of Honouliuli and West Loch area covered in Chapter 2. The National Wildlife Refuge is treated in Chapter 1.

'Ewa Plantation was started in 1890 after the railway was built, and springs around Hono'uli'uli were tapped to support sugar cane production on the 'Ewa

Plain. Over time, the wetlands and likely extensive *kalo lo'i* existing in the valley of Hono'uli'uli Stream were filled and the land developed (the West Loch Golf Course now occupies much of this area).

The fishpond on the north side of Hono'uli'uli Stream (Ka'auku'u; ID ..3181; see photo SP2-01) and the depressions that lie between the railroad berm and the golf course that were once used to harvest salt and more recently for aquaculture (ACOE, 1999), are now heavily overgrown with mangrove, although open water remains in about the western 60% and northern 5% of the fishpond, and in the hidden interior of the southernmost salt pond (ID ..3162). Salinity in Ka'aku'u Fishpond was 16 to 24 ppt (brackish) in different places, measured on 09/15/06. Salinity along the mangrove shore (ID ..3166) east of the old OR&L r-o-w was 32 ppt (marine) at this time.

All of the once open bodies of water west of the OR&L r-o-w were fed by either tidal flux via Hono'uli'uli Stream or culverts or bridged openings in the old railway berm. A separate opening with weir boards (see photo SP2-02) that once fed the three ponds used for salt production (IDs ..3160, ..3161, & ..3162) is no longer functional and water now enters on high tide from Hono'uli'uli Stream (ID ..3171) through a narrow, mangrove clogged channel. The flow finds its way south through a mangrove forest (ID ..3178) and eventually across an extensive *Batis* flat (ID ..3163; see photo SP2-04) to an open pond. Salinity in the mangrove at ..3178 was 18 ppt, and in the pond at ..3163 was 15 ppt on 09/15/06. Because this tidally influenced pond lacks emergent vegetation, it is not a wetland, although it would be jurisdictional "waters of the U.S."

The depression continues south beyond the brackish water pond where the wetland is apparently influenced only by freshwater, and therefore separately identified herein as ID ..3159. This wetland is distinct from wetland ID ..3163 (with which it was mapped in 1999), a distinction that is physical as well as evident from the nature of the vegetation. Wetland ID ..3159 is densely covered by dayflower (*Commelina diffusa*) suggesting a fresh water regime, whereas wetland ..3163 is more typical for this area: a pickleweed flat behind mangrove. Thus, there is likely no tidal connection between the *Commelina* marsh and the open pond to the north. The salinity in ..3159 on 09/15/06 was only 1 ppt (nearly fresh water).

West Loch Shoreline Park extends northward along the West Loch shore to the point where the shore begins to curve eastward. In this area, there is evidence of ongoing removal of mangroves within the park right up to the northern park boundary. In the north part of the park is a small pond (ID ..3185) associated with a residence. The pond appears fed by a spring as there is a small outlet ditch that flows towards the West Loch shore. In 1999, this pond was

described as a "taro lo'i" (*kalo lo'i*), but in 2006 it contained only one taro plant and was stocked with water lilies.

Figure 2-02. West side of West Loch at the mouth of Hono'uli'uli Stream, an area of once extensive wetlands showing locations discussed in text. GCP = golf course pond.

Features in this area are now easily matched with the NWI maps at USFWS (2007). The shoreline mangal (ID ..3166, ..3179, ..3180), as well as the fishpond (ID ..3181), are classified E2SS3N: estuarine, intertidal, regularly flooded broad-leaved scrub-shrub. This description might better fit shoreline areas newly invaded by mangrove or where mangrove is poorly established (*Rhizophora* exists as a shrub) or pickleweed flats; in our opinion, the more appropriate classification for mangal would be E2FO3N: estuarine, intertidal, regularly flooded broad-leaved forest. The pickleweed flat towards the south (excluding the pond) is coded E2EM1N: estuarine, intertidal, emergent persistent vegetation, regularly flooded. We would code this area E2SS3N to reflect the fact that *Batis* is an evergreen shrub. The most recent version of the NWI (USFWS, 2007) does not differentiate our palustrine wetland (ID ..3159) from the pickleweed area.

The latest version of the NWI (USFWS, 2007) indicates no wetlands along the estuarine reach of Honoʻuliʻuli Stream (the channel is E1UBL), but codes the mangrove areas at the stream mouth and in West Loch south of the stream as E2FO3N (= mangal; ID ..3179 in part), but inconsistently also E2SS3N (IDs ..3160, ..3161, ..3162, ..3166, ..3178, ..3179 in part, and ..3180). An area of pickleweed behind the shoreline mangal is coded E2EM1N: estuarine, persistent emergent vegetation, regularly flooded. We would suggest E2SS1N since *Batis* is a shrub.

West Loch Golf Course

The West Loch Golf Course (a City & County of Honolulu municipal course) is located inland from the City & County West Loch Shoreline Park and includes a number of water features (water hazards), some of which can be regarded as wetlands in character, although exempted from consideration as waters of the United States (that is, are not jurisdictional) for the reason that they are isolated and non-naturally occurring ponds (see 33 CFR § 328.34[a]). Presumably, jurisdiction would be decided only after a significant nexus analysis (see pp. 15-16). The golf course has seven water features large enough to appear on the topographic map (Fig. 2-01) that also appear on recent satellite images (Microsoft Corp., 2006). The ACOE (1999) shows a total of six wetlands, one (ID ..3171) being a small area below St. Francis Medical Center where there are today two golf course ponds. Both of these ponds are man-made water traps with the shoreline constructed of concrete and rock (crm). ID ..3171 may have had some established emergent plants when viewed in 1999. The second largest pond (ID ..3168) is located along the south boundary of the course on the west side of Fort Weaver Road. This pond (Fig. 2-03) had no open water at the time of our visits (August and January, 2006-07): the surface being completely overgrown with water hyacinth (*Eichhornia crassipes*; see photo SP2-05) and the margins covered with California grass (*Urochloa mutica*). Pond ID ..3169 is also completely covered by water hyacinth. Because these are ponds with the majority of the vegetation floating and not rooted emergent plants, only the shallow margins can be classified as wetlands by ACOE definition (ACOE, 1987) but are not waters of the U.S. as defined by ACOE or EPA (40 CFR § 122.2).

Other golf course water features east of Fort Weaver Road were assigned IDs ..3173, ..3182, and ..3183 in ACOE (1999). Feature ID ..3182 is not a wetland at all, but a large reservoir with masonry (crm) banks and is used as a driving range and water storage for the golf course. The other two ponds (..3173 and ..3183) have margins that are wetlands, but probably not jurisdictional waters. Honouliuli Stream (see below) passes through the middle of the golf course in a vegetated swale that includes a wetland.

The NWI (USFWS, 2007) codes the golf course ponds as PEM1Cx: palustrine, emergent vegetation, seasonally flooded, excavated; the open waters are PUBHx: palustrine, unconsolidated bottom, permanently flooded, excavated. In one pond the marginal vegetation is coded as a shrub-scrub (PSS1Cx) and in another as a forest (PFO1Cx).

Figure 2-03. The West Loch Golf Course pond (ID ..3168) along the southern edge of the golf course just west of Fort Weaver Road. Water hyacinth dominates the center of this pond feature.

Honoʻuliʻuli Stream

Honoʻuliʻuli Stream arises in several gulches draining the southeast corner of the Waiʻanae Mountain and these converge above H-1 freeway to form

Hono'uli'uli Gulch. This area is seasonally very dry and the stream is intermittent. However, perennial flow, perhaps much reduced by pumping from the aquifer, results from springs all along the lower reach of the stream within the broad swale today mostly occupied by the C&C West Loch Golf Course (see above; Nance, 1998).

The ACOE (1999) mapped six different wetlands along the lower stream course (IDs ..3170, ..3172, and ..3174 through ..3177). These wetlands are separated by cart path crossings penetrated by culverts and the Fort Weaver Road highway viaducts. It is clear that at least ID ..3172 (west side of Fort Weaver Road) and ID ..3174 (east side of Fort Weaver Road) constitute a single marsh dominated by California grass over which Fort Weaver Road crosses on concrete pilings. The west side of this marsh extends south, parallel to the roadway, ending at pipe culverts (2 X 36") that provide an outlet for pond ID ..3168. In January 2007 we observed a spring flowing into this pond near the pond outlet[1].

Upstream of the Fort Weaver Road viaduct, Hono'uli'uli Stream occupies a shallow channel (ID ..3170 and ..3172) that was overgrown with vegetation in January 2007. This wetland actually continues beyond the uppermost cart path crossing and into drainage ditches that drain house lots in an area that was perhaps once extensive wetlands along the stream.

Water in lower Hono'uli'uli Stream becomes brackish within wetland ID ..3175. A grove of red mangrove (or mangal) occupies the lower half of this wetland, whereas the upper half and southern margin are overgrown with California grass and presumably freshwater (see Introduction, Fig. 7). Downstream, wetland IDs ..3176 and ..3177 are in reality the tidal channel (estuary) of Hono'uli'uli Stream with narrow mangrove and pickleweed wetlands present along the margins. Englund, et al. (2000) reported a salinity of 32 ppt in the mangrove area along the lower stream and 4 ppt in the "upstream reaches of the golf course."

The lower segment of Hono'uli'uli Stream around Fort Weaver road is incorrectly identified in the NWI (USFWS, 2007) as PSS3C: palustrine, evergreen shrub-scrub, seasonally flooded instead of PEM1C: palustrine, persistent emergent vegetation, seasonally flooded. The lowermost palustrine section is correctly coded as PEM1C, but shown as PFO3C further downstream, instead of the correct coding of E2FO3N: estuarine intertidal broad-leaved evergreen forested, regularly flooded wetland.

[1] This fact alone will likely subject golf course pond ..3168 to ACOE jurisdiction.

Former Kahua Meat Co. Pond

The landscape in the area around the former Kahua Meat Co. slaughterhouse at the corner of Fort Weaver Road and Old Fort Weaver Road has changed dramatically in the last decade. The Kahua Meat Co. building no longer exists, and the intersection of the new and old roads has been realigned such that the location of the former facility that utilized a pond to treat slaughterhouse wash-down is difficult to establish. The land that lies south of the West Loch Golf Course between the new and old Fort Weaver roads (TMKs: 9-10-17:010 and 9-10-17:041) appears to be fill and is cut by at least three drainage ditches over 2 m (6 ft) deep and 2-3 m wide; these lead from a low area densely overgrown with California grass (Fig. 2-04).

Figure 2-04. All that appears to remain of the wetland behind the former Kahua Meat Co. is a depression completely overgrown with California grass. However, this is not wetland ID ..3167.

This low area may be the remains of the former pond utilized by the slaughterhouse (located on TMK: 9-10-17:041). The description in ACOE (1999) states "sewage is treated in this pond adjacent to West Loch Golf Course's 10th tee and Kahua Nursery". The ACOE 1999 delineation shows such a pond feature in an area now occupied by fill with only the drainage ditches described above remaining; these ditches join into a single ditch draining to the golf course pond (..3168) located at the north end of the fill. A spring that might have once fed feature ID ..3167 was observed in January 2007 to now flow over the sloped ground surface at the southeast corner of the golf course pond.

Laulaunui Island

The peninsula on which the City & County Shoreline Park at West Loch lies extends eastward as a submerged feature, rising above the surface as a cluster of islets know as Laulaunui (see Fig. 2-01). Laulaunui refers to one of the offshore islets and a fishpond. The islets are all part of the Naval Reservation and low parts are overgrown with mangrove. The closest mangrove growth is only about 70 m (230 ft) off the tip of the peninsula, while the larger islet is 260 m (850 ft) across shallow water from the park.

ACOE (1999, p. 23) provides the following descriptions:

> ...Laulaunui Island refers to the main island which is the largest and tallest rising 40-50 feet above sea level. To the southeast is a smaller island which appear[s] on aerial photographs to be connected to the main island. However, there is an opening which is covered by American mangrove. A trail has been cut in the coral forming a path between the two islands. The water was 6-12 inches deep between the two islands at high tide. The islands were formed on an old coral reef which contained a lot of old oyster beds at a time when the water level was much higher. *Kiawe* dominates the upland areas with very little grass on the islands. American mangrove covers the shoreline areas and the islets surrounding the main island.
>
> The fishpond is on the seaward [southeast] end of the island. Mangroves obscure the walls and openings, and the interior of the pond is inaccessible by boat. The footprints of several buildings are on this island.

The NWI wetlands of Laulaunui are all classified as E2SS3N by USFWS (2007) and the open water surrounding the mangrove is E1UBL. E2SS3N is an estuarine, intertidal, regularly flooded broad-leaved scrub-shrub wetland. This description might better fit some of the recently invaded areas of mangrove or where mangrove is poorly established (and *Rhizophora* exists as a shrub); the more appropriate classification for mangal would be E2FO3N: estuarine intertidal broad-leaved evergreen forested, regularly flooded wetland.

West Loch, North Shore Wetlands

The bike trail in West Loch Shoreline Park ends at a locked gate, although an unimproved roadway and the energy corridor continue around the north side of West Loch. The corridor tends to lie along the inner edge of the mangrove belt

(ID ..3219) which widens substantially into West Loch south of Ho‘ae‘ae Street in Waipahu. Just west of a bridge over an unnamed drainage, the wetland appears to extend onto the energy corridor (i.e., at high tide water covers part of the road). Free of mangrove, this area supports sedges (*Cyperus difformis* and *Eleocharis* sp.) on salt-encrusted red soil.

The concrete lined Waipahu drainage channel becomes a mangrove-lined channel through the mangal, turning abruptly eastward, parallel with the energy corridor before emptying into a remnant fishpond surrounded and encroached upon by mangrove. The wetland ID ..3219 is shown in ACOE (1999) ending at about the eastern edge of the fishpond wall and becoming wetland ID ..3221 further east, although there appears to be no particular reason for making this division, except the mangrove forest here extends some 1800 ft (600 m) from the energy corridor south into West Loch on the deltaic deposit of Waikele Stream. The stream and former fishponds beside it mark the western edge of the Waipahu Peninsula (covered in Chap. 3).

Waikele Stream drains the second largest watershed on O`ahu (12,540 ha or 30,980 acres) (GDSI, 1994). The floodway incorporates two outlets—the eastern outlet called Kapakahi Stream (see Chap. 3). The latter drains out through a narrow canal on the west side of Waipahu Depot Road. The main channel of Waikele Stream enters West Loch further to the west. Both streams are presently crossed by rusting, iron bridges. Once safe for vehicles, the bridges now support only the petroleum products pipelines of the energy corridor and foot traffic. The channels crossed by these bridges are estuaries of their respective streams.

The mangrove forest off the mouth of Waikele Stream (IDs ..3221, ..4239, ..4240[2]) is the largest area of mangrove in Pearl Harbor, and its origin is widely reported a consequence of the spread of red mangrove across an expanding stream delta from sediment laden run-off eroded from extensive sugar cane lands of central O‘ahu, especially in the 1940s and 50s as a result of the introduction of mechanical harvesting methods (Wester, 1981; Char, 2000). Englund, et al. (2000) notes this area of West Loch appeared free of mangroves in a 1951 aerial photograph. Subsequent dated photographs (after Wester, 1981) show a steady spread of mangroves across the deltas of Waikele and Kapakahi streams.

Englund, et al. (2000, p. 20) describes the mouth of Waikele (that is, the stream mouth out in front of the mangrove belt) thusly:

[2] Plus the isolated single trees or small clusters assigned IDs ..3222 through ..3230 and ..4247 through ,,4250 all located along the advancing seaward edge of the extensive mangal at the mouth of Waikele Stream.

> At the Waikele Stream mouth, large expanses of tidal mudlflats are exposed at low tide. Tree stumps, shopping carts, tires, abandoned gill-nets, and other urban debris were found strewn throughout this tidal mudflat area. The substrate in the tidal mudflat area consists of thick layers of fine silts, with many areas firm enough to walk on at low tide. However, in some areas it is possible to sink over 1 m (3 ft) deep or more into the fine silt. At low tide, many shallow water pockets are formed in the mudflats near the mangroves, and these extend out several hundred yards into Pearl Harbor.

The NWI maps (USFWS, 2007) classify the extensive mangal in this area as E2FO3N: Estuarine, intertidal, regularly flooded, broad-leaved evergreen (i.e., mangrove) forest. Open waters of West Loch are E1UBL: estuarine subtidal unconsolidated bottom.

Pūpūʻolē Wetlands

Two freshwater wetlands (ID No.s ..3217 and ..3218) lie on the *mauka* or north side of the energy corridor road below Waipahu Intermediate School and just to the east of a small neighborhood park at the end of Pupuole Street in Waipahu. A description from *AECOS* (2000, p. 26) follows:

> ...the [proposed bikeway] route skirts the extensive mangrove swamp and is bounded on the north (*mauka*) side by a marsh adjacent to Pupuole Neighborhood Park (directly below Waipahu Elementary [sic] School). This marsh harbors mostly great bulrush (*Schoenoplectus lacustris*), but parts are overgrown with California grass (*Brachiaria* [=*Urochloa*] *mutica*). The water was only slightly brackish (3 ppt) when water quality measurements were made on January 7. This wetland was revisited on February 3, and additional water testing conducted. The water was found to be somewhat turbid and low in DO: 17 % saturation at 9 AM on January 7 and 31% of saturation at 1125 AM on February 3. Nitrate concentration was low; perhaps not surprising since the vegetation (both bulrush and algae) use up nitrate to promote growth. However, inorganic nitrogen is present here as ammonia. A high total nitrogen content (1280 mg N/l) reflects that nutrient input is probably high, but that most of the inorganic nitrogen has been converted to organic nitrogen by algal productivity. Total P is also very high (503 mg P/l), suggestive again of water quality problems.
>
> Despite the low oxygen, the marsh harbored a large number and variety of aquatic insects, including backswimmers, aquatic beetles, damselfly nymphs, and dragonfly nymphs. Although small numbers of top-minnows (Poeciliidae) were observed, these could not be captured for identification. The low DO may suppress fish populations in this marsh, allowing insect numbers to remain high.

The Pūpūʻolē Wetlands are coded E2EM1N in the NWI (USFWS, 2007) indicating estuarine features with persistent emergent vegetation. We suggest

the correct coding for these features is PEM1F: palustrine, persistent emergent vegetation, semi-permanently flooded.

Miscellaneous Features

A "large sump," partially fenced and described in ACOE (1999, p. 21), is located some 1800 ft (550 m) southwest of the Honouliuli Unit of the Pearl Harbor NWR (see Segment 1). This depression receives runoff from the nearby Lower Village housing development. The depression must function as a sump, as it appears in a satellite photograph (Microsoft Corp., 2006) that no drainages lead out of the roughly 3-acre, well-vegetated area. The bottom of the feature directly off the culvert outlet and 9-12 ft (3-4 m) deep is heavily overgrown with Guinea grass (*Urochloa maxima*) and two large umbrella sedge (*Cyperus involucratus*) plants. The remainder is forested with *kiawe*, *koa haole*, monkey pod, and common guava.

Another drainage feature, not connected to the one described above, receives drainage from Lower Village and carries storm run-off northward from a point just outside of the NWR entrance gate (near a Honolulu Board of Water Supply pump station). This ditch is overgrown with *hau* (*Hibiscus tiliaceus*) and passes through a culvert beneath the C&C bikeway to connect to the wetland we have identified as ID ..3159 (see above).

Tables 2-01 and 2-02 summarize biological observations (fauna and flora, respectively) made in 2006-7 at various wetlands located in the upper East Loch area. Table 2-03 summarizes differences between what was reported for this area as present and surveyed in 1999 (ACOE, 1999) and our 2006-7 observations.

Table 2-01. Aquatic biota listing for wetlands around Honoʻuliʻuli.

Species listed by family	Common name	Notes	Wetland ID No. .3159	.3163	.3166	.3167	.3168	.3171	.3181	.3185
	INVERTEBRATES									
MOLLUSCA, GASTROPODA										
PILIIDAE	Apple snails									P
MOLLUSCA, BIVALVIA										
OSTREIDAE										
Crassostrea virginica	Amer. oyster				A					

Table 2-01. Aquatic biota listing for wetlands around Hono'uli'uli.

Species listed by family	Common name	Notes	Wetland ID No. .3159	.3163	.3166	.3167	.3168	.3171	.3181	.3185
ARTHROPODA, CRUSTACEA										
CAMBRIDAE										
Procambarus clarki	Amer. crayfish									C
CHTHAMALIDAE										
Chthamalus proteus	Caribbean barnacle				C					
PORTUNIDAE										
Thalamita crenata	swimming crab				U					
ARTHROPODA, INSECTA										
DIPTERA										
CULICIDAE										
Indet.	(mosquito larvae)		A							
ODONATA										
COENAGRIONIDAE										
Ischnura ramburii	Rambur's damselfly								O	
AESHNIDAE										
Anax junius	Green darner			R			U			
LIBELLULIDAE										
Crocothemis servillia	Scarlet skimmer			U	O	U				
Tramea lacerata	Black saddlebags			O						
	VERTEBRATES									
PISCES (fishes)										
CICHLIDAE										
Sarotherodon melanotheron	Black-chin tilapia			A	O			C	A	
GOBIIDAE										
Awaous guamensis	*'o'opu nakea*			R						
POECILIIDAE										
Poecilia mexicana	Mexican			A	O			A	A	C

Table 2-01. Aquatic biota listing for wetlands around Hono'uli'uli.

Species listed by family	Common name	Notes	Wetland ID No. .3159	.3163	.3166	.3167	.3168	.3171	.3181	.3185
	molly									
AVES (birds)										
ARDEIDAE										
Bulbucus ibis	*Cattle egret*				C					
CHARADRIIDAE										
Pluvialis fulva	*Kolea*				C					
SCOLOPACIDAE										
Calidris alba	*Hunakai*				U					
Numenius tahitiensis	Bristle-thighed curlew, *kioea*				U					

KEY TO SYMBOLS USED IN TABLE: 2-01

Abundance categories:
R – Rare – only one or two individuals seen.
U – Uncommon – several to a dozen individuals observed.
O – Occasional – regularly encountered, but in small numbers.
C – Common - Seen everywhere, although generally not in large numbers.
A – Abundant – found in large numbers and widely distributed.
P – Present – noted as occurring, but quantitative information lacking.

Table 2-02. Flora listing for Hono'uli'uli, West Loch Shoreline Park, and other selected Chapter 2 wetlands.

Species listed by family	Common name	Notes	Wetland ID No. .3159	.3163	.3167	.3168	.3178	.3179	.3180	.3181
ACANTHACEAE										
Asystasia gangetica	Chinese violet				U					
AIZOACEAE										
Sesuvium portulacastrum	*'äkulikuli*	(2)							O	
ARECACEAE	(palms)									

Table 2-02. Flora listing for Hono'uli'uli, West Loch Shoreline Park, and other selected Chapter 2 wetlands.

Species listed by family	Common name	Notes	..3159	..3163	..3167	..3168	..3178	..3179	..3180	..3181
Cocos nucifera	*niu*	(1)					U			
Phoenix hybrid	date palm (juv.)	(2)	U							
ASTERACEAE										
Pluchea indica	sourbush	(2)	?	C	O			C	U	C
Pluchea X *fosbergii*	sourbush hybrid	(1)								R
BATACEAE										
Batis maritima	*'äkulikuli kai*			A					A	
COMMELINACEAE										
Commelina diffusa			A		C					
CYPERACEAE	(sedges)									
Bulboschoenus maritimus	*kaluhä*			U						
Cyperus involucratus	umbrella sedge				O					
FABACEAE										
Pithecellobium dulce	*'opiuma*	(1)						U		
Prosopis pallida	*kiawe*	(1)					O		O	
Samanea saman	monkeypod	(1)								
MALVACEAE										
Hibiscus tiliaceus	*hau*	(1)	C							
Thespesia populnea	*milo*	(1)					O		C	
NYCTAGINACEAE										
Boerhavia coccinea	false *alena*	(1)							U	
POACEAE										
Cenchrus ciliaris	buffel grass	(1)		U						
Chloris radiata	plushgrass	(1)							U	
Cynodon dactylon	Bermuda grass	(1)							C	
Paspalum vaginatum	seashore paspalum								O	
Sporobolis sp.	---	(1)							A	
Stenotaphrum secundatum	St. Augustine	(1)							A	

Table 2-02. Flora listing for Hono'uli'uli, West Loch Shoreline Park, and other selected Chapter 2 wetlands.

Species listed by family	Common name	Notes	..3159	..3163	..3167	..3168	..3178	..3179	..3180	..3181
	grs									
Urochloa maxima	Guinea grass	(1)			C	C		O	U	U
Urochloa mutica	Calif. grass				A	A				U
PONTEDARIACEAE										
Eichhornia crassipes	water hyacinth					A				
RHIZOPHORACEAE										
Rhizophora mangle	red mangrove			A				A	A	A

Notes:
(1) Typically not a vegetation of wetland, but growing around margin.
(2) Marginal vegetation member; more typically growing close to wetland.

Table 2-03. Summary of Changes Since 1999

Site	Description	Change since 1999	ACOE ID
South end of ID ..3163	Depression with a small palustrine wetland.	Distinctive from ID ,,3163; a palustrine feature.	**..3159**
Pond surrounded by *Batis* flat		No change	**..3163**
Four ponds south of Hono'uli'uli Stream mouth	Overgrown with mangrove.	No change.	**..3160, ..3161 ..3162, ..3178**
Mangrove at mouth of Hono'uli'uli Stream and south along shore	Stream channel through mangal	No change	**..3166, ..3177 ..3179**
Ka'auku'u Fishpond	Heavily overgrown with mangrove. Some open water remaining.	Less open water present.	**..3181**
West Loch Shoreline Park	Mangrove, some areas of *Batis*.	Some expansion of mangrove; but C&C removing mangroves along the park shore.	none

Table 2-03. Summary of Changes Since 1999

Site	Description	Change since 1999	ACOE ID
Honoʻuliʻuli Estuary	Channel lined with mangrove.	No change	**..3175, ..3176 ..3177**
Honoʻuliʻuli Stream	Palustrine wetland overgrown with California grass.	No change.	**..3172, ..3174 ..3177**
Golf Course Water supply reservoir & driving range.	Wetland	Not a wetland.	..3182
West Loch Golf Course ponds/ water traps	Wetlands	Ponds; most do have non-jurisdictional wetland margins.	..3168, ..3169 ..3171, ..3173 ..3183
Former Kahua Meat Co. Pond	Pond utilized for treating wash-down effluent.	Filled in.	..3167
Laulaunui Islet and fishpond	All low areas overgrown with mangrove.	No change.	**..3186 through ..3196**
Private *kalo loʻi*	Spring-fed pond with taro.	Stocked with ornamentals.	**..3185**
West Loch north shore mangrove	Extensive mangal around old fishpond.	No change.	**..3219, ..3220**
Pūpūʻolē wetland	Depressional wetlands.	Nearly choked with California grass.	**..3217, ..3218**
West Loch north shore mangrove	Extensive mangal at mouth of Waikele Stream.	Further expansion of mangroves into West Loch; coalescence of numerous small clusters off stream mouth.	**..3223 through..3230, ..3239, ..3240**

Note: ID numbers in bold are jurisdictional wetlands; others are not.

Following are supplemental photographs (SP) for Chapter 2.

SP2-01 (left): Remnant of open water in mangrove infested Kaʻaukuʻu fishpond (..3181) at West Loch Shoreline Park.

SP2-02 (left): Remains of a concrete *makahā* that once connected Kaʻaukuʻu pond to West Loch via a channel that no longer exists.

SP2-03 (left): Tidal water rushing through the mangrove-blocked channel connecting the lower end of Honoʻuliʻuli Stream (..3177) and a series of former ponds to the south (..3178 and beyond).

SP2-04 (left): Pond feature at wetland ID ..3163 with pickleweed flat at north end showing invasion underway by mangrove. Gray material along pond shore is an algal scum floating on water surface.

SP2-05 (left): Golf Course Pond (ID ..3168) completely covered by water hyacinth, a floating plant and therefore treated under ACOE rules as open water, not wetland.

Chapter 3
Waipiʻo Peninsula

The Waipiʻo Peninsula is an interfluvial remnant between the lower valleys cut by Waikele and Honoʻuliʻuli streams on the west (flooded by West Loch) and Waiawa Stream and its tributaries on the east (flooded by Middle Loch). The topography of the Peninsula is complicated by a transverse cut that forms narrow Walker Bay midway down the 3.3 mi (5.3 km) long peninsula. Although various areas have been built up with fill, the feature is not man-made from fill, only that several former shallows have been “reclaimed” for various purposes. The area encompassed in this chapter corresponds closely to ACOE (1999) Segment 4.

Waikele and Kapakahi Streams

A second, eastern outlet of the Waikele Stream (see Chap. 2) floodway is called Kapakahi Stream, the lower, mangrove-choked portion of which was identified (ACOE, 1999) as ID ..4243. This estuary is confined by levees to a narrow canal running along the west side of Waipahu Depot Street. The banks are steep and clearing of mangrove and brush was occurring in 2006 within the channel and along both banks. By the end of 2006, mangroves (except for widely scattered seedlings) were no longer present here or in a side channel leading eastward and serving as a drain for the C&C, former waste incinerator site. A second, much smaller side branch is located opposite the C&C Police Academy (Ke Kula Makaʻi) that drains that site to Kapakahi channel. This area is interesting because it presently supports a wide variety of wetland plants, including *kaluhā* (*Bolboschoenus maritimus*), *ʻaeʻae* (*Bacopa monnieri*), seashore paspalum (*Paspalum vaginatum*), Indian sourbush (*Pluchea indica*), sedge (*Cyperus polystachyos*), and a few mangrove seedlings, all within a very small area (*AECOS*, 2007).

The channel of Kapakahi extends well into the coastal mangroves of West Loch, and is bermed, isolating fresh or brackish flows from adjacent Poʻuhala Marsh (Ducks Unlimited, 1998; Englund, et al., 2000). Englund, et al. (2000) found that the salinity in West Loch fronting the mangroves off Kapakahi channel was only 9 ppt, but 36 ppt further out in the Loch. Salinities upstream of the coastal mangrove belt were 0 ppt. Upstream, a spring located just north of Farrington Highway and emerging underneath Shiro’s Food parking lot feeds the stream through a thick stand of mangrove (Nance, 1998).

The main channel of Waikele Stream enters West Loch further west (Fig. 3-01 and 3-02). The channels of the streams are estuarine at the old railroad right-of-way. Both streams are presently crossed by rusting, iron bridges that carry petroleum products pipelines (part of the energy corridor) and limited to foot traffic only. This section of the corridor, all the way to the north gate at West Loch Shoreline Park (see Chap. 2) is not yet developed as a bikeway, although some improvements have been made at Poʻuhala Marsh to accommodate school and other visitor groups.

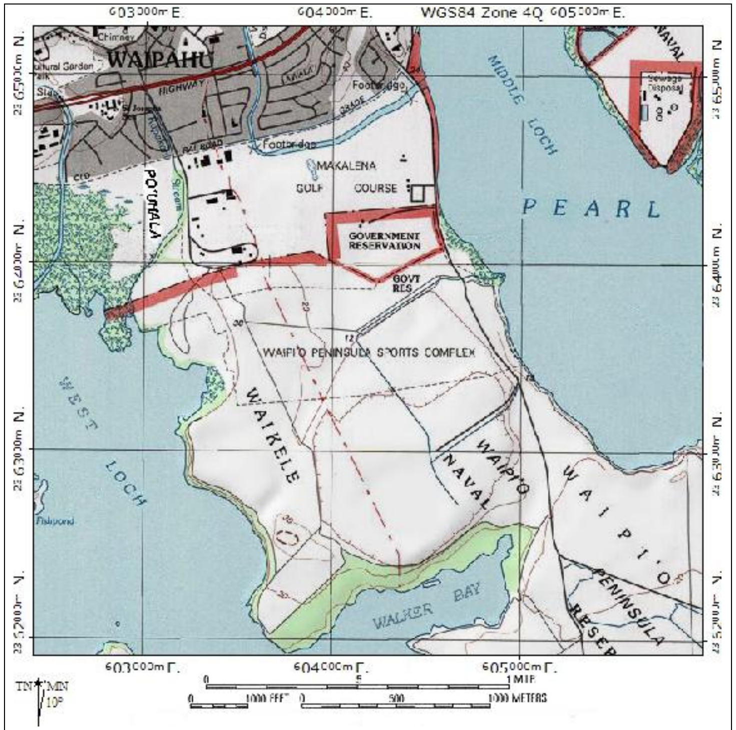


Figure 3-01. Upper half of Waipiʻo Peninsula from Waipahu to Walker Bay

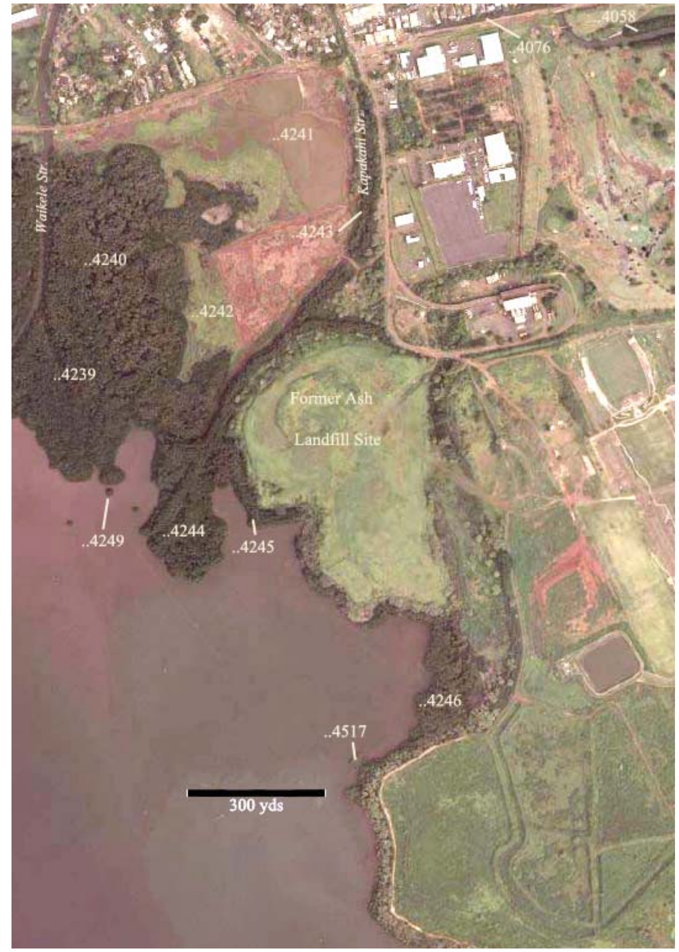


Figure 3-02. Satellite image of West Loch and upper west side of Waipiʻo Peninsula in the vicinity of Poʻuhala Marsh showing ACOE wetlands.

Poʻuhala Marsh

Poʻuhala Marsh (ID ..4241) is a saline wetland dominated by pickleweed (*Batis maritima*), but with expansive shallow, open water areas conducive to utilization by Hawaiian stilt (see photo SP3-03). It is the remnant of an extensive tidal flat that has, in the last 50 years, become nearly isolated from West Loch by a mangrove forest (IDs ..3221, ..4239-..4240, ..4244; see Chap. 2) and by man-made levees and fill. The marsh and a former fishpond together totaled 70 ac (28 ha), of which only 24 ac (10 ha) is marsh useful to waterbirds. Much of the remainder has been filled (8 ac or 3 ha) or overgrown by mangrove (38 ac or 15 ha; Ducks Unlimited, 1998). A large part of the marsh was degraded by solid waste disposal activities over a long period of time, and although dump sites are still present (Figure 3-03), a major clean-up of the area several years previously has greatly improved conditions in the wetland.

Figure 3-03. Portion of the northern shore of Poʻuhala Marsh (*mauka* marsh) with old bottle dump area exposed on mud flat. *Kiawe* trees in background line the levee separating Kapakahi Stream from the marsh, but the trees were removed in 2007.

Because of it's importance to endangered waterbirds, extensive studies have been done in Poʻuhala Marsh including detailed surface contour surveys, soil borings and soil contaminants, water quality, biology, and piezometer (water level) studies for a marsh enhancement plan and environmental assessment (Ducks Unlimited, 1998). Biological studies included flora and fauna (Arthropoda and Aves) surveys. Vegetation of the marsh is described by Nishida and Imada (1997). A map depicting vegetation types and open water areas produced by Ducks Unlimited is reproduced herein as Fig. 3-04. The map shows only the border of the mangrove swamp that extends solidly to the channel of Waikele Stream to the west (see Fig. 3-02). The marsh is divided into two areas by a triangular parcel of ruderal (fill) land along Kapakahi Stream: an upper or *mauka* marsh (ID ..4241), and a lower or *makai* marsh (ID ..4242). The *mauka* marsh is a playa, with large areas of open water and barren mud flats covering the eastern half (see Fig. 3-03). Playas are characterized by seasonal declines in water level that result in salt pans with a powdery sediment that blows away, retaining the basin shape. This wetland type is dependent upon the capture of saline (Pearl Harbor) water as a source of salt. Salinity at the inland (northern) end was 82 ppt on 09/19/06, or about 2.4 times sea water salt content.

The NWI maps for the area around Poʻuhala Marsh designate the mangal around Waikele Stream mouth and south of the marsh as E2FO3N: estuarine, intertidal, regularly flooded, broad-leaved evergreen forest (i.e., mangrove). The more interior part of the area is put in the category E2EM1P: Estuarine, intertidal, irregularly flooded, emergent marsh, for the pickleweed tidal flat and playa. Pickleweed is small shrub, and therefore the correct classification would be E2SS3P. The most interior part is given the coding PEM1F: Palustrine, semipermanently flooded persistent emergent marsh. Although this classification may be correct for a small portion of Poʻuhala Marsh, this type is not shown on the Ducks Unlimited map (our Fig. 3-04) and the NWI mapping is not accurate (indicating the playa). Nearly all of the marsh is either pickleweed flat, open water, or exposed mud flat. However, in the northwestern corner there is a small area with distinct vegetation indicative of freshwater intrusion and palustrine ecology. The same or a similar area is described by Englund, et al. (2000, p. 22):

> A large spring area was observed to issue from the center of Pouhala Marsh, and salinity was measured at 1 ppt near an area of clear water in the center of the marsh; the marsh at this freshwater spring area was dominated by the introduced common cattail (*Typha latifolia*). During our fieldwork, the marsh area also contained several other areas of open water with salinities of 8 to 9 ppt.

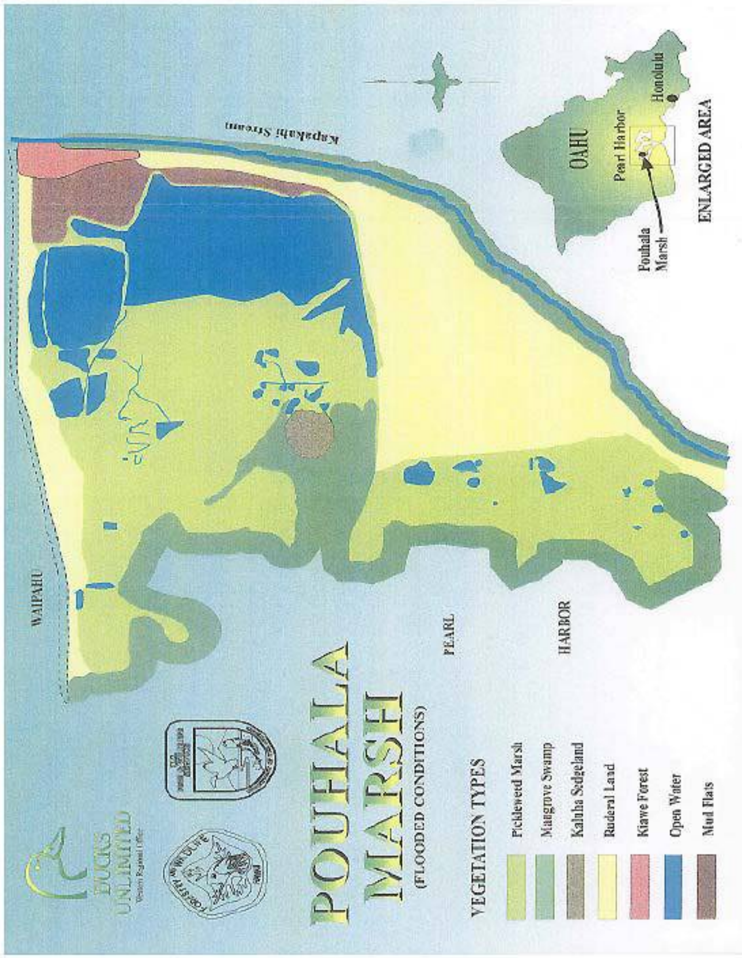


Figure 3-04. Po'uhala Marsh vegetation map (from Ducks Unlimited, 1998).

Table 3-01. Reported waterbird species of Po'uhala Marsh (from Ducks Unlimited, 1998)

Species	Occurrence in Hawai'i		Status on Po'uhala Marsh
Ardeidae			
Black-crowned Night-Heron	Indigenous	Resident	Common
Cattle Egret	Introduced	Resident	Common
Little Blue Heron	Accidental		Three records
Anatidae			
Hawaiian Duck (Koloa)	Endemic	Endangered	Very Rare - hybrids pose problem
Mallard x Koloa	Hybrid Species		Rare
Northern Shoveler	Migratory		Uncommon Winter Visitor
Northern Pintail	Migratory		Uncommon Winter Visitor
Rallidae			
Hawaiian Coot	Endemic	Endangered	Hypothetical Occurrence
Hawaiian Moorhen	Endemic	Endangered	Rare breeder
Recurvirostridae			
Hawaiian Stilt	Endemic	Endangered	Common resident, rare breeder
Charadriidae			
Pacific Golden-Plover	Migratory		Common Winter Visitor
Black-bellied Plover	Migratory		Rare Winter Visitor
Semipalmated Plover	Migratory		<5 records
Scolopacidae			
Bristle-thighed Curlew	Migratory	Sensitive	Rare Fall Transient
Greater Yellowlegs	Migratory		1 record
Wandering Tattler	Migratory		Uncommon Winter Visitor
Ruddy Turnstone	Migratory		Uncommon Winter Visitor
Sanderling	Migratory		Rare Winter Visitor
Western Sandpiper	Migratory		1 record
Least Sandpiper	Migratory		2 records
Ruff	Migratory		2 records
Long-billed Dowitcher	Migratory		< 5 records
Wilson's Phalarope	Migratory		1 record

Table taken from Ducks Unlimited (2000): assembled from the following sources: Rare Birds DataBase (Bishop Museum), DOFAW biannual waterbird survey results 1940 - 1996, A. Engilis, Jr. (1988), A. J. McCafferty pers obs., and P. Donaldson (pers obs.).

West Loch, East Shore

In addition to the mangrove forests that cover the stream deltas extending into West Loch from the mouths of Waikele and Kapakahi streams (Fig. 3-02), a narrow mangrove belt exists along the shore of the old ash landfill southeast of Poʻuhala Marsh. This particular wetland (ID ..4245, por. of ..4246) was delineated by Guinther in 2001 (*AECOS*, 2001a):

> …[T]he definition of jurisdictional waters in 33 CFR 328 includes "all waters subject to the ebb and flow of the tide." In tidal waters, jurisdiction extends to the high tide line, defined as (33 CFR 328.3.d) "…the line of intersection of the land with the water's surface at the maximum height reached by a rising tide." Wetlands delineation by ACOE (1987) applies only to a subset of waters of the United States. Jurisdiction in tidal waters is independent of vegetation and soil type. Because, the Waipahu Ash Landfill site is located on tidal Pearl Harbor, the delineation of the wetland boundary can be established as the high tide line. In most areas around the south and west shore, this boundary is readily discerned in the field because the face of the fill is relatively steep and descends steeply into the intertidal zone (that is, the wetland boundary lies within 0.5 m (1.6 ft) of the intersect between the fill and the vegetated salt flat. Despite the presence of obligate wetland vegetation (*Batis maritima* or pickleweed and overhanging *Rhizophora mangle* or mangrove) approaching 100% cover on slopes above the high tide line, these areas are nearly everywhere characterized by fill debris (usually ash containing metal and glass inclusions) that does not qualify as hydric soil.
>
> Other areas within or adjacent to the project site, especially on the northwest, proved to be less straight-forward because extensive areas of *B. maritima* surround shallow ponds on low-lying ground (Figure [3-05]). Nonetheless, after thorough exploration it was decided that what appeared to be isolated pools were in fact tidal, and a similar reasoning could therefore be applied to delineate the wetland boundary. Note that it is only in the area west and southwest of the project site that the proposed limit of construction extends into jurisdictional waters. These areas are mostly where mangrove has encroached on shallow placed fill, and where it is intended to excavate ash material for return to the interior of the landfill before capping (Earth Tech, 1999b).

South of the old ash landfill, the mangrove forest (ID ..4246) broadens to about 375 ft (115 m), then narrows again as the shoreline turns roughly southwestward. The mangrove ends more or less where the shoreline turns southward. A small mangrove cluster off the west end is numbered ..4517 on one map and ..4284 on another (ACOE, 1999).

ACOE (1999) does not address this area, except to note as we have that the mangrove forest (ID ..4246) at the mouth of this depression is part of the coastal mangrove belt extending south from Kapakahi Stream. However, the

NAVMAG Pearl Harbor INRMP (NAVFACENGCOM, 2001, p. 3-21) contains this statement presumably pertaining to the same depression (and located correctly on their Fig. 3-6):

> California grass…forms a swampy [sic] meadow behind the mangrove forest located near the sanitary landfill.

Figure 3-05. An area on the northwest boundary of the ash landfill site near Station 11 (*AECOS*, 2001a) characterized by a pickleweed (*Batis maritima*) flat with open pools (part of ID ..4244). The old landfill slope is evident in background left.

Further, Whistler (1998) describes "a low, shallow, trough-like area that extends from the landfill area down to the mangroves by [West Loch] at the south end of which is a freshwater marsh." Whistler's description is a bit tentative: "Still further south [along this depression]… the soil apparently becomes moister, and the vegetation changes [from California grass] to a freshwater marsh." The flora, described as patchy over the area, consists of elephant grass, umbrella sedge, Indian pluchea, moon flower (*Ipomoea alba*), California grass, and ivy gourd (*Coccinea grandis*), several species being indicative of a wetland. This report was an appendix to the Soccer Park EIS (Belt Collins Hawaii, 1998) which states (p. 3-16 & 3-18):

> Three possible wetland areas on or next to the soccer park site were identified during the February 1998 [i.e., Whistler] survey: (1) Pickleweed Marsh; (2) Freshwater Marsh; and (3) Mangrove Swamp... However, a subsequent wetlands survey indicated none of the three sites meet the U.S. Army Corps of Engineers criteria for hydric soils [cited as a footnote: ACOE, 1987]. Therefore, there are no wetlands within the proposed project area.

No information is given as to what the "subsequent survey" was; however, for the "Freshwater Marsh," if true (no hydric soil present), the site would not be a jurisdictional wetland. For the mangrove and pickleweed areas, ACOE jurisdiction likely does still apply—both species are obligates and usually indicative of tidal inundation—and wetlands are (or were), in fact, present (see *AECOS*, 2001a for a subsequent delineation of some of these areas, although that document does not really address the described freshwater marsh location). There exists a depression here, presumably a remnant of the old shoreline that was not completely filled but was cut off from West Loch by landfill activities.

A "wetland" PUBKrx (Palustrine unconsolidated bottom, artificially flooded, artificial substrate, excavated) immediately east of the depression described in the previous section is present as a single treatment lagoon of some sort. This feature was apparently built at the same time as the soccer park and does not appear on the ACOE (1999) aerial photographs, but is shown as on the NWI map (USFWS, 2007) and can be seen in Fig. 3-02 near the lower right corner. Man-made waste treatment ponds are non-jurisdictional.

Oahu Sugar Settling Ponds

A large part of the Waipiʻo Peninsula was, until 1992, devoted to sugar cane cultivation and disposal of sugar mill processing water into ponds built behind a series of dikes. In that year, Oahu Sugar ceased operating, fields were abandoned, and sugar mill water was no longer piped to the settling ponds which had become wetlands, significant for waterbird use (Ducks Unlimited, 1998). After 1992, the wetlands rather quickly dried up (ACOE, 1999) and much of the area of former ponds is now a City & County Soccer Park. When visited by the ACOE biologists, some hydric vegetation was still present, but the area was declared non-wetland by virtue of lacking hydrology (ACOE, 1999). Pond basins not yet obliterated are located on Navy property south of the soccer park.

A number of different wetland features are indicated on NWI maps (USFWS, 1999, 2007) covering the interior of the upper Waipiʻo Peninsula. A palustrine, scrub-covered wetland (PSS1/EM1C) shown on the NWI maps (USFWS, 1999)

to the south of the old City & County landfill and inland (southeast) of the mangrove at ID ..4246 is separated from the mangrove by a high berm. USFWS (2007) presents a far more complex picture of aquatic features in this location with most of the depression shown as upland, except the southern tip coded PUSKx and another pond just north coded PSS3Kx. A ditch, coded PEM1Cx, follows the entire western outline of the 1999 feature. A ditch across (on the east side of) Waipahu Depot Road is coded R2UBKx (riverine, lower perennial, unconsolidated bottom, artificially flooded, excavated) and two small pond features are coded PSS3Cx and PUBFx. These are all man-made, excavated features (coding "x") with various vegetation types (or bare of vegetation), and water regimes supposedly ranging from seasonal to artificially flooded to semipermanently flooded ("F") in one case. The "perennial riverine" coding would seem incorrect. This is a dry area of abandoned, man-made ditches and retention basins lacking any source of water other than direct rainfall. The area has changed greatly over the last two decades as discussed above, and the 1999 designations are now certainly irrelevant. The complex coding applied to various man-made ponds and drainage ditches that are nearly always dry (USFWS, 2007) would seem also irrelevant to jurisdictional wetlands considerations.

The NWI (USFWS, 2007) shows several other features further to the south and east that also may be related to the settling ponds and or former agricultural activities. A ditch system coded PEM1Kx (wetland in an artificially flooded, excavated ditch) is shown draining to a pond coded PSS3Kh (an artificially flooded, diked impoundment supporting broad-leaved evergreen scrub-shrub). We found a water-filled ditch dug out several meters below the land surface along the road at the northeast end of the bay. The NWI codes a corresponding feature as PUBHh (palustrine, unconsolidated bottom, permanently flooded diked/impounded) in this area.

The situation is somewhat more complicated around Walker Bay (see below) where the drainage features are basins located closer to Pearl Harbor and closer to sea level.

Walker Bay

Walker Bay is a narrow re-entrant of West Loch partially dividing the Waipiʻo Peninsula. The Bay (Fig. 3-06) is nearly completely surrounded by mangal, only the south shore, where the mangrove border is narrow and broken, affording access to the water without great effort. The northern shore is complicated. Mangal lines the inner, north shore to such an extent (ID ..4068, ..4069, ..4071, and ..4072) that the view of Walker Bay is all but obscured from anywhere on the north side. However, behind this mangal are open areas of *Batis* (Fig. 3-07;

ID ..4070) and various drainage (or perhaps detention) features that contain water in some cases, and are playa-like features in others (Fig. 3-08; ID ..4067 and others not identified in 1999; see photo SP3-02). These depressions, which have high, steep sides, were presumably built to capture and infiltrate runoff from upland sugar cane fields.

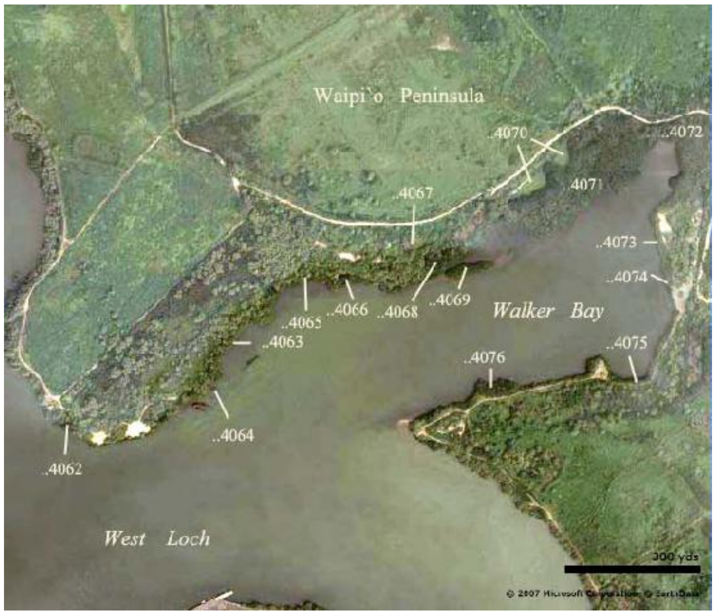


Figure 3-06. Satellite image of Walker Bay showing ACOE (1999) numbered wetlands.

The basins demonstrate an important aspect of playa features: an absence of vegetation of any kind in the central or lowest part(s) of the depression (Fig. 3-08). Here, *Batis* grows away from the central depression, which is barren of vegetation for the reason that after flooding, water slowly evaporates, concentrating salts in an increasingly smaller pool area. Eventually the concentration exceeds that which *Batis* and all other plant can endure. Although clearly isolated, basins having this configuration of a barren flat

surrounded by pickleweed are ephemeral, saline wetlands. The NWI (2007) shows the multiple basins incorrectly (the basins are separated by high berms) as a single long wetland feature coded E2EM1/SS3N (estuarine intertidal with persistent emergent vegetation and broad-leaved evergreen scrub-shrub, regularly flooded). This coding does not fit and we would code at least some of the basins (not all are wetlands) E2SS3J1: estuarine, intertidal broad-leaved evergreen scrub-shrub, intermittently flooded, hyperhaline (or could be seasonally flooded).

Figure 3-07. A *Batis* wetland (ID ..4070) behind dense mangal (ID ..4071) at Walker Bay.

The *Batis* flat (ID..4070) behind the mangal is irregularly flooded, but potentially connected to the mangal (ID..4071) and, by extension, connected to Walker Bay. The isolated depressions (ID ..4067 is an example) are not easily regarded as jurisdictional wetlands. The basins are completely cutoff from tidal incursion by high berms and appear to accumulate water only via direct rainfall. But if that were the entire situation, the bottoms of the basins would support more vegetation and not less vegetation than the surrounding uplands. There must be a source of salt that is being concentrated in the depression, and presumably this source is brackish or saline groundwater. The salts become concentrated because fresh water rainfall, or run-off water that enters during storms, leaves the basin largely by evaporation.

The NWI (2007) indicates several wetlands along the north shore of the Bay. These are designated E2FO3N (Estuarine intertidal, regularly flooded, broad-leaved evergreen forest; i.e., mangal), with a small area of E2SS3N (estuarine intertidal regularly flooded, broad-leaved evergreen scrub-shrub) on the east, presumably indicating less developed mangrove forest. The *Batis* flat just inland (Fig. 3-07) is incorrectly coded E2EM1N, and should be E2SS1P (estuarine intertidal, irregularly flooded, broad-leaved evergreen scrub-shrub; i.e., a "high" *Batis* flat).

Figure 3-08. A playa feature inland of Walker Bay. Note that *Batis* grows away from the central depression, which is bare of vegetation (and salt encrusted) indicating this is an ephemeral, saline wetland. Also, note the steep basin wall covered in dry grasses.

As noted elsewhere, the designation E2SS3N fits where young mangrove plants are shrubs just colonizing an area, but is not an especially useful distinction for mangrove growth because these shrubs grow into trees as the mangal develops. The classification code E2SS3N can also fit an intertidal, *Batis* flat, since

pickleweed is a woody shrub. While there certainly are parts of a mature mangal where surface water floods only infrequently (and therefore the designation "irregularly flooded" would be appropriate), most of the narrow to moderately broad (from low tide to high tide line) mangrove formations around Pearl Harbor are completely flooded on a regular basis by the tide. Application of regularly and irregularly flooded codes to these features is discussed further on page 21.

Peninsula South of Walker Bay

South of Walker Bay, the Peninsula narrows to Waipiʻo Point at the southern tip. Some of this area was leased for farming in the past, and drainage ditches are present, some near the shore supporting "wetland" vegetation such as *Batis* and *Pluchea* (Fig. 3-09). A few scattered wetlands appear on the NWI maps

Figure 3-09. Drainage ditch inland of the south shore of Walker Bay.

(USFWS, 2007), being mostly agricultural detention ponds (PEM1Ch,EM1/SS3Ch, PEM1Fhd, and PFO3Ch) and drainage ditches (PEM1Cx). Two large features at the end of the peninsula are coded PUSCx (palustrine, unconsolidated shore, seasonally flooded, excavated) and L2USAx with L2USCx in its interior: a man-made lake with an unconsolidated shore that is seasonally flooded in the middle and temporarily flooded around the margins. Both of these features are large, soil-diked detention ponds, and are best both coded L2US2Chx. The more northern feature is older and has developed some vegetation, which may be the reason it is coded as a palustrine feature, but it is likely that this vegetation is dominated by weeds growing after the water recedes rather than "emergent wetland plants." Neither is a jurisdictional wetland.

Middle Loch, West Shore

An inlet or inland depression with a wetland (ID ..4057) is shown north of the degaussing station (NWI: E2FO3N surrounded by E2SS3N and some E2FO3P). This feature was not investigated.

Much of the east shore of Waipiʻo Peninsula (Middle Loch west shore) is lined with a thin, broken stand of red mangrove from the U.S. Navy degaussing station north to the U.S. Navy Ship Facility. The most significant area of mangal occurs just south of the latter (ID ..4052 and ..4288). Wetland ID ..4288 was investigated in 2007. This mangrove area is complicated and appears to be part of drainage system and/or detention basin since abandoned, but still receiving runoff from adjacent roads (Waipio Point Access Road near the entrance to Waipio Soccer Park).

Kahu Drainage Channel ~ Kahu Drainage Channel conducts runoff from Wailani Stream draining the eastern half of Waipahu and parts of Waikele/Crestview into Middle Loch of Pearl Harbor (*AECOS*, 1988). This drainage is referred to as Eʻo Stream by Englund, et al. (2000), while admitting the channel is man-made from draining and filling of the former Eʻo Fishpond on Middle Loch. Lands further *mauka* drain to the east (Panakauahi Gulch) or west (Kipapa Gulch). Kahu Draomage Channel is essentially a concrete drainage canal at sea level; water flow is typically sluggish and basically estuarine and tidal much of the time. The channel reaches Waipiʻo Peninsula midway across the peninsular base, then turns eastward after it enters the City & County of Honolulu, Ted Makalena Golf Course. Upstream and through the bend, Kahu Drainage Channel is lined with vertical concrete walls (*AECOS*, 1988) and water salinity has been measured at 13 ppt (Englund, et al., 2000). The channel widens through a revetment-lined section, then is contained in soil banks. From this point, about 150 ft (50 m) downstream of the bend, the channel is lined with a dense band of red mangrove trees (ID ..4058, ..4059, and ..4061) to the channel mouth at Middle Loch. Near where Waipio Point Access Road crosses this channel, conditions are generally marine, with a hard-

bottom of coral rubble present and a water salinity of 35 ppt (Englund, et al., 2000).

The mangrove belts are coded E2SS3N: estuarine intertidal regularly flooded, broad-leaved evergreen scrub-shrub (USFWS, 2007).

Smaller canals (ID ..4076, ..4077, and ..4079) drain into Kahu Drainage Channel from the east and west on the *mauka* (north) side of the old railroad right-of-way (Fig. 3-02; *AECOS*, 2005), now the energy corridor and a developed jogging path and bikeway between Waipahu Depot Road and Waipiʻo Point Access Road (*AECOS*, 2000). These ditches are lined in places by very narrow groupings of mangroves growing on on the banks, which were seen to have been recently cleared at the west end (ID ..4076) of the channel located opposite the C&C Fire Truck Repair Facility. The fact that only a delayed maintenance schedule represents the difference between these man-made urban drainage channels being wetlands or not is problematic from an inventory perspective. The waters are tidal, so jurisdictional issues are independent of their wetland status. The banks are not hydric soils, although the channel bottoms would seem to typically contain anoxic sediments, the more so when clogged by mangrove growth. And, of course, mangrove is an obligate wetland species.

ACOE (1999) marked as wetland ID ..4060, the water hazard or pond at Ted Makalena Golf Course, but did not discuss this feature in their report. This water feature is coded PEM1Cx (west side) and PUBHx (open water) in the NWI (USFWS, 2007); that is, an excavated palustrine feature that is partly permanently flooded and partly seasonally flooded, the latter supporting emergent vegetation.

Middle Loch, North and East Shores

Eastward, beyond the mouth of Kahu Drainage Channel ("Eʻo Stream") is the mangrove-lined north shore of Middle Loch (Chap. 4). It is along this coast that several high volume Pearl Harbor area springs discharge into Pearl Harbor, contributing to palustrine wetland features behind the shore.

Tables 3-02 and 3-03 summarize biological observations (fauna and flora, respectively) made in 2006-7 at various wetlands located in the upper East Loch area. Table 3-04 summarizes differences between what was reported for this area as present and surveyed in 1999 (ACOE, 1999) and our 2006-7 observations.

Table 3-02. Aquatic biota listing for upper West Loch wetlands.

Species listed by family	Common name	Notes	4076	4240	4241	4243
	INVERTEBRATES					
ARTHROPODA, CRUSTACEA						
PORTUNIDAE						
Thalamita crenata						R
ARTHROPODA, INSECTA						
ODONATA						
AESHNIDAE						
Anax junius	Green darner		R			R
LIBELLULIDAE						
Tramea lacerata	Black saddlebags					R
COENAGRIONIDAE						
Ischnura ramburii	Rambur's damselfly			R		
	VERTEBRATES					
PISCES (fishes)						
CICHLIDAE						
Cichlisoma nigrotasciatum	Convict cichlid					O
Sarotherodon melanotheron	Black-chin tilapia		A		A	C
MUGILIDAE						
Mugil cephalis	*ʻamaʻama*		A			
POECILIIDAE						
Poecilia mexicana	Mexican molly		A	C		C
AVES (birds)						
ARDEIDAE						
Bulbucus ibis	*Cattle egret*				R	
RECURVIROSTRIDAE						
Himantopus mexicanus knudseni	*Aeʻo*				C	A
SCOLOPACIDAE						
Calidris alba	*hunakai*				U	

KEY TO SYMBOLS USED IN TABLE: 3-02

Abundance categories:
R – Rare – only one or two individuals seen.
U – Uncommon – several to a dozen individuals observed.
O – Occasional – regularly encountered, but in small numbers.
C – Common - Seen everywhere, although generally not in large numbers.
A – Abundant – found in large numbers and widely distributed.
P – Present – noted as occurring, but quantitative information lacking.

Table 3-03. Flora listing for Honoʻuliʻuli, West Loch Shoreline Park and other selected Chapter 2 wetlands.

Species listed by family	Common name	Notes	3217 (a)	4067	4070	4241 (b)
AIZOACEAE						
Sesuvium portulacastrum	*ʻäkulikuli*	(2)				
Trianthema portulacastrum		(1)				R
AMARANTHACEAE						
Achyranthes aspera	---	(1)			R	
ANACARDIACEAE						
Schinus terebinthefolius	Christmas berry	(1)			R	
ARECACEAE	(palms)					
Cocos nucifera	*niu*	(1)				R
ARALIACEAE						
Schefflera actinophylla	umbrella tree	(1)	R			
ASTERACEAE						
Pluchia carolinensis	sourbush	(1)			R	R
Pluchea indica	Indian sourbush	(2)		U		U
Pluchea X fosbergii	sourbush hybrid	(1)		R		
BATACEAE						
Batis maritima	*ʻäkulikuli kai*				**A**	**A**
BORAGINACEAE						
Heliotropium curassavicum	seaside heliotrope	(1)				U

Table 3-03. Flora listing for Hono'uli'uli, West Loch Shoreline Park and other selected Chapter 2 wetlands.

			Wetland ID No.			
Species listed by family	Common name	Notes	.3217 (a)	.4067	.4070	.4241 (b)
CHENOPODIACEAE						
Atriplex semibaccata	Aust. saltbush	(1)		C		A
CYPERACEAE	(sedges)					
Cyperus involucratus	umbrella sedge					U
Schoenoplectus lascustris	bulrush		A			
FABACEAE						
Desmanthus pernambucanus	virgate mimosa	(1)	U			
Leucaena leucocephala	*koa haole*	(1)	O	C		
Macroptilium atropurpureum	---	(1)	R			
Prosopis pallida	*kiawe*	(1)		A	C	O
LAMIACEAE						
Leonotis nepetifolia	lion's ear	(1)		C		
MYRTACEAE						
Syzygium cumini	Java plum	(1)	U			
NYCTAGINACEAE						
Boerhavia coccinea	false *alena*	(1)				
POACEAE						
Cenchrus ciliaris	buffel grass	(1)		A	C	U
Chloris radiata	plushgrass	(1)		U	U	A
Cynodon dactylon	Bermuda grass	(1)				U
Pennisetum purpureum	elephant grass	(1)	A			
Sporobolis sp.	---	(1)		U	U	A
Urochloa maxima	Guinea grass	(1)	C	A		R
Urochloa mutica	Calif. grass		A			R
RHIZOPHORACEAE						
Rhizophora mangle	red mangrove		R			
VERBENACEAE						
Verbena littoralis	öwï	(1)		R	R	
TYPHACEAE						
Typha latifolia	Cat tail		U			

Notes:
(a) Includes wetland ..3218
(b) Po'uhala marsh near energy corridor.
(1) Typically not a vegetation of wetland, but growing around margin.
(2) Marginal vegetation member; more typically growing close to wetland.

Table 3-04. Summary of Changes Since 1999

Site	Description	Change since 1999	ACOE ID
West Loch north shore mangrove	Po'uhala Marsh.	On-going project to clean up marsh and playa areas and eliminate mangrove.	**..4241**
West Loch north shore mangrove	Kapakahi Stream estuary.	Mangroves removed from part of estuary.	**..4243**, **..4244**
West Loch northeast shore mangrove	Mostly a thin belt of mangrove off the old C&C ash landfill.	No change.	**..4245, ..4246, ..4517 (or ..4284)**
Former Oahu Sugar Co. settling ponds	Settling ponds that developed into extensive wetlands.	Use curtailed before 1999, and now completely dried up.	None
Scattered shoreline areas west of Walker Bay.	Small mangrove clusters.	Unchanged.	**..4062 through ..4066**
Walker Bay, north shore	Mangal with *Batis* flats behind.	Unchanged.	**..4068 through ..4072**
Inland of north side of Walker Bay	Playas in man-made catchment basins.	More than one feature is present.	**..4067**
Walker Bay, south shore	Narrow band of mangrove at shore.	Unchanged	**..4073 through ..4076**
Wetland west of degaussing sta.	Interior wetland	Not investigated.	**..4057**
West shore of Middle Loch	Narrow mangrove belt becoming mangal at north end.	Unchanged.	**..4052 through ..4056, ..4288**
Makalena Golf Course pond	Open water feature with margin of	Unchanged.	**..4060**

Table 3-04. Summary of Changes Since 1999

Site	Description	Change since 1999	ACOE ID
	emergent vegetation.		
Kahu Drainage Channel	Mangroves lining modified drainage channels	Mangroves removed from smaller channels to maintain flood hydrology	..4076 to ..4078, **..4058, ..4059, ..4061**

Note: ID numbers in bold are jurisdictional wetlands; others are not.

Following are supplemental photographs (SP) for Chapter 3.

SP3-01 (left): Red mangrove growing on a concrete block and adjacent rocky cliff, a situation that fails to fit into a wetland definition.

SP3-02 (left): Another one of the playa-like depressions near Walker Bay (see Fig. 3-08). Here the only vegetation is *kiawe*. Note salt-encrusted soil, the only plausible explanation for which in the closed depression is evaporation of saline groundwater.

SP3-03 (left): Hawaiian stilt (*Himantopus mexicanus knudseni*) on the shallow playa pond at Poʻuhala Marsh.

Chapter 4

Middle Loch and Pearl City Peninsula

The wetland areas encompassed in this chapter correspond closely to ACOE (1999) Segments 5 and 6. Middle Loch is the central major subdivision of Pearl Harbor and the smallest loch (counting much smaller Northeast Loch as an arm of East Loch). Middle Loch is bounded by Waipiʻo Peninsula (Chap. 3) on the west and Pearl City Peninsula on the east. Most of the Pearl City Peninsula is U.S. Navy land. However, extensive freshwater wetlands north (*mauka*) of the energy corridor (bike path), which cuts across the very top of the Peninsula, are outside of Navy jurisdiction (Fig. 4-01).

The upper part of the Pearl City Peninsula was mostly fishponds, *loʻi*, and marshlands. The lower end of the peninsula, developed as housing and other operational facilities of Pearl Harbor Naval Base, was at somewhat higher elevation and developed in the late 1800s (PHRI, 1994). The lowlands of the upper peninsula have been filled over time, and wetlands now are found where the land was not raised substantially by fill. Ditches were either dug out or low areas left in narrow strips between fill to facilitate local drainage. To reduce flood hazard, soil dikes isolate lower Waiawa Stream from the floodplain.

Middle Loch North Shore

The north shore of Middle Loch is accessed by an unimproved segment of the jogging/bike trail (energy corridor) and former OR&L right-of-way. The shoreline harbors a mostly thin and scattered border of red mangrove. The mangal is most extensively developed at the eastern end around the mouth of Waiawa Stream.

Kolea Cove Wetland ~ Just inland of the energy corridor near the middle of the north shore is a fenced wetland pond called Kolea Cove Wetland (ID ..6285; named presumably after a development planned for *mauka* properties) constructed as a mitigation (Okada Trucking, DA Permit 1594-S; ACOE, 1999).

Although this wetland is still present, access to view the wetland has become difficult by the fact that dense vegetation now obscures the fence, wetland margin, and most or all of the open water of the feature. The wetland is overgrown with California grass (*Urochloa mutica*) and cattail (*Typha latifolia*; Fig. 4-02). This feature is not indicated on the NWI maps (USFWS, 2007).

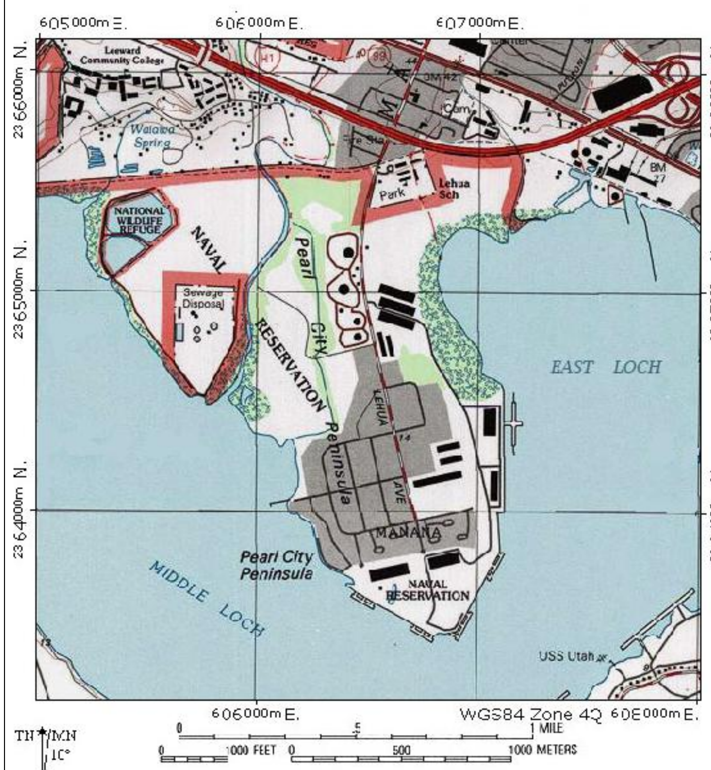


Figure 4-01. Topographic map of Pearl City Peninsula showing place names used in text.

Waiawa Springs and Bike Trail

Waiawa Springs are a series of springs lying along the base of the Koʻolau basalt bluffs below Leeward Community College. The elevation of the highest spring orifice is 3.4 m (11 ft) above sea level (Visher and Mink, 1964). Waiawa Springs is actually the smallest of the major Pearl Harbor spring sites in discharge volume (average flow of 18 Mgd between 1911-1920 according to Nichols, et al., 1997), but has the greatest remaining exposed surface area of the main Pearl Harbor springs with spring-fed ponds totaling 10.1 ha (25 a) in the early 1960's (Visher and Mink, 1964). However, Englund, et al. (2000) reported that portions of the Waiawa Spring complex near the base of the basalt cliffs were possibly being filled and used as a heavy construction staging area.

Figure 4-02. Kolea Cove wetland as it appeared in September 2006 looking into the wetland from the northwest corner. Poles and trees in background are along the bike trail.

Numerous irrigation ditches occur at the Waiawa Springs complex, connecting ponds where watercress (*Nasturtium officinale*) is grown. Other areas consist of silty, vegetation covered ponds. Water can also be seen actively issuing from spring areas where the watercress farmers have cleared vegetation. Measured salinities at Waiawa Springs ranged from 3-5 ppt (Englund et al., 2000).

The watercress wetlands (ID ..6104 through ..6120, ..6122 through ..6125, ..6286 and several others not included in the ACOE inventory in 1999) include several large parcels where watercress is actively farmed, numerous smaller basins that may have been used formerly for aquaculture (appear unsuitable for

watercress) but are now abandoned (see photo SP4-02), and various drainage ditches.

Figure 4-03. Mangal [ID ..6079] denuded of mangrove trees fronting the Waiawa Unit, PHNWR (to left out of frame). Mangroves from which this photo was taken in September 2006 were later also removed.

One large wetland area that appears no longer to be used for watercress is wetland ID ..6125. We attempted to gain permission from the private owner to enter this property but were not successful. However, satellite images of this wetland show active filling underway, and the boundary interpreted from the images we used is considerably different (area reduced) from that indicated by the ACOE in 1999. Outflow from this wetland is into ID ..6124 (see photo SP4-01).

Overflowing water from the Waiawa Springs through the ponds and ditches, eventually discharges into Middle Loch at the northeast corner, adjacent to the Waiawa Unit of the Pearl Harbor National Wildlife Refuge (PHNWR). The mangal through which the outlet stream flowed and which extended southward in front of the PHNWR has been removed (2006-2007; Fig. 4-03, above).

Some water from the springs in this area floods westward beside the bike trail, creating small wetlands just off the trail and feeding man-made ponds in the area. On the south side of the trail, however, a shallow drainage ditch (ID ..6121) is covered in pickleweed (*Batis maritima*; Fig. 4-04), suggesting an infrequent but significant tidal connection, and disconnection from the abundant freshwater present elsewhere just north of the bike trail.

Figure 4-04. A small pickleweed wetland in the drainage ditch on the south side of the bikeway.

ACOE (1999, p. 38) noted the following in this area:

> Chevron ...was installing a new pipeline and excavated a trench near the bike path. The water surface was within 10 inches of the surface and the soil was very black, wet, and clearly hydric. Vegetation was primarily pickleweed with Indian fleabane. The strips with hydric vegetation next to the bicycle path in this area are considered wetlands. The ponds to the north next to the bike path were also field checked.

The ACOE (1999) identified some 22 wetland features (mostly active or former watercress ponds) north of the bike trail and west of Waiawa Stream (two in the upper oxbow bend of Waiawa Stream). We believe at least three more were missed in 1999. The NWI (USFWS, 2007) shows 18 ponds in the same area

(however, 6 of these are in the upper oxbow bend) and applies seven different codes, in addition to the outlet ditch coded as PEM1Cx (excavated palustrine wetland, seasonally flooded, persistent emergent vegetation). This channel feature is more correctly coded using one or all of the following: PUBHx, E1UBLx, or R2UBH.

Five of the NWI "pond" codes start with "PEM1" or palustrine persistent emergent vegetation, with these modifiers:

- PEM1C — seasonally flooded
- PEM1Fx — semipermanently flooded, excavated
- PEM1Hx — permanently flooded, excavated
- PEM1KFh – semipermanently and artificially flooded, diked/impounded
- PEM1KFx - semipermanently and artificially flooded, excavated.

The other two codes applied are:

- PUBHx — palustrine unconsolidated bottom, permanently flooded, excavated (an open pond or channel)
- PSS1Kx — palustrine broad-leaved deciduous scrub-shrub, artificially flooded, excavated.

It is not clear what vegetation type is being described by PSS1Kx for a vegetated, artificial pond. The majority of the watercress ponds are coded PEM1KFx or Fh reflecting construction design. Although manipulation of flows might account for permanent vs. semipermanent vs. artificial flooding, these features are all fed by springs meaning "seasonally flooded" should not be used.

Waiawa Unit, PHNWR

The Waiawa Unit of the Pearl Harbor National Wildlife Refuge (PHNWR) is a 25-acre (10-ha) site on U.S. Navy land with two ponds (Fig. 4-05) supplied with fresh to slightly brackish water pumped from the nearby outlet of the Waiawa Springs complex (USFWS, 2006). As at the Honouliuli Unit of PHNWR (see Chapter 1), the site consists of two diked ponds (IDs ..6080 and ..6081). These drain via a short outlet located along the Middle Loch shore.

Biota sampling in the refuge ponds is reported by Englund, et al. (2000). The ponds are surrounded by pickleweed and have mostly silty bottoms. Salinities were measured as follows (Englund, et al., 2000, p. 25):

> Surface salinities were 1.9 ppt at the piped water outlet on the more inshore side of the refuge, while only 3.1 m (10 ft) away from the pipe outlet salinities increased to 5 ppt. Salinities averaged 9 ppt in the upper half of the diked area of the refuge and averaged 24 ppt in the diked portion of the refuge closest to the ocean.

Each pond is classified differently in the NWI (USFWS, 2007). The northern pond (ID..6080) is an open central pond, E1UBL (estuarine unconsolidated bottom subtidal) with margins E2EM1N: (estuarine persistent emergent herbaceous vegetation regularly flooded wetland). As pointed out elsewhere (see Introduction, p. 21), the correct code is E2SS3P. The southern pond (ID ..6081) is presently coded E1ABL (estuarine subtidal aquatic bed; i.e., submerged aquatic plants). Since both ponds are excavated features, in general similar to the ponds at the Honouliuli Unit (see page 46), the codings should be similar but are not.

Figure 4-05. Northernmost (ID ..6080) of the two ponds at the Waiawa Unit of the PHNWR, looking southwest. The dominant vegetation is pickleweed.

Waiawa Stream and Lower Floodplain

Waiawa Stream drains the west side of Pearl City, forming a double horseshoe bend as it flows out onto the coastal plain directly north of the center of the Pearl City Peninsula (Fig. 4-06). The stream continues to meander down the peninsula before flowing into Middle Loch nearly half way down the west side. The upper half of the peninsula is a floodplain that once supported extensive rice culture (PHRI, 1993). The mouth of the stream is a mangrove forest or mangal, and indicated on NWI maps as E2FO3N: estuarine, intertidal, regularly flooded, broad-leaved evergreen forest (USFWS, 2007) and shown extending upstream nearly to the point where Waipuna Avenue crosses the stream.

Figure 4-06. Satellite image of the lower end of Waiawa Stream and the abandoned WWTP to the west on the western side of the Pearl City Peninsula.

From the bridge at Waipuna Avenue, the stream meanders southward then southwestward in a channel that is heavily overgrown with mangrove. Indeed, the mangrove forest or mangal lining the lower end of the estuary (ID ..6087 and ..6088) is impressive in its size and the height of the trees. Further, immediately southeast of the mouth is a large mangal with an open pond in the middle; the trees east of the pond form a curious circular patch 60 m (190 ft) in diameter. The whole looks very much like an ancient fishpond that is most of the way to being filled by mangrove. Yet, the 1897 land use map of the peninsula (in Helber Hastert & Fee, 1994) shows no ancient fishpond in this area. From the historical map, it would appear that the open pond is simply an old outlet of Waiawa Stream.

Englund, et al. (2000) suggests the upper tidal limit of Waiawa Stream as occurring near the USGS gauge directly beneath the Kamehameha Highway bridge crossing. The water here was fresh. Salinities in the estuary downstream of this point ranged from 8 to 34 ppt; salinity at the old WWTP outfall in Middle Loch was 34 ppt.

Waiawa Wetlands ~ On the western or right bank of the stream, the land is high and apparently mostly fill, being once an area supporting extensive rice fields. To the east of the stream, the land is crossed by several berms[1], but a portion is low enough to remain as wetland. Wedged between the left bank of the Stream, Lehua Avenue, and a former Navy petroleum tank farm, this wetland was delineated by the ACOE in September 1992 for a feasibility study to construct sediment settling ponds (sediment removal facility or SRF) intended to reduce delivery of sediment loads into Pearl Harbor and enhance wetland wildlife habitat in the region (Helber Hastert & Fee, 1994). The feasibility study involved various natural and historical environmental surveys of interest (Char, 1993; Bruner, 1992, PHRI, 1993). ACOE (1999) remapped four wetlands in this area (ID ..6098, ..6099, ..6100, and ..6101) and concluded the wetlands had become reduced in area from what had been delineated previously. The dominant vegetation in three of the wetlands was California grass and umbrella sedge (*Cyperus involucratus*). However, one wetland (ID ..6098), was described as a "mixed forest wetland".

We were only able to access some parts of the wetlands in this area due to the density of the surrounding vegetation of mostly elephant grass (*Paspalum purpureum*). The ACOE (1999, p. 34) noted, for the westernmost wetland [ID ..6101) that "[e]lephant grass is encroaching into the area and is decreasing the jurisdictional area." We could not confirm that this wetland still exists. On the other hand, ID ..6098 is mostly a forest of Java plum (*Syzygium cumini*) and not a wetland, although towards the outlet feeding to a north-south drainage ditch (see below), *hau* (*Hibiscus tiliaceus*) and some mangrove (*Rhizophora mangle*) comprise a small swamp. The central area of the marsh remains dominated by umbrella sedge and California grass as described by ACOE (1999; see Fig. 4-07).

The NWI (USFWS, 2007) does not indicate any wetlands in this area. However, a large wetland coded PF03C (palustrine, broad-leaved evergreen forested, seasonally flooded wetland) is indicated to the southwest from along Waiawa

[1] A north-south berm carries a pipe running from the City and County pump station to the abandoned Pearl City WWTP. An east-west second berm carries an 8-inch underground fuel line and runs from the energy corridor to the nearby, former Navy tank farm. Both berms are choked with heavy vegetation including elephant grass, monkeypod, and Java plum *(Syzygium cumini)*. Both berms also have low points which are breached during floods (ACOE, 1999).

Stream to the drainage ditch (described below), and along the drainage ditch all the way to Waipuna Avenue. This "wetland" is also shown as present along the right bank of the stream extending north nearly to the bikeway. Although a narrow wetland is present along the drainage ditch [ID ..6097], expanding somewhat just above Waipuna Avenue (see below), the PFO3C wetland shown in the NWI may not exist.

Figure 4-07. Waiawa wetlands seen in a satellite image (Microsoft, 2007). The dense, montypic growth of umbrella sedge is readily apparent, distinct from the surrounding California grass.

North-South Drainage Ditch ~ The southern wetland area described above (ID ..6098) drains out through a ditch directed nearly due south (ID ..6093 to ..6097 and ..6287; Fig. 4-06) along the west boundary of the former Navy tank farm. This ditch eventually turns westward behind naval housing units on Ashley Avenue. The numerical subdivisions of this wetland feature by ACOE (1999) represent segments between now abandoned concrete road bridges. The wetland is one continuous feature marked by a monotypic stand of red mangrove. A bridge crosses this ditch at Waipuna Avenue, providing road access to the now abandoned C&C WWTP. Below the Waipuna Avenue bridge, standing water is evident all along the ditch, but mangroves form a closed canopy forest over the water. At one point the ditch wetland expands, forming a small pickleweed wetland (ID ..6096) on the west side of the ditch. Immediately upstream of the Waipuna Avenue bridge, the ditch makes a realignment, and perhaps because of this or the presence of the bridge with choking mangrove growth upstream and downstream, the wetland expands in a crook to the west out onto to the road. This particular area is characterized by *'akulikuli* and Indian pluchea. A soil examination showed a mixture of red clay and limestone sand and rubble, without any gleying.

The ditch opens on a small inlet on the east side of Middle Loch some 350 m (1200 ft) southeast of the mouth of Waiawa Stream where a mangal (ID ..6091) covers the right (north) bank. A narrow strip of mangroves (ID ..6092) lines the shore south to the pier at the end of Lanakila Avenue.

Wetland (ID ..6091; NWI E2FO3N) occurs south of, and disconnected from, the mangal at the mouth of Waiawa Stream. However, along the face of the landfill occurs a strip of pickleweed which was observed by the ACOE (1999) to flood at high tide and thus constitutes a wetland [ID ..6090].

The ditch itself, from a non-existent connection to Waiawa Stream to Waipuna Avenue, is coded R4SBCx: an excavated, seasonally-flooded, intermittent stream bed channel. From the bridge southward, the ditch is E1UBLx: an excavated, unconsolidated bottom subtidal estuary (USFWS, 2007). It seems likely that the dividing line is well upstream of the bridge at whatever point mangrove growth is not supported.

Former Pearl City WWTP Site ~ A former C&C waste water treatment plant (WWTP), now abandoned, is located west of the mangal along lower Waiawa Stream and is surrounded by wetlands (see Fig. 4-06). The WWTP was built on fill land that is at a generally lower elevation than surrounding parcels, which are also fill. The site is thus separated from the surrounding land by various berms or dikes, including on the east, a dike that contains flood waters of Waiawa Stream. To the south and east are narrow wetlands (..6085 and ..6086) separate from both shoreline and stream mangals (that is, IDs ..6083 and ..6087).

The site drains towards a low area on the western edge (ID ..6084) that has become a pickleweed (*Batis*) dominated wetland with a playa feature at its upper (north) end (Fig. 4-08; also see Introduction, Fig. 3 and photo SP4-03). This wetland appears to drain towards a central point where there is a stand of mangrove (part of ID ..6083). Thus, a pond and pickleweed flat at the southern end (ID ..6085) does not appear to connect to either the adjacent Middle Loch or Waiawa Stream mouth, being separated from them by a berm or dike. The northern arm of the playa wetland is coded in the NWI as PEM1Rx (excavated palustrine, persistent emergent herbaceous vegetation seasonally flooded

wetland), which it is certainly not. E2SS3P is the correct coding. The other wetlands are not shown in the NWI (USFWS, 2007).

Figure 4-08. Pickleweed wetland on the west side of the old Pearl City WWTP. Biologists shown walking the wetland boundary with a GPS unit. Note that pickleweed grows up the bank, well beyond the wetland border.

Another similar wetland feature (ID ..6086; pickleweed flat with shallow ponds; see Introduction, Fig. 6), but one without any apparent inlet or outlet, is squeezed between the Waiawa Stream dike and a berm—perhaps representing the former sewer outfall route—that terminates at a concrete box structure at the shore. This wetland is utilized by Hawaiian stilt and contains shallow, flooded areas.

The former WWTP consists of roadways, buildings, and various concrete structures once utilized to treat sewage. The old sludge drying pits are interesting because the 10 rectangular concrete basins accumulate rainwater and support some growth of wetland plants (*Batis*) and are attractive to wetland birds (see photo SP4-04). On our visit on December 14, two pairs of stilt, a pair of sanderling, and at least one Pacific Golden plover were observed in the sludge basins. ACOE (1999, p. 36) relates a similar observation: "Some of the old tanks and basins [of the STP] collect water and were in use by stilts." These basins are incorrectly coded PUBHx (USFWS, 2007), the same as a pond at the south end of the pickleweed wetland (which may be an artificial excavation).

Lower Pearl City Peninsula

There are no wetlands around the developed southern end of Pearl City Peninsula (ACOE, 1999), although an occasional mangrove might be growing at the shore. South of the Middle Loch pier at the end of Lanakila Avenue, the NWI (2007) shows a near shore coded E2EM1N (estuarine intertidal persistent emergent vegetation regularly flooded) at the shore, fronted by an E2ABM (estuarine intertidal aquatic bed irregularly exposed). This connects to or becomes a short mangrove shore (E2SS3N) at the south end. The feature is a reef remnant (or other antecedent platform) for which E2ABM (algal bed) seems correct within Pearl Harbor. The shore is a seawall with a small beach, so E2EM1N has no meaning.

West Shore, East Loch

Directly north of a Naval pier facility (Bldg. 992) on the eastern side of the peninsula occurs an extensive mangal [ID ..6102] running northward along the shore to the Navy property fence. On Navy property, the width of this forest reaches 140 m (450 ft). This mangal extends to and beyond the mouth of Waimanu Stream, where the mangrove extends inland up the channel some 160 m (540 ft; see Chap. 5).

This wetland is described in ACOE (1999, p. 31):

> The Navy property on this portion of the peninsula has been built up by at least 5 feet of fill. There is a large nonwetland area consisting primarily of construction debris and fill on the southern end of the forest. ... [T]he forest of American mangrove rises 50-70 feet high and extends from the base of the [fill land] slope to the ...shoreline. Remnant patches of sea purslane can be found landward of the forest. These are likely to be the areas of the former backshore areas prior to colonization by mangroves.
>
> Behind the warehouses ...[now just concrete slabs], this wetland contained ponded water 4-10 inches deep and schools of mosquitofish *(Gambusia affinis)* were observed. Blackened leaves covered the bottom. A scorpion was observed in the ponded water area outside Building 72 (middle warehouse).

Navy property here extends to Waimanu Stream, although a large, private, plant nursery operation covers the parcel north of the Navy security fence between Lehua Avenue and the East Loch shore. A portion of the mangrove wetland (ID ..6103) bordering the plant nursery has been removed and the

operation expanded across landfill in what was indicated as wetland by the ACOE in 1999 (ACOE, 1999).

The mangal at the East Loch shore is coded in the NWI (USFWS, 2007) as E2SS3N: estuarine intertidal broad-leaved scrub-shrub, regularly flooded wetland, although a more accurate coding would be E2FO3N. The new NWI maps show the portion lost to fill. The NWI maps (USFWS, 2007) show the estuary of Waimanu Stream as E1UBL (same as East Loch Pearl Harbor) extending up to the H-1 viaduct. Four large wetlands depicted inland and to the west on Navy land and coded PEM1KFh (USFWS, 1999) now have been removed from the inventory. However, an extensive area inland of the mangal on the east side of the stream is shown and coded E2EM1N: estuarine persistent emergent herbaceous vegetation, regularly flooded wetland (see Chap. 5).

Tables 4-01 and 4-02 summarize biological observations (fauna and flora, respectively) made in 2006-7 at various wetlands located in the upper Middle Loch and Pearl City Peninsula areas. Table 4-03 summarizes differences between what was reported for this area as present and surveyed in 1999 (ACOE, 1999) and our 2006-7 field observations.

Table 4-01. Aquatic biota listing for upper Middle Loch wetlands.

Species listed by family	Common name	Notes	..6080 (a)	..6111 (b)	..6113	..6120	..6121	..6124	..6125	..6285
	INVERTEBRATES									
MOLLUSCA, GASTROPODA										
THIARIDAE										
Melanoides tuberculata	Melanid snail					C				
ARTHROPODA, INSECTA										
ODONATA										
AESHNIDAE										
Anax junius	Green darner								U	
LIBELLULIDAE										
Crocothemis servillia	Scarlet skimmer			U			U	U	U	
Tramea lacerata	Black saddlebags					R				R
COENAGRIONIDAE										

Table 4-01. Aquatic biota listing for upper Middle Loch wetlands.

Species listed by family	Common name	Notes	Wetland ID No. ..6080 (a)	..6111 (b)	..6113	..6120	..6121	..6124	..6125	..6285
Ischnura ramburii	Rambur's damselfly			U	R				U	
	VERTEBRATES									
PISCES (fishes)										
CICHLIDAE										
Cichlasoma nigrotasciatum	Convict cichlid								O	
Oreochromis mssambicus	Mozambique tilapia					U				
Sarotherodon melanotheron	Black-chin tilapia							O	C	
GOBIIDAE										
Awaous guamensis	*'o'opu nakea*			R						
POECILIIDAE										
Poecilia mexicana	Mexican molly			C				O	C	
AVES (birds)										
ARDEIDAE										
Bulbucus ibis	*Cattle egret*								R	
RECURVIROSTRIDAE										
Himantopus mexicanus knudseni	*Ae'o*		U							
RALIIDAE										
Gallinula chloropus sandwicensis	*'Alae 'ula*								R	
SCOLOPACIDAE										
Arenaria interpres	*'Akekeke*		U							

KEY TO SYMBOLS USED IN TABLE: 4-01

Abundance categories:
- R – Rare – only one or two individuals seen.
- U – Uncommon – several to a dozen individuals observed.
- O – Occasional – regularly encountered, but in small numbers.
- C – Common - Seen everywhere, although generally not in large numbers.
- A – Abundant – found in large numbers and widely distributed.
- P – Present – noted as occurring, but quantitative information lacking.

Notes:
- (a) Includes ..6080 and ..6081.

- (b) Shallow, flooded area north side of bike path near ID ..6111.
- (c) Outflow channel from springs and watercress ponds at bike trail.

Table 4-02. Flora listing for Middle Loch, Pearl City Peninsula, and other selected Chapter 4 wetland sites.

Species listed by family	Common name	Notes	Wetland ID No. ..6120	..6121	..6124	..6125	..6285 (a)
ARECACEAE	(palms)						
Cocos nucifera	*niu*	(1)				U	
ASTERACEAE							
Pluchia carolinensis	sourbush	(1)	O			O	
Pluchea indica	Indian sourbush	(2)	C		O	U	U
Pluchea X fosbergii	sourbush hybrid	(1)	O		U		U
Sphagneticola trilobata	wedelia	(1)				O	
BATACEAE							
Batis maritima	*'äkulikuli kai*			**A**			
CONVOLVULACEAE							
Ipomoea alba	moon flower	(1)			O		
CYPERACEAE	(sedges)						
Cyperus involucratus	umbrella sedge					A	
Cyperus polytstachyos	---					A	
Schoenoplectus sp.	bulrush		O				
FABACEAE							
Leucaena leucocephala	*koa haole*	(1)	U		O	U	**A**
Macroptilium atropurpureum	---	(1)			U		
Prosopis pallid	*kiawe*	(1)	U		C		C
GOODINACEAE							
Scaevola sericea	*naupaka*	(1)					A
LEMNACEAE							
Lemna sp.	duckweed					U	

Table 4-02. Flora listing for Middle Loch, Pearl City Peninsula, and other selected Chapter 4 wetland sites.

			Wetland ID No.				
Species listed by family	Common name	Notes	.6120	.6121	.6124	.6125	.6285 (a)
MORINGACEAE							
Moringa oleifera	horseradish tree	(1)				U	
MYRTACEAE							
Syzygium cumini	Java plum	(1)					U
NYMPHAEACEAE							
Nymphaea sp.	water lily		A				
ONAGRACEAE							
Ludwigia octovalvis	*kamole*					R	
POACEAE							
Cenchrus ciliaris	buffel grass	(1)					**A**
Cynodon dactylon	Bermuda grass	(1)				C	
POACEAE (cont.)							
Urochloa maxima	Guinea grass	(1)					U
Urochloa mutica	Calif. grass		**A**		**A**	C	**A**
PONTEDARIACEAE							
Eichhornia crassipes	water hyacinth					C	
SCROPHULARIACEAE							
Bacopa monnieri	*ʻaeʻae*		U			U	
TYPHACEAE							
Typha latifolia	cat tail		C		C	A	**A**

Notes:
(a) Kolea Cove wetland lies on the boundary and is included in this table, but is discussed in Chap. 3.
(1) Typically not a vegetation of wetland, but growing around margin.
(2) Marginal vegetation member; more typically growing close to wetland.

Table 4-03. Summary of Changes Since 1999

Site	Description	Change since 1999	ACOE ID
Kolea Cove	Mitigation wetland	Much overgrown with loss of biological wetland functions.	**..6285**
Middle Loch, northwest shore wetlands	Shoreline mangal.	Significant portions of mangrove have been removed.	..6077, **..6079, ..6082**, and **..6083**
Waiawa Springs	Numerous ponds/diked enclosures used for watercress production.	Many have been abandoned or are overgrown; ..6125 reduced by fill.	**..6104 to ..6120 and ..6122 to ..6125**
Bikeway drainage ditch	Depression overgrown with *Batis*.	Unchanged.	**..6121**
Waiawa Unit, NWR	Man-made wildlife ponds.	Unchanged; although fronting mangrove removed (see ..6079).	**..6080. ..6081**
Waiawa wetlands	Remnant low areas on flood plain.	More overgrown with elephant grass.	**..6098 through ..6101**
Former WWTP site	*Batis* wetlands and playa	Unchanged	**..6084 through ..6086**
Waiawa Stream estuary	Mangal.	Unchanged	**..6087, ..6088**
Drainage ditch	Narrow, mangrove-lined channel	Unchanged.	**..6098, ..6097, ..6093 through ..6096, ..6287**
Middle Loch east shore	Narrow shoreline mangrove bands,	Unchanged.	**..6090, ..6091, ..6092**
Northwest shore of East Loch	Shoreline mangal	Portion appears to have been filled.	**..6102, ..6103, ..7270**

Note: ID numbers in bold are jurisdictional wetlands; others are not.

Following are supplemental photographs (SP) for Chapter 4.

SP4-01 (above): One of the small pond wetlands (ID ..6124) fed by spring water in the Waiawa area showing how vegetation such as cattail and California grass can completely overgrow a freshwater wetland.

SP4-02 (above): Another pond (ID ..6120) in the same area as photo above. Because of a deeper basin and perhaps more recent use, the open water is not yet obliterated by California grass (growing out onto water surface from right).

SP4-03 (above): Salt encrusted soil at north end of the playa (ID ..6084) at the abandoned Pearl City WWTP.

SP4-04 (above): The abandoned sludge drying pits at the Pearl City WWTP are large concrete depressions that collect rainwater, support wetland plants (*Batis maritima*), and are visited by foraging Hawaiian stilt.

Chapter 5

North Shore of East Loch: Waiau to Kalauao Stream

The shoreline of most of the north shore of East Loch (Fig. 5-01) rises abruptly although only to about 6 ft (2 m) or so above sea level, the result of a long history of reclamation of tidal lands. However, in terms of physical requirements for wetlands, this area is comparable to the north shore of Middle Loch (Chap. 4) with numerous springs discharging inland from the shore, creating freshwater streams and wetlands. The entire area was once more extensively covered by wetlands that extended well inland of the harbor shore. Today, these wetlands are much reduced in area because highway and land development have encroached on the margins or completely filled them in, and outlet streams have been realigned and confined to narrow, man-made channels. Development in this area gradually shifted away from agriculture (rice in the early 20th century, later watercress) to commercial and industrial. A history of the lands around Waiau is reviewed in Coles (1979). The north shore of East Loch corresponds to ACOE (1999) Segment 7.

The Pearl City bikeway and state energy corridor (former OR&L right-of-way) is located closer to the shoreline of Pearl Harbor than any roads or highways and is adjacent to or traverses many of the wetlands in this area. There are no U.S. Navy wetlands in this segment.

Pearl City Stream (aka Waimanu Stream)

Pearl City Stream at one time flowed between the wetlands associated with Kalua'o'opu Springs and Loko Kukono Springs to the HECO west end outlet weir (see below). In 1961, the stream was redirected into a new channel from the grounds of the former Hale Mohalu Hospital to an outlet along the shore 200 m (700 ft) further to the west (*AECOS*, 1994).

The stream flows in a lined channel from above Kamehameha Highway (State Rte. 99), under the H-1 Freeway and adjacent bikeway, and then into a soil bermed channel to Middle Loch. Vegetation in the streambed and on the banks include primrose willow, California grass, umbrella sedge, *'ape*, Guinea grass, castor bean, spiny amaranth, *koa haole*, scarlet-fruited gourd, Java plum, *kiawe*, and monkey pod. The only fish observed in the stream were tilapia (*Sarotherodon melanotheron*). Just *mauka* of the bikeway, the salinity in Pearl City Stream was 0 ppt (measured in the afternoon of 12/7/06).

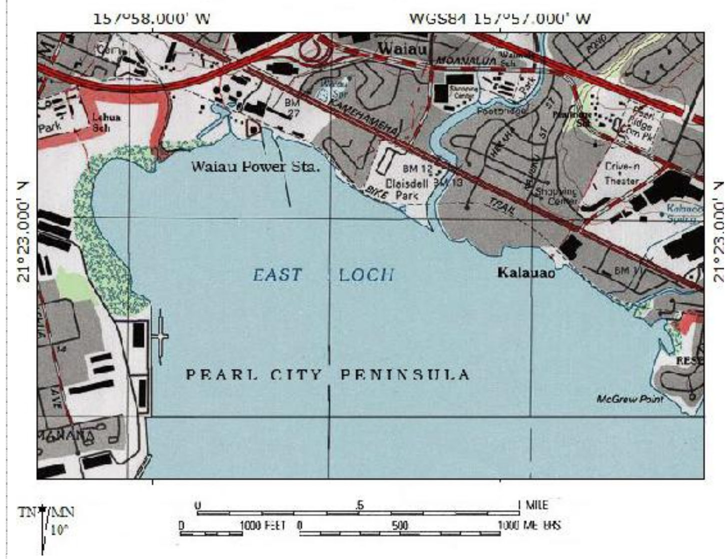


Figure 5-01. Topographic map of area of Pearl Harbor covered by Chapter 5 (the Pearl City Peninsula on left is covered in Chapter 4).

An extensive mangal (ID ..6103 and ..7270) is present along the shoreline west and east of the outlet of Pearl City Stream into East Loch. This growth extends southward to a Navy pier facility (Chap. 4). To the east, Hawaiian Electric (HECO) is removing mangroves fronting the Waiau Power Station.

The land north of the mangrove belt (ID ..6103) and west of Pearl City Stream is possibly Navy property and is bounded by a high security fence. ACOE (1999) indicated this as not Navy property and showed four wetlands present (ID ..6251 to ..6254), the arrangement and shapes of which suggest an abandoned agricultural (taro or watercress) complex. We were unable to locate this area because of access problems, including a dense growth of grasses.

The NWI maps (USFWS, 2007) show the estuary of Pearl City Stream as E1UBL (same as East Loch Pearl Harbor) and depict a very extensive area inland of the mangal on the east side of the stream coded E2EM1N: estuarine persistent emergent herbaceous vegetation, regularly flooded wetland. We are suspicious, based on aerial photographs, that a wetland indeed is present in this area, although the ACOE inventory indicated nothing behind the coastal mangrove (ID ..7270; ACOE, 1999) and have roughly delineated the area (assigned ID .. 7269) which appears to connect eastward with the HECO West Outlet. Unfortunately, the property proved difficult to access because it is private and HECO Waiau Power Station bounds the east side. The mangal along the East Loch shore in this area extends nearly to the HECO discharge point and was correctly coded E2FO3N: estuarine intertidal, regularly flooded, broad-leaved evergreen forest (USFWS, 1999), but was changed recently to E2SS3N.

Figure 5-02. Satellite view of northwest corner of East Loch in the vicinity of the HECO Waiau Power Station showing features discussed in text.

Waiau Pond (Kalua‘o‘opu Spring and Waiau Marsh)

Waiau Pond is located on the grounds of the HECO Waiau Power Station and once served as the cooling water intake basin for the power plant. The pond was dredged out mostly in the 1940s. This basin was fed by numerous springs and associated wetlands (known as Kalua‘o‘opu, Loko Kukono, and Pu‘ukapu) located behind the shoreline to the west of the plant, with the outflow from these springs directed eastward in a channel dug behind the East Loch shoreline. Water supply for cooling purposes was supplemented by artesian wells constructed in 1938 and excess water escaped over an outlet weir at the

shore. The cooling water discharge (from the plant) went to the channel that is now the east end outlet of the pond (Coles, 1979).

Waiau Pond is an open body of water surrounded on the north, east, and south by walls and bulkheads of the HECO facility. The wetland consists of an open water pond (see photo SP5-07), almost half of which supports tape grass (*Vallisneria spiralis*)—a submerged aquatic plant that is widely used in the aquarium trade and also eaten as a vegetable. During a survey in 2001 (*AECOS*, 2002), the vegetation of the wetland was found to be mostly cattail (*Typha* sp.) and California grass (*Brachiaria mutica*), but the ACOE (1999) found primarily tape grass. HECO regularly manages the pond by removing water hyacinth (*Eichhornia crassipes*) and other vegetation.

The clarity of the water was excellent at the time of our visit, although the bottom is mostly a fine silt deposit that clouds the water if disturbed. The pond depth is over 3 ft (1 m). Tilapia (*Sarotherdon* sp. and mollies (*Poecilia mexicana*) are abundant at least along the edges of the pond. Flume clams and crayfish burrow in the bottom of the pond. During December 2006, several different types of water birds were seen foraging and resting in the pond, including the endangered Hawaiian stilt (*Himantopus mexicanus knudseni*) and indigenous *‘auku‘u* (*Nictycorax nictycorax hoactli*). David (2001) reports results of avian surveys in the pond and includes a single sighting of a Hawaiian duck/mallard hybrid (*Anas wyvilliana* x *platyrhynchos*). Coles (1979) reported observing a Hawaiian coot (*Fulica americana alai*) in a part of the wetland that no longer exists. The salinity in the Waiau Ponds was 0 ppt throughout, as measured in several places on the afternoon of 12/6/06.

Waiau Pond as it presently appears is clearly not a wetland; the delineation manual (ACOE, 1987, p. 14) defines as “vegetated shallows” of “deepwater aquatic habitat” areas less than 6.6 ft (2 m) deep that support only submerged aquatic plants. Boundaries of the pond include bulkheads of concrete and a wall of vertical wood piles, in addition to shoreline areas that appear to have been dredged in soil or fill. Weir gates and boards enable HECO to manipulate water level in Waiau Pond, allowing for management options in terms of controlling invasive plants and regulating water depth. This maintenance does present a problem in defining the wetland status in as much as the ACOE manual includes in the definition of wetlands the phrase “under normal circumstances” to cover situations where removal or alteration of emergent vegetation impacts on the delineation mechanism. The absence of emergent vegetation in some parts of the pond would seem to be largely the result of human activities, and ACOE (1999) delineated the western half as ID ..7268.

Wetlands west of the HECO Generating Station end in the *mauka* direction more or less abruptly at the H-1 viaduct. Although the Interstate is supported on piles high above the ground in this section, any wetland features that were present within the r-o-w of the freeway were apparently filled in. The swath cut by the freeway through former wetlands here is evident in Fig. 5-02. Waimano Drainage Channel crosses under the viaduct in an open culvert, and a pipe culvert to the east drains a wetland (ID ..6255) on the north side of the freeway. This particular wetland was surveyed by Guinther (2003) and found to be fed by several springs. The wetland status of the westernmost portion is not firmly established (due to the nature of the soil), but the area was an abandoned pond field overgrown with dayflower (*Commelina diffusa*) and fed by a capped and valved freshwater spring located close to the man-made channel of Waimano Drainage Channel. The springs in this area feed pondfields (Fig. 5-03; also SP5-02) along the bike path west of the HECO Generating Station (ID ..7257 through ..7267).

Figure 5-03. Taro, ung choi, and watercress pondfields or *lo'i* (ID .. 7259 and ..7260 in foreground) utilizing spring water flowing towards East Loch on the west side of the HECO Waiau Generating Station (background). The public bike path can be seen on the left.

These ponds are indicated in the NWI (USFWS, 2007) and coded PEM1KFh: palustrine persistent emergent herbaceous vegetation, semipermanently and artificially flooded, diked impoundments (i.e, pondfields).

Waiau Spring and Wetland

Waiau Spring arises some 1300 ft (410 m) inland of the shore and its perennial discharge, Waiau Stream, flows through small watercress (*Nasturtium microphyllum*) and taro plots and then a pond and wetland (ID ..7128) before entering a concrete culvert under Kamehameha Highway (State Rte. 99) and then a narrow channel on the east side of HECO's Waiau Power Station. This remnant wetland (see photo SP5-01) can be observed from the Zippy's parking lot off Kamehameha Highway or from an access road at the intersection of Kuleana Road and Kuleana Place. A concrete culvert curves around the east side of the wetland and directs drainage from the H-1 Interstate/Moanalua Road interchange past Zippy's to a culvert under Kamehameha Highway. The wetland appears to be mostly overgrown with California grass, water hyacinth, and umbrella sedge, with small pond field areas of ung choi and taro. Open water (primarily at the south end) supports the tape grass (*Vallisneria*), a submerged aquatic plant, which we observed being harvested.

The drainage channel below Kamehameha Highway is unlined and has a natural rock bottom, but it is clearly shaped by man-made landscape features. It seems likely that this is not the original bed of Waiau Stream, although it has probably served as the drainage outlet for Waiau Spring since the HECO Generating Station was constructed in the 1930s. It is possible that outflow from Waiau Spring originally fed into the complex of ponds and wetlands to the west of the power plant (*AECOS*, 2002). Waiau Stream flows through a culvert under the Pearl City bikeway and into a mangrove belt (ID ..7131) along the northern shore of East Loch.

Makai of the bikeway, the east side of the channel is lined with mangrove and also has Indian fleabane and *koa haole* growing on the upper banks. The stream harbors mostly tilapia (*Sarotherodon melanotheron*), flume clam, and the endemic *aholehole* (*Kuhlia xenura*), which was common. Just *makai* of the bikeway, the salinity in Waiau Stream was 0 ppt and off the East Loch shoreline west of the stream mouth the salinity was 5 ppt (measured at 9 am on 12/1/06).

Mangroves once present along the shore to the west of the mouth have been removed (see photo SP5-03). Scattered colonization by red mangrove occur all along the shore between the Waiau Generating Station and Neal S. Blaisdell Park. Those clusters (ID ..7129 & ..7130) directly fronting the east end of the

HECO facility were removed and the land along the bike path to the shore made into a well-maintained wayside park. A mangal (ID ..7131 in part) is present east of the drainage from Waiau Spring and (ID ..7132) along the shore opposite the eastern end of Kaluamoi Drive. All of the others (ID .. 7133, ..7271 through ..7174) fronting and west from Blaisdell Park have been removed. Effort is underway to clear ID ..7132.

The wetland around Waiau Spring is indicated by the NWI (USFWS, 2007) as consisting of two parts coded E1UBL (estuarine subtidal unconsolidated bottom) and E2USN (estuarine intertidal regularly flooded unconsolidated shore). Although possibly a close call given that the vegetation (formerly cattail) is regularly removed from the unconsolidated shore, the pond is fed by springs that flow year-round, so this feature is more likely to fall under the definition of a palustrine environment as it was previously identified (USFWS, 1999).

No wetlands are indicated to the east of the HECO facility on the NWI map (USFWS, 2007) other than small mangrove clusters (ID ..7131 and ..7132) shown as E2SS3N: estuarine, intertidal regularly flooded, broad-leaved evergreen scrub-shrub.

Waimalu Stream and Estuary

Waimalu Stream is tidal at least up to the H-1 Interstate and concrete lined from Kamehameha Highway to well upslope of the Interstate. Englund, et al. (2000) suggest tidal influence extends to the USGS gauge at the upper end of the concrete-lined channel, and reported fresh water by the H-1 viaduct, and salinities ranging from 32 to 37 near the stream mouth. The estuary is unlined (although channelized) below Kamehameha Hwy. and the banks support red mangrove from the highway bridge down to the bike trail bridge (ID ..7134 through ..7139), a distance of approximately 450 ft (140 m), and a large stand of mangrove (ID ..7145) on the west (right) bank extending another 450 ft to the mouth of the stream at East Loch. A narrow band of mangrove lines most of the east bank as well (ID ..7146 to ..7151). Wetlands misidentified by ACOE (1999) as ID ..7135 and ..7137 are large *kiawe* trees along the west bank of the estuary.

The west side of the delta of Waimalu Stream is a wetland (Fig. 5-04; ID ..7140) covered by a monotypic stand of pickleweed, with the large stand of mangrove on Waimalu estuary (ID ..7145; east side) and along much of the harbor side (ID ..7142 to ..7144). The inland boundary of this wetland is defined by the bike trail as it passes through Neal S. Blaisdell Park in Pearl City.

This area (especially the adjacent mangal) is utilized by homeless persons that have set up camps in and adjacent to the Park. In the wetland, rock-walled planters have been constructed to grow ornamental and food plants. Two such planters are visible in Fig. 5-04: one on the far left with a small palm tree, and one on the right close to the mangroves, where ti plants and squash or cucumber plants are being tended (see also photo SP5-04).

Fig. 5-04. Wetland (ID ..7140) at Neal S. Blaisdell Park in Pearl City. The estuary of Waimalu Stream lies beyond the mangal (ID ..7145) in the back; East Loch is beyond mangal (ID ..7142) on right.

The NWI maps (USFWS, 2007) indicate only that the estuary of Waimalu Stream is E1UBL: estuarine subtidal unconsolidated bottom; and there are areas of mangrove along the estuary and at the mouth coded E2SS3N. The larger mangals should be E2FO3N: estuarine, intertidal regularly flooded, broad-leaved evergreen forest.

Drainage Ditch at Harbor Center

Harbor Center is located at the end of Hekaha Street. This area drains through underground culverts that appear to empty into a small inlet at the shore of

East Loch some 220 ft (70 m) east of the Waimalu Stream mouth. A portion of this drainage system includes open ditches on either side of Hekaha Street along the south side of the bike path. These ditches are apparently tidal, and support small wetlands (ID ..7152), dominated in one case by seashore paspalum (*Paspalum virginicum*) with a sparse growth of pickleweed, and pickleweed, mangrove, and Indian fleabane in the other case (Fig. 5-05).

Figure 5-05. Drainage ditch along bike path adjacent to Harbor Center (left) in Pearl City (Hekaha Street at stop sign).

A drainage ditch drains Kamehameha Highway in front of Cutter Ford (98-015 Kamehameha Highway, Aiea, HI), flowing into Waimalu estuary. This ditch supported only Indian fleabane at the time it was inspected (10/25/06); grass in the ditch appeared to have been killed by standing water. This ditch is likely to be dry much of the time, and, unlike the ditch along the bike path, is not reached by the tide and would not be jurisdictional.

The tidal drainage ditches on the *mauka* side of Harbor Center are connected by an underground culvert to an outlet along the shore opening into a small inlet just east of the mouth of Waimalu estuary. Another long drainage ditch (ID ..7275) is present along the east boundary of Harbor court.

Kalauao

The shoreline of East Loch between the outlets of Waimalu and Kalauao streams is partly hardened with walls and massive boulders and partly eroded, with narrow, sand and/or rubble beaches. Red mangrove appears mostly as scattered shrubs taking hold on boulder and sand shorelines (ID ..7047, ..7048, and ..7153 through ..7159, and ..9040; see photos SP5-05 and SP5-06). One grouping has formed a mangal wetland (ID ..7158 and ..7159) marginal to an old iron pier and an unnamed drainage outlet east of an auto wrecking yard. The others are jurisdictional by virtue of being tidal, but are small patches on boulder substrata. Extensive mangal along the shore is present off the outlets from Kalauao Spring and nearby Kalauao Stream.

Figure 5-06. Sumida Farm: watercress farming in pond fields. Only the downstream or *makai* end of an extensive growing area is shown here.

Kalauao Spring and Sumida Farm ~ Kalauao Spring is one of the many large springs that issue from the bedrock inland of the shore of East Loch. In this case, the spring issues forth *mauka* of Kamehameha Highway (State Rte. 99) in a low area surrounded by the Pearl Ridge Shopping Center and the water is utilized to support extensive wetland watercress farming at Sumida Farms

(Fig. 5-06, above). In 1964, the maximum width of the spring area was 244 m (800 ft), extending to the south side of Kamehameha Highway (Visher and Mink, 1964).

Outflow from the pond fields is directed into a concrete-lined culvert that also receives intermittent flow from a stream draining Pearl Country Club. The stream feeds into a small estuary west of the mouth of Kalauao Stream. Salinities in the estuary and in the watercress area were measured at 2-3 ppt by Englund, et al. (2000).

Pearl Kai Mitigation Wetland ~ ACOE (1999) relates the following concerning this area:

> Department of the Army permit number PODCO 1987 was issued to the developer of the Pearl Kai Shopping Center for the placement of fill in the wetlands. To account for the flood storage wetland function, the shopping center's building closest to [Kalauao Stream] was built on posts. As additional mitigation for placing fill in the wetland, mangroves were removed and a wetland pond and nesting island were constructed (Figure 35). Wetland vegetation at the site area includes *Cyperus difformis, Paspalum conjugatum, Cyperus polystachyos,* water hyssop, California grass, umbrella sedge, and mangrove…

Unfortunately, although the wetland was located along the bikeway, it no longer resembles the photograph provided by ACOE (1999, Fig. 35). It is our belief that a much overgrown wetland wedged between the bike path and the south side of the unnamed estuary (ID ..7038) is this mitigation wetland. A small area of shaded open water is visible from the bikeway side of the fence, but most of the wetland is obscured by California grass.

The pond fields of Sumida Farm are correctly coded (USFWS, 2007) PEM1KHh: palustrine emergent persistent herbaceous vegetation, permanently and artificially flooded, diked impoundment. The mitigation wetland is coded E2EM1N: estuarine intertidal persistent emergent herbaceous vegetation regularly flooded wetland. This feature is more likely a palustrine wetland environment given the vegetation present and an artificially dredged or diked one.

Kalauao Stream ~ Kalauao is a long stream that drains the Koʻolau from the ridgeline, flowing to East Loch along the western margin of ʻAiea. The stream is tidal most of the way upstream to the Kamehameha Highway viaduct. Buildings adjacent to this estuarine segment are separated from the stream by low retaining walls, but the stream probably experiences significant flooding as some of these buildings are built on pilings. Englund, et al. (2000) mentions

that one building on pilings adjacent to the stream "was unfortunately built directly over [a] large spring."

Mangrove dominates the left bank and *milo* trees and Indian fleabane bushes are scattered throughout the area. However, the right bank has been cleared of all trees from the mouth to Kamehameha Highway. Only a small patch of pickleweed and mangrove seedlings are growing on shoaled areas along this side of the estuary. Tilapia (*S. melanotheron*) are abundant. Just *mauka* of the bikeway, the salinity in the estuary was 20 ppt (measured in the afternoon of 12/7/06). Englund, et al. (2000) recorded salinities ranging from 7 to 12 ppt in the stream channel, and 7 to 9 ppt at the spring outlet on the surface and 27 ppt at 0.3 m (1 ft) depth.

The only coastal wetlands shown by USFWS (1999) in the NWI east of Waimalu Stream are mangroves at the mouth of Kalauao Stream, indicated as E2SS3N: estuarine, intertidal regularly flooded, broad-leaved evergreen scrub-shrub. More applicable to mature mangrove stands would be E2FO3N.

Not far beyond the mouth of Kalauao Stream is McGrew Point, a Naval housing area covered in Chap. 6.

Tables 5-01 and 5-02 summarize biological observations (fauna and flora, respectively) made in 2006 at various wetlands located in the upper East Loch a area. Table 5-03 summarizes differences between what was reported for this area as present and surveyed in 1999 (ACOE, 1999) and our 2006-7 field observations.

Table 5-01. Checklist of aquatic biota observed in upper East Loch wetlands.

Species listed by family	Common name	Notes	Wetland ID No. .7036	.7128	.7145	.7049	.7275
				(a)	(b)		
INVERTEBRATES							
MOLLUSCA, GASTROPODA							
THIARIDAE							
Melanoides tuberculata	Melanid snail			A			
MOLLUSCA, BIVALVIA							
CORBICULIDAE							
Corbicula fluminea	Flume clam			A			
OSTREIDAE							
Crassostrea virginica	American oyster		A				U
ARTHROPODA, CRUSTACEA							
CAMBARIDAE							

Table 5-01. Checklist of aquatic biota observed in upper East Loch wetlands.

Species listed by family	Common name	Notes	Wetland ID No. 7036	7128 (a)	7145 (b)	7049	7275
Procambarus clarki	American crayfish			C			
GRAPSIDAE							
Grapsus tenuicrustatus	Rock grab		C				C
PORTUNIDAE							
Scylla serrata	Samoan crab				O		
VERTEBRATES							
VERTEBRATA, PICES							
CICHLIDAE							
Sarotherodon melanotheron	Black-Chin Tilapia		A	A	A	C	
KUHLIIDAE							
Kuhlia xenura	*Aholehole*			C			
MUGLIDAE							
Mugil cf. *cephalus*	mullet				C		
POECILIIDAE							
Poecilia mexicana	Mexican Molly		C			C	
VERTEBRATA, AMPHIBIA							
RANIDAE							
Rana catesbeiana	Bullfrog			O			
Rana catesbeiana	Bullfrog (tadpoles)			C			
VERTEBRATA, AVES							
ARDEIDAE							
Nycticorax nyticorax hoactli	*'Auku'u*		R				

KEY TO SYMBOLS USED IN TABLE 5-01:

Status:

Nat – naturalized – A n introduced or exotic species.

Ind – indigenous – A native species also found elsewhere in the Pacific.

Abundance categories:

R – Rare – only one or two individuals seen.

U – Uncommon – several to a dozen individuals observed.

O – Occasional – regularly encountered, but in small numbers.

C – Common – Seen everywhere, although generally not in large numbers.

A – Abundant – found in large numbers and widely distributed.

P – Present – noted as occurring, but quantitative information lacking.

NOTES:

(a) Includes stream down to bike path.

(b) Includes other mangrove areas along Waimalu estuary.

Table 5-02. Flora listing for Upper East Loch wetlands.

Species listed by family	Common name	Notes	Wetland ID No. 7037	7042	7132	7140	7152	7275
ACANTHACEAE	(palms)							
Asystasia gangetica	*Chinese violet*	(1)			U			
ASTERACEAE								
Bidens pilosa	beggartick	(1)				U		
Pluchia carolinensis	sourbush	(1)		O				
Pluchea indica	Indian sourbush	(2)		O	C	O	O	C
Sphagneticola trilobata	wedelia	(1)		C				
Tridax procumbens	coat buttons	(1)				U		
BATACEAE								
Batis maritima	*'äkulikuli kai*		**A**			**A**	**A**	A
CYPERACEAE	(sedges)							
Cyperus involucratus	umbrella sedge			C	O			
FABACEAE								
Desmanthus purnambucanus	virgate mimosa	(1)			U			
Leucaena leucocephala	*koa haole*	(1)		C				R
Pithecellobium dulce	*'opiuma*	(1)		U				
Senna surattensis	*kolomana*			R				
MALVACEAE								
Sida ciliaris	---	(1)				U		
Sida rhombifolia	---	(1)				U		
Thespesia populnea	milo	(1)			C	O		
NYCTAGINACEAE								
Boerhavia coccinea	false alena	(1)				R		
POACEAE								
Bothriochloa pertusa	pitted beardgrass	(1)				O		
Cenchrus echinatus	sandbur	(1)				U		
Chloris sp.	finger grass	(1)				O		

Table 5-02. Flora listing for Upper East Loch wetlands.

Species listed by family	Common name	Notes	Wetland ID No. .7037	.7042	.7132	.7140	.7152	.7275
Paspalum virginicum		(1)					C	C
Sporobolus sp.	---	(1)				O		
Urochloa mutica	Calif. grass			A				
POLYGONACEAE								
Coccoloba uvifera	sea grape							R
RHIZOPHACEAE								
Rhizophora mangle	red mangrove			O	(a)	O	O	O

Notes:
(a) Mangroves recently removed.
(1) Typically not a vegetation of wetland, but growing around margin.
(2) Marginal vegetation member; more typically growing close to wetland.

Table 5-03. Summary of Changes Since 1999

Site	Description	Change since 1999	ACOE ID
Northwest shore of East Loch	Shoreline mangal	Portion appears to have been filled since 1999.	**..6103**
North shore of East Loch	Shoreline mangal	Mangroves removed in front of HECO Waiau Plant.	**..7270**
Abandoned pondfields	Four diked ponds presumably used for watercress or taro production.	Abandoned before 1999.	**..6251 to ..6254**
Pondfields north of H-1	Spring-fed, diked ponds used for watercress or taro production.	Still in use.	**..6255**
Pondfields south of H-1	Spring-fed, diked ponds used for watercress or taro production.	Most still in agricultural use.	**..7256** through **..7267**
Waiau cooling water pond.	Spring-fed, diked pond(s).	Emergent vegetation lacking.	..7268
East of Pearl City	Palustrine wet area(s).	Only ..7258 seen in	**..7258, ..7269**

Table 5-03. Summary of Changes Since 1999

Site	Description	Change since 1999	ACOE ID
Stream.		1999.	
Shoreline mangrove east from Waiau to Blasdell Park.	Isolated mangrove copses and mangal.	Most or all of the mangrove has been removed	..7129, ..7130, **..7131**, ..7132, ..7133, and ..7271-76
Waiau wetland north of Kamehameha Hwy.	Spring-fed wetland with pondfields.	Small agricultural plots.	**..7128**
Blaisdell Park	Mangrove and pickleweed flat.	Mangrove growth consolidated into mangal.	**..7140, ..7144, ..7145**
Kalauao Spring	Sumida Watercress Farm,	Commercial use continues.	**.7049**
Harbor Center	Drainage ditches.	No change.	**..7152, ..7275**
Mangroves, Waimalu Stream to Kalauao Stream	Isolated mangrove copses and some mangal areas.	Some consolidation, other growths are too small to regard as wetlands.	**.7035-8,** ..7040, **..7041, 7043,**.7047-8, ..7053-6, **..7057-9,** ..7283
Pearl Kai wetland	Mitigation wetland.	Generally overgrown.	**..7042**

Note: ID numbers in bold are jurisdictional wetlands; others are not.

Following are supplemental photographs (SP) for Chapter 5.

SP5-01 (above): The small wetland (ID ..7128) fed by Waiau Spring is adjacent to Zippy's on Kamehameha Highway and supports local wetland gardening.

SP5-02 (left): Outlet of the pipe that caries water from springs located north of the H-1 freeway to pondfields (ID ..7266) directly west of HECO Waiau Power Station. Watercress and taro shown.

SP5-03 (left): Mangrove removal in progress along the shoreline west of Blaisdell Park.

SP5-04 (left): View from the shorerline into wetland at Blaisdell Park (ID ..7140) showing "garden" constructed of boulders in order to raise soil above the tidal influence.

SP5-05 (left): Shoreline near drainage channel (ID ..7275) is a massive boulder revetment protecting commercial property behind. Note that pickleweed, milo, and red mangrove have colonized the supratidal.

SP5-06 (left): Mangroves becoming well established on the rock revetment near the photo in SP5-05 (ID ..7153) do not constitute a wetland.

SP5-07 (left): Connecting channel between ponds at the HECO Waiau Power Station. Note long leaves of tape grass (*Vallisneria spiralis*), a submerged aquatic plant.

Chapter 6

Eastern Shore: McGrew Point to Bishop Point and Ford Island

The shoreline along the east side of Pearl Harbor is mostly developed in various piers and docks or otherwise rises abruptly from the water, the result of a long history of development and reclamation on tidal lands. Coastal property and nearshore waters in this area are entirely under control of the U.S. Navy with a few exceptions. Along with Mānana on the Pearl City Peninsula (Chap. 5) and Ford Island (see below), this part of greater Pearl Harbor is the heart of U.S. Naval Base Pearl Harbor. The east shore of East Loch corresponds to ACOE (1999) Segments 8, 9, 10, and 11. Ford Island was designated Segment 12 in the ACOE report.

Along the East Loch shore beyond Kalauao Stream mouth is a housing area on ʻAiea Kai Way consisting of several lots on fill land behind a sea wall (PODCO 1401-S) and, just beyond, the peninsula known as McGrew Point. The remnants of Loko Paʻaiau, an ancient fishpond, lie at the shore off the western side of this peninsula. The fishpond is U.S. Navy property, part of McGrew Point Navy Housing. This area *makai* of the bike path is low-lying, with mangrove trees growing right up to the back of several of the houses.

The drainage ditch along the *mauka* side of the bikeway and a pond in the backyard of a house close to Kalauao Stream (the pond connected to the stream) are coded by USFWS (2007) E1UBLx: estuarine subtidal unconsolidated bottom subtidal excavated (that is, man-made, excavated below tide level).

Loko Paʻaiau

Loko Paʻaiau is mostly overgrown with red mangrove and generally inaccessible, although a central, open water area remains, connected to an opening into East Loch at the pond's north end. The pond biota is described as follows (ACOE, 1999, p. 46):

> There were no waterbirds observed during several visits to the fishpond. Patches of monotypic stands of pickleweed occur along the shoreline and at the opening of the fishpond. However, American mangrove is the predominant vegetation in and around Loko Paaiau. Towards the edges *hau*, Guinea grass, Indian fleabane, *koa haole*, *kiawe*, and *ʻopiuma* (*Pithecellobium dulce*) are common.

Loko Pa'aiau, or at least the vegetated portion, is coded E2SS3N: estuarine, intertidal, broad-leaved evergreen scrub-shrub, regularly flooded wetland on NWI (USFWS, 2007) maps. We would argue that a more appropriate classification for mangal would be E2FO3N: estuarine, intertidal, broad-leaved evergreen forested, regularly flooded wetland (i.e., mangal).

McGrew Point Housing

Navy property known as McGrew Point Housing lies *makai* (south) of the bike path between private property along 'Aiea Kai Way and state land at 'Aiea Bay Recreation Area. East of Pa'aiau and just off the bike path was a soccer field within the McGrew Point Housing area. This field was part of recreational facilities located on low-lying ground that bounded the fishpond on the east and south. This area has been undergoing enhancement and redevelopment and the former soccer field is presently being used as a storage/staging area for the contractors. One or two drainage ditches can still be located in the area as described by ACOE (1999):

> There is a drainage ditch that exits seaward of the soccer field and adjacent to a portion of the fence. This area contains water hyssop and there is an open water connection. This area is fenced and also considered a wetland. The field is low in this vicinity and the ground was saturated at the time of visit. If the field was not maintained, it is likely that this area could revert to a wetland.

Although it is unclear how maintenance prevents the soccer field from reverting to a wetland, the boundary fence along the western edge of the field does appear to cross through wetlands fed by the drainage features and having standing water in channels inland from the former fishpond. Ongoing disturbance resulting from activities related to housing construction made establishing a wetland boundary here not possible with any certainty, but development in this area under Navy control is close to the boundary.

ACOE (1999, p. 48) also describes another area somewhere nearby at McGrew Point:

> At the shoreline on the housing side of the fence is a low lying area that is covered with pickleweed. This area was mowed between the two visits and the area is likely to be maintained. Based on the hydrology and a soil sample taken at this site, the area is a wetland.

Apparently this location was not designated (assigned a code number and mapped) or delineated by ACOE. All that could be located in 2007 was a small beach covered by pickleweed in an area near the tennis courts and used for a time as a parking lot for construction workers.

The southern and eastern sides of McGrew Point drop steeply to the shoreline in most places. Scattered small pockets of red mangrove have become established all along this shore. None of these mostly isolated mangroves is particularly well developed as mangal and therefore not regarded as a wetland, but rather as mangrove plants clinging to the jurisdictional tidal shore. However, the largest (ID ..8007) is perhaps approaching a mangal in structure. Mangrove growth on the boundary between Navy property and state property ('Aiea Bay State Recreation Area) in the northwest corner of 'Aiea Bay was assigned four separate codes by ACOE (1999; ID ..9024, ..9025, ..9026, & ..9027), although none appears to represent an actual wetland. Without intervention, these mangroves may expand and coalesce, becoming a mangal wetland.

The wetlands shown around McGrew Point on the NWI map (USFWS, 2007) are Loko Pa'aiau as noted above and a narrow belt along the entire southeast shore and in a man-made cove-like feature off the southern tip, both areas coded E2SS3N: estuarine, intertidal, broad-leaved evergreen scrub-shrub, regularly flooded wetland (presumably young mangrove plants). Open water is E1UBL: estuarine subtidal, unconsolidated bottom, the same as all of subtidal East Loch.

'Aiea Bay and 'Aiea Stream

The semi-enclosed embayment located in the northeast corner of East Loch is called 'Aiea Bay being opposite the town of 'Aiea. Features around the shore are (from west to east): McGrew Point Naval Housing, 'Aiea Bay State Recreation Area, 'Aiea Stream entering at the head of the Bay, Admiral's Boathouse, and a Navy recreation area, the north end of which lies on an unnamed point marking the southern end of the Bay.

Small areas of mangrove exist off the developed park (see ID ..9024 through ..9027 above and ID ..9029, ..9030, and ..9031) that are not wetlands. Apparently the State of Hawaii has tended to cut mangrove in this area in order to maintain an open shore and views from the park. Further to the southeast, the mangrove growth forms a mangal wetland that is or was extensive around the mouth of 'Aiea Stream (wetlands ..9032, ..9033, and ..9034). In 2007, all of the mangrove in this area was removed (Fig. 6-01). Englund, et al. (2000) sampled aquatic biota in the estuary of this stream, described as "underneath the Kamehameha Highway bridge, …the sides of this stream mouth are entirely encased in concrete." Apparently the lower section of stream receives little freshwater flow and stream mouth "was more marine in character, and surface salinities ranged from 27 to 30 ppt." Our survey noted a barracuda (*Sphyraena helleri*) in the estuary in this area.

Figure 6-01. View from ʻAiea Bay State Recreation Area across the upper end of ʻAiea Bay showing no mangrove trees present.

A small area behind the mangrove is designated as wetland ID ..9028. Inland from the northern end of the removed mangal is a drainage ditch that supports wetland plants (in January 2007, we noted duckweed on shallow pools and California grass; in July 2007, the area was heavily mowed, but supported pickleweed in the lowest section). This specific feature is indicated in the NWI as PEM1A: Palustrine emergent vegetation temporarily flooded (USFWS, 2007).

Before the extensive clearing in 2007, the mangal extended from the mouth of ʻAiea Stream along the shore to the east and then south onto Navy property (ID ..9034). When we did our first survey, we noted that a corridor had been cut through the mangrove growth to the open water of ʻAiea Bay (Fig. 6-02). This action was an initial test of the method for the complete removal of the mangal. The shoreline mangal ends a short distance beyond the Navy security fence, where isolated small mangroves are present on a concrete debris shore (Fig. 6-03).

Figure 6-02. Test cut through the mangal (ID ..9034) out to open water of ʻAiea Bay in January 2007. McGrew Point in background. This entire mangal has since been removed.

An area of mostly what appears to be concrete debris lying off the point between the Admiral's Boathouse and the Navy marina supports a growth of red mangrove shrubs (ID ..9023). Although not visited in 2007, it appears these plants represent opportunistic settlements on an artificial islet similar to the situation depicted in Fig. 6-02 and have not yet develop into a mangal wetland.

The Navy recreation area south of ʻAiea Bay includes a boating facility (yacht basin with docks) extending southward to the Admiral Carey Bridge (connection to Ford Island). A mostly coral rubble shoreline with scattered bulkheads (with a few mangrove shrubs) extends southward fronting the USS *Bowfin* Submarine Museum and USS *Arizona* Visitor Center. A small project involving mangrove removal between the two museums was undertaken by Hunt Building Co., leaseholder on the parcel between the two museum parcels.

Figure 6-03. Shoreline near the very north end of Navy property on the east side of ʻAiea Bay showing opportunistic establishment of red mangrove on concrete and boulders. Mangal in the background has since been removed.

The NWI (USFWS, 1999) did not previously indicate any wetlands present in ʻAiea Bay, but the updated inventory does (USFWS, 2007). The mangal on either side of the mouth of ʻAiea Stream is coded E2FO3N: estuarine, intertidal, broad-leaved evergreen forested, regularly flooded wetland (i.e., mangal). Open waters are E1UBL: estuarine subtidal, unconsolidated bottom, the same as all of subtidal East Loch. The area of scattered mangrove shrubs on mostly

concrete debris and sand is E2SS3N: estuarine, intertidal, broad-leaved evergreen scrub-shrub, regularly flooded wetland.

Halawa Stream

The *U.S.S. Arizona* Visitor Center is situated on the shore at the mouth of Halawa Stream, and the transport boats out to the memorial off Ford Island utilize a pier in the Halawa Estuary channel. The shore of the estuary is lined with bulkheads up to a former footbridge, further upstream of which the shore is mostly natural (*AECOS*, 1999).

Kamehameha Hwy. (State Rte. 99) crosses the estuary close to the *U.S.S. Arizona* Visitor Center, and upstream, there are no additional crossings until Salt Lake Blvd. The pedestrian crossing located just downstream of Kamehameha Highway (ACOE, 1999) has been closed and the foot bridge removed; the fuel pipeline crossing remains. Tidal influence in Halawa Stream extends upstream to the concrete footings of the Salt Lake Boulevard bridge (Englund, et al., 2000). Halawa Stream is confined to a concrete culvert upstream of Salt Lake Blvd. The following description of the area in the vicinity of the Kamehameha Highway bridges is taken from AECOS (1999):

> The stream in the project area is 30 to 40 m (100 to 130 ft) across and clearly tidal. Stream flow, *per se*, was not evident during the visits. However, areas of rock strewn mud flats on either sides of the channel (but most particularly on the north side under the highway viaducts) were exposed at low tide and submerged at high tide. The shoreline is mostly fill material in the immediate project area, with numerous functional and abandoned old pipes and drains located along the shore.
>
> Downstream (west) from the viaducts, red mangrove (*Rhizophora mangle*) forms several groves that occupy most of the shoreline, with pickleweed (*Batis maritimus*) covering the ground along the inland mangrove border and at the shore between the trees. At the mouth of the stream, concrete bulkheads line the shore. Upstream of the highway viaducts the channel widens to some 90 m (300 ft) across. The riparian zone is mostly steep banks of lateritic soils supporting scattered trees and weedy herbaceous species such as \`uhaloa (*Waltheria indica*), false alena (*Boerhavia coccinea*), little bell (*Ipomoea triloba*), plushgrass (*Chloris radiata*), and Guinea grass (*Panicum maximum*). A single cotton plant (*Gossypium* sp.) was observed in the project area. Riparian trees and shrubs present in this area include numerous kiawe (*Prosopis pallida*) and lesser numbers of koa-haole (*Leucaena leucocephala*), milo (*Thespesia populnea*), klu (*Acacia farnesiana*), ʻopiuma (*Pithecellobium dulce*), Indian fleabane (*Pluchea indica*), pink shower tree (*Cassia grandis*), monkeypod (*Samanea saman*), and Christmasberry (*Schinus terebinthifolius*).
>
> Substantial amounts of litter and flotsam, including a stripped automobile, are present beneath the highway viaducts. Stream banks are mostly soil, and vary

> from only a meter or so above high tide to over 10 meters on the south shore upstream of the project area.

A small wetland area on the left bank immediately upstream of the former pedestrian bridge was investigated in January 2007. Two wetlands are indicated by ACOE (1999) in this area and designated ..10050 and 10051. The former is an area of mangrove growing on a sand bank or bar in the estuary channel; the latter is a growth of mostly pickleweed behind the mangrove, but also includes some *milo* and Indian fleabane. This open area merges into the former channel bank. Plants growing clearly above the wetland here include Indian fleabane, *kiawe*, and Guinea grass. An area of vegetated wetland shown by ACOE (1999; ..10050 in part) between the east and west bound highway viaducts has since been removed because these highway bridges, at the time of our survey, are undergoing replacement.

The formation of stream bars at this particular place in the estuary has afforded the opportunity for mangroves to establish. The channel banks across the channel and upstream are generally too steep and rocky. The channel towards the mouth from the pipeline crossing is dredged on occasion, and this part of the estuary is one of shoreline bulkheads. The designated wetlands support obligate wetland plants as dominants, but these are growing on relatively coarse sediment deposited as a beach, and therefore not hydric soil. It is also unclear if the higher feature (ID ..10052) is intertidal, although some minimal flooding at extreme high tides might occur. ACOE (1999, p. 49-50) came to a different conclusion despite stating first that "[m]angroves can be found in other waters of the U.S. including streams, rivers, embayments and shorelines…but of themselves do not constitute a regulatory wetland." For this "wetland", the report stated "[i]n areas where there is a buildup of sediment caused by mangrove encroachment, the stream or shoreline may change from a waterway to a wetland." Soil pit sample points showed (in 1999) soil of low chroma with possible gleying. We contend that this location represents a natural sediment bar of coarse material (not soil) upon which mangroves have established, and is not a "buildup of sediment <u>caused</u> by mangroves."

Halawa estuary water quality results are provided in AECOS (1999). Surface salinities near the Kamehameha Highway bridge and in the area of the USS Arizona Memorial ranged between 30 to 37 ppt, while salinities near the Salt Lake Boulevard McDonald's ranged from 0 ppt in the weakly flowing freshwater channel to 26 to 32 ppt slightly downstream (Englund, et al., 2000).

The NWI (USFWS, 1999) showed no wetlands in or around Halawa Stream, but the small wetland described above for the left bank between the pipeline crossing and the west bound viaduct of Kamehameha Highway is now shown

(USFWS, 2007) as E2SS3N: estuarine intertidal regularly flooded, broad-leaved evergreen scrub-shrub (pickleweed and/or shrubby mangrove). The stream estuary is coded E1UBL: estuarine subtidal, unconsolidated bottom, the same as all of subtidal East Loch. The estuary is mapped as extending approximately 900 ft (300 m) upstream from Salt Lake Blvd., and a narrow band of presumably mangrove shrub is indicated along the right bank above the bend in the estuary (USFWS, 2007) .

Shipyard

Directly south of Halawa Stream mouth and extending southward along the Harbor shore are the piers and docks of the Naval Base. Only a very few scattered, short sections of shoreline are not concrete bulkhead, and therefore cannot support mangal or other vegetation. No streams exist in this area[1], and no wetlands are present. Included here is what is sometimes referred to as Southeast Loch, an embayment a part of which is the Pearl Harbor submarine base. Further south and west along the shore is the Pearl Harbor Naval Shipyard. Only at Hospital Point to the west of the shipyard is there shoreline that is not hardened by porting facilities.

ACOE (1999, p. 50) includes only the following regarding this entire area:

> Based upon a request from PACNAVFACENGCOM, we visited the shoreline from the pier near Building 478 to pier K12. The shoreline is presently covered by construction debris with *milo* occurring in the area. The top of the slope was 4-8 feet higher than the water level at the time of the visit. Because most of the area is paved or hardened, wetland hydrology and soils are not present thus these areas are not considered wetlands.
>
> The remainder of the shoreline up to South Avenue appears to be hardened with the exception of portions of the Hospital Point Housing area. We visited this site and found that the landward portions of the area drops down 2-4 feet to a coral and sand substrate. Mangrove and *milo* exist in relatively sparse clumps. This area and the shipyard area as a whole, does (sic) not contain any jurisdictional wetlands.

The NWI (USFWS, 2007) shows no wetlands on the main base, although unconsolidated shore areas (beaches) are shown.

Makalapa Crater

Makalapa Crater is a former cinder cone located east of Kamehameha Highway and west of H-1 Freeway a short distance south of Halawa Stream. Makalapa is

[1] The ACOE (1999) did locate a drainage outlet under H-1 Freeway feeding a small stream between Makalapa Drive and H-1 flowing in a natural channel to the vicinity of Radford Drive on the Naval Reservation. The ACOE concluded the stream was jurisdictional (waters of the U.S.).

one of three eruption cones located close together, the other two being Aliamanu and (Salt Lake). The eruption of these cones diverted more mauka stream flows to the east, away from Pearl Harbor. It is likely that all three once contained wetlands. Aliamanu crater floor is fully developed as a Naval Housing area. Salt Lake once held a saline pond, but this has been mostly filled for private development including a golf course which incorporates the last remants (now freshwater) of the former body of water. Most of Makalapa Crater floor remains undeveloped. A fishpond once located here (Sterling and Summers, 1978) disappeared under 30-40 ft of sediment from harbor dredging (VTN Pacific, 1977). ACOE (1999) investigated a small patch of ground supporting pickleweed and California grass, suspecting that a wetland might be present. However, no evidence of recent flooding or hydric soil indicators were found, and the team concluded the site "was a remnant patch of vegetation that at one time, may have been part of a larger wetland that no longer exists."

A stream that flows through a small neighborhood park between H-1 Interstate and Radford Drive discussed in ACOE (1999) was revisited in January 2007. The stream was flowing and seen to support small populations of several "wetland" plants (*'ae'ae*, umbrella sedge, primrose willow), but is a stream and not a wetland.

The NWI (USFWS, 2007) no longer shows wetlands in this area.

Bishop Point and Outer Pearl Harbor Entrance Channel

On the south side, the shipyard and naval base end at South Avenue. Beyond is Hickam AFB. This shoreline, from the shipyard down to and around Bishop Point, is defined by old bulkheads. South of Bishop Point is a small piece of Navy property with concrete bulkheads and docks (in part described in *AECOS*, 2002b). Two large, old concrete docks frame the Fort Kamehameha wastewater treatment plant located on another Navy parcel behind a concrete wall shoreline. There is a moderately large drainage outlet from Hickam AFB on the north side of the WWTP.

The more southerly of the old concrete docks, now abandoned and overgrown, marks the start of a broad coral reef that extends nearly 1500 ft (450 m) out from the shoreline on the east side of the Pearl Harbor entrance channel opposite Hammer Point at Puuloa (Chap. 1). The shoreline at Hickam in from the reef flat is, for the most part, a sand beach. The southern end of the beach, part of old Fort Kamehameha, supports a mangal extending in places over 400 ft (120 m) out from the beach shoreline (Fig. 6-04). This mangal wetland is opposite Seaman Avenue in Ft. Kamehameha where the road turns from

roughly N-S to E-W. This shoreline mangal is outside of the project study area and therefore was not investigated further.

Figure 6-04. Aerial view of mangrove growth extending onto the reef flat off Fort Kamehameha at the mouth of Pearl Harbor (4/11/07).

The NWI maps a change in the Pearl Harbor entrance channel with a line across the channel from the abandoned concrete dock, the inner zone being E1UBL (estuarine subtidal unconsolidated bottom) and the outer zone M1UBL (same, only marine system instead of estuarine system). The reef south of the dock is M2US2N: marine intertidal regularly flooded unconsolidated sand shore. The mangal off Fort Kamehameha is E2SS3N: estuarine intertidal regularly flooded, broad-leaved evergreen scrub-shrub (USFWS, 1999, 2007).

Ford Island

Ford Island (*Moku'ume'ume*) is an offshore island located in East Loch of Pearl Harbor that approaches, in size, the area of the Pearl City Peninsula (Chap. 4). The island is a developed part of the Naval Base at Pearl Harbor, and the shoreline reflects a long history of ramp, pier, and dock construction, bulkheads and revetments, and land fill. The interior is completely developed as an airfield, other Navy facilities of various sorts, including new Navy housing projects (Fig. 6-05).

Figure 6-05. Satellite image of Ford Island (Microsoft Corp., 2006) showing relationship to adjacent areas of Pearl Harbor and U.S. Navy facilities that completely cover the island.

In the 1999 survey of Pearl Harbor wetlands (ACOE, 1999), all of the shoreline of the island (excepting the pier and docking facilities along the east side from the southern tip to Pier F-5—*U.S.S. Missouri* berth) was carefully surveyed to ascertain if any wetlands were present. The fact that a separate Segment was devoted to Ford Island in the 1999 report suggests the Navy had a special interest at the time in whether wetland resources were present or not. The conclusion of the 1999 report (ACOE, 1999, p. 54) was that "…the [Ford Island] shoreline has many plants that are commonly found in wetlands such as pickleweed, American [red] Mangrove, Indian fleabane and *milo*. Investigation of

these areas found that hydric soils and hydrology indicators were lacking and thus, wetlands do not presently exist at Ford Island."

The latest version of the NWI (USFWS, 2007) indicates shoreline and shallow reef features and a couple of mangrove wetlands on the east shore, including one small area coded E2FO3N (a mangal) and E2EM1N (estuarine intertidal emergent vegetation regularly flooded). These look more like *kiawe* in our photographs and are not wetlands as defined by ACOE (1987).

Ford Island was not surveyed for our report for the reason that neither ACOE nor USFWS (1999) recorded any wetlands on Ford Island or along its shore, and that no recent changes in hydrology are known that could potentially alter this situation. However, a narrow strip on the island directly adjacent along the south side of the ramp to the Admiral Clarey Bridge, is a ditch coded R4SBCrx (Riverine intermittent streambed seasonally flooded artificial substrate excavated) and E2SS3Nx (an excavated estuarine intertidal regularly flooded, broad-leaved evergreen scrub-shrub). Actually, this area is a concrete-lined drainage swale feeding to a short remnant of the original shore, providing drainage along the road fill that was placed along and just off the shore on a former shallow reef platform. Why a normally dry, concrete drain would be considered an aquatic environment at all is unknown. However, subtidal concrete drains are normally coded E1UBLx, and upstream lined stream channels coded R4SBCrx (e.g., Aiea Stream at Moanalua Road).

Table 6-02. Summary of Changes Since 1999

Site	Description	Change since 1999	ACOE ID No.
Loko Pa'aiau	Former fishpond, overgrown with mangrove	No change	**..8001**
McGrew Point	Scattered mangrove growth along shore	Potentially one area (..8007) consolidating towards a mangal	**..8007** to ..8022, ..8045, & ..8046
'Aiea Bay	Extensive mangal at head of embayment.	All mangrove removed in 2007.	..9024 to ..9034
Halawa Stream	Mangals along the estuary	In part removed by bridge reconstruction.	..10050 & ..10051
Makalapa Crater	California grass and pickleweed patches; not wetlands.	Not known, but unlikely changed into wetlands.	..11200 & ..11201*

* Misnumbered by ACOE (1999) on their index map as ..01200 & ..01201

No supplemental photographs (SP) submitted for Chapter 6.

1 ATTACHMENT. Pearl Harbor Wetlands Inventory Maps

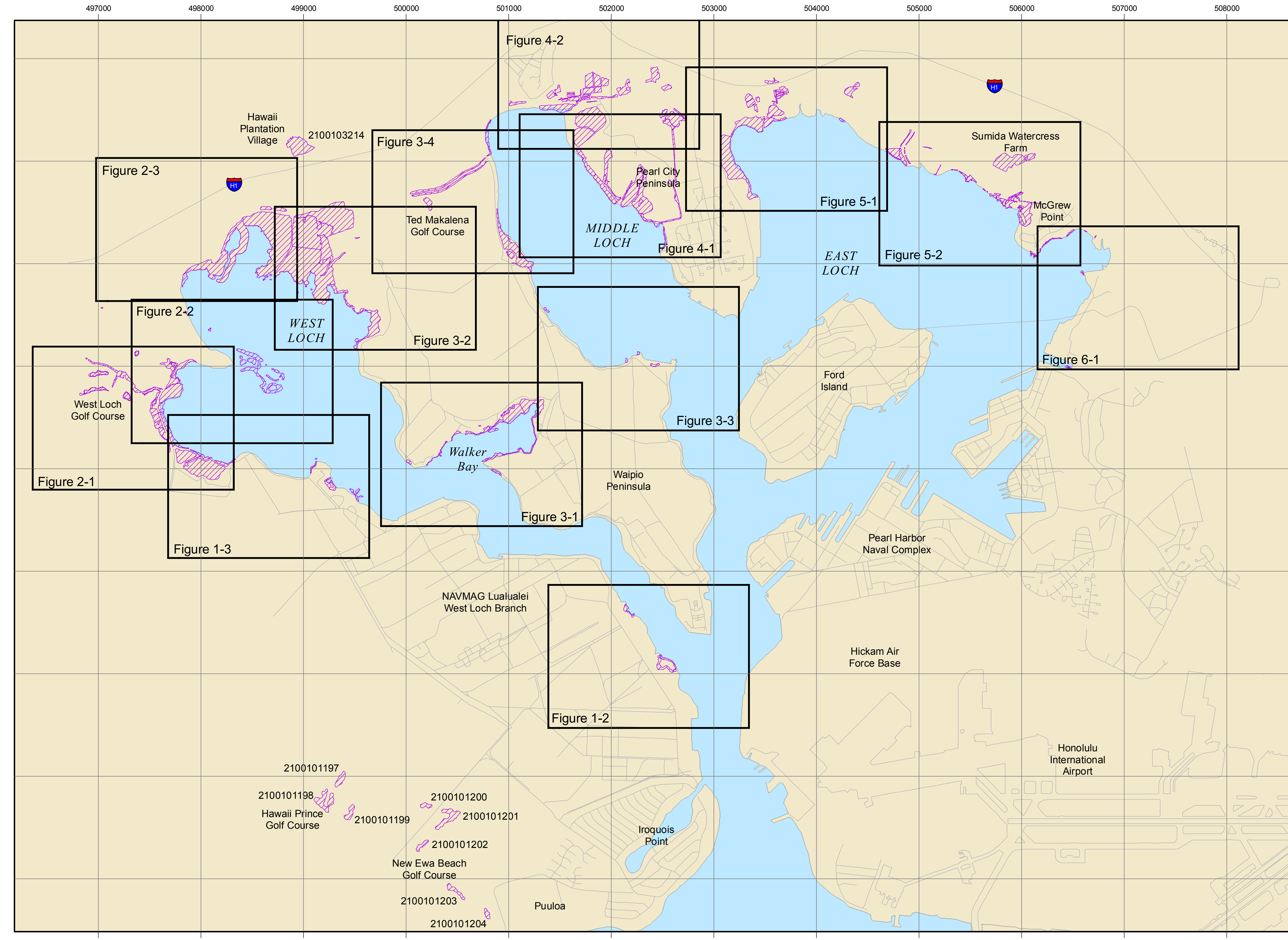


Figure 1-1
Index Map for
Wetland Identification Numbers
Wetlands of Pearl Harbor
Pearl Harbor, Oahu, Hawaii

LEGEND

Wetlands

NOTES

1. The accuracy of this map is limited to the quality and scale of the source information and is not suitable for mapping engineering applications and is not to be used for "As Built."

2. Grid system based on Hawaii State Plane Coordinate System, Zone 3.

SOURCE

U.S. Army Corps of Engineers, Wetlands of Pearl Harbor, Nov 1999

Hawaii Statewide Planning and Geographic Information System

2,000 1,000 0 2,000 Feet
600 300 0 600 Meters

Scale 1:35,000

Figure 1-2
NAVMAG West Loch
Wetland Identification Numbers
Wetlands of Pearl Harbor
Pearl Harbor, Oahu, Hawaii

LEGEND

Wetlands

NOTES

1. The accuracy of this map is limited to the quality and scale of the source information and is not suitable for mapping engineering applications and is not to be used for "As Built."

2. Grid system based on Hawaii State Plane Coordinate System, Zone 3.

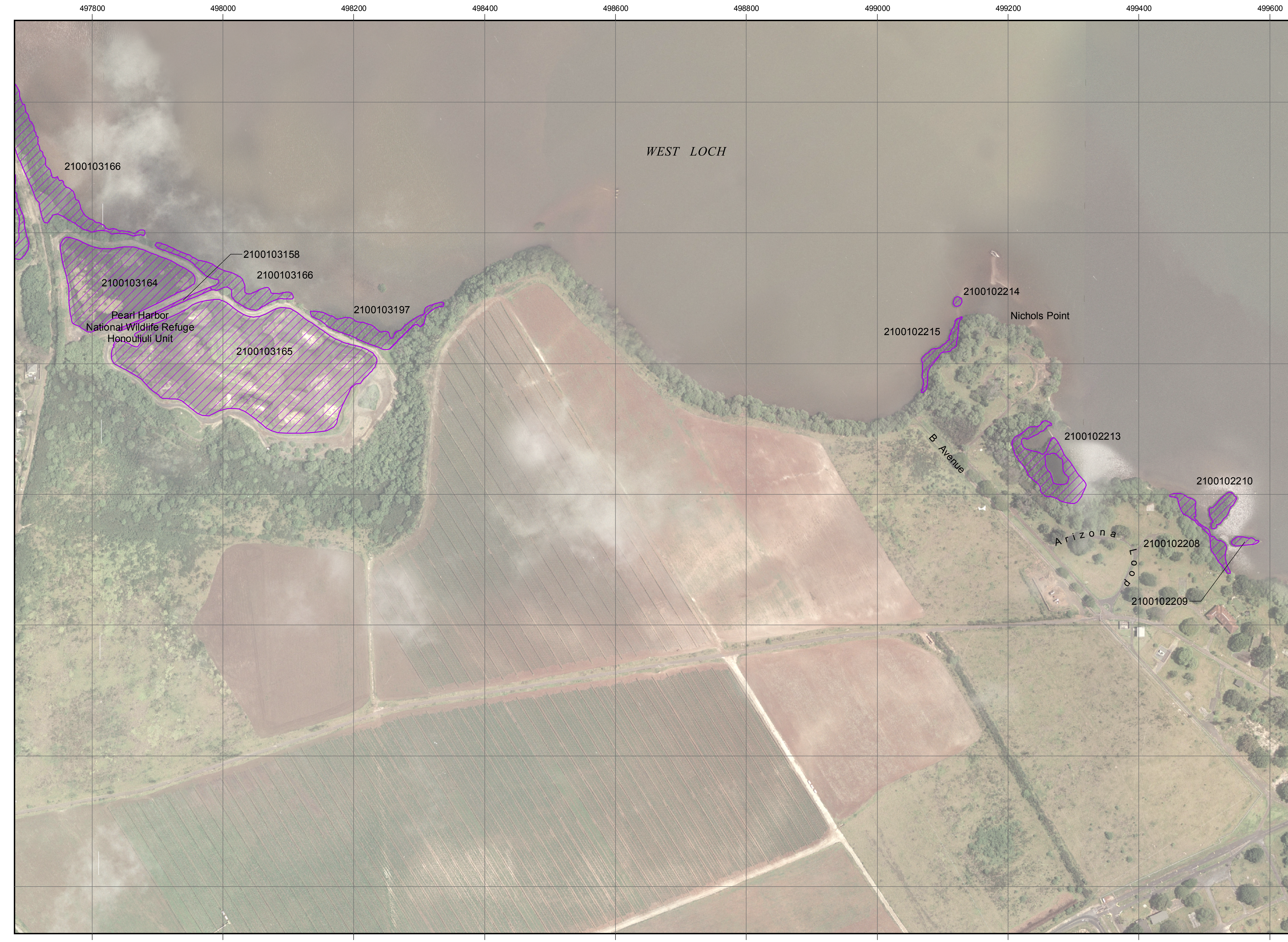
SOURCE

U.S. Geological Survey, 4QFJ045580, 4QFJ606580, 4QFJ045595, and 4QFJ060595

U.S. Army Corps of Engineers, Wetlands of Pearl Harbor, Nov 1999

400 200 0 400 Feet
100 50 0 100 Meters
Scale 1:5,500

Figure 1-3
NAVMAG West Loch
Wetland Identification Numbers
Wetlands of Pearl Harbor
Pearl Harbor, Oahu, Hawaii



LEGEND

Wetlands

NOTES

1. The accuracy of this map is limited to the quality and scale of the source information and is not suitable for mapping engineering applications and is not to be used for "As Built."

2. Grid system based on Hawaii State Plane Coordinate System, Zone 3.

SOURCE

U.S. Geological Survey, 4QFJ000610, 4QFJ015610, and 4QFJ030610

U.S. Army Corps of Engineers, Wetlands of Pearl Harbor, Nov 1999

400 200 0 400 Feet

100 50 0 100 Meters

Scale 1:5,500

Figure 2-1
West Loch
Wetland Identification Numbers
Wetlands of Pearl Harbor
Pearl Harbor, Oahu, Hawaii

LEGEND

Wetlands

NOTES

1. The accuracy of this map is limited to the quality and scale of the source information and is not suitable for mapping engineering applications and is not to be used for "As Built."

2. Grid system based on Hawaii State Plane Coordinate System, Zone 3.

SOURCE

U.S. Geological Survey, 4QFJ000610, 4QFJ000625, 4QFJ015610, and 4QFJ015625

U.S. Army Corps of Engineers, Wetlands of Pearl Harbor, Nov 1999

400 200 0 400 Feet

100 50 0 100 Meters

Scale 1:5,500

Figure 2-2
West Loch
Wetland Identification Numbers
Wetlands of Pearl Harbor
Pearl Harbor, Oahu, Hawaii

LEGEND

Wetlands

NOTES

1. The accuracy of this map is limited to the quality and scale of the source information and is not suitable for mapping engineering applications and is not to be used for "As Built."

2. Grid system based on Hawaii State Plane Coordinate System, Zone 3.

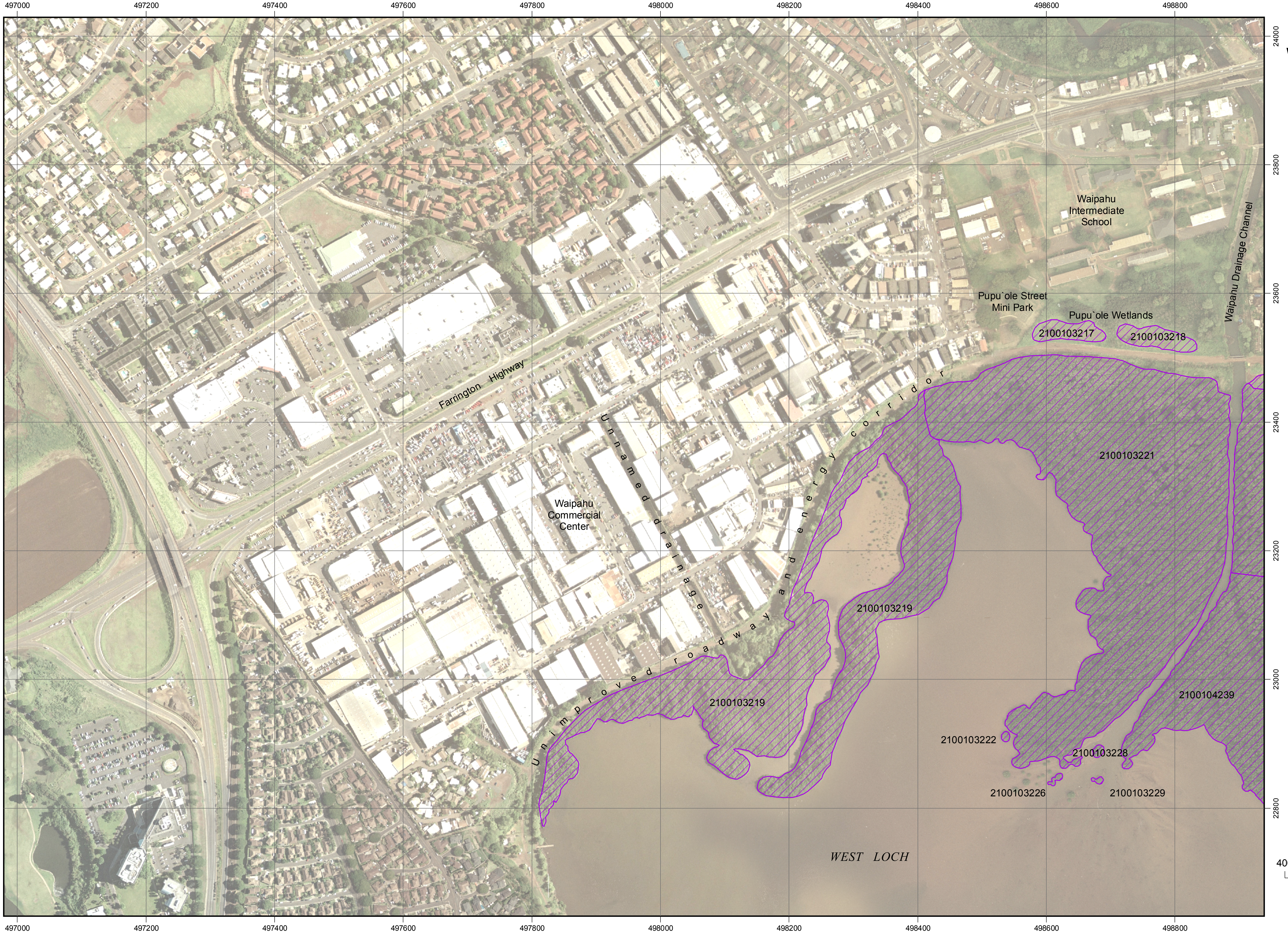
SOURCE

U.S. Geological Survey, 4QFJ000610, 4QFJ000625, 4QFJ015610, and 4QFJ015625

U.S. Army Corps of Engineers, Wetlands of Pearl Harbor, Nov 1999

400 200 0 400 Feet
100 50 0 100 Meters
Scale 1:5,500

Figure 2-3
Waipio
Wetland Identification Numbers
Wetlands of Pearl Harbor
Pearl Harbor, Oahu, Hawaii



LEGEND

Wetlands

NOTES

1. The accuracy of this map is limited to the quality and scale of the source information and is not suitable for mapping engineering applications and is not to be used for "As Built."

2. Grid system based on Hawaii State Plane Coordinate System, Zone 3.

SOURCE

U.S. Geological Survey, 4QFJ000625, 4QFJ000640, 4QFJ015625, and 4QFJ015640

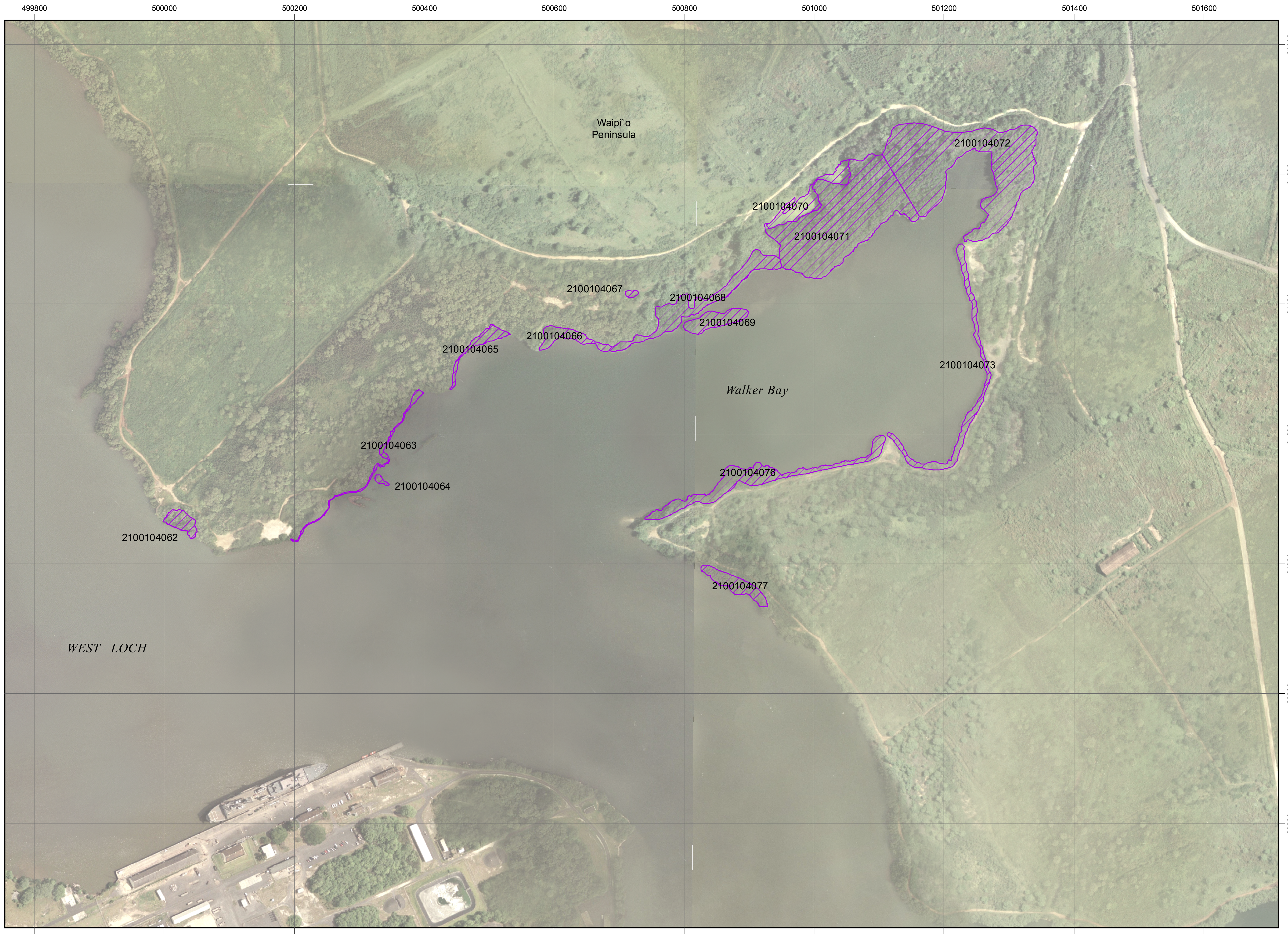
U.S. Army Corps of Engineers, Wetlands of Pearl Harbor, Nov 1999

400 200 0 400 Feet

100 50 0 100 Meters

Scale 1:5,500

Figure 3-1
Waipio
Wetland Identification Numbers
Wetlands of Pearl Harbor
Pearl Harbor, Oahu, Hawaii



LEGEND

Wetlands

NOTES

1. The accuracy of this map is limited to the quality and scale of the source information and is not suitable for mapping engineering applications and is not to be used for "As Built."

2. Grid system based on Hawaii State Plane Coordinate System, Zone 3.

SOURCE

U.S. Geological Survey, 4QFJ030610, 4QFJ030625, 4QFJ045610, and 4QFJ045625

U.S. Army Corps of Engineers, Wetlands of Pearl Harbor, Nov 1999

400 200 0 400 Feet
100 50 0 100 Meters
Scale 1:5,500

Figure 3-2
Waipio
Wetland Identification Numbers
Wetlands of Pearl Harbor
Pearl Harbor, Oahu, Hawaii

LEGEND

Wetlands

NOTES

1. The accuracy of this map is limited to the quality and scale of the source information and is not suitable for mapping engineering applications and is not to be used for "As Built."

2. Grid system based on Hawaii State Plane Coordinate System, Zone 3.

SOURCE

U.S. Geological Survey, 4QFJ015625, 4QFJ015640, 4QFJ030625, and 4QFJ030640

U.S. Army Corps of Engineers, Wetlands of Pearl Harbor, Nov 1999

400 200 0 400 Feet
100 50 0 100 Meters
Scale 1:5,500

Figure 3-3
Waipio
Wetland Identification Numbers
Wetlands of Pearl Harbor
Pearl Harbor, Oahu, Hawaii

LEGEND

Wetlands

NOTES

1. The accuracy of this map is limited to the quality and scale of the source information and is not suitable for mapping engineering applications and is not to be used for "As Built."

2. Grid system based on Hawaii State Plane Coordinate System, Zone 3.

SOURCE

U.S. Geological Survey, 4QFJ045610, 4QFJ045625, 4QFJ060610, and 4QFJ060625

U.S. Army Corps of Engineers, Wetlands of Pearl Harbor, Nov 1999

400 200 0 400 Feet
100 50 0 100 Meters
Scale 1:5,500

Figure 3-4
Waipio
Wetland Identification Numbers
Wetlands of Pearl Harbor
Pearl Harbor, Oahu, Hawaii

LEGEND

Wetlands

NOTES

1. The accuracy of this map is limited to the quality and scale of the source information and is not suitable for mapping engineering applications and is not to be used for "As Built."

2. Grid system based on Hawaii State Plane Coordinate System, Zone 3.

SOURCE

U.S. Geological Survey, 4QFJ030625, 4QFJ030640, 4QFJ045625, and 4QFJ045640

U.S. Army Corps of Engineers, Wetlands of Pearl Harbor, Nov 1999

400 200 0 400 Feet
100 50 0 100 Meters
Scale 1:5,500

Figure 4-1
Pearl City Peninsula
Wetland Identification Numbers
Wetlands of Pearl Harbor
Pearl Harbor, Oahu, Hawaii

LEGEND

Wetlands

NOTES

1. The accuracy of this map is limited to the quality and scale of the source information and is not suitable for mapping engineering applications and is not to be used for "As Built."

2. Grid system based on Hawaii State Plane Coordinate System, Zone 3.

SOURCE

U.S. Geological Survey, 4QFJ045625, 4QFJ045640, 4QFJ060625, and 4QFJ060640

U.S. Army Corps of Engineers, Wetlands of Pearl Harbor, Nov 1999

400 200 0 400 Feet

100 50 0 100 Meters

Scale 1:5,500

Figure 4-2
Pearl City Peninsula West
Wetland Identification Numbers
Wetlands of Pearl Harbor
Pearl Harbor, Oahu, Hawaii

LEGEND

Wetlands

NOTES

1. The accuracy of this map is limited to the quality and scale of the source information and is not suitable for mapping engineering applications and is not to be used for "As Built."

2. Grid system based on Hawaii State Plane Coordinate System, Zone 3.

SOURCE

U.S. Geological Survey, 4QFJ045640, 4QFJ045655, 4QFJ060640, and 4QFJ060655

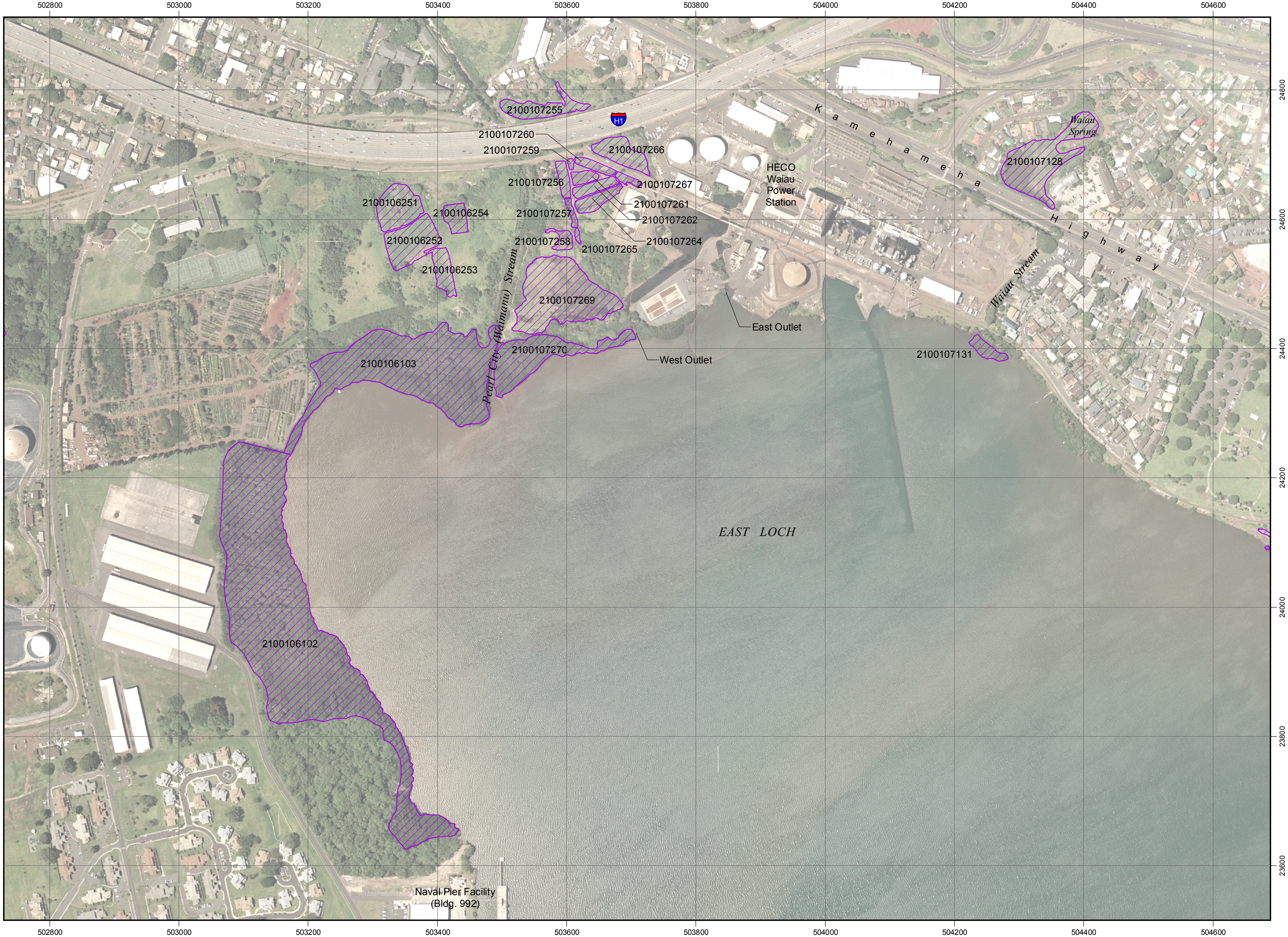
U.S. Army Corps of Engineers, Wetlands of Pearl Harbor, Nov 1999

400 200 0 400 Feet

90 45 0 90 Meters

Scale 1:5,500

Figure 5-1
Pearl City Peninsula East
Wetland Identification Numbers
Wetlands of Pearl Harbor
Pearl Harbor, Oahu, Hawaii



LEGEND

Wetlands

NOTES

1. The accuracy of this map is limited to the quality and scale of the source information and is not suitable for mapping engineering applications and is not to be used for "As Built."

2. Grid system based on Hawaii State Plane Coordinate System, Zone 3.

SOURCE

U.S. Geological Survey, 4QFJ045640, 4QFJ045655, 4QFJ060640, and 4QFJ060655

U.S. Army Corps of Engineers, Wetlands of Pearl Harbor, Nov 1999

400 200 0 400 Feet

100 50 0 100 Meters

Scale 1:5,500

Figure 5-2
East Loch/McGrew Point
Wetland Identification Numbers
Wetlands of Pearl Harbor
Pearl Harbor, Oahu, Hawaii

LEGEND

Wetlands

NOTES

1. The accuracy of this map is limited to the quality and scale of the source information and is not suitable for mapping engineering applications and is not to be used for "As Built."

2. Grid system based on Hawaii State Plane Coordinate System, Zone 3.

SOURCE

U.S. Geological Survey, 4QFJ075625, 4QFJ075640, 4QFJ090625, and 4QFJ090640

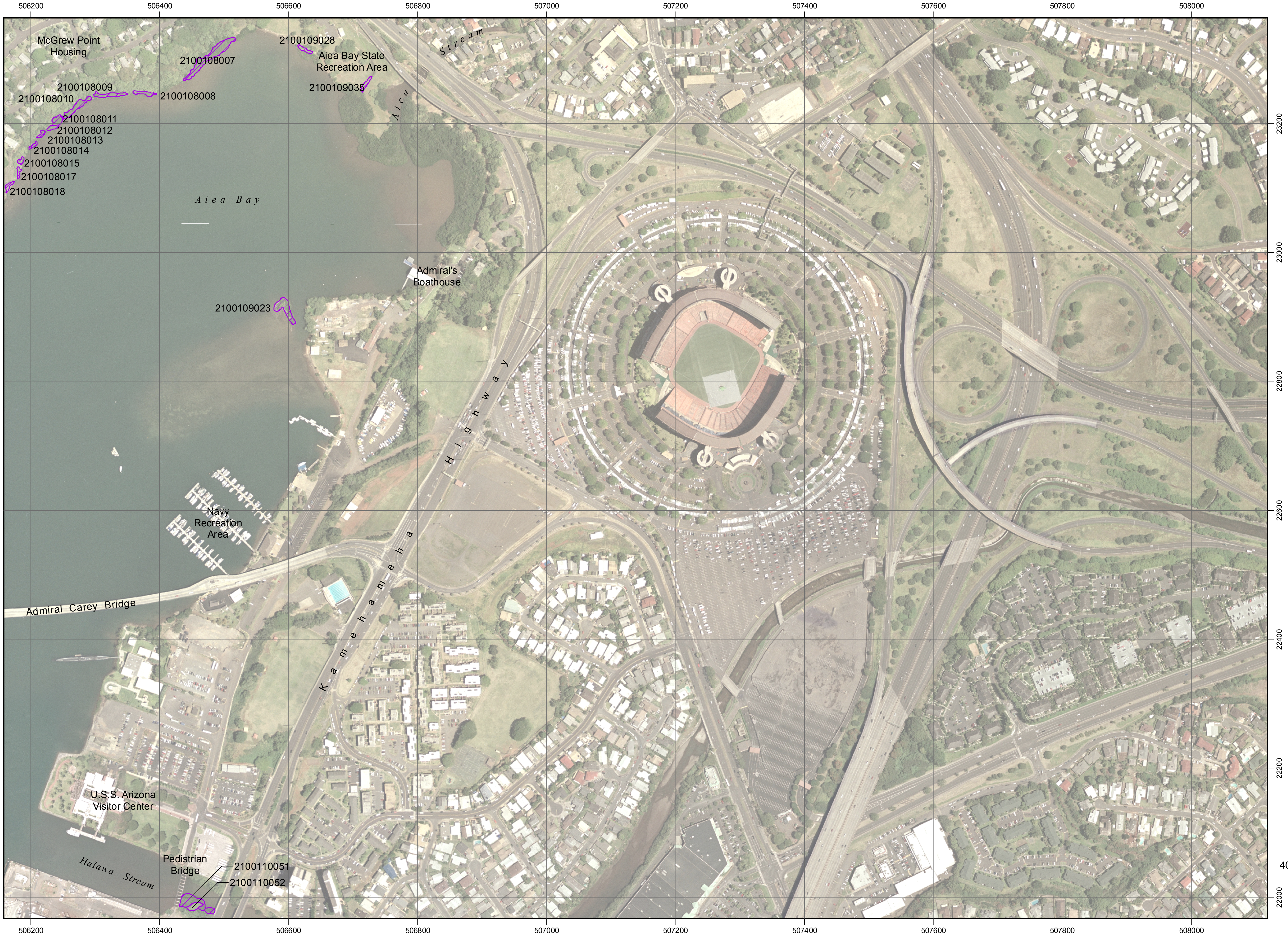
U.S. Army Corps of Engineers, Wetlands of Pearl Harbor, Nov 1999

400 200 0 400 Feet

100 50 0 100 Meters

Scale 1:5,500

Figure 6-1
Aiea Bay
Wetland Identification Numbers
Wetlands of Pearl Harbor
Pearl Harbor, Oahu, Hawaii



LEGEND

Wetlands

NOTES

1. The accuracy of this map is limited to the quality and scale of the source information and is not suitable for mapping engineering applications and is not to be used for "As Built."

2. Grid system based on Hawaii State Plane Coordinate System, Zone 3.

SOURCE

U.S. Geological Survey, 4QFJ090625, 4QFJ090640, 4QFJ105625, and 4QFJ105640

U.S. Army Corps of Engineers, Wetlands of Pearl Harbor, Nov 1999

400 200 0 400 Feet
100 50 0 100 Meters
Scale 1:5,500

A14 – BIRD SPECIES OBSERVED AT PHNC (FROM NAVFAC PAC 2006A; BURNER 1999B, 2000A)

This page is intentionally left blank.

Table 1: Summary of Bird Species Observed at Makalapa Crater

Common Name	Hawaiian Name	Latin Binomial	Recorded During 1998 Survey	Recorded During 2006 Survey	Comments
Regulatory Status: MBTA					
Cattle egret		*Bubulcus ibis*	No	Yes	Introduced shorebird
Pacific golden plover	kōlea	*Pluvialis fulva*	Yes, four observed	Yes	Migratory shorebird
Regulatory status: not protected					
Red jungle fowl		*Gallus gallus*	No	Yes	Introduced
Spotted dove		*Streptopelia chinensis*	Uncommon, less than 5	Yes	Introduced
Zebra dove		*Geopelia striata*	Common, 5 to 10	Abundant	Introduced
Red-vented bulbul		*Pycnonotus cafer*	Common, 5 to 10	Abundant	Introduced
Japanese bush-warbler		*Cettia diphone*	Recorded, seen or heard only once	No	Introduced
Common myna		*Acridotheres tristis*	Uncommon, less than 5	Yes	Introduced
Japanese white-eye		*Zosterops japonicus*	Common, 5 to 10	Yes	Introduced
Northern cardinal		*Cardinalis cardinalis*	Uncommon, less than 5	Yes	Introduced
Red-crested cardinal		*Paroaria coronata*	Uncommon, less than 5	Yes	Introduced
House finch		*Carpodacus mexicanus*	Common, 5 to 10	Yes	Introduced
Common Waxbill		*Estrilda astrild*	Common, 5 to 10	Abundant	Introduced
House sparrow		*Passer domesticus*	Recorded, seen or heard only once	No	Introduced
Java Sparrow		*Padda oryzivora*	Uncommon, less than 5	Yes	Introduced
Saffron finch		*Sicalis flaveola*	No	Yes	Introduced
Yellow-fronted canary		*Serinus mozambicus*	No	Yes	Introduced
Nutmeg manikin		*Lonchura punctulata*	No	Yes	Introduced

Source: NAVFAC 2006a and Bruner 1999b.

Table 2: Summary of Bird Species Observed at Pearl City Peninsula

Common Name	Hawaiian Name	Latin Binomial	Recorded During 1999 Survey	Recorded During 2006 Survey	Comments
Regulatory Status: Federally-listed Endangered Species					
Black-necked stilt		*Himantopus mexicanus knudsensi*	Yes, rare less than 5	Yes	Introduced shorebird
Regulatory Status: MBTA					
Black-crowned night heron*	'auku'u	*Nycticorax nycticorax*	Yes, rare, less than 5	Yes	Native waterbird
Cattle egret		*Bubulcus ibis*	Yes, 15 to 20	Yes	Introduced shorebird
Pacific golden plover*	kōlea	*Pluvialis fulva*	Yes, greater than 25	No	Migratory shorebird
Ruddy turnstone	'akekeke	*Arenaria interpres*	Yes, 15 to 25	No	Migratory shorebird
Regulatory status: not protected					
Ring-necked pheasant		*Phasianus colchicus*	Yes, rare, less than 5	No	Introduced
Rock dove		*Columba livia*	Uncommon, less than 5	Yes	Introduced
Spotted dove		*Streptopelia chinensis*	Uncommon, less than 5	Yes	Introduced
Zebra dove		*Geopelia striata*	Yes, greater than 25	Yes	Introduced
Eurasian skylark		*Aluda arvensis*	Uncommon, less than 5	No	Introduced
Red-vented bulbul		*Pycnonotus cafer*	Yes, greater than 25	Yes	Introduced
Japanese bush-warbler		*Cettia diphone*	Uncommon, less than 5	No	Introduced
White-rumped shama		*Copsychus malbaricus*	Yes, rare, less than 5	Yes	Introduced
Northern mockingbird		*Mimus polyglottos*	Uncommon, less than 5	No	Introduced
Common myna		*Acridotheres tristis*	Yes, greater than 25	Yes	Introduced
Japanese white-eye		*Zosterops japonicus*	Uncommon, less than 5	Yes	Introduced
Northern cardinal		*Cardinalis cardinalis*	Common, 5 to 10	Yes	Introduced
Red-crested cardinal		*Paroaria coronata*	Common, 5 to 10	Yes	Introduced
Saffron finch		*Sicalis flaveola*	Yes, rare, less than 5	No	Introduced

Table 2: Summary of Bird Species Observed at Pearl City Peninsula (Continued)

Common Name	Hawaiian Name	Latin Binomial	Recorded During 1999 Survey	Recorded During 2006 Survey	Comments
House finch		*Carpodacus mexicanus*	Yes, greater than 25	Yes	Introduced
House sparrow		*Passer domesticus*	Common, 5 to 10	No	Introduced
Common Waxbill		*Estrilda astrild*	Yes, greater than 25	Yes	Introduced
Red Avadavat		*Amandava amandava*	Yes, rare, less than 5	No	Introduced
Nutmeg manikin		*Lonchura punctulata*	Common, 5 to 10	No	Introduced
Chestnut manikin		*Lonchura malacca*	Yes, rare, less than 5	No	Introduced
Java Sparrow		*Padda oryzivora*	Common, 5 to 10	No	Introduced

Source: NAVFAC 2006a and Bruner 2000a.

Table 3: Summary of Bird Species Observed at Red Hill Fuels Storage Area

Common Name	Hawaiian Name	Latin Binomial	Recorded During 1999 Survey	Recorded During 2006 Survey	Comments
Regulatory Status: MBTA					
Pacific golden plover*	kōlea	*Pluvialis fulva*	Uncommon, less than 5	No	Migratory shorebird
Regulatory status: not protected					
Spotted dove		*Streptopelia chinensis*	Yes, greater than 25	Yes	Introduced
Zebra dove		*Geopelia striata*	Common, 5 to 10	Yes	Introduced
Red-vented bulbul		*Pycnonotus cafer*	Yes, greater than 25	Yes	Introduced
Red-whiskered bulbul		*Pycnonotus jocosus*	Common, 5 to 10	Yes	Introduced
Japanese bush-warbler		*Cettia diphone*	Uncommon, less than 5	No	Introduced
White-rumped shama		*Copsychus malbaricus*	Uncommon, less than 5	No	Introduced
Red-billed Leiothrix		*Leiothrix lutea*	Yes, rare, less than 5	No	Introduced
Northern mockingbird		*Mimus polyglottos*	Uncommon, less than 5	No	
Common myna		*Acridotheres tristis*	Common, 5 to 10	Yes	Introduced
Japanese white-eye		*Zosterops japonicus*	Yes, greater than 25	Yes	Introduced
Northern cardinal		*Cardinalis cardinalis*	Common, 5 to 10	Yes	Introduced
Red-crested cardinal		*Paroaria coronata*	Common, 5 to 10	Yes	Introduced
Saffron finch		*Sicalis flaveola*	Yes, rare, less than 5	Yes	Introduced
House finch		*Carpodacus mexicanus*	Yes, greater than 25	Yes	Introduced
House sparrow		*Passer domesticus*	Uncommon, less than 5	No	Introduced
Common Waxbill		*Estrilda astrild*	Common, 5 to 10	No	Introduced
Java Sparrow		*Padda oryzivora*	Common, 5 to 10	No	Introduced

Source: NAVFAC 2006a and Bruner 2000a.

Table 4: Summary of Bird Species Observed at Waiawa Watershed

Common Name	Hawaiian Name	Latin Binomial	Recorded During 1999 Survey	Recorded During 2006 Survey	Comments
Regulatory Status: MBTA					
Black-crowned night heron*	'auku'u	*Nycticorax nycticorax*	Yes, rare, less than 5	Yes	Native waterbird
Cattle egret		*Bubulcus ibis*	Yes, rare, less than 5	No	Introduced shorebird
Pacific golden plover*	kōlea	*Pluvialis fulva*	Yes, rare, less than 5	No	Migratory shorebird
Wandering Tattler		*Heteroscelus incanus*	Yes, rare, less than 5	No	Migratory shorebird
Regulatory status: not protected					
Rock dove		*Columba livia*	No	Yes	Introduced
Spotted dove		*Streptopelia chinensis*	Common, 5 to 10	No	Introduced
Zebra dove		*Geopelia striata*	Common, 5 to 10	Yes	Introduced
Red-vented bulbul		*Pycnonotus cafer*	Yes, greater than 25	Yes	Introduced
Red-whiskered bulbul		*Pycnonotus jocosus*	Common, 5 to 10	Yes	Introduced
Japanese bush-warbler		*Cettia diphone*	Uncommon, less than 5	Yes	Introduced
White-rumped shama		*Copsychus malbaricus*	Common, 5 to 10	Yes	Introduced
Red-billed Leiothrix		*Leiothrix lutea*	Common, 5 to 10	Yes	Introduced
Red junglefowl		*Gallus gallus*	No	Yes	Introduced
Common myna		*Acridotheres tristis*	Common, 5 to 10	Yes	Introduced
Japanese white-eye		*Zosterops japonicus*	Yes, greater than 25	Yes	Introduced
Northern cardinal		*Cardinalis cardinalis*	Common, 5 to 10	Yes	Introduced
Red-crested cardinal		*Paroaria coronata*	Common, 5 to 10	Yes	Introduced
House finch		*Carpodacus mexicanus*	Yes, greater than 25	Yes	Introduced
House sparrow		*Passer domesticus*	Rare, less than 5	Yes	Introduced
Common Waxbill		*Estrilda astrild*	Common, 5 to 10	Yes	Introduced
Red Avadavat		*Amandava*	Rare, less than 5	No	Introduced

Table 4: Summary of Bird Species Observed at Waiawa Watershed (Continued)

Common Name	Hawaiian Name	Latin Binomial	Recorded During 1999 Survey	Recorded During 2006 Survey	Comments
		amandava			
Nutmeg manikin		*Lonchura punctulata*	Uncommon, less than 5	Yes	Introduced

Source: NAVFAC 2006a and Bruner 2000a.

Table 4: Summary of Bird Species Observed at NAVMAG PH West Loch Branch

Common Name	Hawaiian Name	Latin binomial	Comments
Regulatory Status: federally-listed as Endangered Species			
Hawaiian stilt	āe'o	*Himantopus mexicanus knudsensi*	Recorded at West Loch
Regulatory Status: SOH-listed Endangered Species			
Hawaiian owl	pueo	*Asio flammeus*	Recorded at Waipi'o Peninsula.
Regulatory Status: MBTA-protected Species			
Black-crowned night heron*	ʻaukuʻu	*Nycticorax nycticorax*	Recorded at West Loch and Waipi'o Peninsula.
Cattle egret		*Bubulcus ibis*	Recorded at West Loch and Waipi'o Peninsula.
Pacific golden plover*	kōlea	*Pluvialis fulva*	Recorded at West Loch and Waipi'o Peninsula.
Ruddy turnstone*	ʻakekeke	*Arenaria interpres*	Recorded at West Loch.
Osprey		*Pandion haliaetus*	Recorded at Waipi'o Peninsula.
Regulatory Status: Not protected			
Ringed-neck pheasant		*Phasianus colchicus*	Recorded at Waipi'o Peninsula. Introduced species.
Gray francolin		*Francolinus pondicerianus*	Recorded at West Loch and Waipi'o Peninsula. Introduced species.
Spotted dove		*Streptopelia chinensis*	Recorded at West Loch and Waipi'o Peninsula. Introduced species.
Zebra dove		*Geopelia striata*	Recorded at West Loch and Waipi'o Peninsula. Introduced species.
Red-vented bulbul		*Pycononotus cafer*	Recorded at West Loch and Waipi'o Peninsula. Introduced species.
Red-whiskered bulbul		*Pycnonotus jocosus*	Recorded at Waipi'o Peninsula. Introduced species.
White-rumped shama		*Copsychus malabaricus*	Recorded at West Loch. Introduced species.
Common myna		*Acridotheres tristis*	Recorded at West Loch and Waipi'o Peninsula. Introduced species.
Japanese white-eye		*Zosterops japonicus*	Recorded at West Loch and Waipi'o Peninsula. Introduced species.

Table 4: Summary of Bird Species Observed at NAVMAG West Loch Branch (Continued)

Common Name	Hawaiian Name	Latin binomial	Comments
Northern cardinal		*Cardinalis cardinalis*	Recorded at West Loch and Waipi'o Peninsula. Introduced species.
Red-crested cardinal		*Paroaria coronata*	Recorded at West Loch. Introduced species.
House finch		*Carpodacus mexicanus*	Recorded at Waipi'o Peninsula. Introduced species.
Yellow-fronted canary		*Serinus mozambicus*	Recorded at Waipi'o Peninsula. Introduced species.
Common waxbill		*Estrilda astrild*	Recorded at West Loch and Waipi'o Peninsula. Introduced species.
Red avadavat		*Amandava amandava*	Recorded at West Loch and Waipi'o Peninsula. Introduced species.
Warbling silverbell		*Lonchura malabarica*	Recorded at West Loch. Introduced species.
Chestnut mannikin		*Lonchura Malacca*	Recorded at West Loch. Introduced species.

Source: NAVFAC 2006a

APPENDIX B
PHNC MARINE AND FISHERY RESOURCES SURVEYS

B1 – CHARACTERIZATION OF FISH AND BENTHIC COMMUNITIES OF PEARL HARBOR AND PEARL HARBOR ENTRANCE CHANNEL HAWAI‘I (SMITH *ET AL.* 2006)

This page is intentionally left blank.

CHARACTERIZATION OF FISH AND BENTHIC COMMUNITIES OF PEARL HARBOR AND PEARL HARBOR ENTRANCE CHANNEL, HAWAI'I

FINAL REPORT - DECEMBER 2006

CONTRACT NUMBER: N62470-02-D-9997 TASK ORDER NUMBER: 0069

Prepared by:
S. H. Smith (Naval Facilities Engineering Command, Pacific, Pearl Harbor, Hawai'i)
K.J.P. Deslarzes, (Geo-Marine, Inc., Plano, Texas)
R. Brock (Environmental Assessment Co., Honolulu, Hawai'i)

Funded by:
Department of Defense Legacy Resource Management Program, Project Number 03-183

CHARACTERIZATION OF FISH AND BENTHIC COMMUNITIES OF PEARL HARBOR AND PEARL HARBOR ENTRANCE CHANNEL, HAWAI'I

FINAL REPORT - DECEMBER 2006

CONTRACT NUMBER: N62470-02-D-9997
TASK ORDER NUMBER: 0069

Prepared by:
S. H. Smith (Naval Facilities Engineering Command, Pacific, Pearl Harbor, Hawai'i)
K.J.P. Deslarzes, (Geo-Marine, Inc., Plano, Texas)
R. Brock (Environmental Assessment Co., Honolulu, Hawai'i)

Funded by:
Department of Defense Legacy Resource Management Program, Project Number 03-183

Naval Facilities Engineering Command

TABLE OF CONTENTS

Page

This page intentionally left blank.

LIST OF FIGURES

This page intentionally left blank.

LIST OF TABLES

This page intentionally left blank.

Characterization of Fish and Benthic Communities of
Pearl Harbor and Pearl Harbor Entrance Channel, Hawai'i
NAVFAC, Pacific

LIST OF ACRONYMS AND ABBREVIATIONS

%	Percent
°	Degree(s)
°C	Degree(s) Celsius
ANOVA	Analysis of Variance
CCA	Crustose Coralline Algae
cm	Centimeter(s)
cm^2	Square Centimeter(s)
DoN	Department of the Navy
g	Gram(s)
g/m^2	Gram(s) Per Square Meter
GMI	Geo-Marine, Inc.
GPS	Global Positioning System
H	Pearl Harbor
ha	Hectare(s)
kg	Kilogram(s)
km	Kilometer(s)
km^2	Square Kilometer(s)
m	Meter(s)
m^2	Square Meter(s)
m^3/day	Cubic Meter(s) Per Day
NITROX	Enriched Air
PCQM	Point Centered Quarter Method
PHEC	Pearl Harbor Entrance Channel
PQA	Photo-Quadrat Analyzer
psu	Practical Salinity Unit(s)
PVC	Polyvinyl Chloride
QIM	Quadrat Intercept Method
SCUBA	Self Contained Underwater Breathing Apparatus
SD	Standard Deviation
SE	Standard Error
SNK	Student-Newman-Keuls
t	Ton(s)
U.S.	United States

This page intentionally left blank.

1.0 INTRODUCTION

1.1 PURPOSE

The objective of this project that took place in September 2005 was to assess the status of selected elements of the marine community in Pearl Harbor and the Pearl Harbor Entrance Channel (PHEC), O'ahu, Hawai'i. **Figures 1-1**, **1-2a**, and **1-2b**, depict the project areas and study sites. Particular emphasis was placed upon assessing fin fishes and sessile macro-benthic communities. Data was also gathered on threatened and endangered species.

Within this broad context, the authors attempted to address the following questions:

1. Have there been any changes in the fish and benthic communities since the Evans (1974) investigations?
2. How do fish communities and fish stocks in Pearl Harbor compare to other locations around O'ahu and in the Main Hawaiian Islands?
3. What is the status of stony corals in Pearl Harbor and the PHEC? How does this compare with the findings of Evans (1974) and Smith (2000, 2002)?
4. What changes have occurred in Turtle/Tripod Reef coral community between 2002 and 2005?
5. How did the construction of the Fort Kamehameha Outfall Replacement affect stony coral distribution in the trenched portion of the outfall corridor, located within the PHEC?
6. Are corals recruiting to the pile supported portions of the Fort Kamehameha Outfall and what other macrobenthic species are present on the outfall pipe and pile supports?
7. What marine threatened and endangered species occur within Pearl Harbor, the PHEC, and along the pile supported portion of the outfall, seaward of the PHEC?

1.2 ENVIRONMENTAL SETTING

1.2.1 Pearl Harbor

Pearl Harbor is located on the island of O'ahu, one of the eight Main Hawaiian Islands. O'ahu was formed by two volcanoes, the Waianae volcano to the west and Koolau volcano to the east. A broad coastal plain extends to the south, between the two volcanoes; Pearl Harbor is a landlocked estuary situated on this plain. It covers an area of approximately 21 square kilometers (km^2) and consists of three main lochs (West Loch, Middle Loch, and East Loch) and a smaller loch (Southwest Loch). These lochs are the remnants of drowned river valleys which connect to a common channel leading to the Pacific Ocean (Coles et al. 1997; Dollar and Brock 2001). The total length of the Pearl Harbor shoreline is approximately 58 kilometers (km).

The boundary between Pearl Harbor and the PHEC is considered to be Hammer Point (**Figure 1-2a**). The area seaward of Hammer Point, to the outermost channel markers buoys, is defined as the PHEC. The PHEC is approximately 3.2 km long and 300 meters (m) wide.

Water depths within Pearl Harbor average 9 m, with a maximum depth of 28 m. A fossilized reef platform forms the eastern and western edges of the PHEC; much of this platform is less than 3 m deep. The central portions of the PHEC range from 15 to 20 m deep (**Figure 1-2a**).

The Pearl Harbor watershed drains roughly 22 percent (%) of the island of O'ahu, or approximately 347 km^2. Seven perennial streams enter Pearl Harbor; however, 70% of the natural fresh water discharge is from springs, the largest of which is Waimanu-Waiau spring complex (Englund et al. 2000). These springs are the largest in the Hawaiian Islands and one of the largest of the Pacific islands (Englund et al. 2000). Grovhoug (1992) estimated the median flow from the Waimanu-Waiau springs to be 121,120 cubic meters per day (m^3/day). Stream flows into Pearl Harbor are heavily influenced by the springs and both the spring and stream discharge vary dramatically during the year. The total fresh water input into Pearl Harbor was calculated to be 189,250 to 378,500 m^3/day during the dry summer season and rainy winter months, respectively (Grovhoug 1992).

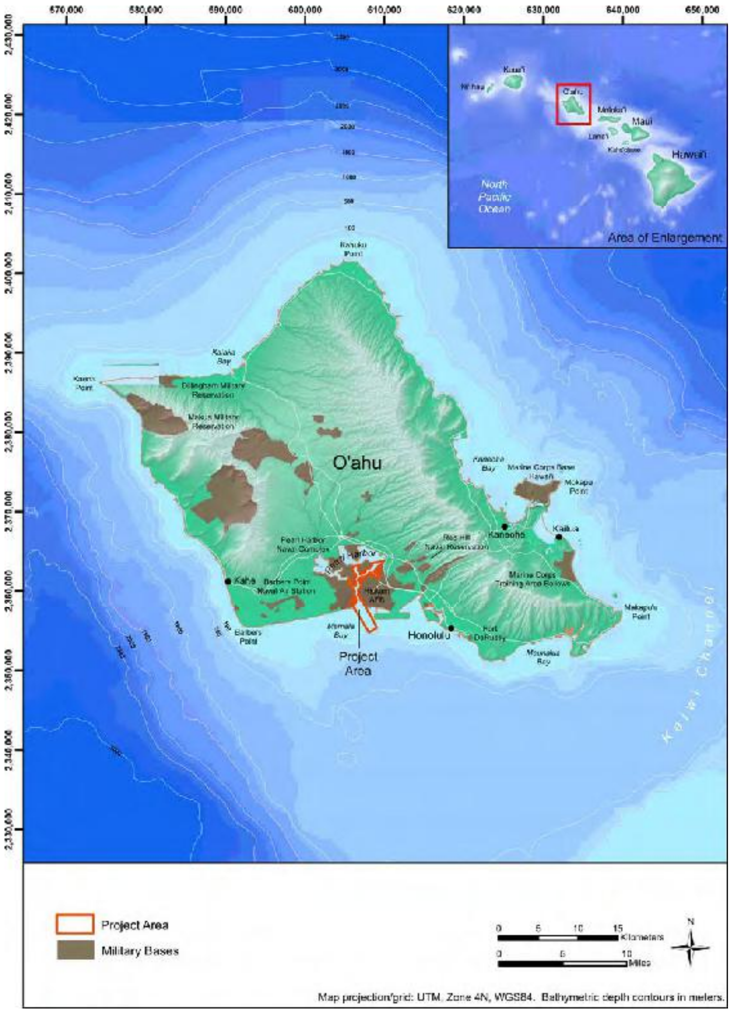


Figure 1-1. Location map of Pearl Harbor, Hawai'i and the project area (Source data: NOAA 2002; Sandwell et al. 2004).

Figure 1-2a. Location of study sites within Pearl Harbor, and the Pearl Harbor Entrance Channel, Hawai'i (Source data: NCCOS 2005).

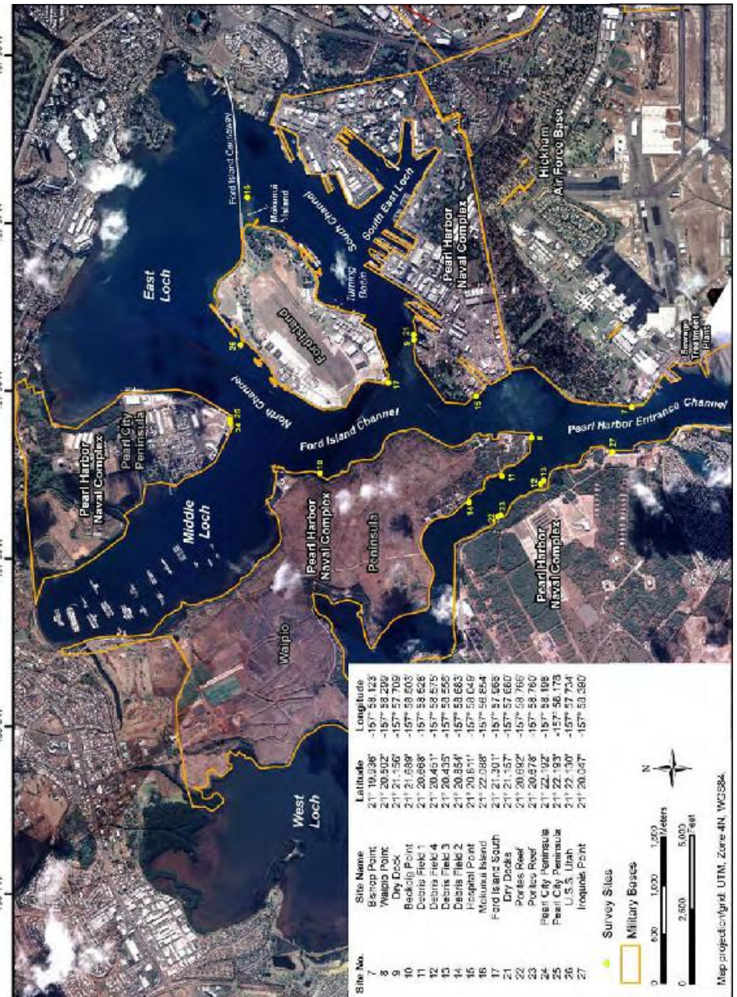


Figure 1-2b. Location of study sites within Pearl Harbor, and the Pearl Harbor Entrance Channel, Hawai'i (Source data: NCCOS 2005).

Turbidity within Pearl Harbor is an important factor affecting the distribution of organisms. B-K Dynamics (1972) estimated that Pearl Harbor's streams introduce approximately 386 tons (t) of sediment per day into Pearl Harbor.

Due to the shape of Pearl Harbor and the relatively narrow Pearl Harbor mouth, water exchange between Pearl Harbor and the open ocean is slow. Grovhoug (1992) estimated that the residence time for bottom waters is up to six days and for surface waters one to three days. The conditions in the PHEC are significantly different. Although no actual measurements are available, the complete exchange of water within the PHEC (as defined in this study) probably takes place on a daily basis.

Water temperatures within Pearl Harbor range from 23 to 29 degrees Celsius (^{o}C) and salinity ranges from 10 to 37 practical salinity units (psu) (Coles et al 1997). Buske and Evans (1974) found a single thermocline and single halocline within Pearl Harbor at depths of 1.5 and 5.5 m, respectively. As expected in an area with substantial freshwater input, surface salinities are lower than those near the Pearl Harbor bottom, except in the case of underwater springs where strong mixing and upwelling can occur. In the PHEC oceanic influences become progressively stronger as one proceeds seaward from Hammer Point, and the differences noted above diminish.

Recent Human Activity and Anthropogenic Impacts—Prior to 1910 Pearl Harbor was a more confined, and probably more estuarine environment (Coles et al. 1997). A 5 m deep limestone sill functioned as a natural barrier between the present Pearl Harbor and the PHEC. In 1911 a deeper entrance channel was dredged, and over the next several decades Pearl Harbor became a hub of United States (U.S.) Naval activities in the Pacific. Much of the Pearl Harbor coastline was modified and substantial portions of all the Lochs were dredged. In addition to dredging, native Hawaiian fish ponds were filled and other shoreline areas were reclaimed with fill and dredge spoil. At the same time the Navy was developing Pearl Harbor as a major base, the surrounding lands were undergoing rapid changes as well. Mechanized sugar cane cultivation, the extensive use of fertilizers and pesticides, industrialization and residential development all contributed to increased sedimentation and pollution of Pearl Harbor. The American Sugar Company intentionally introduced the red mangrove (*Rhizophora mangle*) on Molokai in 1902. Although the mangroves were reported in Pearl Harbor by 1917, they did not spread rapidly within Pearl Harbor until the 1940s when mechanized agriculture caused the deltaic accumulation of sediments along the harbor shoreline. Today, substantial portions of the undeveloped shoreline are lined with this tree.

Human-induced impacts on water quality and natural resources reached their peak during the 1940 to 1970 period. During that time the Pearl Harbor environment became polluted and degraded by sewage (over 100 sewer outfalls), agricultural waste (including pesticides and fertilizers), sedimentation from land development, and industrial waste (including corrosion products, oil, and brewery waste) (Evans et al. 1972). In the early 1970s, sewage outfalls from the Navy discharged an average of 24,000 m^3/day and City and County of Honolulu sewage outfalls discharged an average of 34,000 m^3/day (Evans et al. 1972) into Pearl Harbor.

Several mass mortalities of marine life in Pearl Harbor were recorded during the 1970s. In June 1972, large numbers of invertebrates were killed in Middle Loch, in the vicinity of the City and County of Honolulu's Pearl City Sewage Treatment Plant (DoN 2001). In July of the same year, an estimated 34 million oysters, primarily located in West Loch, died from a parasitic infection. Substantial fish kills were also reported in the 1970s; the kills were attributed to red tide caused by the dinoflagellate *Cochlodinium catenatum* (DoN 2001).

1.2.2 Ecological Zonation within Pearl Harbor

Pearl Harbor has two primary ecological zones based upon substrate type: a soft bottom zone comprised of unconsolidated sediment and a hard substrate zone comprised of fossilized reefal material or anthropogenic items, such as steel sheet piles, concrete piers, wooden piles, and sunken items (Dollar and Brock 2001).

Roughly 90% of the Pearl Harbor seafloor is classified as unconsolidated sediment; it is primarily terrigenous mud and calcareous sand. The proportion of terrigenous mud relative to coarse, calcareous sand decreases in a seaward direction from the inner Pearl Harbor toward the PHEC. The unconsolidated sediment layer in the inner Pearl Harbor is believed to be more than several meters thick in most areas of Pearl Harbor that are deeper than 10 m. Surrounding much of the Pearl Harbor shoreline there is a submerged limestone/fossilized reef platform, which is covered by a relatively thin layer of mud and/or sand. At its outer edges, the limestone platform ends in a natural or dredged wall, or slopes more gradually to the Pearl Harbor seafloor. In addition to these natural substrates, substantial portions of the Pearl Harbor shoreline are lined with concrete, steel walls, and sheet piles. Substantial quantities of wooden, metallic, and concrete debris are scattered throughout Pearl Harbor (Smith pers. obs.). This debris includes the remnants of piers, barges, navigation aids, and materials from the December 7, 1941 Pearl Harbor attack. This human-made material currently plays an important ecological role, as will be discussed later in this report.

1.2.3 Ecological Characteristics of the Pearl Harbor Entrance Channel

There are four distinct ecological zones in and immediately adjacent to the PHEC: the channel seafloor, the fossilized reef platform, the vertical wall between the reef platform and the channel seafloor, and the reefs seaward of the PHEC. The largest component of this study area was the channel itself. The channel is approximately 300 m wide and 3.2 km long; it consists almost entirely of unconsolidated sediment, which becomes increasingly coarse in a seaward direction. The channel seafloor is generally flat; small widely dispersed patches of seagrass occur and stony coral cover is less than 0.5%. A second distinct zone flanks both sides of the PHEC and consists of a fossilized reef platform. Depths on this platform range from approximately 1 to 20 m, the deeper end being located at the seaward end of the channel. Most of the fossilized reef platform is less than 4 m deep and is routinely subject to high wave energies. For the majority of the channel's length, there is a steep 25 to 45 degree (°) slope that joins the fossilized reef platform to the PHEC seafloor; however, there are also significant segments where there is a vertical wall joining the fossilized reef platform to the channel seafloor. Along the western side of the PHEC, most of these vertical walls appear to be natural, while those on the eastern side appear to be a mix of natural and dredged walls. The fourth ecological zone is located both seaward of and adjacent to the PHEC. It consists of poorly to modestly developed spur and groove coral reefs and fossilized reef platform areas. The spur and groove topography is best developed on the western side of the channel in depths of approximately 7 to 9 m. In this area the spurs range from 6 to 30 m in width and the grooves range from 3 to 14 m in width; spur height average is 1.5 m (Smith 2002). Along the eastern side of the PHEC, near the Pearl Harbor end of the channel, the fossilized reef platform is dotted with microatolls formed by *Porites lobata* (Scoffin and Stoddart 1978; Marine Research Consultants, Inc. 2001). Coral cover is highest on the western side of the PHEC (Marine Research Consultants, Inc. 2001; Smith pers. obs.).

1.3 STUDY SITES

Selected marine resources, including corals, fishes and sea turtles, were assessed at 18 sites within Pearl Harbor and 11 sites in or adjacent to the PHEC (**Figures 1-2a** and **1-2b**; **Table 1-1**). The assessments were conducted within relatively small areas and resulted in detailed site-specific information. Marine resources assessed here were encountered on hard substrates, unconsolidated substrates (gravel to soft bottom), and artificial substrates (wood, concrete, and metal structures) (**Table 1-1**).

Stephen H. Smith, Navy Technical Representative, designated the locations of the study sites. Geographical coordinates of study sites were recorded using a Global Positioning System (GPS) (**Table 1-1**). Fish and benthic communities were assessed in areas previously surveyed by Evans (1974), and Smith (2000 and 2002). Study sites were located in the PHEC environs (including Ahua Reef and Tripod Reef), and at selected shoreline sites within Pearl Harbor (**Figures 1-2a** and **1-2b**).

Characterization of Fish and Benthic Communities of
Pearl Harbor and Pearl Harbor Entrance Channel, Hawai'i NAVFAC, Pacific

Table 1-1. List of study sites and their location in Pearl Harbor (PH) and Pearl Harbor Entrance Channel (PHEC). PHEC sites extended from south of PH to the mouth of the PHEC. Pearl Harbor sites extended from the mouth of PHEC, up the main channels, and into the Lochs. [AS = Artificial Substrate; HB = Hard Bottom; SB = Soft Bottom; US = Unconsolidated Substrate]

Site #	Site (GMI Team)	Type	Location	Site #	Site (Navy Team)	Type	Location
1	**Ahua Reef Offshore** PHEC	HB	21°17.951 N 157°57.194 W	16	**Mokunui Island** (Ford Island Causeway, east side of Ford Island) PH	US HB	21°22.088 N 157°56.854 W
2	**Ahua Reef** PHEC	HB	21°18.113 N 157°57.361 W	17	**Ford Island South** (South end by seaplane ramp) PH	US	21°21.301 N 157°57.966 W
3	**Turtle/Tripod Reef** PHEC	HB	21°18.046 N 157°57.571 W	18	**PHEC, Outfall Aggregate Mound**	AS	21°18.025 N 157°57.315 W
4	**Outfall** PHEC	AS	21°17.876 N 157°57.278 W	19	**PHEC, Channel Bottom**	US	21°17.953 N 157°57.310 W
5	**PHEC, East Side, Opposite Buoy 5**	HB	21°18.918 N 157°57.802 W	20	**Tripod Reef** (Offshore Deep) PHEC	HB	21°17.894 N 157°57.635 W
6	**PHEC, West Side, Adjacent to Buoy 5**	US	21°18.892 N 157°58.017 W	21	**Dry Docks** PH	HB	21°21.157 N 157°57.680 W
7	**Bishop Point** (Channel Wall) PH	US HB	21°19.936 N 157°58.123 W	22	**Porites Reef, West Loch, Channel Bottom** PH	SB	21°20.692 N 157°58.766 W
8	**Waipio Point** PH	HB US	21°20.502 N 157°58.299 W	23	**Porites Reef, West Loch** PH	HB and US	21°20.678 N 157°58.760 W
9	**Dry Docks** (Facing crane P63) PH	HB	21°21.156 N 157°57.709 W	24	**Pearl City Peninsula** PH	US	21°22.192 N 157°58.198 W
10	**Beckoning Point** (Waipio Peninsula, East) PH	US SB	21°21.689 N 157°58.503 W	25	**Pearl City Peninsula** PH	SB	21°22.193 N 157°58.178 W
11	**Debris Field 1** (Entrance West Loch, East, submerged pier) PH	AS	21°20.668 N 157°58.528 W	26	**USS Utah** PH	AS	21°22.130 N 157°57.734 W
12	**Debris Field 3** (Entrance West Loch, West, Barge) PH	AS	21°20.854 N 157°58.683 W	27	**Iroquois Pt Landing** PH	AS SB	21°20.047 N 157°58.390 W
13	**Debris Field 3** (Entrance West Loch, West) PH	US	21°20.435 N 157°58.556 W	28	**PHEC, East Side, Opposite Buoy 5**	US	21°18.919 N 157°57.782 W
14	**Debris Field 2** (Entrance West Loch, East, Barge) PH	AS	21°20.451 N 157°58.575 W	29	**PHEC, East Side, Opposite Buoy 5**	HB	21°18.895 N 157°57.793 W
15	**Hospital Point** PH	US	21°20.811 N 157°58.049 W				

This page intentionally left blank.

2.0 MATERIALS AND METHODS

A combination of standard underwater survey methods was used to assess the fish and benthic communities within the study area. Each of these methods is described below. All observations were made using open circuit self contained underwater breathing apparatus (SCUBA), using compressed air or enriched air (NITROX).

2.1 Percent Cover Assessments

Quantitative benthic visual assessments of sessile and motile organisms (including turf algae, macroalgae, sponges, stony corals, and echinoderms) were done using two methods. One was a combination of line intercept and quadrat methods (English et al. 1994; Conand et al. 1999, 2000; Hill and Wilkinson 2004), hereafter referred to as the quadrat intercept method (QIM). The other technique was the point centered quarter method (PCQM) (Cottam and Curtis 1956; Dix 1961; Risser and Zedler 1968; Randall et al. 1988; Paulay et al. 2001).

Quadrat Intercept Method (QIM)—The percent cover of sessile and motile organisms was estimated within 50 centimeters (cm) by 50 cm quadrats randomly placed along randomly located transect lines. Each transect measured 20 m in length and was marked using a fiberglass measuring tape stretched out close to the benthic substrate. To increase the accuracy of the coverage estimates (actual percent cover within a quadrat), the quadrat was divided into one hundred 5 cm by 5 cm squares using 0.2 cm diameter plastic trimmer line threaded through pre-drilled holes. A photo was also taken of each quadrat as a permanent record, when turbidity conditions made this feasible.

The surveyed substrate was confined to a narrow depth range and in some cases to relatively small artificial substrates. Where possible, transects were set along random compass headings. Random transect headings (000-360) were generated from a table of random numbers (Rohlf and Sokal 1969). In areas where random headings could not be used (e.g., vertical substrates), transects were haphazardly placed while avoiding pseudo-replication. Eight quadrats were set at random distances along each transect (Hill and Wilkinson 2004). The random distances (00-20) were determined using a table of random numbers (Rohlf and Sokal 1969).

Point Centered Quarter Method (PCQM)—Smith (1999, 2002, unpublished data) previously utilized the PCQM at selected portions of the PHEC. Two of these locations, a segment of the Fort Kamehameha outfall corridor and Turtle/Tripod Reef (**Figure 1-2b**) were reassessed using the PCQM. To reduce the potential for investigator bias/error, Smith repeated these transects. General procedures of the PCQM were as follows:

a) Base points established during surveys in 1999 and 2002 were relocated. The 1999 points were relocated using GPS; the 2002 Turtle/Tripod Reef transect had been demarcated with steel pins, in addition to GPS. Those pins were simply relocated.
b) A transect line was established beginning at the base point and extended for 100 m along a predetermined depth contour.
c) Additional points were established at 20 m intervals along the transect line. At the base point, and at each 20 m point, the transect line was bisected at a 90° angle, thus creating four quarters around each point.
d) The distance from the point to the edge of the closest stony coral colony was then measured and recorded and the coral identified to the lowest possible taxa.
e) The identification of stony corals was based on Maragos (1995), Devaney and Eldredge (1977), and Veron (2000).
f) The greatest dimension of the colony, parallel to the substrate, was recorded.

Most of the coral colonies measured had a roughly circular 'footprint' on the seafloor. The greatest dimension, measured parallel to the seafloor, was considered to be a diameter from which the area of the seafloor covered by the colony could be determined. The actual area for colonies not having a circular footprint was either over- or under-estimated, depending on the shape of the colony. However, the most commonly encountered corals, within the areas where the PCQM was used were *Pocillopora meandrina, Pocillopora damicornis* and *Pocillopora eydouxi* all of which have generally circular growth patterns in this area.

2.2 FORT KAMEHAMEHA WASTEWATER OUTFALL PIPE

The waste water treatment plant at Fort Kamehameha located along the east side of the PHEC has a deep ocean outfall that currently disposes treated effluent into the open coastal waters of Mamala Bay. The outfall became operational on January 7, 2005 (DoN 2005). The pipe is made of polyvinyl chloride (PVC) and the piles are made of concrete.

A 50 m long section of the pile-supported segment of the outfall was surveyed between pile number 15 and pile number 20 (**Figure 2-1**). The inside diameter of the pipe is 1.2 m. The piles are on 9.5 m centers. The construction of the pile-supported segment began on September 12, 2003 and was completed on November 21, 2003. Our survey of the outfall pipe and piles took place on September 13, 2005, roughly two years following installation.

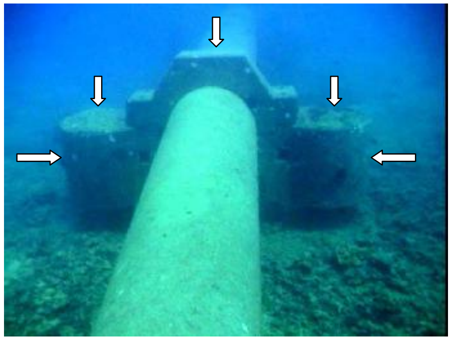


Figure 2-1. Fort Kamehameha wastewater outfall pipe and pile in a 27 m water depth, Pearl Harbor Entrance Channel, Mamala Bay, Hawai'í. Arrows point to where photo quadrats of the pile substrate were taken.

The surveyed portion of the outfall pipe was located at a depth of 27 m between the terminus of the trenched/buried portion of the outfall and the outfall diffuser. The sessile benthic taxa found on the sunlit (top) part of the pipe and piles were assessed using 18 random photo quadrats and a video transect. The video camera was moved perpendicularly over the outfall pipe in such a way that the entire width of the pipe was contained within the recorded image. Photo quadrats were taken vertically 1.5 m above the pipe. Each photo quadrat measured approximately 581 square centimeters (cm^2). A bubble level attached to the upper face of the underwater housing allowed the diver to position the camera in a vertical position above the pipe. The benthos on the piles was recorded using five photo quadrats per pile: two images of the sides of the pile and three images of the top of the pile (**Figure 2-1**). Photo quadrats were taken at each pile.

Live percent cover on the pipe and piles was estimated from the photo quadrats using the point count method (Aronson et al. 1994). Each photo quadrat was viewed on a personal computer and superimposed with random dots. The organism or substrate found below each dot was identified and recorded. The total observations (point counts) of a given species/substrate served as the basis for the

percent cover estimate. Based on previous experience in lower cover environments, we used 50 random dots per photo quadrat to estimate percent cover. The analysis of photo quadrats was done using the Geo-Marine, Inc. (GMI) software application Photo-Quadrat Analyzer (PQA). The software prepared individual images for analysis by superimposing independent sets of random dots on each image.

Statistical comparisons of live percent cover, colony size, and colony density were done for the different substrate types and exposures using the paired two-tailed t test (Zar 1984). Data sets used in each of the comparisons were tested for homogeneity of variances using Bartlett's test. When data were found to be non-homoscedastic, they were arcsine transformed before applying the t test (Zar 1984).

2.3 FISH AND MACROINVERTEBRATE BELT TRANSECTS

Thirty-two transects were completed at 17 locations to sample fish and diurnally exposed macroinvertebrate communities (**Table 2-1**). The latitude-longitude coordinates at each of the 17 sites were established using a hand-held GPS (Garmin 176-C). All transects were situated parallel to shore (or channels) and each individual transect was run along approximately the same depth contour except for two transects duplicating surveys conducted in the early 1970's.

In the PHEC seven transects were sampled at six different locations (**Table 2-1**). Inside of Pearl Harbor, there were 25 transects at 11 different locations (**Table 2-1**). At some locations, more than one transect was carried out; in these cases, transects were established at different depths.

Fish Belt Transects—On arrival at a given station, a visual fish census was undertaken first to estimate the abundance of fishes. This was conducted within a 25 m by 4 m corridor and all fishes within this area to the water's surface were counted. Data collected included species, numbers of individuals and an estimate of their length; the length data were later converted to standing crop estimates using linear regression techniques (Ricker 1975). A single diver equipped with SCUBA, transect line, slate and pencil entered the water, counted and noted all fishes in the prescribed area (method modified from Brock 1954). The 25 m transect line was laid out as the census progressed, thereby avoiding any previous underwater activity in the area which could frighten wary fishes. Fish abundance and diversity are often related to small-scale topographical relief over short linear distances. A long transect may bisect a number of topographical features (e.g., cross coral mounds, sand flats, and algal beds), thus sampling more than one community and obscuring distinctive features of individual communities. To alleviate this problem, a short transect (25 m in length) has proven adequate in sampling many Hawaiian benthic communities (Brock and Norris 1989).

Besides frightening wary fishes, other problems with the visual census technique include the underestimation of cryptic species such as moray eels (Muraenidae) and nocturnal species (e.g., squirrelfishes, Holocentridae; bigeyes, Priacanthidae). This problem is compounded in areas of high relief and coral coverage affording numerous shelter sites. Species lists and abundance estimates are more accurate for areas of low relief, although some fishes with cryptic habits or protective coloration (e.g., scorpionfish, Scorpaenidae; flatfishes, Bothidae) might still be missed. Obviously, the effectiveness of the visual census technique is reduced in turbid water and species of fishes that move quickly and/or are very numerous may be difficult to count and to estimate sizes. Additionally, bias related to the experience of the diver conducting counts should be considered in making any comparisons between surveys. In spite of these drawbacks, the visual census technique probably provides the most accurate non-destructive method available for the assessment of diurnally active fishes (Brock 1982).

Macroinvertebrate Belt Transects—After the assessment of fishes, an enumeration of epibenthic invertebrates (excluding corals) was undertaken using the same transect line as established for fishes. Exposed invertebrates usually greater than 2 cm in some dimension (without disturbing the substrate) were censused in a 4 m by 25 m area. This sampling methodology is quantitative for only a few invertebrate groups (e.g., some echinoids and holothurians, mollusks, a few crustaceans, and polychaetes). Most coral reef invertebrates (other than corals and some sponges) are cryptic or nocturnal in their habits making accurate assessment of them in areas of topographical complexity very difficult.

Table 2-1. Fish and macroinvertebrate sampling site numbers, substrate classification, station identifier, and site descriptions. Note that Stations A through F were established in the Pearl Harbor Entrance Channel while all others were in the confines of Pearl Harbor. [PHEC = Pearl Harbor Entrance Channel, SB = Soft Bottom, W = Wall, DF = Debris Field]

Site #	Fish Substrate Classification	Fish Station	Description
1		A	Entrance Channel east side (locID#4)
	PHEC		Transect #1, 14 m deep, hard substrate
2		B	Ahua reef between buoys 2 & 4 (locID#7)
	PHEC		Transect #2, 6 m deep, hard substrate
3		C	Turtle/Tripod Reef (locID#6a)
	PHEC		Transect #3, 9 to 12 m deep, along wall
4		D	Outfall Pipe/Stanchions (locID#1)
	PHEC		Transect #4, 8 to 8 m deep, sand substrate
5		E	Entrance Channel E opposite buoy 5 (locID#8)
	PHEC		Transect #5, 6 to 8 m deep, along wall
6		F	Entrance Channel W adjacent buoy 5 (locID#9)
	PHEC		Transect #6, 6 to 8 m deep, hard substrate
	PHEC		Transect #7, 11 m deep, rubble slope
7		G	Bishop Pt. N side channel wall (locID#10)
	W		Transect #8, 3 to 6 m deep, along wall
	SB		Transect #9, 12 m deep, rubble slope
8		H	Waipio Pt. by concrete platform E side (locID#13)
	W		Transect #10, 6 m deep, along wall
	SB		Transect #11, 12 m deep, rubble/mud slope
9		I	Drydock by Crane P63 (locID#18)
			Transect #12, 2 m deep, hard substrate
	W		Transect #13, 5 to 6 m deep, along wall
	SB		Transect #14, 12 m deep, rubble/mud slope
10		J	Beckoning Pt. east side (locID#14)
	SB		Transect #15, 1 to 1.5 m deep, sand slope with *Gracilaria salicornia*, Grovhoug transect
	SB		Transect #16, 1 to 12 m deep, down rubble/sand slope, Grouhoug transect
	SB		Transect #17, 3 to 5 m deep, sand/rubble slope
	SB		Transect #18, 9 to 12.5 m deep, mud substrate
11		K	Debris Field (Finger Pier) (locID#20)
	DF		Transect #19, 8.5 to 9 m deep, old finger pier ~50m long
12		L	Debris Field (metal box in shallow water)
	DF		Transect #21, 2 m deep, sand/rubble substrate around box
13		M	Debris Field (barge) (locID#22)
	DF		Transect #20, 9 to 12 m deep, barge
14		N	Debris Field (barge) (locID#4)
	DF		Transect #22, 3 to 5 m deep, barge
15		O	Hospital Pt. by concrete discharge
	W		Transect #23, 6 m deep, E side along wall, Grovhoug transect
	W		Transect #24, 6 m deep, W side along wall, Grovhoug transect
	SB		Transect #25, 11 to 12 m deep, rubble/sand
16		P	Mokunui Is. by Ford Is. Bridge (locID#16)
	W		Transect #26, 6 m deep, along mauka wall, Grovhoug transect
	W		Transect #27, 6 m deep, along makai wall, Grovhoug transect
			Transect #28, 3 to 11 m deep, over slope, Grovhoug transect
			Transect #29, 1.5 to 2.4 m deep, on top, mix of sand, rubble, hard substrate
	SB		Transect #30, 12 m deep, mud substrate
17		Q	Ford Is. makai end (locID#31)
			Transect #31, 1 to 2.4 m deep, mix of sand, rubble, concrete
	SB		Transect #32, 5 to 6 m deep, rubble/limestone slope

This, coupled with the fact that the majority of these cryptic invertebrates are small, necessitates the use of methodologies that are beyond the scope of this survey (e.g., Brock and Brock 1977). Recognizing constraints on time and the scope of this survey, the invertebrate censusing technique used here attempted only to assess those few macroinvertebrate species that are diurnally exposed.

2.4 Threatened and Endangered Species Assessment

The threatened green sea turtle (*Chelonia mydas*) is commonly sighted within the PHEC, and occasionally sighted within Pearl Harbor. Only three other protected marine species have been recorded within Pearl Harbor or the PHEC: the endangered hawksbill sea turtle (*Eretmochelys imbricata*), the endangered Hawaiian monk seal (*Monachus schauinslandia*), and the endangered humpback whale (*Megaptera novaeangliae*). Single sightings of the first two species were made by Smith on March 14, 2002 and August 9, 2005. Residents of the Iroquois Point housing area have periodically reported a single monk seals hauled out on the Iroquois Point beach. These sightings were made between 2001 and September 2006. This area is approximately 200 m west of the western edge of the study area. The Pearl Harbor Master reported the presence of an adult humpback and a calf in East Loch on March 21, 1998. The whale sighting is considered to be an extraordinarily unusual event. The team was prepared to identify sea turtles and monk seals and to record as much information as possible. This information would include:

- Activity when first sighted (swimming, resting, foraging, being cleaned)
- Carapace length for sea turtles (<0.5 m; >0.5 m – 1.0 m; >1.0 m)
- Total length for monk seal
- Presence/absence of fibropapilloma tumors for turtles
- Presence/absence of other distinguishing features, such as tags, or scars.

In addition to recording the presence of these protected species at each study site, a census of green sea turtles was made by Smith. During the month following our field work, each study site was visited for a period of 15 minutes. Each sighting was recorded as a separate event, unless more than one individual could be seen at once, and/or individuals could be positively identified based upon distinguishing characteristics. Therefore, if four separate green sea turtles were seen simultaneously, and then they disappeared, this was recorded as four individuals. If a single turtle was seen four times during a dive, and it could not be determined if it was the same individual, this was recorded as four sightings. During the course of the 2005 surveys, only green sea turtles were observed.

This page intentionally left blank.

3.0 RESULTS

3.1 BENTHIC COMMUNITIES

Benthic data were collected at a total of 20 of the 29 sites within the PHEC and Pearl Harbor (including two survey locations at Iroquois Point). The number of transects, number of quadrats, and substrate type for each site are listed in **Table 3-1**.

Table 3-1. List of sites where benthic communities were assessed within the Pearl Harbor Entrance Channel (PHEC) and Pearl Harbor (H) and their corresponding site numbers, locations, sample sizes; and underlying substrates.

Site	Site #	Location	Number of Benthic Transects	Number of Quadrats	Substrate Type
Ahua Reef Offshore	1	PHEC	4	32	Hard Bottom
Ahua Reef	2	PHEC	4	32	Hard Bottom
Tripod Reef	3	PHEC	4	31	Hard Bottom
Ft. Kamehameha Outfall	4	PHEC	1	18	Artificial Substrate
PHEC, Opp. Buoy 5	5	PHEC	4	32	Hard Bottom
PHEC, West at Buoy 5	6	PHEC	4	32	Unconsolidated Substrate
Bishop Point	7	H	4	32	Hard Bottom/Unconsolidated Substrate
Waipio Point	8	H	4	32	Hard Bottom/Unconsolidated Substrate
Dry Dock	9	H	4	32	Hard Bottom
Beckoning Point	10	H	4	32	Soft Bottom
Debris Field 1	11	H	4	31	Artificial Substrate
Debris Field 3 Barge	12	H	3	19	Artificial Substrate
Debris Field 3	13	H	3	24	Unconsolidated Substrate
Debris Field 2	14	H	4	15	Artificial Substrate
Hospital Point	15	H	3	24	Unconsolidated Substrate
Mokunui	16	H	3	24	Hard Bottom/Unconsolidated Substrate
Porites Reef - deep	22	H	4	32	Soft Bottom
Porites Reef - shallow	23	H	4	32	Hard Bottom/Unconsolidated Substrate
Iroquois Point	27a	H	4	32	Soft Bottom
Iroquois Point - wall	27b	H	4	32	Artificial Substrate

3.1.1 Fort Kamehameha Outfall Pipe and Piles

Pipe—The quantitative assessment of the benthos on the sunlit portion of a 50 m section of the Fort Kamehameha outfall pipe was based on random photographic quadrats taken on September 13, 2005, two years following the pipe emplacement. The video transect of the pipe gave an overall non-quantitative perspective of the sessile organisms having grown on the pipe.

Overall, the sunlit portion of the section of the outfall pipe surveyed was almost entirely covered by turf algae (mean percent cover: 99.2% ± 1.3 Standard Deviation [SD], n = 17) (**Table 3-2**). Few areas of small hard coral (scleractinian) colonies (0.5% ± 1.3 SD), small patches of crustose coralline algae (0.1% ± 0.5 SD), and small areas colonized by encrusting sponges (0.1% ± 0.5 SD) were located in the study area. While hardened calcium carbonate polychaete tubes were observed on the sunlit portion of the pipe, they were too few to be accounted for in terms of percent cover using the point count method. The density of coral colonies was relatively low and highly variable: 0.8 coral colonies per random quadrat

Table 3-2. Percent cover (%) of hard corals, encrusting sponges, turf algae, and crustose coralline algae in 17 random photographic quadrats of a 50 m section of the sunlit side of the Fort Kamehameha outfall pipe between the micro-tunneled shoreline and the outfall diffuser. Data were collected on September 13, 2005, two years after pipe installation. [SD = Standard Deviation; CCA = Crustose Coralline Algae]

Statistic	Hard Corals	Encrusting Sponges	Turf Algae	CCA
Mean	0.5	0.1	99.2	0.1
SD	1.3	0.5	1.3	0.5

(± 1.2 SD, *n* = 17) (which corresponded to a density of 14.2 coral colonies per square meters [m^2] ± 21.3 SD). Corals were represented by at least three species from three genera, *Pocillopora meandrina*, *Porites sp.* and *Montipora sp.* The diameters of corals ranged from 0.7 to 3.7 cm (mean diameter: 1.9 cm ± 1.1 SD, *n* = 20). Patches of crustose coralline algae measured on average 1.1 cm (± 1.7 SD; *n* = 10).

Piles—The sessile benthos was assessed on five piles located within a 50 m section of the outfall pipe. Much like the sunlit portion of the outfall pipe, the majority of the sessile benthic cover consisted of turf algae (89.0% ± 12.7 SD, *n* = 24). The remaining sessile cover included highly variable cover values of hard corals, encrusting sponges, crustose coralline algae, and sessile bivalves (**Table 3-3**). Comparing the mean cover made of corals, encrusting sponges, crustose coralline algae, and sessile bivalves between the tops (4.5% ± 3.4 SD, *n* = 15) and the sides (21.7% ± 15.3 SD, *n* = 9) of the piles, we found that the sides of the piles supported significantly greater cover that the tops of the piles ($t_{0.05\ (2),\ 22}$ = 4.18; *P* = 0.001). There was no significant difference in percent live cover (corals, encrusting sponges, crustose coralline algae, and sessile bivalves) between the east-exposed and west-exposed sides of the piles ($t_{0.05\ (2),\ 7}$ = -1.50; *P* = 0.18).

Table 3-3. Percent cover (%) of hard corals, bivalves, encrusting sponges, turf algae, and crustose coralline algae in 24 photographic quadrats of five piles supporting the Fort Kamehameha outfall pipe. Data were collected on September 13, 2005, two years after pipe installation. [SD = Standard Deviation; CCA = Crustose Coralline Algae]

Statistic	Hard Corals	Bivalves	Encrusting Sponges	Turf Algae	CCA
Mean	0.3	0.6	7.1	89.0	3.0
SD	1.0	1.9	11.4	12.7	4.8

The mean diameter of hard corals on the piles was 1.6 cm (± 0.9 SD, *n* = 31). The patches of crustose coralline algae measured on average 1.9 cm (± 2.5 SD, *n* = 78). The density of corals was highly variable: 1.8 individuals per random quadrat (± 1.8 SD, *n* = 24) (which corresponded to 30.1 individuals/m^2 ± 31.8 SD).

3.1.2 Natural and Artificial Seafloor Substrates (Excluding Outfall Pipe)

3.1.2.1 Quadrat Intercept Method Transects

Using QIM transects, percent substrate cover (including biotic and abiotic categories) was assessed at each of the sites (**Figure 3-1**). Live cover categories included live coral, zoanthid, sponge, oyster, echinoid, annelid, crustacean, and tunicate cover (**Figure 3-2**). Mean total live cover, averaged for all

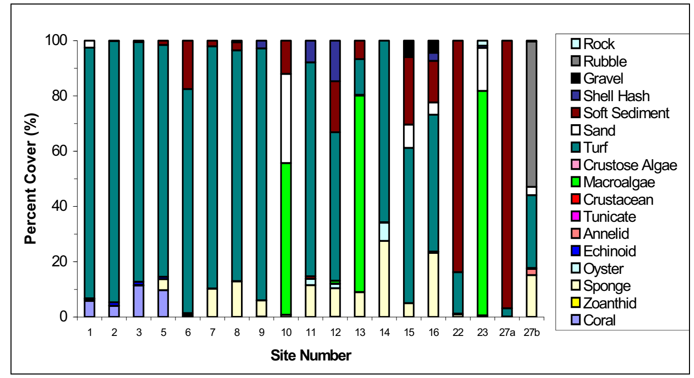


Figure 3-1. Percent cover of substrates and biota (sessile and motile) in Quadrat Intercept Method transects at Pearl Harbor Entrance Channel and Pearl Harbor sites.

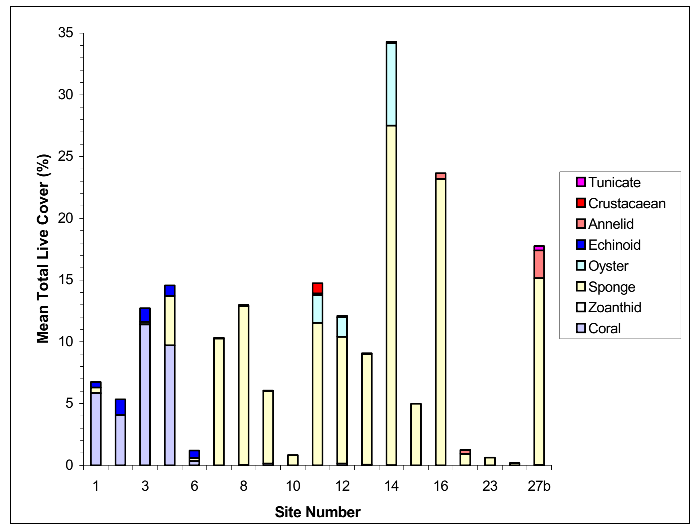


Figure 3-2. Mean total live cover of sessile and motile organisms in Quadrat Intercept Method transects at Pearl Harbor Entrance Channel and Pearl Harbor sites.

sites, was 9.97% (± 8.81 SD). Live coral and sponge cover were highly variable contributing 1.68% (± 6.28 SD) and 7.27% (± 8.12 SD), respectively. The greatest amount of live coral cover among sites was recorded at Turtle/Tripod Reef, located south of the PHEC: 11.42% (± 1.71 Standard Error [SE]). Debris Field 2 had the highest mean total live cover at 34.31% (± 7.21 SE) with 27.5% (± 3.66 SE) attributed to sponge cover.

Live cover was dominated by turf algae. Mean turf cover was 73.43% (± 20.11 SD), excluding sites where macroalgae were present and/or sites with soft bottom substrates where turf algae could not adhere (for example Beckoning Point and Porites Reef – deep). Crustose coralline algae were recorded in a total of three quadrats at only three sites (Debris Field 3, Hospital Point, and Mokunui) with percent cover in these quadrats ranging from 1% to 6%.

Three sites in Pearl Harbor (Beckoning Point, Debris Field 3, and Porites Reef - shallow) supported substantial macroalgal cover (gorilla seaweed, *Gracilaria salicornia,* Rhodophyta) overlying either unconsolidated or soft bottom substrates. At Beckoning Point, there was 54.91% (± 11.74 SE) *G. salicornia* cover. At Debris Field 3 and Porites Reef – shallow, the *G. salicornia* cover amounted to 71.08% (± 7.09 SE) and 81.22% (± 10.81 SE), respectively.

Figures 3-3 and **3-4** present mean total live cover for PHEC and Pearl Harbor sites. At PHEC sites, live cover consisted mainly of corals (scleractinians) and echinoderms. Sponges dominated live cover in Pearl Harbor sites. All of the Pearl Harbor sites had less than 0.2% mean live coral (scleractinian) cover. PHEC sites had a mean live coral cover of 6.28% (± 4.43 SD) which was higher than that found in Pearl Harbor but still highly variable.

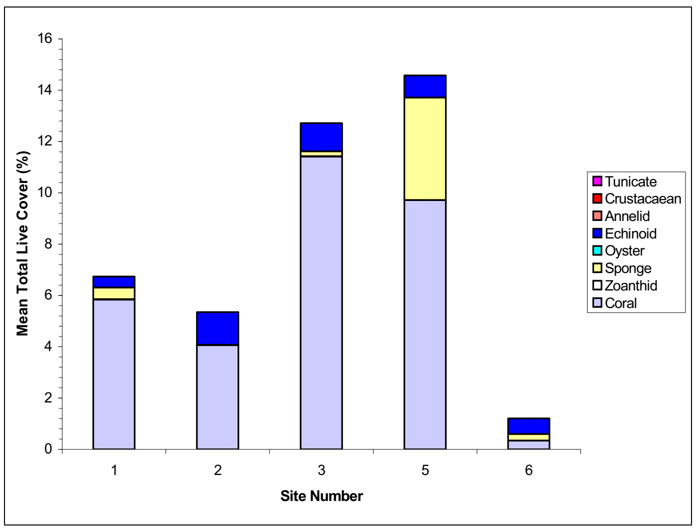


Figure 3-3. Mean total live cover by sessile organism category in Quadrat Intercept Method transects at Pearl Harbor Entrance Channel sites.

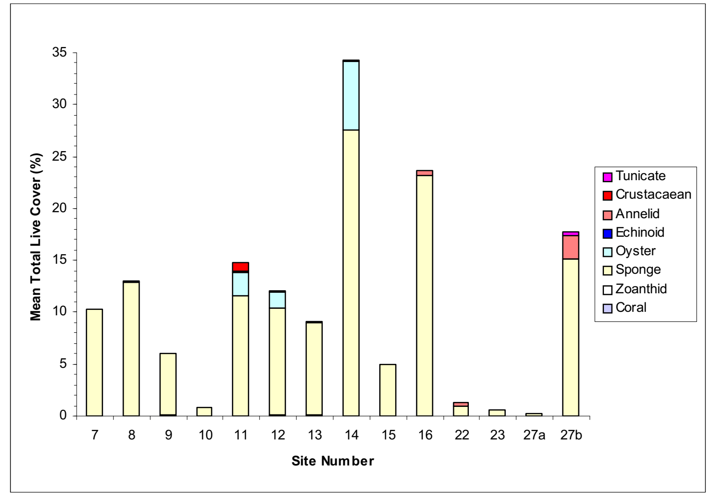


Figure 3-4. Mean total live cover by sessile organism category in Quadrat Intercept Method transects at Pearl Harbor sites.

Of the PHEC sites, site 6 (west side of channel at Buoy 5) had less live coral cover (0.34% ± 0.15 SE) than the rest of the PHEC sites (Sites 1, 2, 3, and 5), most likely due to a difference in substrate type. The substrate at site 6 was unconsolidated while there was hard bottom at the other PHEC sites. Sponges covered more area in Pearl Harbor sites (9.51% ± 8.36 SD) than PHEC sites (0.98% ± 1.70 SD).

The introduced eastern oyster, *Crassostrea virginica*, was recorded at three sites in Pearl Harbor (debris fields at sites 11 through 14), all located in the West Loch and all consisting of artificial substrate. The eastern oyster was recorded in 16 of the 65 quadrats surveyed at these three sites. Percent cover values were highly variable and ranged from 6.67% (± 6.67 SE) at Site 14 (Debris Field 2) to 1.56% (± 1.11 SE) at Site 12 (Debris Field 3 bis Barge).

The featherduster worm, *Sabellastarte spectabilis*, was recorded in 10 of the 14 study sites in Pearl Harbor. Barnacles were recorded on an artificial substrate at Site 11 (Debris Field 1) located in Pearl Harbor. Echinoids were only recorded at PHEC sites (Sites 1, 2, 3, 5, and 6) and their mean live cover was 0.85% (± 0.34 SD) cover.

Substrate types (hard bottoms, soft bottoms, unconsolidated substrates, and artificial substrates) and associated live cover were further examined. Of the four substrate categories, artificial substrate supported the greatest amount of live cover (19.73% ± 9.99 SD). Sponge cover was recorded on all substrate types but was particularly prominent on artificial substrates, where it represented 75% of the live cover (16.11% ± 7.87 SD), and on unconsolidated substrates where sponges represented 93% of the live cover (4.74% ± 4.36 SD) (**Figure 3-5**). Soft bottom substrates supported low live cover (0.72% ± 0.44 SD) compared to other substrate types; most of the live cover consisted of sponges. Compared to other substrates, hard bottoms supported less live cover (9.09% ± 4.24 SD). Yet, hard bottoms supported more coral cover (6.24% ± 4.50 SD) than artificial substrates (0.05% ± 0.07 SD).

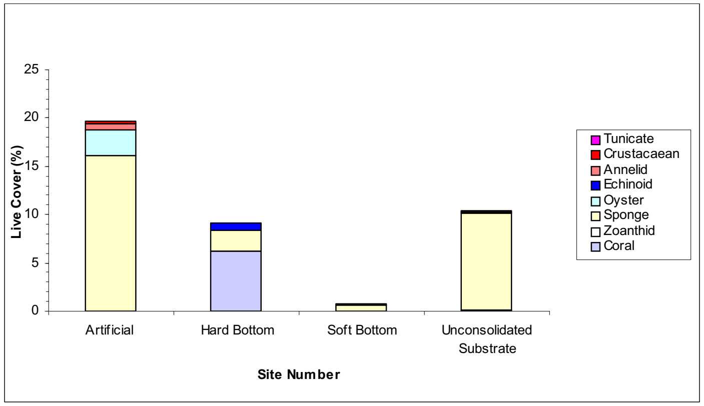


Figure 3-5. Mean total live cover by substrate type in benthic transects at 19 sites in Pearl Harbor.

3.1.2.2 Point Centered Quarter Method Transects

Two separate locations, which had been previously surveyed using PCQM transects, were re-evaluated during this project. The first location had been surveyed in July and August of 2000, as part of the Fort Kamehameha Outfall Extension Project. This site was re-evaluated using only the PCQM. The second location, Turtle/Tripod Reef, had been initially surveyed in August of 2002. At that time permanent markers were installed to facilitate future monitoring. Both of these PCQM surveys were initially conducted by Smith; to minimize investigator bias, the 2005 measurements were also done by Smith. During this project, Turtle/Tripod Reef was also assessed using QIM transects.

Outfall Corridor—In support of the Fort Kamehameha Outfall Replacement Project, in 2000, 17 PCQM transects were completed, covering a linear distance of 2,100 m, 85% of which were at a depth of 15 m. The seafloor in this area consisted of coarse sand and rubble. Surveys Smith conducted in 2000 were completed prior to any construction activity. The current study replicated a segment of the 2000 survey by completing 140 m of the PCQM transects at a depth of 15 m in the coarse sand and rubble zone.

The 2000 survey area was eventually trenched in 2003. After the outfall pipe was placed in the trench it was buried and covered with heavy aggregate, concrete pillows, and lastly with the naturally occurring sand and rubble which had been removed to form the trench (and piled adjacent to it for reuse). At the time of the 2005 survey, the area of the seafloor that was assessed had the same general appearance that it had in 2000.

In 2005, *Pocillopora meandrina* comprised 75% of all the colonies measured and the mean colony size was 17 cm^2. The other species which were identified within and/or adjacent to the PCQM transects were: *Montipora capitata, Montipora flabellata, Pavona duerdeni, Porites lobata* and *Porites* sp. The mean area within which all coral colonies were located was 9.9 m^2; the percentage of the seafloor covered by coral was 0.02%.

Turtle/Tripod Reef—In 2002, this site supported the densest concentration of stony corals within or adjacent to Pearl Harbor or the PHEC. At Turtle/Tripod Reef corals grew in tiers or layers, and the PCQM transects yielded percent cover estimates that exceeded 100%. This was caused by branching colonies

of *Pocillopora meandrina* and *Pocillopora eydouxi* underlain by well-developed encrusting forms of *Porites lobata, M. capitata,* and *M. flabellata*. As a result of these growth patterns, the PCQM cover estimates made in 2002 were 188%. The 2005 results were dramatically different; the PCQM-estimated live coral cover was 15%; the QIM transects yielded an 11% coral cover estimate. The majority of large colonies of *P. meandrina, P. eydouxi,* and *P. lobata* located on Turtle/Tripod Reef were dead in 2005. Most *P. lobata* colonies seen in 2002 were encrusting growth forms. Those which were still alive in 2005 were predominately head-forming colonies. Most of the dead colonies of all species were structurally intact yet heavily overgrown with crustose coralline algae. Based upon their appearance and condition of the corallites, the corals appeared to have been dead for about two years. Mean colony size, spacing and dominance rankings, based upon frequency of occurrence and the percentage of the seafloor occupied are shown in **Table 3-4**. It should be noted that neither the PCQM, nor most other benthic survey methods, provide an estimate of the volumetric displacement of coral colonies. If volumetric displacement had been assessed, the upright, branching colonies of *P. meandrina* and *P. eydouxi* would have displaced *P. lobata* as the dominant coral in the survey area. It was also observed that there were large numbers of coral recruits and juvenile corals (less than 3 cm in diameter) growing within and adjacent to the PCQM transect corridor.

Table 3-4. Comparison of the coral population status at Turtle/Tripod Reef in 2002 and 2005 based on Point Centered Quarter Method (PCQM) and Quadrat Intercept Method (QIM) data. [P = *Porites* sp.; PL = *Porites lobata*; PM = *Pocillopora meandrina*; M = *Montipora* sp.; MCF = *Montipora capitata* and *Montipora flabellata*]

Date	Method	Quarters With Coral (%)	Mean Colony Size (cm^2)	Mean Area Including Coral Colony (cm^2)	Coral Cover (%)	Dominant Species by Occurrence	Dominant Species by Cover
Jul & Aug 2002	PCQM	100	423	225	>100	PL PM MCF	PL PM MCF
Sep 2005	PCQM	100	154	1024	15.0	PL MCF PM	MCF PM PL
Sep 2005	QIM	NA	—	—	11.4	PM P M	PM P M

3.2 Fish Communities

In total, 90 species of fishes from 26 families were recorded; 64 species were found at the seven transects carried out along the PHEC and 48 species inside of Pearl Harbor at transect numbers 8 through 32 (**Table 3-5**; **Appendix 1**). None of the fish species encountered in this survey were unusual or rare but the sizes of many individuals of some species were unusually large.

In general, coral reef fishes are usually more abundant in areas where shelter is more available. To demonstrate this hypothesis, transects were grouped according to the relative abundance of shelter at each and the abundance of fishes was compared. Transects were assigned to one of four categories: PHEC sites (all with reasonably well-developed cover and all subjected to less environmental stress than in Pearl Harbor sites) and Pearl Harbor sites on (a) soft substrate with low local cover, (b) along channel walls providing some shelter and (c) in debris fields where shelter is high. The fish community parameters measured included the number of species, the abundance of each species and the estimated standing crop of fish present at transect site. These data are summarized in **Table 3-6**. Seven transects (numbers 1 through 7) were conducted in the PHEC, ten on sediment substrates (transect numbers 9, 11, 14 through 18, 25, 30, 32), seven along walls in Pearl Harbor (numbers 8, 10, 13, 23, 24, 26, 27) and four in

Table 3-5. List of fish species observed within Pearl Harbor and the Pearl Harbor Entrance Channel in this study.

Species	Family	Common Name
Acanthurus blochi	Acanthuridae	ringtail surgeonfish
Acanthurus dussumieri	Acanthuridae	eyestripe surgeonfish
Acanthurus nigrofuscus	Acanthuridae	brown surgeonfish
Acanthurus nigroris	Acanthuridae	blue-lined surgeonfish
Acanthurus olivaceus	Acanthuridae	orangeband surgeonfish
Acanthurus triostegus	Acanthuridae	convict tang
Acanthurus xanthopterus	Acanthuridae	yellowfin surgeonfish
Ctenochaetus strigosus	Acanthuridae	spotted surgeonfish
Naso brevirostris	Acanthuridae	spotted unicornfish
Naso hexacanthus	Acanthuridae	sleek unicornfish
Naso lituratus	Acanthuridae	orangespine unicornfish
Naso unicornis	Acanthuridae	bluespine unicornfish
Zebrasoma flavescens	Acanthuridae	yellow tang
Zebrasoma veliferum	Acanthuridae	Pacific sailfin tang
Apogon kallopterus	Apogonidae	iridescent cardinalfish
Foa brachygramma	Apogonidae	weed cardinalfish
Pranesus insularum	Atherinidae	Hawaiian islands silverside
Aulostomus chinensis	Aulostomidae	trumpetfish
Rhinecanthus rectangulus	Balistidae	wedgetail triggerfish
Sufflamen bursa	Balistidae	scythe triggerfish
Caranx ignobilis	Carangidae	giant trevally
Caranx melampygus	Carangidae	bluefin trevally
Decapterus macarellus	Carangidae	mackerel scad
Gnathanodon speciosus	Carangidae	golden trevally
Scomberoides laysan	Carangidae	double-spotted queenfish
Chaetodon auriga	Chaetodontidae	threadfin butterflyfish
Chaetodon ephippium	Chaetodontidae	saddle butterflyfish
Chaetodon lunula	Chaetodontidae	raccoon butterflyfish
Chaetodon lunulatus	Chaetodontidae	oval butterflyfish
Chaetodon miliaris	Chaetodontidae	millet butterflyfish
Chaetodon multicinctus	Chaetodontidae	pebbled butterflyfish
Chaetodon quadrimaculatus	Chaetodontidae	fourspot butterflyfish
Chaetodon unimaculatus	Chaetodontidae	teardrop butterflyfish
Forcipiger flavissimus	Chaetodontidae	longnose butterflyfish
Chanos chanos	Chanidae	milkfish
Paracirrhites arcatus	Cirrhitidae	arc-eye hawkfish
Paracirrhites forsteri	Cirrhitidae	blackside hawkfish
Diodon hystrix	Diodontidae	porcupinefish
Elops hawaiiensis	Elopidae	ten-pounder or ladyfish
Asterropteryx semipunctatus	Gobiidae	starry goby
Bathygobius fuscus	Gobiidae	dusky frillgoby
Gnatholepis anjerensis	Gobiidae	no common name
Psilogobius mainlandi	Gobiidae	Hawaiian shrimp goby
Myripristis amaenus	Holocentridae	brick soldierfish
Sargocentron punctatissimum	Holocentridae	speckled squirrelfish
Bodianus bilunulatus	Labridae	saddleback hogfish
Cheilinus bimaculatus	Labridae	twospot wrasse
Coris gaimard	Labridae	yellowtail coris

Table 3-5 (Continued). List of fish species observed within Pearl Harbor and the Pearl Harbor Entrance Channel in this study.

Species	Family	Common Name
Coris venusta	Labridae	elegant coris
Gomphosus varius	Labridae	bird wrasse
Halichoeres ornatissimus	Labridae	ornate wrasse
Labroides phthirophagus	Labridae	Hawaiian cleaner wrasse
Oxycheilinus unifasciatus	Labridae	ringtail wrasse
Pseudocheilinus octotaenia	Labridae	eightstripe wrasse
Pseudojuloides cerasinus	Labridae	smalltail wrasse
Stethojulis balteata	Labridae	belted wrasse
Thalassoma duperrey	Labridae	saddle wrasse
Thalassoma purpureum	Labridae	surge wrasse
Lutjanus fulvus	Lutjanidae	blacktail snapper
Cantherhines dumerili	Monacanthidae	yelloweye filefish
Cantherhines sandwichiensis	Monacanthidae	Sandwich Isle filefish
Mugil cephalus	Mugilidae	flathead mullet
Mulloides flavolineatus	Mullidae	yellowstripe goatfish
Mulloides vanicolensis	Mullidae	yellowfin goatfish
Parupeneus bifasciatus	Mullidae	doublebar goatfish
Parupeneus cyclostomus	Mullidae	goldsaddle goatfish
Parupeneus multifasciatus	Mullidae	manybar goatfish
Parupeneus porphyreus	Mullidae	whitesaddle goatfish
Echidna nebulosa	Muraenidae	snowflake moray
Gymnothorax flavimarginatus	Muraenidae	yellow-edged moray
Gymnothorax meleagris	Muraenidae	whitemouth moray
Parapercis schauinslandi	Parapercidae	redspotted sandperch
Pomacanthus imperator	Pomacanthidae	emperor angelfish
Abudefduf abdominalis	Pomacentridae	green damselfish
Abudefduf sordidus	Pomacentridae	blackspot sergeant
Chromis vanderbilti	Pomacentridae	Vanderbilt's chromis
Dascyllus albisella	Pomacentridae	Hawaiian dascyllus
Plectroglyphidodon imparipennis	Pomacentridae	brighteye damselfish
Plectroglyphidodon johnstonianus	Pomacentridae	Johnston Island damselfish
Stegastes fasciolatus	Pomacentridae	Pacific gregory
Priacanthus cruentatus	Priacanthidae	glasseye
Calotomus carolinus	Scaridae	stareye parrotfish
Chlorurus sordidus	Scaridae	bullethead parrotfish
Scarus perspicillatus	Scaridae	spectacled parrotfish
Scarus psittacus	Scaridae	palenose parrotfish
Scarus rubroviolaceus	Scaridae	redlip parrotfish
Cephalopholis argus	Serranidae	peacock grouper
Monotaxis grandoculis	Sparidae	humpnose big-eye bream
Sphyraena barracuda	Sphyraenidae	great barracuda
Hippocampus kuda	Syngathidae	spotted seahorse
Saurida gracilis	Synodontidae	slender lizardfish
Arothron hispidus	Tetraodontidae	white-spotted pufferfish
Canthigaster coronata	Tetraodontidae	crown toby
Canthigaster jactator	Tetraodontidae	Hawaiian whitespotted toby
Zanclus cornutus	Zanclidae	Moorish idol

Table 3-6. Summary of biological parameters measured at 28 of the 32 fish belt transects surveyed in this study. These transects are grouped according to substrate type or rugosity and/or by location. Means of parameters are given for each group.

Substratum or Location	Transect Number	Number of Species	Number of Individuals	Biomass (g/m^2)
Entrance Channel				
	1	13	105	14
	2	28	320	215
	3	33	208	414
	4	20	170	126
	5	8	40	2
	6	10	79	7
	7	3	18	3
Means		***16***	***134***	***112***
In Pearl Harbor Soft Substratum				
	9	3	16	1
	11	9	91	66
	14	3	8	55
	15	3	7	3
	16	3	68	2
	17	1	4	>0.1
	18	0	0	0
	25	1	1	18
	30	0	0	0
	32	7	77	35
Means		***3***	***27***	***18***
In Pearl Harbor Along Walls				
	8	14	281	184
	10	14	336	547
	13	8	222	187
	23	17	270	612
	24	13	148	162
	26	3	59	172
	27	6	37	26
Means		***11***	***193***	***270***
In Pearl Harbor Debris Fields				
	19	20	924	1550
	20	16	690	1343
	21	7	314	487
	22	21	2347	490
Means		***16***	***1069***	***968***

debris fields in Pearl Harbor (numbers 19 through 22). Four stations in Pearl Harbor were not included in this analysis; three of these (numbers 28, 29, and 31) were conducted on a mixed substrate (hard and sedimentary materials) and one (transect number 12) on a singular sampled habitat type in Pearl Harbor (shallow smooth limestone). Inclusion of these sites for the analysis below increases variance; thus, they were not considered further.

To test the hypothesis that shelter space or cover is important to the observed distribution of fishes, we compared the means of the three parameters, number of fish species, number of individual fish, and fish biomass, measured at transects in each of the four substrates/locations (i.e., the PHEC, in Pearl Harbor soft substrate, in Pearl Harbor along channel walls, and in Pearl Harbor debris fields). Mean parameter measurements were compared among the four substrates/locations using the nonparametric Kruskal-

Wallis Analysis of Variance (ANOVA) which determines whether significant differences exist and the Student-Newman-Keuls (SNK) Test to show where those differences actually are.

Table 3-7 presents the results of the Kruskal-Wallis ANOVA and the SNK Test for these data. The Kruskal-Wallis ANOVA found significant differences in the means for all three parameters as measured in the four groups. However, the SNK Test did not find a clear statistical separation among the four transect groups for the number of fish species (**Table 3-7**) but both the number of individual fish and standing crop of fish in Pearl Harbor debris fields transects are significantly greater than any of the other three transect groupings. In summary, there were significantly more fish and a significantly greater standing crop of fishes in the sampled debris fields in Pearl Harbor than at other sampled locations.

Table 3-7. Summary of the Kruskall-Wallis ANOVA and Student-Newman-Keuls (SNK) Test applied to the parameters (number of fish species, number of individuals, and estimated standing crop) measured at four groupings of sample sites: entrance channel sites (n=7), debris field sites (n=4), channel wall sites (n=7), and sedimentary (soft) bottom sites (n=10). Letters with the same designation show means that are related; changes in letter designation show where significant differences exist. Overlaps in letters indicate a lack of significant differences; in such cases, only the extremes may be significantly different.

Number of fish species (P >0.002)

Location	Mean	SNK Grouping	
Entrance Channel	16.4	A	
Debris Fields	16.0	A	
Channel Walls	10.7	A	B
Sediment Bottom	3.0	B	
Interpretation	Greater diversity of fish species at the PHEC stations because of distance/lessening impact of sediment/freshwater input at the Pearl Harbor head, however, statistical separation is weak.		

Number of individual fish (P >0.0005)

Location	Mean	SNK Grouping	
Debris Fields	1,068.8	A	
Channel Walls	193.3		B
Entrance Channel	134.3		B
Sediment Bottom	27.2		B
Interpretation	Numbers of fish are significantly greater in the debris fields than over other sampled areas.		

Estimated Standing Crop (P >0.0007)

Location	Mean	SNK Grouping	
Debris Fields	967.5	A	
Channel Walls	270.0		B
Entrance Channel	111.6		B
Sediment Bottom	18.0		B
Interpretation	Significantly greater biomass of fishes at debris field stations over other sampled areas.		

3.3 MACROINVERTEBRATE COMMUNITIES

Table 3-8 presents a list of the species and numbers of individuals of each of those species encountered in the 25 m by 4 m transect areas of each of the 32 fish belt transects. At the foot of **Table 3-8** are the total number of species and individuals found on each transect; transect numbers 1 through 7 (PHEC) had a mean of 5.6 species and 107.6 individuals per transect and the inner Pearl Harbor transect means were 2.2 species and 26.6 individuals per transect. The higher numbers in the PHEC probably reflect the more marine conditions present relative to the inner reaches of Pearl Harbor.

There were no rare macroinvertebrate species at any of the 32 transect sites surveyed in this study; however several species were observed which are infrequently sighted around O'ahu. It should be noted that the pearl oyster (*Pinctada margaritifera*) was seen at two PHEC transects and at three transects in the inner Pearl Harbor. For many years, pearl oysters have been virtually absent from inner Pearl Harbor; the increasing numbers of this species in the inner Pearl Harbor is probably related to the improving environmental conditions of the area in recent years. Large specimens of the horned helmet (*Cassis cornuta*) and Triton's trumpet (*Charonia tritonis*) were seen in the PHEC. These shells are highly prized by collectors and specimens of the sizes recorded (30 cm and 40 cm, respectively) are uncommon. In addition to these sightings, an aggregation of 56 of the uncommon blue-spinned urchin (*Astropyga radiata*) were recorded by Smith in the PHEC in June 2002. The urchins were all physically touching one another and remained in the area for one week and then disappeared.

The presence or absence of specific macroinvertebrate species in this survey is related to the substrate present in the transect area. The presence of hard substrate (limestone or anthropogenic surfaces such as concrete or steel) will usually allow a greater development of visually obvious benthic species than will be found on soft (mud or sand) substrates. However, considering only transects within Pearl Harbor (transect numbers 8 through 32), commercially important crab species (*Portunus sanguinolentus, Podophthalmus vigil, and Thalamita crenata*) were all encountered on transects dominated by unconsolidated sediments. Conversely, *Echinothrix diadema*, the banded urchin (*Echinothrix calamaris)*, brown sea cucumber (*Actinopyge mauritana*), and pink sea cucumber (*Opheodesoma spectabilis*), which are not particularly common in Pearl Harbor, were found on transects dominated by hard substrate.

3.4 THREATENED AND ENDANGERED SPECIES

As previously noted, the only protected marine species sighted during this study was the threatened green sea turtle. Specimens of this species were observed inside Pearl Harbor and within the PHEC (**Table 3-9**).

A total of 58 green sea turtle sightings were made in the PHEC or the adjacent study areas. The total observation time was approximately 135 minutes. The largest number of individuals sighted simultaneously was 13, at Turtle/Tripod Reef. The second largest number was on the Outfall Extension Pipe, where nine individuals were simultaneously counted as they rested between the bottom of the pipe and the seafloor. Insufficient data is available to determine the actual number of separate individuals sighted during this survey. There were only seven sightings within Pearl Harbor and no more than a single individual was ever seen at one time. The total observation time within Pearl Harbor was approximately 270 minutes. Of all the sightings at all locations, 26 were females, 17 were males and the remaining 22 were undetermined. Ten of the green sea turtles seen at Turtle/Tripod Reef and all of the turtles under the outfall pipe were estimated to have carapace lengths over 100 cm, with four specimens estimated to exceed 130 cm. When first observed, eight of the specimens were apparently being cleaned; 33 were resting and 24 were swimming. None of the individuals appeared to be feeding. While conducting a fish transect, one of the field investigators (Evans) recorded a specimen estimated to have a carapace length of 170 cm.

Forty two of the 58 sightings outside Pearl Harbor were either at Turtle/Tripod Reef or underneath the Outfall pipe. All of the cleaning activity was noted at Turtle/Tripod Reef where a cleaning station appears to be located. On three separate dives during this study four turtles were simultaneously observed at this

Table 3-8. Diurnally exposed macroinvertebrates encountered in the 25 m by 4 m census area on each of 32 transects. The first seven transects were established in the Pearl Harbor Entrance Channel and the remainder were carried out inside of the Pearl Harbor on 12-15 September 2005.

	Transect Number																															
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**	**17**	**18**	**19**	**20**	**21**	**22**	**23**	**24**	**25**	**26**	**27**	**28**	**29**	**30**	**31**	**32**
MOLLUSCA																																
Conus vexillum																															1	
C. striatus	1																															
C. lividus		1																														
C. ebreus						1																										
C. miles						1																										
C. leopardus					1																											
Pinctada margaritifera					1		1	1				2							1													
Chama elatensis												1	2									3										
Arca ventricosa	7		19		14																											
Spondylus tenebrosus		2	3																													
Octopus cyanea	1					1																										
ANNELIDA																																
Sabellastarte spectabilis					3			30		23		24	8	3	4				11	30	11	28	58	57		24	92	6	111		28	16
Loimia medusa					1																											
Thelepus setosus								1	4		6		9										9									6
ARTHROPODA																																
Corallianassa borradailei		1				6																										
Pseudosquilla ciliate																													1			
Lysiosquilla maculatus													1	1				1							1							
Gonodactylus mutates													1																			
Stenopus hispidus										2			2																			
Portunus sanguinolentus									2		1							1							1					2		1
Podophthalmus vigil														1																		
Thalamita integra																													1			
T. crenata																									1							
ECHINODERMATA																																
Echinothrix diadema	5	27	20	12	56	17	26	9		1																						
E. calamaris	1				4	10	17		1																							
Tripneustes gratilla	5	1	7		100	135	55																									
Echinostrephus aciculatum		21	1																													
Echinometra mathaei		174																														
Diadema paucispinum					3																											
Actinopyge mauritana								11																								
Opheodesoma spectabilis																					2	1										
Total Number of Species	**6**	**7**	**5**	**1**	**9**	**7**	**4**	**5**	**3**	**3**	**2**	**3**	**6**	**3**	**1**	**0**	**0**	**2**	**2**	**1**	**2**	**3**	**2**	**1**	**3**	**1**	**1**	**1**	**3**	**1**	**2**	**3**
Total Number of Individuals	**20**	**218**	**50**	**12**	**183**	**171**	**99**	**52**	**7**	**26**	**7**	**27**	**33**	**5**	**4**	**0**	**0**	**2**	**12**	**30**	**13**	**32**	**67**	**57**	**3**	**24**	**92**	**6**	**113**	**2**	**29**	**23**

Table 3-9. Number of green sea turtle observations made underwater at sites surveyed within Pearl Harbor (H) and within or adjacent to the Pearl Harbor Entrance Channel (PHEC). Turtles over 65 cm carapace length were judged to be sexually mature and were recorded as male (M) or female (F). All turtles estimated to be less than 65 cm were recorded as sex unknown (?). Some turtles over 65 cm were also recorded as sex unknown (?) when sex could not be clearly determined.

Site #	Sightings	Confirmed No Of Individuals	Sex	Site #	Sightings	Confirmed No Of Individuals	Sex
1 PHEC	4	2	2 F 2 ?	16 H	0	0	
2 PHEC	1	1	1 ?	17 H	0	0	
3 PHEC	28	13	10 M 10 F 8 ?	18 PHEC	3	2	1 M 2 F
4 PHEC	14	9	5 M 9 F	19 PHEC	1	1	1 M
5 PHEC	3	2	1 F 2 ?	20	—	—	—
6 PHEC	1	1	1 ?	21 H	0	0	
7 H	0	0		22 H	0	0	
8 H	0	0		23 H	0	0	
9 H	0	0		24 H	0	0	
10 H	0	0		25 H	0	0	
11 H	0	0		26 H	0	0	
12 H	2	1	1 F 1 ?	27 H	2	1	2 ?
13 H	0	0		28 PHEC	3	2	3 ?
14 H	3	1	1 F 2 ?	29=5	—	—	—
15 H	0	0					

station (**Appendix 2**). The following species of fish were observed biting at/cleaning the turtles' carapaces and or other body parts: 1) Hawaiian whitespot toby (*Canthigaster jactator*), 2) Gold-ring surgeonfish (*Ctenochaetus strigosus*), 3) Hawaiian cleaner wrasse (*Labroides phthirophagus*) and 4) Trumpetfish (*Aulostomus chinensis*) (**Appendix 2**). The authors are not aware of any reports of trumpetfish acting as cleaners; however, a single trumpetfish was observed at the cleaning station on two separate days where it could be clearly seen biting at something at the junction of the carapace and neck of a large male turtle.

All the turtles estimated to have carapace lengths of less than 65 cm had at least one visible fibropapilloma tumor. Approximately 50% of the larger specimens had visible tumors. None of the turtles had any bite marks.

4.0 DISCUSSION

4.1 PEARL HARBOR AS A NATURE PRESERVE

The control of Pearl Harbor by the U.S. Navy for a century has limited civilian use. This has made much of Pearl Harbor a de facto aquatic preserve which has allowed resources to exist with little or no fishing pressure exerted upon them. The result is that some fishery resources are relatively abundant, especially species such as the eastern oyster (*Crassostrea virginica*) in West Loch and the flathead mullet (*Mugil cephalus*). The only permitted civilian capture fishery has been for baitfish used as live bait in the skipjack tuna pole-and-line fishery. This fishery has dramatically declined since the closure of the tuna cannery in 1984; similarly the capture of baitfish has also decreased in Pearl Harbor. At present a small amount of fishing occurs in portions of East Loch by military and civilian personnel working on base and some fishing is done around the warm water discharge of the Hawaiian Electric Company facility at Waiau in East Loch. These fishing activities are carried out with hook and line methods. Some illegal trap and gill net fishing is also known to occur, primarily in the upper reaches of East Loch. With the recognition of possible contamination of fish and shellfish in Pearl Harbor due to pollution in the mid-1980's, both the U.S. Navy and the Hawai'i State Department of Health have posted warnings along shoreline areas to not consume fish taken in Pearl Harbor. More recently with the need for heightened security following the tragic events of 11 September 2001, unauthorized civilian entry and use of the Pearl Harbor resources has decreased. The net result has been little fishing activity occurring in Pearl Harbor.

Similarly, the waters around the entrance channel to Pearl Harbor are likewise controlled by the U.S. Navy. In the past this control has varied which allowed fishing to occur (albeit illegally) around the PHEC during periods when enforcement of security was more relaxed; however, since 11 September 2001, security has been increased and fishing activities have probably ceased in the PHEC. In short, base security has made access to the Pearl Harbor aquatic resources difficult for much of the civilian population, thus again enhancing the Pearl Harbor marine preserve status.

4.2 BENTHIC COMMUNITIES

4.2.1 Benthos

Biological collections from Pearl Harbor commenced at the turn of the century but none were very extensive in their efforts. It was not until the work by Evans et al. (1974) and the more recent effort by Coles et al. (1997) that the biological collections been more systematic and representative of Pearl Harbor. Coles et al. (1997) listed 434 taxa (36 algae, 1 spermatophyte, 338 invertebrates, and 59 fish species and higher taxa) collected from 15 stations in Pearl Harbor. In total, 394 of these taxa were from fouling communities, sediment samples or fish observations. The remaining 40 taxa were exclusively from sediment samples. Evans et al. (1974) listed 388 taxa (23 algae, 278 invertebrate and 87 fish) collected or seen in the 1971-73 period. Grovhoug (1992) reported 130 taxa (79 invertebrate and 51 fish) from Pearl Harbor. Brock (1994, 1995) found 96 and 99 taxa, respectively from the six stations sampled in East Loch. All other studies carried out in Pearl Harbor previous to those above have reported ten or fewer taxa. The present study has noted 16 large diurnally-exposed macroinvertebrate species on the 25 transects in Pearl Harbor and 18 species on the seven transects carried out in the PHEC. Relative to the studies cited above these species totals appear to be low. However, the above studies focused on many of the small, generally cryptic species and utilized grabs, box cores, traps, and nets to collect specimens. Therefore, the taxonomic lists are considerably longer.

The list of species given in Coles et al. (1997) is the most complete to date. However, many species in the list are recorded as "off Pearl Harbor" or "Fort Kamehameha reef flat." It is recognized that many motile species (such as fish and crabs) may move in and out of Pearl Harbor as adults, or larvae of some may recruit to Pearl Harbor having originated from areas outside. Sampling biological communities seaward of Pearl Harbor should result in a much longer species list simply because the conditions are more marine and less estuarine in a seaward direction.

Military activities dominated and affected much of Pearl Harbor's environment for the 1900 to 1960 period. During much of that time most of the surrounding hinterland was in sugar production. Commencing in the 1950's and continuing over the next 30 years, the hinterland changed from agriculture to urban and commercial/retail uses as Honolulu's population grew. These changes affected the inputs occurring to Pearl Harbor. Since much of the urbanization has been completed (i.e., landscaping matured, hardened surfaces, and drainage in place), sediment inputs have probably decreased as have the input of certain agricultural pollutants. However, pollution/pollutants typically associated with urbanized areas (e.g., motor oil and grease from automobiles and roads) has probably increased. Increased governmental regulation of pesticides in recent years has led to a banning of products that persist in the environment and the introduction of more environmentally-friendly products (i.e., those with short half-lives). In addition, the U.S. Navy initiated an active program to reduce pollution to Pearl Harbor. From an aquatic biological perspective, the result has been one of species disappearance during the period of time when pollution was probably greater (i.e., less regulated) and the reappearance of these species with the improvement of the Pearl Harbor aquatic environment. Two examples are noted below.

The early improvements of the Pearl Harbor environment resulted in the increased abundance of commercially important species such as the spanner crab (*Ranina ranina*) and the striped mantis shrimp (*Lysiosquilla maculatus*). Fishing for striped mantis shrimp is not well-known among Hawai'i's fishermen today, but many years ago this species was a highly prized species to catch attaining a length in excess of 30 cm. The striped mantis shrimp has, however, not been seen or collected in Pearl Harbor since 1923 (see Coles et al. 1997). In this study, the striped mantis shrimp was encountered on transect numbers 13, 14, 18, and 25 (**Table 3-6**) and thus was reasonably well represented in this study.

The second group of organisms that were conspicuously absent in the extensive biological survey in the early 1970's (Evans et al. 1974) was the corals. Evans et al. (1974) suggested that the environmental conditions had deteriorated to such an extent that corals could not tolerate the conditions in Pearl Harbor and thus were absent. Brock (1994) reported one coral species (*Leptastrea purpurea*) in Pearl Harbor and Coles et al. (1997) noted five species present in Pearl Harbor. During extensive surveys Smith (2002) recorded eight species and the current total of stony coral species is now 11. The reappearance of *Lysiosquilla maculatus*, the increasing abundance of stony corals and the number and size of fishes in Pearl Harbor suggest that the environmental conditions have improved.

These improving environmental conditions are probably related to the Navy's efforts to curb pollution entering Pearl Harbor, the maturing of the adjacent urban areas with a subsequent reduction in sediment input and the virtual absence of fishing. However, improving environmental conditions have not necessarily increased to such an extent to allow formerly dominant species to return in high numbers. At one time Pearl Harbor provided a habitat appropriate for pearl oysters. There are two common species in Hawai'i including the black-lipped pearl oyster (*Pinctada margaritifera*) which is used in the pearl aquaculture industry in Tahiti and elsewhere in the South Pacific, and the smaller *Pinctada radiata* which was the most abundant species in Pearl Harbor many years ago (Kay 1979). As noted by Bryan (1915), page 444:

> A species of pearl oyster family occurs at Pearl Harbor. The common species "pa" is often three or four inches or more across....Without a doubt it was the presence of this shell with the iridescent interior, occurring at Pearl Harbor, on O'ahu, that gave that sheet of water its name. Although they belong to the same sub-family, they are not the famous pearl shell of the South Pacific islands. However, a pearl-bearing species is found in Pearl Harbor and at certain other places about the group in the deeper water offshore, and pearls were found to some extent by the natives, but the pa was chiefly used by them for making fishhooks and to some extent in making the curious shell-eyes for their wooden gods.

Pinctada radiata was recorded by numerous studies in Pearl Harbor up through 1938 (Dall et al. 1938) and apparently was not seen again in Pearl Harbor until Coles et al. (1997) noted this species at one site in the vicinity of *The Machinist*, which is part of the inactive fleet near the head of Middle Loch. In his 1999 survey of the warm-water discharge from Hawaiian Electric Company's electrical generation plant at Waiau, Brock (pers. obs.) found many dead *P. radiata* valves (shells) in an area where the discharge

currents had recently removed the overlying mud exposing many hundreds of these oyster shells in a small section of the old reef flat at Waiau. The apparent abundance of these shells suggests that *P. radiata* was extremely abundant at one time in Pearl Harbor.

Both Coles et al. (1997) and Evans et al. (1974) recorded the black-lipped pearl oyster in Pearl Harbor, but this species is not at all common. Our survey noted the black-lipped oyster in transects 8, 12 and 19 in Pearl Harbor as well as at transect 5 and 7 in the PHEC. However, it continues to be an uncommon species in Pearl Harbor.

The question arises as to why these species are near absent today in Pearl Harbor? Again, changes in water quality or habitat destruction may have all played a role in the near demise of these *Pinctada* species in the waters of Pearl Harbor. Other possible factors related to the decline in pearl oysters in Pearl Harbor may be (1) the arrival of a parasite or disease specific to these oysters from another locality in the Pacific transported by vessel traffic or (2) similarly, due to another sessile species non-native to Hawaiian waters becoming established and simply outcompeting the native oysters. However, no single species appears to have come to dominate subtidal hard substrate in Pearl Harbor which is required by the adult oysters but rather, an assemblage of sessile species including many species of sponges, polychaete worms, mollusks (vermetids and bivalves), arthropods (barnacles), and urochordates (tunicates). Many of these are known or suspected alien species and in Pearl Harbor are among the most abundant sessile forms. These aliens may simply be competitively superior space occupiers relative to the formerly common pearl oysters. However, only time will tell that with the continuing recent improvement in environmental quality, Pearl Harbor may once again become a habitat suitable for the growth of pearl oysters.

4.2.2 Sessile Benthos on the Fort Kamehameha Outfall Pipe and Piles

The assessment of the benthos on a section of the Fort Kamehameha outfall pipe and piles presented here was conducted about two years (732 days) following the completion of the outfall construction. As mentioned earlier, most of the biotic cover found on the pipe and piles consisted of turf algae (99% on the pipe and 89% on the piles). The remainder of the live cover consisted mainly of hard corals, encrusting sponges, crustose coralline algae (CCA), and sessile bivalves. Differences between the piles and the pipe included the presence of sessile bivalves on the piles and significantly more live cover (excluding turf algae) on the piles compared to the pipe. The mean live cover (excluding turf algae) on the sides of the piles was significantly greater than that on the pipe ($t_{0.05(2),24} = 7.60$; $P = 0.001$). The same was true for a comparison between the mean cover on the tops of the piles versus the pipe ($t_{0.05(2),30} = 4.15$, $P = 0.001$). The source of the cover differences was CCA and encrusting sponge cover; both were significantly greater on the piles compared to the pipe (CCA comparison: $t_{0.05(2),39} = 2.96$; $P = 0.005$; encrusting sponge comparison: $t_{0.05(2),39} = 3.38$, $P = 0.005$). There was no significant difference in the cover of corals between substrates ($t_{0.05(2),39} = 0.70$, $P = 0.49$). Further, the size of hard corals (largest diameter) was statistically identical on the two substrates ($t_{0.05(2),45} = 1.69$, $P = 0.10$). The sizes (largest diameter) of CCA patches were not significantly different between substrate types ($t_{0.05(2),86} = 0.94$, $P = 0.37$) yet the density of patches of CCA was significantly greater on the piles than on the pipe ($t_{0.05(2),39} = 4.09$, $P = 0.001$).

4.3 Current and Previous Point Centered Quarter Method Findings and Other Observations

Pearl Harbor—During 2002 much of the perimeter of Pearl Harbor was surveyed to assess the distribution of stony corals and sea turtles.

No stony corals were observed during 1973 and 1974 at any of the study sites (Evans et al. 1974). Coles (1999) found five stony coral species within Pearl Harbor, including specimens at some of Evans et al. (1974) study sites. Smith (2002) found eight stony coral species with one or more species were present at five of the 11 Evans et al. (1974) study locations. Three additional hard coral species were recorded during the present study (**Table 4-1**).

Table 4-1. Stony coral species recorded within Pearl Harbor.

Coles (1999)	Smith (2002)	Present Study
Montipora patula	*Montipora patula*	*Montipora patula*
	Montipora capitata	*Montipora capitata*
	Montipora flabellata	*Montipora flabellata*
		Leptoseris incrustans
		Pavona varians
Leptastrea purpurea	*Leptastrea purpurea*	*Leptastrea purpurea*
Pocillopora damicornis	*Pocillopora damicornis*	*Pocillopora damicornis*
Pocillopora meandrina	*Pocillopora meandrina*	*Pocillopora meandrina*
Porites compressa	*Porites compressa*	*Porites compressa*
	Porites lobata	*Porites lobata*
		Psammocora explanulata

Coles (1999) listed *Leptastrea purpurea* as the most common coral in Pearl Harbor. By 2002, and continuing through this study, *Pocillopora damicornis was* the dominant scleractinian species based upon frequency of occurrence. Most specimens are less than 10 cm in diameter although larger ones are present (**Figure 4-1**). The second most commonly sighted species was *Leptastrea purpurea.* Many of *L. purpurea colonies* within Pearl Harbor are less than 3 cm in their greatest dimension and are most frequently observed growing on old bottles (**Figure 4-2**). The largest individual colonies measured were *P. compressa* colonies in West Loch. During 2002, specimens with low head shaped growth forms and short fused branches were discovered in West Loch. Although it was difficult to clearly differentiate between the beginning and end of overlapping colonies, some appeared to be more than 100 cm in diameter. Specimens of this size, would probably be more than 50 years old. These sites were revisited during the present study and nearly all the colonies were partially or completely overgrown by gorilla seaweed, *G. salicornia* (**Figures 4-3** and **4-4**).

Based upon the size of some of *M. capitata, M. patula,* and *P. compressa* specimens, some of these colonies were probably present prior to the 1973 to 1974 surveys conducted by Evans et al. (1974). Nevertheless, the total number of stony corals and diversity of species appears to have increased substantially since Evans et al. (1974). This is a good indication that the marine environmental conditions in Pearl Harbor have improved significantly. Of concern however, is the dramatic increase in *G. salicornia* between 2002 and 2005 (Smith, personal observation). This alga has devastated corals in many areas of Hawai'i and its presence in Pearl Harbor will adversely impact stony coral growth and recruitment, and the general macrobenthic invertebrate diversity and fish stocks (see Section 4.4.1 for a discussion of its apparent impact on fishes).

Outfall Corridor—The habitat in the surveyed portion of the Fort Kamehameha Outfall Corridor was depauperate from the perspective of stony corals, both prior to construction of the outfall and after construction. The seafloor consisted of coarse sand and rubble bottom. Stony corals were sparsely distributed, with most colonies occurring on rubble and being less than 10 cm in their greatest dimension. The percentage of the seafloor covered by coral was 0.13% in 2000 and 0.02% in 2005. Six species were recorded in 2000; five of the six were observed in 2005. The exception was *P. eydouxi* which was not observed in 2005. *Pocillopora meandrina* comprised 59% of all corals measured in 2000 and 75% in the present study. The mean colony size of this species recorded in 2000 was 113 cm^2; mean colony size in 2005 was 17 cm^2. The mean area within which all coral colonies were located was similar between studies: 8.7 and 9.9 m^2 in 2000 and 2005, respectively.

Based on their size frequency distribution, corals present in 2000 within the outfall corridor were probably less than five years old. The estimated age of five years for most of the corals coincides roughly with the

Figure 4-1. Large colony of lace coral (*Pocillopora damicornis*) at Site 21 (Pearl Harbor, Dry Docks).

Figure 4-2. Small specimens of crust coral (*Leptastrea purpurea*) are often sighted growing on discarded bottles, as shown here.

Figure 4-3. Colony of finger coral (*Porites compressa*) in West Loch, Pearl Harbor being overgrown with gorilla seaweed (*Gracilaria salicornia*). Note the additional epiphytes growing on *G. salicornia*.

Figure 4-4. The gorilla seaweed (*Gracilaria salicornia*) below the stripebelly puffer (*Arothron hispidus*) has completely buried a patch of finger coral (*Poites compressa*) which was healthy in 2002.

periodic occurrence of waves large enough to roll coarse rubble on the seafloor in a water depth of 15 m. The periodicity of such wave impacts has the potential of limiting the size distribution of corals in this particular area (i.e., the outfall corridor).

Further, the mean colony size of 113 cm^2 in 2000, versus only 17 cm^2 in 2005 was not surprising, because all of the coral colonies observed in 2005 recruited to the outfall corridor after September 2003 when trenching was completed. The fact that the area surrounding each colony is nearly the same in the two surveys is believed to indicate that the distribution of rubble, suitably sized for successful coral recruitment, is comparable before and after construction. In other words, trenching for the outfall pipe in that portion of the PHEC has not significantly altered that portion of the PHEC's ability to support corals. Substrate composition and stability were the most important limiting factors prior to construction of the outfall extension and remained the most important limiting factors in 2005.

Pearl Harbor Entrance Channel Seafloor—During 2002, Smith conducted PCQM transects covering a total length of 1,680 m. The results of these surveys are presented in **Table 4-2**. It is clear that no portion of the PHEC Channel seafloor supports significant coral growth. It is also clear that as one proceeds in a seaward direction, increasing quantities of stony coral are present. The inner portions of the PHEC are composed of higher percentages of fine sand and mud. While the substrate in the outer portions of the channel is barely marginal for coral development, the substrate in the inner portions is even less well suited for coral recruitment. It should be noted, however, that scattered metallic and concrete debris, some of which resulted from the December 7th, 1941 Pearl Harbor Attack, does support moderate to good coral growth at all points within the PHEC. This debris, therefore, serves to increase the percentage of stony coral cover within the PHEC (**Appendix 2**).

Table 4-2. Coral cover in the outfall corridor and seafloor of the Pearl Harbor Entrance Channel in 2000, 2002, and 2005. Data gathered by Smith at depths of 13 to 15 m within the PHEC, adjacent to the permanent Channel Marker Buoys. Odd numbered buoys are located on the West side of the Channel, even numbers are on the East side. [PCQM = Point Centered Quarter Method; * = A single moderate sized colony was encountered growing on a metallic hull section].

Location	Date	Method	Quarters With Coral (%)	Mean Colony Size (cm^2)	Coral Cover (%)
Outfall Corridor	July and Aug 2000	PCQM	62	111	0.13
Outfall Corridor	Sept 2005	PCQM	25	17	0.02
Buoy 1*	April to Sept 2002	PCQM	100	38	1.21
Buoy 3	April to Sept 2002	PCQM	67	531	0.21
Buoy 5	April to Sept 2002	PCQM	1	1,963*	0.24
Buoy 7	April to Sept 2002	PCQM	0	NA	0
Buoy 4	April to Sept 2002	PCQM	4	15	0
Buoy 6	April to Sept 2002	PCQM	0	NA	0

There was very little macroalgae observed on the seafloor of the PHEC during surveys conducted by Smith in 1999, 2000, 2002, or during the present study. Significant portions of the channel bottom are covered by the seagrass *Halophila decipiens*. **Table 4-3** shows the distribution of seagrass recorded during 2002.

The areas adjacent to Buoys 1, 3, 4, 5, 6 and 7 were qualitatively assessed by Smith and Marx during this survey. The distribution of *H. decipiens* and stony corals was judged to be comparable to that observed in 2002.

Table 4-3. Seagrass occurrence in the Pearl Harbor Entrance Channel in 2002.

Location	Transect Length (m)	Survey Points	Points with Seagrass	Occurrence (%)
Buoy 1	340	20	0	0
Buoy 2	360	22	0	0
Buoy 3	280	17	12	71
Buoy 4	100	6	6	100
Buoy 5	300	18	10	56
Buoy 6	280	17	0	0
Buoy 7	60	4	3	75

During the 2002 coral surveys, Smith conducted PCQM transects on the fossilized reef platform adjacent to the PHEC and the slope/wall connecting this zone to the channel seafloor. The study locations were located beside the Channel Marker Buoys. **Table 4-4** presents the results of those investigations.

Table 4-4. Coral cover on the fossilized reef platform (FRP) and channel slopes/walls in 2002 based on Point Centered Quadrat Method transects.

Location	Quarters with Coral FRP (%)	Quarters with Coral Slope (%)	Mean Colony Size - FRP (cm^2)	Mean Colony Size - Slope (cm^2)	Coral Cover - FRP (%)	Coral Cover - Slope (%)
Buoy 1	100	NA	198	NA	19.00	NA
Buoy 3	100	88	133	158	2.36	0.19
Buoy 5	86	100	177	154	1.40	0.86
Buoy 7	54	0	64	0	0.05	0
Buoy 4	NA	NA	NA	NA	NA	NA
Buoy 6	100	100	314	452	4.30	5.20

Turtle/Tripod Reef—Turtle/Tripod reef is actually a portion of the fossilized reef platform. It has been treated separately because it is physically distinct from all other areas investigated. The reef is approximately 120 m long and has distinct boundaries on all sides and a vertical 9 m drop along most of its eastern edge, with deeply undercut grottos along its base. In 2000 and 2002, the reef supported much denser coral development than any other study site; it also was frequented by substantial numbers of fishes, sharks, rays, and green sea turtles.

Prior to 1982, Grigg (1995) reported that coral cover for well developed reefs off the south coast of O'ahu ranged from 60% to 75%. However, as a result of Hurricane Iwa in 1982 many reefs off O'ahu "…were reduced to rubble" (Grigg 1995). Furthermore, Grigg (1995) stated that as a result of Hurricane Iwa in 1982 and Hurricane Iniki in 1992 "…coral abundance/cover [off the south coast of O'ahu] is low averaging 7 – 29%...Today recovery is underway, but almost all reefs support less than 30% living coral cover…"

Based upon these observations, Turtle/Tripod reef had significantly higher coral cover in 2002 than most south coast O'ahu reefs. The cover in 2005 (11% to 15%) was within the range of coral cover commonly reported by Grigg in 1995. The reduction in coral cover between 2002 and 2005 was probably not the result of wave action, since the colonies were structurally intact in 2005. Part of the reduction of coral cover may have been caused by periods of heavy sedimentation during the outfall construction. Brock

and Smith made separate observations of such events at Turtle/Tripod reef from commercial airlines while landing into Honolulu International Airport. *Pocillopora meandrina* and *P. eydouxi* have a very low tolerance for sedimentation and turbid water (Gulko 1998). Although *P. lobata* is resilient to sedimentation and turbidity, most colonies on the reef were encrusting forms which are less able to rid themselves of sediments as compared to head forming colonies.

It is interesting to note, that surveys of the spur and groove reefs immediately to the west of Turtle/Tripod reef conducted in 2002 produced coral cover estimates of 19%. Based upon qualitative observations of this spur and groove zone in 2005 the coral cover in the area appeared unchanged since 2002.

The presence of large numbers of coral recruits and the survival of some of the large specimens of all the dominant species suggests that a recovery is taking place at Turtle/Tripod Reef and that coral cover may return to 2002 levels in the future.

4.4 FISHES OF PEARL HARBOR

In their detailed study of the ecosystems of Pearl Harbor, Grovhoug in Evans et al. (1974) found 87 species of fishes among 46 families. Many of these species are of commercial and recreational importance. Among these are the flathead mullet (*Mugil cephalus*), milkfish (*Chanos chanos*), bonefish (*Albula vulpes*), Hawaiian ten pounder (*Elops hawaiiensis*), threadfin (*Polydactylus sexfilis*), barracuda (*Sphyraena barracuda*), flagtail (*Kuhlia sandvicensis*), chub (*Kyphosus cinerascens*), blotcheye soldierfish (*Myripristis berndti*), glasseye (*Priacanthus cruentatus*), nehu (*Stolephorus purpureus*), blacktail snapper (*Lutjanus fulvus*), goatfishes (*Mulloides flavolineatus, Mulloides vanicolensis*, *Parupeneus porhyreus*, *Parupeneus multifasciatus*, *Parupeneus pleurostigma*, and *Upeneus taeniopterus*), jacks (*Carangoides gymnostethoides*, *Caranx ignobilis*, *Caranx sexfasciatus*, *Gnathanodon speciosus*, *Caranx melampygus, Caranx mate*, and *Scomberoides laysan*), flatfish (*Bothus pantherinus*), parrotfish (*Calatomus carolinus*, *Chlorurus sordidus*), cigar wrasse (*Cheilio inermis*), sergeant major (*Abudefduf abdominalis*), eyestripe surgeonfish (*Acanthurus dussumieri*), convict surgeonfish (*Acanthurus triostegus*), ringtail surgeonfish (*Acanthurus blochii*), yellowfin surgeonfish (*Acanthurus xanthopterus*), orangebar surgeonfish (*Acanthurus olivaceus*), goldring surgeonfish (*Ctenochaetus strigosus*), bluespine unicornfish (*Naso unicornis*), and spotted unicornfish (*Naso brevirostris*).

The Coles et al. (1997) survey of the biological resources of Pearl Harbor added only a few fishes to the Evans et al. (1974) list. Among the species added of commercial or recreational interest were the brown surgeonfish (*Acanthurus nigrofuscus*) and the striped goatfish (*Upeneus vittatus*). The striped goatfish probably became established in Hawaiian waters through a careless introduction of other fish species from Nuku Hiva, Marquesas in 1955 (Randall 1987). Brock's (1995) annual surveys of the zone of mixing for Hawaiian Electric's Waiau electrical plant has included the native mullet (*Neomyxus leuciscus*).

The present survey noted 64 species of fishes among the seven transects carried out along the PHEC and 48 species at the 25 transects conducted in Pearl Harbor. Several fish species noted in previous studies (Evans et al. 1974; Coles et al. 1997) were not encountered in any of the transects, but were present outside of the transect areas. These include species of commercial and recreational interest such as the flathead mullet (*Mugil cephalus*), milkfish (*Chanos chanos*) and the ten-pounder (*Elops hawaiiensis*). Nine species of fishes encountered in the transects established in Pearl Harbor in this study represent new records as per Coles et al. (1997). These species are the silverside (*Pranesus insularum*), speckled squirrelfish (*Sargocentron punctatissimum*), and brick soldierfish (*Myripristis amaenus*) all at transect 22; stareye parrotfish (*Calatomus carolinus*) at transect 8; redlip parrotfish (*Scarus rubroviolaceus*) and oval butterflyfish (*Chaetodon lunulatus*) at transect 21; mackerel scad (*Decapterus macarellus*) at transects 12 and 19; ringtail wrasse (*Oxycheilinus unifasciatus*) at transects 10, 19 and 21; and spectacled parrotfish (*Scarus perspicillatus*) at transects 8, 10, 12, 19 through 24, 27, 29 and 31. These new records lend further support to the contention that the environmental quality is improving in Pearl Harbor.

A single adult specimen of the emperor angelfish (*Pomacanthus imperator*) was sighted on two separate days near the north eastern tip of Ford Island. It could not be determined if the sightings were of the same, or different individual fish. Hoover (1993) notes only a single record of this species from Hawai'i; Myers (1991) lists two records for Hawai'i. This species was first observed in Hawai'i by Vernon E. Brock in 1948, which predates the aquarium trade. Richard Brock has occasionally recorded emperor angelfish on the Sand Island outfall (south shore of O'ahu) to about 26 m, over the last ten years.

Individuals of many fish species encountered in Pearl Harbor are often large or more abundant relative to those seen outside of Pearl Harbor. Carangids or jacks are highly sought by commercial and recreational fishers in Hawai'i. Shomura (1987) estimated that the catch of carangids decreased more than 85% between 1900 and 1986 (to ~40,300 kg) in Hawai'i and these declines appear to be continuing today. Thus, adult carangids are not often seen on Hawai'i's reefs, yet in Pearl Harbor several species including the giant trevally (*Caranx ignobilis*) and the golden trevally (*Gnathanodon speciosus*) as well as other species are frequently seen. One area not sampled in this study but examined by Brock on several occasions over a twenty-year period in Middle Loch, serves as an aggregation point for giant trevally where more than fifty individuals weighing between 5 to 25 kg have always been present; such aggregations are extremely unusual elsewhere around the high Hawaiian Islands. Jacks were present in three fish census areas (transects 14, 25 and 27) during this study; individual fish ranged from 1.8 to 5.4 kg in estimated weight. Fish census surveys carried out along the south shore of Lana'i Island over a ten-year period encompassing 290 transects (depths from 5 to 20 m) encountered one *Gnathanodon speciosus* with an estimated weight of 0.25 kg and no *Caranx ignobilis*. Similarly, 49 transects spanning a seven-year period at the Atlantis Submarine dive site (depths 23 to 30 m) offshore of Waikiki, O'ahu did not record either of these species. Methods used were the same among all transects and were carried out by the same individual (Brock) in all surveys.

The whitesaddle goatfish (*Parupeneus porphyreus*) is esteemed among island consumers commanding the highest ex-vessel price of any inshore fish species in Hawai'i's market and this species has had this distinction for many years (Hawai'i State Division of Aquatic Resources annual fishery catch statistics). Thus, *Parupeneus porphyreus* are targeted by recreational and commercial fishers resulting in their low abundance on Hawai'i's reefs and when seen, most individuals are small (less than 120 grams [g]). No *Parupeneus porphyreus* were encountered in the 290 Lana'i Island transects or in the 49 transects conducted at the Atlantis Submarine dive site. In contrast, *Parupeneus porphyreus* were censused on seven of the 23 transects carried out in Pearl Harbor in this study. In total, fifteen individuals were censused having a mean estimated weight of 950 g with the largest individual estimated at 1.8 kg.

Finally, the spectacled parrotfish (*Scarus perspicillatus*) is also esteemed and sought by commercial and recreational fishers. By 1986, the catch was estimated to be less than 5% of what it was in 1900 (Shomura 1987). Again, the abundance and mean size of this fish on Hawai'i's reefs has declined. *Scarus perspicillatus* has separate sexes and this trait was recognized by the old Hawaiians with the males being a strikingly blue/green color and the females a duller red. This species changes sex as individuals grow: they are females first and then become males in the terminal phase. *Scarus perspicillatus* were encountered in 12 of the 23 transects carried out in Pearl Harbor with 311 individuals censused with a mean estimated weight of 243 g and a maximum weight of 1.8 kg. All of these fishes were female and no terminal phase males were seen, suggesting that Pearl Harbor is serving as a nursery and grow-out area for this species. The abundance of *Scarus perspicillatus* in the Pearl Harbor transects is high relative to other sampled Hawaiian reef sites with a mean number of 14 individuals per transect. In contrast, the 290 Lana'i Island transects yielded a total of 529 *Scarus perspicillatus* individuals, ranging in estimated weight from ~1 g to 2.3 kg and had a mean weight of 71 g. *Scarus perspicillatus* was also present at the Atlantis Waikiki site where 567 fish were censused on 49 transects, ranging in estimated weight from 19 g to 3.2 kg and had a mean estimated weight of 87 g.

The active policing of non-military activities in Pearl Harbor especially since the September 2001 events has served to curtail fishing activities in Pearl Harbor. Thus in the absence of fishing, resident fishes are able to attain greater sizes. The data above support this contention and demonstrate the impact that fishing may have on select coral reef fish species as well as suggest that despite the long history of environmental degradation, Pearl Harbor remains an important habitat for many coral reef fish species.

Characterization of Fish and Benthic Communities of
Pearl Harbor and Pearl Harbor Entrance Channel, Hawai'i NAVFAC, Pacific

4.4.1 Comparison with the Evans (1974) Study

As noted above, 90 species of fish among 46 families were reported to be present in Pearl Harbor by Evans (1974). The Evans (1974) survey was carried out over a one-year period encompassing seasonal variation with repeated sampling of individual sites utilizing a number of sampling methods. These methods included the use of gill and hand nets, fish traps, hook and line methods as well as underwater visual censuses of resident fishes resulting in a comprehensive picture of the fish communities present in Pearl Harbor at that time. Since the present survey utilized only visual census techniques at each sample site on a single occasion to sample the fish communities, the results from these two surveys are not directly comparable.

Not surprisingly, Evans (1974) noted many species not seen in the present survey because of the duration of their study and the diversity of methods used. Some fish species are wary of divers and are not easily seen in underwater transects but may be easily detected using gill nets or hook and line methods. Examples include the bonefish (*Abula vulpes*) and the scalloped hammerhead shark (*Sphyrna lewini*). Some species are present in Pearl Harbor on a seasonal basis thus may be missed in surveys that do not coincide with their seasonal presence. Female scalloped hammerhead sharks (S*phyrna lewini*) are known to seasonally enter Pearl Harbor to pup (Clarke 1971).

Three areas (Beckoning Point, Hospital Point and Mokunui Islet) examined by Evans (1974) were re-surveyed in the present study. Every effort was made to locate and resample the well-defined locations surveyed in 1974. The Evans (1974) study did not attempt to directly census all fishes seen on a transect but ranked their abundance by species, making direct comparisons difficult. Despite the methodological differences between the Evans (1974) and present study carried out more than 25 years later, some comparisons are made and the results are given in **Table 4-5**. The early study found considerably more fish species present than in the present study at all three sites (**Table 4-5**). However as noted above, the early study used a variety of sampling techniques spanning an entire year so the probability of finding wandering species such as the eagle ray (*Aetobatus narinari*), reef shark (*Carcharhinus limbatus*), milkfish (*Chanos chanos*), several species of jacks, ten-pounder (*Elops hawaiiensis*), halfbeaks (*Hemirhamphus depauperatus*), hammerhead sharks (*Sphyrna lewini*) is much greater than in the present study which spent no more than ~2.5 hours at each site. It should be noted that during various surveys conducted by Smith within Pearl Harbor between 2000 and 2004 all of the above species were recorded, except for the sharks.

Table 4-5. Analysis of fish communities at three locations in Pearl Harbor comparing results of a one-year field study (Evans 1974) to those from single visual census surveys in the present study. Standing crop estimates are given in grams per square meter (g/m^2).

Location	Evans et al. (1974)		Present Study	
	Species	Biomass	Species	Biomass
Beckoning Point	28	748	3	3
Hospital Point	24	14	15	387
Mokunui Islet	42	153	—	—

Standing crop estimates were made in both studies and are also summarized in **Table 4-5**. In the present survey, the standing crop estimates are considerably greater at two of the three sites than those from the early (Evans 1974) study. However, the number of species as well as the estimated biomass at Beckoning Point is extremely low in the present study which raises the question of why the difference? The Evans (1974) study found the substrate at Beckoning Point to be a mix of sand, rubble, and coralline (pavement) substrate with some native algal species present in the shallows adjacent to shore. The present study found the subtidal substrate to be almost entirely covered (~98% coverage) by the alien alga, *Gracilaria salicornia* which does not provide suitable shelter for most fishes. As a result, the fish community at that site today is poorly developed. In contrast, estimated standing crops today are considerably greater than found by Evans (1974) at both Hospital Point and adjacent to Mokunui Islet which suggests that the habitat and/or environmental quality has improved at these locations.

4.4.2 Observations of Sharks and Rays in the PHEC

During various surveys conducted by Smith in 1999, 2000, 2002 and 2004 the following shark species were sighted in the PHEC: Blacktip reef shark (*Carcharhinus melanopterus*; 10 sightings), whitetip reef shark (*Triaenodon obesus*; eight sightings), sandbar shark (*Carcharhinus plumbeus*; two sightings), Galapagos shark (*Carcharhinus galapagensis;* one sighting), tiger shark (*Galeocerdo cuvier;* one sighting), and scalloped hammerhead (*Sphyrna lewini*; one sighting). The largest sharks sighted were the Galapagos and tiger sharks, each estimated to be 3.5 m total length. Other large elasmobranchs Smith recorded in the PHEC include manta rays (*Manta* sp.) and spotted eagle rays (*Aetobatus narinari*); all the individuals sighted were large adults. Within Pearl Harbor, juvenile spotted eagle rays, approximately 25 cm across the pectoral fins were sighted in East Loch.

4.5 The Role of Shelter in Structuring Fish Communities

Inspection of the fish transect data from sample sites in the PHEC as well as within Pearl Harbor points to higher abundances of fishes in Pearl Harbor particularly at sites where cover or shelter is available. During this study, transects carried out over soft substrate in Pearl Harbor yielded three species, 27 individuals and a standing crop of 18 g/m^2. In contrast, along Pearl Harbor walls there were 11 species, 193 individuals, and a standing crop of 270 g/m^2. Further, the debris fields comprised 16 species, 1,069 individuals, and a standing crop of 968 g/m^2. The significantly greater development of fish communities in the debris fields is probably related to (1) the protection from fishing pressure created by Pearl Harbor security (i.e., the "de facto" preserve) and (2) the relatively greater amount of shelter afforded by the debris (the "artificial reef effect").

Studies conducted on coral reefs in Hawai'i and elsewhere have estimated fish standing crops to range from 20 to 200 g/m^2 (Brock 1954; Brock et al. 1979). Eliminating the direct impact of man due to fishing pressure and/or pollution, the variation in standing crop appears to be related to the variation in the local topographical complexity of the substrate. Space, structural diversity, and cover are important factors governing the distribution of coral reef fishes (Risk 1972; Sale 1977). Thus habitats with high structural complexity affording considerable shelter space usually harbor a greater estimated standing crop of coral reef fish. Conversely, transects conducted in structurally simple habitats (e.g., sand flats) usually result in a lower estimated standing crop of fish (0.2 to 20 g/m^2). Goldman and Talbot (1975) noted that the upper limit to fish biomass on coral reefs is about 200 g/m^2. Hawaiian studies (Brock and Norris 1989) suggest that with the manipulation (increasing) of habitat space or food resources (Brock 1987), local fish standing crops may approach 2,000 g/m^2. Thus under certain circumstances, coral reefs may be able to support much larger standing crops of fishes than previously realized.

These studies suggest that if structural diversity, and hence fish biomass are low in a given locality, the addition of structural relief in the form of artificial reefs usually results in an increase in the biomass of fish present. Fishery managers have capitalized on these attributes building artificial reefs to enhance local fisheries usually for consumptive purposes. The greater relief and shelter present in the sampled debris fields in this study is probably responsible for the significantly greater development in those fish communities over other sampled locations in Pearl Harbor.

4.6 Threatened and Endangered Species

Green sea turtles are the only protected species which are routinely encountered within the study area. In a three month field study conducted in 1999, Smith concluded that the PHEC supported a resident population of green sea turtles. Smith used five methods to estimate the number of turtles; the resident population was estimated to range from 32 to 41 individuals. The present study did not attempt to duplicate the 1999 effort. However, the authors believe that the PHEC still supports a modest resident

population of these threatened sea turtles and that the total population is at least as large as it was estimated to be in 1999. The PHEC provides both preferred resting habitat and preferred forage. The amount of preferred algal forage does not appear (subjectively) to have changed since the 1999 observations. Resting habitat has increased, if one includes the areas under the pile supported portions of the Fort Kamehameha Outfall Extension.

At most study sites within Pearl Harbor, green sea turtles were never recorded. This observation is consistent with those made during previous Pearl Harbor surveys. There are no significant quantities of preferred forage within Pearl Harbor. Preferred resting habitat is also limited. With the possible exception of the lower reaches of West Loch, the authors believe that few if any green sea turtles are resident within Pearl Harbor. Those individuals which are sighted, are most likely only transient.

Monk seals are very rare in the Main Hawaiian Islands. None are believed to be resident within or adjacent to the study area. However, single monk seals have periodically hauled out on the Iroquois Point – Puuloa Beach area for at least the last five years (Smith pers. obs.). As noted, one individual was observed in the PHEC. Observations appear to support the idea that a single monk seal will visit the project area from time to time and probably remain in the vicinity for periods of up to a month. No monk seal sighting have been reported within Pearl Harbor itself.

4.7 The Impact of Alien Species on The Pearl Harbor Ecosystem

Biologists in recent years are becoming much more aware of the impact that alien species may have in host communities. Alien species may arrive in new geographical locations by natural colonization or mediated through the activities of man. Most successful introductions in marine environments occur through the movement of ships either on the hulls or in the ballast water of ships (Ruiz et al. 2000; Wonham et al. 2000, 2001; Eldredge and Carlton 2002). Once established, alien species may be competitively superior to native species for specific resources eventually resulting in the alien species displacing native forms and possibly leading to their demise (Coles et al. 1997).

Coles et al. (1997) provide an in-depth review and analysis of the establishment of alien species in Pearl Harbor. Of the 434 species and higher taxa reported by them, 96 (22%) were considered to be introduced or cryptogenic (of unknown origin). A common attribute with most Hawaiian aquatic introductions is that they appear to have a competitive advantage for space or food. The introduced species may also prey on natives in the shared habitat. In general, the impact of introductions is more evident in communities with fewer species such as in Hawaiian streams where much of the native fauna in the lower reaches of streams has been replaced by a handful of non indigenous species (Devick 1991). At the other extreme, in many marine settings where the communities are speciose, the impact of the recent introductions appears to be less evident.

The most obvious impact of alien aquatic species in Pearl Harbor is for those which require the occupation of substrate for part of their lifecycle. Once established, these sessile species may increasingly dominate space formerly occupied by native species. The alien intertidal barnacle, *Chthamalus proteus*, was first reported by Coles et al. (1997) in Pearl Harbor. This barnacle is one of the dominant life forms on hard substrate in the intertidal of Pearl Harbor as well as other harbors of Hawai'i and represents a serious threat to native species that occupy the same habitat (Coles et al. 1997). Similarly, the red mangrove (*Rhizophora mangle*) has become a dominant lifeform along the undeveloped shorelines of Pearl Harbor and elsewhere in Hawai'i where sheltered bodies of brackish water exist. The thickets and canopy of this species exclude all other intertidal vegetation.

The gorilla seaweed, *G. salicornia*, is an apparently alien species that in recent years has become very abundant in parts of Kaneohe Bay, Pearl Harbor and at numerous other sites statewide. It is believed to have been introduced in the early 1970s, and has become a dominant life form over large areas (hundreds of square meters) in many shallow portions areas of Pearl Harbor. Sites 10 (Beckoning Point), 13 (Debris Field 3), and 23 (Porites Reef, West Loch) in the present study had a large percent cover of this macroalga (Percent cover of *G. salicornia* as determined by the Quadrat Intercept Method; site 10 = 55%, site 13 = 71%, and site 23 = 81%). The second most common subtidal alga is also an alien

Rhodophyta (*Acanthophora spicifera*); it is believed to have been introduced to Hawai'i in the early 1950s (Doty 1961).

The eastern oyster, *Crassostrea virginica*, was introduced to Hawai'i in 1866 (Kay 1979). Although this species has experienced massive die offs in the past, it has recovered in West Loch and is extremely abundant in upper reaches. Today, *Crassostrea virginica* beds in West Loch are estimated to support 35 million oysters (Brock pers. obs.).

The featherduster worm, *Sabellastarte spectabilis*, was recorded in the majority of benthic and macroinvertebrate transects in Pearl Harbor. This species is abundant on O'ahu's south shore reefs, and in Pearl Harbor and Kaneohe Bay at shallow depths, especially in dredged areas that receive silt-laden waters and may be an indicator of waters with high sediment content (Bailey-Brock 1976).

All of these successfully established alien species occupy space that might otherwise be utilized by native species. The biota of Pearl Harbor represents a mosaic of alien and native forms. Many of the most visually obvious aquatic and intertidal species in Pearl Harbor today are not native in their origin.

The situation with impacts created by alien fishes is more difficult to quantify. Several alien fishes encountered in this and previous studies in Pearl Harbor include guppies and mollies (Poecilidae), silvery tilapia (*Tilapia melanotheron*), blacktail snapper (*Lutjanus fulvus*), small mullet (*Valamugil engeli*), striped goatfish (*Upeneus vittatus*) and goldspot herring (*Herklotsichthys quadrimaculatus*). In his discussion of the impacts of alien fishes, Maciolek (1984, page 148) notes:

> Impacts of immigrant species may be beneficial, negligible, adverse, or a combination of these for a given species under some circumstances. Beneficial and negligible effects generally relate to the purpose for a species introduction, such as for food, forage, recreation, or biological control. Adverse effects center on changes in natural ecosystems induced by exotics, particularly on native species that may be direct (competition and predation) or indirect (e.g., introduction and transmission of disease or parasites). Benefits are generally self-evident, as are some adverse impacts, but even these are difficult to quantify.

There has been federal recognition of the impact that aquatic alien species may have on native ecosystems. Adoption of the International Maritime Organization Assembly Resolution A.868(20) (IMO 1997) that provides guidelines for the control and management of ships' ballast water should help to reduce or eliminate future introductions. In addition, the Navy has implemented procedures which significantly reduce the likelihood that alien species will be introduced into Pearl Harbor.

5.0 SUMMARY AND CONCLUSIONS

The following answers to the seven questions posed in the Introduction (refer to Section 1.1) summarize the findings and offer general conclusions.

1. Have there been any changes in the fish and benthic communities since the Evans (1974) investigation?

The duration of the present study was shorter and only non-destructive data collection methods were utilized. Nevertheless, the authors believe the following conclusions are supported by the data:

- The standing crop of fishes at some study sites has increased, for example, Hospital Point and Mokunui Islet.
- In areas such as Beckoning Point, where the alien gorilla seaweed *Gracilaria salicornia* has taken over more than 98% of the seafloor, habitat complexity has been significantly reduced and the standing crop of fishes has declined.
- Individuals of a number of ecologically, recreationally and commercially important fish species are significantly more common and larger within Pearl Harbor than at other locations in the Main Hawaiian Islands. These species include giant trevally (*Caranx ignobilis*), golden trevally (*Gnathanodon speciosus*), whitesaddle goatfish (*Parupeneus porphyreus*) and spectacled parrotfish (*Scarus perspicillatus*).
- No stony corals were recorded at any of the Evans study sites in 1974. In Coles (1999) five stony coral species were recorded, while Smith (2002) recorded eight and the present study recorded 11 species. The return of stony corals to Pearl Harbor is believed to be a strong indicator or improving environmental conditions. It should be noted, however, that some specific coral colonies recorded in 2002 were being overgrown and killed by the alien gorilla seaweed *Gracilaria salicornia* in 2005.
- In addition to stony corals, other formerly abundant species appear to be making a comeback as well. The striped mantis shrimp (*Lysiosquilla maculatus*), for example, was well represented at four separate transect sites.

2. How do fish communities and fish stocks in Pearl Harbor compare to other locations around O'ahu and in the Main Hawaiian Islands?

- The data strongly show, for the species compared, fishes in Pearl Harbor are not only more abundant, they are also significantly larger. For example, the highly esteemed spectacled parrot fish surveyed off Lana'i averaged 71 g per fish and 1.8 specimens sighted per transect (290 transects). In Pearl Harbor a mean of 14 individuals were recorded per transect with a mean weight of 243 g.
- The control of Pearl Harbor by the U.S. Navy for a century has limited civilian use of the aquatic resources in Pearl Harbor. This has made much of Pearl Harbor a de facto aquatic preserve which as allowed resources to exist with little or no fishing pressure exerted upon them. The result is that some fishery resources are relatively abundant with individuals of some highly-sought commercially important species attaining much greater mean sizes in Pearl Harbor than found elsewhere outside of Pearl Harbor.
- The highest fish densities within Pearl Harbor were found associated with artificial structures, such as sunken barges and piers. These debris items were providing important habitat to diverse fish populations.

3. What is the status of stony corals in Pearl Harbor and the Pearl Harbor Entrance Channel? How does this compare with the findings of Evans (1974) and Smith (2000, 2002)?

- As noted in the response to question 1, 11 species of stony corals have been recorded within Pearl Harbor. The number of species and locations at which they occur has steadily increased since 1999. The greatest threat to stony corals in Pearl Harbor is judged to be the spread of the alien gorilla seaweed *Gracilaria salicornia.*

- The PHEC provides relatively poor habitat for stony corals, due to the quality of the substrate. Coral cover on the seafloor is very sparse, less than 1%. The only mature coral colonies on the PHEC seafloor are located on metallic or concrete debris or limestone blocks which have broken off the channel walls, In contrast to the seafloor of the PHEC, the walls and adjacent fossilized reef platforms support modest to substantial coral development. The best developed reefs occur on the western side of the channel between Buoys 1 and 3; during this study the percentage of seafloor covered by stony corals was quantitatively estimated to be as high as 15%.

4. What changes have occurred in the Turtle/Tripod Reef coral community between 2002 and 2005?

- Permanent transects were established in 2002. In 2002, the percentage of the seafloor covered by stony coral was quantitatively determined to be 100%, within the transect corridor.
- Coral cover on the western side of the PHEC was significantly lower in 2005 than when the same sites were assessed in 2002, prior to construction. Coral cover was estimated to be 15.0% and 11.4% based on the PCQM and QIM, respectively.
- Although this is a dramatic change, the authors believe coral at this site is recovering due to the large numbers of young coral colonies and the absence of disease, bleaching, algal overgrowth and other indicators of stress.
- Species composition of stony corals, other macro invertebrates and fishes appears to be the same as in 2002, although quantitative surveys of these other organisms were not done in 2002.

5. How did the construction of the Fort Kamehameha Outfall Replacement affect stony coral distribution in the trenched portion of the outfall corridor, located within the PHEC?

- Extensive quantitative coral surveys were completed in the outfall corridor during 2000, prior to construction in 2003. During the 2005 surveys, a portion of the 2000 survey area was reassessed using the same techniques and personnel. The seafloor appeared to be the same; it consisted of coarse sand and unstable rubble.
- In 2000, coral diversity was low, the percent coral cover was 0.13% and the mean area within which each coral colony occurred was 8.7 m^2. In 2005 five of the six species recorded in 2000 were present, the percent coral cover was 0.02% and the mean area surrounding each colony was 9.9 m^2.
- Based upon the area within which each coral colony occurred, the authors concluded that the amount of suitably sized rubble for coral larval settlement was not changed as a result of the construction project. As expected, individual colony size was smaller in 2005, since the oldest colony was only two years old. Of course, the younger, smaller colonies resulted in a reduced percent coral cover.
- Construction of the outfall did not produce significant long term impacts to the corals community within the trenched portion of the outfall corridor in the PHEC. Coral development was extremely sparse in 2000, and remained extremely sparse in 2005.

6. Are corals recruiting to the pile supported portions of Fort Kamehameha Outfall and what other macrobenthic species are present on the outfall pipe and pile supports?

- Most of the biotic cover on both the piles and the pipe was turf algae; however stony corals, encrusting sponges, crustose coralline algae and sessile bivalves were also recorded.
- The size of stony corals on the pipe and piles was statistically identical.
- At least three species from three genera (*Pocillopora meandrina*, *Porites* sp., and *Montipora* sp.) were present. The largest specimen measured was 3.7 cm in diameter. Based upon generally accepted growth rates for these genera in Hawai'i, the largest specimen presumably settled on the outfall shortly after it was completed (two years prior to the survey).

7. What marine threatened and endangered species occur within Pearl Harbor, the PHEC and along the pile supported portion of the outfall, seaward of the PHEC?

- The only protected marine species sighted within Pearl Harbor during this study was the threatened green sea turtle.
- Historically, there have been single sightings of the endangered humpback whale and the endangered hawksbill sea turtle. There are no recorded sightings of the endangered monk seal within Pearl Harbor.
- With the possible exception of the lower reaches of West Loch, it is unlikely that there are any resident green sea turtles within Pearl Harbor. Green sea turtles do, however, enter and transit through Pearl Harbor occasionally.
- The PHEC supports a resident population of green sea turtles, estimated to range in number from 32 to 41 individuals. Preferred resting habitat and preferred forage were both abundant in the PHEC.
- The pile supported portion of the outfall appeared to attract green sea turtles. Specimens were sighted there on every dive.
- Single adult monk seals have periodically hauled out on the Iroquois Point – Puuloa Beach during the last five years. A single sighting was recorded underwater in the PHEC (August 2005). The individual bore a tag (H 58) and was estimated to be 2.5 m long.
- No monk seals are believed to be resident within Pearl Harbor, the PHEC or the adjacent areas.

Based upon this investigation, the marine biological communities in Pearl Harbor, the PHEC and the immediately adjacent areas are judged to be generally healthy. The numbers of fin fish and size of fin fish is larger than at other sites investigated in the Main Hawaiian Islands. Stony corals and other key invertebrates which were absent or undetected during the extensive surveys in 1974 are returning, and indicative of improving environmental conditions. Sunken derelict items, hull fragments and piers are providing important habitat for fish, corals and green sea turtles both in Pearl Harbor and in the PHEC. These items should not be removed unless they create a navigational hazard. Corals sustained some impacts in the PHEC during construction of the Fort Kamehameha Outfall Extension (2001-2003); however, they were recovering at the time this survey was conducted and are expected to return to their pre-construction densities and size in the future.

The most significant threat to organisms investigated during this study is judged to be the alien gorilla seaweed *Gracilaria salicornia.* This species is a serious problem at many locations throughout the Hawaiian Islands, in addition to Pearl Harbor. As documented in this report it has over grown and killed coral colonies within Pearl Harbor and degraded formerly productive fish habitat, such as Beckoning Point. Control of *Gracilaria salicornia* should be considered the most important priority for sustaining and protecting the fishery and benthic invertebrate resources of Pearl Harbor.

This page intentionally left blank.

6.0 LITERATURE CITED

Aronson, R.B., P.J. Edmunds, W.F. Precht, D.W. Swanson, and D.R. Levitan. 1994. Large-scale, long-term monitoring of Caribbean coral reefs: Simple, quick, inexpensive techniques. Washington, D.C.: Smithsonian Institution, National Museum of Natural History.

Bailey-Brock, J.H. 1976. Habitats of tubicolous polychaetes from the Hawaiian Islands. Pacific Science 30:69-81.

B-K Dynamics, Inc. 1972. Marine environmental impact analysis, Waiau Power Plant. Prepared by B-K Dynamics, Inc. for Hawaiian Electric Company, Inc., Honolulu, Hawaii.

Brock, R.E. 1982. A critique on the visual census method for assessing coral reef fish populations. Bulletin of Marine Science 32:269_276.

Brock, R.E. 1987. An assessment of the fishes and macrobenthos off the Kahuku coast, Oahu in relation to an aquaculture effluent. Prepared for AECOS, Inc., Kailua, Hawaii.

Brock, R.E. 1994. An analysis of benthic communities in the zone of mixing for the Waiau electrical generation facility: year 1 report - 1993. Prepared for Environmental Department, Hawaiian Electric Co., Inc., P.O. Box 2750, Honolulu, Hawaii 96840. EAC Rept No. 94-02.

Brock, R.E. 1995. An analysis of benthic communities in the zone of mixing for the Waiau electrical generation facility: year 7 report - 1999. Prepared for Environmental Department, Hawaiian Electric Co., Inc., P.O. Box 2750, Honolulu, Hawaii 96840. EAC Rept No. 95-02.

Brock, R.E. and J.H. Brock. 1977. A method of quantitatively assessing the infaunal community residing in coral rock. Limnology and Oceanography 22:948-951.

Brock, R.E. and J.E. Norris. 1989. An analysis of the efficacy of four artificial reef designs in tropical waters. Bulletin of Marine Science 44:934-941.

Brock, R.E., C. Lewis and R.C. Wass. 1979. Stability and structure of a fish community on a coral patch reef in Hawaii. Marine Biology 54:281-292.

Brock, V.E. 1954. A preliminary report on a method of estimating reef fish populations. Journal of Wildlife Management 18:297_308.

Bryan, W.A. 1915. Natural history of Hawaii. The Hawaiian Gazette Co., Ltd., Honolulu.

Buske, N.L., and E.C. Evans III. 1974. Tides, runoff and currents. Pages 3.3-1 – 3.3-79 in E.C. Evans III, ed. Pearl Harbor biological survey - Final report. San Diego, California: Naval Undersea Center.

Clarke, T.A. 1971. The ecology of the scalloped hammerhead shark, *Sphyrna lewini*, in Hawaii. Pacific Science 25:133-144.

Coles, S.L. 1999. Colonization of reef corals in Pearl Harbor, Oahu, Hawaii. Coral Reefs 18:28.

Coles, S.L., R.C. DeFelice, L.G. Eldredge, J.T. Carlton, R.L. Pyle, and A. Suzumoto. 1997. Biodiversity of marine communities in Pearl Harbor, Oahu, Hawaii with observations on introduced exotic species. Department of Defense Legacy Project Number 106. Contribution No. 1997-014 to the Hawaii Biological Survey. Bishop Museum Technical Report No. 10. Honolulu, Hawai'i: Bishop Museum Press.

Conand, C., P. Chabanet, J.P. Quod, and L. Bigot. 1999. Guidelines: Coral reefs monitoring in the south-west region of the Indian Ocean. Indian Ocean Commission and the Regional Environmental Programme, Mauritius.

Conand, C., P. Chabanet, J.P. Quod, and L. Bigot. 2000. Manual méthodologique pour le suivi de l'état de santé des récifs coralliens du sud-ouest de l'océan Indien. Commission Océan Indien, Mauritius.

Cottam, J., and T. Curtis. 1956. The use of distance measurements in phyto-sociological sampling. Ecology. 37(3):721-727.

Dall, W.H., P. Bartsch and H.A. Rehder. 1938. A manual of recent and fossil marine pelecypod molluscs of the Hawaiian Islands. Bishop Museum Bulletin 153:1-233.

Devaney, D.M. and L.G. Eldredge. 1977. Reef and shore fauna of Hawaii. Section 1: Protozoa through Ctenophora. Bishop Museum Special Publication 64(1). Honolulu, Hawaii: Bishop Museum Press.

Devick, W.S. 1991. Patterns of introductions of aquatic organisms to Hawaiian freshwater habitats, new directions in research, management and conservation of Hawaiian freshwater stream ecosystems. Pages 189-213 in Proceedings of the 1990 Symposium on Freshwater Stream Biology and Fisheries Management. State of Hawaii, Department of Land and Natural Resources, Division of Aquatic Resources. Honolulu.

Dix, R.M. 1961. An application of the point-centered quarter method to sampling grassland vegetation. Journal of Range Management 14:63-69.

Dollar, S., and R. Brock. 2001. Pearl Harbor INRMP marine and fishery resources. Appendix G in DoN (Department of the Navy). Pearl Harbor Naval Complex integrated natural resources management plan. Final report. Prepared for Commander, Navy Region Hawai'i, Honolulu, Hawai'i by Helber Hastert & Fee, Planners, Honolulu, Hawai'i.

DoN (Department of the Navy). 2001. Pearl Harbor Naval Complex integrated natural resources management plan. Final report. Prepared for Commander, Navy Region Hawai'i, Honolulu, Hawai'i by Helber Hastert & Fee, Planners, Honolulu, Hawai'i.

DoN (Department of the Navy). 2005. Navy's deep water outfall at Pearl Harbor now online: Meeting stricter permit requirements and taking care of the environment. Press Release. 26 January. Pearl Harbor, Hawai'i: Naval Facilities Engineering Command, Public Works Center Pearl Harbor.

Doty, M.S. 1961. *Acanthophora*, a possible invader of the marine flora of Hawaii. Pacific Science 15:547-552.

Eldredge, L.G. and J.T. Carlton. 2002. Hawaiian marine bioinvasions: A preliminary assessment. Pacific Science 56(2):211-212.

English, S., C. Wilkinson, and V. Baker. 1994. Survey manual for tropical marine resources. Townsville, Australia: Australian Institute of Marine Science.

Englund, R.A., D.J. Preston, R. Wolff, S.L. Coles, L.G. Eldredge, and K. Arakaki. 2000. Biodiversity of freshwater and estuarine communities in lower Pearl Harbor, Oahu, Hawaii with observations on introduced species. Department of Defense Legacy Project Number 106. Bishop Museum Technical Report No. 10. Honolulu, Hawai'i: Bishop Museum Press.

Evans III, E.C., editor. 1974. Pearl Harbor biological survey-final report. San Diego, California: Naval Undersea Center.

Evans III, E.C., T.J. Peeling, A.E. Murchison, and Q.D. Stephen-Hassard. 1972. A proximate biological survey of Pearl Harbor, Oahu, 13 May to 18 June 1971. San Diego, California: Naval Undersea Research and Development Center.

Goldman, B. and F.H. Talbot. 1975. Aspects of the ecology of coral reef fishes. Pages 125-154 in O.A. Jones and R. Endean, eds. Biology and geology of coral reefs. Volume 3: Biology 2. New York, New York: Academic Press.

Grigg, R.W. 1995. Coral reefs in an urban embayment in Hawaii: A complex case history controlled by natural and anthropogenic stress. Coral Reefs 14:253-266.

Grovhoug, J.G. 1992. Evaluation of sediment contamination in Pearl Harbor. Technical Report 1502. San Diego, California: Naval Command, Control and Ocean Surveillance Center.

Gulko, D. 1998. Hawaiian coral reef ecology. Honolulu, Hawaii: Mutual Publishing.

Hill, J., and C. Wilkinson. 2004. Methods for ecological monitoring of coral reefs. Version 1. Townsville, Australia: Australian Institute of Marine Science.

Hoover, J.P. 1993. Hawaii's fishes: A guide for snorkelers divers and aquarists. Honolulu, Hawaii: Mutual Publishing.

IMO (International Maritime Organization). 1997. Guidelines for the control and management of ships' ballast water to minimize the transfer of harmful aquatic organisms and pathogens. Resolution A.868(20) adopted on 27 November 1997. London, United Kingdom: International Maritime Organization.

Kay, E.A. 1979. Hawaiian marine shells. Reef and shore fauna of Hawaii, Section 4: Mollusca. B.P. Bishop Museum Special Publication 64(4). Honolulu, Hawaii: Bishop Museum Press.

Maciolek, J.A. 1984. Exotic fishes in Hawaii and other islands of Oceania. Pages 131-161 in W.R. Courtney and J.R. Stauffer, Jr., eds. Distribution, biology and management of exotic fishes. Baltimore, Maryland: Johns Hopkins University Press.

Maragos, J.E. 1995. Revised checklist of extant shallow-water corals from Hawai'i (Cnidaria: Anthozoa: Scleractinia). Bishop Museum Occasional Papers 42: 54–55.

Marine Research Consultants, Inc. 2001. Assessment of water quality and marine community structure: Fort Kamehameha ocean outfall extension oceanographic study. Appendix VI in DoN (Department of the Navy). Final environmental impact statement: Outfall replacement for wastewater treatment plant at Fort Kamehameha, Navy Public Works Center, Pearl Harbor, Hawaii. Pearl Harbor, Hawaii: Naval Facilities Engineering Command, Pacific.

Myers, R.F. 1991. Micronesian reef fish. 2d ed. Barrigada, Guam: Coral Graphics.

NCCOS (National Centers for Coastal Ocean Science). 2005. Aerial photography: Hawaii. Accessed November 2006. http://www8.nos.noaa.gov/biogeo_public/aerial/search.aspx.

NOAA (National Oceanic and Atmospheric Administration) 2002. NGDC coastal relief model, vol. 10: Hawaii. Boulder, Colorado: National Oceanic and Atmospheric Administration.

Paulay, G., L. Kirkendale, C. Meyer, P. Houk, T. Rongo, and R. Chang. 2001. Marine biodiversity resource survey and baseline reef monitoring survey of the southern Orote Peninsula and north Agat Bay Area, COMNAVMARIANAS. Mangilao, Guam: Marine Laboratory, University of Guam.

Randall, J.E. 1987. Introductions of marine fishes to the Hawaiian Islands. Bulletin of Marine Science 41:490-502.

Ricker, W.E. 1975. Handbook of computations for biological statistics of fish populations. Bulletin of the Fisheries Board of Canada. 119.

Risk, M.J. 1972. Fish diversity on a coral reef in the Virgin Islands. Atoll Research Bulletin 153:1-6.

Risser, P.G., and P.H. Zedler. 1968. An evaluation of the grassland quarter method. Ecology. 49 (5):1006-1009.

Rohlf, F.J., and R.R. Sokal. 1969. Statistical tables. San Francisco, California: W.H. Freeman and Company.

Ruiz, G.M., P.W. Fofonoff, J.T. Carlton, M.J. Wonham, and A.H. Hines. 2000. Invasion of coastal marine communities in North America: Apparent patterns, processes, and biases. Annual Review of Ecology and Systematics 31:481-531.

Sale, P.F. 1977. Maintenance of high diversity in coral reef fish communities. American Naturalist 111:337-359.

Sandwell, D.T., W.H.F. Smith, S.M. Smith, and C. Small. 2004. Global topography: Measured and estimated seafloor topography. Accessed 21 February 2005. http://topex.ucsd.edu/marine_topo/mar_topo.html.

Scoffin, T.P., and D.R. Stoddart. 1978. The nature and significance of microatolls. Philosophical Transactions of the Royal Society of London B 284:99-122.

Shomura, R.S. 1987. Hawaii's marine fishery resources: yesterday (1900) and today (1986). Southwest Fisheries Center Administrative Report H-87-21.

Smith, S.H. 1999. Field survey of sea turtles in the vicinity of the Pearl Harbor Entrance Channel. Technical report. Pearl Harbor, Hawaii: Naval Facilities Engineering Command Pacific.

Smith, S.H. 2000. Coral survey of selected portions of the outfall replacement corridor wastewater treatment plant Fort Kamehameha, Navy Public Works Center, Pearl Harbor, Hawaii. Technical report. Pearl Harbor, Hawaii: Naval Facilities Engineering Command Pacific.

Smith, S.H. 2002. Survey of stony corals in Pearl Harbor and the Pearl Harbor Entrance Channel. Technical report. Pearl Harbor, Hawaii: Naval Facilities Engineering Command Pacific.

Veron, J. 2000. Corals of the world. (Volumes 1, 2 and 3). Townsville, Australia: Australian Institute of Marine Science.

Wonham, M.J., J.T. Carlton, G.M. Ruiz, and L.D. Smith. 2000. Fish and ships: Relating dispersal frequency to success in biological invasions. Marine Biology 136:1111-1121.

Wonham, M.J., W.C. Walton, G.M. Ruiz, A.M. Frese, and B.S. Galil. 2001. Going to the source: Role of the invasion pathway in determining potential invaders. Marine Ecology Progress Series 215:1-12.

Zar, J.H. 1984. Biostatistical analysis. 2d ed. Englewood Cliffs, New Jersey: Prentice Hall Inc.

This page intentionally left blank

7.0 LIST OF PREPARERS

- The following individuals originated and sponsored this project:

Name/Title/Affiliation	Project Role
Stephen H. Smith Naval Facilities Engineering Service Center Pearl Harbor, Hawai'i	Navy Project Manager Navy Technical Representative
Elloise M. Hitshew Naval Facilities Engineering Command Atlantic Norfolk, Virginia	Contracting Officer
David James Naval Facilities Engineering Command Atlantic Norfolk, Virginia	Navy Technical Representative
Pedro Morales Legacy Resource Management Program Arlington, Virginia	DOD Legacy Resource Management Program Project Manager
Lorri Schwartz Naval Facilities Engineering Command Washington Navy Yard, District of Columbia	Project Development Project Oversight

- The following individuals participated in the preparation of the report:

Name/Title/Affiliation	Education	Project Role
Dan L. Wilkinson Vice President, Environmental Resources Geo-Marine, Inc. Plano, Texas	Ph.D., Botany Texas A&M University M.S., Zoology Stephen F. Austin State University B.S., Biology Central State University	GMI Program Manager Technical Review
Stephen H. Smith Naval Facilities Engineering Service Center Pearl Harbor, Hawai'i	M.S., Biology California State University, Long Beach M.A., Apologetics/Philosophy Simon Greenleaf School of Law Orange CA B.S., Biological Science University of California, Irvine	Navy Project Manager Report coordination Data analyses (benthos, fishes, T&E species) Report preparation
Ken Deslarzes Senior Marine Ecologist Geo-Marine, Inc. Plano, Texas	Ph.D., Oceanography Texas A&M University Diploma of Biology University of Lausanne, Switzerland License of Biology University of Lausanne, Switzerland	GMI Project Manager Report coordination Data analyses (benthos) Report preparation

Name/Title/Affiliation	Education	Project Role
Richard Brock Environmental Assessment, LLC Honolulu, Hawai'i	Ph.D., Fisheries/Ecology University of Washington M.S., Zoology University of Hawai'i B.S., Zoology University of Hawai'i	Data analyses (fishes) Report preparation
David J. Evans Marine Biologist Geo-Marine, Inc. Plano, Texas	B.S., Marine Biology Texas A&M University	Data analyses (fishes)
Alan Kam Environmental Assessment, LLC Honolulu, Hawai'i	B.A., Sociology University of Hawai'i	Data analyses (fishes) Report preparation
Jacqueline Karle Report Production Geo-Marine, Inc. Plano, Texas	B.S., Zoology Biomedical Sciences University of Oklahoma	Report production
Donald E. Marx Jr. Naval Facilities Engineering Command Mid-Atlantic	B.S., Biology Old Dominion University	Data analyses (T&E species) Report preparation
Leslie Whaylen Geo-Marine, Inc. Plano, Texas	B.S. Marine Biology Texas A&M University	Data analyses (fishes and benthos) Report preparation

- The following individuals participated in the fieldwork:

Name/Title/Affiliation	Education	PROJECT ROLE
Stephen H. Smith Naval Facilities Engineering Service Center, Pearl Harbor, Hawai'i	M.S., Biology California State University, Long Beach M.A., Apologetics/Philosophy Simon Greenleaf School of Law Orange CA B.S., Biological Science University of California, Irvine	Navy Project Manager Benthos, fishes, T&E species
Ken Deslarzes Senior Marine Ecologist Geo-Marine, Inc. Plano, Texas	Ph.D., Oceanography Texas A&M University Diploma of Biology University of Lausanne, Switzerland License of Biology University of Lausanne, Switzerland	GMI Project Manager Benthos
Richard Brock Environmental Assessment, LLC Honolulu, Hawai'i	Ph.D., Fisheries/Ecology University of Washington M.S., Zoology University of Hawai'i B.S., Zoology University of Hawai'i	Fishes, macroinvertebrates

Name/Title/Affiliation	Education	PROJECT ROLE
David J. Evans Marine Biologist Geo-Marine, Inc. Plano, Texas	B.S., Marine Biology Texas A&M University	Fishes
Alan Kam Environmental Assessment, LLC Honolulu, Hawai'i	B.A., Sociology University of Hawai'i	Logistics, boat captain, surface support
Donald E. Marx Jr. Naval Facilities Engineering Command Mid-Atlantic	B.S., Biology Old Dominion University	Benthos, T&E species
Mobile Diving Salvage Unit 1 Pearl Harbor, Hawai'i Commander Daniel Colman		Diving support Logistics support

This page intentionally left blank.

Characterization of Fish and Benthic Communities of
Pearl Harbor and Pearl Harbor Entrance Channel, Hawaiʻi
NAVFAC, Pacific

APPENDIX 1

QUANTITATIVE VISUAL CENSUSES OF FISH

Appendix 1. Abundance of fishes observed in 32 visual census transects conducted among 17 locations in Pearl Harbor and the Pearl Harbor Entrance in 2005. The transects were each 25 m long, 4 m wide, and the height of transects reached from the seafloor to the water's surface. Twenty-five transects were done at 11 locations in Pearl Harbor (sites 7 through 17), and seven transects at six locations within the Pearl Harbor Entrance Channel (sites 1 through 6).

Species	1	2 3 4			5 6		7 8		9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32
MURAENIDAE																																
Gymnothorax flavimarginatus				1																												
Gymnothorax meleagris			1																													
Echidna nebulosa						1																										
SYNODONTIDAE																																
Saurida gracilis																			1		1											
ATHERINIDAE																																
Pranesus insularum																						2000										
HOLOCENTRIDAE																																
Adioryx lacteoguttatus																						14										
Myripristis amaenus																						61										
PRIACANTHIDAE																																
Priacanthus cruentatus																						1										
SYNGATHIDAE																																
Hippocampus kuda																													1			1
SERRANIDAE																																
Cephalopholis argus			1																													
APOGONIDAE																																
Apogon kallopterus			31					5			1																					
Foa brachygramma					4		5		3				22													12	10					
CARANGIDAE																																
Gnathanodon speciosus																									1		1					
Caranx ignobilis														1																		
Scomberoides laysan																			40													
Decapterus macarellus												9							88													
Caranx melampygus				2																												
LUTJANIDAE																																
Lutjanus fulvus										46	1	3							190		124	48	73	44				8	29			
SPARIDAE																																
Monotaxis grandoculis			2																													
MULLIDAE																																
Mulloides flavolineatus												2										6	1									
Mulloides vanicolensis																						23	6									
Parupeneus cyclostomus		1		3																												
Parupeneus porphyreus												1							2		6	2	2	1							1	
Parupeneus multifasciatus	1		5	3	2																2	1										
Parupeneus bifasciatus		1																														
CHAETODONTIDAE																																
Forcipiger flavissimus				2																												
Chaetodon auriga								3		1	2	2	2						10		15	1	2	2								1
Chaetodon unimaculatus			1																													
Chaetodon lunula			2					2												2	1	1	1									
Chaetodon lunulatus																					2											
Chaetodon quadrimaculatus		2	1																													
Chaetodon multicinctus	2		2																													
Chaetodon miliaris		5	9																													
Chaetodon ephippium			2							2									2		8	1										
POMACENTRIDAE																																
Dascyllus albisella	4		15		18	8		48		22	53		6						51				3	9								20
Abudefduf abdominalis								32		51		21							66		105	44	28	34			2		34			
Abudefduf sordidus												2									1	1	2	4								
Plectroglyphidodon johnstonianus			4																													
Plectroglyphidodon imparipennis		6																														
Chromis vanderbilti	14	125																														
Stegastes fasciolatus			4																													
CIRRHITIDAE																																
Paracirrhites arcatus	4	6																														
Paracirrhites forsteri			1																													
SPHYRAENIDAE																																
Sphyraena barracuda															1									1				8				

Appendix 1 (continued). Abundance of fishes observed in 32 visual census transects conducted among 17 locations in Pearl Harbor and the Pearl Harbor Entrance in 2005. The transects were each 25 m long, 4 m wide, and the height of transects reached from the seafloor to the water's surface. Twenty-five transects were done at 11 locations in Pearl Harbor (sites 7 through 17), and seven transects at six locations within the Pearl Harbor Entrance Channel (sites 1 through 6).

Species	1	2 3 4			5 6		7 8		9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32
LABRIDAE																																
Labroides phthirophagus			1		2																											
Bodianus bilunulatus		1	1	3																												
Oxycheilinus unifasciatus										2									1		1											
Cheilinus bimaculatus	5				3	1																										
Pseudocheilinus octotaenia			1																													
Thalassoma duperrey		25	8	1	5	14		14																1								
Thalassoma purpureum		1																														
Gomphosus varius		4	4																				1									
Coris venusta	2																															
Coris gaimard		1	2																													
Pseudojuloides cerasinus			1	8																												
Stethojulis balteata	5					26																										
Halichoeres ornatissimus		1																														
SCARIDAE																																
Calotomus carolinus								1																								
Scarus perspicillatus		7	4					2		21		29							19	2	13	21	10	2			19		106		67	
Chlorurus sordidus		13	11							50		19																				
Scarus psittacus		14				23		23		8	12	94	103			64				138		36						1			4	
Scarus rubroviolaceus			1	1																	2											
GOBIIDAE																																
Bathygobius fuscus					3											1															3	
Gnatholepis anjerensis				3		1																										
Psilogobius mainlandi																				4												
Asterropteryx semipunctatus						12		72	12		19	18	35	6 4		3 4						23				9 4		8	16 18			35
PARAPERCIDAE																																
Parapercis schaunslandi				8																												
ACANTHURIDAE																																
Acanthurus triostegus						1		14		1		3							1												1	
Acanthurus nigrofuscus	57	47	18	11																												
Acanthurus nigroris		3		5																												
Acanthurus blochi		25	41	63				18		87			33		2				15	152	390	82	73	43					86			14
Acanthurus olivaceus	1			4															391													
Acanthurus dussumieri		1		48				46		27		37							35	8		1	4									
Acanthurus xanthopterus																										38	1	93	109		29	
Ctenochaetus strigosus		5	23																				10	3								
Zebrasoma flavescens			1							16	1								4	8	6	1		2				2	2			
Zebrasoma veliferum		6								2		11																				
Naso hexacanthus		7																														
Naso lituratus		3	1																													
Naso unicornis												2																				
Naso brevirostris													18						1		13		29									5
ZANCLIDAE																																
Zanclus cornutus				1															4			1	2	2								
BALISTIDAE																																
Rhinecanthus rectangulus		1				1																										
Sufflamen bursa	2	5	2	1																												
MONACANTHIDAE																																
Cantherhines dumerili				2	1																											
Cantherhines sandwichiensis	1	1																														
TETRAODONTIDAE																																
Arothron hispidis						1		1	1		1		3	1				2			1							1 1				1
Canthigaster coronata				1																												
Canthigaster jactator	7	3	5		3	3																										
DIODONTIDAE																																
Diodon hystrix											1								1													
Number of Species	**13**	**28**	**33**	**20**	**8**	**0**	**3**	**4**	**3**	**4**	**9**	**15**	**8**	**3**	**3**	**3**	**1**	**0**	**20**	**7**	**16**	**21**	**17**	**13**	**1**	**3**	**6**	**6**	**9**	**0**	**8**	**7**
Number of Individuals	**106**	**320**	**208**	**170**	**40**	**79**	**18**	**281**	**16**	**336**	**91**	**253**	**222**	**8**	**7**	**68**	**4**	**0**	**924**	**314**	**690**	**2347**	**270**	**148**	**1**	**59**	**37**	**120**	**384**	**0**	**124**	**77**
Biomass (g/m2)	**14.1**	**214.9**	**414.3**	**1260.6**	**2.3**	**7.3**	**3.5**	**184.4**	**1.5**	**547.4**	**66.2**	**644.9**	**187.2**	**54.9**	**3.1**	**1.7**	**0.01**	**0.0**	**1549.9**	**487.4**	**1343.1**	**490.5**	**611.7**	**162.4**	**18.1**	**172.5**	**25.7**	**560.0**	**744.0**	**0.0**	**17.6**	**35.12**

APPENDIX 2

PHOTOGRAPHIC ILLUSTRATIONS

Plate 1. Manta ray (*Manta birostris*) at Site 5 (Pearl Harbor Entrance Channel, east side, opposite Buoy 5).

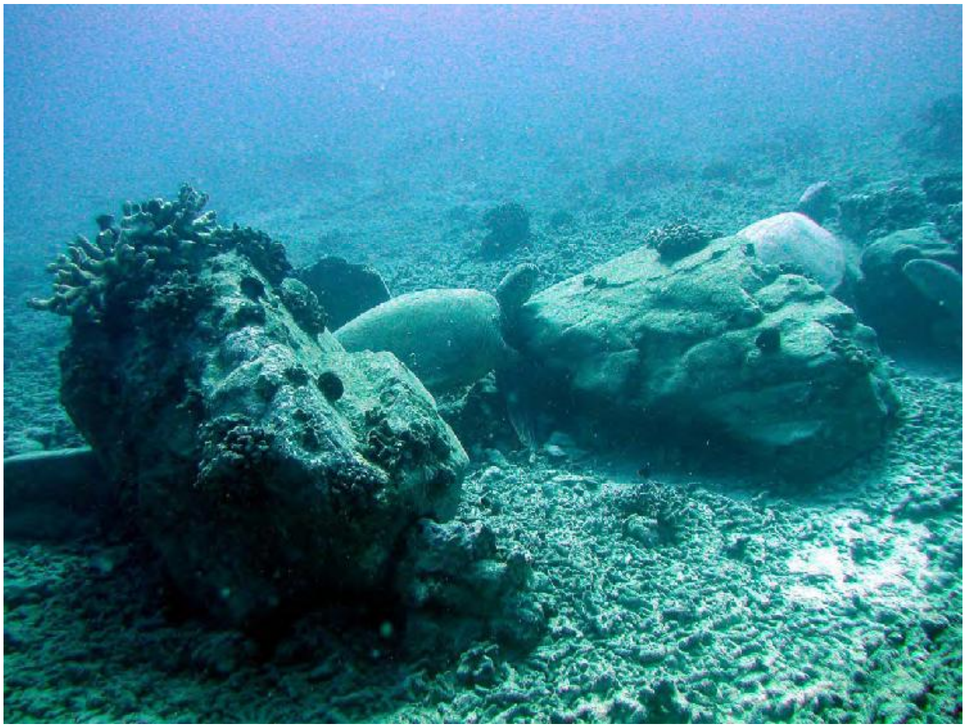


Plate 2. Green sea turtles (*Chelonia mydas*) at the "turtle cleaning station" by Site 3 (Pearl Harbor Entrance Channel, Turtle/Tripod Reef).

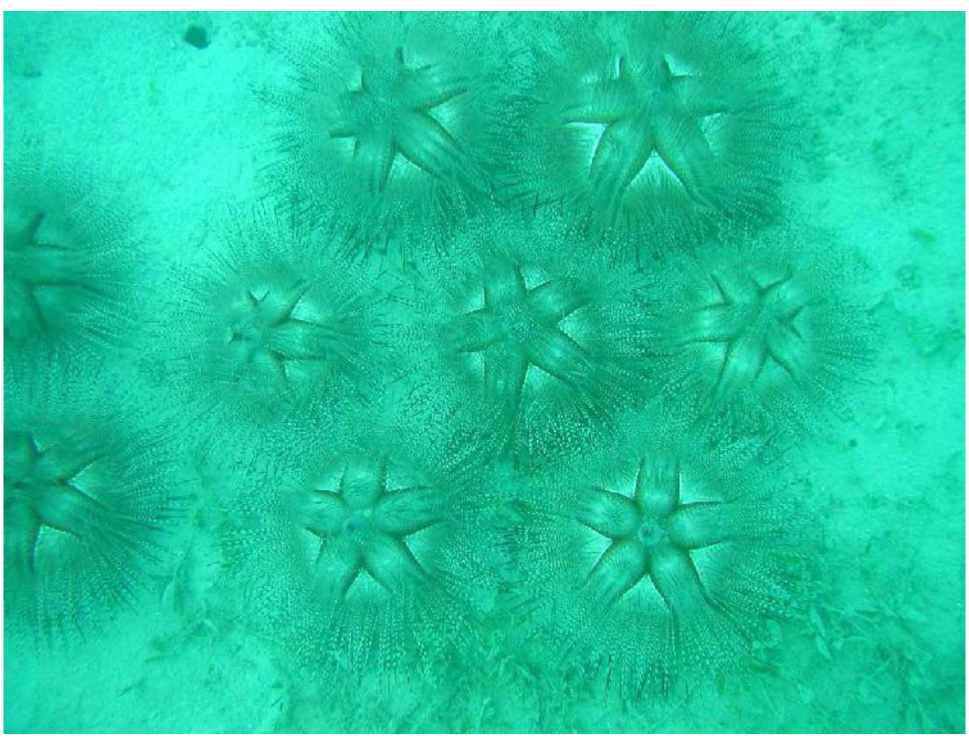


Plate 3. An aggregation of blue-spotted urchins (*Astropyga radiata*) near Site 6 (Pearl Harbor Entrance Channel, west side, adjacent to Buoy 5).

Plate 4. Black-lip pearl oyster (*Pinctada margaritifera*) at Site 17 (Ford Island south, south end by seaplane ramp).

Characterization of Fish and Benthic Communities of
Pearl Harbor and Pearl Harbor Entrance Channel, Hawai'i NAVFAC, Pacific

Plate 5. Concrete debris near Site 6 (Pearl Harbor Entrance Channel, west side, adjacent to Buoy 5). Note the presence of lobe coral (*Porites lobata*).

Plate 6. Cauliflower coral (*Pocillopora meandrina*) at Site 7 (Pearl Harbor, Bishop Point, Channel wall).

Characterization of Fish and Benthic Communities of
Pearl Harbor and Pearl Harbor Entrance Channel, Hawai'i NAVFAC, Pacific

Plate 7. Finger coral (*Porites lobata*) at Site 22 (Pearl Harbor, Porites Reef, West Loch, Channel bottom). Note fused branches.

Plate 8. Rice coral (*Monitpora capitata*) at Site 8 (Pearl Harbor, Waipio Point).

Plate 9. Spreading coral (*Montipora patula*) at Site 15 (Pearl Harbor, Hospital Point).

Plate 10. Don Marx and a large lace coral (*Pocillopora damicornis*) at Site 21 (Pearl Harbor, Dry Docks).

Plate 11. A typical assemblage of Pearl Harbor fishes. Note convict tangs (*Acanthurus triostegus*) and ringtail surgeonfish (*Acanthurus blochii*).

Plate 12. Gorilla seaweed, *Gracillaria salicornia*, colonizing the shallow near shore area at Beckoning Point (study site 10). Note the mangrove propagule from *Rhizophora mangle*, another invasive alien species.

Plate 13. Schools of golden trevally (*Gnathodon speciosus*) are frequently sighted within Pearl Harbor.

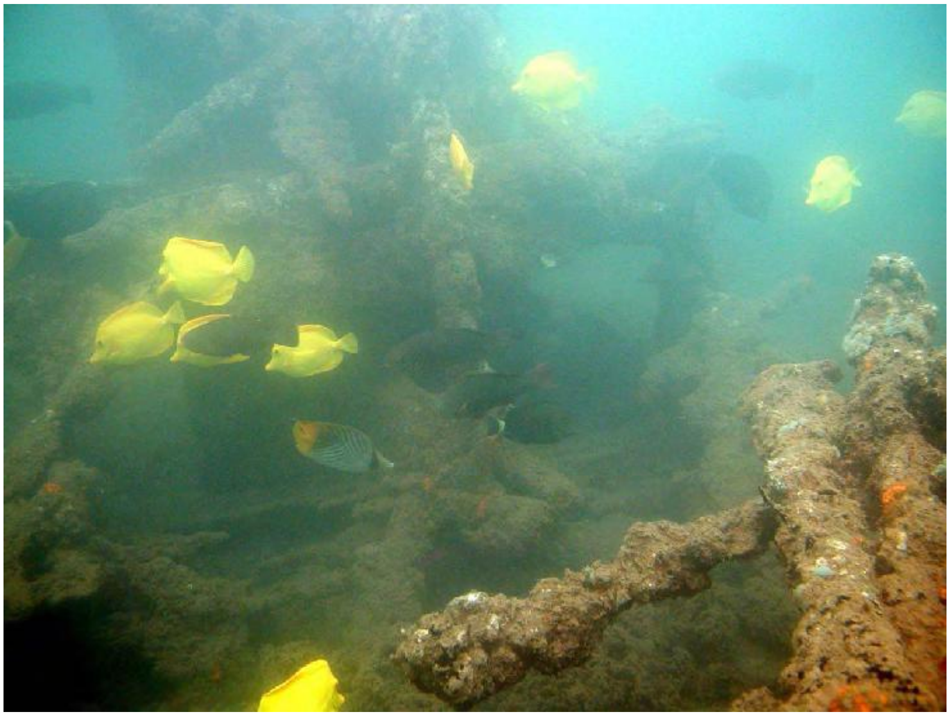


Plate 14. Yellow tangs (*Zebrasoma flavescens*), threadfin butterflyfish (*Chaetodon auriga*), parrot and surgeonfishes swimming amidst a sunken pier in West Loch.

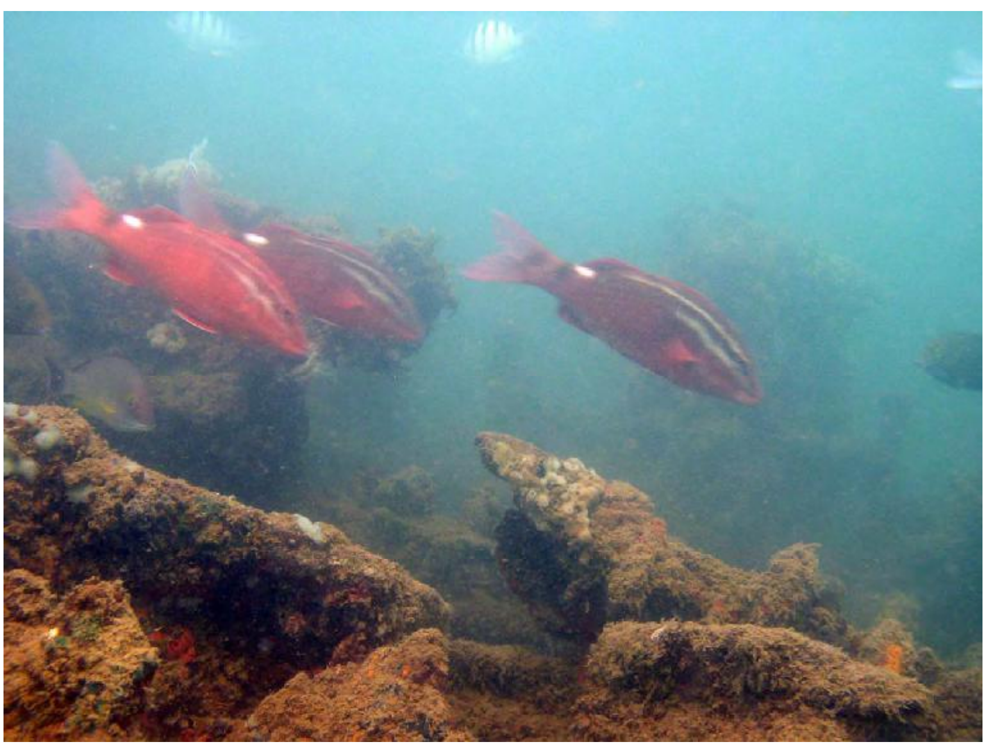


Plate 15. Whitesaddle goatfish (*Parupeneus porphyreus*) in West Loch.

B2 – MARINE AND FISHERY RESOURCES
PEARL HARBOR INTEGRATED NATURAL RESOURCES
(DOLLAR *ET AL.* 2000)

This page is intentionally left blank.

PEARL HARBOR
INTEGRATED NATURAL RESOURCES
MANAGEMENT PLAN

MARINE and FISHERY RESOURCES

Prepared by:

Steven Dollar, Ph.D.
Marine Research Consultants
4467 Sierra Dr.
Honolulu, HI 96816

Richard Brock, Ph.D.
Environmental Assessment Co.
1820 Kihi St.
Honolulu, HI 96821

For:

Helber, Hastert & Fee
733 Bishop St., Suite 2590
Honolulu, HI 96813

This page is intentionally left blank.

CONTENTS

CONTENTS (cont'd)

1.1 INTRODUCTION

The Commander Navy Region Hawaii (CNR-HI) is preparing an Integrated Natural Resources Management Plan (INRMP) for Naval Station (NAVSTA) Pearl Harbor, Fleet and Industrial Supply Center (FISC) Pearl Harbor and Public Works Center (PWC) Pearl Harbor. The Pearl Harbor INRMP will address the ten elements listed in the Sikes Act Improvement Amendments (SAIA) as follows:

1. Fish and wildlife management, land management, forest management, and fish and wildlife-oriented recreation;
2. Fish and wildlife habitat enhancement or modification;
3. Wetland protection, enhancement and restoration, where necessary for support of fish, wildlife, or plants;
4. Integration of, and consistency among, the various activities conducted under the plan;
5. Establishment of specific, natural resource management goals and objectives and time frames for proposed action;
6. Sustainable use by the public of natural resources to the extent that the use is not inconsistent with the needs of fish and wildlife resources;
7. Public access to the military installation that is necessary or appropriate for the sustainable use of natural resources, subject to requirements necessary to ensure safety and military security;
8. Enforcement of applicable natural resource laws (including regulations);
9. No net loss in the capability of the installation's lands to support the military mission of the installation; and
10. Such other activities as the Navy has determined are appropriate.

The SAIA also requires the INRMP to comply with the requirements of the National Environmental Policy Act (NEPA). Accordingly, appropriate NEPA documentation will be prepared for the INRMP recommendations, and pertinent agency consultations will be completed.

The INRMP is required under the federal Sikes Act Improvement Amendments (SAIA) of 1997 (P.L. 105-85). This Congressional legislation requires military installations to prepare and implement a plan for the management, conservation and rehabilitation of their natural resources, while still supporting the installation's military mission. The SAIA requires the INRMP to be prepared in cooperation with the U.S. Fish and Wildlife Service and the appropriate State fish and wildlife. To accomplish this, the Navy intends to consult with the following agencies:

1. U.S. Fish and Wildlife Service
2. National Marine Fisheries Service

3. State Department of Land & Natural Resources (e.g., Divisions of Aquatic Resources and Forestry and Wildlife)
4. State Dept. of Business, Economic Development & Tourism (e.g., CZM Program and Ocean Resources Branch)

The study area for this Integrated Natural Resources Management Plan (INRMP) consists of areas owned and controlled by Naval Station (NAVSTA) Pearl Harbor, Fleet and Industrial Supply Center (FISC) Pearl Harbor and Public Works Center (PWC) Pearl Harbor. These include all the waters of Pearl Harbor (up to the high tide mark) and the fast lands shown in Figure 1. Other lands in the Pearl Harbor region (which are under the control of other Navy activities) will be addressed in separate INRMP documents.

Most of the fast lands are within the Pearl Harbor industrial area, or other developed areas. These lands have little remaining natural resource value. The principal area under consideration in the present document are the waters and intertidal areas of Pearl Harbor. The nine-square mile "defensive sea area" extending from the mouth of the harbor out into Mamala Bay is also under NAVSTA control. Due to funding limitations however, this area will be included in a subsequent update of the Pearl Harbor INRMP.

2. 0 OBJECTIVES

The overall objective of the INRMP is to establish a sound rationale for establishment of specific natural resource management goals and objectives, time frames, and budgets for proposed actions. The plans are to be updated every five years. Specific objectives of an INRMP are to maintain, develop and implement an ecosystem-based conservation program that:

1. Provides a baseline source of natural resource information;
2. Provides the basis for formulating the Naval Base's natural resources budget;
3. Provides for conservation and rehabilitation of natural resources in a manner that is consistent with the military mission;
4. Integrates and coordinates all Pearl Harbor natural resources management activities;
5. Provides for sustainable multi-purpose uses of natural resources;
6. Provides for public access for use of natural resources, subject to safety and military security considerations.

The present document addresses these topics with respect to the marine resources within the confines of Pearl Harbor. These confines are defined as the shorelines of the Harbor per se, and do not consider the setting of the various streams that flow from the watershed into the Harbor. The bulk of the work consists of item number one in providing a baseline source of information of the natural resource setting of the harbor.

We have divided the contents of the report into four three sections. The first provides an overview of the physical setting of Pearl Harbor from both a historic perspective and from data recently collected specifically for the present document. The main constituents of this section are the presentation of a physical zonation pattern, which differentiates the major habitat types found within the Harbor. In addition, a characterization of water chemistry within the Harbor is also presented. The second section provides as overview of the biotic resources of the Harbor, both from historical literature and recent observations. The overview includes descriptions of the fishery components, introduced species, mangrove communities, and potential contaminants to the biotic components of the estuary. The third section describes the status of the fishponds that remain within Pearl Harbor. The fourth section, which serves as a summary based on the information in the previous sections, provides recommendations for activities that will fulfill the objectives of the INRMP.

3.0. NATURAL SETTING OF PEARL HARBOR

3.1. Environmental Setting

Pearl Harbor is the largest landlocked estuarine body of water in Hawaii and has a surface area of 21 km2, mean depth of 9.2 m and about 58 km of shoreline. Twenty percent of Oahu's surface area drains into Pearl Harbor. The harbor has four lochs, which are remnants of drowned valleys joined by a main channel that connects the harbor with the ocean. Grovhoug (1992) notes that Pearl Harbor is relatively isolated from oceanic circulation, and water exchange is slow with a mean water residence time in the harbor of about 6 days for bottom waters and one to three days for surface waters. Surface water circulation is primarily offshore and driven by the tradewinds, while weak tidal flows of 0.15 to 0.3 m/sec control the movement of bottom water in and out of the harbor.

Pearl Harbor has been the hub for the U.S. Naval operations in the Pacific since the turn of the century. Berthing and maintenance facilities for hundreds of ships in the form of construction of piers and sheet-piling along much of the harbor shoreline (outside of West Loch) have greatly transformed the natural shoreline. In addition, most of the harbor floor has been dredged to accommodate deep-draft ship traffic.

3.2 Physical-biological Zones of Pearl Harbor

3.2.1 Factors in Determining Zonation

One objective of the INRMP was to characterize the ecological zones within Pearl Harbor. A comprehensive understanding of the physical/biotic composition of the region provides one component for devising sound management strategies. There are obviously many criteria on which to base divisions in a zonation pattern. In Pearl Harbor, the most obvious divisions would be based on depth (shallow vs. deep habitats) or type of bottom cover (soft vs. hard cover). Within these divisions there is also considerable overlap. We have chosen to base our zonation pattern on the major parameter of bottom type (hard vs. soft). Presented below is a description of each of the dominant zones within Pearl Harbor, along with representative photographs to depict the regions.

Most of the biological studies undertaken in Pearl Harbor conclude that the major gradients of impact present in the harbor are those created by freshwater and terrigenous inputs at the mauka end of the system. Thus examination of aquatic communities at different points along this gradient will show the lessening impact of these inputs with distance from the source.

Turbidity within the harbor is obviously an important factor affecting the distribution of organisms. Chamberlain (in B-K Dynamics 1972) estimated that about 317,450 kg (350 tons) of sediment enter Pearl Harbor each day from the eight major streams that flow into it. This yields a mean accumulation of 5 cm (2 inches) of sediment per year throughout the harbor. In reality, the accumulation of sediment and its impacts will be greater in the more landward (mauka) areas of the harbor and will have a greater affect on benthic communities situated on horizontal surfaces over those on vertical surfaces. The terrigenous input results in the Navy undertaking maintenance dredging of about 9 million yd3 on four to five year cycles (Nystedt 1977 in Grovhoug 1992).

Freshwater flow into Pearl Harbor has been estimated to be about 187,500 m3/day (or 50 mgd) during dry periods and in excess of 375,000 m3/day (100 mgd) during wet periods (Cox and Gordon 1970). The high volume of freshwater entering the harbor must have a significant effect on the distribution of biota, especially on the shallow reef flats and inner portions of the harbor.

3.2.1.1 Soft Bottom Habitats

While Pearl Harbor is a large estuarine feature, diversity of the underwater physical zonation is relatively low. Overall, there are two major physical zones within Pearl Harbor. The first zone rings the shoreline of most of the Harbor (except in areas where wharfs and sheet piling) and consists of a shallow limestone platform of fossil reef origin. The shallow platform is divided into two subzones; sediment covered (Figure 9) and bared hard bottom (Figure 10). The distinction between the two subzones is gradual with a gradient of highest sediment cover on the mud flats that predominate in the mauka heads of the lochs where streams enter the estuary, and lowest near the juncture of the entrance channel with the open ocean. The inner harbor mud flats that extend over most of the mauka heads of the three lochs comprise about 5.6 km2, while the hard bottom reef flat comprise about 0.5 km2.

The shallow platform terminates in either a dredged vertical face, or slopes gradually to the second major zone, which consists of the sand/mud channel floor. The structure and composition of the channel floor is similar throughout the Harbor, the main difference being a higher percentage of calcareous sands and lower percentage of terrigenous mud with proximity to the ocean. Surface area of the channel floor comprises about 12.7 km2 of the total harbor area of 21 km2 .

Together the two soft sediment zones are the dominant bottom type, comprising approximately 90% of the surface area of Pearl Harbor. Soft bottom communities are important in that many contaminants (e.g., some heavy metals and pesticides) entering Pearl Harbor from a number of sources and will preferentially be adsorbed to sediment particles which fall to the bottom where water movement decreases, thus sequestering these pollutants. Bioturbation (or disturbance of the sediments by fauna such as digging crabs) may reintroduce these materials to the water column, or deposit feeding species may consume contaminants on particles and in turn become repositories for these materials. If these deposit feeders are consumed by other organisms (such as crabs feeding on deposit feeding polychaetes) these species in turn can make these contaminants available to other predators in the food web including humans. This recycling of pollutants is well known in tropical aquatic habitats including the Ala Wai Canal in Honolulu and Enewetak Atoll in the Federated States of Micronesia.

Coles et al. (1997) list 59 taxa in two phyletic groups (the Mollusca and the Arthropoda) that as adults are found in the soft substratum of the harbor however, their list does not have any polychaetes which are usually the most specious and abundant of the infaunal groups. Most species found on soft sediments are infaunal, or living in the sediment and most are very small being retained on 0.25 and 0.50 mm mesh sieves. Relative to benthic communities on other substrates, the standing crop of soft bottom infauna is usually low but the turnover (or movement of energy) through the community can be large.

There are a number of larger species found in the soft sediment communities of Pearl Harbor. Among these are crustaceans such as ghost shrimps (family Callianassidae), mantis shrimps (family Squillidae), burrowing shrimps (particularly family Alpheidae), the blue pincher crab (Thalamita integra), Samoan crab (Scylla serrata), Hawaiian crab (Podophthalmus vigil), Haole crab (Portunus sanguinolentus) and clams such as Tellina rugosa. Fishes that feed on the soft bottom communities include the nightmare goatfish or weke pueo (Upeneus arge), the eagle ray or hihimanu (Aetobatus narinari), the flatfish or paki`i (Bothus pantherinus) as well as a number of other species that may opportunistically forage across the soft bottom communities at night for crustaceans and polychaetes that may emerge from the sand substratum. Species in this category include most of the goatfishes, some squirrelfishes, the introduced snapper or Toau (Lutjanus fulvus), the bonefish or o`io (Albula vulpes), cardinalfishes or upapalus and a number of goby species.

Communities of the water column are dominated by minute phytoplankton and zooplankton and large pelagic jellyfish (e.g., Aurelia aurita and Mastigias sp.). Almost every aquatic species found in Pearl Harbor utilizes the water column during some part of their lifecycle (i.e., such as larval phases) but the water column communities are only important to the present discussion as a mechanism to link energy flow from one trophic level to another.

3.2.1.2 Hard Bottom Habitats

Hard substratum in Pearl Harbor occurs primarily as three categories; 1) the makai portions of the natural reef flat that borders the shoreline that are not covered by a layer of terrigenous sediment; 2) near vertical dredge-cut limestone surfaces that comprise channel walls; and 3) solid surfaces that are the result of human activities (i.e., pier pilings, sheet pilings, submerged and/or derelict materials).

Because of the high sediment loads benthic communities have historically been better developed on vertical surfaces than on horizontal ones where sediment accumulation may result in smothering. As a result, benthic communities on horizontal limestone surfaces are best developed in areas removed from the proximity of freshwater and/or terrigenous input (i.e. away from the heads of bays or mauka areas). However, in recent years it has become evident that the sediment loads in the water column have decreased, owing to the increase in abundance of stony corals. While corals had been absent, or extremely rare in past decades, recent surveys show abundant corals (primarily Pocillopora damicornis and Leptastrea purpurea) growing on hard substratum in many areas of the reef platform (Figures 11-12).

The hard bottom reef flats are most dominant around the undeveloped areas of Ford Island, the eastern shoreline of Waipio Peninsula adjacent to the main channel, and the western shoreline of main channel and the branch leading into West Loch. Hard bottom reef flats also occur around the fringes of the islets in the back of West Loch. Much of the hard bottom in these areas consists of shelly substratum from the living and dead oysters (Figure 13). The reef along the edge of Waipio Peninsula contains large amounts of debris that forms a complexity of habitat space that is occupied by a variety of reef fish (Figure 14). Along the channel leading into West Loch, areas of the reef flat are completely covered with thick mats of the red algae Gracilaria salicornia. In these areas, the mats completely cover the substratum in globular masses (Figure 15).

The largest area of reef flat covering approximately 0.7 km2 occurs on the eastern side of the harbor entrance extending from area near the Fort Kamehameha Sewage Treatment Plant seaward to Hickam Harbor. The reef flat has been studied extensively in recent years in connection with extension of the Fort Kamehameha Sewage Outfall. In brief, the reef flat consists of a mix of a limestone bench large covered by sand flats. Living corals occur on

the reef flats, predominantly in the middle portions. The reef flat is the site of extensive limu collecting and fishing.

The dredged channel walls and the man-made structures throughout the harbor are occupied by a variety of invertebrates, primarily sponges, tunicates and hydroids (Figures 16-18).

3.3 Patterns of Water Chemistry in Pearl Harbor

3.3.1 Introduction

A basis tenet in marine sciences is that the composition and effects to biotic community composition is a direct result of the physical composition of the environment. In marine and aquatic systems water quality is the prime component for affect to biotic resources. For this reason, one component of the present INRMP was to obtain a thorough spatial characterization of patterns and constituency of water quality in Pearl Harbor.

A summary of current studies in Pearl Harbor (Surface et al. 1975) indicates that throughout the estuary a freshwater surface layer moves southerly (seaward) regardless of tidal condition at an average of 0.1 to 0.3 knot (kt). The boundary between the surface flow and the deep layer is about 1.5 m deep. Contrary to the unidirectional nature of the surface flow, direction of flow of the deep layer reverses with the tidal phase.

Evans et al. (1974) collected data on seasonal variations in physical parameters (temperature, salinity, dissolved oxygen, secchi depth, turbidity and pH) at a series of stations throughout the Harbor. Expectedly there was a seasonal variation in both surface and deep water with peaks of most parameters in the late summer and lows in the winter. As a whole, the temperature regime throughout the harbor was uniform. Seasonal measurements of salinity revealed the characteristics of a salt wedge estuary (surface layer of low salinity water) primarily in west and middle lochs that was more evident in the wetter winter months. A turbid surface layer was noted, due primarily to suspended silt introduced into the harbor by streams. Analyses of nutrient data showed little useful correlation to biological data. In general TP was higher in surface water compared to deep water, and was highest in west and middle lochs. It was noted that data collected when sewage discharged into harbor.

In order to identify if major changes to these patterns had occurred over the 16-year interval that might relate to future management scenarios, a water chemistry sampling program was carried out as part of the INMRP investigations. Because of time constraints, it was not possible to evaluate the temporal (seasonal) aspects of water chemistry as was the protocol for the 1974 studies. Rather, sampling was carried out as a single event designed to depict the spatial variation throughout the Harbor, with the purpose of determining if major changes were evident relative to the earlier work. The sampling scheme was designed, however, to serve as a first phase in an ongoing program, should the need arise.

3.3.2 Methods

Fourteen stations in Middle Loch, East Loch and the main entrance channel of Pearl Harbor were selected as sampling sites for the assessment program (Figure 1). Stations 1-4 were in Middle Loch; stations 5-7 were in the North Channel of East Loch between Ford Island and Pearl City Peninsula; stations 8-9 were in the Ford Island Channel, and Stations 10-14 were in the Pearl Harbor Entrance Channel. Water samples were collected from a boat using a 1.8 liter Niskin-type oceanographic sampling bottle. The bottle was lowered to the desired sampling depth with endcaps cocked in an open position so that water flowed freely through the bottle. At the sampling depth a weighted messenger released from the surface tripped the endcaps closed, isolating a volume of water. Surface samples were collected within 25 centimeters (cm) of the air-sea interface, and deep samples were collected within 50 cm of the harbor floor.

Water chemistry constituents measured in the sampling program include the specific criteria designated for open coastal waters in Chapter 11-54, Section 06 (Open Coastal waters) of the State of Hawaii, Department of Health (DOH) Water Quality Standards. These criteria include: total nitrogen (TN), nitrate + nitrite nitrogen (NO3- + NO2-, hereafter referred to as NO3-), ammonium (NH4+), total phosphorus (TP), chlorophyll a (Chl a), turbidity, temperature, pH and salinity. In addition, orthophosphate phosphorus (PO43-) and silica (Si) are also reported because these parameters are sensitive indicators of biological activity and the degree of groundwater mixing, respectively.

Subsamples for nutrient analyses were immediately placed in 125-milliliter (ml) acid-washed, triple rinsed, polyethylene bottles and stored on ice until returned to Honolulu. Analyses for NH4+ , PO4-3 -, and NO3- were done with a Technicon autoanalyzer using standard methods for seawater analysis (Strickland and Parsons 1968, Grasshoff 1983). Total nitrogen (TN) and total phosphorus (TP) were analyzed in a similar fashion following oxidative digestion. Dissolved organic nitrogen (DON) and dissolved organic phosphorus (DOP) were calculated as the difference between TN and dissolved inorganic N, and TP and dissolved inorganic P, respectively. Limits of detection for the dissolved nutrients are 0.01 mM (0.14 mg/L) for NO3- and NH4+, 0.01 mM (0.31 mg/L) for PO43-, 0.1 mM (1.4 mg/L) for TN and 0.1 mM (3.1 mg/L) for TP.

All water chemistry analyses were conducted by Marine Analytical Specialists (Honolulu, HI). Marine Analytical Specialists possesses the appropriate approval ratings for these analyses from the State of Hawaii Department of Health, and the U.S. Environmental Protection Agency.

In addition to the discrete water samples, continuous profiles of temperature, salinity and turbidity were acquired using an Ocean Sensors Model 200 CTD.

3.3.3 Results

Figures 2-4 show continuous vertical profiles of temperature, salinity and turbidity, respectively at the 14 sampling stations. The plot on the left of each figure shows profiles from East Loch, while the plot on the right shows the profiles from Middle Loch. The profiles from the entrance channel are shown in both plots.

It can be seen that the temperature profiles in the land most portions of the two lochs differ substantially. In Middle Loch, there is a distinct surface layer of cooler water in the upper two m of the water column. The cooler surface layer is also evident at Stations 4, 8 and 9 in the Ford Island Channel, but is essentially absent at Stations 10-14 in the main entrance channel. The water column in East Loch shows no similar layer of cooler surface water. Rather, at the station closest to land (No. 5), there is a surface layer of distinctly warmer water.

Profiles of salinity reveal somewhat similar patterns as temperature. In Middle Loch, there is a distinct surface layer (upper 2 m) of low salinity water with the steepest gradient at the sampling station nearest to shore, and decreasing gradients with distance toward the main channels. At stations in East Loch, there are virtually no gradients of salinity. Similarly, in the Entrance Channel there are no gradients in salinity, and the entire water column is nearly uniform in both temperature and salinity.

These patterns of temperature and salinity reflect the input of freshwater (primarily stream discharge) into various regions of Pearl Harbor. As the sampling was done during a time of relatively dry winter weather, the patterns reflect what might be considered the “typical” situation that occurs over the large majority of time, as opposed to the infrequent situation that would occur during periods of heavy rainfall or storm events. It is apparent that the input of freshwater is substantially greater in Middle Loch compared to East Loch. In fact, profiles of salinity and temperature reveal essentially no freshwater component in East Loch. The inverted temperature profile at the station closest to shore indicates solar warming of the shallow water column over the reef flat. The influence of stream input is evident throughout the length of Middle Loch, but is absent within the main channels of the Harbor.

Vertical profiles of turbidity show different patterns than temperature or salinity (Figure 4). In both East and Middle Lochs there are well-defined layers of substantially increased turbidity near the bottom of the stations within the landward regions of the lochs. Profiles from the main channels of the harbor display nearly homogenous turbidity throughout the water column, with only slight increases near the channel floors at some locations.

These data suggest that during the sampling period, turbidity within the harbor was not a function of stream input, as the regions with strongly stratified water columns with respect to decreased salinity and temperature do not have correspondingly elevated turbidity. Rather, elevated turbidity appears to be a result of resuspension of fine particulate material over the shallow mud flats in the innermost regions of the harbor.

Table 1 shows the results of analyses of discrete water samples collected at the fourteen stations shown in Figure 1. Histograms of the concentrations of each constituent along the horizontal gradients from the land most parts of the harbor toward the open ocean are shown in Figures 5-8.

As with temperature and salinity, the horizontal gradients of several of the inorganic nutrients differ between the two lochs as a function of input of freshwater. In Middle Loch, the concentrations of NO3-, NH4+ and Si are highest in the most landward areas of the loch and decrease with distance toward the ocean. No such gradients are apparent in East Loch, where there is essentially no variation over the entire sampling regime. The exception to the pattern occurs at Station 13, where there were unusually high concentrations of NO3- and PO4-3 in the surface sample. Station 13 was located just seaward of the Fort Kamehameha Sewage Outfall discharge, and it is likely that the spikes in concentrations of NO3- and PO4-3 are a result of sampling in the discharge plume. As the discharge consists of freshwater, the plume is confined to a surface layer. There is also no evidence of the plume in the concentrations of NH4+ or dissolved inorganic nitrogen or phosphorus (DON, DOP).

The histograms of Si display a consistent pattern of vertical stratification, with concentrations in surface water elevated compared to bottom waters at all sampling stations. Si is present in high concentration in groundwater and surface water relative to ocean water, and is not utilized rapidly within the nearshore environment by biological processes. The observed pattern of elevated surface Si reiterates the occurrence of a thin surface layer of low salinity water that originates from freshwater input into the estuary. The pattern is especially evident in Middle Loch (Figure 7), where the concentration of Si in surface water decreases in a nearly exponential function from the regions of freshwater input to the mouth of Pearl Harbor.

Because the biotic uptake of other inorganic nutrients (NO3- and PO4-3) is rapid compared to Si, the horizontal gradients of these constituents do not display a continuous decrease with distance from the back of the Harbor. While the concentrations of NO3- are very high in the area of freshwater input (Station 1), the water column is stripped of NO3- in

the central region of the harbor. The histogram of Chl a in Middle Loch also shows a consistent decrease with highest concentrations in the most landward regions, and lowest concentrations at the juncture of the entrance channel and the open ocean. In addition, concentrations of Chl a at each station are higher in the surface sample relative to the bottom sample.

Table 2 shows the Department of Health Water Quality Standards specific criteria for Pearl Harbor estuary. Three criteria are shown; geometric means, values not to be exceeded more than 10% and 2% of the time. It can be seen in Table 1 that none of the individual measurements for the current survey exceed the 10% or 2% criteria. Inspection of Figure 4 reveals that only several measurements of turbidity exceeded the 10% criteria near the bottom at Stations 1 and 5. Geometric means of all measurements for each constituent are also shown in Table 1. None of the geometric means fall close to the limits listed in Table 2. These comparisons indicate that at the present time, water quality in the Pearl Harbor estuary is well within the DOH limits. As stated above, the present survey provides a snapshot of water chemistry during a typical period of low rainfall. During episodes of high rainfall and runoff, it is likely that the same relationships between water chemistry and DOH water quality standards would not occur.

In summary, the assessment of water chemistry within the Pearl Harbor estuary conducted in December 1999 revealed essentially consistent patterns as previous work. The dominant feature of the water column throughout most of the estuary is the occurrence of two distinct layers; the surface layer is influenced by freshwater input, and is most pronounced near the points where streams enter the estuary. The bottom layer is primarily oceanic in salt content, indicating little mixing with the upper layer. Nutrient concentration in the upper layer are elevated near the points of stream input and decrease rapidly with proximity to the ocean as a result of uptake by plankton and mixing with ocean water. This pattern is most pronounced for NO3-, which decreases by two orders of magnitude from the areas of stream input to the harbor channels. At the time of sampling, water quality within Pearl Harbor was well within all relevant DOH water quality standards. These results suggest that the Harbor is not presently experiencing impacts from poor water quality during “normal” dry periods. While water quality obviously changes as a result of high rainfall and stream flow, these effects appear to be short-lived, with rapid return to the patterns evident in the present work.

4.0 BIOTIC RESOURCES OF PEARL HARBOR

4.1 Historical Accounts of Pearl Harbor Resources

There are reports that Pearl Harbor had great abundance of fish and shellfish and the area was important to Hawaiian culture as evidenced by the numerous fishponds along its shores (Coles et al. 1997). Handy and Handy (1972) state that the harbor “...offered the most favorable locality in all the Hawaiian Islands for the building of fish ponds and fish traps into which deep sea fish came on the inflow of tidal water...” (see fishpond section). These authors further note that the harbor’s many bays “...provided a greater variety and abundance of edible shellfish, and were the summer home of mullet.”

For many years there have been a number of sources of potential pollution that are known to enter Pearl Harbor. Cox and Gordon (1970) summarized the situation noting that the primary sources of pollution in the harbor at that time included; 1) the sanitary sewer outfalls of the City and County of Honolulu; 2) the U.S. Navy, sugar mill wastewater discharges, ships using the harbor, storm-sewer discharges, cesspool seepage and; 3) high temperature discharge from the Hawaiian Electric Company power plant.

Obvious other sources of pollution in the harbor have been from the operation of the U.S. Naval Shipyard. Among the contributions from the military operation include the addition of heavy metals and heat from the operation of the naval power plant (Evans 1974).

Turbidity within the harbor is obviously an important factor affecting the distribution of organisms. Chamberlain (in B-K Dynamics 1972) estimated that about 317,450 kg (350 tons) of sediment enter Pearl Harbor each day from the eight major streams that flow into it. This yields a mean accumulation of 5 cm (2 inches) of sediment per year throughout the harbor. In reality, the accumulation of sediment and its impacts will be greater in the more landward (mauka) areas of the harbor and will have a greater affect on benthic communities situated on horizontal surfaces over those on vertical surfaces. The terrigenous input results in the Navy undertaking maintenance dredging of about 9 million yd3 on four to five year cycles (Nystedt 1977 in Grovhoug 1992).

Freshwater flow into Pearl Harbor has been estimated to be about 187,500 m3/day (or 50 mgd) during dry periods and in excess of 375,000 m3/day (100 mgd) during wet periods (Cox and Gordon 1970). The high volume of freshwater entering the harbor must have a significant effect on the distribution of biota, especially on the shallow reef flats and inner portions of the harbor.

McCain (1977) noted that numerous fish and invertebrate kills had been reported in Pearl Harbor. In July 1972, an estimated 34 million oysters were killed by a parasitic fungus primarily in West Loch. Peeling et al. (1972) reported an extensive invertebrate kill in Middle Loch during June 1972, presumably caused by the release of large quantities of an oxygen scavenging substance into the harbor. Algal blooms with their attendant fish kills have also been reported from Pearl Harbor. A “red tide” caused by Cochlodinium catenatum was the probably source of a fish kill in East and Middle Lochs during 1973 (McCain 1977).

Despite the tremendous change and impact that had occurred, the exhaustive studies carried out by Evans et al. (1974) found the harbor biota to be diverse and abundant, and that this diversity and abundance in Pearl Harbor has continued up to through the 1990's (Grovhoug 1992, Coles et al. 1997). Brock (1999) notes that the majority of the benthic communities on hard substratum are dominated by particulate feeding species such as sponges, tunicates, barnacles, oysters, vermetids and numerous polychaetes.

4.2 Fishery Resources of Pearl Harbor

Biological collections from Pearl Harbor commenced at the turn of the century, but none were very extensive or in-depth in their efforts. It was not until the work by Evans et al. (1974) and the more recent effort by Coles et al. (1997) have the biological collections been more systematic and representative of the harbor. Coles et al. (1997) listed 434 taxa (36 algae, 1 spermatophyte, 338 invertebrate and 59 fish) species and higher taxa collected from 15 stations in the harbor. In total, 394 of these taxa were from fouling communities, sediment samples or fish observations and the remaining 40 taxa were exclusively from sediment samples. Evans et al. (1974) listed 388 taxa (23 algae, 278 invertebrate and 87 fish) collected or seen in the 1971-73 period. Grovhoug (1979) reported 130 taxa (79 invertebrate and 51 fish) from the harbor. Brock (1994, 1995) found 96 and 99 taxa from the six stations sampled in East Loch. All other studies carried out in the harbor previous to those above have reported ten or fewer taxa. Not surprisingly, most taxa reported from Pearl Harbor are not directly part of Hawaii’s inshore fisheries. Species that are, are discussed below.

As noted above, it is evident that in the period from 1900 through the 1970's many changes occurred to the habitats and consequently to the biota of the harbor due to human activities both in the harbor and surrounding hinterland. Thus, some commercially important species appearing in the earlier collections are now very rare or absent. Among these are the kona crab (Ranina ranina) listed in B.P. Bishop collections from 1902 as well as the striped mantis shrimp or aloalo (Lysiosquilla maculatus) which was recorded in the B.P. Bishop Museum collection in 1923 (see Coles et al. 1997). Aloalo fishing is not well-known among Hawaii’s fishermen today but many years ago the striped aloalo was a highly prized species to catch attaining a length in excess of 30 cm.

The list of species given in Coles et al. (1997) is the most complete to date. However, many species in the list are recorded as “off Pearl Harbor” or “Fort Kamehameha reef flat.” In contrast, the presents study is focused on the biological resources of Pearl Harbor and not the waters adjacent to it. Thus we are considering fishery resources present in the waters of the harbor and not in the area seaward of it. It is recognized that many motile species (such as fish and crabs, etc.) may move in and out of the harbor as adults, or larvae of some may recruit to the harbor having originated from areas outside. Sampling biological communities seaward of the harbor should result in a much longer species list simply because the conditions are more marine and less estuarine in a seaward direction. Additionally, we recognize that there are many species that have been recorded as being present in Pearl Harbor and are edible, but are small in size, and today that are not a significant part of Hawaiian fisheries. Some of these species were extensively fished at the turn of the century and earlier but not to the same extent today. This group includes species such as the glass shrimps or opae (family Palaemonidae). These species are not considered further in the discussion of Pearl Harbor fishery resources.

A number of algal species favored for consumption have been found in Pearl Harbor including sea lettuce or limu pahala (Ulva lactuca and Ulva fasciata; Evans et al. 1974) and Brock (1994) noted limu wawae`iole (Codium edule). Although not consumed, the most common algae we have encountered in Pearl Harbor are probably both introduced. These species are Acanthophora spicifera and Gracilaria salicornis. Gracilaria salicornis occurs as a near continuous blanket in areas up to several hundred square meters in size at depths from 0.6 to 5 m at a number of locations in Pearl Harbor (see description of ecological zones).

There are a number of commercially important crab species present in Pearl Harbor and their presence has been recorded in many of the studies that have been done in the harbor including the taxonomic work on Hawaiian crabs by Rathbun (1906). Among the most common are the swimming crabs (Thalamita crenata and T. integra) which are seen in the shallows of many parts of the harbor. Not previously recorded but seen during this survey was the black ama`ama crab (Grapsus grapsus). Large individuals are found on the rocky limestone shoreline of Waipio Peninsula and elsewhere. The Hawaiian crab (Podophthalmus vigil) and haole crab (Portunus sanguinolentus) were seen usually below depths of 3 m on the mud or sand bottom in the present study. Highest densities that we recorded in this survey using line transects were as great as one individual of either species per 8 m2. These densities were seen in West and Middle Lochs but the overall mean abundance is very much lower (probably on the order of one crab per 120 m2. In East Loch maximum densities were lower, not exceeding one individual per 25 m2 in the areas we examined. The mud or Samoan crab has been recorded in numerous previous studies in Pearl Harbor and were also seen during our surveys. The Samoan crab was seen in waters from 0.2 m and deeper on mud or sand bottoms. These crabs are frequently found in the middle of mangrove thickets making density estimates very difficult. However, our qualitative observations suggest that the Samoan crab is not as abundant as the two previous species but this species may grow quite large, attaining a 60 cm span between the tips of the chelipeds stretched out and weighing up to 3.6 kg.

Other arthropods found in Pearl Harbor include the slipper lobster or ula`papa (Scyllarides squamosus) which is occasionally encountered in caves and ledges at depths below 4 to 5 m. Both Evans et al. (1974) and Brock (1994) record this species. Less frequently seen is

the spiny lobster or ula (Panulirus penicillatus) which Evans et al. (1974) recorded in the harbor. Some sea urchin species are collected for their gonads or “uni” when they are ripe. One of these species, the black short-spined sea urchin or hawa’e (Tripneustes gratilla) is occasionally encountered in the more seaward portions of the harbor usually below depths of 2m.

Clams are well-known in Pearl Harbor. Probably the best known is the introduced Japanese or oriental clam, Venerupis phillipinarum. Brock (1960) notes that 10 barrels of Japanese clams were released at three localities: Pearl Harbor, Kaneohe Bay and Waialae (Maunalua) Bay in 1920. Prior to this time, V. phillipinarum was available live in Honolulu markets (B.P. Bishop Museum collections). Shells of this species were encountered in our surveys but time was not spent determining the abundance of this species in the harbor. Coles et al. (1997) record its presence in Pearl Harbor. Kay (1979) states that after an initial spread by this species following its introduction, abundance declined such that it was only exploited in Kaneohe Bay commencing in 1965. The Kaneohe beds were closed in 1969 due to over harvesting (Yap 1977).

Another clam found in the harbor is the olepe or Tellina palatam. Bryan (1915) notes that the olepe (Tellina palatam) is “the most important shell-bearing food mollusk of the group.” Both Tellina and Venerupis are found in the shallow flats in the mud and sand. Densities of Tellina palatam may be quite high, locally as many as 7 individuals per 0.1 m2 where the substratum has a greater percentage of sand rather than fine mud.

Pearl Harbor is presently off-limits to civilian fishermen. Concerns over possible health problems due to bacteria and the bioaccumulation of heavy metals and pesticides precludes the use of the harbor clam resource as a human food.

4.3 The Oysters of Pearl Harbor

At one time Pearl Harbor provided a habitat appropriate for pearl oysters. There are two common species in Hawaii including the black-lipped pearl oyster (Pinctada margaritifera) which is used in the pearl aquaculture industry in Tahiti and elsewhere in the South Pacific, and the smaller Pinctada radiata which was the most abundant species in Pearl Harbor many years ago (Kay 1979). As noted by Bryan 1915, page 444:

“A species of pearl oyster family occurs at Pearl Harbor. The common species “pa” is often three or four inches or more across. Without a doubt it was the presence of this shell with the iridescent interior, occurring at Pearl Harbor, on Oahu, that gave that sheet of water its name. Although they belong to the same sub-family, they are not the famous pearl shell of the South Pacific islands. However, a pearl-bearing species is found in Pearl Harbor and at certain other places about the group in the deeper water offshore, and pearls were found to some extent by the natives, but the pa was chiefly used by them for making fishhooks and to some extent in making the curious shell-eyes for their wooden gods."

Pinctada radiata was recorded by numerous studies in Pearl Harbor up through 1938 (Dall et al. (1938) and apparently was not seen again in the harbor until Coles et al. (1997) noted that this species was encountered at one site in the vicinity of The Machinist, which is part of the inactive fleet near the head of Middle Loch. In his 1999 survey of the warm water discharge from Hawaiian Electric Company's electrical generation plant at Waiau, Brock (pers. obs.) found many dead Pinctada radiata valves (shells) in an area where the discharge currents had recently removed the overlying mud exposing many hundreds of pearl oyster shells in a small section of the old reef flat at Waiau. The apparent abundance of these shells suggests that Pinctada radiata was extremely abundant at one time in the harbor. Both Coles et al. (1997) and Evans et al. (1974) recorded the black-lipped oyster (Pinctada margaritifera) in the harbor, but this species is not at all common. Our survey noted the black-lipped oyster in Middle and West Lochs as well in the entrance channel that connects the lochs together. However, it is not a common species in Pearl Harbor.

The question arises as to why these species are near-absent today in the harbor? Again, changes in water quality or habitat destruction may have all played a role in the near demise of these Pinctada species in the waters of the harbor. Other possible factors related to the decline in pearl oysters in the harbor may be (1) the arrival of a parasite or disease specific to these oysters from another locality in the Pacific transported by vessel traffic or (2) similarly, due to another sessile species non-native to Hawaiian waters becoming established and simply outcompeting the native oysters. However, no single species appears to have come to dominate subtidal hard substratum in the harbor which is required by the adult oysters but rather, an assemblage of sessile species including many species of sponges, polychaete worms, mollusks (vermetids and bivalves), arthropods (barnacles), and urochordates (tunicates). Many of these are known or suspected alien species and in Pearl Harbor are among the most abundant sessile forms.

Evan et al. (1974) pointed out the absence of corals from Pearl Harbor and suggested that the environmental conditions had deteriorated to such an extent that corals could not tolerate the conditions in the harbor and thus were absent. The documented return of some coral species, particularly Leptastrea purpurea first noted by Brock (1994) and later by Coles et al. (1997) suggests that the quality of the environment within the harbor is improving. Besides Leptastrea, Coles et al. (1997) found Pocillopora damicornis and Porites compressa in the harbor along with Montipora patula, Pocillopora meandrina and P. damicornis at the harbor's mouth. In 1999 (Brock pers. obs.) collected a small colony of Montipora verrucosa at Ford Island.

With the continuing recent improvement in environmental quality, Pearl Harbor may once again become a habitat suitable for the growth of pearl oysters. Re-establishment of the two species of pearl oysters in the harbor may be an appropriate activity for any envisioned restoration program.

Besides pearl oysters, there are three other oyster species commonly seen in Pearl Harbor. The first of these is the small native oyster (Ostrea sandvicensis) and the two introduced commercially important species of Crassostrea. The eastern oyster, Crassostrea virginica was first imported in 1871 from the west coast of the US but none from this shipment survived. A second shipment made in 1883 was likewise not successful. Two shipments, the first made in 1893 of 1,000 oysters and a second of 38,000 oysters in 1895 successfully established this species in Pearl Harbor (Brock 1960). Crassostrea virginica was subsequently collected from Pearl Harbor for cultivation in other estuarine areas around Hawaii. Crassostrea gigas was also brought in from Japan first in 1926 and planted offshore of Kalihi (Brock 1960). None survived and a second shipment of 2,500 individuals was planted at Pearl Harbor and Mokapu (Kaneohe) in 1938. In 1939 a third shipment of 2.1 million C. gigas was brought in and released in Kaneohe Bay but none survived (Brock 1960). However, Kay (1979) notes that this species is abundant in Kaneohe Bay. Brock (1995) found Crassostrea gigas in Pearl Harbor although the intensive collection made in the harbor by Coles et al. (1997) did not list it. The present study found more Crassostrea gigas on vertical natural (mangrove prop roots) and man-made surfaces (e.g., concrete and metal pilings). Nowhere in the harbor was Crassostrea gigas very abundant relative to C. virginica.

The beds of commercially desirable Crassostrea virginica in West Loch are well-known. Sparks (1963) provides details on the estimated sizes of the West Loch beds with more than 35.6 million (or 55,630 bushels) of eastern oysters present. These oysters were spread over 150,000 square yards of area among 19 major beds in West Loch. Despite the potential commercial importance of these oyster beds, coliform bacteria levels measured at the time of the study were high precluding any commercial development. The Hawaii State Division of Aquatic Resources undertook transplantation experiments moving oysters from West Loch to clean water settings for possible purging of bacteria. The results of these tests are given (Sakuda 1964 and 1966) and the project proved to be not economically viable and was dropped. It is this population of oysters which was almost completely decimated in 1974 by a parasitic fungus (McCain 1977).

Any commercial exploitation of the Crassostrea beds of West Loch would have to contend with the high rate of infestation by the boring polychaete, Polydora websteri which bores into the oyster shell packing it's tube with mud and bacteria. Not only does the worm provide a continuing source of bacteria but it's boring activity causes the oyster to expend energy that would otherwise go into growth, walling off the bores that penetrate the oyster's inner shell (Bailey-Brock and Ringwood 1982). In the present study, a number of live oysters were opened in the field to ascertain the presence of Polydora and all individuals examined from West Loch were infected with this worm.

The survey of West Loch carried out in the present study did not visit all of the old eastern oyster beds. However, a cursory examination was made at several noting the approximate density of live oysters present with an overall mean of large adults (defined here as 10 to 17 cm in length) to be approximately 22 individuals per m2. These density estimates would be much higher if all smaller size classes of oysters were considered. As with the other shellfish resources (i.e., clams), the possibility of bioaccumulation of heavy metals and pesticides in the tissues of the oysters as well as probable continuing high levels of coliform bacteria, preclude any consideration of consumptive exploitation of this resource at the present time. Source of coliform bacteria include sewage, soils, and domesticated animal wastes, the latter entering via the streams that flow into the harbor.

4.4 Featherduster Worms

The featherduster worm, Sabellastarte sanctijosephi, grows to a length of 15 cm or more and has a beautiful branchial crown that will be up to 6 cm in diameter. This crown varies in color in an array ranging from creams to reddish browns. The worm builds a tough leathery tube attached to the substratum and uses the crown to gather particulate food materials from the water column (Bailey-Brock 1987).

Featherduster worms are usually found in protected bays and harbors where the particulate loading is relatively high. Because of their large size, colorful branchial crown and relative ease in keeping them in captivity, the aquarium fish collectors seek these tubeworms for sale and shipment out of the state. Collecting has been relatively heavy in many areas where this species normally occurs such as Kaneohe Bay, Oahu. Price of worms to the collectors varies, but averages about $1.00 per worm. Because collecting effort has been high, obtaining specimens has become more difficult in the last several years. Although funding has been sought, no organized attempt has been made to raise this species in captivity to supplement the collection of wild stocks.

Featherduster worms are very abundant on hard substratum in certain areas of Pearl Harbor where sedimentation is not too great and most populations are best developed on vertical surfaces. On small local scales (over several square meters) mean densities of featherduster worms may be greater than 50 individuals per m2. More commonly, densities of 5 to 15 individuals per m2 were encountered on vertical surfaces or horizontal hard substratum well removed from terrigenous and/or freshwater inputs (such as around Ford Island and Waipio Peninsula).

From the standpoint of commercial exploitation, the collection of featherduster worms in Pearl Harbor for the aquarium fish trade may be one resource that could be developed. This is one of the few natural resources whose exploitation does not include consumption of the catch which entails problems with the bioaccumulation of heavy metals and pesticides that may be present in the tissues.

4.5 Fishes of Pearl Harbor

In their detailed study of the ecosystems of Pearl Harbor, Grovhoug and Evans (1974) found 90 species of fishes in among 46 families. Many of these species are commercially important insofar as Hawaiian inshore fishery resources are concerned. Among the commercially important species found in Pearl Harbor are the grey mullet or ama'ama (Mugil cephalus), milkfish or awa (Chanos chanos), bonefish or o'io (Albula vulpes), awa'awa (Elops hawaiiensis), threadfin or moi (Polydactylus sexfilis), barracuda or kaku (Sphyraena barracuda), flagtail or aholehole (Kuhlia sandvicensis), chub or nenue (Kyphosus cinerascens), soldierfish or menpachi (Myripristis berndti), bigeye or aweoweo (Priacanthus cruentatus), baitfish or nehu (Stolephorus purpureus), introduced snapper or to'au (Lutjanus fulvus), goatfishes such as the weke (Mulloides flavolineatus), weke'ula (Mulloides vanicolensis), kumu (Parupeneus porhyreus), moano (Parupeneus multifasciatus), malu (Parupeneus pleurostigma), weke pueo (Upeneus taeniopterus), jacks or papios (Carangoides gymnostethoides, Caranx ignobilis, Caranx sexfasciatus), pao`pao Gnathanodon speciosus), omilu (Caranx melampygus), omaka (Caranx mate), la'i (Scomberoides laysan), flatfish or paki'i (Bothus pantherinus), parrotfish or ponuhunuhu (Calatomus carolinus), bulletnose parrotfish or uhu (Scarus sordidus), cigar wrasse or kupoupou (Cheilio inermis), sargeant major or mamo (Abudefduf abdominalis), eye-stripe surgeonfish or palani (Acanthurus dussumieri), convict surgeonfish or manini (Acanthurus triostegus), ringtail surgeonfish or pualo (Acanthurus blochii), yellowfin surgeonfish or pualo (Acanthurus xanthopterus), orangebar surgeonfish or na'ena'e (Acanthurus olivaceus), goldring surgeonfish or kole (Ctenochaetus strigosus), bluespine unicornfish or kala (Naso unicornis) and the spotted unicornfish or kala lolo (Naso brevirostris).

The Coles et al (1997) survey of the biological resources of Pearl Harbor added only a few fishes to the Grovhoug and Evans (1974) effort. Among the species added of commercial or recreational interest were the bluelined surgeonfish or ma'i'i (Acanthurus nigrofuscus) and another goatfish, the striped goatfish (Upeneus vittatus). The striped goatfish probably became established in Hawaiian waters through a careless introduction of other fish species from Nuku Hiva, Marquesas in 1955 (Randall 1987). Brock's (1995) annual surveys of the zone of mixing for Hawaiian Electric Waiau electrical plant has included the smaller native mullet or uouoa (Neomyxus leuciscus).

Perhaps the fish species of greatest importance through time to humans in Pearl Harbor has been the grey mullet or ama'ama (Mugil cephalus) which attains sizes up to about 60 cm in length. The mullet was the mainstay of the fishponds that ringed much of the shoreline of the harbor (see fishpond section). The wild populations of this species utilized the harbor then and now and were fished as a major source of protein before such activity was curtailed by the Navy's tenure of the harbor. A hundred years of human activity in the harbor and hinterland draining into the harbor has taken its toll on the abundance of mullet. In 1902 it was reported that the waters were teeming with shoals of mullet (Anon. 1902). Today, schools of this species are present but their abundance is greatly reduced due to numerous factors including the loss of appropriate juvenile habitat (the brackish stream mouths draining into the harbor) which is not polluted and habitat without competing alien species.

The abundance of mullet and milkfish in Pearl Harbor was estimated using visual techniques. Proper population estimates of these species can only be made using a carefully planned series of gillnet sets in the field, each set at dusk and picked up first thing the following day. A series of sets should be executed in the different ecological zones in each of the lochs and conducted during different seasons of the year which are related to the movement of spawning adults. This level of field effort greatly exceeded the limits of the present study and thus the presence and physical extent of mullet schools was estimated either from the work vessel at anchor and/or swimming and quietly waiting in the shallows for the waters of small bays and inlets to settle and fish rise to the surface where they may be seen. These qualitative observations were made in each loch and the results suggest that schools of both ama'ama and awa are relatively common, being more easily seen in the morning hours. This crude measure puts their abundance as being greater than seen anywhere else by the author in Hawaii in recent memory.

Randall (1987) hypothesizes that the kanda (Valamugil engeli) which is an alien species of mullet probably arrived from the Marquesas that was introduced incidentally with a shipment of Marquesan sardines in 1955. This mullet was not identified until 1966 and it is difficult to separate from small juvenile native striped mullet. Valamugil engeli does not get any larger than about 15 cm in length and may compete with the native mullet at some stages of its life history (Randall 1987). Since both species co-occur in Pearl Harbor, this competition may be occurring there.

4.6 The Pearl Harbor Baitfish Fishery

For many years the most important commercial fishery in the Hawaiian Islands was the pole-and-line, live-bait fishery for skipjack tuna or aku (Katsuwonus pelamis). Aku are a high-seas species and are seasonally abundant around the Hawaiian Islands especially during the summer months. The fishery annually landed more than 2,500 metric tons of skipjack tuna at its height from 1937 through the 1960's. This fishery began in the early 1900's with technology originating from Japan utilizing live bait captured in bays around the islands used to hold the aku school close to the vessel, where lures are dipped into the water catching the fish. The landed fish were used to satisfy the fresh raw fish (sashimi)

market with the remainder going to the local cannery based in Honolulu (built in 1917). A sustained drop in the catch per unit of effort (CPUE) of large skipjack occurred in the early 1970's which was related to environmental changes which affected local fish availability (Boggs 1988). Combined with increased fishing costs, partially due to chronic shortages in baitfish, market competition from other tuna products and later to the closure of Hawaiian Tuna Packers cannery in 1984, the fishery went into a decline (Boggs and Pooley 1987) from which it has never recovered. By 1991 only four vessels were active on a full-time basis (Boggs and Kikkawa 1993).

The primary bait species used in the aku fishery was the nehu (Encrasicholina purpureas) and to a lesser extent, the silverside or I`ao (Pranesus insularum). Baitfish were harvested from wild populations. The quiet waters of Pearl Harbor and Kaneohe Bay were important sources of baitfish contributing more than 70% of the total state harvest. Commercial fishermen entered Pearl Harbor under permits taking an average of 33% of all bait captured in the state. Pearl Harbor showed wide fluctuations in bait catch and effort in the 1960-81 period, but no trends in the catch/effort data are apparent (Shomura and Sakuda 1983). Because the availability of baitfish had been identified by fishermen early on as a problem, considerable effort was expended in searching for methods to improve the situation including aquaculture, habitat improvement, etc., (Shomura and Sakuda 1983). This work began in the early 1950's and continued up until the demise of the fishery.

The statewide capture of baitfish from 1946-72 ran from 22,849 buckets in 1960 to 49,712 buckets in 1955 with an average of 35,528 buckets with a bucket holding 3.2 kg of nehu (Yoshida et al. 1977, Uchida 1977). Therefore, in this period about 37,500 kg were annually captured in Pearl Harbor. Somerton et al. (1993) estimated that the spawning biomass of nehu in Pearl Harbor ranged from 0.5 to 5.0 metric tons over a two-year study period (1986-88) with the fluctuation in response to continuing intensive fishery and seasonal cyclicity in spawning. The reported baitfish catch from Pearl Harbor was 7,664 kg or a little less than 2,400 buckets, reflecting the decline in the pole-and-line, live-bait aku fishery in Hawaii.

Fishermen pointed out that there was a gradual increase in the catch of "marquesan sardine" which comprised 10% in 1977 and made up 21% of the baitfish catch in 1981. The species involved is actually the gold-spot herring (Herklotsichthys quadrimaculatus) common to the waters of the Marshall Islands and not the AMarquesan sardine (Sardinella marquesensis) that was originally introduced from the Marquesas Islands in the late 1950's. The sardine is established in Hawaii, but it is not abundant (Randall 1987). In contrast, the gold-spot herring populations have mushroomed and it is a dominant baitfish in most bays and harbors today (Baldwin 1984). Fishermen strongly believe that this alien gold-spot herring preys on the eggs and larvae of the nehu giving the alien a competitive edge over the native nehu (Shomura and Sakuda 1983). This may very well be the case.

We noted the presence and estimated school size of any baitfish encountered during our field surveys of Pearl Harbor. Large schools of baitfish (nehu) were not seen during this study. The largest schools seen were comprised of the introduced herring (15 to 20 buckets in size). All three species of common baitfish were seen including nehu, the introduced herring and less frequently, the i'ao. To our knowledge, today there few fishermen or vessels capturing and using live bait for the capture of aku and the fishery for bait in Pearl Harbor is either no longer existent or only occurs on a very much reduced scale.

5.0 HAWAIIAN FISHERIES AND MANAGEMENT OPTIONS

5.1 Status of Hawaiian Fisheries

Pearl Harbor has been very important in terms of fishery resources from the time before contact with the western world because of its sheltered location, productive waters and numerous freshwater inputs along the landward (mauka) side. As Cobb (1905) notes in 1900, 26 of the Oahu commercially operated fishponds were in Pearl Harbor annually producing more than 49 metric tons of fish. With the exception of the fishponds, there is very little information about the fishery resources of Pearl Harbor prior to the tenure of the U.S. Navy. However, some generalizations emerge about the abundance of fish around the islands. Titcomb (1952) asked how abundant had been the supplies of fish? There are numerous accounts of lavish supplies for feasts. As recorded by Manini (Don Francisco de Paula y Marin) a companion of Kamehameha I in 1814, "...they caught among them all about 50,000 fish, and between men and women, about 10,000 were present..." It is difficult to determine what the abundance of fishery resources were but the impression remained among Hawaiians in the early part of this century that there had been plenty of fish. As noted by Ka Nupepa Kuokoa (1923) "?this matter of fish supply is going to be an important question for several generations, to understand why there was so much fish in the days of our ancestors and so little in our time although much meat and fish is now imported to help supply the people with food." The same argument and discussion continues today with no consensus and/or resolution in sight.

Shomura (1987) put the status of Hawaiian inshore fisheries into perspective when he conducted a simple comparison between the landings made in 1900 (data from Cobb) to the reported commercial landings made in 1986. The population of Hawaii in 1900 was about 154,000 and the 1980 census revealed about 964,700 individuals. In this period of time the catch of inshore species had decreased by 80 percent. Shomura (1987) hypothesizes that a number of factors could explain these decreases, including; (1) shortcomings in the statistical data used, (2) overfishing, (3) shifts in targeting of species because of changes in the ethnic makeup of the population, (4) changes in the abundance of species due to human induced changes in the environment of embayments, shoreline and coastal waters. These possible changes include the reduction of freshwater flow to the

ocean, loss of fishponds, filling in of shallow reef areas and creating of beaches (i.e., the importation of sand). Finally, he notes that pollution could impact the abundance and diversity of inshore species. A final possible factor to the observed changes in the abundance of Hawaiian coastal fish are largely unknown natural cycles. Examples of such fluctuations of abundance are known from many ecosystems. Ecologists and fishery biologists have not studied tropical systems for a sufficient period of time to (1) know if these fluctuations exist here and (2) understand the cycles if they exist.

Undoubtedly, all of the above factors have contributed to the declines seen in Hawaiian inshore fisheries and examples are known. However, one perturbation that appears to have had the greatest impact is overfishing. Declines in resource abundance in areas far removed from development (and pollution) are known. Interestingly, the documented declines are most apparent for species that are targeted by fishermen (Brock, unpublished data from Keahole Point, Hawaii). However, species distributions are large (archipelago wide), fish do move, and sampling programs can only cover so much area, resulting in data with relatively high variance so the statistical picture is not absolutely "black and white". With the diverse ethnic makeup of Hawaii's population, inshore fishing for subsistence and recreation are important to many and assumed to be a right. Unfortunately, the only known control for overfishing is to curtail fishing effort and would be very unpopular among Hawaii's ocean resource users.

It is evident from the above that modern management and resource conservation has not been successful in maintaining the inshore fishery resources. Prior to the acceptance of the western cash economy, old Hawaiians were very aware of unneeded waste and conservation of resources. As noted by Titcomb (1952, page 12), "To conserve the supply of all resources was constantly in the Hawaiian mind...Fishing grounds were never depleted, for the fishermen knew that should all the fish be taken from a special feeding spot (ko'a) other fish would not move in to replenish the area. When such a spot was discovered it was as good luck as finding a mine, and fish were fed sweet potatoes and pumpkins (after their introduction) and other vegetables so that the fish would remain and increase. When the fish became accustomed to the good spot, frequented it constantly, and had waxed fat, then the supply was drawn upon carefully. Not only draining it completely was avoided, but also taking so many that the rest of the fish would be alarmed. At the base of this action to conserve was the belief that the gods would have been displeased by greediness or waste."

Titcomb (1952, page 13) continues, "Tabus were an instrument in the conservation programme. The political power was concentrated in the upper class, the chiefs, and the laws of the land and of the sea were their edicts. The penalties for breaking tabus were heavy, often the death penalty for what seems to us a trifling fault. This held the people in a strict discipline. Besides tabus, the relationship with the gods was a powerful determinant of action. The lesser gods that each person had, personal gods, as well as the greater gods whose power was universal, were ever present. Their will was interpreted through the priests, but understood well by the people too. To conserve resources was a custom rigidly adhered to. It was the will of the chiefs, and also the will of the gods, and it was obviously wise. When a man broke this law he expected punishment from the chief's agent (konohiki), if his act was detected, but punishment from the gods certainly, for no knowledge was hidden from their perception. Man appealed to his gods for good luck, but the gods expected man to do his share in making this possible."

This management strategy was obviously successful with the population densities present prior to the breakdown of the old laws and tabus (which started in the early 1820's with changes instigated by Queen Kaahamanu) because of the old accounts suggesting the high abundance of fishery resources present (as given above). One such account relates to Pearl Harbor. Cobb (1905) noted that Pearl Harbor also had two permanent fish traps in 1900. These traps were used to catch sharks, akule (Selar crumenophthalmus), weke (Mulloides flavolineatus), and kawakawa or bonito (Euthynnus affinis). The larger which was near Puuloa (on the Ewa side of the Pearl Harbor entrance channel) was built of coral rock forming walls. Fish entered the trap at high water and were trapped when the tide receded. Neither of these fish traps remains today having been destroyed with the dredging of the entrance channel (Stokes 1909). The point to be made is that kawakawa is rarely seen in shallow water today. It is surmised that this species was drawn into the Pearl Harbor entrance channel area due to the abundance of larval fish, crabs and baitfish which were originating from the harbor and adjacent reefs (see also Birkeland 1984).

Today, fishermen will attest the fact that pelagic fish are usually found well offshore. Only rarely will tunas or other pelagic species be caught in nearshore waters and when one is, it often makes local news (e.g., Hawaii Fishing News May 1998, page 6; June 1998, page 1). Further evidence of this comes from the work of Tester and Nakamura (1957) where experimental trolling for pelagic species was conducted outside of Kaneohe Bay. Kaneohe Bay like Pearl Harbor is an important quiet water area for baitfish species such as ia`o and nehu (see next section) as well as a source of the larvae of many reef organisms. Tester and Nakamura's (1957) experimental program was initiated in 1951 and continued through 1955. Catch rates were sufficiently high that the fishing vessel never had to venture more than five miles seaward of Moku Manu Island offshore of Mokapu Point at the south end of Kaneohe Bay. Today to find the same species of pelagic fishes and to have similar catch rates, most fishermen travel from 3 to 50 miles offshore of Kaneohe Bay with most catches being made from 10 to 20 miles offshore (Brock, pers. obs.). Stomach contents of the pelagic fish examined by Tester and Nakamura (1957) showed a predominance of prey from inshore sources (see Leis and Miller 1976). Today, the overall abundance of these pelagic species is probably much less that it was more than 40 years ago and likewise the presence of larval and baitfish food resources similarly less.

These two factors are probably responsible for the decrease in pelagic fishes venturing close to shore which reflects the declines that have occurred in nearshore resources since the turn of the century.

The higher productivity found in waters surrounding islands relative to more offshore oceanic waters is well-known (the "island mass effect" Birkeland 1984). Not only is primary production frequently greater due to nutrient inputs from land but there are efficient mechanisms to recycle nutrients within the nearshore reef system. This greater productivity stimulates and is the source of the production of larvae from the invertebrates and fishes living on the island's reefs which are carried out offshore by currents into the pelagic realm. Once completing the pelagic phase, these larvae recruit back to the shallow reefs surrounding the island. This emanating of larvae out into the pelagic environment is a food resource to pelagic predators such as tunas and serves as a stimulus to draw these pelagic fishes relatively close to shore for feeding as well as reproduction. The island mass effect may explain the presence of pelagic fishes close to shore as noted above.

5.2 Status of Pearl Harbor Fisheries

As noted in section 1, Pearl Harbor has historically had and continues to have significant fishery resources. The U.S. Naval jurisdiction over the Pearl Harbor estuary has in effect made the harbor a de facto preserve by banning most civilian entry to the harbor. One exception has been the permits issued to the pole-and-line, live-bait skipjack tuna (aku) vessels seeking bait in the harbor which in recent years has declined. At present a small amount of fishing is evident in portions of East Lock by personnel working on base. This fishing activity is carried out with hook and line methods. Observations made during the field surveys suggests that this fishing is infrequent and carried out away from the center of military activities in East Loch. It probably represents a minor level of effort and the catches are probably small.

There is a second group of individuals fishing in Pearl Harbor. This group is comprised of civilians who use a variety of methods including nets, spears and hook and line techniques. Many of these fishermen focus their efforts in the more remote parts of the harbor and some keep small skiffs in the mangrove thickets. The mangrove-based fishermen use primarily gill nets, most of which are probably set after dark and retrieved before sunrise in the morning. Occasionally however, sets are made during daylight hours, again in areas well removed from the base activities. These gill nets are generally set on the mauka shallow reef flats probably targeting awa'awa (mullet) and awa (milkfish). The authors have encountered nets set on the reef flats in East Loch probably set by this group of fishermen. Skiffs have been encountered in mangrove thickets in both East and West Lochs. There are a number of civilians that fish from numerous points along the Pearl Harbor shoreline trail in East Loch. These fishermen fish from shore using hook and line techniques and are frequently present at the Hawaiian Electric Company's warm-water discharge at their

Waiau generating station. Many fish aggregate in the warm-water discharge and Blaisdell Park as well as the shoreline trail make for easy access. Species caught by this group include silvery tilapia (Tilapia melanotheron), papios (family Carangidae), to'au (Lutjanus fulvus) and yellowfin surgeonfish or pualo (Acanthurus xanthopterus). Some of these fishermen also set crab nets in the water from shore targeting Samoan crabs (Scylla serrata), haole crab (Portunus sanguinolentus) and the Hawaiian crab (Podophthalmus vigil).
Evidence of spear fishing was found in the shallows along Waipio Peninsula near Nevada Point where a pole spear was found on the bottom during this survey. Evidence of gathering oysters in West Loch was encountered on Laulaunui Island where piles of shucked oyster shells were found, some of which appeared to be relatively recent in origin. On 11 November 1999 two boys were seen pole fishing from one of the emergent rocks west of Laulaunui Island in West Loch. Thus fishing activities are ongoing albeit at a relatively low level and will probably continue. Catches are unknown but must be of sufficient size and/or frequency to serve as an impetus to continue the activity.

6.0 IMPACT OF ALIEN SPECIES ON PEARL HARBOR ECOSYSTEM

Biologists in recent years are becoming much more aware of the impact that alien species may have in host communities. Alien species may arrive in new geographical locations by natural colonization or mediated through the activities of man. Most successful introductions in marine environments occurs through the movement of ships either on the hulls or in the ballast water of ships. Once established, alien species may be competitively superior over native species for specific resources eventually resulting in the alien species displacing the native form and possibly leading to its demise.

Coles et al. (1997) provide an in-depth review and analysis of the establishment of alien species in Pearl Harbor. Of the 434 species and higher taxa reported by them, 96 or 22% are considered to be introduced or cryptogenic (a species that is not native and cannot be demonstrated to have been introduced *sensu* Carlton 1996). The reporting of these non-native species in Pearl Harbor is apparently related to the recent concern of alien species (hence increased effort of collection), as well as to increased ship traffic with time (Coles et al. 1997). Thus, more reports of alien species in the harbor have been made in recent years. Once established, most nonindigeneous species found in Pearl Harbor show a high level of persistence, i.e., that they continue to appear in subsequent biological collections (Coles et al. 1997).

As noted above, one common attribute with most Hawaiian aquatic introductions is that they appear to have a competitive edge over native species. This competition may be for space, food, or the introduced species may simply be a predator on natives in the shared habitat. In general, the impact of introductions is more evident in communities with fewer species such as in Hawaiian streams where much of the native fauna in the lower reaches

of streams has been replaced by a handful of nonindigeneous species (Devick 1991). At the other extreme, in many marine settings where the communities are speciose, the impact of the recent introductions appears to be less evident.

Review of the literature suggests that documentation of impacts due to aquatic introductions is anecdotal. There are little or no quantitative data upon which to base any scientific analysis of impacts or to provide any predictive ability. The impact of a successful introduction of a species may or may not cause obvious disruption to the host (or recipient) community, but nowhere is quantitative documentation available. The reason(s) for this probably lie with the difficulty ecologists have in defining and understanding the relationships among members of tropical marine communities (like coral reefs) as well as the fact that the concern over aquatic introductions is relatively new, thus attention has not been focused on quantifying the problem. In addition, since most introductions are relatively recent phenomena, sufficient time has not passed to determine the full successional cycle that may occur. For instance, introduced species may initially dominate an ecosystem soon after the introduction, with a gradual dimunition as a result of adjustment from the remaining biotic components (e.g., predation, grazing, outcompeting for space).

Despite these shortcomings, the most obvious impact of some alien aquatic species may most evident in those species that require the occupation of substratum for part of their lifecycle. Once established, these sessile species may increasingly dominate space formerly occupied by native species. The alien intertidal barnacle, Chthamalus proteus, was first reported by Coles et al. (1997) in Pearl Harbor. This barnacle is probably the dominant life form on hard substratum in the intertidal of Pearl Harbor as well as other harbors of Hawaii and represents a serious threat to native species that occupy the same habitat (Coles et al. 1997). Similarly, the red mangrove (Rhizophora mangle) has become a dominant lifeform along the undeveloped shorelines of Pearl Harbor and elsewhere in Hawaii where sheltered bodies of brackish water exist. The thickets and canopy of this species exclude all other intertidal vegetation.

The alga, Gracilaria salicornia, is a species that in recent years has become very abundant in parts of Pearl Harbor and Kaneohe Bay. This species may not be an alien to the Hawaiian flora (unknown at this point in time), but it has become a dominant lifeform over large areas (hundreds of square meters) in shallow subtidal areas of Pearl Harbor which is a characteristic of a non-native species. The alien alga, Acanthophora spicifera, is probably the second most common subtidal algal species found in Pearl Harbor. When considering the entire harbor, probably the alga that is third in abundance is Chloradesmis caespitosa. Acanthophora spiciferi arrived sometime in the early 1950's (Doty 1961). As noted above, the introduced eastern oyster, Crassostrea virginica, occupies large areas of the shallows in West Loch.

All of these successfully established alien species occupies space that might otherwise be utilized by native species. The biota of Pearl Harbor represents a mosaic of alien and native forms. Probably the most visually obvious aquatic and intertidal species in the harbor today are not native in their origin. This fact has implications to the future management of the biological resources of the harbor.

The situation with impacts created by alien fishes is more difficult to quantify. Several alien fishes encountered in this and previous studies in Pearl Harbor include guppies and mollies (family Poecilidae), silvery tilapia (Tilapia melanotheron), the to'au (Lutjanus fulvus), small mullet (Valamugil engli), striped goatfish (Upeneus vittatus) and the goldspot herring (Herklotsichthys quadrimaculatus). In his discussion of the impacts of alien fishes, Maciolek (1984, page 148) notes, "Impacts of immigrant species may be beneficial, negligible, adverse, or a combination of these for a given species under some circumstances. Beneficial and negligible effects generally relate to the purpose for a species introduction, such as for food, forage, recreation, or biological control. Adverse effects center on changes in natural ecosystems induced by exotics, particularly on native species that may be direct (competition and predation) or indirect (e.g., introduction and transmission of disease or parasites). Benefits are generally self-evident, as are some adverse impacts, but even these are difficult to quantify. Direct studies of impacts have been few and the appraisals that follow are, therefore, largely qualitative and subjective."

The impacts of alien fishes on the native fishes in Pearl Harbor are presently unknown. Intuitively, their presence must have an impact on the native fish populations for resources that are shared. For example, the dominant fishes seen in the fishpond remnants examined in this study have been tilapia (Tilapia melanotheron and T. mossambica) and members of the guppy/molly complex (family Poecilidae). Despite this, native fishes such as the grey mullet or ama'ama continue to persist.

Management of the biological resources of Pearl Harbor should support all efforts to curb further aquatic alien species introductions. Recent federal legislation (Resolution A.774(18) adopted on 4 November 1993) controlling the release of ballast water in harbors should help in reduce more introductions. The increased awareness of the negative impact that aquatic alien species may has led to more careful consideration in the movement of ships. The recent movement of the historic USS Missouri from Bremerton, Washington to Pearl Harbor led to the recommendation that the ship be placed in freshwater (in the Columbia River at Astoria, Oregon) for more than a week to rid the hull of alien fouling communities which in places were more than 30 cm in thickness (Brock et al. 1999). This simple management procedure completely cleared the hull of unwanted alien species saving more than $1 million in drydocking costs and only 11 species survived upon the arrival of the ship in Pearl Harbor. Subsequent examination of the hull 83 days

later showed that none of these aliens survived demonstrating that simple measures can be effective controlling agents (Brock et al. 1999).

7.0 BIOACCUMULATION OF POLLUTANTS IN PEARL HARBOR ORGANISMS

It has been recognized for many years that Pearl Harbor is a region that has received pollutant inputs from many sources. These sources include the surrounding civilian controlled lands for many years in the production of sugar and general urban, commercial and light-industrial areas. Inputs from these sources are probably greatest from the eight major streams that drain into the mauka portions of the Harbor as well as from the Hawaiian Electric Company cooling water discharges at Waiau (heated effluent and metal cleaning wastes) and sewage discharges that formerly entered the harbor. The U.S. Naval operations have also been a source of materials into the harbor. Most of these pollutants eventually are sequestered in the bottom sediments of the harbor. There are many organisms that feed in the sediments and detrital foodwebs of the harbor that ultimately are consumed by larger aquatic organisms. The movement of pollutants up through aquatic foodwebs increases the probability that some of these materials may eventually reaching protected waterbirds and humans.

The U.S. Navy has an ongoing program that is (1) characterizing the chemicals in the sediments and marine life in the harbor, (2) evaluating the potential threat of chemicals to human health and the environment and (3) identifying areas that need cleanup. Toxicity tests using standard marine bioassay organisms have pointed out problem areas in Southeast Loch, Middle Loch, West Loch and the main ship channel. Further examination of the sediments from 105 sample sites found 148 chemicals from a list of 252 to be present. Major groups of chemicals found include metals, organotins, polynuclear aromatic hydrocarbons, semivolatile organic compounds, chlorinated pesticides, polychlorinated biphenyls, polychlorinated dioxins and furans, chlorinated herbicides, and ordnance compounds. Sources of these compounds are unknown but locations of detection suggest both civilian and military origins (Anon. February 1998).

These findings have resulted in the State, Navy and other federal officials to post warnings about the consumption of fish, crabs and oysters caught in Pearl Harbor (Star Bulletin, 28 August 1998). This article notes that despite the fact that many of the detected compounds in the sediments and tissues of organisms from the harbor have been banned for many years, the half-lives of these compounds means that it will probably be many years before fish are safe for human consumption. According to the ongoing study, consumption of more than half a meal per month of whole fish or one meal per month of fish fillets could present an unacceptable risk due to both cancer effects and non-cancer effects in both adults and children. In addition, consumption of more than one half a meal per month of whole crabs could present an unacceptable cancer risk over a lifetime of exposure (Anon. August 25, 1998).

In response, the Navy has instituted a program to (1) target a 50% toxic chemical reduction at Pearl Harbor by 1999, (2) reduce future liability for waste disposal, (3) reduce waste management costs, and (4) provide resources for pollution source reduction. The program has resulted in a 42% reduction of solid and hazardous wastes at Pearl Harbor from 1.3 million pounds in 1994 to 786,000 pounds in 1998 (Anon. August 26, 1998).

In summary, the status at the present time is that any fish or shellfish collected in Pearl Harbor should not be consumed. This posted warning is not expected to change in the near future which certainly limits the use and management options for these aquatic resources.

8.0 MANAGEMENT ALTERNATIVES FOR PEARL HARBOR AQUATIC RESOURCES

The control of Pearl Harbor by the U.S. Navy for close to a century has limited civilian use of the aquatic resources in the harbor. This has made much of Pearl Harbor a de facto aquatic preserve which has allowed resources to exist with little or no fishing pressure exerted upon them. The result is that fishery resources are relatively abundant, especially species such as the eastern oyster (Crassostrea virginica) in West Loch and the grey mullet or ama'ama (Mugil cephalus). As noted above, the only permitted capture fishery has been that for baitfish used in the skipjack or aku fishery. This fishery has dramatically declined in the last ten years. Most other capture fishing activities by civilians in the harbor are carried out illegally (i.e., not sanctioned by the Navy) thus could be considered to be poaching. This fact and the possible contamination of the fish and shellfish by pollutants which has caused the State and Federal agencies to post warnings as to not consume the fish taken in the harbor, point to a present situation where fishing for consumption cannot be considered in the present management plan. However, in the future with environmental cleanup programs and careful management, fish caught in Pearl Harbor could be someday be deemed safe for consumption.

The U.S. Navy has instructions and regulations governing the recreational use in specific areas of Pearl Harbor. These regulations were put into effect in 1987 (COMNAVBASEPEARLINST 5510.21B) but an updated draft (1999 version) has been prepared (COMNAVREGPEARLINST 5510.21C). The 1999 regulations state that the reason for restrictive use of Pearl Harbor is related to the security of the Pearl Harbor Defensive Sea Area. In areas that are not sensitive, and where security or safety requirements are not in conflict, recreational use is permitted when in compliance with the issued instructions. Summarizing civilian fishery use, vessels must have been issued a permit prior to entry into the harbor and entry must be cleared with the Port Authority. All fishing must comply with applicable state regulations with the recognition that all fishing is done on a catch-and-release basis. Shoreline fishing is permitted from a number of

shoreline areas well away from the military installations and/or activities. Again, all shore fishing is for catch-and-release only, thus no take is permitted which is in conformance with the recent pollutant warnings regarding consumption of fish and shellfish from the harbor. Throw nets are allowed "...for catching baitfish is authorized provided the mesh is 1.5 inches or larger..." and all other nets, traps or spears are not allowed. Shoreline fishing can only be undertaken during the daylight hours.

The draft regulations allow for several possible management options. Assuming that the physical boundaries of areas where fishing activities are allowed cannot be enlarged, management can focus on (1) improving the access to these resources, (2) enhancing the resource availability and abundance, (3) undertake local environmental cleanup thereby lessening the potential for bioaccumulation of pollutants in the fishery resources, (4) continue with the present minimal management strategy or (5) curtail all or some recreational activities that impact aquatic resources thus increasing the preserve status of the harbor. These alternatives are discussed below.

At one end of the spectrum to improve the access includes the both the improvement of the Pearl Harbor shoreline trail with associated parking as well as the publicizing these fishing opportunities to the other extreme of not doing anything more to increase fishing effort in Pearl Harbor. In Hawaii, fishing to much of the public means the capture of fish or shellfish for consumption. Catch-and-release programs are in their infancy among Hawaii's fishermen and particularly so for shore based fishing activities. Any program that improves access should have an educational aspect to it with the message of not consuming what is caught. Besides a simple warning message, a fine for offenders should be considered. The question of liability arises with possible human health problems associated with consumption of fish or shellfish having unacceptable body burdens of pollutants. Despite signage, is the State or Navy responsible if someone claims that pollutant laden fish were the cause of their health problem? This aspect should be explored by those versed in the law (see also Lenzini 1984). If this question cannot be resolved, then closure of the shoreline fishery is a possible option.

It is quite evident that the level of regulation of those participating in the shoreline fisheries is inadequate. Most fishing activities witnessed in the field was obviously for consumption. Discussion with some fishermen indicated that the catch could be consumed. Thus, the signage posted along the shoreline warning against consumption, is not working. Besides being illegal in Pearl Harbor, gill nets are not set for "catch-and-release" programs. Thus, no matter what direction the management of Pearl Harbor aquatic resources ultimately goes toward, there must be more people involved with the policing of the users whether the waters of the harbor are open to fishing or closed to this activity. If community interest is high and they will accept a catch-and-release program, then perhaps the community could become involved in a self-policing program to curtail catch and consumption activities.

Short of this means that funds and manpower would have to allocated to patrolling the harbor for illegal fishing operations.

The enhancement of the fish resource and its availability to the fishing public is a logical step if the resource is going to be consumed by the fishing public. However, even under this circumstance, it may not be cost-effective. Resource enhancement would include the development of shelter that results in local increases in the populations of certain fish species. This enhancement technology (artificial reefs) has been demonstrated to significantly increase the biomass and diversity of Hawaiian fishery resources (Brock and Norris 1989). Development of artificial reefs in Pearl Harbor would not be appropriate for those areas in proximity to the mauka shoreline of the harbor because of high sedimentation rates in those areas. Most of the fishing areas presently open to the public are along the mauka shorelines of East and Middle Lochs. High sediment loading would serve to bury any structures deployed for enhancement. The technology could be successfully used in small local areas in the more seaward portions of the harbor. However, development of shelter in a harbor is counter to the purpose of the harbor (i.e. a body of water clear of hazards to the navigation of vessels). Deployment of artificial reefs in Pearl Harbor would create hazards to navigation if placed in the seaward portions of the harbor. This technology is not proposed for use here.

Related to the improvement of access and enhancing the fishery resource is the possible development of fishing piers. Fishing piers are an integral part of urban fishing programs (see Allen, 1984). However development of fishing piers promotes fishing and unless the participants understand the necessary catch-and-release aspect to the program, spending funds to create fishing piers is probably not the best use of limited financial resources in Pearl Harbor. However, resource managers across the United States are well aware of the problem of often high contaminant levels in the flesh of fishes captured in the urban setting (Mackenthun 1984, Grant 1999) yet these fisheries continue and are sometimes promoted. The potential health problems that may arise from consumption of contaminated fish have not been adequately addressed but some managers feel that the positive social interactions that occur with urban fishing make such programs worthy (Manfredo et al. 1984, Marolf 1984, Grant 1999). This ignoring of the potential health issues is not proposed here.

The possibility of environmental cleanup exists, however, until sources of pollutants are identified, cleanup effort could be in vain. Pearl Harbor receives runoff from 20 percent of the land area of Oahu. This drainage basin includes former agriculture lands, urban settings as well as commercial and light industrial areas. Contaminants are known to enter Pearl Harbor through the streams bisecting this drainage basin. Naval operations over the last 80+ years have contributed to the pollutant load of the harbor (Grovhoug 1992). Once sources of contaminants were known, local cleanup would be possible but would be of

limited utility for the consumption of fish because their movement and feeding throughout the harbor.

Cleanup of pollutants raises the issue of cost-effectiveness relative to the resource to be utilized by humans for food. Cleanup of contaminated subtidal sediments is costly and the cleanup of sources may be even greater. This cost must be weighed against the value (primarily social) of the fishery if it were to be consumed. What is the monetary value of the fishery resources of Pearl Harbor? There is no precise answer but a rough calculation based on the reported productivity of the fishponds operating in the harbor in 1900 was 216 kg/ha/yr (see fishpond section). If the entire acreage of Pearl Harbor (~5,000 acres or 2,024 ha) were as productive as the fishponds, then the harbor could “produce” about 437 metric tons of fish per year on a sustainable basis. If these fish had a wholesale value of $4.00 per pound, the fish produced in the harbor would be annually worth $3.8 million. It should be remembered that this estimate is very crude and assumes that the entire harbor would be “in production” and have habitat that is environmentally acceptable and similar to what it was in 1900. This is obviously not the case so the estimate is high but provides an indication of economic value. In addition, this calculation assumes that the fishery would be managed much as a fishpond is managed, capturing adult fish at the appropriate rates -- not a “free-for-all” fishery. Obviously, the present use of Pearl Harbor as a major military port has much greater economic and military value than would the area have as a simple fishery.

The fourth management option to be suggested is the continuance of the present minimal management of the aquatic resources of Pearl Harbor. This strategy focuses on the implementation of the Navy’s draft regulations governing recreational use of Pearl Harbor (COMNAVREGPEARLINST 5510.21C) which specifies specific areas for fishing. The draft regulations call for catch-and-release of all fish caught in the harbor (other than baitfish). However, as noted above, fishing now occurs in areas outside of the boundaries of the present fishing areas, uses illegal fishing gear and the fishery is primarily a fishery for consumption. Without some increase in educational efforts and greater surveillance to enforce existing regulations, the continuance of the status quo is not protecting the resource or the individuals unknowingly consuming the fish caught. If the present draft regulations are to be continued, some consideration should be given to a greater educational effort as well as better enforcement of the rules.

Enforcement of the draft fishing/recreation regulations (COMNAVREGPEARLINST. 5510.21C) with some modifications would reduce fishing mortality, thus serving to enhance the preserve status of the biological resources of Pearl Harbor. If all fishermen were required to obtain an annual fishing permit, education as to where fishing is allowed, mandatory catch-and-release rules, and gear types allowed could occur at that time. Enforcement through active patrols would insure compliance to the regulations. Providing penalties such as gear confiscation and a civil fine could serve as a deterrant to illegal fishing. Loss of a small boat fishing with gill nets and having no permit for the boat or fishing activity, would quickly curtail the present illegal fishing activities in the harbor.

From a fishery management perspective, a final option considered here is the curtailment of all fishing activities in the harbor other than organized catch-and-release derbies. Banning all fishing in the harbor along with greater enforcement of the ban would alleviate the problem of consumption of possibly contaminated fish and would serve to protect the aquatic resources of the harbor from further exploitation. As with the previous scenario, this management option would require an educational effort as well as increased enforcement to insure compliance. Implementation of this strategy would create greater negative feeling towards the Navy by the general public. However, enforcement of the present mandatory catch-and-release or any other portion of the 1999 draft rules would also increase negative feelings towards the Navy.

The banning of all fishing in the harbor would formalize the present situation where most of the harbor waters are presently off-limits to any fishing activity. A ban on fishing would complement and be in keeping with the historic nature of Pearl Harbor as the first site of the U.S. involvement in WWII as well as the de facto natural resource preserve that it has been for most of the twentieth century. Banning fishing would put the management of the area more in line with the mandates of other federal agencies. Some federal preserves for the protection of aquatic, wildlife and historic resources are managed by other agencies such as the National Park Service, U.S. Fish & Wildlife Service or the NOAA Sanctuary Program. Transferring these management responsibilities would decrease the burden on the Navy to manage the system.

Closure of the harbor to all fishing except baiting activities for the skipjack fishery or implementation of the proposed revised recreation regulations as above would serve to increase the fishery resources in the harbor, some of which would serve to enhance the fishery resources in areas seaward of the harbor. Limited tagging of fishes in Pearl Harbor has demonstrated that some species will move out of the harbor and down the coastline (Evans et al. 1974). The closed-to-fishing management option could still allow organized catch-and-release fishing derbies in the harbor that local fishing clubs could participate in. With the abatement of pollution into Pearl Harbor as evidenced by the increased abundance and diversity of coral species, the fishery resources in the harbor under a no fishing regime would also likely increase due to the improvement in environmental conditions.

The curtailment of fishing in the harbor does not run counter to the recommendation that Hawaiian fishpond resources be restored using community input. As noted in the fishpond section, if the production in the form of live adult fish from any restored fishpond are released back into the wild (which is in keeping with the no consumption regulation), these

fish will contribute to the spawning biomass of adults in the harbor and may move out and colonize other shoreline areas of Oahu.

In summary, given the problems with environmental cleanup of the pollutants of the harbor and the persistence of the fishing public to ignore many of the regulations now in effect suggests that closure of the harbor to fishing may be an appropriate management option. This option or the strategy of continuing to allow fishing in certain areas and with specified gears could also be an appropriate management action but either of these management strategies will require a greater effort towards educating the public with respect to the adopted rules and health issues related to consumption as well as a greater level of enforcement to insure that regulations are adhered to.

9.0 MANGROVES IN PEARL HARBOR

9.1 Background

In 1902 the American Sugar Company introduced seedlings of the red mangrove, Rhizophora mangle, from Florida into Hawaii. The seedlings were planted on the mudflats of the south Molokai to prevent erosion into the sea. A second introduction of mangrove occurred in 1922 when the Insular Bureau of Forestry of the Philippine Islands shipped seedlings of Rhizophora mucronata, Bruguiera sexangula, and Sonneratia caseolaris to Hawaii. Presently Rhizophora mangle and Bruguiera sexangula are extending their ranges in the Hawaiian Islands, by invading sheltered habitat in bays and estuaries formerly occupied by the hau (Hibiscus tiliaceus).

Rhizophora mangle is well established in Pearl Harbor. Where this species occurs, it usually dominates the shoreline and intertidal to the exclusion of most other vegetation. Mangrove thickets in Pearl Harbor appear to be best developed in proximity to freshwater (stream) inputs. Mangroves are found along much of the undeveloped shorelines of all lochs of the harbor.

9.2 Impact of Mangroves

Mangroves are an introduced species, and like many other introduced species that are sessile as adults, dominate the space occupied by them to the near-exclusion of other plants. In their natural range, mangroves are considered to be an important part of the overall estuarine habitat serving as a nursery ground for many fishes and invertebrate species as well as a natural means to stabilize eroding shorelines and absorbing contaminants. Indeed, in the United States where habitat restoration is an important part of the coastal and aquatic resource managers efforts, mangroves are being planted along shorelines where they have been destroyed by storms, human-induced habitat alteration and/or degradation. One such example is the federally-funded mangrove restoration

program at Sugar Bay, St. Croix where old growth mangrove forest which was destroyed by Hurricane Hugo in 1989 is being replanted (Anon. 1999).
A number of native species in Hawaii utilize mangroves where their ranges overlap (e.g., the snail Littorina scabra, the goby Oxyurichthys lonchotus, juvenile mullet or pua (Mugil cephalus) and others) mangroves are an important habitat as they are for some introduced aquatic species such as the mud or Samoan crab (Scylla serrata). Thus, in other parts of the world in their natural range, mangroves are an important habitat to these and many other species. This recognized importance has led to the mangrove restoration programs that are being undertaken in many tropical estuarine and shoreline areas.

Mangroves in Pearl Harbor serve as habitat for a number of species. On the upper parts of the prop roots are often seen the black crab (Metapograpsus thukuhar), the snail (Littorina scabra), the alien barnacle (Chthamalus proteus). Slightly further down in the intertidal on the prop roots are the native oyster (Ostrea sandvicensis), alien oysters (Crassostrea virginica and Crassostrea gigas) and unidentified amphipods. Subtidally, the alien alga (Acanthophora spicifera) is seen as are the sponges (Halichondria coerulea, Zygomycale parishii, Mycale armata and other species) as are mud or Samoan crabs (Scylla serrata), the blue pincher crab (Thalamita integra), tilapia (Tilapia melanotheron), juvenile mullet (Mugil cephalus), introduced guppies and topminnows (family Poecilidae), barracuda or kaku (Sphyraena barracuda) as well as many other species. The species composition of the “epifauna” on mangrove prop roots is partially dependent upon the proximity and volume of freshwater inputs as well as sedimentation. The more marine the local setting, the more marine (and diverse) the fauna will be.

9.2 Management of Mangroves

The question arises as to the biological value of mangroves in Pearl Harbor. On the positive side, as noted above, mangroves may serve as habitat for a number of aquatic species, stabilize the shoreline and may have a role in sequestering pollutants. The negative aspects of mangroves include usually forming monospecific thickets that completely eliminate other plants, or open tidal flats they may constitute habitat that would otherwise be available for wading waterbirds. In addition, the relentless growth of mangroves may increase the breakup and disruption of historic features such as fishpond walls.

There are three strategies that may be considered with respect to the mangroves in Pearl Harbor. The first is total removal, the second is partial removal and the third is to leave the mangroves are they presently are in the harbor.

Mangroves occupy a large proportion of the undeveloped shoreline of Pearl Harbor. Complete removal of mangroves from the harbor would require a tremendous effort and cost. Not only is their removal costly, but the continuing cost to monitor and remove their

floating seeds and sprouts would be high. Not all mangroves around Pearl Harbor are located on federal property. Those plants on adjoining private lands would continue to be a source of floating seeds hence recruitment in the harbor would continue. Total removal of mangroves from federal property would require continuing maintenance costs. If this option is to be given serious consideration, besides the large initial cost of clearing, a long-term source of funds for this maintenance would need to be identified. Any consideration of this option must weigh the costs against the benefits accrued from mangrove removal. From an aquatic biological perspective, there seems to be very obvious little benefit to be derived to the total removal of mangroves from within Pearl Harbor.

Partial removal of mangroves from select sites may be an option worthy of consideration. As an aquatic biologist there are only a few sites where mangrove removal should be considered. These sites are the fishpond remnants in Pearl Harbor that are under Naval jurisdiction, i.e., Laulaunui Fishpond on Laulaunui Island in West Loch, Oki`okilepe Fishpond on the makai side of the West Loch channel and Pa`aiau Fishpond on McGrew Point in East Loch. In all cases, mangrove removal from these fishponds would slow the senescence or infilling that is occurring in all of these ponds and removing mangroves from the relatively loose, dry-stack rock walls and makahas (sluice gates) of the ponds will slow down the decay of these historic features. Mangrove removal from the fishponds will allow light to penetrate the fishpond waters and assist in restoring the aquatic community structure to what was present prior to the near takeover by this species. As with the management strategy of total mangrove removal, removal of mangroves from select sites such as fishponds will require regular maintenance hence allocation of financial and manpower resources. However, it should be recognized that maintenance of three relatively small (~4.5 ha in total area) fishpond sites is far less than maintenance of the much of the harbor’s shoreline if all mangroves were to be removed.

If removal of mangroves is considered from select areas, some considerations should be given to replacement of these trees along cleared shorelines with native forms. Presently mangroves are serving to stabilize some shoreline areas and simple removal may locally increase erosion. Thus, appropriate native plant species should be propagated in sufficient quantities to replant some of the mangrove-denuded areas subject to erosion. Increasing the erosion should not be allowed to occur over what inputs to the harbor presently occur. The present terrigenous inputs have considerable influence over the development of marine and estuarine communities particularly in the mauka portions of the harbor.

The third management option is to leave the mangroves as they presently are not altering their distribution. This is the lest-costly option but does not address the important issue of maintenance of culturally-significant historic places such as the fishpond remnants under Navy jurisdiction. Anyone visiting these sites can easily see that mangroves are causing dislocation of rock walls and obviously increasing the infilling of these ponds. Selecting the strategy of no mangrove removal in Pearl Harbor dodges Navy responsibility of stewardship of these resources.

10.0 FISHPONDS

10.1 General Historical Perspective

Cobb (1905) provides an general picture of the Hawaiian fishpond fishery of 1900. Over the next two pages is material excerpted from his 1905 report. The most interesting of the fishery resources of the islands are the fish ponds. This is the only place in United States territory where fish ponds are found on such an immense scale and put to such general and beneficent use. The time of the building of many of them goes back into the age of fable, the Hawaiians, for instance, attributing the construction of one of the most ancient, the deep-water fish pond wall at the Huleia River on Kauai to the Menehunes, a mythical race of dwarfs, distinguished for cunning industry and mechanical and engineering skill and intelligence. Many of the very old ponds are still in practical use and look as though they would last for centuries. As the ponds were originally owned by the kings and chiefs, it is very probable that most of them were built by the forced labor of the common people. There is a tradition among the native that Loko Wekolo (Wekolo Pond), on Pearl Harbor, Oahu, was built about two hundred and fifty years ago, and that the natives formed a line from the shore to the mountain and passed the lava rock from hand to hand till it reached the shore where the building was going on without once touching the ground in transit. As the distance is considerably over a mile, this is significant of the density of the population at that time.

Hawaiian fishponds are found principally in the bays indenting the shores of the islands, the common method of construction having been to build a wall of lava rock across the narrowest part of the entrance to a small bay or bight of land and use the enclosed space for the pond (loko pu'uone). Ponds were also built on the seashore itself, the wall in this case being run out from two points on the shore, some distance apart, in the shape of a half circle (loko kuapa). Most of the Molokai fish ponds were built in this manner. A few were constructed somewhat interior, and these are filled by the fresh water streams from the mountains (loko wai) or by tidal water from the sea carried to them by means of ditches (auwai). Most of the interior ponds are on Oahu, near Honolulu. The Nomilo fish pond at Lawai, on Kauai, is formed from an old volcanic crater with an opening towards the sea which a wall has been built, and as the opening is below the surface of the sea the tide plays in and out when the gates are opened.

In the sea ponds the walls are about 5 feet in width and are built somewhat loosely, in order that the water may percolate freely. The interior ponds have dirt sides generally, although a few have rock walls covered with dirt, while others have rock walls backed with dirt. The sea ponds generally have sluice gates which can be raised or lowered, or else which open and close like a door (the makaha). In the interior ponds there are usually two small bulkheads with a space about 8 feet square between them. Each of these has a small door which usually slides up or down. When the tide is coming in both doors are opened and the fish are allowed to go in freely. At the turn of the tide the doors are closed. When the owner wishes to remove any of the fish he generally opens the inner door when the tide is ebbing. The fish rush into the narrow space between the bulkheads, from which they are dipped out by means of hand dip nets. In the sea ponds the gate is opened when the tide is coming in and closed when it turns.

There is usually a small runway, built of two parallel rows of loosely piled stones, from the gate to about 10 feet into the pond. As the fish congregate in this runway when the tide is going out, it is very easy to dip out the supply needed for market. Seines and gill nets are also used in taking fish from the ponds, a method which is easy, owing to the shallowness of the ponds.

The sea ponds usually contain only the ama'ama, or mullet and the awa (milkfish). In the fresh and brackish water ponds gold-fish, china-fish, o'opu, opae, carp, aholehole, and okuhekuhe are kept. Practically no attempt at fish-culture is made with these ponds. Besides the fish which come in through the open gates at certain seasons of the year, the owner usually has men engaged in catching young ama'ama and awa in the open sea and bays, and transporting them alive to these enclosures, where they are kept until they attain a marketable size, and longer, frequently, if the prices quoted in the market are not satisfactory. It costs almost nothing to keep them, as they find their own food in the sea ponds. It is supposed that they eat a fine moss which is quite common there.

There are probably not more than one-half the number of ponds in use today than there were thirty years ago. There are numerous reasons for this, the principal ones being the following:

1. The native population is rapidly disappearing, and where there were prosperous and populous villages in the early years of the last century there is practically a wilderness now. Owing to this depopulation, there is no sale for fish in the immediate neighborhood of the ponds, the only market possible, owing to the difficulty in transporting any distance without the use of ice. The ponds have thus naturally been allowed to go to decay, the walls breaking down from the action of storms, and the sea filling them with sand if they are located on the immediate shore. This condition of affairs is especially prevalent on Molokai.

2. Two of the important crops of the islands are rice and taro. As both must be grown in a few inches of water, and are very profitable corps, a number of the interior ponds were turned into rice fields and taro patches. Oahu has shown the greatest changes in this respect.

3. On Hawaii ponds were filled up by the volcanic lava flows of 1801 and 1859. The Kamehameha fish pond, which was filled up in this manner in 1859, was said to have been the largest on the islands. Only traces of it are now to be found on the beach (at Kiholo, North Kona).

4. At Hilo, on Hawaii, some ponds, mostly quite small, are so filled with the water hyacinth that it is no longer possible to use them for fish. This year a few of the biggest of these were cleaned out, but as there is very little profit to be made from them, and their ownership is in dispute, there is but little desire to do much to build them up.

5. Other ponds have been filled up to make way for building operations and for other purposes. This is especially true of ponds in and around Honolulu and Lahaina. There use to be a number of fish ponds on Lanai, but they have all been allowed to fall into decay.

6. A number of ponds are kept up by their owners merely as private preserves, as it were, the fish taken from them being either consumed by the owner's household or given to friends. Such ponds are scattered all over the islands.

Cobb notes that as of 1900 there were 74 ponds in commercial production on Oahu ranging in size from 1 to 543 acres with a total water surface of 2,912 acres. On Molokai he states that were 51 ponds ranging in size from 0.5 to 54.4 acres and having a total of 963.5 acres. Kauai was noted as having just seven ponds but only one listed with acreage (19.5 acres), Maui had four ponds from 1 to 37 acres in size to a total of 50.9 acres and Hawaii had 11 ponds ranging from 0.1 to 50 acres in size and having a total of 108 acres of water surface. Cobb's (1905) list appears to be most complete for Oahu and he notes that many ponds were not seen by him which would account for the obvious small number for places such as the on the West Hawaii coast where there a number of ponds he failed to list (i.e., Kuuali'i and Kahapapa at Anaehoomalu, the fishponds at Maunalani Resort, etc.).

This author goes on to say that owners of ponds rarely have anything to do with the practical working of them, usually leasing them to Chinese. Most of the ponds on Oahu were controlled by two Chinese merchant firms in Honolulu, who worked in close harmony. These merchants took particular care that the Honolulu market was never overstocked with ama'ama and awa, and were thus able to command almost any price they pleased during certain seasons of the year when ama'ama were not to be had from elsewhere.

In 1900 the Oahu fish ponds employed 142 persons and the ponds themselves had an estimated value of $148,850. The total catch or yield that year from those ponds was 560,283 pounds with a value of $139,714.

10.2 Pearl Harbor Fish Ponds

Fish ponds operational in Pearl Harbor in 1900 are given in Table 3. In total there were 26 ponds having a total water surface area of almost 564 acres. Titcomb (1952) and Stokes (1909) both comment on the fact that Pearl Harbor (former name Pu'uloa) was famous for its fish and fishponds. In 1900 Cobb (1905) wrote that a number of the Pearl Harbor ponds had been partly filled and all but two were being used commercially. Today, the remnants of only four fishponds remain and all are in need of restoration. These ponds are Oki'okilepe at the mouth of West Loch, Laulaunui on Laulaunui Island in the middle of West Loch, Pouhala and Ka'auku'u at the mauka-east end of West Loch and Pa'aiau in East Loch along the west side of McGrew Point. Presently all remaining fishponds in Pearl Harbor are badly degraded having been overgrown by mangroves and other vegetation as well as having become filled with sediment, debris and alien fishes. Walls and makahas are in need of repair. Any restoration must consider a number of factors including safe access, land ownership as well as sources of funds to carry out these activities.

Oki'okilepe Pond is within the Naval Magazine (NAVMAG) Lualualei explosives safety quantity distance (ESQD) arc and thus is not situated in a location with safe access for the general public if they were to be involved with restoration activities. Pouhala and Ka'auku'u fishponds were formerly adjacent to one another but are considered here as a single unit on lands owned by the State and leased to the City and County of Honolulu. These ponds were almost completely filled earlier in the century and are covered with mangroves. Through restoration, a part of Pouhala has become a wetland and sanctuary for waterbirds. There are plans for its expansion.

Inspection of Oki'okilepe Fishpond found the walls facing the West Loch channel to be nearly intact but overgrown with mangrove as well as some displacement of the coral rock. On the eastern side of the pond, the wall (or makaha) has collapsed and is open to the Pearl Harbor channel. Much of the interior of the pond appears to have been filled and/or is silted in and mangroves cover much of what was probably the pond in the past. The remains of what appears to be an small barge or floating dock have sunk and settled along the seaward side of the fishpond's wall along the West Loch channel. At some point, consideration should be given to its removal. Evidently Oki'okilepe fishpond is within the ESQD arc thus access by the public would probably be restricted.

Laulaunui fishpond is in the middle of West Loch on Laulaunui Island. A short inspection of this fishpond found it to be surrounded by encroaching mangroves. Like the other, this pond appears to be filling in with sedimentary materials. Public access would be restricted to this pond due to it being situated within the ESQD arc.

Pa'aiau fishpond is situated along the western side of McGrew Point in East Loch. In 1900 this pond was 2.3 acres in size (Cobb 1905). Recent investigations show that it is roughly

rectangular being about 100 x 200 feet in dimensions or about 0.46 acre today. The outer wall is badly overgrown by mangroves and the pond is heavily silted in. However, this pond is situated just below naval housing and could be accessible through the housing area. Recent restoration plans by the Hawaii State Department of Agriculture and community groups have focused on Pa'aiau Fishpond over the other remaining Pearl Harbor fishponds because of its relative accessibility to the public.

Restoration of any fishpond in Pearl Harbor would necessarily include the removal of mangroves and other encroaching vegetation as well as removal of sediment, restoration of fishpond walls and any makahas that may be present. Alien fishes (especially tilapia - Tilapia melanotheron) are very common in all of the fishponds visited in this survey (Pa'aiau, Laulaunui and Oki'okilepe). Since these alien fishes are well established, they cannot be eliminated but any management of the restored fishpond will have to take into account controlling their numbers.

The goal of the restoration plan for Pa'aiau Fishpond is to develop a demonstration educational project that is operated by the community. Specifically, the project would "...establish a self-sustaining, cooperative, community-based program to restore, maintain and operate Pa'aiau Fishpond, Pearl Harbor, and conduct research, education and community outreach activities focusing on Hawaiian history, traditional knowledge and cultural practices for the benefit of the leeward community." It should be recognized that the goal of any fishpond restoration/demonstration/educational program undertaken in Pearl Harbor should not consider the consumptive uses of any fishes raised in the pond because of the possibility of environmental contaminants in the flesh of those fishes (see the fishery resource section). However, despite the constraint on consumption, the demonstration of Hawaiian fishpond aquaculture should be promoted because the fishes grown in the fishpond could be released back into the wild to supplement wild stock. These individual fishes cannot be consumed but their release into the wild will improve the local abundance of spawning fishes. This effort ultimately serves to enhance the resource base not only in Pearl Harbor but to the adjoining waters offshore of Honolulu and Ewa.

10.3 Productivity of Hawaiian Fishponds

There are numerous accounts from the old oral traditions of Hawaiian fishponds in ancient times providing bountiful supplies of fish. Most fishponds were owned and controlled by the ali'i or ruling class. The konohiki or steward would oversee the operation of the fishpond and he was assisted by commoners in the day-to-day operations, but the products of these fishponds usually belonged to the ali'i. The ali'i would travel from place to place in the lands under their control and the products of the fishponds situated in those lands were used to feed the chiefs and mobile court while residing in the vicinity of those fishponds. This strategy reduced the burden of the commoners having to relinquish their food resources when the ali'i were in the neighborhood (Kikuchi 1976). The development of fishponds were probably fostered by the ali'i to expand their socioeconomic power and food base (Wyban 1992). Under the old Hawaiian management system, both the wild fishery resources as well as those grown in fishponds were never wasted and only what was needed was taken.

The strategy practiced in the old Hawaiian fishpond systems was one of stocking of fingerlings and allowing them to grow utilizing the natural food resources in the fishpond. Thus there was no intensive cultivation using supplemental feeds as is the case today in most aquaculture systems. However, in some cases there was limited supplemental feeding in the form of placement of stones with attached algae into the fishponds (Titcomb 1952). Hawaiian fishponds were designed and situated to take advantage of any natural fresh and brackish water inputs present in the area. Hawaiian coastal groundwater is often high in essential inorganic nutrients (nitrate nitrogen and orthophosphorus) which fuel plant growth and on the mauka (inland) portions of many fishponds are such natural springs. Despite these inputs the fishponds were subject to the same constraints as any other natural system insofar as productivity is concerned. These constraints include the availability of food, the presence of an appropriate chemical and physical regime for fish growth (i.e., oxygen, etc.) and sufficient appropriate space for the organisms to live. In heavily managed systems manipulation of these parameters (such as artificial feeds and aeration) serves to increase the production or yield over natural systems.

The perception that Hawaiian fishponds were highly productive by modern standards is probably not supported by the facts. The old management strategies of capturing and releasing fry into these ponds for growout coupled with insuring the flow and flushing of water through the system along with the removal of unwanted predators would enhance yields. However, constraints on food availability, predators, disease, water quality and space would limit the productivity of the system. If harvesting a fishpond occurred only when the ali'i were present, these harvests may have occurred infrequently and could easily explain the apparent high abundances that are often noted in old accounts of these fishponds. Thus besides being a growout system, these ponds served as a reservoir of fish for use at specific times when needed. Modern aquaculture using additional nutritional inputs, genetic manipulation of stock for high growth characteristics coupled with enhanced circulation to oxygenate the water and improve water quality all serve to increase yields well above the old system. Yields in southeast Asian fishponds that are managed with modern strategies attain yields of 4,450 kg/ha (Kikuchi 1976).

There are very few hard data regarding the productivity of Hawaiian fishponds. The data in Cobb (1905) may provide some insight into yields. Using the information for Oahu only, there were 64 fishponds in commercial production in 1900 with a combined surface area of 2,912 acres (or 1,178 hectares) with a total harvest of 560,283 pounds (or 254,674 kg) (Cobb 1905). Simple division results in an estimated yield of 216 kg/ha/yr (192

lbs/acre/year) or 0.6 kg/ha/day (0.5 lb/acre/day). This estimate would be low for as noted above, the supply to the market was controlled by business people during those times of the year when mullet and milkfish (the major species grown) were not available elsewhere to maximize the price.

Using Cobb's (1905) data for the commercial operations on other islands the annual yields range from a low of 34 kg/ha/yr on Hawaii Island (7 ponds), to Molokai (18 ponds) having a yield of 328 kg/ha/yr to Kauai with yielding 12,913 kg. No estimate of annual yield per unit area can be made from the Kauai data because Cobb (1905) lists only one pond with acreage and six others without. These yields are from fishponds that were cared for using the old methods, thus they did not receive the benefit of modern aquaculture technology.

How do the 1900's estimates of yield from Hawaiian fishponds (above) compare with recent yield estimates from coral reef areas? Yields from coral reefs have been summarized by Marshall (1980) and Marten and Polovina (1982). Available evidence suggests that harvests of fish of 40 to 60 kg/ha/yr are attainable from coralline shelves (Munro 1977, 1983, Carpenter 1977, Murdy and Ferraris 1980). Coralline shelves are defined as extending from shore to the 200 m isobath and encompass a diverse array of habitats including seagrass beds, sand flats, as well as sublittoral and emergent reefs. The fishes captured in these fisheries are comprised of neritic (coastal) species. More recent evidence from fisheries based on reef flats and areas of heavy coral growth have shown harvests of reef fish and invertebrates in excess of those above. Hill (1978) and Wass (1982), respectively, estimated average yields of fish of 80 kg/ha/yr and 180 kg/ha/yr for the shoreline fishery of American Samoa. In the central Philippines, Alcala (1981) and Alcala and Luchavez (1981) have estimated harvests of 80 to 147 (mean = 114) kg/ha/yr at Apo Island and a range of 97 to 237 (mean = 165) kg/ha/yr over a five year period at Sumilon Island. These data suggest that many Hawaiian fishponds were more productive than many tropical coastal fisheries on a sustainable basis. It should be remembered that Hawaiian fishponds were probably operated with little additional food inputs and the species in them (particularly ama'ama and awa) are well suited to culture.

10.4 Fishpond Restoration

Apple and Kikuchi (1975) in their exhaustive review of Hawaiian fishponds attempted to identify surviving Hawaiian fishponds and remnants worthy of preservation as part of the cultural heritage of the State of Hawaii. In total they noted 157 fishponds and/or remnants and 101 of these were eliminated from further consideration because they did not possess sufficient integrity to merit preservation. Thus 56 ponds were considered in greater detail for possible nomination to the National Register of Historic Places. These fishponds were evaluated on a number of criteria, then given a numerical ranking and presented in the order of their rankings with the highest first. These authors did note that any pond receiving a ranking greater than 1.05 was believed to be restorable and could be placed back as working fishponds, Hawaiian style, but this analysis did not consider the cost to do so. The four extant fishponds in Pearl Harbor were among those on the list of 56 ponds considered in greater detail. Ka'auku'u fishpond in West Loch was placed at number 45 on the list, Laulaunui fishpond in West Loch was number 47, Oki'okilepe fishpond at the entrance of West Loch was number 48 and Pa'aiau fishpond in East Loch was number 49. None of these fishponds were given a numerical score above 1.00 thus were not considered to be restorable.

As mentioned above, if restoration of Pa'aiau fishpond is undertaken, it must be done so with the recognition that the fishery products of the pond cannot be consumed at the present time under the current Department of Health and Navy regulations due to possible contamination of fishes and invertebrates due to pollution in the harbor (see fishery section). If this is understood, then the products of the fishpond could be utilized for purposes of increasing the populations of these valuable species in the Pearl Harbor ecosystem through their release into the harbor. These adult fishes would contribute to the spawning biomass of the harbor. Over the long term, the release of the production of the fishpond will reproduce and the progeny contribute to the enhancement of these species along the south shore of Oahu (see below). Besides the enhancement effects, the restoration and operation of the fishpond will serve as a demonstration of Hawaiian aquacultural technology. The bringing together of diverse elements of the civilian community and the pride derived by restoring and operating an ancient fishpond are beyond any measure. The cooperation of the U.S. Navy in bringing such a project to fruition should have a positive impact in the eyes of the civilian community. Perhaps with time and further testing of sediments from the restored fishpond, the yield of Pa'aiau fishpond may eventually be found acceptable for human consumption. Finally, there needs to be recognition that the Navy's tenure at Pearl Harbor has allowed Pa'aiau fishpond to remain to this day. There are few extant fishponds today on private lands of Oahu due to development. Pa'aiau fishpond represents an opportunity from both an ecological and a human perspective. Its restoration and operation should be pursued.

This same argument could be invoked for the restoration and operation of any of the other remaining fishponds at Pearl Harbor. Perhaps if the restoration of Pa'aiau fishpond is successful and the community demonstrates the positive aspects above, there may be future opportunity for Oki'okilepe or Laulaunui fishponds to become candidates for restoration.

The positive benefits derived from the growth and release of fish from Pa'aiau fishpond are given below. An average adult mullet is approximately 26 cm (10 inch) in standard length and has an average wet weight of 222 g (~0.5 lb). If the annual production of mullet from a restored one hectare area Pa'aiau fishpond was approximately 300 kg, this pond would

annually produce about 1,350 adult fish for release into the waters of Pearl Harbor. This number is assuming that the traditional approach to management is followed where the pond is stocked with fry and these are allowed to grow without additional nutritional inputs (feeding). If released back into the wild, these fish will increase the abundance of adults, all of which could participate in spawning thus assisting in the rebuilding of Oahu's mullet stocks. The restoration and operation of Pa'aiau or any other fishpond in Pearl Harbor will not only enhance mullet stocks, but all of the other species that inhabit Hawaiian fishponds including awa or milkfish (Chanos chanos), aholehole or flagtail (Kuhlia sandvicensis), la'i or leatherback (Scrombroides laysan), papio (various species family Carangidae), ta'ou or snapper (Lutjanus fulvus), pualo or yellowfin surgeonfish (Acanthurus xanthopterus), palani or eye-stripe surgeonfish (Acanthurus dussumieri), kaku or barracuda (Spyraena barracuda), o'opu or goby (Oxyurichthys lonchotus), o`opu or goby (Awaous genivittatus), o'opu nakea or goby (Awaous stamineus), moi or threadfin (Polydactylus sexfilis), puhi laumilo or moray eel (Gymnothorax undulatus), opae or glass shrimp (Palaemon debilis), opae'oeha'a or native prawn (Macrobrachium grandimanus), Tahitian prawn (Macrobrachium lar), swimming crab (Thalamita integra), Samoan crab (Scylla serrata), Hawaiian crab (Podophthalmus vigil), and haole crab (Portunus sanguinolentus).

11.0 RECOMMENDED MANAGEMENT MEASURES

11.1 General

1. Continue the Navy policy of pollution reduction for Pearl Harbor including the identification of sources of pollutants in the harbor and their reduction/elimination.

2. Continue federal policies and guidelines regarding the discharge of ship's ballast water (Resolution A.774(18) adopted 3 November 1993) as well as other appropriate measures to reduce the opportunities for unwanted alien species introductions into Pearl Harbor.

3. If funds are available and environmental quality of the harbor's waters appropriate, work towards the re-establishment of pearl oysters in Pearl Harbor.

11.2 Pearl Harbor Biological Resources

1. Enact the draft regulations regarding recreational use of Pearl Harbor waters (COMNAVREGPEARLINST 5510.21C) but modifying to include fishing by annually-issued permit only. Also modify to include funds and personnel to patrol fishing and other areas of Pearl Harbor to insure that regulations regarding catch-and-release, use of appropriate gears and fishing only in designated fishing areas are adhered to. Provide for penalties including confiscation of all fishing gear as well as civil penalties.

Rationale: Enactment of the above policy will reduce consumption of possibly contaminated fish and shellfish, use of illegal fishing gear and fishing in restricted areas. Education of the current rules and regulations will be possible at the time the permit issuance. Patrols and penalties will reduce illegal activities as well as exposure to possible pollutants in tainted fish and shellfish.

This policy will reduce present fishing mortality thereby increasing the protection afforded to the biological resources in the harbor.

2. Establish Pearl Harbor as a national historic preserve which would include the historic and biological resources in the harbor.

   Rationale: Federal protection is existing on the historic battleships and sites associated with WWII. Increasing the preserve status to include all of the waters of the harbor under federal jurisdiction will afford protection to all of the as yet to be identified historic resources as well as the unique biological resources in Pearl Harbor.

3. With community involvement, develop a program to restore fishpond resources under the Navy's jurisdiction in Pearl Harbor. This program should focus on the restoration of Pa'aiau Fishpond at McGrew Point and secondly on the removal of mangroves from Laulaunui and Oki'okilepe Fishponds to retard the senescence of these historic structures.

   Rationale: Fostering the restoration of Pa'aiau Fishpond will assist the community in attaining its goal of a demonstration fishpond project. However, this must be done with the knowledge that fishery products cannot be consumed but must be released back into the wild to avoid the problem of consumption of pollutant-tainted fish and shellfish.

11.3 Recommended Projects for Future Enhancement of INRMP

One aspect of the INRMP document is to prepare a set of prospective projects that could be implemented to enhance the level of understanding of the natural system under consideration. Such enhanced understanding would be a key element in the continued improvement of management of the resource. Presented below are a suite of projects that together represent an integrated monitoring program that would address these goals for the Pearl Harbor estuarine system. In developing this prospective program a major point that is stressed is that the monitoring is to be repetitive, so that sequentially collected data can distinguish gradual changes over time. Secondly, all of the facets of the program are interlinked with each other. Such an "integrated" approach is mandatory if the program is to serve the intended function of linking cause and effect within the system under study.

11.3.1 Water Quality Monitoring Program

A basic tenet of ecosystem monitoring is the identification of definitive cause-and-effect scenarios. With respect to natural marine resources of Pearl Harbor, it has been established that prior usage of the Harbor, as well as of the surrounding watershed had resulted in degradation of water quality to the point of adversely affecting biotic distributions, particularly of species of commercial and recreation importance. Recent work, however, including the report prepared for the INRMP indicate that this trend may be reversing. Improved land use practices and regulation may be resulting in lessening of impact to the estuary through impaired water quality. In order to establish if this trend is real, and if it is continuing, we propose to initiate a long-term repetitive water quality monitoring program. This program would essentially replicate the protocol that was developed in the INRMP. Series of transects would be established as permanent stations through the major lochs of the Harbor from the mauka regions where streams drain to the open ocean. Sampling of water quality parameters (dissolved nutrients, turbidity, suspended solids, chlorophyll a, and salinity) would provide an indication of condition of the harbor waters. Repeated at least twice annually (dry and wet seasons) over multiple years would provide a time-course data set that would show both seasonal and long-term changes that could be valuable in establishing management goals. To date, no such repetitive time-course program has been conducted in Pearl Harbor.

Estimated Cost: $25,000 per year.

11.3.2. Biotic Resource Assessment

At the present time, much work has been conducted in Pearl Harbor to identify existing biota (particularly with respect to occurrence of alien species). While the biological composition of the Harbor appears to be improving, there does not appear to be a systematic ongoing program to evaluate changes to important biotic resources. We propose to develop such a program by establishing permanent monitoring sites in each of the major lochs to evaluate the condition and status of biotic resources (primarily fish and macrobenthos). While the exact number of sites has not been established, the selection process would include representative areas from each of the major biotopes (ecological zones). Emphasis in the monitoring program would focus on species that serve as indicators of environmental health that appear to be making a comeback in the Harbor (e.g., corals, oysters), as well as alien species. The key component to the program would be the ability to establish to the direction of trends in biotic composition, that could relate to future management decisions. One potentially valuable site for the program would be on the reef flat in the vicinity of the existing Fort Kamehameha Sewage Discharge, which is scheduled to be replaced by a deep ocean outfall in the near future. Establishment of the biotic monitoring station(s) in this area would provide important information on the effects of relaxation of sewage input in the area.

Cost: $20,000 per year.

11.3.3. Bioaccumulation Monitoring

At present, State of Hawaii Regulatory Agencies (DOH) have established that levels of contamination in fish from Pearl Harbor are sufficient to restrict human intake. Such a regulatory act clearly has a major impact on the use of marine resources in the Harbor. We propose to institute an ongoing assessment of the bioaccumulation of toxic materials in representative organisms collected in the Harbor. An important outcome of this program would be to potentially lift the present restrictions if it can be shown that conditions have changed to the point where critical levels of contaminants are no longer present. Constituents that would be monitored would consist of these found in previous work to be of concern. Sample organisms would consist of species that are of commercial and recreational importance (e.g., fish, crabs, oysters). The selection of such species that are consumed is important as the levels of bioaccumulation may differ substantially between such organisms and others that are not consumables. While the details of sampling protocols are beyond the scope of this document, an important criteria that would go into development of the methodological approach to the program would be to design a statistically rigorous protocol that could stand scientific scrutiny for validity.

Cost: $25,000 per year.

11.3.4 Multispectral Remote Sensing Imaging of the Estuary

Recent developments in Remote Sensing Technology has led to relatively cost-effective methods to determine large-scale environmental changes. One method involves overflight imaging of large areas using multispectral methods. The unique importance of this imaging is the ability to penetrate shallow water for discrimination of various marine biotypes (coral, algae, sand). Such imaging of Pearl Harbor would provide a data base for distinguishing quantitatively the composition of the marine and nearshore environments, and provide the baseline for determining long-term changes in the quantity and quality of habitats. For instance, this method would provide a good estimate of the coverage of introduced species such as marine algae, and provide a permanent record of the sequential changes in this coverage over time.

Cost: $30,000 per year.

12.0 LITERATURE CITED

Alcala, A.C. 1981. Fish yields of coral reefs of Sumilon Island, Central Philippines. Nat.Res.Counc. Philipp. Res. Bull. 36:1-7.

Alcala, A.C. and T. Luchavez. 1981. Fish yield of the coral reef surrounding Apo Island, Negros Occidental, Central Visayas, Philippines. Proc. 4th Int. Coral Reef Symp. 1:69-73.

Allen, L.J. (editor). 1984. Urban fishing syposium proceedings. American Fisheries Society, Bethesda, Maryland. x+297p.

Anon. 1902. Pearl Harbor. Paradise of the Pacific 15:36-37.

Anon. February 1998. Pearl Harbor sediment remedial investigation/feasibility study, Pearl Harbor, Hawaii. Fact Sheet No. 2. Department of the Navy.

Anon. August 25, 1998. Pearl Harbor sediment study/fish advisory fact sheet. August 25, 1998.

Anon. August 26, 1998. Navy environmental programs fact sheet, August 26, 1998.

Anon. 1999. University of Puerto Rico VIMAS helping to restore Sugar Bay mangrove forest. Communicator Winter 1999, Published by the National Sea Grant College Program, 7(3):2.

Apple, R.A. and W.K. Kikuchi. 1975. Ancient Hawaii shore zone fishponds: an evaluation for historical preservation. Prepared for the Office of the State Director, National Park Service, U.S. Department of the Interior, 677 Ala Moana Blvd., Suite 512, Honolulu, Hawaii, 96813. Honolulu. 157p.

B-K Dynamics, Inc. 1972. Marine environmental impact analysis, Waiau Power Plant. B-K Dynamics, Inc. For Hawaiian Electric Company, Inc. (cited in McCain 1977).

Bailey-Brock, J.H. 1987. Phylum Annelida. Pp.213-461, In:Devaney, D.M. and L.G. Eldredge (eds.). Reef and shore fauna of Hawaii. B.P. Bishop Museum Spec. Publ. 64(2 and 3). Honolulu.

Bailey-Brock, J.H. and A. Ringwood. 1982. Methods for control of the mud-blister worm, Polydora websteri, in Hawaiian oyster culture. Univ. Hawaii Sea Grant Quarterly 4(3):1-6.

Baldwin, W.J. 1984. A note on the occurrence of the gold-spot herring, Herklotsichthys quadrimaculatus (Ruppell) in Hawaii. Pacif. Sci. 38:123-126.

Birkeland, C. 1984. Influence of topography of nearby land masses in combination with local water movement patterns on the nature of nearshore marine communities. Unesco/IOC session on marine science, XVth Pacific Science Congress, Dunedin, New Zealand. Pp.16-31.

Boggs, C.H. 1988. Forecasting skipjack tuna availability in Hawaii. Southwest Fish. Cent., NMFS, La Jolla, Ca., Tuna Newsletter 91:5-7.

Boggs, C.H. and S.G. Pooley. 1987. Forces of change in Hawaii's aku (skipjack tuna) industry, 1986 workshop summary. U.S. Dep. Commer., NOAA Tech. Memo. NMFS-SWFC-72, 70p.

Boggs, C.H. and B.S. Kikkawa. 1993. The development and decline of Hawaii's skipjack tuna fishery. Mar. Fish. Rev. 55:61-68.

Brock, R.E. 1994. An analysis of benthic communities in the zone of mixing for the Waiau electrical generation facility: year 1 report - 1993. Prepared for Environmental Department, Hawaiian Electric Co., Inc., P.O. Box 2750, Honolulu, Hawaii 96840. EAC Rept No. 94-02. 32p.

Brock, R.E. 1995. An analysis of benthic communities in the zone of mixing for the Waiau electrical generation facility: year 7 report - 1999. Prepared for Environmental Department, Hawaiian Electric Co., Inc., P.O. Box 2750, Honolulu, Hawaii 96840. EAC Rept No. 95-02. 34p.

Brock, R.E. 1999. An analysis of benthic communities in the zone of mixing for the Waiau electrical generation facility: year 7 report - 1999. Prepared for Environmental Department, Hawaiian Electric Co., Inc., P.O. Box 2750, Honolulu, Hawaii 96840. EAC Rept No. 99-09. 38p.

Brock, R.E. and J.E. Norris. 1989. An analysis of the efficacy of four artificial reef designs in tropical waters. Bull. Mar. Sci. 44:934-941.

Brock, R.E., J.H. Bailey-Brock and J. Goody. 1999. A case study of efficacy of freshwater immersion in controlling introduction of alien marine fouling communities: the USS Missouri. Pacif. Sci. 53:223-231.

Brock, V.E. 1960. The introduction of aquatic animals into Hawaiian waters. Int. Revue ges. Hydrobiol. 45:463-480.

Bryan, W.A. 1915. Natural history of Hawaii. The Hawaiian Gazette Co., Ltd., Honolulu. 596p.

Carlton, J.T. 1996. Biological invasions and cryptogenic species. Ecology 77:1653-1655.

Carpenter, K.E. 1977. Philippine coral reef fisheries resources. Philipp. J. Fish. 17:95-125.

Cobb, J.N. 1905. The commercial fisheries. Section III. The aquatic resources of the Hawaiian Islands. Bull. U.S. Fish Commission for 1903. Part II, pages 715-765, plates 102-106. Washington, U.S. Government Printing Office.

Coles, S.L., R.C. DeFelice, L.G. Eldredge, J.T. Carlton, R.L. Pyle and A. Suzumoto. 1997. Biodiversity of marine communities in Pearl Harbor, Oahu, Hawaii with observations on introduced exotic species. Final report prepared for the U.S. Navy. B.P. Bishop Museum Hawai`i Biological Survey, B.P. Bishop Museum Technical Report No. 10, Honolulu, Hawaii. vii+76p+appendices.

Cox, D.C. and L.C. Gordon. 1970. Estuarine pollution in the State of Hawaii. Vol. 1, Statewide study. Water Resources Research Center Tech. Rept. No. 31. University of Hawaii, Honolulu.

Dall, W.H., P. Bartsch and H.A. Rehder. 1938. A manual of recent and fossil marine pelecypod molluscs of the Hawaiian Islands. Bishop Museum Bull. 153:1-233.

Doty, M.S. 1961. Acanthophora, a possible invader of the marine flora of Hawaii. Pacif. Sci. 15:547-552.

Evans, E.C. III (editor). 1974. Pearl Harbor biological survey final report. Hawaii Laboratory, Naval Undersea Center, San Diego, California. Rept. No. NUC TN 1128, var. pagination.

Grant, B. 1999. On the waterfront: urban anglers enrich local culture, face environment, and health problems. Urban Ecology 1999(3):10-12.

Grovhoug, J.G. 1992. Evaluation of sediment contamination in Pearl Harbor. Tech. Rept 1502. Naval Command, Control and Ocean Surveillance Center, San Diego

Handy, E.S.C. and E.G. Handy. 1972. Native planters in old Hawaii. Their life, lore and environment. B.P. Bishop Museum Bull. 233:260-473.

Hill, R.B. 1978. The use of nearshore marine life as a food resource by American Samoans. Pacific Island Studies Program, Univ. Hawaii, Honolulu. 170p.

Ka Nupepa Kuokoa. 1923. Saving the fish. Translated excerpts from Hawaiian newspapers by Mary Pukui. Dated 8 March 1923.

Kikuchi, W.K. 1976. Prehistoric Hawaiian fishponds. Science 193:295-299.

Leis, J.M. and J.M. Miller. 1976. Offshore distributional patterns of Hawaiian fish larvae. Mar. Biol. 36:359-367.
Lenzini, P.A. 1984. Urban fishing: liability and legal considerations. Pp. 81-91. In: Allen, L.J. (ed.). Urban fishing symposium proceedings. American Fisheries Society, Bethesda, Maryland.

Maciolek, J.A. 1984. Exotic fishes in Hawaii and other islands of Oceania. Pp. 131-161. In: Courtney, W.R. and J.R. Stauffer, Jr. (eds.). Distribution, biology and management of exotic fishes. Johns Hopkins Univ. Press, Baltimore.

Mackenthun, K.M. 1984. Water quality and contaminant considerations. Pp. 48-54. In: Allen, L.J. (ed.). Urban fishing symposium proceedings. American Fisheries Society, Bethesda, Maryland.

Manfredo, M.J., C.C. Harris and P.J. Brown. 1984. The social values of an urban recreational fishing experience. Pp. 156-164. In: Allen, L.J. (ed.). Urban fishing symposium proceedings. American Fisheries Society, Bethesda, Maryland.

Marolf, J. 1984. Educational considerations for urban youth, the elderly, and the handicapped. Pp. 169-173. In: Allen, L.J. (ed.). Urban fishing symposium proceedings. American Fisheries Society, Bethesda, Maryland.

Marshall, N. 1980. Fishery yield of coral reefs and adjacent shallow-water environments, p. 103-109. In: S.B. Saila and P.M. Roedel, (eds.) Stock assessment for tropical small-scale fisheries. Int. Cent. Mar. Res. Dev. University of Rhode Island, Kingston.

Marten, G.G. and J.J. Polovina. 1982. A comparative study of fish yields from various tropical ecosystems. P. 255-289. In:D. Pauly and G.I. Murphy (eds.) Theory and management of tropical fisheries. ICLARM Conference Proceedings 9, 360p.

McCain, J.C. 1977. A benthic survey in the vicinity of the Waiau generating station. Environmental Department, Hawaiian Electric Co., Rept No. NV-99, 24p. (Internal report).

Munro, J.L. 1977. Actual and potential fish production from the coralline shelves of the Caribbean Sea. FAO Fish. Rep. 200:301-321.

Munro, J.L. 1983. Assessment of the potential productivity of Jamaican fisheries. P.232-248 In: J.L. Munro (ed.) Caribbean coral reef fishery resources. A second edition of the biology, ecology, exploitation and management of Caribbean reef fishes: Scientific reports of the ODA/UWI fisheries ecology research project 1969-1973: University of the West Indies, Jamaica. ICLARM, Manila, Philippines.

Murdy, E.O. and C.J. Ferraris. 1980. The contribution of coral reef fisheries to Philippine fisheries production. ICLARM Newsletter 3(1):21-22.

Pauley, Marin, Don Francisco de. 1937. The Marin journal (edited by Maude Jones), entry of July 31, 1814. Paradise of the Pacific, 49(9):2.

Peeling, T.J., J.G. Grovhoug and E.C. Evans, III. 1972. Pearl Harbor biological survey - summary report for the first survey cycle. Naval Undersea Center, Tech. Note 801, iii+218p.

Randall, J.E. 1987. Introductions of marine fishes to the Hawaiian Islands. Bull. Mar. Sci. 41:490-502.

Rathbun, M.J. 1906. The Brachy;ura and Macrura of the Hawaiian Islands. Bull. U.S. Fish Commission 1903:827-930.

Sakuda, H.M. 1964. Experimental purification of easter oyster (Crassostrea virginica) in Hawaii. Division of Aquatic Resources, Department of Land and Natural Resources, Honolulu.

Sakuda, H.M. 1966. Condition of the American oyster, Crassostrea virginica, in West Loch, Pearl Harbor, Hawaii. Trans. Amer. Fish. Soc. 95:426-429.

Shomura, R.S. and H.M. Sakuda. 1983. A summary of the 1983 tuna baitfish workshop. NMFS, Honolulu Laboratory, SWFC Adm. Rept H-83-9. 11p.

Somerton, D.A., D.R. Kobayashi and K.C. Landgraf. 1993. Stock assessment of nehu Encrasicholina purpurea, using the egg production method. Bull. Mar. Sci. 53:768-777.

Stokes, J.F.G. 1909. Walled fish traps in Pearl Harbour. B.P. Bishop Museum Occ. Paps. 4(3):23-36.

Sparks, A.K. 1963. Survey of the oyster potential of Hawaii. Division of Fish and Game, Department of Land and Natural Resources, State of Hawaii. May, 1963. 44p.

Surface, S. W., Moncreif, R. M. and E. F. C. Lau. 1975. Determination of a zone of mixing for the Fort Kamehameha Sewage Treatment Plant Discharge. Prepared by: Environmental Branch, Pacific Division, Naval Facilities Engineering Command.

Tester, A.L. and E.L. Nakamura. 1957. Catch rate, size, sex, and food of tunas and other pelagic fishes taken by trolling off Oahu, Hawaii, 1951-55. U.S. Dep. Interior, U.S. Fish and Wildl. Serv. Spec. Sci. Rept. Fish. No. 250. Washington, D.C. 25p.

Titcomb, M. 1952. Native use of fish in Hawaii. Supplement to the Jour. Polynesian Sco. Mem. 29. New Plymouth, New Zealand. 162p.

Wyban, C.A. 1992. Tide and current: fishponds of Hawai`i. University of Hawaii Press, Honolulu. xvi+192p.

Uchida, R.N. 1977. The fishery for nehu, Stolephorus purpureus, a live bait used for skipjack tuna, Katsuwonus pelamis, fishing in Hawaii. NOAA Tech. Tept. NMFS Circular 408:57-62.

Yap, W.G. 1977. Population biology of the Japanese little-neck clam, Tapes philippinarum, in Kaneohe Bay, Oahu, Hawaiian Islands. Pacif. Sci. 31:223-244.

Yoshida, H.O., R.N. Uchida and T. Otsu. 1977. The Pacific tuna pole-and-line and live-bait fisheries. NOAA Tech. Rept. NMFS Circular 408:36-51.

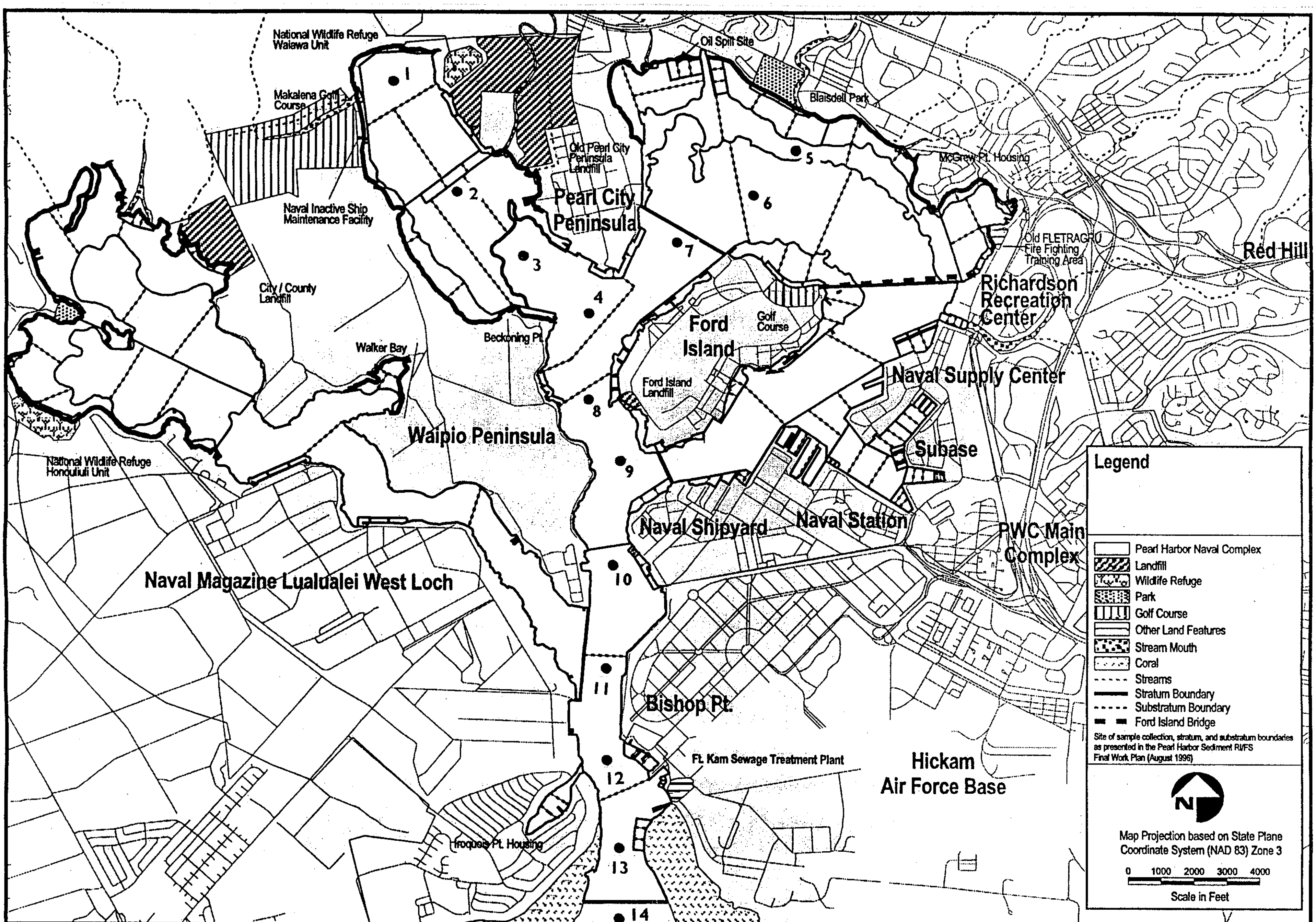


Figure 1. Map of Pearl Harbor estuary showing locations of water chemistry sampling stations.

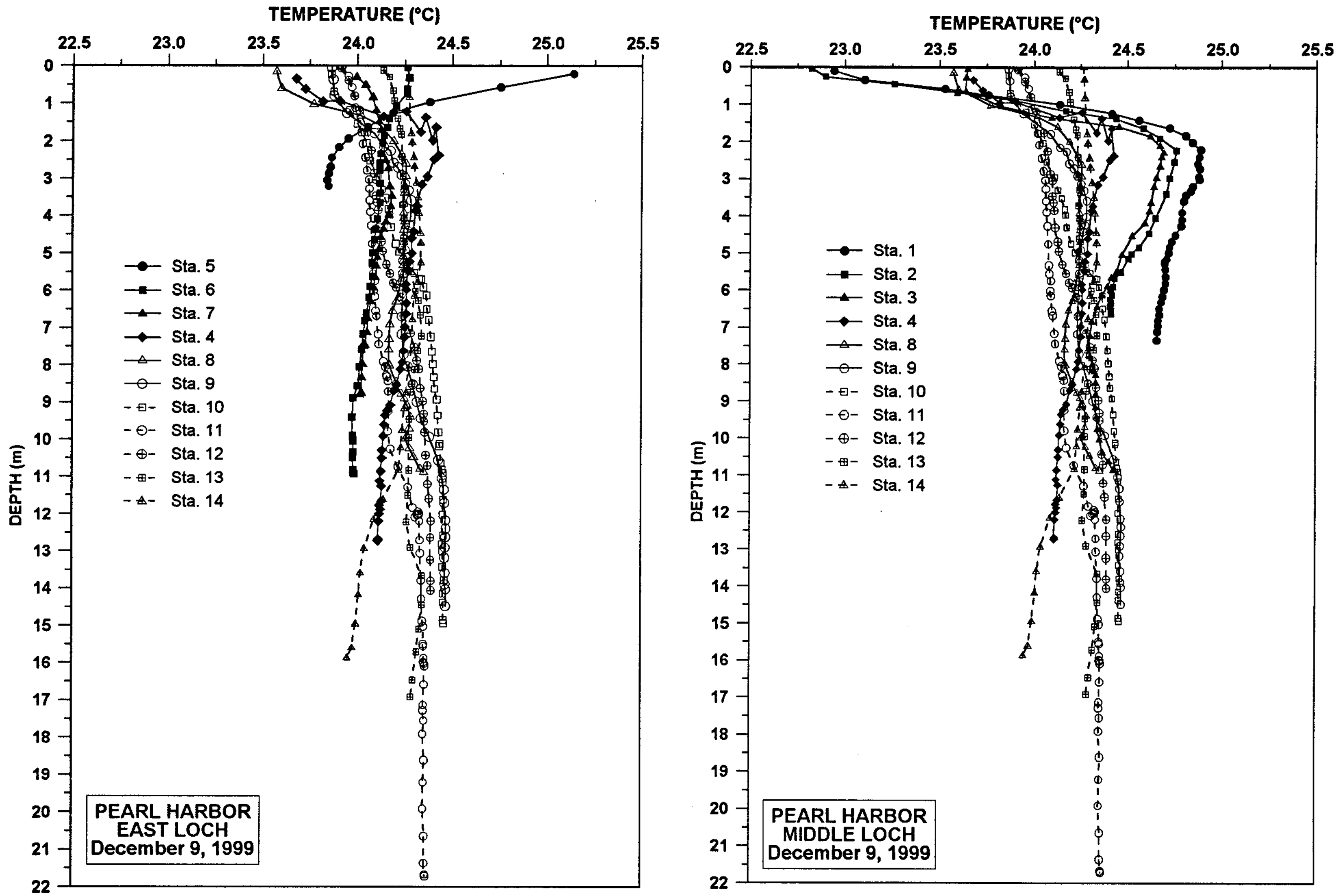


FIGURE 2. Vertical profiles of temperature along the axes of East Loch and Middle Loch of Pearl Harbor. See Figure 1 for locations of sampling stations.

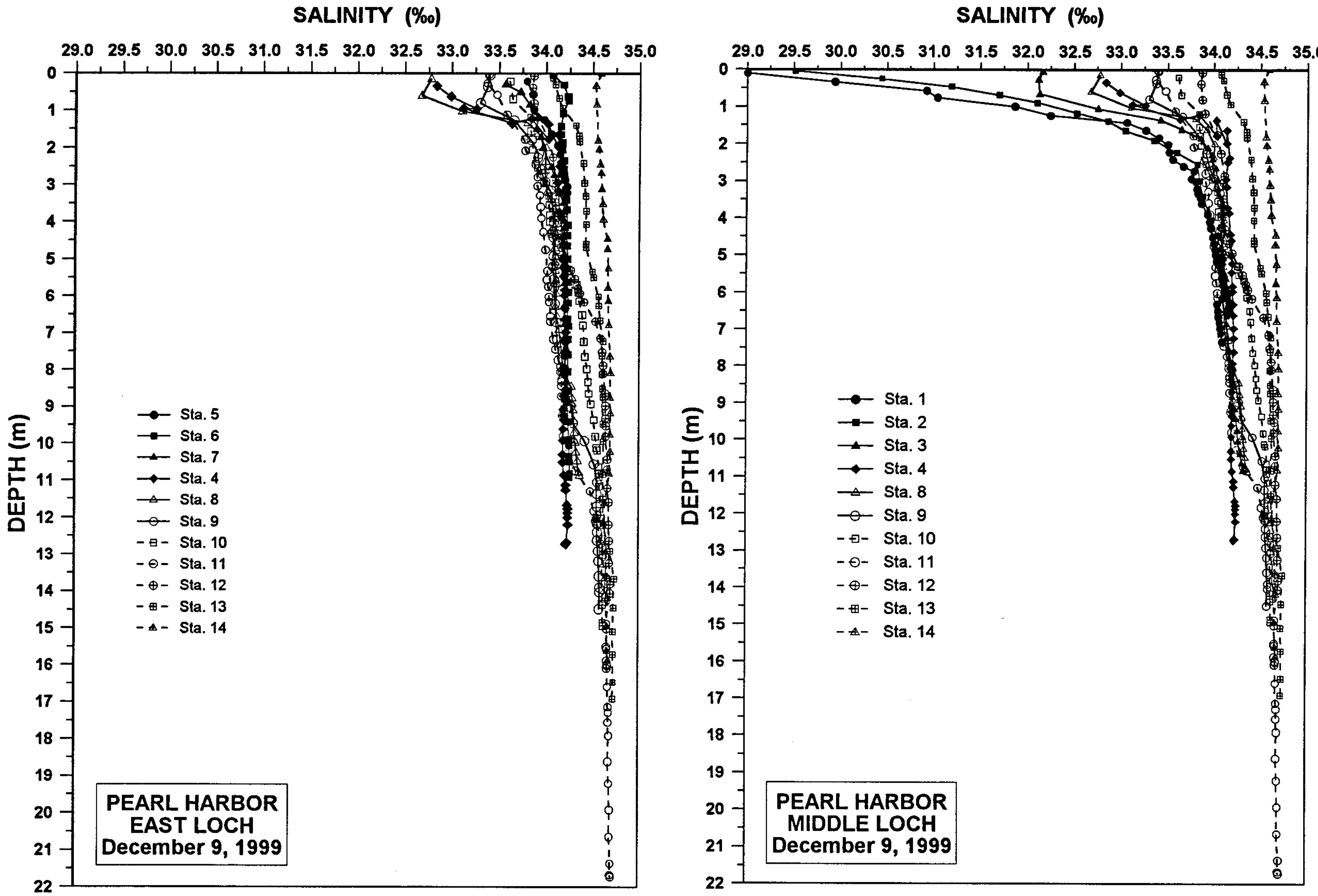


FIGURE 3. Vertical profiles of salinity along the axes of East Loch and Middle Loch of Pearl Harbor. See Figure 1 for locations of sampling stations.

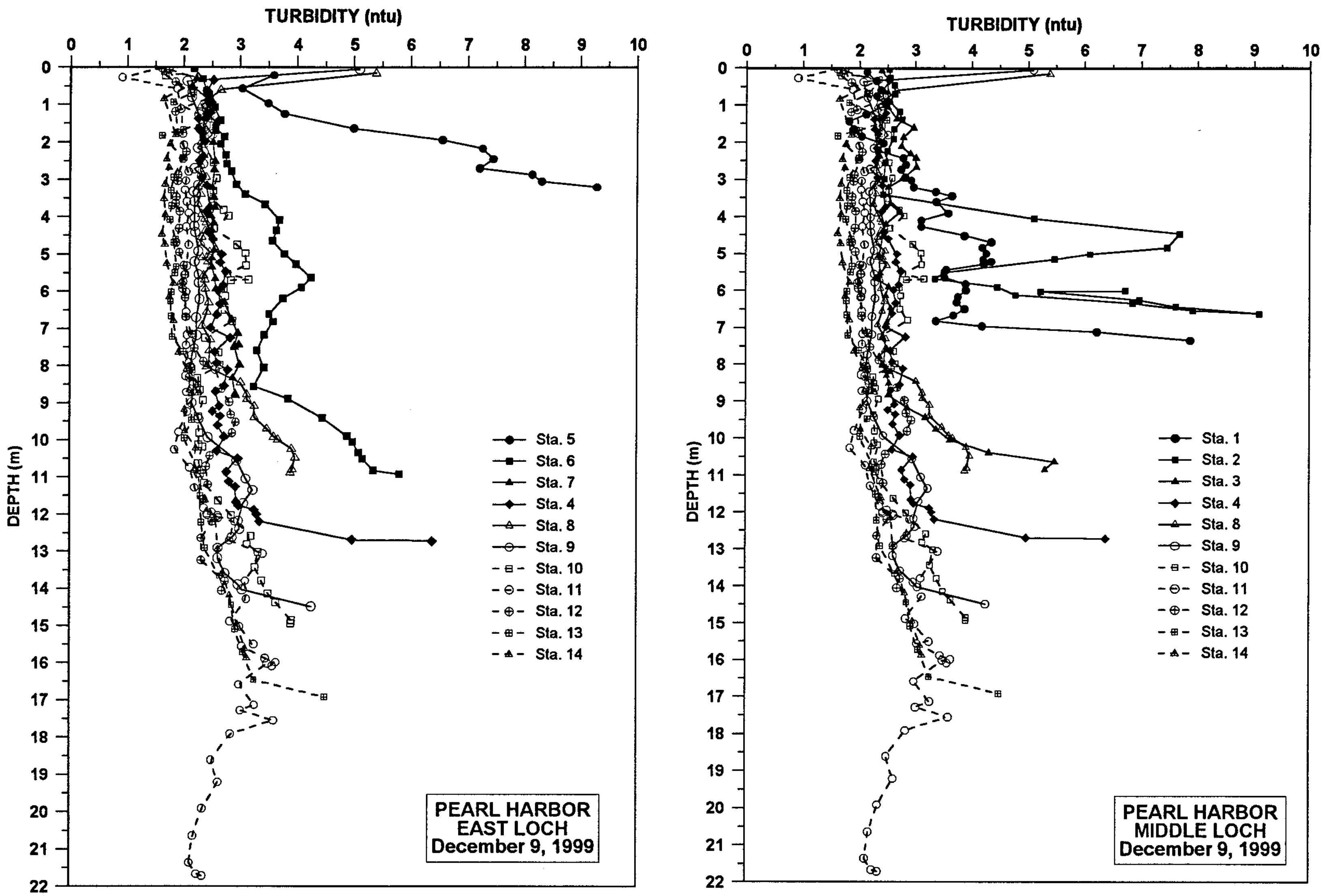


FIGURE 4. Vertical profiles of turbidity along the axes of East Loch and Middle Loch of Pearl Harbor. See Figure 1 for locations of sampling stations.

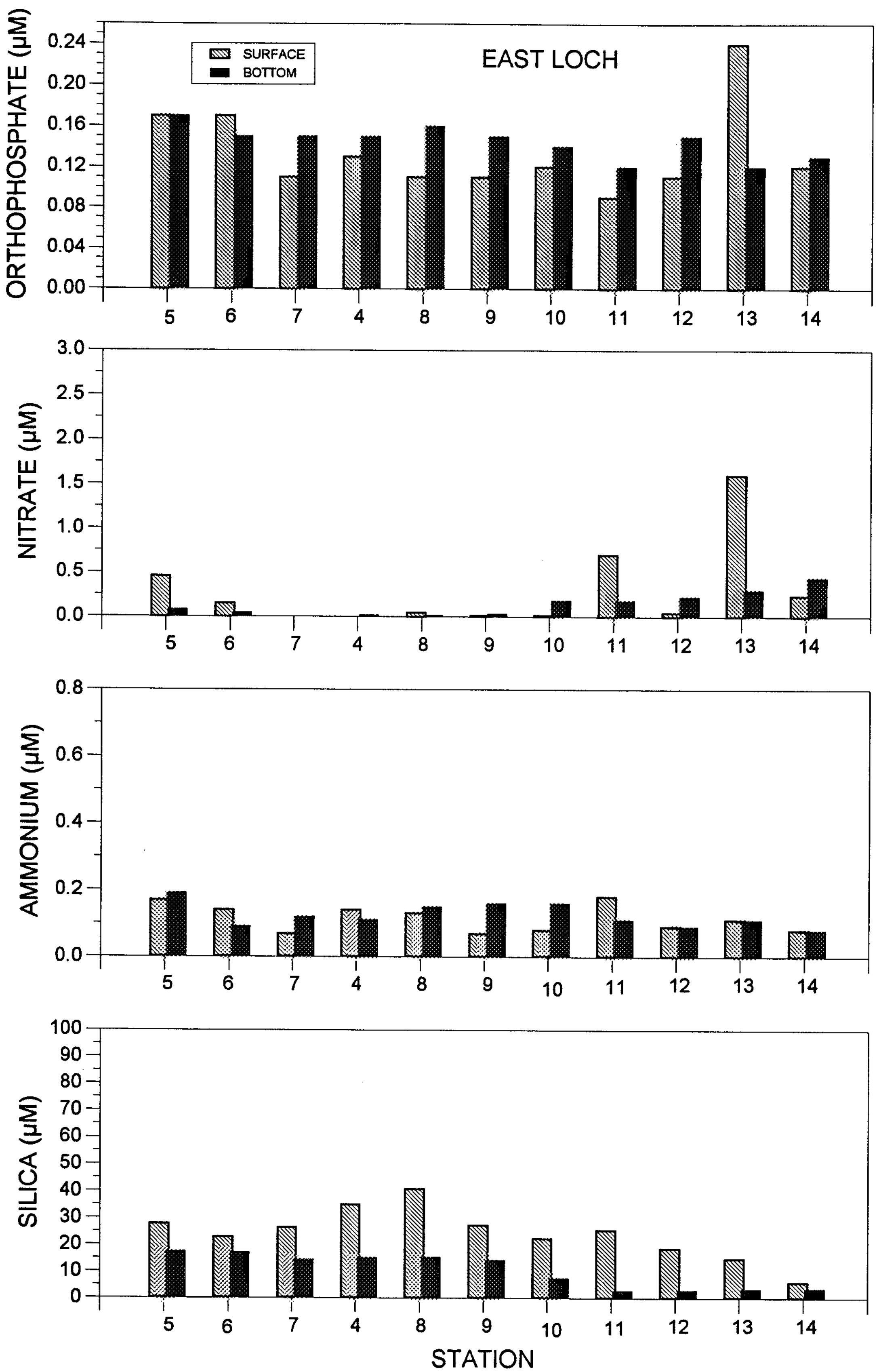


FIGURE 5. Histograms of concentrations of dissolved nutrients in surface and bottom waters of East Loch and the main entrance channel of Pearl Harbor, Hawaii. For station locations, see Figure 1.

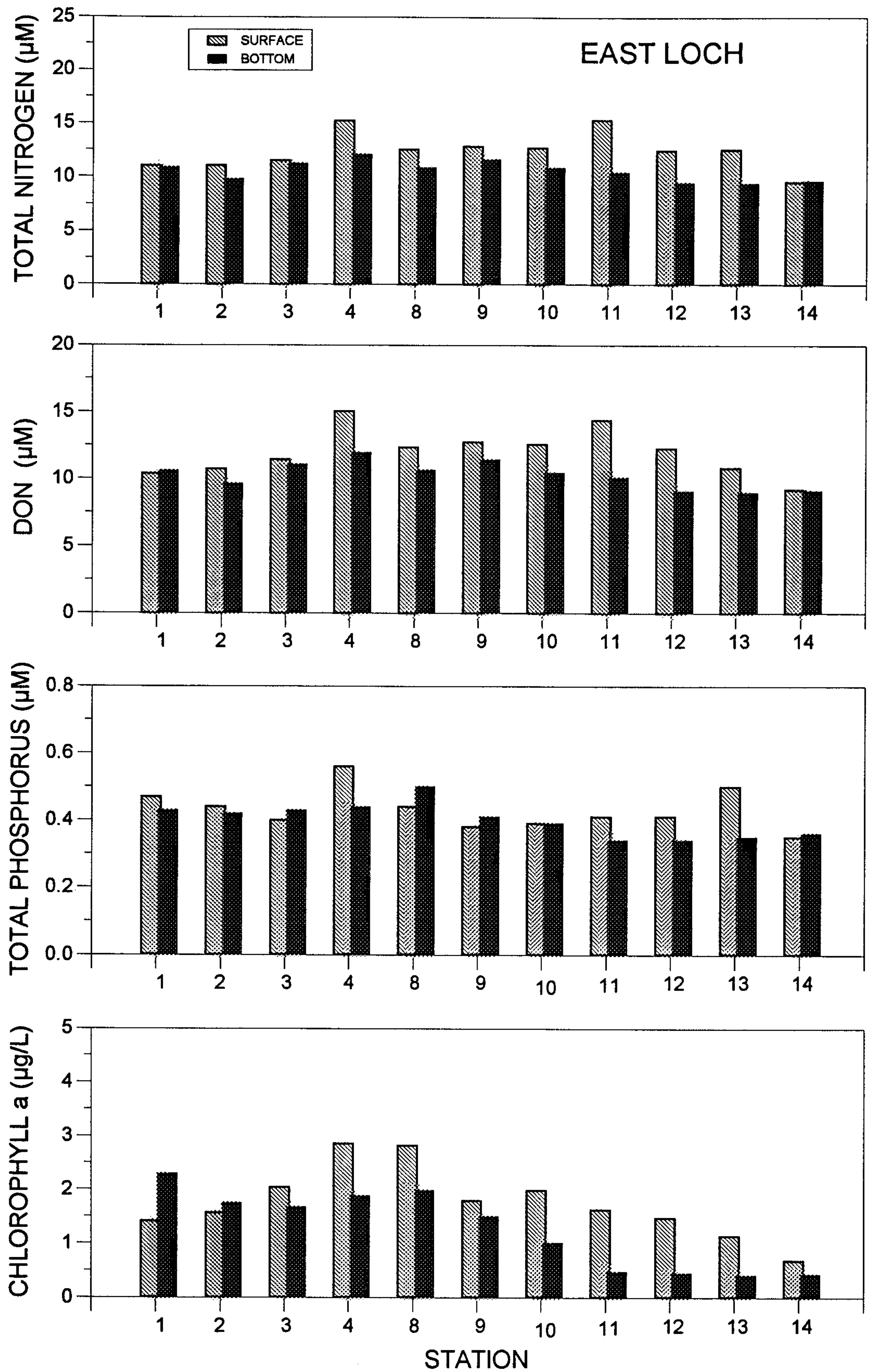


FIGURE 6. Histograms of concentrations of total nitrogen, total phosphorus, dissolved organic nitrogen (DON), and Chlorophyll a in surface and bottom waters of East Loch and the main entrance channel of Pearl Harbor, Hawaii. For station locations, see Figure 1.

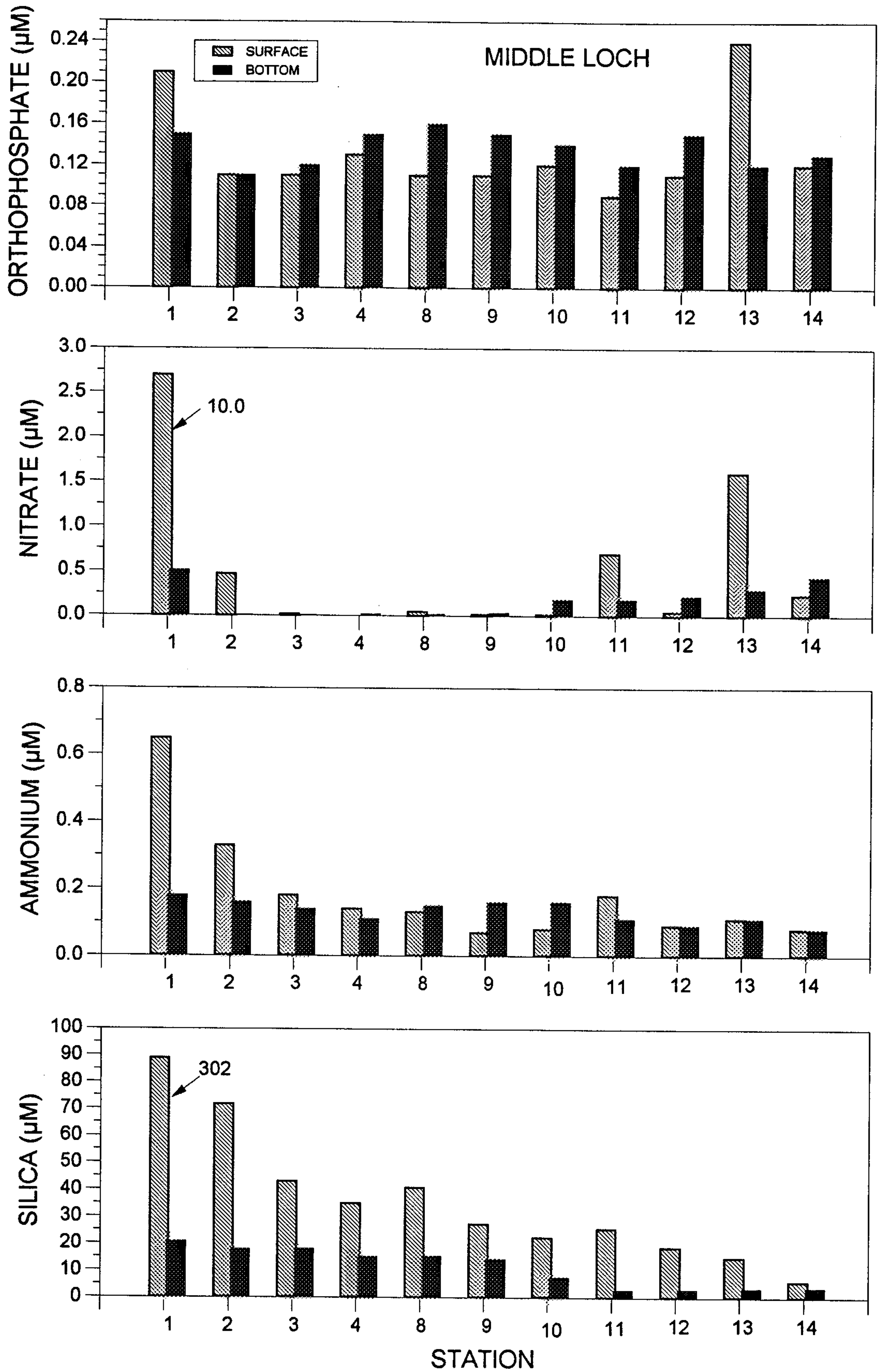


FIGURE 7. Histograms of concentrations of dissolved nutrients in surface and bottom waters of Middle Loch and the main entrance channel of Pearl Harbor, Hawaii. For station locations, see Figure 1.

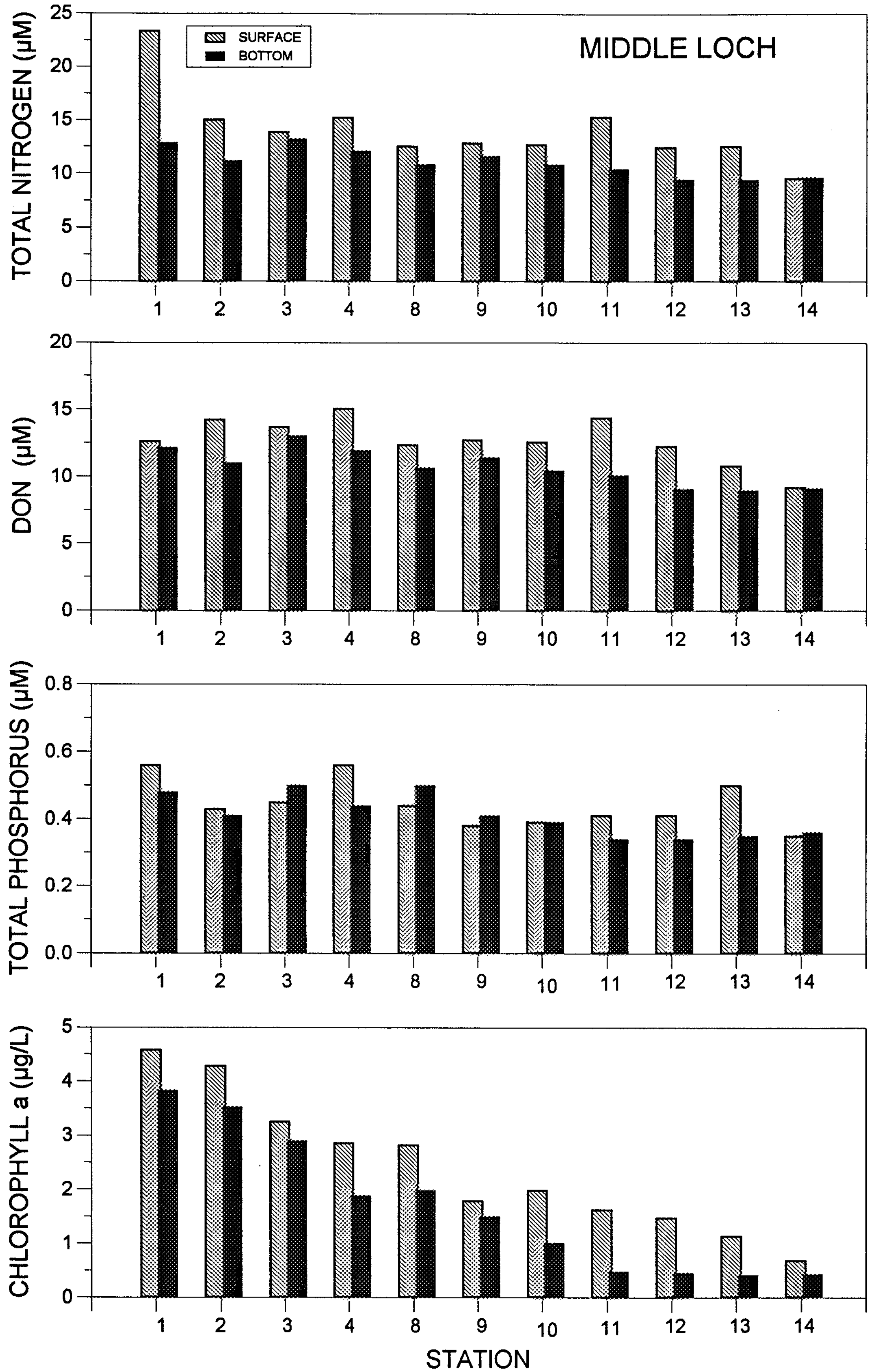


FIGURE 8. Histograms of concentrations of total nitrogen, total phosphorus, dissolved organic nitrogen (DON), and Chlorophyll a in surface and bottom waters of West Loch and the main entrance channel of Pearl Harbor, Hawaii. For station locations, see Figure 1.

FIGURE 9. View of mud-covered reef flat and mangrove seeds that is the predominant bottom type around most of the heads of lochs of Pearl Harbor.

FIGURE 10. Solid surface of reef flat with little sediment cover that typifies the shoreline setting in outer Pearl Harbor.

FIGURE 11. Colony of *Pocillopora damicornis* growing on edge of reef flat near Ford Island. Note lack of suspended sediment in water column.

FIGURE 12. Colony of *Leptastrea purpurea* growing on old bottle on edge of reef flat.

FIGURE 13. Surface of reef flat showing numerous oyster shells near the islets in the back of West Loch. Note high levels of suspended sediment in water column.

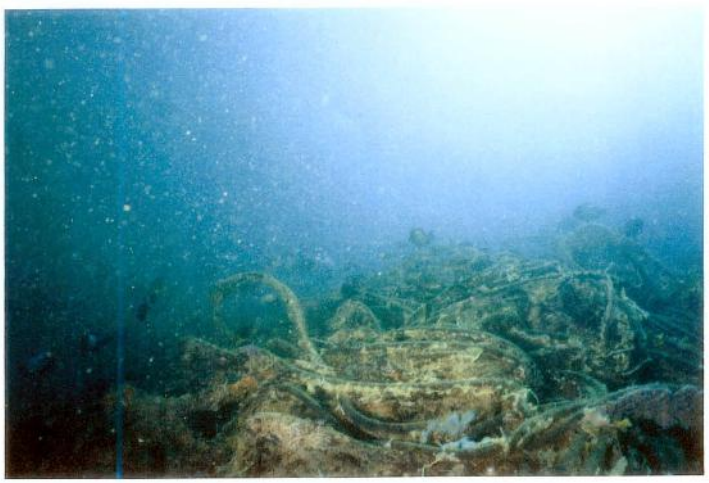


FIGURE 14. Debris on edge of reef flat off east side of Waipio Peninsula. Note colonization by numerous invertebrates and fish.

FIGURE 15. Mats of *Gracilaria salicornia* covering the reef flat on the west side of entrance channel near Okiokiolepe Fishpond.

FIGURE 16. Concrete structures near shoreline on west side of Waipio Peninsula.

FIGURE 17. Diverse assemblage of fouling organisms that occur on metal pilings and other man-made structures throughout Pearl Harbor.

FIGURE 18. Section of vertical wall of channel cut in inner Pearl Harbor.

TABLE 1. **Water chemistry results from samples collected in East and Middle Lochs of Pearl Harbor, Hawaii on December 9, 1999. "s" indicates surface sample, "d" indicates deep sample. Nutrient conentrations are in micromoles (µM) in top table and micrograms per liter (µg/L) in bottom table. For station locations see Figure 1.**

STATION NUMBER	PO4 (µM)	NO3 (µM)	NH4 (µM)	Si (µM)	DOP (µM)	DON (µM)	TP (µM)	TN (µM)	Chl-a (µg/L)
1s	0.21	2.70	0.65	89.00	0.35	12.66	0.56	23.34	4.586
1d	0.15	0.51	0.18	20.88	0.33	12.18	0.48	12.87	3.835
2s	0.11	0.47	0.33	71.96	0.32	14.24	0.43	15.04	4.284
2d	0.11	0.01	0.16	17.92	0.30	11.02	0.41	11.19	3.524
3s	0.11	0.02	0.18	43.20	0.34	13.70	0.45	13.90	3.260
3d	0.12	0.01	0.14	18.26	0.38	13.08	0.50	13.23	2.899
4s	0.13	0.00	0.14	35.08	0.43	15.09	0.56	15.23	2.857
4d	0.15	0.02	0.11	15.29	0.29	11.99	0.44	12.12	1.892
5s	0.17	0.46	0.17	28.03	0.30	10.41	0.47	11.04	1.418
5d	0.17	0.08	0.19	17.61	0.26	10.64	0.43	10.91	2.303
6s	0.17	0.15	0.14	23.00	0.27	10.74	0.44	11.03	1.578
6d	0.15	0.05	0.09	17.24	0.27	9.66	0.42	9.80	1.754
7s	0.11	bdl	0.07	26.52	0.29	11.46	0.40	11.53	2.047
7d	0.15	bdl	0.12	14.51	0.28	11.09	0.43	11.21	1.682
8s	0.11	0.05	0.13	40.88	0.33	12.35	0.44	12.53	2.820
8d	0.16	0.02	0.15	15.57	0.34	10.66	0.50	10.83	1.985
9s	0.11	0.02	0.07	27.47	0.27	12.74	0.38	12.83	1.787
9d	0.15	0.04	0.16	14.43	0.26	11.43	0.41	11.63	1.502
10s	0.12	0.02	0.08	22.36	0.27	12.60	0.39	12.70	1.989
10d	0.14	0.19	0.16	7.63	0.25	10.50	0.39	10.85	1.011
11s	0.09	0.70	0.18	25.73	0.32	14.40	0.41	15.28	1.628
11d	0.12	0.19	0.11	3.03	0.22	10.13	0.34	10.43	0.487
12s	0.11	0.05	0.09	18.66	0.30	12.28	0.41	12.42	1.481
12d	0.15	0.23	0.09	3.20	0.19	9.12	0.34	9.44	0.453
13s	0.24	1.60	0.11	14.84	0.26	10.82	0.50	12.53	1.137
13d	0.12	0.30	0.11	3.50	0.23	8.99	0.35	9.40	0.415
14s	0.12	0.24	0.08	6.12	0.23	9.22	0.35	9.54	0.692
14d	0.13	0.44	0.08	3.69	0.23	9.13	0.36	9.65	0.436

STATION NUMBER	PO4 (µg/L)	NO3 (µg/L)	NH4 (µg/L)	Si (µg/L)	DOP (µg/L)	DON (µg/L)	TP (µg/L)	TN (µg/L)	Chl-a (µg/L)
1s	6.51	37.80	9.10	2492.00	10.85	177.24	17.36	326.76	4.586
1d	4.65	7.14	2.52	584.64	10.23	170.52	14.88	180.18	3.835
2s	3.41	6.58	4.62	2014.88	9.92	199.36	13.33	210.56	4.284
2d	3.41	0.14	2.24	501.76	9.30	154.28	12.71	156.66	3.524
3s	3.41	0.28	2.52	1209.60	10.54	191.80	13.95	194.60	3.260
3d	3.72	0.14	1.96	511.28	11.78	183.12	15.50	185.22	2.899
4s	4.03	0.01	1.96	982.24	13.33	211.26	17.36	213.22	2.857
4d	4.65	0.28	1.54	428.12	8.99	167.86	13.64	169.68	1.892
5s	5.27	6.44	2.38	784.84	9.30	145.74	14.57	154.56	1.418
5d	5.27	1.12	2.66	493.08	8.06	148.96	13.33	152.74	2.303
6s	5.27	2.10	1.96	644.00	8.37	150.36	13.64	154.42	1.578
6d	4.65	0.70	1.26	482.72	8.37	135.24	13.02	137.20	1.754
7s	3.41	0.01	0.98	742.56	8.99	160.44	12.40	161.42	2.047
7d	4.65	0.01	1.68	406.28	8.68	155.26	13.33	156.94	1.682
8s	3.41	0.70	1.82	1144.64	10.23	172.90	13.64	175.42	2.820
8d	4.96	0.28	2.10	435.96	10.54	149.24	15.50	151.62	1.985
9s	3.41	0.28	0.98	769.16	8.37	178.36	11.78	179.62	1.787
9d	4.65	0.56	2.24	404.04	8.06	160.02	12.71	162.82	1.502
10s	3.72	0.28	1.12	626.08	8.37	176.40	12.09	177.80	1.989
10d	4.34	2.66	2.24	213.64	7.75	147.00	12.09	151.90	1.011
11s	2.79	9.80	2.52	720.44	9.92	201.60	12.71	213.92	1.628
11d	3.72	2.66	1.54	84.84	6.82	141.82	10.54	146.02	0.487
12s	3.41	0.70	1.26	522.48	9.30	171.92	12.71	173.88	1.481
12d	4.65	3.22	1.26	89.60	5.89	127.68	10.54	132.16	0.453
13s	7.44	22.40	1.54	415.52	8.06	151.48	15.50	175.42	1.137
13d	3.72	4.20	1.54	98.00	7.13	125.86	10.85	131.60	0.415
14s	3.72	3.36	1.12	171.36	7.13	129.08	10.85	133.56	0.692
14d	4.03	6.16	1.12	103.32	7.13	127.82	11.16	135.10	0.436
Geo.Mean	4.19	0.91	1.86	468.29	8.84	159.55	13.15	167.94	1.636

TABLE 2. Specific Criteria for Pearl Harbor Estuary based on Hawaii Administrative Rules, Title 11, Department of Health, Chapter 54, Water Quality Standards.

Parameter	Geometric mean not to exceed the given value	Not to exceed the given value more than 10% of the time	Not to exceed the given value more than 2% of the time
Total Nitrogen (μg N/L)	300	550	750
Ammonia Nitrogen (μg NH_4-N/L)	10	20	30
Nitrate + Nitrite Nitrogen (μg [NO_3 + NO_2]-N/L)	15	40	70
Total Phosphorus (μg P/L)	60	130	200
Turbidity (NTU)	4	8	15
Chlorophyll a (μg/L)	3.5	10	20

TABLE 3. List of fish ponds and their water surface areas in acres located in Pearl Lochs as given by Cobb (1905).

Note that all of these ponds but two were in commercial production in 1900.

Pond	Area (Acres)
Pouhala, in Waikele, remnant leased	22.0
Kaaukuu, in Waikele	4.1
Maaha, in Waikele	4.8
Mokuola, in Waikele	2.3
Eo, in Waipio, partly filled	137.0
Name not known, in Waipio	5.7
Hanaloa, in Waipio	195.0
Moo, in Waiawa	1.3
Kuhialoko, in Waiawa	13.3
Nameless pond (not used commercially)	2.8
Apala, in Waiawa	7.6
Paauau, in Waiawa, partly filled	32.0
Weloka, in Waimano	27.0
Kukona, in Waimano	2.7
Luakahaole, in Waiau	1.0
Paakea, in Waimalu	12.0
Opu, in Kalauao	10.5
Paaiau, in Kalauao	2.3
Kunana, in Halawa, partly filled	25.0
Loko Muliwai	4.0
Kahakupohaku, in Halawa	3.0
Amana, in Halawa, filled up	NA
Pohaku, in Halawa, partly filled (not used commercially)	2.5
Name not known, in Halawa, partly filled	5.0
Okiokiolepe, in Puuloa	6.0
Kapamuku, in Puuloa	3.0
Waiaho, in Halawa	32.0
Total Number of Ponds	26.0
Total Acreage	563.9
Total Acreage in Production in 1900	558.6

B3 – SUMMARY OF MARINE ANIMAL SPECIES OBSERVED AT PEARL HARBOR AND PHEC (FROM SMITH *ET AL.* 2006)

Table B3-1: Summary of Marine Animal Species Observed at Pearl Harbor and PHEC

Common Name	Hawaiian Name	Latin Binomial	Total number of individuals observed: Transect # (# of individual at transect)
Fish Species			
Family Acanthuridae			
Eyestripe surgeonfish	palani	*Acanthurus dussumieri*	Total of 207 observed: Transect 2 (1), 4 (48), 8 (46), 10 (27), 12 (37), 19 (35), 20 (8), 22 (1), and 23 (4).
Ringtail surgeonfish	pualu	*Acanthurus blochii*	Total of 1,124 observed: Transect 2 (25), 3 (41), 4 (63), 8 (18), 10 (87), 13 (33), 15 (2), 19 (15), 20 (152), 21 (390), 22 (82), 23 (73), 24 (43), 29 (86), and 32 (14).
Brown surgeonfish	ma'i'i'	*Acanthurus nigrofuscus*	Total of 232 observed: Transect 1 (57), 2 (47), 3 (18), and 4 (11).
Blue-hued surgeonfish	maiko	*Acanthurus nigroris*	Total of 8 observed: Transect 2 (3) and 4 (5).
Orangeband surgeonfish*	naenae	*Acanthurus olivaceus*	Total of 396 observed: Transect 1 (1), 4 (4), and 19 (391).
Convict tang*	manini	*Acanthurus triostegus*	Total of 21 observed: Transect 6 (1), 8 (14), 10 (1), 12 (3), 19 (1), and 31 (1).
Yellowfin surgeonfish	pualu	*Acanthurus xanthopterus*	Total of 270 observed: Transect 26 (38), 27 (1), 28 (93), 29 (109), and 31 (29).
Goldring surgeon	kole	*Ctenochaetus strigosus*	Total of 41 observed: Transects 2 (5), 3 (23), 23 (10), and 24 (3).
Sleek unicornfish	kala holo	*Naso hexacanthus*	Total of 7 observed: Transect 2 (7).
Spotted unicornfish		*Naso brevirostris*	Total of 66 observed: Transect 13 (18) 19 (1), 21 (13), 23 (29), and 32 (5).
Orangespine unicornfish	umaumalei	*Naso lituratus*	Total of 4 observed: Transect (2) 3 and 3 (1).
Bluespine unicornfish	kala	*Naso unicornis*	Total of 2 observed: Transect 12 (2).
Yellow tang	lau'ipala	*Zebrasoma flavescens*	Total of 43 observed: Transect 3 (1), 10 (16), 11 (1), 19 (4), 20 (8), 21 (6), 22 (1), 24 (2), 28 (2), and 29 (2).
Pacific sailfin tang		*Zebrasoma veliferum*	Total of 19 observed: Transect 2 (6), 10 (2), and 12 (11).
Family Apogonidae			
Iridescent cardinalfish	'upapalu	*Apogon kallopterus*	Total of 37 observed: Transect 3 (31), 8 (5), and 11 (1).
Weed cardinalfish		*Foa brachygramma*	Total of 56 observed: Transect 5 (4), 7 (5), 9 (3), 13 (22), 26 (12), and 27 (10).
Family Atherinidae			
Hawaiian islands silverside		*Pranesus insularum*	Total of 2,000 observed: Transect 22 (2,000).
Family Balistidae			
Reef triggerfish	humuhumu nukunuku 'apua'a	*Rhinecanthus rectangulus*	Total of 2 observed: Transect 2 (1) and 6 (1).
Lei triggerfish	humuhumu lei	*Sufflamen bursa*	Total of 10 observed: Transect 1 (2), 2 (5), 3 (2), and 4 (1).

Table B3-1: Summary of Marine Animal Species Observed at Pearl Harbor and PHEC (Continued)

Common Name	Hawaiian Name	Latin Binomial	Total number of individuals observed: Transect # (# of individual at transect)
Family Carangidae			
Giant trevally		*Carangoides ignobilis*	Total of 1 observed: Transect 14 (1).
Bluefin trevally	'omilu	*Caranx melampygus*	Total of 2 observed: Transect 4 (2).
Mackerel scad	'opelu	*Decapterus macarellus*	Total of 97 observed: Transect 12 (9) and 19 (88).
Yellow jack or golden trevally	ulua pa'opa'o	*Gnathanodon speciosus*	Total of 2 observed: Transect 25 (1) and 27 (1).
Double-spotted queenfish		*Scomberoides laysan*	Total of 40 observed: Transect 19 (40).
Family Chaetodontidae			
Threadfin butterflyfish	kikakapu	*Chaetodon auriga*	Total of 41 observed: Transect 8 (3), 10 (1), 11 (2), 12 (2), 13 (2) 19 (10), 21 (15), 23 (2), 24 (2), and 32 (1).
Saddle butterflyfish		*Chaetodon ephippium*	Total of 15 observed: Transect 3 (2), 10 (2), 19 (2), 21 (8), and 22 (1).
Raccoon butterflyfish	kikakapu	*Chaetodon lunula*	Total of 9 observed: Transect 3 (2), 8 (2), 20 (2), 21 (1), 22 (1), and 23 (1).
Oval butterflyfish		*Chaetodon lunulatus*	Total of 2 observed: Transect 21 (2).
Milletseed butterflyfish	lau wiliwili	*Chaetodon miliaris*	Total of 14 observed: Transect 2 (5) and 3 (9).
Multiband butterflyfish	kikakapu	*Chaetodon multicinctus*	Total of 4 observed: Transect 1 (2) and 3 (2).
Fourspot butterflyfish	lauhau	*Chaetodon quadrimaculatus*	Total of 3 observed: Transect 2 (2) and 3 (1).
Teardrop butterflyfish	lauhau	*Chaetodon unimaculatus*	Total of 1 observed: Transect 3 (1).
Longnose butterflyfish	lau wiliwili nukunuku 'oi'oi	*Forcipiger flavissimus*	Total of 2 observed: Transect 4 (2).
Family Cirrhitidae			
Arc-eye hawkfish	pilikoa	*Paracirrhites arcatus*	A total of 10 observed: Transect 1 (4) and 2 (6).
Blackside hawkfish	hilu pilikoa	*Paracirrhites forsteri*	A total of 1 observed: Transect 3 (1).
Family Diodontidae			
Porcupinefish		*Diodon hystrix*	A total of 1 observed: Transect 11 (1) and 19 (1).
Family Gobiidae			
Starry goby		*Asterropteryx semipunctatus*	A total of 298 observed: Transect 7 (12), 8 (72), 13 (12), 15 (19), 16 (18), 17 (35), 18 (6), 19 (4), 16 (3), 17 (4), 23 (23), 26 (9), 27 (4), 28 (8), 29 (16), 31 (18), and 32 (35).
Dusky frilgoby		*Bathygobius fuscus*	A total of 7 observed, 1 Station 16 and 3 each at Stations 5 and 30.

Table B3-1: Summary of Marine Animal Species Observed at Pearl Harbor and PHEC (Continued)

Common Name	Hawaiian Name	Latin Binomial	Total number of individuals observed: Transect # (# of individual at transect)
		Gnatholepis anjerensis	Total of 4 observed: Transect 4 (3) and 6 (1).
Hawaiian shrimp goby		*Psilogobius mainlandi*	Total of 4 observed: Transect 20 (4).
Family Holocentridae			
		Adioryx lacteoguttatus	Total of 14 observed: Transect 22 (14).
menpachi		*Myripristes amaena*	Total of 61 observed: Transect 22 (61).
Peppered squirrelfish	'alai'ihi	*Sargocentron punctatissimum*	No observations recorded.
Family Labridae			
Hawaiian dogfish	'a'awa	*Bodianus bilunulatus*	Total of 5 observed: Transect 2 (1), 3 (1), and 4 (3).
Twospot wrasse		*Cheilinus bimaculatus*	Total of 9 observed: Transect 1 (5), 5 (3), and 6 (1).
Yellowtail coris	hinalea 'akilolo	*Coris gaimard*	Total of 3 observed: Transect 2 (1) and 3 (2).
		Oxycheilinus unifasciatus	Total of 4 observed: Transect 10 (2), 19 (1), and 21 (1).
Wrasse	hinalea	*Coris venusta*	Total of 2 observed; Transect 1 (2).
Bird wrasse	hinalea 'i'iwi	*Gomphosus varius*	Total of 9 observed: Transect 2 (4), 3 (4), and 23 (1).
Ornate Wrasse	'ohua	*Halichoeres ornatissimus*	Total of 1 observed: Transect 2 (1).
Hawaiian cleaner wrasse	–	*Labroides phthirophagus*	Total of 3 observed: Transect 3 (1) and 5 (2).
Eightstripe wrasse	–	*Pseudocheilinus octotaenia*	Total of 1 observed: Transect 3 (1).
Smalltail wrasse	–	*Pseudojuloides cerasinus*	Total of 9 observed: Transect 3 (1) and 4 (8).
Belted wrasse	omaka	*Stethojulis balteata*	Total of 31 observed: Transect 1 (5) and 6 (26).
Saddleback wrasse	hinalea lauwili	*Thalassoma duperrey*	Total of 68 observed: Transect 2 (25), 3 (8), 4 (1), 5 (5), 6 (14), 8 (14), and 24 (1).
Rainbow or surge wrasse	hou	*Thalassoma purpureum*	Total of 1 observed: Transect 2 (1).
Family Lutjanidae			
Blacktail snapper	to'au	*Lutjanus fulvus*	Total of 570 observed: Transect 10 (46), 11 (1), 12 (3), 19 (190), 21 (124), 22 (48), 23 (73), 24 (44), 28 (8), and 29 (29).
Family Monacanthidae			
Barred filefish	o'ili	*Cantherhines dumerili*	Total of 3 observed: Transect 4 (2) and 5 (1).
Squaretail filefish	*o'ili lepa*	*Cantherhines sandwichiensis*	Total of 2 observed: Transect 1 (1) and 2 (1).

Table B3-1: Summary of Marine Animal Species Observed at Pearl Harbor and PHEC (Continued)

Common Name	Hawaiian Name	Latin Binomial	Total number of individuals observed: Transect # (# of individual at transect)
Family Mullidae			
Yellowstripe goatfish	weke'a	*Mulloidichthys flavolineatus*	Total of 9 observed: Transect 12 (2), 22 (6), and 23 (1).
Yellowfin goatfish	weke'ula	*Mulloidichthys vanicolensis*	Total of 29 observed: Transect 22 (23) and 23 (6).
Doublebar goatfish	munu	*Parupeneus bifasciatus*	Total of 1 observed: Transect 2 (1).
Blue goatfish	moano kea	*Parupeneus cyclostomus*	Total of 4 observed: Transect 2 (1) and 4 (3).
Manybar goatfish	moano	*Parupeneus multifasciatus*	Total of 14 observed: Transect 1 (1), 3(5), 4(3), 5(2), 21 (2), and 22 (1).
Whitesaddle goatfish	kumu	*Parupeneus porphyreus*	Total of 15 observed: Transect 12 (1) 19 (2), 21 (6), 22 (2), 23 (2), 24 (1), and 31 (1).
Family Muraenidae			
Snowflake moray		*Echidna nebulosa*	Total of 1 observed: Transect 6 (1).
Yellow-edged moray		*Gymnothorax flavimarginatus*	Total of 1 observed: Transect 4 (1).
Whitemouth moray		*Gymnothorax meleagris*	Total of 1 observed: Transect 3(1).
Family Parapercidae			
Redspotted sandperch		*Parapercis schauinslandi*	A total of 8 observed: Transect 4 (8).
Family Pomacentridae			
Green damselfish or Hawaiian sergeant major	mamo	*Abudefduf abdominalis*	Total of 417 observed: Transect 8 (32), 10 (51), 12 (21), 19 (66), 21 (105), 22 (44), 23 (28), 24 (34), 27 (2), and 24 (34).
Blackspot sergeant		*Abudefduf sordidus*	Total of 10 observed: Transect 12 (2), 21 (1), 22 (1), 23 (2), and 24 (4).
Vanderbilt's chromis or Blackfin chromis	--	*Chromis vanderbilti*	Total of 139 observed: Transect 1 (14) and 2 (125).
Hawaiian damsel or Hawaiian dascyllus	'alo'ilo'i	*Dascyllus albisella*	Total of 257 observed: Transect 1 (4), 3 (15), 5 (18), 6 (8), 8 (48), 10 (22), 11 (53), 13 (6), 19 (51), 23 (3), 24 (9), and 32 (20).
Brighteye damselfish		*Plectroglyphidodon imparipennis*	Total of 6 observed: Transect 2 (6).
Johnston Island damselfish or blue-eye damselfish		*Plectroglyphidodon johnstonianus*	Total of 4 observed: Transect 3 (4).
Pacific gregory		*Stegastes fasciolatus*	Total of 4 observed: Transect 3 (4).
Family Priacanthidae			
Glasseye	aweoweo	*Priacanthus cruentatus*	Total of 1 observed: Transect 22 (1).

Table B3-1: Summary of Marine Animal Species Observed at Pearl Harbor and PHEC (Continued)

Common Name	Hawaiian Name	Latin Binomial	Total number of individuals observed: Transect # (# of individual at transect)
Family Scaridae			
Stareye parrotfish	ponuhunuhu	*Calotomus carolinus*	Total of 1 observed: Transect 8 (1).
Bullethead parrotfish	uhu	*Chlorus sordidus*	Total of 93 observed: Transect 2 (13), 3 (11), 10 (50), and 12 (19).
Spectacled parrotfish	uhu uli uli, uhu 'ahu'ula	*Scarus perspicillatus*	Total of 322 observed: Transect 2 (7), 3 (4), 8 (2), 10 (21), 12 (29), 19 (19), 20 (2), 21 (13), 22 (21), 23 (10), 24 (2), 26 (19), 29 (106), and 31 (67).
Palenose parrotfish	uhu	*Scarus psittacus*	Total of 534 observed: Transect 1 (14), 6 (23), 10 (8), 11 (12), 12 (94), 13 (103), 16 (64), 20 (138), 22 (36), 28 (1), and 31 (4).
Redlip parrotfish	palukaluka	*Scarus rubroviolaceus*	Total of 4 observed: Transect 3 (1), 4 (1), and 21 (2).
Family Serranidae			
Peacock grouper	roi	*Cephalopholis argus*	Total of 1 observed: Transect 3 (1).
Family Sparidae			
Humpnose big-eye bream		*Monotaxis grandoculis*	Total of 2 observed: Transect 3 (2).
Family Sphyraenidae			
Great barracuda		*Sphyraena barracuda*	Total of 10: Transect 15 (1), 24 (1), and 28 (8).
Family Syngathidae			
Spotted seahorse		*Hippocampus kuda*	Total of 2: Transect 29 (1) and 32 (1).
Family Synodontidae			
Slender lizardfish		*Saurida gracilis*	Total of 2 observed: Transect 19 (1) and 21 (1).
Family Tetraodontidae			
White-spotted pufferfish		*Arothron hispidus*	Total of 14 observed: Transect 7 (1), 8 (1), 9 (1), 11 (1), 13 (3), 14 (1), 19 (2), 22 (1), 29 (1), 31 (1), and 32 (1).
Crown toby		*Canthigaster comata*	Total of 1 observed: Transect 4 (1).
Hawaiian whitespotted toby		*Canthigaster jactator*	Total of 21 observed: Transect 1 (7), 2 (3), 3 (5), 5 (3), and 6 (3).
Family Zanclidae			
Moorish idol	kihikihi	*Zanclus cornutus*	Total of 10 observed: Transect 4 (1), 19 (4), 22 (1), 23 (2), and 24 (2).
Macroinvertebrates			
Group Mollusca			
Cone shells		*Conus vexillum*	Total of 1 observed: Transect 31 (1).

Table B3-1: Summary of Marine Animal Species Observed at Pearl Harbor and PHEC (Continued)

Common Name	Hawaiian Name	Latin Binomial	Total number of individuals observed: Transect # (# of individual at transect)
Cone shells		*Conus striatus*	Total of 1 observed: Transect 1 (1).
Cone shells		*Conus lividus*	Total of 1 observed: Transect 2 (1).
Cone shells		*Conus ebreus*	Total of 1 observed: Transect 6 (1).
Cone shells		*Conus miles*	Total of 1 observed: Transect 6 (1
Cone shells		*Conus leopardus*	Total of 1 observed: Transect 5 (1).
Black-lipped oyster	pa	*Pinctada margaritifera*	Total of 6 observed: Transect 5 (1), 7 (1), 8 (1), 12 (2), and 19 (1).
		Chama elatensis	Total of 6 observed: Transect 12 (1), 13 (2), and 22 (3).
		Arca ventricosa	Total of 40 observed: Transect 1 (7), 3 (19), and 5 (14).
Rock oyster		*Spondylus tenebrosus*	Total of 5 observed: Transect 2 (2) and 3 (3).
Octopus	he'e	*Octopus cyanea*	Total of 2 observed: Transect 1 (1) and 7 (1).
Phylum Annelida			
		Sabellstarte spectabilis	Total of 457 observed: Transect 5 (3), 8 (30), 10 (23), 12 (24), 13 (8), 14 (3), 15 (4), 19 (11), 20 (30), 21 (11), 22 (28), 23 (58), 24 (57) 26 (24), 27 (92), 28 (6), 29 (111), 31 (28), and 32 (16).
		Loimia medusa	Total of 1 observed: Transect 6 (1).
		Thelepus setosus	Total of 35 observed: Transect 8 (1), 9 (4), 11 (6), 13 (9), 23 (9), and 32 (6).
Phyllum Arthropoda			
Slipper lobster	'ula'papa	*Corallianassa borradailei*	Total of 7 observed: Transect 2 (1) and 6 (6).
		Pseudosquilla ciliate	Total of 1 observed at Station 29.
		Lysiosquilla maculatus	Total of 4 observed: Transect 12 (1), 13 (1), 18 (1), and 25 (1).
		Gonodactylus mutates	Total of 1 observed: Transect 13 (1).
		Stenopus hispidus	Total of 4 observed: Transect 10 (2) and 13 (2).
		Portunus sanguinolentus	Total of 8 observed: Transect 9 (2), 11 (1), 18 (1), 24 (1), 30 (2), and 32 (1).
		Podophthalmus vigil	Total of 1 observed: Transect 14 (1).
		Thalamita integra	Total of 1 observed: Transect 29 (1).
		Thalamita crenata	Total of 1 observed: Transect 25 (1).
Phyllum Echinodermata			
Sea urchin		*Echinothrix diadema*	Total of 173 observed: Transect 1 (5), 2(27), 3 (20), 4 (12), 5 (56), 6 (17), 7 (26), 8 (9), and 10 (1).

Table B3-1: Summary of Marine Animal Species Observed at Pearl Harbor and PHEC (Continued)

Common Name	Hawaiian Name	Latin Binomial	Total number of individuals observed: Transect # (# of individual at transect)
Sea urchin		*Echinothrix calamaris*	Total of 33 observed: Transect 1 (1), 5 (4), 6 (10), 7 (17), and 9 (1).
Sea urchin		*Tripneustes gratilla*	Total of 303 observed: Transect 1 (5), 2 (1), 3 (7), 5 (100), 6 (135), and 7 (55).
Sea urchin		*Echinostrephus aciculatum*	Total of 22 observed: Transect 2 (21) and 3 (1).
		Echinometra mathaei	Total of 174 observed: Transect 2 (174).
		Diadema paucispinum	Total of 3 observed: Transect 5 (3).
Sea cucumber		*Actinopyge mauritana*	Total of 11 observed: Transect 8 (1).
		Ophiodesoma spectabilis	Total of 3 observed: Transect 20 (2) and 21 (1).

Source: Smith et al 2006

Table B3-2: Fishes Observed at the Pearl Harbor Marine Assessment Sites

Site Number - Location	Transect Number	Substrate type	No. of Species	No. of Individuals	Biomass (g/m2)	Fishes Observed and Number of Individuals Observed
7 - Bishop Point (Channel Wall)	8	Unconsolidated and hard bottom -10 to 20 ft (3 to 6) m deep along wall	13	281	184.4	Iridescent cardinalfish (5), threadfin butterflyfish (3), raccoon butterflyfish (2), Hawaiian damsel (48), green damselfish (32), saddleback wrasse (14), stareye parrotfish (1), spectacled parrotfish (2), palenose parrotfish (23), starry goby (72), convict tang (14), ringtail surgeonfish (18), eyestripe surgeonfish (48), and white-spotted pufferfish (1).
	9	Rubble slope – 39 ft (12 m) deep	3	16	1.5	Weed cardinalfish (3), starry goby (12), and white-spotted pufferfish (1).
8 - Waipi'o Point- by concrete platform, east side	10	Along the wall – 10 to 20 ft (3 to 6 m) deep	14	336	547.4	Blacktail snapper (48), threadfin butterflyfish (1), saddle butterflyfish (2), Hawaiian damsel (22), green damselfish (51), *Oxycheilinus unifasciatus* (2), spectacled parrotfish (21), bullethead parrotfish (50), palenose parrotfish (8), convict tang (1), ringtail surgeonfish (87), eyestripe surgeonfish (27), yellow tang (16), and Pacific sailfin tang (2).
	11	Rubble slope – 39 ft (12 m) deep	9	91	66.2	Iridescent cardinalfish (1), blacktail snapper (1), threadfin butterflyfish (2), Hawaiian damsel (53), spectacled parrotfish (12), starry goby (19), yellow tang (1), white-spotted pufferfish (1), and porcupinefish (1).
9 - Dry Docks (Facing Crane P63)	12	Hard bottom – 7 ft (2 m) deep	15	253	644.9	Mackerel scad (9), blacktail snapper (3), yellowstripe goatfish (2), whitesaddle goatfish (1), threadfin butterflyfish (2), green damselfish (21), blackspot sergeant (2), spectacled parrotfish (29), bullethead parrotfish (19), spectacled parrotfish (94), starry goby (18), convict tang (3), eyestripe surgeonfish (37), Pacific sailfin tang (11), and bluespine unicornfish (2).
9 - Dry Docks (Facing Crane P63) (Continued)	13	Along wall – 16 to 20 ft (5 to 6 m) deep	8	222	187.2	Weed cardinalfish (22), Threadfin butterflyfish (2), Hawaiian damsel (6), Palenose parrotfish (103), Starry goby (35), Ringtail surgeonfish (33), Spotted unicornfish (18), and White-spotted pufferfish (3).
	14	Rubble/mud slope – 16 to 20 ft (5 to 6 m) deep	3	8	54.9	Giant trevally (1), starry goby (6), and white-spotted pufferfish (1).

Table B3-2: Fishes Observed at the Pearl Harbor Marine Assessment Sites (Continued)

Site Number - Location	*Transect Number*	*Substrate type*	*No. of Species*	*No. of Individuals*	*Biomass (g/m2)*	*Fishes Observed and Number of Individuals Observed*
10 - Beckoning Point (Waipi'o Peninsula, East)	15	Sand slope with Gracilaria salicornia – 3 to 5 ft (1 to 1.5 m) deep	3	7	3.1	Great barracuda (1), starry goby (4), and ringtail surgeonfish (2).
	16	Rubble/sand slope – 3 to 39 ft (1 to 12 m) deep	3	7	3.1	Palenose parrotfish (64), dusky frilgoby (1), and starry goby (3).
	17	Sand/rubble slope – 10 to 16 ft (3 to 5 m) deep	3	66	1.7	Starry goby (4).
	18	Mud substrate – 30 to 41 ft (9 to 12.5 m) deep	0	0	0	No fishes observed
11 - Debris Field 1 - Finger Pier (entrance to West Loch, east, submerged pier)	19	Old finger pier – 28 to 30 ft (8.5 to 9 m) deep	20	924	1,549.9	Slender lizardfish (1), double-spotted queenfish (40), mackerel scad (88), blacktail snapper (190), whitesaddle goatfish (2), threadfin butterflyfish (10), saddle butterflyfish (2), Hawaiian damsel (51), green damselfish (66), Oxychellinus unifasciatus (1), spectacled parrotfish (19), convict tang (1), ringtail surgeonfish (15), orangeband surgeonfish (391), eyestripe surgeonfish (35), yellow tang (4), spotted unicornfish (1), Moorish idol (4), white-spotted pufferfish (2), and porcupinefish (1).
12 - Debris Field 3 (entrance to West Loch, west, barge)	21	Metal box in shallow water – 7 ft (2 m) deep	16	690	1,343.1	Slender lizardfish (1), bBlacktail snapper (124), whitesaddle goatfish (6), manybar goatfish (2), threadfin butterflyfish (15), raccoon butterflyfish (1), oval butterflyfish (2), saddle butterflyfish (8), green damselfish (105), blackspot sergeant (1), *Oxychellinus unifasciatus* (1), spectacled parrotfish (13), redlip parrotfish (2), ringtail surgeonfish (390), yellow tang (6), and spotted unicornfish (13)
13 - Debris Field 3 (entrance to West Loch, west)	20	Barge – 30 to 39 ft (9 to 12 m) deep	7	314	487.4	Raccoon butterflyfish (2), spectacled parrotfish (2), palenose parrotfish (138), Hawaiian shrimp goby (4), ringtail surgeonfish (152), eyestripe surgeonfish (8), yellow tang (8).

Table B3-2: Fishes Observed at the Pearl Harbor Marine Assessment Sites (Continued)

Site Number - Location	*Transect Number*	*Substrate type*	*No. of Species*	*No. of Individuals*	*Biomass (g/m2)*	*Fishes Observed and Number of Individuals Observed*
14 - Debris Field 2 (entrance to West Loch, east, barge)	22	Barge – 10 to 16 ft (3 to 5 m) deep	21	2,847	490.5	Hawaiian islands silverside (2,000), Adioryx lacteoguttatus (14), menpachi (61), glasseye (1), blacktail snapper (48), yellowstripe goatfish (6), yellowfin goatfish (23), blue goatfish (2), doublebar goatfish (1), threadfin butterflyfish (1), raccoon butterflyfish (1), saddle butterflyfish (1), green damselfish (44), blackspot sergeant (1), spectacled parrotfish (21), palenose parrotfish (36), ringtail surgeonfish (82), eyestripe surgeonfish (1), yellow tang (1), Moorish idol (1), and white-spotted pufferfish.
15 - Hospital Point – by concrete discharge	23	East side along wall – 20 ft (6 m) deep	17	270	611.7	Blacktail snapper (73), yellowstripe goatfish (1), yellowfin goatfish (6), whitesaddle goatfish (2), threadfin butterflyfish (2), raccoon butterflyfish (1), Hawaiian damsel (3), green damselfish (28), blackspot sergeant (2), bird wrasse (1), spectacled parrotfish (10), starry goby (23), ringtail surgeonfish (73), eyestripe surgeonfish (4), goldring surgeon (10), spotted unicornfish (29), and moorish idol (2).
15 - Hospital Point – by concrete discharge	24	West side along wall – 20 ft (6 m) deep	13	148	162.4	Blacktail snapper (44), whitesaddle goatfish (1), threadfin butterflyfish (2), Hawaiian damsel (9), green damselfish (34), blackspot sergeant (4), great barracuda (1), saddleback wrasse (1), spectacled parrotfish (2), ringtail surgeonfish (43), yellowfin surgeonfish (3), yellow tang (2), and Moorish idol (2).
	25	Rubble/sand slope – 36 to 39 ft (11 to 12 m) deep	1	1	18.1	Yellow jack (1)
16 – Mokunui Island (Ford Island Causeway east side of Ford Island)	26	Along mauka wall – 20 ft (6 m) deep	3	59	172.5	Iridescent cardinalfish (12), starry goby (9), and yellowfin surgeonfish (38).
	27	Along makai wall – 20 ft (6 m) deep	6	37	25.7	Weed cardinalfish (10), yellow jack (1), green damselfish (2), spectacled parrotfish (19), starry goby (4), and yellowfin surgeonfish (1).
	28	Over slope – 10 to 36 ft (3 to 11 m) deep	6	120	560.0	Blacktail snapper (8), great barracuda (8), spectacled parrotfish (1), starry goby (8), yellowfin surgeonfish (93), and yellow tang (2).

Table B3-2: Fishes Observed at the Pearl Harbor Marine Assessment Sites (Continued)

Site Number - Location	*Transect Number*	*Substrate type*	*No. of Species*	*No. of Individuals*	*Biomass (g/m2)*	*Fishes Observed and Number of Individuals Observed*
	29	On top, mix of sand, rubble, and hard substrate – 5 to 8 ft (1.5 to 2.4) m deep	9	384	744	Spotted seahorse (1), blacktail snapper (29), green damselfish (34), spectacled parrotfish (108), starry goby (16), ringtail surgeonfish (86), yellowfin surgeonfish (109), yellow tang (2), and white-spotted pufferfish (1).
	30	Mud substrate – 39 ft (12 m) deep	0	0	0	No fishes observed.
17 - Ford Island South (south end by the seaplane ramp)	31	Mix of sand, rubble, and concrete – 3 to 8 ft (1 to 2.4 m) deep	8	124	17.6	Whitesaddle goatfish (1), spectacled parrotfish (67), palenose parrotfish (4), dusky frilgoby (3), starry goby (18), convict tang (1), yellowfin surgeonfish (29), white-spotted pufferfish (1).
	32	Rubble/limestone slope – 16 to 20 ft (5 to 6 m) deep	7	77	35.12	Spotted seahorse (1), longnose butterflyfish (1), Hawaiian damsel (20), starry goby (35), ringtail surgeonfish (14), spotted unicornfish (5), and white-spotted pufferfish (1).

Source: Smith et al 2006

Table B3-3: Fishes Observed at the PHEC Marine Assessment Sites

Site Number - Location	Transect Number	Substrate type	No. of Species	No. of Individuals	Biomass (g/m2)	Fishes Observed and Number of Individuals Observed
1 - Āhua Reef Offshore	1	Hard bottom – 46 ft (14 m) deep	13	106	14.1	Manybar goatfish (1), multiband butterflyfish (2), Hawaiian damsel (4), Vanderbilt's chromis (14), arc-eye hawkfish (4), twospot wrasse (5), wrasse (2), belted wrasse (5), brown surgeonfish (57), orangeband surgeonfish (1), lei triggerfish (2), squaretail filefish (1), and Hawaiian whitespotted toby (7).
2 - Ahua Reef	2	Hard bottom -20 ft (6 m) deep	28	320	214.9	Blue goatfish (1), doublebar goatfish (1), fourspot butterflyfish (2), milletseed butterflyfish (5), brighteye damselfish (6), Vanderbilt's chromis (125), arc-eye hawkfish (6), Hawaiian dogfish (1), saddleback wrasse (25), rainbow or surge wrasse (1), bird wrasse (4), yellowtail coris (1), ornate Wrasse (1), spectacled parrotfish (7), bullethead parrotfish (13), palenose parrotfish (14), brown surgeonfish (47), blue-hued surgeonfish (3), ringtail surgeonfish (25), eyestripe surgeonfish (1), goldring surgeon (5), Pacific sailfin tang (6), sleek unicornfish (7), orangespine unicornfish (3), reef triggerfish (1), lei triggerfish (5), squaretail filefish (1), Hawaiian whitespotted toby (3).
3 - Turtle/Tripod Reef	3	Along wall-30 to 39 ft (9 to 12 m) deep along	33	208	414.3	Peacock grouper (1), iridescent cardinalfish (31), humpnose big-eye bream (2), manybar goatfish (5), multiband butterflyfish (1), raccoon butterflyfish (2), fourspot butterflyfish (1), multiband butterflyfish (2), milletseed butterflyfish (9), saddle butterflyfish (2), Hawaiian damsel (15), Johnston Island damselfish (4), Pacific gregory (4), blackside hawkfish (1), Hawaiian cleaner wrasse (1), Hawaiian dogfish (1), eightstripe wrasse (1), saddleback wrasse (8), bird wrasse (4), yellowtail coris (2), smalltail wrasse (1), spectacled parrotfish (4), bullethead parrotfish (11), redlip parrotfish (1), brown surgeonfish (18), ringtail surgeonfish (41), goldring surgeon (23), yellow tang (1), orangespine unicornfish (1), lei triggerfish (2), and Hawaiian whitespotted toby (5).
4 - Outfall	4	Sand substrate – 26 ft (8 m) deep	20	170	1,260.6	Yellow-edged moray (1), bluefin trevally (2), blue goatfish (3), longnose butterflyfish (2), Hawaiian dogfish (3), saddleback wrasse (1), smalltail wrasse (8), redlip parrotfish (1), *Gnatholepis anjerensis* (3), redspotted sandperch (8), brown surgeonfish (11), blue-hued surgeonfish (5), ringtail surgeonfish (63), orangeband surgeonfish (4), eyestripe surgeonfish (48), Moorish idol (1), lei triggerfish (1), barred filefish (2), and crown toby (1).

Table B3-3: Fishes Observed at the PHEC Marine Assessment Sites (Continued)

5 - PHEC, east side, opposite Buoy 5	5	Along wall – 20 to 26 ft (6 to 8 m) deep	8	40	2.3	Weed cardinalfish (4), manybar goatfish (2), Hawaiian damsel (18), Hawaiian cleaner wrasse (2), twospot wrasse (3), saddleback wrasse (5), dusky frilgoby (3), barred filefish (1), and Hawaiian whitespotted toby (3).
6 - PHEC, west side, adjacent to Buoy 5	6	Hard substrate – 20 to 26 ft (6 to 8 m) deep	10	79	7.3	Snowflake moray (1), Hawaiian damsel (8), twospot wrasse (1), saddleback wrasse (14), belted wrasse (26), palenose parrotfish (23), *Gnatholepis anjerensis* (1), convict tang (1), reef triggerfish (1), and Hawaiian whitespotted toby (3).
	7	Rubble slope – 36 ft (11 m) deep	3	8	3.5	Weed cardinalfish (6) and starry goby (12).

Source: Smith et al 2006

This page was intentionally left blank.

B4 – TURTLE DENSITIES (NAVFAC PAC 2011)

Turtle Densities in Pearl Harbor
Dates Covered: 8 March 2000 - 12 April 2011

Location	# of ind. surveys	mean density	SE density	warm seas. density	# of ind. warm survey	cold seas. density	# of ind. cold survey
1	31	9.07	4.32	12.3810	15	5.9736	16
2	30	241.16	64.90	211.1232	18	286.2126	12
3A	21	126.92	25.61	120.2121	10	133.0155	11
3B	29	222.10	53.48	163.6635	20	351.9612	9
4	27	40.10	16.49	23.2684	20	88.1945	7
5	15	34.57	18.50	10.7143	7	55.4509	8
6	36	28.67	11.18	15.1339	20	45.5830	16
7	18	26.35	15.87	15.3061	14	65.0000	4
8	22	2.84	2.84	0.0000	16	10.4167	6
10	15	0.00	0.00	0.0000	12	0.0000	3
11	8	8.93	8.93	11.9048	6	0.0000	2
12	37	0.90	0.90	1.7622	19	0.0000	18
13	7	0.00	0.00	0.0000	4	0.0000	3
14	21	0.00	0.00	0.0000	3	0.0000	18
15	17	4.20	4.20	0.0000	7	7.1429	10
16	29	7.26	4.24	14.0323	15	0.0000	14
17	21	17.86	13.04	22.7273	11	12.5000	10
18	8	0.00	0.00	0.0000	2	0.0000	6
19	20	25.88	14.66	3.2051	9	44.4399	11
20	12	39.55	21.70	59.3235	8	0.0000	4
21	24	6.13	6.13	0.0000	12	12.2549	12

B5 – MARINE MAMMAL, HAWAIIAN MONK SEAL, TURTLE SIGHTING LOG

			SIGHTINGS AND OBSERVATIONS
			Logged by Patricia Colemon (effective 17Nov08, formerly RMKH, N00L), based on reports made to her and others by Harbor Patrol or Tower. Logged by Aaron Hebshi effective 6/1/2010.
	DATE	**TIME**	**SIGHTINGS AND OBSERVATIONS**
	3/21/98		Whale and calf enter PH/back side of Ford Island/Saturday morning; traffic stopped; effort made to boom off West Loch; kept watch 'til sunset; gone Sunday morning.
			PH1 William Goodwin photographs whale in Pearl Harbor
	same season, later		USS LOUISVILLE (sub) departing channel glanced whale
			Tower reporting procedure put in place to watch for whales during season and to pass word to other traffic
	6/1/99		Coral collision Kaneohe, LCU from USS PELELIU, June JTFX,
	1/18/00		Six whales sighted aprx 2 miles out from Papa Hotel
			Four reported by TWR 7, two reported by CLINGER
	5/26/00		Cynthia Pang advises OSOT team has observed at various times:
			Hammer heads, turtles, one seal pup, dolphins at Intrepid BayPoint
	2/20/01	8:28 a.m.	USS CHICAGO - Whale seen, entrance Papa Hotel
	2/21/01		USS CHARLOTTE - Saw whales 2-3 miles away - channel btwn Molokai & Oahu
	2/27/01		NMFS called by Signal Tower of whale in Pearl Harbor -- error. Meant Buoys 1 & 2, not in harbor
	1/6/04	6:00 p.m.	USS COLUMBIA - Departing Pearl Harbor, whales either side, 200 yds Buoys 1 & 2
	1/21 or 1/22/2004	5:45 p.m.	KISKA - whale btwn Buoys 1 & 2
	2/5/04	5:00 p.m.	HOPPER (inbound) whales headed east (DH) btwn 1&2
	2/12/04	5:15 p.m.	Whale observed in vicinity of PH entrance Buoy 1
	2/26/04	11:00 a.m.	Security boats - whales btwn Buoys 1 & 2
	3/18/04	9:30 a.m.	Pod of dolphins seen by vessel inbound Buoy 7 security boat
	4/12/04	9:09 a.m.	Monk seal 100' off Hickam O'Club. Spotted by Danny aboard Tug Lanai transiting from
			Victor Pier to Alpha Docks
	2004 December		Port Ops advises whale sighting PH (Papa Hotel)
	1/16/05	4:00 p.m.	Monk seal basing at Iroquois Point harbor
	1/19/05	10:48 a.m.	Ctrl Tower reports two whales spotted headed east at Buoys 1 & 2
	1/20/05	10:00 a.m.	Whales seen 1MSW Buoys 1 & 2
	1/24/05	1:00 p.m.	Channel marker 7 at IP - Buoy 7, "injured" presumed, no fishing line
			Monk seal - hauled out on beach
	2/1/05	5:40 p.m.	Outbound sub reports two whales headed west 500 yds off Buoys 1 & 2
	2/11/05		Monk seal - White Sands Beach
	2/16/05		Monk seal - White Sands Beach
	3/4/05	10:30 a.m.	Monk seal basking, White Plains
	3/10/05	2:47 p.m.	Seal at White Plains
	3/11/05	9:02 a.m.	Monk seal - White Plains
	4/30/05	9:45 a.m.	Monk seal - White Plains
	2005 May		USS RUSSELL firing - 50 cal - VIP saw spout - firing stopped
	2006 February	3:20 p.m.	NOAA calls - advises charter boat saw HMS entangled S of Niihau. Advised PMRF
		4:10 p.m.	Whale sighted 1,000 yds west of Buoy 1
	3/27/06	10:00 a.m.	Whale headed E 2 NM S of reef runway
		1:30 p.m.	Whale 300 yds Buoys 1 & 2 headed east
		1:45 p.m.	Two whales west of Buoys 1 & 2, 300 NM
	4/3/06		Flt departing PMRF saw adult whale & calf
	5/1/06		Tower reports two whales, Buoys 3 & 4, headed east

	5/19/06	7:20 a.m.	White Plains Beach cottage HMS
	12/5/06	2:15 p.m.	Iroquois Point/Hammer Point HMS hauled out
	1/22/07	9:14 a.m.	Whale headed SW at Papa Hotel - report from ship to tower
	6/4/07	9:00 a.m.	HMS White Plains Beach
	7/5/07	819am	H:MS west loch area; traffic advised
	8/1/07		Dead turtle (papilomas) at Iroquois Point EOD dock
	8/16/07		Dead turle (papilomas) at Laulaunui in West Loch
	2/xx/2008		Turtle recovered from IP - propped
			Navy authorizes Hunt to open IP for limited shore-based fishing
	2/xx/2008		J. Fukawa & I walking beach find shell slice
	3/xx/2008		HMS on beach at IP near Edgewater; IP patrol advises "it's Chester"
			Chester reported dead on windward side island
	4/26/08		Reportedly 2 turtles wrapped in fishing line beached at IP turned into NOAA
	4/28/08		One whale 1000 yds off buoys 1 & 2
	6/12/08		NAVSTA XO reports live tumored turtle at USS ARIZONA
	6/24/08		Tumored turtle found on beach, IP, NOAA responds and euthanizes
	7/9/08		Propped turtle at Hickam
	7/16/08		Propped turtle at Lima Landing
COLOR LEGEND ***WHALES***	12/9/08		From: Dick, Mike J CIV (PMRF 7322) Sent: Tuesday, December 09, 2008 8:07; From BSURE techs: Whales heard this morning, 1st time noticed this season.
GREEN SEA TURTLE or HAWKBILL TURTLE	12/1/08		Per email from Becky Hommon, 1 DEC at around 4:23 PM, a whale was sighted, about l/2 mile off the reef runway, by a Navy vessel exiting the harbor. All incoming/outgoing traffic was advised.
HAWAIIAN MONK SEAL	1/13/09		From: Hommon, Rebecca M CIV CNRH, N00L Sent: Tuesday, January 13, 2009 9:35 AM Tower reported 4 whales sighted 5 miles offshore of Buoys 1 & 2 which are the buoys the furthest out to line up to enter Pearl Harbor. Whales were headed SE. Tower will advise all incoming/outgoing traffic. VR Beck

OTHER, i.e., DOG, CAT, ETC.	1/14/09	1337	fyi John Burger and I both distro'd this email to our ops people to apprise them of the animal's presence, condition, and to report it if they see it. Ed Lyman and I went to Univ of New Hampshire. :) VR Beck -----Original Message----- From: Ed Lyman [mailto:Ed.Lyman@noaa.gov] Sent: Tuesday, January 13, 2009 22:46 To: Lyman Edward Subject: 1/13/09 Entangled humpback whale reported off Hauula - Oahu At approximately 17:30 HST on January 13, 2009 a local fisherman reported a subadult, humpback whale off Hauula, Oahu, entangled by the tailstock in what was reported (but not confirmed) as local crab pot gear. The good-intentioned fisherman proceeded to approach and cut off an undetermined amount of what is believed to be surface marking/buoyline, along with all surface floats. Unfortunately, it is believed that a significant amount of weighted (pots and/or anchor system) and potentially lethal gear remains on the animal. The report was subsequently called into state and federal Hotlines at approximately 18:15 HST. No authorized response was possible due to time of day. The remainder of the entanglement is still likely life threatening. Any response efforts are dependent on a re-sight of the animal. < Is can be found on the Disentanglement Network website at: http://www.whaledisentanglement.org/ <http://www.whaledisentanglement.org/> or directly at: http://www.whaledisentanglement.org/Hawaii/Case_Pages/2009_Cases/1-13-09_183Mn-208/1-13-09_09183Mn-208.html Please report sightings of this animal to either NOAA Fisheries Marine Mammal Response Hotline at (888) 256-9840 or directly to the Humpback Whale Sanctuary at (808) 264-8023. ~~~~~~ Edward Lyman Marine Mammal Response Manager Hawaiian Islands Humpbac anctuary 726 S. Kihei Rd Kihei, HI 96753 Voice: (808) 879-2818 Fax: (808) 874-3815 Cell: (808) 264-8023 ed.lyman@noaa.gov http://hawaiihumpbackwhale.noaa.gov
	1/20/09		Whale reported moving SW near buoy 1 and 2 (line up to enter Pearl Harbor channel) around 330 PM today 20 JAN. All traffic advised. R, Beck
	2/5/09	1353	thanks -- yes they pass by this time of year -----Original Message----- From: Hewlen, Grace R CIV CNRH, N00PA Sent: Thursday, February 05, 2009 11:43 To: Hommon, Rebecca M CIV CNRH, N00L Subject: Whale spotted near Hickam Harbor Importance: High Becky, got word from Mark Matsunaga at about 1130 that a whale was spotted at Hickam Harbor. Don't have much more info than that. Coast Guard is aware. Our shop is buzzing hoping to get a photo... grace
	2/27/09	1100	P, Tuesday morning (Feb 24) a live turtle was sighted as ship backed up at Bravo 20, reported to tower and all traffic advised to avoid. Vr, Beck

	3/2/09	900	Jennifer Sakai and Rich Tanaka along with Port Ops responded to the spotting of a dead sea turtle floating near Westloch. They pushed the turtle to shore to decompose naturally. The wounds/damages to the shell and torso appeared it had been hit by a boat's propeller.
	3/3/09	1030	Spotted a live green sea turtle swimming near Westloch as EV/ARE1 team attempted to relocate a dead turtle found the day before but was unsuccessful.
	3/10/09	1500	Cynthia Pang received call from Port Ops re: Turtle w/tumor spotted on shore at Beckoning Pt. by a contractor. First thought was that it may be injured due to large tumor by tail section. I called NOAA to advise. NOAA called contractor directly for more information. Ktr noted that turtle went back into water, but is swimming eratically. NOAA asked ktr to watch out for it and if it comes back on shore to call them to pick up for vet care.
	3/11/09	1300	NOAA called to say ktr at Beckoning Pt. said turtle is partially on shore and had been swimming around the same area all morning. NOAA to retrieve turtle for assessment and medical attention. <3/20/09-Followed up with NOAA on turtle condition. Turtle was euthanized because it had too many tumors hindering its ability to feed and survive.>
	Sat 3/14/2009	8:23 AM	Per email from R. Hommon: Friday whale reported 6 miles west of entrance buoys headed east. Thursday at 530 pm turtle (small) seen swimming near shore by charlie landing by water taxi passenger.
	3/20/09	830	Per C. Pang, dead turtle sigted at Lima Landing, West Loch. T. Tengan went to look at it and emailed me pictures and map for NOAA/NMFS. Spoke with Will Connor/NOAA/NMFS, they will respond at 1300 due vehicle shortage and numerous non-Navy turtle calls. <1520 - Per Irene/NOAA, she spoke with Will regarding the turtles' condition. It was severely decomposed and falling apart in his hands. Irene thinks could be possible this turtle was the same one that we couldn't find on 3/03/09. No necropsy conducted due to advanced stage of decomposition.>
	3/23/09	1030	Per C. Pang, Monk Seal observed on shore at Alpha-docks at Hickam. NOAA to be contacted by reporter.
	3/26/09	930	Ed Jarvis/PORT OPS, told me that there's dead dog in the harbor at Bravo 25. COMNAVREGHIINST 5800.4E Dead Animals, states reports go to Navy Installation's Police Department for removal arrangements.
	3/31/09		3/30/09 - 1239pm - received phone message from Wayne Fukumoto/PHNSY Hazwaste Mgr. saying there is a monk seal at marine railway near DD #3 in CIA area. It seems to be breathing and is in a crevice with its head tucked down. It is tagged and the tag number is #30 on one side and #31 on the other side of the tag. Wayne said the shop guys said the seal had been there since this past Saturday. It does not seem to be injured as it is moving around and breathing. I advised Wayne not to touch the seal and to make sure everyone leaves it alone. I called Monk Seal Haul Out Hotline: #220-7802 and left message on their recording. I then called the Stranded Seal #1-888-256-9840 and spoke with a woman there. I gave her info above. I called Wayne back and he said that Gail Shon/PHNSY Environmental has made calls to NOAA Stranded Seal line. I called Gail and she seems to have everything taken care of. She advised workers in area to stay away but ok to keep an eye out for it. I called NOAA Stranded Seal line again and gave them tag number, Gail's name and my personal cell number in case they need to call back. Touched bases with Gail Shon, she said she told NOAA that area is secure so they cannot come in and that workers are aware not to disturb the seal. NOAA (Tracy) returned my call and conveyed they would still appreciate updates regarding the seal especially if events change.

	3/31/09		Hi Patty, I received a message from Tracie from NOAA. She said she'll be getting reports from you so I'll send you updates. The seal left but returned this morning. I checked at 0630 and the seal wasn't there. Workers said the seal usually returns around 0800. (Must be after colors so she doesn't have to salute). Anyway, Rosie has a red tag that's similar to a red badge so we decided she can stay in the CIA. Nathan, Kim, Noreen and I went out there a little while ago to set up barricade tape so people don't go close to the edge to see the seal. I also announced at the Cheyenne project meeting to stay away from the seal and to not feed it. Rich's wife called DB Dunlap, a guy who has dedicated his entire life each and every day preserving Hawaiian Monk Seals. When she told him the tag numbers, he told her that it was two tags on the same seal, Rosie. Rosie is a female, about 3 years old, born near Molokai, has been spotted around Oahu numerous times since May of last year, and has also made a couple trips to Kauai and back to Molokai. The advice is to leave the seal alone as it is just resting. I have photos that are going through the public release process. Let me know if you want copies once it's been cleared. Thanks, Gail
	4/1/09	809	Per Gail Shon/PHNSY, Rosie has not arrived yet. Someone posted an official warning sign to stay away from the monk seal. Gail did not know who did this. NOAA advised.
	4/1/09	1332	Per Christie Chun/PHNSY, Gail went out after lunch and told her that Rosie was back at the Marine Railway #2. NOAA advised.
	4/29/09		Per email from Becky Hommon 4/30/09 - Thu 4/30/2009 9:49 AM Patty, Neighbor told me last night a monk seal was sleeping on the beach at Iroquois Point yesterday afternoon. Please add that to the log. Neighbor said she'd reported it to NOAA's David Schofield. There's a lot of people who like to track seals and make reports to NOAA. Caren, Are you still the POC for communications with the Iroquois Point management? As a best management practice to make sure we're doing what we can to avoid problems with the seals or regulators, I'd like to work out a way that our tower gets this information about monk seals so that our vessel traffic is told about their presence. If someone knows a monk seal is in the area, it would be good if the tower knew so they could inform traffic to be especially watchful. Don't know how to make that happen. Ideas? Thanks. Beck
	4/30/09	Thu 4/30/2009 9:13 AM	Email from T. Tengan: Just a heads up. I was informed that there was a sea turtle hanging around at West Loch Lima Landing. It was observed swimming in the water near the pier for a long period, not sure if it is injured. The turtle is presently not in the area. Will keep you posted if we need further assistance from NOAA/NMFS.
	4/30/09	1012	P.Colemon advised TOWER (474-6262) there are turtles at Lima Landing and seal at Iroquois Pt.

	2/17/09	1653	No message necessary as green sea turtles are listed as threatened, not endangered. Navmag security has been shown the turtle (surf zone, boat ramp, lima landing) and given the turtle response number of noaa which is 288 5685. Navmag security indicated they would call noaa and meet at the office. Soft parts (face, flippers) were white , no visible tumors, no obvious fish line entangled. Shell had one crack obvious crack but don't know if turtles molt their shell or not. Sad. Vr Beck ----- Original Message ----- From: Hommon, Rebecca M CIV CNRH, N00L To: Pepi, Vanessa E CIV NAVFAC PAC ; CNRH ROC Sent: Tue Feb 17 16:53:23 2009 Subject: Dead turtle Lima landing boat ramp.
	5/9/09	3pm	Email from David Schofield to R. Hommon: perfect and thanks! Hommon, Rebecca M CIV CNRH, N00L wrote: > David, others may have reported but watched hawaiian monk seal cruise the shore line along iroquois pt beach saturday afternoon around 3 PM. Might be Rosie __ small seal. No problems, just present. Beach goers took phone photos but kept their distance. She vocalized a bit then returned to swimming along the shore. Lost track of her as she headed out. Let me know if more needed. All the best, Beck
	6/8/09	1009	I received phone call from Rich Tanaka that there is a dead sea turtle floating at Bravo 13 and 14. Hawaiian Dredging workers notice it at 0630. They contacted FEAD who in turn called EV2. I contacted NOAA/Tiffany Hooper, and met her at 1145 to take her to get the turtle. The turtle appeared to have been dead for quite a while as it was badly composed. 3/4 of its lower carapace was missing. Because it was next to the silt boom and at the bottom of the pier stairs, NOAA could access it easily. NOAA to conduct necropsy and email results to me for record.
	6/9/09	942	Received call from Daris Cook/FEAD, other half of dead sea turtle showed up at almost the same area as yesterday (6/08/09). I called NOAA Stranded Turtle and left message for call back. 1145-Went with NOAA to retrieve the turtle carcass. NOAA to perform necropsy of both halves tomorrow and let me know via email what the results will be. One week later, called NOAA for necropsy results: Non-conclusive, turtle was very decomposed, could not determine cause of death. DNA sample taken for records.
	6/22/09	900	Turtle suspected to be in PHNSY DD #2 during evolution. Rec'd call from John Muraoka. I contacted PHNSY environmental, Gail Shon, she said that workers saw turtle swimming in DD and some workers said that they saw the turtle swim out of the DD. PHNSY called NOAA, NFP Biologist, J. T. Hesse was also called and responded. Hesse worked in collaboration with George Balasz/NOAA on possible take. Ultimately, no turtle was found after DD drained.
	7/23/09	1315	PHNSY env. Called saying workers sighted An HMS swimming in the harbor. Not sure if Rosie. NOAA, PORT OPS, ROC advised.
	7/28/09	740	Voicemail from PH Tower: Multiple turtles sighted around USS Utah memorial. All appeared to be swimming fine.
	8/7/09	701	Tower reported 2 turtles at Lima Landing. Turtles are healthy and swimming near shore. Units advised to stand clear.
	8/12/09	710	Tower reported pod of ~30 dolphins near buoys 1 & 3; 3 turtles swimming near Hik Alpha docs; Units advised to stand clear.
	8/12/09	1302	ROC reported dead HMS (advance decay, covered with marine growth) floating in waters south of Maui.

	10/20/09		Email from Becky Hommon: Fyi -- turtle (medium sized) swimming /feeding at usual spot off of Lima Landing last evening (545 PM, OCTt 19) and this morning (650AM OCT 20) -- water taxi was very careful to avoid disturbing. Very calm winds so easy to spot. Didn't look tumored. Picked up quite a bit of plastic trash from the wood/trash collection at the boat ramp.
	1/29/10	906	29 jan. 906 am. Two whales tran siting. Half mile seaward of buoys 1 and 2. Vr beck
	2/11/10	1310	PHNSY Env. Natural Resources PM (R. Young) left voicemail re: dead sea turtle reported by PHNSY worker at Gun Dock area between DD #1 & #2. PHNSY POC to go and check it out and let me know. I returned call and left voicemail for status.
	2/22/10	___	Per BH, 22 FEB: whales spotted near buoys 1/2, transiting. All traffic advised.
	2/21/10	650	Per BH, 21 FEB: 0650 one turtle spotted occasional showing its head above the water apparently feeding. Seen from Iroquois Point beach half way between beach and cement structure.
	3/8/10	1625	ROC just advised that one of our subs spotted two whales headed west, buoys 1 & 2. 1625. All traffic advised.
	3/16/2010	719	Flat, still conditions. Good looking med sized turtle having brkfast in waters near lima landing this morning. 0715. Water taxi went very slowly as we departed the area. Sun already up. Vr beck
	4/12/10	1431	Per BH, For logging purposes, two whales reported passing by Papa Hotel at 1124 this morning.
	4/28/10	1546/1550	Matty/Metson Marine callded saying HMS sighted at Lima Landing. Port Ops Twr called with the same and they have issued an advisory to the vessels that HMS in area.
	7/26/10		Becky's neighbors reported seeing 3 monk seals at Ocean end of Iriquois Point this week - two adults and 1 young one.
	10/14/10	930	Port Ops received call of sighting of live turtle swimming near Pier 9. No troubles.
	10/21/10	1150	Port Ops relayed message from 324Delta boat, which spotted turtle near dry dock 3. No troubles.
	11/4/10	1029	3-4 turtles in vicinity of utah memorial. No distress issues. Reported by port ops control tower
	11/8/10	1354	Received call from Dennis Djou on dead turtle recovered by Richard Aoki, contractor, at NAVMAG westloch Wharf W-1. Turtle was entangled in netting. also lots of tumors. 35-40 years old, estimated. NOAA personnel removed carcass for necropsy.
	12/9/10	1207	Harbor control tower reported ship sightings of two whales, possibly mother & calf, in areas of buoys 1 and 2.
	12/16/10	720	Dead sea turtle found floating at lima landing. NOAA retrieved. Turtled had tumors near head. No other obvious signs of cause of death
	1/24/11	840	port ops tower reported two monk seal swimming near charlie pier
	1/24/11	854	Matson marine reported a dead turtle floating at the boat ramp at Lima Landing. NOAA retrieved. Necropsy reported concluded it was likely shark bitten and hit by a propeller, but order of events could not be inferred. Animal was
	1/26/11	1755	Harbor control observed dolphins between Alpha docks and Bravo 1. unconfirmed.
	1/27/11	1005	Harbor control observed whales around buoys 1 and 2
	3/16/11	1030	two green sea turtles diving in West Loch. Hebshi observation.
	4/19/11	600	Becky Hommon reports two green sea turtles on surface adjacent to Lima landing. Appear to be mating

APPENDIX C
NAVMAG PH LUALUALEI BRANCH AND WEST LOCH BRANCH PLANT AND ANIMAL SURVEYS

C1 – LUALUALEI BOTANICAL PROJECTS REPORT (NAVFAC PAC 2006E)

This page is intentionally left blank.

LUALUALEI VALLEY

This report provides an update to new and ongoing botanical projects from 2001-2006 in Lualualei Valley, Oahu.

Much of the undeveloped and upper elevation land at NAVMAG Lualualei was designated as critical habitat for threatened and endangered plants in 2002. Additionally, two areas in NCTAMS RTF were designated for ihi`ihi (*Marsilea villosa*).

Exclosures

The Navy installed two fenced exclosures in 1994 which were designed to exclude feral ungulates in Lualualei Valley. The exclosure locations were chosen to protect rare lama (*Diospyros sandwicensis*) and lonomea (*Sapindus oahuensis*) plant communities containing a high concentration of endangered species, including ko`oloa`ula (*Abutilon sandwicense*), *Bonamia menziesii*, mehamehame (*Flueggea neowawraea*), *Nototrichium humil*e, and *Lipochaeta lobata*. One exclosure is in the Halona district of the valley ("Halona"), the other below Puu Hapapa ("Puu Hapapa") in the Mikilua district.

The one acre Halona exclosure was situated for preservation of a lonomea forest containing endangered *Abutilon sandwicense* (Photo _). Other indigenous species that are common in the exclosure include hao (*Rauvolfia sandwicensis*), olopua (*Nestigis sandwicense*), mamaki (*Pipturus albidus*) and hame (*Antidesma pulvinatum*). In 2002, a contract was initiated to aid the Navy with removal of invasive species that were encroaching on the *A. sandwicense* population, reducing it to one large, adult individual. The density of endangered plants and the diversity of invasive species required a variety of removal methods, including manual and mechanical, herbicide treatment, and outplanting of native species. The outplantings were primarily derived from seeds collected in Lualualei. The contractor has followed a Navy prescribed restoration plan in the exclosure, including removal of passion flower (*Passiflora suberosa*) and coral berry (*Ravina humilis*) and outplanting of native species. Manual removal (pulling) was used on the thick patches of coral berry, often resulting in the uncovering of seedling *A. sandwicense* that had been struggling to emerge through the invasive ground cover. Removal of *P. suberosa* required manual cutting followed by herbicide application. By 2005, fourteen new *A. sandwicense* had emerged in the Halona exclosure, primarily as the direct result of manual removal of coral berry. Additionally, strong natural recruitment of other native species, including lonomea, ala`alawainui (*Peperomia sp.*), and hao has also been observed. Results indicate that invasive species such as *R. humilis* and tree daisy (*Montanoa hibiscifolia)* were most successfully removed manually, while passion flower required a combination of methods. The adult individual that remained in 2002 currently stands approximately 35 feet tall and continues to flower and seed several times per year. Outplanting of a`alii (*Dodonaea viscosa*), koa (*Acacia koa*), *S. oahuensis* and *P. albidus* has also occurred, mostly in the open canopy area mauka of the largest *A. sanwicense*. A catchment system was also installed in 2006 to assist with maintenance of the outplanted seedlings.

Seeds and cuttings from *A. menziesii* have been collected by Navy and provided to Lyon Arboretum for research and tissue storage.

The one-half acre Puu Hapapa exclosure contains rare lama (*Diospyros sandwicensis*) forest that provides habitat for three endangered species – mehamehame (*Flueggea neowawraea*), (*Nototrichium humile*) and *A. sandwicense* and one species of concern - halapepe (*Pleomele forbesii*). Other endemic species include hao, *Schidea lingustrina*, nioi (*Eugenia reinwardtiana*) and papala (*Charpentiera obovatum*). Several white hibiscus or koki`o ke`oke`o (*H. arnottianus*) can be found just outside the exclosure. In June 2006, there was one individual mehamehame tree, three *N. humile*, and twenty six *A. sandwicense*. Approximately fifteen other *A. sandwicense* have been observed along the trail to the exclosure as well.

Two other endangered species had been previously identified in the Puu Hapapa exclosure - *Bonamia menziesii* and *Lipochaeta lobata*. The *B. menziesii* was last observed in 2004, intertwined with a lama tree, and showing very poor vigor. Since then, it appears to have died. Several surveys, including June 2006 with Navy and Army biologists, have not observed the *L. lobata* since reported in 1994.

All of the listed plants in both exclosures have been tagged using standard silver tags and are monitored regularly by Navy biologists and contractors.

Threatened and Endangered Plant Collection

Navy biologists provide field support to Army environmental biologists from Schofield in obtaining cuttings and seeds from threatened and endangered plants in Lualualei as outlined in the Army's Makua Implementation Plan. Collections have been obtained from all *F. neowawraea* trees and all of the *Neraudia angulata* plants that within reach (one will require ropes down from Puu Kaua). Additionally, Army has also collected from *Nototrichium humile* in the Puu Hapapa exclosure.

Under an Endangered Species Recovery Permit from the U.S. Fish and Wildlife Service, Navy biologists also opportunistically collect plant material (cuttings and seeds) from threatened and endangered plants. The material is provided to Lyon Arboretum or other researchers for use in propagation and outplanting, research and genetic storage. Many Lualualei populations (*A. sandwicense, Cyperus trachysanthos, M. villosa, A. menziesii*) had not been represented in the storage facility before this permit was obtained in 2005.

Marsilea villosa, Abutilon menziesii and *Cyperus trachysanthos* monitoring

M. villosa, A. menziesii and *C. trachysanthos*, all endangered, occur in the antenna fields and adjacent natural areas of NCTAMS RTF in Lualualei Valley. All are monitored bi-monthly by NAVFAC biologists for vigor, seed dispersal and to regulate grass mowing.

The habitat requirements of both *M. villosa* and *C. trachysanthos* are very specialized. They both require periodic flooding and drying to emerge, reproduce and thrive. They are found seasonally in low spots, ephemeral streams and seasonal wetlands. In many areas, they only emerge after a significant rain event; they have been known to stay dormant for many years. Federal regulations require that those habitat conditions cannot be modified without consultation under the Endangered Species Act.

Critical habitat is not designated for any of these species.

M. villosa:

M. villosa (Photo) is dispersed into five small populations – four at NCTAMS RTF and one at NAVMAG LLL. (See Table 1). All populations have been tagged. Three of them occur in the antenna fields at NCTAMS RTF which are regularly mowed. A fourth is located in a sparse kiawe forest area that is not maintained. It was previously used for cattle grazing. The fifth population, at NAVMAG LLL, occurs in an area that is leased out to a local farmer for cattle grazing. The first four areas are delineated with signage (photo _) and removable PWC posts to avoid inadvertent negative impacts (e.g. mowing when still flooded, construction impacts, vehicle traffic, etc.) to the plants. The NCTAMS contracted landscaping crew has been educated about the mowing restrictions and do not mow the three areas unless informed in writing that it has been approved.

Endangered species consultations conducted with the USFWS allow the Navy to mow the areas where *M. villosa* occurs, but only once there is no longer standing water and the majority of the plants are dry and dormant. NAVFAC Pacific biologists monitor the areas monthly and provide guidance on when conditions are appropriate for mowing.

Plans for FY07 include research into soil composition for the five populations and adjacent areas. Graduate student research will also be considered.

C. trachysanthos:

C. trachsanthos is dispersed into three small populations, all of which are in the mowed areas of the antenna fields (See Table 2). All populations have been tagged. Two of them were first observed during a contracted botanical survey in 2004, the third in 2006 by NCTAMS landscaping staff. Population CYPTRA-1 (see photo _) was first observed when the area was flooded and the sedges were quite large already. When the botanists returned the following week, they observed CYPTRA-2 (see photo _) upslope in an adjacent area, re-sprouting after having been mowed a couple of weeks prior. CYPTRA-1 and 2 present different morphology, apparently resulting from their locations in a deep gulch versus slightly upslope. The gulch gets 1-2 feet () of standing water, whereas the upslope area gets less than one foot (m). The plants in CYPTRA-1 are much larger in all dimensions – up to 1 m in height, and 0.5 m in diameter (see photo _). CYPTRA-3 is one single individual, which is up-gulch, towards Niulii Ponds, from CYPTRA-1.

An ESA consultation with USFWS allows the Navy to mow the *C. trachysanthos* populations, if necessary, after they have dropped at least fifty percent of their seeds. The plants are regularly monitored by NAVFAC Pacific biologists and the installation is advised when mowing is approved.

A. menziesii:

A. menziesii (Photo _) occurs in three populations, two of which are within 30m of each other (see Table 3). All individuals have been tagged. ABUMEN-1 has been monitored for many years, however, ABUMEN-2 and 3 were first observed in 2005. All three are found in sparse kiawe forest, with bufflegrass as the predominant ground cover. Rainfall permitting, they seed throughout the year; seeds are provided to Lyon Arboretum for storage. Encroaching kiawe branches are occasionally trimmed back to avoid negative impacts to the endangered plants. Additionally, when predation from insects is severe, insecticide is applied the plants.

In early 2007, fencing and signage were installed around all three populations to protect them from inadvertent impacts from landscaping or development.

Chamaesyce kuwalaena protection and monitoring

C. kuwaelaena occurs on the peak of Kauaopuu and the two peaks to the northwest of Kauaopuu. This is at the installation boundary where it meets Waianae Kai. At least half of the known individuals exist within the installation boundary so this population is very important from a conservation standpoint. The main threat to the population is invasive species and fire, particularly for the plants at the seaward edge of the ridge. Areas adjacent to them have already been impacted by brushfires and the threat may be increasing due to the increasing coverage of invasive grasses. HiNHP also reported that this area has a higher rate of caterpillar damage than the plants found further inland, which will be monitored.

Plans for FY07 include a more comprehensive field survey to further delineate the population, regular monitoring, and invasive species (guineagrass, molasses grass, fountaingrass) removal to reduce the fuels. Invasive grasses will be replaced with native grass such as pili (*Heteropogon contortus*), along with other appropriate native groundcover.

Marsilea villosa

CYPTRA-1 – gulch habitat


Cyperus trachysanthos, with seeds, in CYPTRA-1


CYPTRA-2 – dry area


A. menziesii (ABUMEN-2)

Table 1. *Marsilea villosa* population information

	Population Name	**Tag Number**	**UTM coordinates**	**Management**	**Number of Individuals**
1	SE corner	MARVIL LLL-1	2368699.320N 588822.770E	Mowed	High hundreds
2	SW corner (largest)	MARVIL LLL-2	2368136.077N 587935.099E	Mowed	Thousands
3	Old cattle site	MARVIL LLL-3	2370015.056N 586011.060E	Hand weeding	High hundreds
4	Costa site	MARVIL LLL-4	2371873.123N 588476.176E	None	Thousands
5	Middle field	MARVIL LLL-5	2369661.01N 586432.50E	Mowed	~100

Table 2. *Cyperus trachysanthos* population information

	Population Name	**Tag Number**	**UTM coordinates**	**Management**	**Number of Individuals**
1	Gulch	CYPTRA LLL-1	2368696.481N 588803.141E	Mowed	70-80
2	Dry	CYPTRA LLL-2	2368699.718N 588845.215E	Mowed	400-500
3	Middle field	CYPTRA LLL-3	2368858.305N 588803.141E	Mowed	1

Table 3. *Abutilon menziesii* population information

	Population Name	**Tag Number**	**UTM coordinates**	**Management**	**Number of Individuals**
1	Niulii Ponds	ABUMEN LLL-1	2369846.911N 588911.205E	Varied	1
2	NAVMAG 1	ABUMEN LLL-2 through LLL-6	2369090.458N 589299.803E	Varied	5
3	NAVMAG 2	ABUMEN LLL-7 through LLL-11	2369090.458N 589299.803E	Varied	4

C2 – FLORA AND FAUNA SURVEY OF NAVAL MAGAZINE PEARL HARBOR LUALUALEI BRANCH, LUALUALEI VALLEY, O‘AHU, HAWAI‘I (HNHP 2004A)

Flora and Fauna Survey of Naval Magazine Pearl Harbor, Lualualei Branch, Lualualei Valley, Oahu, Hawaii.

Prepared for
Commander,
Navy Region Hawaii

Prepared by
Hawaii Natural Heritage Program
University of Hawaii at Manoa
Center for Conservation Research and Training
677 Ala Moana Blvd., Suite 705
Honolulu, HI 96813

October 2004

Executive Summary

The Hawaii Natural Heritage Program (HINHP) conducted a survey for rare, threatened, and endangered flora and fauna on Naval Magazine Pearl Harbor, Lualualei Branch (NAVMAG PH LLL), Lualualei Valley, Oahu, Hawaii. Lualualei Branch (PH LLL) is a 3030 ha installation located on the leeward side of the Waianae Mountains. Elevation ranges from 25 meters to over 750 meters (82-2461 feet).

The objective of the survey was to conduct biological surveys for rare, threatened and endangered flora and fauna and to identify areas of significant native dominated habitat in order for the Navy to meet objectives in its Integrated Natural Resources Management Plan for PH LLL. Thirty rare plant taxa and seven animal taxa were thought to potentially exist in the area prior to the initiation of these surveys.

Surveys for all species were conducted January through June 2004. Native and rare plants were searched for in areas where they were known to exist or thought to be likely to occur. Twenty-three rare plant taxa were observed: sixteen endangered taxa, one candidate taxon, and six species of concern.

Landsnails of the genera *Achatinella* and *Amastra* were searched for in areas where they were most likely to exist. *Achatinella mustelina* were observed in five different locations. A single population of the species of concern *Amastra cylindrica* was observed.

Bird surveys were conducted using three different methods to determine the species present in PH LLL and to target native or endangered species. Twenty-nine bird species were observed, one was endangered, and three other bird species were native. The remaining twenty-five species were non-native. High numbers and densities of non-native birds occurred throughout the area sampled.

Limiting factors to native species populations in PH LLL are similar to those found throughout Hawaii. Included among these are loss of habitat, damage from feral ungulates, competition from non-native species, depredation by non-native mammals, and, in birds, mosquito-borne disease.

Acknowledgments

The input, guidance and assistance of several individuals and organizations aided the Hawaii Natural Heritage Program during this survey. In particular, we note the efforts of Stefan Kropidlowski, Jeffrey Preble and Ken Suzuki who provided assistance in the field. We thank Sara Burgess, Eric VanderWerf, and Kenneth Wood for providing their specific expertise and guidance in the field.

Navy staff at Navy Region Hawaii, NAVFAC Pacific, and Naval Magazine Pearl Harbor, Lualualei Branch provided invaluable assistance. William Kramer, Randy Miyashiro, Vanessa Pepi, Julie Rivers, Tim Sutterfield, and Terrence Tengan aided us by providing information pertinent to the survey area and by coordinating access onto the facility. We appreciate the assistance of the security staff on the station, especially Phil Manandic.

Table of Contents

List of Tables

List of Figures

This page is intentionally left blank.

Introduction

The Hawaii Natural Heritage Program (HINHP) was contracted in September 2003 by the Naval Facilities Engineering Command, Pacific to conduct biological surveys for rare, threatened and endangered flora and fauna on Naval Magazine Pearl Harbor, Lualualei Branch, Lualualei Valley, Oahu (NAVMAGPH LLL) in order for the Navy to meet objectives in the Integrated Natural Resources Management Plan.

Lualualei Valley is located on the western side of the Waianae Mountains on the island of Oahu (Figure 1). Before settlement by humans, Lualualei Valley would likely have been composed of coastal strand communities, lowland dry forest and shrubland at mid-elevations, lowland mesic forest and shrubland along cliff faces, dry cliff communities on the leeward summits and ridgelines, and wet cliff communities on windward cliff faces (Gon and Matsuwaki 2003). Activities during Polynesian times that would have altered habitat include agriculture, introduction of rats, and fire. Further alteration in post-contact times was caused by ranching, agricultural practices, feral ungulates, and invasion by alien plants. As a result, vegetation composition has been modified greatly over time; areas below 300 (984 feet) meters elevation are largely non-native vegetation. Areas above 300 meters are more likely to contain native communities, plants, and animals, however habitat disturbance allows for intrusion of non-native species (Loope et al. 2001), and few areas in the valley are intact native communities (Hawaii Natural Heritage Program 1994).

Prior to the 1994 biological inventory conducted by HINHP, Lualualei Branch (PH LLL) had not been systematically inventoried for rare plants. Since that time, several other surveys have been conducted by Navy personnel and others. These include a search in 2002 by HINHP and Navy personnel for two rare tree taxa, *Alectryon macrococcus* var. *macrococcus* and *Flueggea neowawraea* (Hawaii Natural Heritage Program 2003). In 2003, personnel from the Army Directorate of Public Works, Environmental Division, the Navy, and HINHP also conducted surveys for various plant taxa.

Rare plant taxa recorded from PH LLL prior to the 2004 survey are *Abutilon sandwicense, Alectryon macrococcus* var. *macrococcus, Bobea sandwicensis*, *Bonamia menziesii*, *Chamaesyce kuwaleana*, *Diellia unisora, Flueggea neowawraea*, *Hedyotis parvula*, *Labordia kaalae*, *Lepidium arbuscula*, *Lipochaeta lobata* var. *leptophylla*, *Lobelia niihauensis*, *Lobelia yuccoides*, *Marsilea villosa*, *Melanthera tenuis*, *Neraudia angulata*, *Neraudia melastomifolia*, *Nototrichium humile*, *Platydesma cornuta* var. *decurrens*, *Pleomele forbesii*, *Schiedea hookeri*, *Schiedea pentandra*, *Tetramolopium filiforme,* and *Viola chamissoniana* subsp. *chamissoniana*. These species were targeted during this survey.

Several other rare plant taxa had not been recorded from PH LLL but were thought to have a fair chance of being found in PH LLL since they have been recorded just outside PH LLL boundaries. These plants included *Abutilon menziesii, Cyanea calycina, Diellia falcata, Dubautia sherffiana, Joinvillea ascendens* var. *ascendens, Melicope pallida, Melicope saint-johnii, Phyllostegia hirsuta, Plantago princeps* var. *princeps, Sicyos lanceoloidea, Silene perlmanii, Spermolepis hawaiiensis, Tetramolopium lepidotum* subsp. *lepidotum*, and *Urera* *kaalae*. Plant taxonomic information and references can be found in Appendix 1 and Appendix 2. Bird taxonomy follows Pyle 2002.

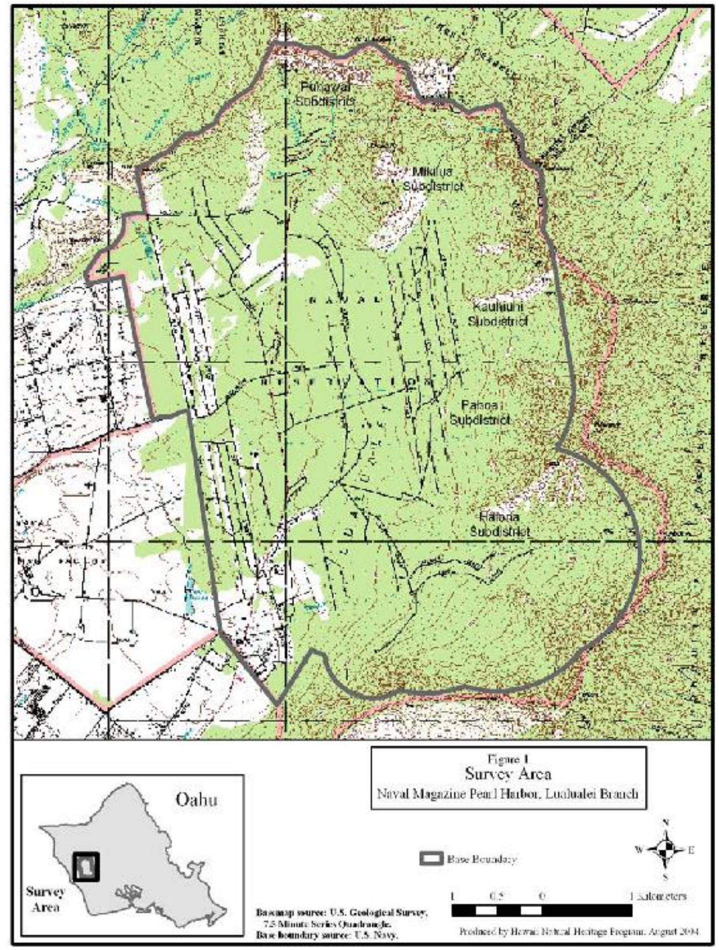


Figure 1
Survey Area
Naval Magazine Pearl Harbor, Lualualei Branch

An objective of this survey was to search for rare snails in the genera *Achatinella* and *Amastra*. *Achatinella*, which is genus of tree snails endemic to Oahu, includes the only listed endangered invertebrate species currently known to occur in PH LLL, *A. mustelina*. A second species of *Achatinella*, A. *concavospira*, once occurred in PH LLL, but is now probably extirpated there. A species in the land snail genus Amastra, *A. cylindrica*, is not a listed endangered species, yet its current known state-wide distribution is a single small colony in PH LLL, and is therefore of extreme conservation concern. There are also several species of *Amastra* aside from *A. cylindrica* that potentially occur in PH LLL, but they are either extremely rare or thought to be extinct.

Native birds known from PH LLL include the Hawaiian owl or pueo (*Asio flammeus sandwichensis*), Oahu elepaio (*Chasiempis sandwichensis ibidis*), Oahu amakihi (*Hemignathus flavus*), apapane (*Himatione sanguinea*), and iiwi (*Vestiaria coccinea*). Five *C. sandwichensis ibidis* individuals were known to occur before the initiation of this survey. The birds detected during the 1994 survey by HINHP were: *A. flammeus sandwichensis*, *C. sandwichensis ibidis*, and *H. flavus* (Hawaii Natural Heritage Program 1994).

Methods

Botanical Survey

The rare plant survey was conducted from January through June 2004. Because this period tends to have more precipitation, it was to our advantage for detecting the few annuals among the rare Hawaiian plants, as well as certain rare native plants whose stems die back to their roots at the onset of the dry summer season.

Taxa searched for on this survey included all plant taxa listed as endangered or threatened by the U.S. Fish and Wildlife Service, and taxa that are candidates for listing as endangered or threatened. Additionally, taxa considered to be species of concern (SOC) by the Pacific Ecoregion office of the U.S. Fish and Wildlife Service (USFWS) were searched for in this survey.

Surveys within PH LLL were concentrated in areas known to contain rare plants and areas with the most potential for finding new rare plant occurrences. Previously documented rare plant occurrences were visited in order to obtain current information on their status. New occurrences were sought by covering previously unsurveyed areas, or areas and habitats that might have been overlooked in the past. Where rare plants were not accessible due to steep terrain, binoculars were used to observe the plants. In some cases ropes were used to reach rare plants growing on cliffs.

A Trimble ProXR GPS unit with TSCe Datalogger using TerraSync™ , a Trimble ProXR GPS unit with at TSC1 Datalogger using Asset Surveyor software, and a Geo Explorer3 unit were used to determine the locations of rare plants seen on the survey as precisely as possible, and to record the survey routes. However, it was not always possible to obtain readings, especially in the gulches and alongside the cliffs where many of the rare plants occur. In such instances, USGS 7.5 minute Quadrangle Maps were used to approximate rare plant locations and survey routes.

A species list was compiled for the naturally occurring native plants and the naturalized alien plants encountered on this survey (Appendix 1).

Achatinella and *Amastra* Survey

Prior to the survey, current and historical records on the distribution of *Achatinella* and *Amastra* on PH LLL and adjacent areas were consulted in order to identify areas with the most potential for supporting surviving populations of these snails. *A. mustelina* is one of Hawaii's most comprehensively and accurately documented snail species with regard to historical maps that indicate precise locations of historic populations (Welch 1938). In addition to the historically and recently documented areas of occurrence of *Achatinella* and *Amastra*, we also searched certain areas where the genera had never been reported but that appeared to constitute favorable habitat.

Achatinella have been found in and around PH LLL in the upper elevations on or adjacent to the summit ridge of the Waianae Mountains in mesic and wet forests and shrublands. In the southern and central Waianae Mountains they are most likely to be found in native vegetation or in areas with at least some remnant native plants. The habitat of *Achatinella* extends from ridge crests to gulch slopes and gulch bottoms. At the beginning of the survey, the general areas within PH LLL that were thought to have the best potential for finding surviving populations of *Achatinella* were the stretches of the Waianae summit ridge near Puukumakalii, on Puuhapapa, and south of Puuhapapa; as well as the PH LLL side of Puukaua, and in areas on or adjacent to the Waianae summit ridge between Pohakea Pass and Palikea.

The search for *Achatinella* was focused on the plant species known to frequently serve as host plants for *Achatinella* in the southern and central portions of the Waianae Mountains (Table 1). These are mostly native plant species, but also included among them are several alien plant species.

Table 1. List of host plant species for snails in the genus *Achatinella*.

Species Name	Common Name	Status
Antidesma platyphyllum	Mehame	Native
Coprosma longifolia	Pilo	Native
Freycinetia arborea	Ieie	Native
Melicope spp.	Alani	Native
Metrosideros polymorpha	Ohia lehua	Native
Myrsine lessertiana	Kolea	Native
Nestegis sandwicensis	Olopua	Native
Perrottetia sandwicensis	Olomea	Native
Pisonia sandwicensis	Papala kepau	Native
Pisonia umbellifera	Papala kepau	Native
Pouteria sandwicensis	Alaa	Native
Psidium cattleianum	Strawberry guava	Alien
Psidium guajava	Common guava	Alien
Schinus terebinthifolius	Christmas berry	Alien

When live *Achatinella* were found at a given spot, the host plants and number of snails were recorded. The number of *Achatinella* recorded at each site does not normally represent the total population of snails at the site. In most cases this number represents but a fraction of actual number of individuals in the area. The *Achatinella* reconnaissance was aimed at determining the general outlines of the current distribution of *Achatinella* throughout PH LLL, only a limited amount of time could be spent at any given location.

In cases where the PH LLL boundary runs along a ridge top, the boundary was considered to be positioned precisely along the divide separating the two drainages on either side of the ridge, and not along trails or fences. Individual *Achatinella* that were seen within two meters of the PH LLL boundary were recorded in addition to *Achatinella* seen within the PH LLL boundary, since *Achatinella* are mobile and individuals close to the boundary could easily venture onto PH LLL land or fall onto PH LLL land if dislodged from or blown off of their host plant.

Living *Amastra* colonies were sought by concentrating in areas appearing favorable for the occurrence of the several species of *Amastra* recorded from the southern Waianae Mountains, which includes primarily native mesic forests in gulch bottoms and on gulch slopes. Concentrations of shells on the ground were sought because they are indicative of the former or current occurrence of *Amastra*. Fresh shells on the ground signify the presence of living *Amastra* in the recent past, and therefore our search concentrated in the areas where the freshest shells were found. For both *Achatinella* and *Amastra* locations, GPS was used to mark locations.

Bird Survey

Surveys were conducted from January through April 2004. Surveys for forest birds concentrated on higher elevation areas thought to be most likely to contain native avifauna. Because pueo frequent open areas as well as forested areas (Berger 1981), surveys for this species focused on both open areas and forested areas on the magazine.

Survey routes and data points were collected with a Trimble ProXR GPS unit and TSCe Datalogger using TerraSync™. In cases where satellite reception was poor or nonexistent, locations were approximated on USGS 7.5 minute Quadrangle Maps in ArcView GIS upon return from the field. In order to increase the likelihood of detecting native species, three sampling methods were employed.

Point Counts

The variable circular plot (VCP) method (Reynolds et al. 1980) was used to census forest bird populations at stations along transects. Transect locations were selected *a priori* using UGSG 7.5 minute Quadrangle Maps as reference to locate areas with the highest probability of containing native birds, while also sampling a representative portion of PH LLL. Stations were created along the transects at 150 meters (492 feet) apart and were loaded into the GPS unit as waypoints to be navigated to.

During the count, each species and distance to each individual was recorded during an eight-minute time period. The type of detection (audio or visual) was also recorded.

In order to optimize detection probability and precision, we did not survey when wind exceeded 30 kilometers per hour or during heavy rain.

Opportunistic Sampling

Because transects in the VCP portion of the survey covered relatively uniform habitat types and elevation ranges, and because transects tended to end in areas that were more likely to contain native birds, we tried to increase the likelihood of detecting native birds by sampling in the habitat beyond and between transects after reaching the final station of a transect, and along ridgelines. Specifically, the ridgelines between Puuhapapa and Puukaneoha, and north from Palikea were surveyed because they were accessible from trails on adjacent property. Because these trails make up the border between PH LLL and other landholders, auditory and visual observations were focused toward the PH LLL side of the property.

Routes walked at the end of transects focused on locating elepaio individuals or populations in addition to those already known. We targeted areas with suitable habitat and topography. The playback method described below was utilized in these instances.

To target pueo outside of forested habitat, we drove through areas of the magazine that had relatively open habitat and looked for pueo.

Elepaio Playback

To target elepaio, playbacks of their song were used to maximize the likelihood of detection (Johnson et al. 1981, Marion et al. 1981, VanderWerf et al. 2001). In order to avoid bias during point counts, playback recordings were utilized in areas of suitable habitat along survey transects only after the eight-minute count period was completed. Because elepaio are already known from PH LLL, searches for additional populations or individuals were conducted. Targeted areas included small gulches between the known individuals in the Kauhiuhi subdistrict and areas that contained suitable habitat in Halona, Pahoa, and Mikilua subdistricts. GPS lines were recorded for these survey routes, and points were recorded when the playback method was utilized.

Data Management and Summary

Point count data were entered into the Avian Monitoring Entry Form software (AMEF) created by USGS-BRD Kilauea Field Station. AMEF was created to manage variable circular plot data, so that it can be exported to standard spreadsheet and analysis programs. Species lists were derived from these data. Additional species detected from opportunistic sampling were added to these lists.

All GPS data were downloaded from the Trimble unit into Pathfinder Office software and were differentially corrected to increase the accuracy of the data recorded in the field. The corrected data were exported as shapefiles for use in creation of maps in ArcView.

Results

Botanical Survey

Surveys covered all areas that were likely to contain target plant taxa (Figure 2). We observed 23 rare plant taxa: 16 endangered taxa, one candidate taxon, and six species of concern (Table 2, Figures 3, 4, 5 and 6). Another endangered species, *Bonamia menziesii*, was not observed during this survey. However, two individuals of the species were observed in 2002 and are likely to still be alive. Another candidate taxon, *Platydesma cornuta* var. *decurrens*, was seen on the 1994 survey but not on the 2004 survey. It is possible that the single plant of the taxon seen in 1994 may have been missed in 2004. There are no rare taxa that are known to have occurred in PH LLL but are likely extirpated from PH LLL. Two rare plant taxa have been discovered on PH LLL since the 1994 survey. *Diellia unisora* was first found in PH LLL during surveys in 2003, and *Spermolepis hawaiiensis* was first recorded in PH LLL during this survey. Species information on taxa with Federal Status or SOC on PH LLL can be found in Appendix 2.

Achatinella and *Amastra* Survey

In the 2004 search for *Achatinella* on PH LLL, no living *A. concavospira* were found. The species did occur within the PH LLL boundaries in Halona in the past, as evidenced by the distribution of old shells on the ground and under boulders. However, no recently dead shells of the species were found.

A. mustelina is historically documented from several parts of PH LLL, mostly in areas where the PH LLL boundary extends up to the main dividing ridge of the Waianae Mountains (Welch 1938). During the1994 biological survey of PH LLL, no *A. mustelina* were found within the PH LLL boundaries, although individuals were seen in several locations just outside the PH LLL boundaries. Daniel Chung (n.d.) reported the observation of five individuals of *A. mustelina* in 1995 on the PH LLL portion of Puuhapapa, and in 2003, the species was seen on the PH LLL side of Puukumakalii by Vincent Costello (pers. comm.).

On this survey, *A. mustelina* was confirmed to occur within PH LLL in the area of Puuhapapa, which is south of Kolekole Pass, and the area of Puukumakalii, which is to the north of Kolekole Pass (Figure 7). The numbers of individuals of *A. mustelina*, and the host plants they were found on are given below in Table 3. Most likely, the number of individuals reported below for each site does not represent the total number of individuals that were actually present at the site. Some individuals undoubtedly went undetected, as *Achatinella* can be difficult to spot amongst the leaves of their host trees. As the aim of the *Achatinella* reconnaissance was to determine the general outlines of *Achatinella* survival throughout PH LLL, only a limited amount of time could be spent at any given *Achatinella* site or potential site.

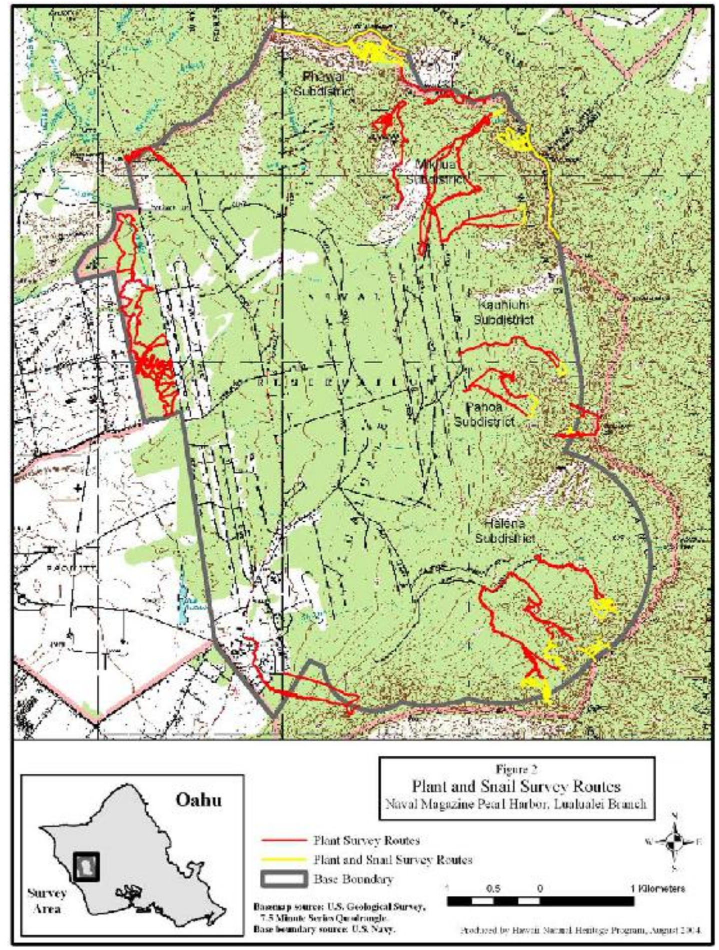
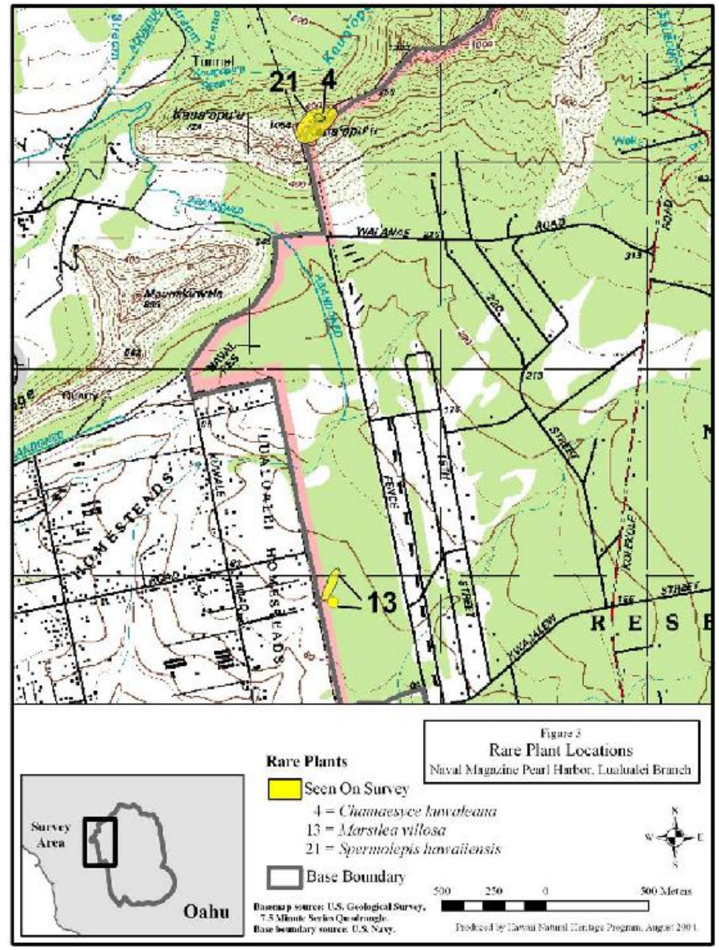


Figure 2
Plant and Snail Survey Routes
Naval Magazine Pearl Harbor, Lualualei Branch

Table 2. Rare, threatened or endangered plants recorded in Naval Magazine Pearl Harbor, Lualualei Branch in 2004.

Species Name	Common Name	Federal Status*
Abutilon sandwicense	None known	LE
Alectryon macrococcus var. *macrococcus*	Alaalahua, mahoe	LE
Bobea sandwicensis	Ahakea	SOC
*Bonamia menziesii***	None known	LE
Chamaesyce kuwaleana	Akoko, koko, ekoko, kokomalei	LE
Diellia unisora	None known	LE
Flueggea neowawraea	Mehamehame	LE
Hedyotis parvula	None known	LE
Labordia kaalae	Kamakahala	SOC
Lepidium arbuscula	Anaunau, naunau, kunana	LE
Lipochaeta lobata var. *leptophylla*	Nehe	LE
Lobelia niihauensis	Oha, haha, oha wai	LE
Lobelia yuccoides	Panaunau	SOC
Marsilea villosa	Ihi ihi, ihi laau	LE
Melanthera tenuis	Nehe	SOC
Neraudia angulata	Maaloa, maoloa, oloa	LE
Neraudia melastomifolia	Maaloa, maoloa, oloa	SOC
Nototrichium humile	Kului	LE
Platydesma cornuta var. *decurrens****	Pilokea	C
Pleomele forbesii	Halapepe	C
Schiedea hookeri	None known	LE
Schiedea pentandra	None known	SOC
Spermolepis hawaiiensis	None known	LE
Tetramolopium filiforme	None known	LE
Viola chamissoniana subsp. *chamissoniana*	Pamakani	LE

*Federal Status - Official U.S. Fish and Wildlife Service, Endangered Species Act (ESA) categories for endangered and candidate endangered taxa (species, subspecies, & varieties) according to the Federal Register. Listed Endangered (LE)=Taxon formally listed as endangered; Listed Threatened (LT)=Taxon formally listed as threatened; Proposed Endangered (PE)=Taxon proposed to be formally listed as endangered; Proposed Threatened (PT)=Taxon proposed to be formally listed as threatened; Candidate (C)=Taxon for which substantial information on biological vulnerability and threat(s) support proposals to list them as endangered or threatened; Species of Concern (SOC)=Taxon that is not listed or a candidate for endangered or threatened status, but is nevertheless of conservation concern.
**Not seen on this survey, but seen as recently as 2003.
***Not seen on this survey, but possibly extant in PH LLL.



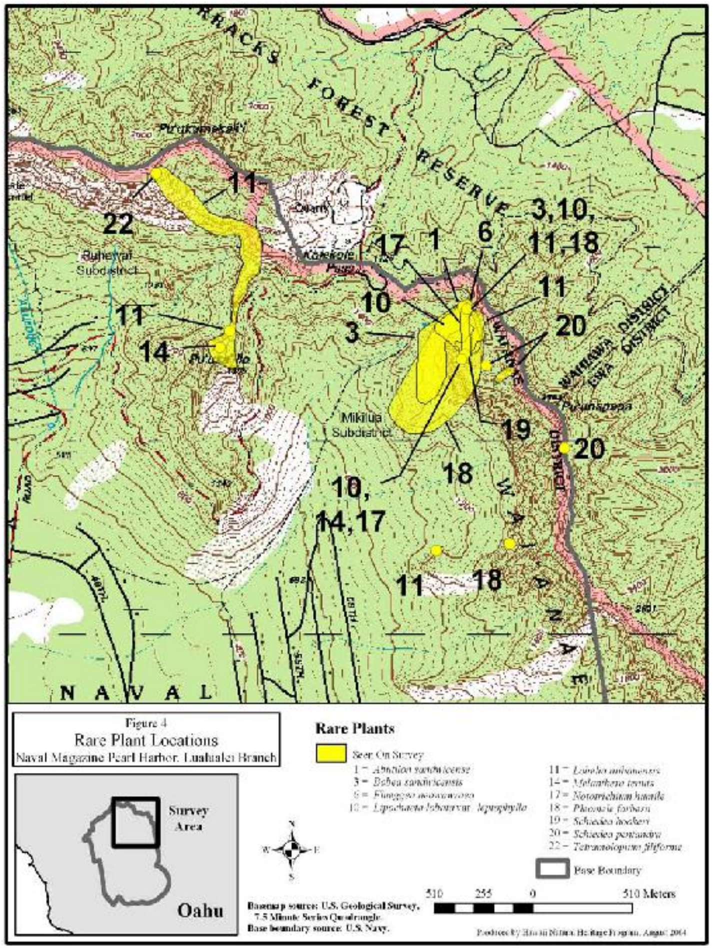


Figure 4
Rare Plant Locations
Naval Magazine Pearl Harbor, Lualualei Branch

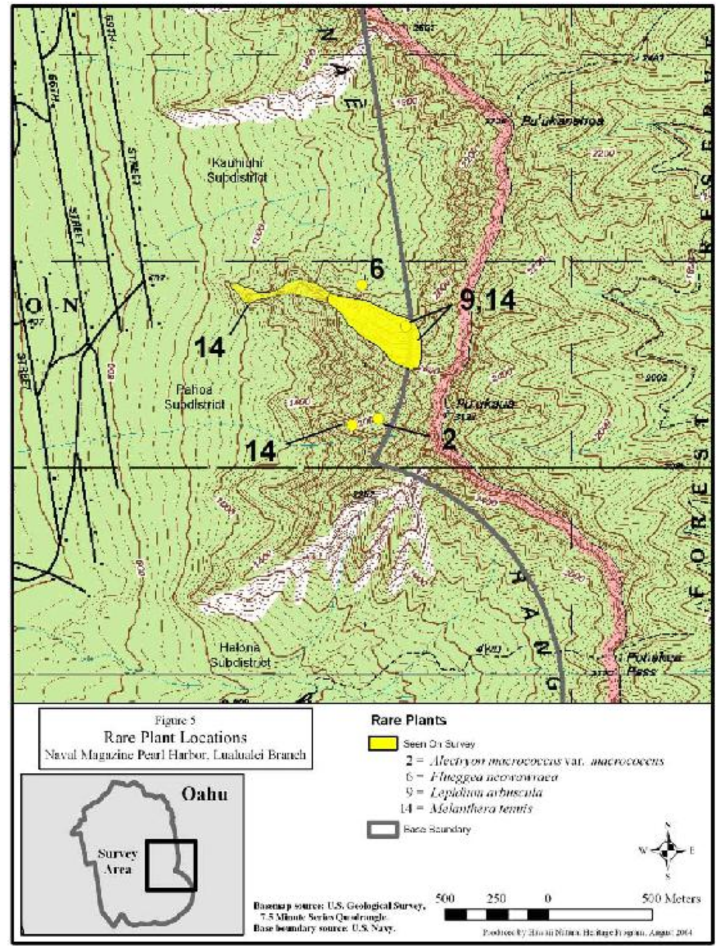


Figure 5
Rare Plant Locations
Naval Magazine Pearl Harbor, Lualualei Branch

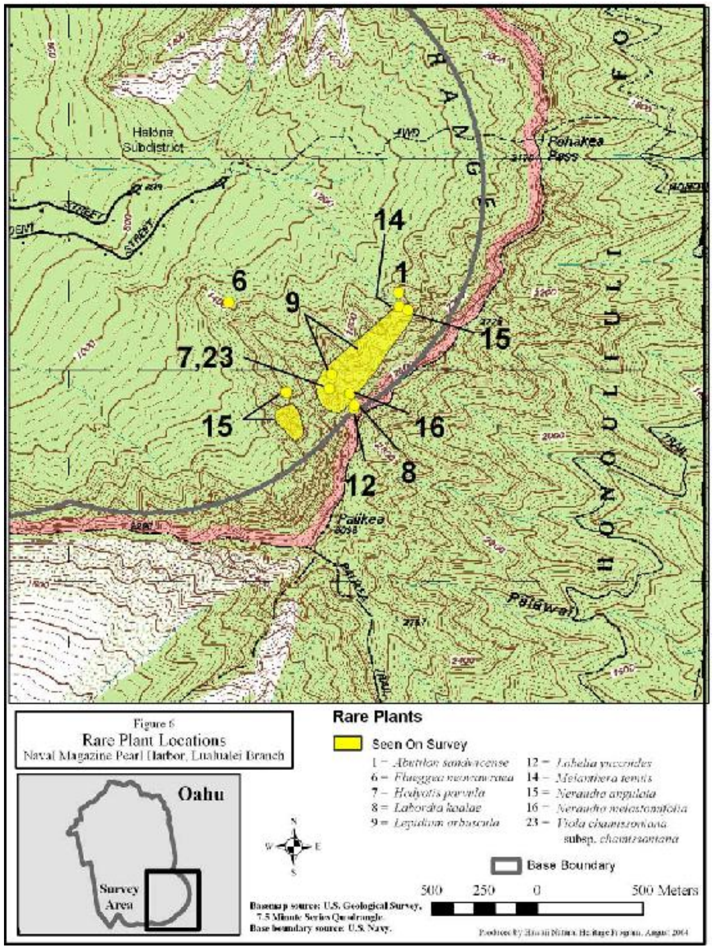


Figure 6
Rare Plant Locations
Naval Magazine Pearl Harbor, Lualualei Branch

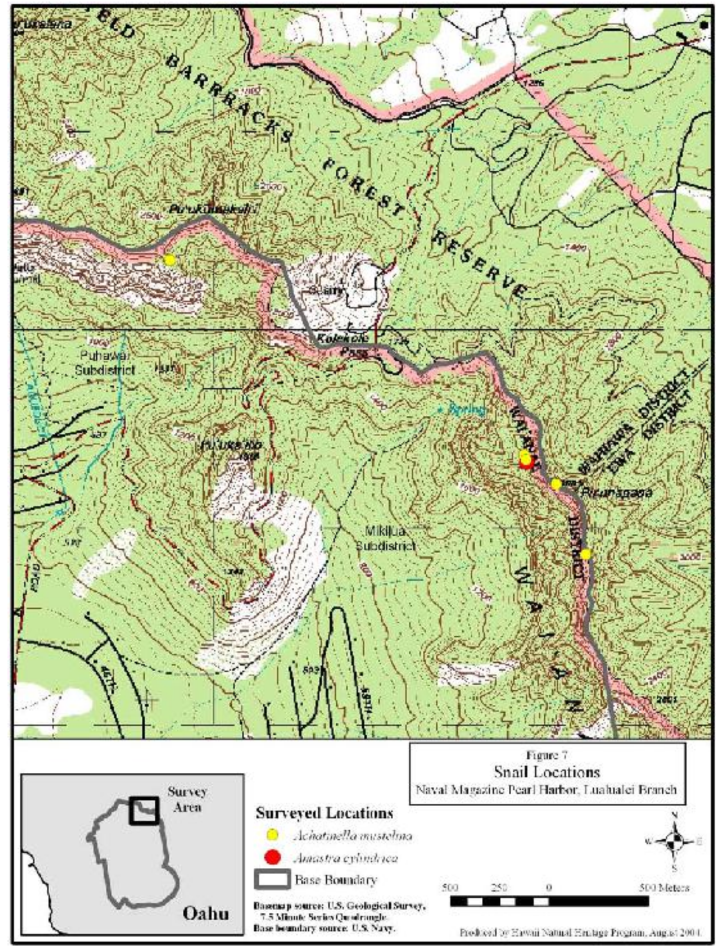


Figure 7
Snail Locations
Naval Magazine Pearl Harbor, Lualualei Branch

Table 3. Location, number, and host plant of *Achatinella mustelina* individuals observed in Naval Magazine Pearl Harbor, Lualualei Branch in 2004.

Location	Location Details	Date	Number of *A. mustelina* observed	Host Plants	Comments
Puukumakalii	southwest side of Puukumakalii	May 18	2 mature 7 immature	8 on *Myrsine lessertiana* (kolea) 1 on *Xylosma hawaiiense* (maua)	Well within PH LLL.
Puuhapapa A	summit divide near Puuhapapa summit	Apr. 17	4 mature 3 immature (not counting individuals seen outside the PH LLL boundary)	1 on *Myrsine lessertiana* (kolea) 6 on *Schinus terebinthifolius* (Christmas berry)	This colony straddles the boundary between PH LLL and Schofield Barracks Military Reservation (SBMR). More individuals were seen on the SBMR side than on the PH LLL side.
Puuhapapa B	northwest side of Puuhapapa	Apr. 17	3 mature	3 on *Pisonia sandwicensis* (papala kepau)	Well within PH LLL.
Puuhapapa C	northwest side of Puuhapapa	Apr. 17	3 mature	1 on *Myrsine lanaiensis* (kolea) 2 on *Schinus terebinthifolius* (Christmas berry)	Well within PH LLL.
Puuhapapa D	summit divide south of Puuhapapa	June 4	1 mature 1 immature	2 on *Myrsine lessertiana* (kolea)	The two individuals seen were outside PH LLL, but within two meters of PH LLL's ridge top boundary.

Numerous old *A. mustelina* shells were found on the PH LLL portion of Puukaua, but no recently dead ones were seen. A moderate number of *A. mustelina* shells were seen in the Halona section of PH LLL, but all were old.

A population of *A. cylindrica* on PH LLL is the only population of the species known to remain in the wild. The population was first recorded in July 1995 by D. Chung in a report on the terrestrial mollusks seen by him on a hike on the PH LLL side of Puuhapapa (Chung n.d.). The population was observed again in November 2002 by an HINHP biologist when it was encountered incidentally during a survey for the endangered trees *Alectryon macrococcus* var. *macrococcus* and *Flueggea neowawraea* (Hawaii Natural Heritage Program 2003).

No new living populations of *Amastra* were located on PH LLL in the course of this survey. The only living *Amastra* seen were in the previously recorded colony of *A. cylindrica* on Puuhapapa on a slope near a gulch bottom. The *Amastra* population was visited on two occasions during the 2004 survey. On the first visit on Feb. 20, 2004, the environment of the *Amastra* site appeared relatively unchanged from when it was observed in 2002. However,

when visited again on Apr. 17, 2004, the *Amastra* colony was found to have been impacted by a landslide. Included in the landslide were large rocks that crashed through the site, knocking down trees and shrubs or breaking off their branches. Because parts of the forest canopy and understory were destroyed, the site is now more exposed to sunlight than before, and therefore the suitability of the site for *Amastra* has been reduced. The area where live *Amastra* can be found is less than 15 meters by 15 meters (45 feet by 45 feet) across.

At this site, the primary canopy tree is the native *Pisonia umbellifera* (papala kepau) and also has a lot of *Claoxylon sandwicensis* (poola), which is a small native tree or shrub. The non-native Christmas berry (*Schinus terebinthifolius*) is also common.

It was not possible to estimate the number of individual snails in the colony and the area that they occupy without excessively disturbing the site. Estimating the size of the population would be difficult since most of snails are not normally in the open during the day, but are hidden in the leaf litter or in the spaces between rocks. Even when out in the open, they are hard to spot since their shells are usually dark in color, and they do not stand out very well against the leaf litter and soil.

The snails were much harder to find when the site was visited on this survey as compared to when they were seen in 2002. The average time it took to find a living *Amastra* in 2002 was approximately five minutes, while on the first visit during the 2004 survey it took an average of 11 minutes, and on the second visit it took an average of 14 minutes.

Evidence was found at the site of recent predation on *Amastra* by rats. The shells of snails killed by rats are characteristically broken on one side or on one end. More than half of the recently-dead shells showed signs of having been predated by rats, and rat feces was often seen within the *Amastra* colony.

A shell of the introduced carnivorous snail *Euglandina rosea* was found within the *Amastra* colony that still contained the rotting remains of the shell's occupant. A few older *Euglandina* shells were also found near the *Amastra* site.

Bird Survey

A total of 29 bird species was observed during the survey period (Table 4). Four of five targeted native avian species were observed on or near PH LLL. The remaining species observed were non-native, and some are considered to be pest species.

<u>Point Counts</u>

A total of 68 stations along ten transects was surveyed (Figure 8). Nineteen bird species were counted; 18 of these were non-native species (Table 5). The sole native species observed during counts was Oahu elepaio. One individual was observed at 1044 am on March 31. This individual was previously known, and had recently been banded (see below).

Table 4. Native and non-native vertebrates encountered in Naval Magazine Pearl Harbor, Lualualei Branch during bird surveys in 2004.

Species Name	Common Name	Residency Status*	Federal Status**	HINHP Rank***
Phaethon lepturus	White-tailed Tropicbird	Ri		G5
Bubulcus ibis	Cattle Egret	An		G5
Francolinus erckelii	Erckel's Francolin	An		G5
Pavo cristatus	Common Peafowl	An		G5
Pluvialis fulva	Pacific Golden Plover	Vc		G5
Columba livia	Rock Dove	Al		G5
Streptopelia chinensis	Spotted Dove	Al		G5
Geopelia striata	Zebra Dove	Al		G4G5
Asio flammeus sandwichensis	Pueo	Re		G5T2
Chasiempis sandwichensis ibidis	Oahu Elepaio	Re	LE	G3T1
Alauda arvensis	Eurasian Skylark	Al		G5
Pycnonotus cafer	Red-vented Bulbul	An		G5
Cettia diphone	Japanese Bush-warbler	Al		G5
Copsychus malabaricus	White-rumped Shama	Al		G5
Garrulax canorus	Melodious Laughingthrush	Al		G4G5
Leothrix lutea	Red-billed Leothrix	Al		G4G5
Zosterops japonicus	Japanese White-eye	Al		G5
Mimus polyglottis	Northern Mockingbird	Al		G5
Acridotheres tristis	Common Myna	Al		G5
Paroaria coronata	Red-crested Cardinal	Al		G4G5
Cardinalis cardinalis	Northern Cardinal	Al		G5
Carpodacus mexicanus	House Finch	Al		G5
Hemignathus flavus	Amakihi	Re		G3
Himatione sanguinea	Apapane	Re		G3
Passer domesticus	House Sparrow	Al		G5
Estrilda astrild	Common Waxbill	An		G5
Lonchura cantans	African Silverbill	An		G5
Lonchura punctulata	Nutmeg Mannikin	Al		G5
Padda oryzivora	Java Sparrow	An		G5
Sus scrofa scrofa	Feral Pig			G5
Herpestes auropunctatus	Mongoose			G5

* Avian residency status from Pyle 2002. Al =Alien; long established and breeding since before 1945; An=Alien; new introduction since 1945; apparently established; Re=Resident; endemic species; not extinct; Ri=Resident; indigenous species; Hawaiian population is not endemic; Vc=Visitor; common migrant to Hawaii.
**Federal Status - Official U.S. Fish and Wildlife Service, Endangered Species Act (ESA) categories for endangered and candidate endangered taxa (species, subspecies, & varieties) according to the Federal Register. Listed Endangered (LE)=Taxon formally listed as endangered; Listed Threatened (LT)=Taxon formally listed as threatened; Proposed Endangered (PE)=Taxon proposed to be formally listed as endangered; Proposed Threatened (PT)=Taxon proposed to be formally listed as threatened; Candidate (C)=Taxon for which substantial information on biological vulnerability and threat(s) support proposals to list them as endangered or threatened; Species of Concern (SOC)=Taxon that is not listed or a candidate for endangered or threatened status, but is nevertheless of conservation concern.
*** HINHP Rank. G1 (or T1 for subspecific taxa) = Critically imperiled globally. 1-5 occurrences and/or fewer than 1,000 individuals remaining; or more abundant but facing extremely serious threats range-wide.
G2 (or T2 for subspecific taxa) = Imperiled globally. 6-20 occurrences and/or 1,000-3,000 individuals remaining; or more abundant but facing serious threats range-wide.
G3 (or T3 for subspecific taxa) = Moderately imperiled globally. 21-100 occurrences and/or 3,000-10,000 individuals remaining; or more abundant but facing moderate threats range-wide; or restricted in range.
G4 (or T4 for subspecific taxa) = Widespread, abundant, and apparently secure, but with cause for long-term concern.
G5 (or T5 for subspecific taxa) = Demonstrably widespread, abundant, and secure.
The Global Rank (Grank) is a international ranking system developed by the Natural Heritage network. It determines the rarity of a species worldwide, and guides agencies to set priorities for protection. The ranking system is based on an element's (taxa or ecosystem) number of occurrences and individuals, health, threats, etc. It is independent from the U.S. Fish and Wildlife Federal List of Endangered Species, but the USFWS often cites the Heritage Global Rank to help express how rare and imperiled a species is.

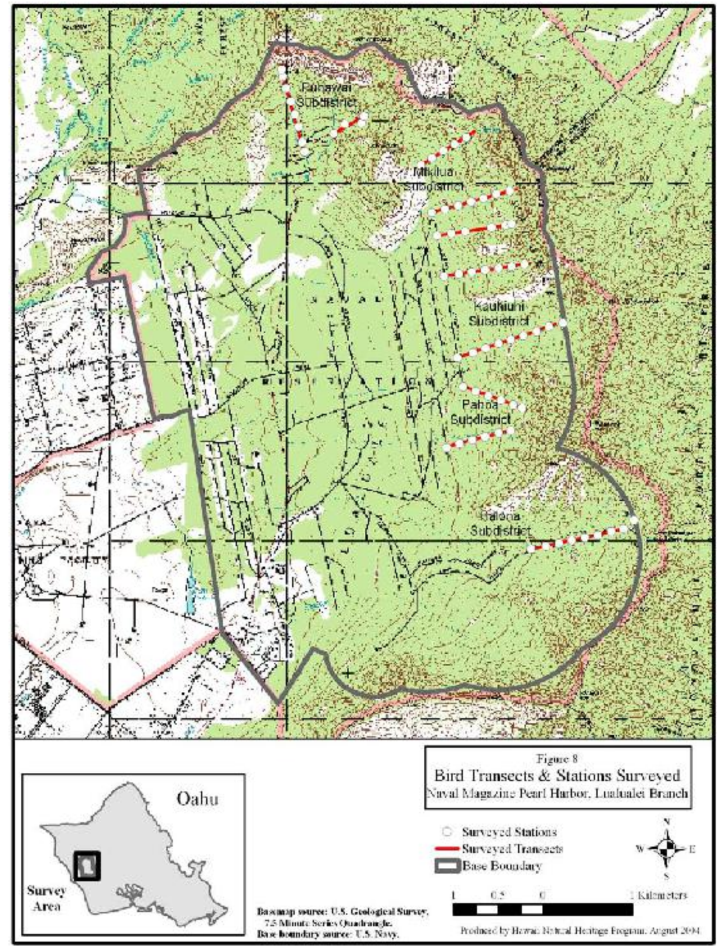


Figure 8
Bird Transects & Stations Surveyed
Naval Magazine Pearl Harbor, Lualualei Branch

Table 5. Forest bird species observed during point count surveys of Naval Magazine Pearl Harbor, Lualualei Branch in 2004.

Species Name	Common Name	Residency Status*	Federal Status**	HINHP Rank***
Francolinus erckelii	Erckel's Francolin	An		G5
Pavo cristatus	Common Peafowl	An		G5
Columba livia	Rock Dove	Al		G5
Streptopelia chinensis	Spotted Dove	Al		G5
Geopelia striata	Zebra Dove	Al		G5
Chasiempis sandwichensis ibidis	Oahu Elepaio	Re	LE	G3T1
Pycnonotus cafer	Red-vented Bulbul	An		G5
Cettia diphone	Japanese Bush-warbler	Al		G5
Copsychus malabaricus	White-rumped Shama	Al		G5
Garrulax canorus	Melodious Laughingthrush	Al		G4G5
Leothrix lutea	Red-billed Leothrix	Al		G4G5
Zosterops japonicus	Japanese White-eye	Al		G5
Mimus polyglottis	Northern Mockingbird	Al		G5
Acridotheres tristis	Common Myna	Al		G5
Paroaria coronata	Red-crested Cardinal	Al		G4G5
Cardinalis cardinalis	Northern Cardinal	Al		G5
Carpodacus mexicanus	House Finch	Al		G5
Estrilda astrild	Common Waxbill	An		G5
Lonchura cantans	African Silverbill	An		G5

*Avian residency status from Pyle 2002. Al=Alien; long established and breeding since before 1945; An=Alien; new introduction since 1945; apparently established; Re=Resident; endemic species; not extinct; Ri=Resident; indigenous species; Hawaiian population is not endemic; Vc=Visitor; common migrant to Hawaii.
**Federal Status - Official U.S. Fish and Wildlife Service, Endangered Species Act (ESA) categories for endangered and candidate endangered taxa (species, subspecies, & varieties) according to the Federal Register. Listed Endangered (LE)=Taxon formally listed as endangered; Listed Threatened (LT)=Taxon formally listed as threatened; Proposed Endangered (PE)=Taxon proposed to be formally listed as endangered; Proposed Threatened (PT)=Taxon proposed to be formally listed as threatened; Candidate (C)=Taxon for which substantial information on biological vulnerability and threat(s) support proposals to list them as endangered or threatened; Species of Concern (SOC)= Taxon that is not listed or a candidate for endangered or threatened status, but is nevertheless of conservation concern.
*** HINHP Rank. G1 (or T1 for subspecific taxa) = Critically imperiled globally. 1-5 occurrences and/or fewer than 1,000 individuals remaining; or more abundant but facing extremely serious threats range-wide.
G2 (or T2 for subspecific taxa) = Imperiled globally. 6-20 occurrences and/or 1,000-3,000 individuals remaining; or more abundant but facing serious threats range-wide.
G3 (or T3 for subspecific taxa) = Moderately imperiled globally. 21-100 occurrences and/or 3,000-10,000 individuals remaining; or more abundant but facing moderate threats range-wide; or restricted in range.
G4 (or T4 for subspecific taxa) = Widespread, abundant, and apparently secure, but with cause for long-term concern.
G5 (or T5 for subspecific taxa) = Demonstrably widespread, abundant, and secure.
The Global Rank (Grank) is a international ranking system developed by the Natural Heritage network. It determines the rarity of a species worldwide, and guides agencies to set priorities for protection. The ranking system is based on an element's (taxa or ecosystem) number of occurrences and individuals, health, threats, etc. It is independent from the U.S. Fish and Wildlife Federal List of Endangered Species, but the USFWS often cites the Heritage Global Rank to help express how rare and imperiled a species is.

Of the non-native birds observed, several species were detected at high rates (Table 6). These species included spotted dove *Streptopelia chinensis* (10.6% of all detections), red-vented bulbul *Pycnonotus cafer* (8.3%), Japanese white-eye *Cettia diphone* (16.9%), northern cardinal *Cardinalis cardinalis* (14.3%), and house finch *Carpodacus mexicanus* (17.7%).

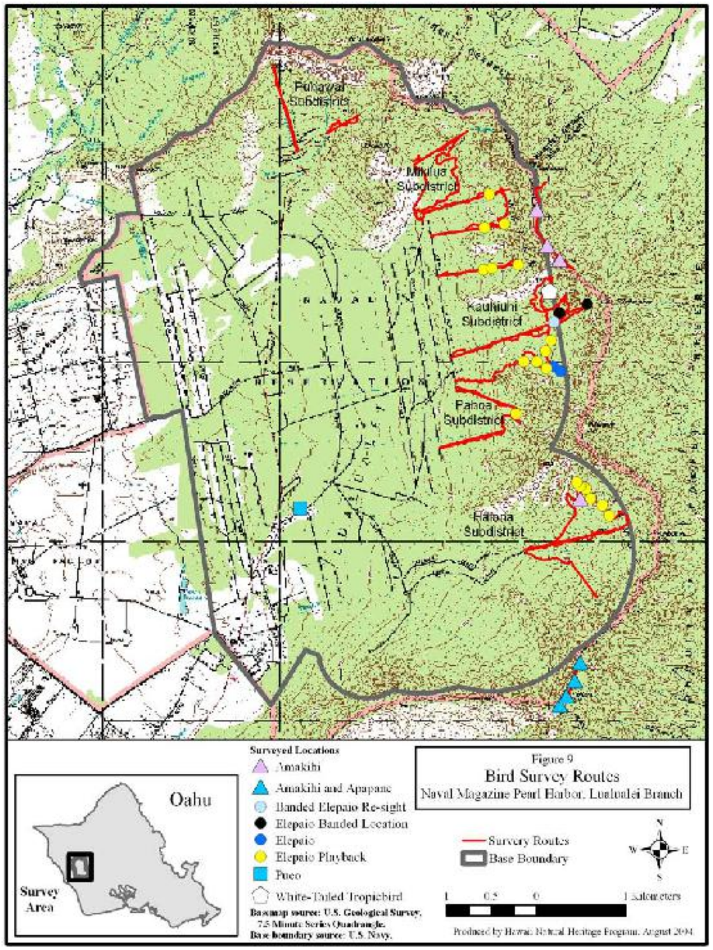
Table 6. Average number of individuals of bird species observed at each of 68 stations surveyed at Naval Magazine Pearl Harbor, Lualualei Branch using point counts in 2004.

Species Name	Common Name	Total	Average birds per Station	Percent of Birds Detected
Francolinus erckelii	Erckel's Francolin	86	1.26	5.1
Pavo cristatus	Common Peafowl	104	1.53	6.1
Columba livia	Rock Dove	27	0.40	1.6
Streptopelia chinensis	Spotted Dove	179	2.63	10.6
Geopelia striata	Zebra Dove	109	1.60	6.4
Chasiempis sandwichensis ibidis	Oahu Elepaio	1	0.01	0.1
Pycnonotus cafer	Red-vented Bulbul	140	2.06	8.3
Cettia diphone	Japanese Bush-warbler	86	1.26	5.1
Copsychus malabaricus	White-rumped Shama	82	1.21	4.8
Garrulax canorus	Melodious Laughingthrush	4	0.06	0.2
Leothrix lutea	Red-billed Leothrix	2	0.03	0.1
Zosterops japonicus	Japanese White-eye	286	4.21	16.9
Mimus polyglottis	Northern Mockingbird	3	0.04	0.2
Acridotheres tristis	Common Myna	7	0.10	0.4
Paroaria coronata	Red-crested Cardinal	19	0.28	1.1
Cardinalis cardinalis	Northern Cardinal	242	3.56	14.3
Carpodacus mexicanus	House Finch	300	4.41	17.7
Estrilda astrild	Common Waxbill	17	0.25	1.0
Lonchura cantans	African Silverbill	1	0.01	0.1

Opportunistic Sampling

We walked in higher elevation forested areas and drove the roads on the base. In addition to the 19 bird species observed during point counts, we observed ten other species opportunistically. Three native species observed were pueo, Oahu amakihi, and apapane. One white-tailed tropicbird (*Phaethon lepturus*), a resident indigenous species was observed (Figure 9).

The pueo was observed on 10 March on Guadalcanal Road next to bunker 10L29 at 1500 hrs. The bird was sitting on the ground and did not fly away as we approached slowly in a vehicle. Because this species nests on the ground, we returned to the area the following day to check for nesting activity, but found no evidence. No other pueo were observed during the survey. Security personnel reported seeing a pair of pueo on the Lualualei Naval Road, and found a dead pueo on the side of the road in the antenna fields of the Radio Transmitting Facility adjacent to the magazine. According to the observer, the dead pueo appeared to have been hit by a car.



One amakihi was observed on 26 March in the Halona subdistrict of PH LLL. Additional amakihi were observed during ridgeline surveys. Amakihi were observed on 1 April at two locations along the ridgeline area from Puuhapapa to Puukaneoha on the PH LLL side of the boundary, totaling three individuals. On 27 April on the ridge north from Palikea, 15 amakihi were detected at four different locations. Because this ridge is steep, we were unable to survey in Navy property. Our location during the observations at Palikea was outside the PH LLL property boundary, but several of these individuals were detected at distances greater than 40 meters (131 feet) from the observer. It is likely that these individuals regularly travel into PH LLL.

No apapane were observed within the Navy property boundaries. However, six were observed at four locations along Palikea ridgeline on 27 April. As with amakihi, it is likely these individuals regularly utilize habitat within PH LLL boundaries.

One white-tailed tropicbird was observed on 1 April. This individual was in the Kauhiuhi subdistrict.

Elepaio Playback

On 15 January, HINHP staff accompanied two Navy staff and elepaio expert Sara Burgess to the southern portion of the Kauhiuhi subdistrict with known elepaio individuals. The purpose of this outing was to account for the known individuals and to search for nests. During this outing we utilized the song playback method and detected two to three individuals. Each of these individuals was thought to be one of the birds known to exist in the area

On 11 February, HINHP staff, one Navy staff, and elepaio expert Dr. Eric VanderWerf again visited the southern portion of the Kauhiuhi subdistrict to account for known individuals, search for nests and band birds with unique color combinations and a U.S. Fish and Wildlife Service aluminum band. Two individuals were detected using the playback technique. We did not attempt to capture them for banding. We surveyed areas of the Kauhiuhi subdistrict that were surveyed by Dr. VanderWerf in 2000. At that time he detected three individuals (a pair with a juvenile) by sight and detected one male by song only (Dr. E. VanderWerf, pers. comm.). Although we searched in the same location, we failed to detect individuals at the same location. We did observe two individuals presently monitored by Navy staff.

HINHP staff and Dr. Eric VanderWerf surveyed the northern portion the Kauhiuhi subdistrict on 18 March. We detected two known males using the playback method and banded them. The color combination for the male banded within Navy property is left leg: white over white, right leg: white over aluminum. The other male was left leg: white over aluminum, right leg: white over green (Figure 7, Appendix 6 and 7). An additional individual was heard near the eastern bird, but was not seen.

HINHP staff conducted point counts and opportunistic sampling in the Kauhiuhi subdistrict on 31 March. One of the males banded on 18 March was detected at the last station during the count. Three additional birds were detected during our search.

Discussion

Botanical Survey

Unlike the 1994 HINHP survey, the 2004 survey was limited to land within PH LLL, and did not include lands in Lualualei Valley owned by the State of Hawaii. As much as possible, GPS was used to determine whether or not a given rare plant was within the PH LLL boundary. GPS was not utilized in 1994, and so it was more difficult in some cases to determine the position of a rare plant in relation to the boundary, especially since the boundary between Navy and State land is not marked, and most often does not follow geographical features.

In some cases a rare plant has been documented from Lualualei Valley, but the locality was not specifically recorded. If we were not certain whether an historic location of a plant was on Navy property, the plant was not counted as a PH LLL plant.

A few of the plant taxa included among the rare plant taxa on the 1994 survey are no longer considered rare by HINHP, and have not been dealt with on the 2004 survey. These taxa are *Panicum beecheyi*, *Schiedea ligustrina*, and *Schiedea mannii*. A comparison of the rare, threatened, and endangered species encountered during this survey and the 1994 HINHP survey can be found in Appendix 3.

With respect to many of the rare plant occurrences in PH LLL, it is difficult to make comparisons between this survey and the one conducted by HINHP in 1994 for several reasons that include plant location and characteristics, and observer methodology. Cliff plants are difficult to reach and their numbers must be estimated from afar. For plant species that grow in close patches, estimation of the number of individuals is problematic. Likewise, drawing comparisons between observations is especially difficult if different individuals made the observations. Unless an occurrence is marked in some manner, it is not possible to determine if the plants observed in one year are exactly the same plants observed in another year.

Most of the rare plants of PH LLL are better represented elsewhere in the Waianae Mountains in terms of population size, population health, habitat quality, and the feasibility of management for conservation. However, for three taxa, PH LLL is critically important because half or more of the known individuals are within the PH LLL boundaries. The three plants are *Chamaesyce kuwaleana*, *Lipochaeta lobata* var. *leptophylla*, and *Melanthera tenuis*. If rare plant management priorities are set for plants of PH LLL, these taxa deserve top priority. Of all the PH LLL rare plant taxa, the listed endangered *C. kuwaleana* stands to benefit the most from the implementation of rare plant management measures on PH LLL since the species currently occurs only in small areas on PH LLL and on lands bordering PH LLL. Threat from fire is sharply on the rise for this species.

The *C. kuwaleana* at the seaward end of the ridge separating Lualualei from Waianae Kai (i.e., the peak Kauaopuu and two peaks to the northwest of Kauaopuu) is the population center of this species. All of the plants at this seaward end of the ridge represent typical *C. kuwaleana*, whereas the plants further inland on the ridge and on Puukailio (near Kolekole Pass) are extremely variable, and are apparently members of hybrid swarms involving *C. kuwaleana* and another native species of *Chamaesyce*, *C. multiformis*. Furthermore, the plants at the dry seaward end of the ridge appear to be more gravely threatened than those further inland. The plants at this end of the ridge have already been impacted by brushfires, and the threat of fire is increasing. A further stress to the seaward population is a higher rate of caterpillar damage as compared to the plants further inland.

The threat of fire to *C. kuwaleana* and other rare plants in dry and mesic vegetation of the Waianae Mountains is on the rise as the coverage of alien grasses increases throughout the mountain range. Of particular concern in that regard is the ongoing spread of Guineagrass (*Panicum maximum*) and molassesgrass (*Melinus minutiflorus*). Another alien grass of concern is fountaingrass (*Pennisetum setaceum*), which is a fire-adapted grass that has contributed to a large upswing in the incidence of wildfires on the leeward side of the island of Hawaii. It is not yet established in the Waianae Mountains, but a few plants have been found in the Waianae Mountains in the past decade. These few plants have been eradicated in an attempt to prevent the species from gaining a firm foothold here. Two of the eradicated plants were found in 2002 just outside the PH LLL boundary on Kauaopuu, within the area where *C. kuwaleana* occurs (J. Lau, pers. obs., Appendix 5). The incidence and severity of wildfires in the Waianae Mountains would increase dramatically if fountaingrass successfully naturalizes there. The potential of an existing seed bank in areas of the Waianae Mountains where fountaingrass has occurred probably increases the risk of establishment in those areas, and in nearby locations.

More knowledge of the status of *C. kuwaleana* on lands adjacent to PH LLL would serve to better assess the management need for the species as a whole. Especially in need of survey are the plants just beyond the northwest corner of PH LLL on Maunakuwale, which is where the species was first recorded in 1949. The species was confirmed to survive on Maunakuwale in 1990s, but the population has never been adequately surveyed.

Two other rare plant taxa with a majority of individuals located on PH LLL lands are *M. tenuis*, which is a candidate for listing as an endangered species, and *L. lobata* var. *leptophylla*, which is a listed endangered taxon. More than half of the known plants of *M. tenuis* and more than 90% of those of *L. lobata* var. *leptophylla* occur on PH LLL lands.

The taxonomic status of the varieties of *L. lobata* in Lualualei Valley requires further study by plant taxonomists. Two specimens from the Kauhiuhi subdistrict have been identified as var. *leptophylla* (Christophersen 3672 and 3693, BISH) and another as var. *lobata* (Christophersen 3691, BISH). The two varieties do not appear to be well differentiated.

Feral goats are one of the main threats to the survival of the rare plants of PH LLL. Several feral goats were seen in PH LLL on Puukaua during this biological survey. At the time of the 1994 biological survey, goats were established in the Puukaua area and on the ridge between Lualualei and Nanakuli Valley. Subsequently, the goats in the southern Waianae Mountains were marked for eradication by state and federal agencies and private landowners, and control measures were carried out. By 2001, it was thought that the goats had been totally eradicated in PH LLL (E. Shiinoki, pers. comm.), but observation of individuals during this survey shows the population was not entirely eliminated.

Achatinella and *Amastra* Survey

Achatinella and *Amastra* are both threatened by predation from rats and the carnivorous snail *Euglandina rosacea*. One approach taken by the State of Hawaii and the U.S. Army to minimize predation pressure involved the construction of exclosures, which serve as stopgap measures to protect *A. mustelina* until effective field techniques are developed to combat these predators. Two small exclosures were built for use in the northern Waianae Mountains (Makua Implementation Team et al. 2003). A swath of vegetation was cleared away along the exclosure walls to prevent rats from entering via tree branches. The design of these exclosures includes the use of electrified barriers to ward off predators and a trough containing salt to prevent *Euglandina* from entering into the exclosure.

The building of exclosures of this design in forested *Achatinella* habitat has raised some concerns regarding potential negative effects to the *Achatinella* and their habitat (Chung and Miyano 2001), including the fragmentation of *Achatinella* habitat and the disruption of *Achatinella* dispersal and movement. Other concerns include the possibility of increased erosion caused by the building of such exclosures and the potential for harmful effects of the salt upon the environment.

Another approach to controlling predation by rats taken at several *A. mustelina* sites in the Waianae Mountains involves the use of rat poison to lower predation rates by rats on *Achatinella*. Rat bait stations are regularly re-stocked with fresh rat poison. The Army Directorate of Public Works has implemented such rat control programs at *A. mustelina* sites on Army-controlled lands on the Makua Military Reservation and on Schofield Barracks Military Reservation. Included among these *A. mustelina* sites is an area of the Schofield Barracks Military Reservation adjoining PH LLL on the windward (eastern) side of Puuhapapa. Similar rat control measures are being carried out by personnel of The Nature Conservancy (TNC) on the portion of windward Puuhapapa that TNC manages as part of their Honouliuli Preserve. Further decrease in size of the rat population in the Puuhapapa area would probably ensure higher survival probability for the *A. mustelina* in that region

Pigs have been shown to be harmful to snail populations due to their destruction of snail host plants and the snail habitat in general. A pig-proof fence will soon be built around a dense concentration of *A. mustelina* on windward Puuhapapa in TNC's Honouliuli Preserve (D. Sailer, pers. comm.), and on the Army-owned portion of Puuhapapa small pig-proof exclosures have already been built to protect colonies of *A. micans*.

Goats have historically been responsible for the degradation and destruction of much native Hawaiian snail habitat throughout the Waianae Mountains, including PH LLL.

As noted above, alien plants sometimes also host *Achatinella*. However, in some of the cases where *Achatinella* is found on alien plants, it may be due to a lack of sufficient native host plants. This may be the case for the *A. mustelina* in the Puuhapapa summit area that are often found on alien Christmasberry (Chung and Miyano 2001).

In general, research on the native snails and the reasons for their decline in the wild is necessary for the perpetuation of native snail populations in the wild. Important areas of research include the study of predation upon snails by rats, *Euglandina*, other less well studied predators, and potential predators. Other factors that might be involved in the dynamics of native snail populations, such as pathogens and climatic conditions, should also be the subject of research.

***Achatinella* spp.**

The genus *Achatinella* is endemic to both the Koolau and Waianae Mountain ranges on the island of Oahu, and the entire genus is listed as endangered (U.S. Fish and Wildlife Service 1999). *Achatinella* were once known from the lowlands to summit areas, but habitat modification, introduction of predators such as rats, *Rattus* spp., and the carnivorous snail, *Euglandina rosea*, the spread of non-native vegetation, and over-collection have contributed to the decline of this genus (U.S. Fish and Wildlife Service 1993). Currently, populations of the genus are only known to occur above approximately 400 meters (1312 feet) in elevation. *Achatinella* lives in mesic and wet forests and shrublands. The vegetation in which *Achatinella* occurs is usually native-dominated, although some populations have been recorded from vegetation dominated by alien plants.

Achatinella are generally nocturnal. During the day, they are usually sealed to leaves, branches, or trunks, and remain stationary until nightfall, although they can be active during the day during wet weather. Favored plant hosts of *Achatinella* differ depending on the particular species of *Achatinella*, the type of habitat the snails are living in, or on the particular population. The snails feed by rasping off and ingesting the thin layer of algae, fungus, and lichen covering the surface of the leaves and branches of their host plants.

Individuals of *Achatinella* are hermaphroditic. It is not known if they are capable of self fertilization. The young are born live, one at a time, and can be born at any time of the year. Field studies of *A. mustelina* populations in the wild have shown that the snails reach sexual maturity at approximately seven years of age and give birth to one to four young per year. The newborn snails are about 4.5 millimeters long (Hadfield and Mountain 1980).

Thirty-six of the 41 species of *Achatinella* are endemic to the Koolau Mountains, and five are endemic to the Waianae Mountains. Three of the five Waianae endemics, *A. lehuiensis*, *A. spaldingii*, and *A. thaanumi*, are known from only a few historical collections. The remaining two, *A. mustelina* and *A. concavospira*, are still extant. *A. mustelina* is distributed throughout the Waianae Mountains, whereas *A. concavospira*'s range includes only the portion of the mountain range south of Kolekole Pass. Only *A. mustelina* is known to be extant in PH LLL. *A. concavospira* occurred historically in at least the southeastern part of PH LLL (in Halona) as evidenced by the distribution of old shells of the species. The two species have similar habitat requirements, and can be found living together on the same trees.

Where they co-occur, the species can be distinguished by shell shape, shell color and color pattern, and in some places, by the direction in which the shells are coiled. Included in Appendix 4 is a photograph showing old shells of the two species found under a single tree in the Halona area of Lualualei, illustrating how different the shell morphology of these species can be.

Achatinella mustelina

In a study by Holland and Hadfield (2002), genetic sequencing of mitochondrial DNA was used to evaluate genetic variation between *A. mustelina* populations throughout the Waianae Mountains. The results of the sequencing were used to circumscribe evolutionarily significant units (ESUs) within *A. mustelina* to be utilized in setting priorities in the implementation of conservation actions among the various populations throughout the Waianae Mountains. An ESU was defined as comprising a population or a set of populations with a distinct, long-term evolutionary history that has been isolated from other populations in terms of contemporary gene flow. This genetic analysis resulted in the identification of six ESUs among the *A. mustelina* populations that were sampled.

Three of the identified *A. mustelina* ESUs are distributed over the portion of the Waianae Mountains bordering PH LLL. The northernmost of the ESUs relevant to PH LLL extends from sites far to the north of PH LLL on the ridge between Makaha and Waianae Kai Valleys west of Kaala, southward to Puuhapapa. Snails sampled from a location on the windward side of Puukaua comprise the second ESU in the PH LLL area, and samples from the Palikea area near the southern end of PH LLL constitute the third ESU.

All *A. mustelina* colonies known to remain in PH LLL are located within the stretch of the Waianae Mountains occupied by the first of the aforementioned ESUs. This ESU covers more territory than all other *A. mustelina* ESUs that have been identified. This ESU has more recorded individuals than any of the other ESUs due to the more than 500 individuals found along transects on the windward side of Puuhapapa in 2000 by Chung and Miyano (2001) on lands managed by the Army and TNC. This ESU appears to be the least endangered of the *A. mustelina* ESUs. The *A. mustelina* surviving in PH LLL in the Puukumakalii and Puuhapapa areas are located on or near the edges of large areas of *A. mustelina* occurrence on the windward sides of the Waianae Mountains.

In contrast the ESU that includes the Puukumakalii and Puuhapapa areas, the Palikea ESU is one of the most endangered of the *A. mustelina* ESUs. Surviving individuals in the Palikea area are known only from isolated spots in a narrow zone along the Waianae summit ridge extending from Maunakapu to about 1 km (0.62 miles) north of Palikea. The boundary of PH LLL barely reaches the Waianae summit ridge north of Palikea. No live *A. mustelina* were found in this part of PH LLL, but there remains some potential for the survival of the species here since a recently dead shell of *A. mustelina* was found just outside the PH LLL boundary north of Palikea.

***Amastra* spp.**

The genus *Amastra* is an endemic Hawaiian genus of land snails that once occurred throughout the main Hawaiian Islands. Over 100 species have been described (Cowie et al.

1995). All species of *Amastra* are thought to be extinct in the wild except for three species in the Waianae Mountains, namely *A. cylindrica*, *A. micans*, and *A. spirizona*. A live population of *A. cylindrica* is located on PH LLL. Extant populations of the other two *Amastra* species are located on the windward side of the Waianae Mountains not far from the PH LLL boundary with TNC's Honouliuli Preserve (J. Lau, pers. comm.). One of the live *A. micans* colonies is located less than 30 meters (98 feet) from the PH LLL boundary south of Puuhapapa, in Kaluaa Gulch in TNC's Honouliuli Preserve. The live *A. spirizona* population closest to PH LLL is also located in Kaluaa Gulch, at a site that lies within 0.4 kilometers (0.25 miles) of the PH LLL boundary. The historical occurrence of the three extant *Amastra* species within PH LLL is evidenced by the sometimes abundant presence of old shells of these species at scattered sites throughout PH LLL. The shells of several *Amastra* species not known to be extant can also be found in PH LLL, and so these species potentially still survive there. These species include *A. cornea*, *A. crassilabrus*, *A. reticulata*, and *A. subrostrata*.

Most species of *Amastra* are ground dwelling snails, and are often found on or under leaf litter, or amongst rocks where they feed on decaying leaves. A few species are recorded to live on vegetation, and some live both on the ground and in vegetation. Most *Amastra* species have been recorded from mesic vegetation, with only a few recorded from wet vegetation in high rainfall areas. The three species of *Amastra* still extant in the wild are known from mesic forests on gulch slopes and in gulch bottoms. *A. cylindrica* is ground-dwelling. *A. spirizona* is usually found on trees and shrubs, and often lives in patches of the native vine ieie (*Freycinetia arborea*). *A. micans* is primarily ground-dwelling, but is also sometimes found on vegetation (Chung and Costello 1997). *Amastra* are primarily nocturnal, but can also be active during the day in wet weather.

Life cycles in wild populations of *Amastra* have not been studied, though Chung (1996) reported information on the life cycles of *A. cylindrica*, *A. rubens*, and *A. spirizona* raised in captivity. *Amastra* give birth to live young one at a time. Chung reported that a particular captive individual of *A. cylindrica* had an estimated birth rate of one offspring every 12 days. With respect to *A. rubens*, well-fed, healthy individuals had estimated birth rates ranging from one birth every 12.5 days per adult to one birth every 23 days per adult. For *A. spirizona*, estimated birth rates under optimal conditions ranged from one birth every 11 days per adult to one birth every 23 days per adult. Three estimates of the time required for *A. rubens* to reach maturity are known: one year and seven months, one year and 11 months, and two years and five months. *A. cylindrica* was raised to maturity in two years and one month. Estimates of age to first birth for *A. spirizona* under favorable conditions ranged from two years and two months to two years and seven months. The life span of captive *A. spirizona* was estimated to be four years and 11 months. Two different estimates for the life span of *A. rubens* were four years and two months, and four years and three months. *Amastra cylindrica* was determined to likely have a life span of at least four years.

The taxonomy of the genus *Amastra* is need of study. There has been very little taxonomic research conducted on the genus since the early 1900s. When first reported in 1995, the extant *Amastra* population at PH LLL was identified as *A. intermedia* (Chung n.d.). As initially treated by the malacologists H. A. Pilsbry and C. M. Cooke, *A. intermedia* was recognized as a species distinct from *A. cylindrica*. However, in a subsequent publication, they revised their taxonomic opinion of *A. intermedia*, and placed it in synonymy under *A. cylindrica* (Pilsbry and Cooke 1912-1914). There have been no subsequent published studies concerning the taxonomic position of *A. intermedia* (Cowie et al. 1995). With further study, *A. intermedia* may well be shown to represent a taxon distinct from *A. cylindrica*, but in any case, whether classified as *A. intermedia* or *A. cylindrica*, the live *Amastra* in PH LLL represent the only known wild population of their species.

Amastra cylindrica
The vulnerability of the PH LLL *A. cylindrica* population to extirpation due to stochastic events is extremely high as was illustrated by the occurrence of the landslide during the course of this survey. The PH LLL *Amastra* represent the only wild *A. cylindrica* population known to survive, and is very vulnerable to extinction from stochastic events. The establishment of satellite populations in very rare species minimizes extinction risk (Derrickson et al. 1998). Several species of *Amastra* have been successfully raised in captivity for successive generations over a period of almost seven years (Chung 1996).

Ornithological Survey
During this survey, we detected few native forest birds relative to the number of non-native forest birds observed. It is not possible to determine if there was a change in species composition between the 1994 and 2004 surveys because survey methods differed and the 1994 survey did not indicate numbers of non-native species detected. The reason for low numbers of native species in PH LLL are likely the same as those responsible for the decline and extinction of many Hawaiian birds: habitat loss, competition from non-native birds, mosquito-borne avian disease, and predation from introduced mammalian predators (Loope et al. 2001). Additionally, the vertebrate survey was conducted primarily during the month of March. Had the survey been conducted throughout the year, we may have found additional use of PH LLL by native birds. Many native forest bird species are not territorial and roam widely in search of food resources that are seasonally available (Hess et al. 2001).

The greater part of the forested area surveyed in PH LLL was non-native vegetation, and the habitat at the first few stations on each transect was mostly a monotypic stand of koa haole (*Leucanena leucocephala*). During the point count survey and during opportunistic sampling at lower elevations we did not encounter stands of native dominated forest. Canopy in these areas was consistently non-native species such as kukui (*Aleurites moluccana*), Christmas berry, and Australian red cedar (*Toona ciliata*). Oahu elepaio and amakihi can be found in non-native habitat (Conant 1977, Lindsey et al. 1998). Elepaio are often found in mesic mixed-species forests with tall canopy and well-developed understory at elevations between 550-850 meters (1804 – 2789 feet) in the Waianae mountain range (VanderWerf et al. 1997, VanderWerf 1998). Apapane, on the other hand, are most commonly found in wet and mesic native forests, and rely heavily upon the nectar from ohia (*Metrosideros polymorpha*) blossoms for food (Fancy and Ralph 1997). We encountered ohia stands only along the ridgeline surveys, and not at lower elevations. Because elepaio and amakihi can be found in non-native habitat, the low number of these species encountered during this survey must not be due solely to inadequate habitat, however, the relatively specialized habitat requirements of apapane may be a primary reason why this species was not observed.

Competition from non-native birds for food or other resources could compound the lack of adequate habitat for some of the forest bird species. We found high numbers (>2 birds per station) of Japanese white-eye, red-vented bulbul, spotted dove, northern cardinal and house finch. Mountainspring and Scott (1985) found direct competition between Japanese white-eye with Hawaii elepaio (*Chasiempis sandwichensis sandwichensis*), apapane, and amakihi in a study that included ten native species and four non-native species.

In addition to competing for resources, exotic birds serve as a source for mosquito-borne avian disease, and they tend not to be susceptible to these diseases. During the course of the survey, we encountered high numbers of mosquitoes, a vector for avian malaria (*Plasmodium relictum*) and pox (*Poxvirus avium*). In a study of native and non-native bird species on Oahu, Shehata et al. (2001) found the highest rates of malaria infection in white-rumped shama (*Copsychus malabaricus*), red-vented bulbul (*Pycnonotus cafer*), nutmeg manikin (*Lonchuria punctulata*) and spotted dove (*Streptopelia chinensis*). All of these species were found during our survey, with the spotted dove and red-vented bulbul being found in high numbers. The combination of high vector density and high host density at PH LLL probably results in a high level of disease transmission. Native forest birds are more susceptible to avian pox than introduced birds (van Riper et al. 2002), so avian disease probably has had an impact on species composition of PH LLL. Both of the elepaio banded during this study had poxlike lesions.

The introduction of mammalian predators is postulated as one of the main causes of the extinction and decline of Hawaiian avifauna species (Berger 1981, Scott et al. 1986). Hawaiian birds are naïve to mammalian predators whereas most or all introduced bird species are not. In order to reduce mortality risk, active predator control occurs at the five known elepaio territories in PH LLL during the breeding season. Personnel from the U.S. Department of Agriculture's Animal Plant Health Inspection Service report that rat density at these territories is potentially very high if estimates are based on the amount of bait taken (M. Ono, pers comm.). Control of rats using snap traps and rodenticide prior to and during the breeding season is an effective method for protecting nesting forest birds (Nelson et al. 2002). We banded two of the known male elepaio in the northern portion of the Kauhiuhi subdistrict. Identification of individuals, territory size, and survival is more easily assessed with banded birds (U.S. Geological Survey 2002).

The Oahu amakihi has not been well studied so little is known about its breeding phenology, except that the season extends from at least April through June (VanderWerf 1997). Since only a few nests have been found, the breeding period could be much longer. Hawaii amakihi (*Hemignathus virens*) on Mauna Kea have a breeding season that lasts nine months (van Riper 1987). Amakihi are territorial during the nesting season and have large overlapping home ranges during the non-breeding season (Lindsey et al. 1998). It is quite possible that Oahu amakihi regularly use PH LLL for feeding during the non-breeding season, and that we detected few individuals because they were nesting in more optimal habitat just outside of PH LLL.

Apapane are one of the most abundant species of Hawaiian honeycreeper. They are locally common above 600 meters (1969 feet) elevation on Oahu and are considered seasonally migratory in response to food availability (Fancy and Ralph 1997). They are most often found in wet and mesic native forests, and rely heavily upon the nectar from ohia blossoms, as well as insects and spiders for food. There was no indication that apapane were detected during the 1994 survey by HINHP (Hawaii Natural Heritage Program 1994). We detected six individuals outside the boundary of PH LLL along Palikea Trail. Because of the close proximity to PH LLL, it is likely that individuals utilize habitat within Navy property. We were unable to ascertain this because of the steep terrain.

We did not detect iiwi during this survey or during the 1994 HINHP survey (Hawaii Natural Heritage Program 1994). However, iiwi are extremely rare on Oahu. Previously they were known from wet and mesic habitat, and probably would have been common at the higher elevation areas on PH LLL.

One pueo was observed during this survey and one was observed during HINHP's 1994 survey of PH LLL (Hawaii Natural Heritage Program 1994). It is listed as endangered by the State, but not federally. Unlike its mainland relatives, the pueo is diurnal, and because it utilizes open habitat, it is relatively easy to detect when present. However, pueo do utilize forested habitat, unlike their mainland counterparts. The single pueo observed during each of these surveys was in open habitat.

White-tailed tropicbirds were once known to nest in all of Oahu's cliffs (Harrison 1990), but documentation of current breeding areas is incomplete. They generally breed during the spring. The bird we observed did not appear to enter the cliff face, but could have been exploring for nest sites.

Literature Cited

Berger, A. J. 1981. Hawaiian birdlife. Second Edition. Honolulu. University of Hawaii Press, Honolulu.

Chung, D. Undated. Letter to Joel Uribe [Moribe] regarding snails found on July 19, 1995.

Chung, D. 1996. Raising amastrid landsnails in captivity. Hawaiian Shell News 44: 3-4.

Chung, D. and V. Costello. 1997. Recent records of the landsnails *Amastra micans* (Pfeiffer) and *Laminella sanguinea* (Newcomb) (Pulmonata: Amastridae). Bishop Museum Occasional Papers 56: 58-59.

Chung, D. and L. Miyano. 2001. Field survey of the land snails of Puu Hapapa and Waieli Gulch, Waianae Mountains, Oahu. Unpublished report prepared for the Division of Forestry and Wildlife, Department of Land and Natural Resources, State of Hawaii.

Conant, S. 1977. The breeding biology of the Oahu Elepaio. Wilson Bulletin 89: 193-210.

Cowie, R.H, N.L. Evenhuis, and C.C. Christensen. 1995. Catalog of the native land and freshwater mollusks of the Hawaiian Islands. Backhuys Publishers, Leiden.

Darwin, S.P. and S. Chaw. 1990. *Bobea*. pp. 1114-1118 *in* W.L. Wagner, D.R. Herbst and S.H. Sohmer. Manual of the flowering plants of Hawai`i. 2 Vols. University of Hawaii Press and Bishop Museum, Honolulu (Bishop Museum Special Publication 83).

Derrickson, S.R., S.R. Beissinger, and N.F.R. Snyder. 1998. Directions in endangered species research. *In* Marzluff, J.M. and R. Sallabanks. Avian conservation: Research and management. Island Press, Washington DC.

Fancy, S.G., and C.J. Ralph. 1997. Apapane (*Himatione sanguinea*). *In* The Birds of North America, No. 296 (A. Poole and F. Gill, eds.). The Birds of North America, Inc., Philadelphia.

Gon, S. and D. Matsuwaki. 2003. Hawaii Natural Heritage Program. Native ecosystems before human settlement and remaining native ecosystems today. GIS Ecosystem Data Layers of the State of Hawaii.

Hadfield, M.G. and B.S. Mountain. 1980. A field study of a vanishing species, *Achatinella mustelina* (Gastropoda, Pulmonata), in the Waianae Mountains of Oahu. Pacific Science 34: 345-358.

Harrison, C.S. 1990. Seabirds of Hawaii: Natural history and conservation. Cornell University Press, Ithaca.

Hawaii Natural Heritage Program. 1994. Biological inventory and management needs assessment, Naval Magazine, Headquarters, Lualualei, Oahu, Hawaii.

Hawaii Natural Heritage Program. 2003. A survey for *Alectryon macrococcus* var. *macrococcus* and *Flueggea neowawraea* in Lualualei Valley, Waianae Mountains, Oahu, Hawaii. Prepared for: Commander, Navy Region Hawaii; Regional Environmental Division (COMNAVREG HI). Under contract to PACNAVFACENGCOM PLN23; Environmental Planning Division. Final report, April 2003.

Hawaii Natural Heritage Program. 2004. Database of rare and endangered plants, animals, and natural communities of the Hawaiian Islands. University of Hawaii at Manoa, Honolulu.

Hayden, J.W. 1990. *Flueggea*. Pp. 420-489 *in* W.L. Wagner, D.R. Herbst and S.H. Sohmer. Manual of the flowering plants of Hawai`i. 2 Vols. University of Hawaii Press and Bishop Museum, Honolulu (Bishop Museum Special Publication 83).

Hess, S.C., P.C. Banko, M.H. Reynolds, G.J. Brenner, L.P. Laniawe, and J.D. Jacobi. Drepanadine movements in relation to food availability in subalpine woodland on Mauna Kea, Hawaii. *In* Scott, J.M.., S. Conant, and C. van Riper, editors. Evolution, ecology, conservation, and management of Hawaiian birds: A vanishing avifauna. Studies in Avian Biology No. 22.

Holland, B.S. and M.G. Hadfield. 2002. Islands within an island: phylogeography and conservation genetics of the endangered Hawaiian tree snail *Achatinella mustelina*. Molecular Ecology 11: 365-375.

Johnson, R.R., B.T. Brown, L.T. Haight, and J.M. Simpson. 1981. Playback recordings as a special avian censusing technique. Studies in Avian Biology. 6:68-75.

Koutnik, D.L. 1990. *Chamaesyce* (native species). Pp. 602-617 *in* W.L. Wagner, D.R. Herbst and S.H. Sohmer. Manual of the flowering plants of Hawai`i. 2 Vols. University of Hawaii Press and Bishop Museum, Honolulu (Bishop Museum Special Publication 83).

Lammers, T.G. 1990. Campanulaceae. Pp. 420-489 *in* W.L. Wagner, D.R. Herbst and S.H. Sohmer. Manual of the flowering plants of Hawai`i. 2 Vols. University of Hawaii Press and Bishop Museum, Honolulu (Bishop Museum Special Publication 83).

Lindsey, G.D., E.A. VanderWerf, H. Baker, and P.E. Baker. 1998. Hawaii (*Hemignathus virens*), Kauai (*Hemignathus kauaiensis*) Oahu (*Hemignathus chloris*), and Greater Amakihi (*Hemignathus sagittirostris*). *In* The Birds of North America, No. 360 (A. Poole and F. Gill, eds.). The Birds of North America, Inc., Philadelphia.

Loope, L.L, F.G. Howarth, F. Kraus, and T.K. Pratt. 2001. Newly emergent and future threats of alien species to pacific birds and ecosystems. Studies in Avian Biology 22:291-304.

Makua Implementation Team, W. Chee-Planning, Inc., and Hawaii Natural Heritage Program. 2003. Implementation Plan, Makua Military Reservation, Island of Oahu.

Marion, W.R., T.E. O'Meara, and D.S. Maehr. 1981. Use of playback recordings in sampling elusive or secretive birds. Studies in Avian Biology 6:81-85.

Mountainspring, S. and J.M. Scott. 1985. Interspecific competition among Hawaiian forest birds. Ecological Monographs 55: 219-239.

Nelson, J.T., B.L. Woodworth, S.G. Fancy, G. Lindsey, M.P. Moore, and E.J. Tweed. 2002. Effectiveness of rodent control and monitoring techniques for a montane rainforest. Wildlife Society Bulletin 30:82-92.

Palmer, D.D. 2003. Hawai`i's ferns and fern allies. University of Hawaii Press, Honolulu.

Pilsbry H.A. and C.M. Cooke. 1912-1914. Manual of Conchology. Structural and systematic. With illustrations of the species. Second series: Pulmonata. Vol. XXII. Achatinellidae. Academy of Natural Sciences, Philadelphia. lviii + 428 pp., 63 pls.

Pyle, R.L. 2002. Checklist of the birds of Hawaii 2002. Elepaio 62:135-148.

Reynolds, R T., J.M. Scott, and R. Nussbaum. 1980. A variable circular-plot method for estimating bird numbers. The Condor 82: 309-313.

Scott, J. M., S. Mountainspring, F.L. Ramsey, and C.B. Kepler. 1986. Forest bird communities of the Hawaiian Islands: Their dynamics, ecology, and conservation. Studies in Avian Biology No. 9. Cooper Ornithological Society. Allen Press, Lawrence.

Shehata, C., L.F. Freed, and R.L. Cann. 2001. Changes in native and introduced bird populations on Oahu: Infectious diseases and species replacement. Studies in Avian Biology 22: 264-273.

U.S. Fish and Wildlife Service. 1993. Recovery plan for the Oahu tree snails of the genus *Achatinella*. U.S. Fish and Wildlife Service, Portland, Oregon. 64 pp + 64 pp as appendices.

U.S. Fish and Wildlife Service. 1999. Endangered and threatened wildlife and plants. 50 CFR 17.11 and 17.12, December 1999. U. S. Dept. of Interior, Washington, DC. 55 pp.

U.S. Geological Survey. 2002. The North American Bird Banding Manual, Volume 1 (electronic version). www.pwrc.usgs.gov/BBL/manual/manual.htm

VanderWerf, E.A. 1997. Oahu amakihi nest in Manoa Valley. Elepaio 57: 125-126.

VanderWerf, E.A. 1998. Elepaio (*Chasiempis sandwichensis*). *In* The Birds of North America, No. 344 (A. Poole and F. Gill, eds.). The Birds of North America, Inc., Philadelphia.

VanderWerf, E.A., A. Cowell, and J.L. Rohrer. 1997. Distribution, abundance, and conservation of Oahu elepaio in the southern leeward Koolau Range. Elepaio 57:99-106.

VanderWerf, E.A., J.L. Rohrer, D.G. Smith, and M.D. Burt. 2001. Current distribution and abundance of the Oahu elepaio. Wilson Bulletin 113:10-16.

van Riper, C. III. 1987. Breeding ecology of the Hawaii common amakihi. Condor 89: 85-102.

van Riper, C. III, S.G. van Riper, and W.R. Hansen. 2002. Epizootiology and effects of avian pox on Hawaiian forest birds. Auk 119:929-942.

Wagner, W.L., D.R. Herbst, and S.H. Sohmer. 1990. Manual of the flowering plants of Hawai`i. 2 Vols. University of Hawaii Press and Bishop Museum, Honolulu (Bishop Museum Special Publication 83).

Wagner, W.L., D.R. Herbst, and S.H. Sohmer. 1999. Manual of the flowering plants of Hawai`i, revised edition with Manual Supplement by Wagner, W.L. and D.R. Herbst, University of Hawaii Press, 1919 pp. in 2 volumes. (Bishop Museum Special Publication 97).

Wagner, W.L. and E.M. Harris. 2000. A unique Hawaiian *Schiedea* (Caryophyllaceae: Alsinoideae) with only five fertile stamens. American Journal of Botany 87: 153-160.

Welch, d'A.A. 1938. Distribution and variation of *Achatinella mustelina* Mighels in the Waianae Mountains, Oahu. Bernice P. Bishop Museum Bulletin 152, 164 p., 13 pls. [1 September]

List of Preparers and Contributors

Hawaii Natural Heritage Program

Director
Dr. Barbara Gibson (beginning June 2004)
Shannon McElvaney (through November 2003)

Biologists
Joel Lau (Botanist)
Megan Laut (Zoologist)
Michele Harman (Assistant Biologist)
Mark Luke (Assistant Biologist)

Production Staff
Jennifer Ho (Administrative Assistant)
Roy Kam (Database Manager, Acting Director)
Dwight Matsuwaki (GIS Specialist)
Selima Siddiqui (GIS Analyst)

Contract Biologists
Kenneth Wood (Research Botanist)
Stefan Kropidlowski (Assistant Biologist)
Jeffrey Preble (Assistant Biologist)
Ken Suzuki (Assistant Biologist)

Appendices

Appendix 1. Naval Magazine Pearl Harbor, Lualualei Branch Vascular Plant Species List

The following is a list of the native and naturalized vascular plants observed during the 2004 Hawaii Natural Heritage Program survey of Naval Magazine Pearl Harbor, Lualualei Branch. The taxonomy and nomenclature of the flowering plants are according to the *Manual of the flowering plants of Hawai`i*, revised edition with Manual Supplement (Wagner et al. 1999); and *Hawai`i's ferns and fern allies* (Palmer 2003) for the ferns and fern allies.

Symbols:
+ = Rare
A = Alien (Introduced, Non-native)
NNE = Native, not endemic (Native to Hawaii and elsewhere)
E = Endemic (Occurs naturally only in Hawaii)
? = Status uncertain

	STATUS	TAXON	COMMON NAME
		FERNS AND FERN ALLIES	
		Aspleniaceae	
	E	*Asplenium acuminatum* Hook. and Arnott	
	NNE	*Asplenium adiantum-nigrum* L.	Iwaiwa
	NNE	*Asplenium aethiopicum (Burm. F.) Bech.*	
	E	*Asplenium contiguum* Kaulf.	
	NNE	*Asplenium horridum* Kaulf.	Iwa, alae
	E	*Asplenium macraei* Hook. and Grev.	
	NNE	*Asplenium nidus* L.	Ekaha, bird's-nest fern
+	E	*Diellia unisora* W. H. Wagner	
		Blechnaceae	
	A	*Blechnum occidentale* L.	
	E	*Doodia kunthiana* Gaud.	Okupukupulauii
	E	*Sadleria cyatheoides* Kaulf.	Amau, mau
		Cyatheaceae	
	A	*Sphaeropteris cooperi* (Hook. ex F. Muell.) R. M. Tryon	Australian treefern
		Dicksoniaceae	

STATUS	TAXON	COMMON NAME
E	*Cibotium chamissoi* Kaulf.	Hapuu pulu, treefern
	Dennstaedtiaceae	
NNE	*Microlepia speluncae* (L.) T. Moore	Palapalai
E	*Microlepia speluncae* (L.) T. Moore x *M. strigosa* (Thunb.) Presl	Palapalai
NNE	*Microlepia strigosa* (Thunb.) Presl	Palapalai
E	*Pteridium aquilinum* (L.) Kuhn var. *decompositum* (Gaud.) R. M. Tryon	
	Dryopteridaceae	
NNE	*Cyrtomium caryotideum* Presl	Kaapeape
A	*Cyrtomium falcatum* (L. fils.) Presl	
E	*Deparia fenzliana* (Luerss.) M. Kato	
A	*Deparia petersenii* (Kunze) M. Kato	
E	*Diplazium sandwichianum* (Presl) Diels	Hoio, pohole
E	*Dryopteris fusco-atra* (Hillebr.) Rob.	
	Dryopteris glabra (Brack.) Kuntze var. *nuda* (Underw.) Fraser-Jenk.	
E	*Dryopteris sandwicensis* (Hook. And Arn.) C. Chr.	
E	*Nephrolepis exaltata* (L.) Schott subsp. *hawaiiensis* W. H. Wagner	Kupukupu, nianiau
A	*Nephrolepis multiflora* (Roxb.) F. M. Jarrett ex C. V. Morton	Kupukupu, nianiau
E	*Tectaria gaudichaudii* (Mett.) Maxon	Iwaiwa lau nui
	Gleicheniaceae	
NNE	*Dicranopteris linearis* (N. L. Burm.) Underw.	Uluhe
	Grammitidaceae	
E	*Adenophorus tamariscinus* (Kaulf.) Hook. and Grev.	Wahine noho mauna
E	*Grammitis tenella* Kaulf.	Kolokolo
	Hymenophyllaceae	
NNE	*Gonocormus minutus* (Blume) Bosch	
E	*Vandenboschia davallioides* (Gaud.) Copel.	
	Lindsaeaceae	
NNE	*Sphenomeris chinensis* (L.) Maxon	Palaa

	STATUS	TAXON	COMMON NAME
		Lomariopsidaceae	
	E	*Elaphoglossum alatum* Gaud.	Hoe a Maui
	E	*Elaphoglossum aemulum* (Kaulf.) Brack.	
	E	*Elaphoglossum crassifolium* (Gaud.) Anders. and Crosby	Hoe a Maui
	NNE	*Elaphoglossum paleaceum* (Hook. and Grev.) Sledge	Makue
		Marsileaceae	
+	E	*Marsilea villosa* Kaulf.	Ihiihi, ihi laau
		Polypodiaceae	
	NNE	*Lepisorus thunbergianus* (Kaulf.) Ching	Pakahakaha, ekaha akolea
	A	*Phlebodium aureum* (L.) J. Sm.	Hare's-foot fern, lauae haole
	A	*Phymatosorus scolopendria* (Burm.) Pic.-Ser.	Lauae
	E	*Polypodium pellucidum* Kaulf.	Ae
		Psilotaceae	
	NNE	*Psilotum nudum* (L.) Beauv.	Moa
		Pteridaceae	
	A	*Adiantum hispidulum* Sw.	Rough maidenhair fern
	A	*Adiantum raddianum* Presl	Maidenhair fern
	A	*Cheilanthes viridis* (Forssk.) Sw.	Green cliffbrake
	E	*Doryopteris decipiens* (Hook.) J. Sm.	Kumuniu
	E	*Doryopteris decipiens* (Hook.) J. Sm. x *D. decora* Brack.	Kumuniu
	NNE	*Pteris cretica* L.	
	E	*Pteris cretica* L. x *P. irregularis* Kaulf.	
	E	*Pteris irregularis* Kaulf.	Mana, ahewa
		Selaginellaceae	
	E	*Selaginella arbuscula* (Kaulf.) Spring	Lepelepe-a-moa
		Thelypteridaceae	
	A	*Macrothelypteris torresiana* (Gaud.) Ching	
	E	*Pneumatopteris hudsoniana* (Brack.) Holttum	
	A	*Christella parasitica* (L.) H. Lev.	

	STATUS	TAXON	COMMON NAME
		GYMNOSPERMS	
		Araucariaceae	
	A	*Araucaria columnaris* (Forst. fil.) Hook.	Cook pine
		Cupressaceae	
	A	*Juniperus* sp.	Juniper
		FLOWERING PLANTS: DICOTS	
		Amaranthaceae	**Amaranth family**
	A	*Achyranthes aspera* L. var. *aspera*	
	A	*Amaranthus spinosus* L.	Spiny amaranth, pakai kuku
	E	*Charpentiera obovata* Gaud.	Papala
	E	*Charpentiera tomentosa* Sohmer var. *tomentosa*	Papala
+	E	*Nototrichium humile* Hillebr.	Kului
		Anacardiaceae	**Mango family**
	A	*Mangifera indica* L.	Mango
	A	*Schinus terebinthifolius* Raddi	Christmas berry, wilelaiki
		Apiaceae	**Parsley family**
	A	*Centella asiatica* (L.) Urb.	Asiatic pennywort, pohe kula
	A	*Ciclospermum leptophyllum* (Pers.) Sprague	Fir-leaved celery
+	E	*Spermolepis hawaiiensis* Wolff	
		Apocynaceae	**Dogbane family**
	E	*Alyxia oliviformis* Gaud.	Maile
	E	*Rauvolfia sandwicensis* A. DC	Hao
		Aquifoliaceae	**Holly family**
	E	*Ilex anomala* Hook. and Arnott	Kawau
		Araliaceae	**Ginseng family**
	E	*Cheirodendron trigynum* (Gaud.) A. Heller subsp. *trigynum*	Olapa

	STATUS	TAXON	COMMON NAME
	E	*Reynoldsia sandwicensis* A. Gray	Ohe-o-kai, ohe kukuluaeo
	A	*Schefflera actinophylla* (Endl.) Harms	Octopus tree
	E	*Tetraplasandra oahuensis* (A. Gray) Harms	Ohe mauka
		Aristolochiaceae	**Birthwort family**
	A	*Aristolochia littoralis* Parodi	Calico flower
		Asclepiadaceae	**Milkweed family**
	A	*Asclepias curassavica* L.	Butterfly weed, laulele
	A	*Stapelia gigantea* N. E. Brown	Zulu-giant, giant toad plant
		Asteraceae	**Sunflower family**
	A	*Ageratina adenophora* (Spreng.) R. King and H. Robinson	Maui pamakani
	A	*Ageratina riparia* (Regel) R. King and H. Robinson	Hamakua pamakani
	A	*Ageratum conyzoides* L.	Maile hohono
	E	*Artemisia australis* Less.	Hinahina, hinahina kuahiwi
	A	*Bidens alba* (L.) DC var. *radiata* (Schultz-Bip.) Ballard ex Melchert	-
	E	*Bidens cervicata* Sherff	Kookoolau, kokoolau
	A	*Bidens cynapiifolia* Kunth	Spanish needle, beggartick
	A	*Bidens pilosa* L.	Spanish needle, beggartick
	E	*Bidens torta* Sherff	Kookoolau, kokoolau
	A	*Conyza bonariensis* (L.) Cronq.	Hairy horseweed, ilioha
	A	*Crassocephalum crepidioides* (Benth.) S. Moore	-
	E	*Dubautia plantaginea* Gaud. subsp. *plantaginea*	Naenae
	A	*Emilia fosbergii* Nicolson	Flora's paintbrush
	A	*Emilia sonchifolia* (L.) DC	Flora's paintbrush
	A	*Erechtites valerianifolia* (Wolf) DC	Fireweed
	A	*Erigeron karvinskianus* DC	Daisy fleabane
	A	*Galinsoga parviflora* Cav.	
	A	*Gnaphalium purpureum* L.	Purple cudweed
	A	*Hypochoeris radicata* L.	Hairy cat's ear, gosmore
	A	*Lactuca serriola* L.	Prickly lettuce
+	E	*Lipochaeta lobata* (Gaud.) DC var. *leptophylla* Degener and Sherff	Nehe
+	E	*Melanthera tenuis* (Degener and Sherff) W. L. Wagner and H. Rob.	Nehe
	A	*Montanoa hibiscifolia* Benth.	Tree daisy
	A	*Pluchea symphytifolia* (Mill.) Gillis	Sourbush

	STATUS	TAXON	COMMON NAME
	A	*Sonchus oleraceus* L.	Sow thistle, pualele
	A	*Synedrella nodiflora* (L.) Gaertn.	Nodeweed
+	E	*Tetramolopium filiforme* Sherff	
	A	*Tridax procumbens* L.	Coat buttons
	A	*Verbesina encelioides* (Cav.) Benth. and Hook.	Golden crown-beard
	A	*Vernonia cinerea* (L.) Less. var. *parviflora* (Reinw.) DC	Little ironweed
	A	*Wedelia trilobata* (L.) Hitchc.	
	A	*Xanthium strumarium* L. var. *canadense* (Mill.) Torr. and A. Gray	Cocklebur, kikania
	A	*Youngia japonica* (L.) DC	Oriental hawksbeard
		Basellaceae	**Basella family**
	A	*Anredera cordifolia* (Ten.) Steenis	Madeira vine, uala hupe
		Bignoniaceae	**Bignonia family**
	A	*Spathodea campanulata* P. Beauv.	African tulip tree
	A	*Tecoma castanifolia* (Don) Melch.	
		Boraginaceae	**Borage family**
	A	*Heliotropium procumbens* Mill. var. *depressum* (Cham.) Fosb.	
		Brassicaceae	**Mustard family**
	A	*Coronopus didymus* (L.) Sm.	Swinecress
+	E	*Lepidium arbuscula* Hillebr.	Anaunau, naunau, kunana
		Buddlejaceae	**Butterfly bush family**
	A	*Buddleia asiatica* Lour.	Dogtail
		Cactaceae	**Cactus family**
	A	*Opuntia ficus-indica* (L.) Mill.	Prickly pear, panini
		Campanulaceae	**Bellflower family**
+	E	*Lobelia niihauensis* St. John	Oha, haha, ohawai
+	E	*Lobelia yuccoides* Hillebr.	Panaunau
		Caryophyllaceae	**Pink family**
	A	*Cerastium fontanum* Baumg. subsp. *triviale* (Link) Jalas	Common mouse-ear chickweed

	STATUS	TAXON	COMMON NAME
	A	*Drymaria cordata* (L.) Willd. ex Roem. and Schult. var. *pacifica* Mizush.	Pipili, pilipili
+	E	*Schiedea hookeri* A. Gray	
	E	*Schiedea ligustrina* Cham. and Schlechtend.	
	E	*Schiedea mannii* St. John	
+	E	*Schiedea pentandra* W. L. Wagner and E. M. Harris	
	A	*Stellaria media* (L.) Vill.	Common chickweed
		Casuarinaceae	**She-oak family**
	A	*Casuarina equisetifolia* L.	Common ironwood, paina
		Celastraceae	**Bittersweet family**
	E	*Perrottetia sandwicensis* A. Gray	Olomea
		Chenopodiaceae	**Goosefoot family**
	A	*Chenopodium murale* L.	Goosefoot, pigweed
	E	*Chenopodium oahuense* (Meyen) Aellen	Aheahea, aweoweo
		Convolvulaceae	**Morning glory family**
	A	*Ipomoea alba* L.	Moon flower, koali pehu
	A?	*Ipomoea cairica* (L.) Sweet	Ivy-leaved morning glory, koali ai
	NNE	*Ipomoea indica* (J. Burm.) Merr.	Koali awa, koali awahia
	A	*Ipomoea obscura* (L.) Ker-Gawl.	Morning glory
	A?	*Merremia aegyptia* (L.) Urb.	Hairy merremia
		Crassulaceae	**Orpine family**
	A	*Kalanchoe pinnata* (Lam.) Pers.	Air plant, oliwa ku kahakai
	A	*Kalanchoe* sp.	
		Cucurbitaceae	**Gourd family**
	A	*Coccinia grandis* (L.) Voigt	Scarlet-fruited gourd
	A	*Cucumis dipsaceus* Ehrenb. ex Spach	Hedgehog gourd, teasel gourd
	A	*Momordica charantia* L.	Balsam pear
	E	*Sicyos pachycarpus* Hook. and Arnott	Anunu, kupala
		Ebenaceae	**Ebony family**
	E	*Diospyros hillebrandii* (Seem.) Fosb.	Lama, elama
	E	*Diospyros sandwicensis* (A. DC) Fosb.	Lama, elama

	STATUS	TAXON	COMMON NAME
		Elaeocarpaceae	**Elaeocarpus family**
	E	*Elaeocarpus bifidus* Hook. and Arnott	Kalia
		Epacridaceae	**Epacris family**
	NNE	*Styphelia tameiameiae* (Cham. and Schlechtend.) F. v. Muell.	Pukiawe
		Ericaceae	**Heath family**
	E	*Vaccinium dentatum* Sm.	Ohelo
		Euphorbiaceae	**Spurge family**
	A	*Aleurites moluccana* (L.) Willd.	Candlenut, kukui
	E	*Antidesma platyphyllum* H. Mann var. *platyphyllum*	Hame, mehame
	E	*Antidesma pulvinatum* Hillebr.	Hame, mehame
	E	*Chamaesyce celastroides* (Boiss.) Croizat and Degener var. *amplectens*	
	A	*Chamaesyce hirta* (L.) Millsp.	Hairy spurge, garden spurge, koko kahiki
	A	*Chamaesyce hypericifolia* (L.) Millsp.	Graceful spurge
+	E	*Chamaesyce kuwaleana* (Degener and Sherff) Degener and I. Degener	Akoko, koko, kokomalei
	E	*Chamaesyce multiformis* (Hook. and Arnott) Croizat and Degener var. *microphylla* (Boiss.) Degener and I. Degener	Akoko, koko, kokomalei
	E	*Chamaesyce multiformis* (Hook. and Arnott) Croizat and Degener var. *multiformis*	Akoko, koko, kokomalei
	E	*Claoxylon sandwicense* Mull. Arg.	Poola
+	E	*Flueggea neowawraea* W. Hayden	Mehamehame
	A	*Mallotus philippensis* (Lam.) Mull. Arg.	
	E	*Phyllanthus distichus* Hook. and Arnott	Pamakani mahu
	A	*Ricinus communis* L.	Castor bean, paaila, koli
		Fabaceae	**Pea family**
	A	*Acacia confusa* Merr.	Formosan koa
	A	*Acacia farnesiana* (L.) Willd.	Klu, kolu
	E	*Acacia koa* A. Gray	Koa
	NNE	*Caesalpinia bonduc* (L.) Roxb.	Kakalaioa, gray nickers
	A?	*Caesalpinia major* (Medik.) Dandy and Exell	Yellow nickers, kakalaioa
	E	*Canavalia galeata* (Gaud.) Vogel	Awikiwiki, puakauhi

STATUS	TAXON	COMMON NAME
A	*Chamaecrista nictitans* (L.) Moench subsp. *patellaria* (DC ex Collad.) H. Irwin and Barneby var. *glabrata* (Vogel) H. Irwin and Barneby	Partridge pea, lauki
A	*Crotalaria pallida* Aiton	Smooth rattlepod
A	*Desmanthus virgatus* (L.) Willd.	Slender mimosa, virgate mimosa
A	*Desmodium incanum* DC	Spanish clover, kaimi
A	*Desmodium sandwicense* E. Mey.	Spanish clover, pua pilipili
E	*Erythrina sandwicensis* Degener	Wiliwili
A	*Glycine wightii* (Wight and Arnott) Verde	
A	*Haematoxylum campechianum* L.	Logwood, bloodwood tree
A	*Indigofera suffruticosa* Mill.	Indigo
A	*Indigofera spicata* Forssk.	Creeping indigo
A	*Leucaena leucocephala* (Lam.) de Wit	Haole koa, koa haole, ekoa
A	*Macroptilium lathyroides* (L.) Urb.	Wild bean, cow pea
A	*Paraserianthus falcataria* (L.) I. Nielsen	
A	*Prosopis pallida* (Humb. and Bonpl. ex Willd.) Kunth	Algaroba, mesquite, kiawe
A	*Senna pendula* (Humb. and Bonpl. ex Willd.) H. Irwin and Barneby var. *advena* (Vogel) H. Irwin and Barneby	
A	*Tephrosia purpurea* (L.) Pers. var. *purpurea*	Auhuhu, hola
	Flacourtiaceae	**Flacourtia family**
E	*Xylosma hawaiiense* Seem.	Maua
	Gentianaceae	**Gentian family**
A	*Centaurium erythraea* Raf. subsp. *erythraea*	Bitter herb, European centaury
	Gesneriaceae	**African violet family**
E	*Cyrtandra waianaeensis* St. John and Storey	Haiwale, kanawao keokeo
	Goodeniaceae	**Goodenia family**
E	*Scaevola gaudichaudiana* Cham.	Naupaka kuahiwi
	Hydrangeaceae	**Hydrangea family**
E	*Broussaisia arguta* Gaud.	Kanawao, puahanui
	Lamiaceae	**Mint family**
A	*Hyptis pectinata* (L.) Poit.	Comb hyptis
A	*Leonotis nepetifolia* (L.) R. Br.	Lion's ear

	STATUS	TAXON	COMMON NAME
	A	*Ocimum gratissimum* L.	Basil
	NNE	*Plectranthus parviflorus* Willd.	Alaala wai nui
	A	*Salvia coccinea* Juss. ex J. A. Murray	Scarlet sage, Texas sage, lililehua
	A	*Salvia occidentalis* Sw.	West Indian sage
	A	*Stachys arvensis* L.	Staggerweed
	E	*Stenogyne kaalae* Wawra	
		Loganiaceae	**Logania family**
+	E	*Labordia kaalae* C. Forbes	Kamakahala
		Lythraceae	**Loosestrife family**
	A	*Ammannia coccinea* Rottb.	Toothcup
	NNE?	*Lythrum maritimum* Kunth	Pukamole
		Malvaceae	**Mallow family**
	A	*Abutilon grandifolium* (Willd.) Sweet	Hairy abutilon, mao
	NNE?	*Abutilon incanum* (Link) Sweet	Hoary abutilon, mao
+	E	*Abutilon sandwicense* (Degener) Christoph.	
	E	*Hibiscus arnottianus* A. Gray subsp. *arnottianus*	Kokio keokeo
	NNE?	*Hibiscus tiliaceus* L.	Hau
	A	*Malva parviflora* L.	Cheese weed
	A	*Malvastrum coromandelianum* (L.) Garcke subsp. *coromandelianum*	False mallow
	NNE	*Sida fallax* Walp.	Ilima
	A?	*Sida rhombifolia* L.	
	A	*Sida spinosa* L.	Prickly sida
		Melastomataceae	**Melastoma family**
	A	*Clidemia hirta* (L.) D. Don var. *hirta*	Koster's curse
		Meliaceae	**Mahogany family**
	A	*Melia azedarach* L.	Chinaberry, Pride-of-India, inia
	A	*Swietenia macrophylla* King	Broad-leafed mahogany
	A	*Toona ciliata* M. Roem. var. *australis* (F. v. Muell.) C. DC	Austrailian red cedar
		Menispermaceae	**Moonseed family**
	NNE	*Cocculus trilobus* (Thunb.) DC	Huehue

STATUS	TAXON	COMMON NAME
	Moraceae	**Mulberry family**
A	*Ficus macrophylla* L. fil.	Moreton Bay fig
A	*Ficus microcarpa* L. fil.	Chinese banyan, Malayan banyan
NNE	*Streblus pendulinus* (Endl.) F. v. Muell.	Aiai
	Myoporaceae	**Myoporum family**
NNE	*Myoporum sandwicense* A. Gray	Naio, bastard sandalwood
	Myricaceae	**Bayberry family**
A	*Morella faya* (Aiton) Wilbur	Firetree
	Myrsinaceae	**Myrsine family**
E	*Myrsine lanaiensis* Hillebr.	Kolea
E	*Myrsine lessertiana* A. DC	Kolea
E	*Myrsine sandwicensis* A. DC	Kolea lau lii
	Myrtaceae	**Myrtle family**
A	*Eucalyptus robusta* Sm.	Swamp mahogany
A	*Eucalyptus* spp.	Eucalyptus
NNE	*Eugenia reinwardtiana* (Blume) DC	Nioi
A	*Melaleuca quinquenervia* (Cav.) S. T. Blake	Paperbark
E	*Metrosideros polymorpha* Gaud. var. *glaberrima* (H. Lev.) St. John	Ohia, ohia lehua, lehua
E	*Metrosideros polymorpha* Gaud. var. *incana* (H. Lev.) St. John	Ohia, ohia lehua, lehua
E	*Metrosideros polymorpha* Gaud. var. *polymorpha*	Ohia, ohia lehua, lehua
A	*Psidium cattleianum* Sabine	Strawberry guava, waiawi
A	*Psidium guajava* L.	Guava, kuawa
A	*Syzygium cumini* (L.) Skeels	Java plum
A	*Syzygium jambos* (L.) Alston	Rose apple
E	*Syzygium sandwicensis* (A. Gray) Nied.	Ohia ha
	Nyctaginaceae	**Four-o`clock family**
A	*Boerhavia coccinea* Mill.	
NNE	*Boerhavia repens* L.	Alena
NNE	*Pisonia brunoniana* Endl.	Papala kepau
E	*Pisonia sandwicensis* Hillebr.	Papala kepau, aulu

STATUS	TAXON	COMMON NAME
E	*Pisonia umbellifera* (G. Forster) Seem.	Papala kepau
	Oleaceae	**Olive family**
A	*Fraxinus uhdei* (Wenzig) Lingelsh.	Tropical ash
E	*Nestegis sandwicensis* (A. Gray) Degener, I. Degener and L. Johnson	Olopua, pua
	Onagraceae	**Evening primrose family**
A?	*Ludwigia octovalvis* (Jacq.) Raven	Primrose willow, kamole
	Oxalidaceae	**Wood sorrel family**
A?	*Oxalis corniculata* L.	Yellow wood sorrel, ihi makole
	Passifloraceae	**Passion flower family**
A	*Passiflora edulis* Sims	Passion fruit, lilikoi
A	*Passiflora suberosa* L.	Huehue haole
	Phytolaccaceae	**Pokeweed family**
A	*Phytolacca octandra* L.	Southern pokeberry
A	*Rivina humilis* L.	Coral berry
	Piperaceae	**Pepper family**
NNE	*Peperomia blanda* (Jacq.) Kunth var. *floribunda* (Miq.) H. Huber	Alaala wai nui
E	*Peperomia latifolia* Miq.	Alaala wai nui
E	*Peperomia membranacea* Hook. and Arnott	Alaala wai nui
E	*Peperomia sandwicensis* Miq.	Alaala wai nui
NNE	*Peperomia tetraphylla* (G. Forster) Hook. and Arnott	Alaala wai nui
	Pittosporaceae	**Pittosporum family**
E	*Pittosporum confertiflorum* A. Gray	Hoawa
E	*Pittosporum glabrum* Hook. and Arnott	Hoawa
	Plantaginaceae	**Plantain family**
A	*Plantago major* L.	Broad-leaved plantain, laukahi
	Plumbaginaceae	**Plumbago or leadwort family**
NNE	*Plumbago zeylanica* L.	Iliee

	STATUS	TAXON	COMMON NAME
		Polygonaceae	**Buckwheat family**
	E	*Rumex albescens* Hillebr.	Huahuako
		Portulacaceae	**Purslane family**
	A	*Portulaca oleracea* L.	Pigweed, ihi
	A	*Portulaca pilosa* L.	Pigweed, ihi
		Primulaceae	**Primrose family**
	E	*Lysimachia hillebrandii* J. D. Hook. ex A. Gray	
		Proteaceae	**Protea family**
	A	*Grevillea robusta* A. Cunn. ex R. Br.	Silk oak
		Rosaceae	**Rose family**
	NNE	*Osteomeles anthyllidifolia* (Sm.) Lindl.	Ulei
	A	*Rubus rosifolius* Sm.	Thimbleberry
		Rubiaceae	**Coffee family**
	E	*Bobea brevipes* A. Gray	Ahakea
+	E	*Bobea sandwicensis* (A. Gray) Hillebr.	Ahakea
	NNE	*Canthium odoratum* (G. Forster) Seem.	Alahee
	E	*Coprosma foliosa* A. Gray	Pilo
	E	*Coprosma longifolia* A. Gray	Pilo
	E	*Hedyotis acuminata* (Cham. and Schlechtend.) Steud.	Au
	E	*Hedyotis centranthoides* (Hook. and Arnott) Steud.	
+	E	*Hedyotis parvula* (A. Gray) Fosb.	
	E	*Hedyotis schlechtendahliana* Steud. var. *schlechtendahliana*	
	E	*Hedyotis terminalis* (Hook. and Arnott) W. L. Wagner and Herbst	Manono
	E	*Psychotria hathewayi* Fosb. var. *hathewayi*	Kopiko, opiko
	E	*Psychotria mariniana* (Cham. and Schlechtend.) Fosb.	Kopiko, opiko
		Rutaceae	**Rue family**
	E	*Melicope clusiifolia* (A. Gray) T. Hartley and B. Stone	Alani
	E	*Melicope peduncularis* (H. Lev.) T. Hartley and B. Stone	Alani
	E	*Zanthoxylum dipetalum* H. Mann var. *dipetalum*	Kawau

	STATUS	TAXON	COMMON NAME
		Santalaceae	**Sandalwood family**
	E	*Santalum ellipticum* Gaud.	Iliahi, sandalwood
		Sapindaceae	**Soapberry family**
+	E	*Alectryon macrococcus* Radlk. var. *macrococcus*	Alaalahua, mahoe
	NNE	*Dodonaea viscosa* Jacq.	Aalii
	E	*Sapindus oahuensis* Hillebr. ex Radlk.	Lonomea, aulu
		Sapotaceae	**Sapodilla family**
	A	*Chrysophyllum oliviforme* L.	Satin leaf, caimitillo
	E	*Pouteria sandwicensis* (A. Gray) Baehni and Degener	Alaa
	A	*Sideroxylon persimile* (Hemsl.) T.D. Penn	Bully tree
		Solanaceae	**Nightshade family**
	A	*Datura stramonium* L.	Jimson weed
	A	*Lycopersicon pimpinellifolium* (Jusl.) Mill.	Currant tomato
	A	*Nicandra physalodes* (L.) Gaertn.	Apple of Peru
	A	*Nicotiana glauca* R. C. Graham	Tree tobacco
	A	*Physalis peruviana* L.	Cape gooseberry, poha
	NNE?	*Solanum americanum* Mill.	Glossy nightshade, Popolo
	A	*Solanum seaforthianum* Andr.	
		Sterculiaceae	**Cacao family**
	NNE?	*Waltheria indica* L.	Uhaloa, hialoa
		Thymelaeaceae	**Akia family**
	E	*Wikstroemia oahuensis* (A. Gray) Rock var. *oahuensis*	Akia
		Tiliaceae	**Linden family**
	A	*Triumfetta semitriloba* Jacq.	Sacramento bur
	A	*Heliocarpus popayanensis* Kunth	Moho, white moho
		Urticaceae	**Nettle family**
	E	*Boehmeria grandis* (Hook. and Arnott) A. Heller	
+	E	*Neraudia angulata* R. Cowan	Maaloa, maoloa, oloa
+	E	*Neraudia melastomifolia* Gaud.	Maaloa, maoloa, oloa

	STATUS	TAXON	COMMON NAME
	NNE	*Pilea peploides* (Gaud.) Hook. and Arnott	
	E	*Pipturus albidus* (Hook. and Arnott) A. Gray	Mamaki
	E	*Urera glabra* (Hook. and Arnott) Wedd.	Opuhe
		Verbenaceae	**Verbena family**
	A	*Lantana camara* L.	Lantana
	A	*Stachytarpheta dichotoma* (Ruiz and Pav.) Vahl	Oi
	A	*Stachytarpheta jamaicensis* (L.) Vahl	Jamaica vervain, oi
	A	*Verbena litoralis* Kunth	Hauoi, oi
		Violaceae	**Violet family**
+	E	*Viola chamissoniana* Ging. subsp. *chamissoniana*	Pamakani
	E	*Viola chamissoniana* Ging. subsp. *tracheliifolia* (Ging.) W. L. Wagner, Herbst and Sohmer	Pamakani
		Viscaceae	**Mistletoe family**
	E	*Korthalsella cylindrica* (Tiegh.) Engl.	Hulumoa, kaumahana
		FLOWERING PLANTS: MONOCOTS	
		Agavaceae	**Agave family**
	A	*Cordyline fruticosa* (L.) A. Chev.	Ti, ki
	A	*Furcraea foetida* (L.) Haw.	Mauritius hemp, malina
+	E	*Pleomele forbesii* Degener	Halapepe
		Araceae	**Philodendron or aroid family**
	A	*Alocasia macrorrhiza* (L.) Schott	Ape
		Commelinaceae	**Spiderwort family**
	A	*Commelina benghalensis* L.	Hairy honohono
	A	*Commelina diffusa* N. L. Burm.	Honohono
		Cyperaceae	**Sedge family**
	NNE	*Carex meyenii* Nees	
	E	*Carex wahuensis* C. A. Mey. subsp. *wahuensis*	
	A	*Cyperus gracilis* R. Br.	McCoy grass, mauu hunehune
	A	*Cyperus halpan* L.	
	A	*Cyperus rotundus* L.	Nut grass, kilioopu

STATUS	TAXON	COMMON NAME
A	*Kyllinga brevifolia* Rottb.	Kilioopu
A	*Kyllinga nemoralis* (J. R. Forster and G. Forster) Dandy ex Hutchinson and Dalziel	Kilioopu
NNE	*Mariscus cyperinus* (Retz.) Vahl	
E	*Mariscus hillebrandii* (Boeck.) T. Koyama	
E	*Mariscus phleoides* Nees ex Kunth	
	Juncaceae	**Rush family**
E	*Luzula hawaiiensis* Buchenau var. *oahuensis* (Degener and Fosb.) Degener and I. Degener	Wood rush
	Lemnaceae	**Duckweed family**
A?	*Lemna perpusilla* Torr.	Duckweed
	Liliaceae	**Lily family**
NNE	*Dianella sandwicensis* Hook. and Arnott	Ukiuki
	Musaceae	**Banana family**
A	*Musa* x *paradisiaca* L.	Banana, maia
	Orchidaceae	**Orchid family**
A	*Epidendrum* x *obrienianum* Rolfe	Scarlet orchid, butterfly orchid
A	*Spathoglottis plicata* Blume	Malayan ground orchid,
	Pandanaceae	**Screw pine family**
NNE	*Freycinetia arborea* Gaud.	Ieie
	Poaceae	**Grass family**
NNE	*Agrostis avenacea* J. G. Gmelin	Heupueo
A	*Aira caryophyllea* L.	Silver hairgrass
A	*Andropogon virginicus* L.	Broomsedge, yellow bluestem
A	*Bothriochloa pertusa* (L.) A. Camus	Pitted beardgrass
A	*Brachiaria plantaginea* (Link) Hitchc.	Alexandergrass, creeping signalgrass
A	*Bromus mollis* L.	Soft chess
A	*Cenchrus ciliaris* L.	Buffelgrass
A	*Cenchrus echinatus* L.	Common sandbur, umealu
A	*Chloris barbata* (L.) Sw.	Swollen fingergrass, mauu lei
A	*Chloris virgata* Sw.	Feather fingergrass

STATUS	TAXON	COMMON NAME
NNE?	*Chrysopogon aciculatus* (Retz.) Trin.	Golden beardgrass, manienie ula, pilipili
A	*Cynodon dactylon* (L.) Pers.	Bermuda grass, manienie
A	*Dactyloctenium aegyptium* (L.) Willd.	Beach wiregrass
A	*Digitaria insularis* (L.) Mez ex Ekman	Sourgrass
A	*Echinochloa crus-galli* (L.) P. Beauv.	Barnyard grass
A	*Ehrharta stipoides* Labill.	Meadow ricegrass
A	*Eleusine indica* (L.) Gaertn.	Wiregrass
E	*Eragrostis grandis* Hillebr.	Kawelu
A	*Eragrostis tenella* (L.) P. Beauv ex Roem. and Schult.	Japanese lovegrass
NNE?	*Heteropogon contortus* (L.) P. Beauv. ex Roem. and Schult.	Pili, twisted beardgrass
A	*Melinis minutiflora* P. Beauv.	Molasses grass
A	*Oplismenus hirtellus* (L.) P. Beauv.	Basketgrass, honohono kukui
E	*Panicum beecheyi* Hook. and Arnott	
A	*Panicum maximum* Jacq.	Guinea grass
E	*Panicum nephelophilum* Gaud.	Konakona
A	*Paspalum conjugatum* Bergius	Hilo grass
A	*Paspalum fimbriatum* Kunth	Fimbriate paspalum
NNE?	*Paspalum scrobiculatum* L.	Ricegrass
A	*Rhynchelytrum repens* (Willd.) Hubb.	Natal redtop
A	*Setaria gracilis* Kunth	Yellow foxtail
A	*Setaria verticillata* (L.) P. Beauv.	Bristly foxtail
A	*Sporobolus indicus* (L.) R. Br.	Smutgrass, West Indian dropseed
A	*Vulpia bromoides* (L.) S. F. Gray	Brome fescue
	Smilacaceae	**Catbrier family**
E	*Smilax melastomifolia* Sm.	Hoi kuahiwi

Appendix 2. Species Information

Background information of all Federally endangered, threatened, or species of concern observed on Naval Magazine Pearl Harbor, Lualualei Branch.

Endangered Species

Plants

Photo J. Obata

Abutilon sandwicense (Degener) Christoph.
Common name: No common name
Family: Mallow family (Malvaceae)
Federal status: Listed endangered (USFWS 1999)
Heritage global rank: G1 (Hawaii Natural Heritage Program 2004)

A. *sandwicense* is a shrub 1.5 to 6.0 meters tall. Its leaves are heart-shaped and 8 to 22 centimeters long. The flowers are solitary in the leaf axils, and pendulous. The narrow petals of the flower are green to reddish brown and 4 to 5 centimeters long. Its fruit is vase-like and 17 to 25 millimeters long (Wagner et al. 1990).

A. sandwicense is endemic to dry forests of the Waianae Mountains of Oahu from 365 to 610 meters (1,200 to 2,000 feet) in elevation (Hawaii Natural Heritage Program 2004).

Photo J. Obata

Alectryon macrococcus Radlk. var. *macrococcus*
Common name: Alaalahua, mahoe
Family: Soapberry family (Sapindaceae)
Federal status: Listed endangered (USFWS 1999)
Heritage global rank: G1T1 (Hawaii Natural Heritage Program 2004)

A. *macrococcus* var. *macrococcus* is a tree 3 to 11 meters tall. Its compound leaves are 20 to 55 centimeters long, with two to five pairs of leaflets. Its small flowers are either perfect (containing both male and female parts) or staminate (containing only male parts) and borne in panicles up to 30 centimeters long. The fruit is subglobose, and 2.5 to 7.0 centimeters in diameter. The flesh of the fruit is scarlet and is enclosed within a hard rind (Wagner et al. 1990).

A. macrococcus is endemic to Kauai, Oahu, Molokai, and Maui, and consists of two varieties. The variety *macrococcus* is endemic to Kauai, Oahu, Molokai, and West Maui. The other variety, var. *auwahiensis*, is known only from East Maui. *A. m*. var. *macrococcus* occurs in mesic forests from 365 to 1,035 meters in elevation (1197 to 3395 feet) (Hawaii Natural Heritage Program 2004).

Photo J. Obata

Bonamia menziesii A.Gray
Common name: No common name
Family: Morning glory family (Convolvulaceae)
Federal status: Endangered (USFWS 1999)
Heritage global rank: G2 (Hawaii Natural Heritage Program 2004)

B. menziesii is a vine with twining stems up to 10 to 15 meters long. The leaves are oblong-elliptic, ovate to rarely orbicular, and 3 to 9 centimeters long and 1 to 4 centimeters wide. The upper surface of the leaves may be smooth or covered with short woolly hairs, while the lower surface is almost always densely covered with yellowish-brown hairs. The flowers are solitary or sometimes in cymes. The corollas are white to greenish-white and are 20 to 25 millimeters long and 15 to 20 millimeters wide (Wagner et al. 1990).

B. menziesii is endemic to Kauai, Oahu, Molokai, Lanai, Maui, and Hawaii. It has been reported from dry to mesic and, rarely, wet forests and shrublands, from 150 to 750 meters (492 to 2461 feet)in elevation (Hawaii Natural Heritage Program 2004).

Photo HINHP

Chamaesyce kuwaleana (Degener and Sherff) Degener and I. Degener
Common name: Akoko, koko, ekoko, kokomalei
Family: Spurge family (Euphorbiaceae)
Federal status: Listed endangered (USFWS 1999)
Heritage global rank: G1 (Hawaii Natural Heritage Program 2004)

C. kuwaleana is a shrub that grows 0.2 to 0.9 meters tall. The oppositely arranged leaves are 11 to 25 millimeters long and 8 to 15 millimeters wide and are ovate or rarely orbicular. The flowers are borne in cyathia (specialized inflorescences) arranged singly in the leaf axils or rarely at the tips of branches. The size and shape of the capsules are not known (Koutnik 1990).

With the exception of a single specimen collected in 1937 from Moku Manu, an islet off the windward coast of Oahu, *C. kuwaleana* is endemic to the Lualualei-Waianae Kai area in the Waianae Mountains of Oahu. This species has been found on dry to mesic ridges and cliffs between 60 and 550 meters (197 to1804 feet) in elevation (Hawaii Natural Heritage Program 2004).

Photo HINHP

Diellia unisora W.H. Wagner.
Common name: No common name
Family: Spleenwort family (Aspleniaceae)
Federal status: Endangered (USFWS 1999)
Heritage global rank: G1 (Hawaii Natural Heritage Program 2004)

D. unisora grows from a slender, erect rhizome 0.5 to 3.0 centimeters tall and 0.4 to 1.0 centimeters in diameter. The stipes are black and shiny. The rhizome and stipe bases are clothed with small jet-black scales. The fronds have 20 to 35 pairs of pinnae, and are linear, gradually narrowing towards the apex. The pinnae are usually strongly asymmetrical in outline. A single marginal sorus runs along the anterior edge of each pinna (Palmer 2003).

D. unisora is endemic to the southern Waianae Mountains of Oahu. It grows in mesic grasslands, shrublands, or forests between the elevations of 535 and 775 meters (1755 to 2543 feet) (Hawaii Natural Heritage Program 2004).

Prior to the 2004 biological survey, only a single plant of *D. unisora* had been found within the PH LLL boundaries. It was found in 2003 in Halona (J. Lau, pers. comm.).

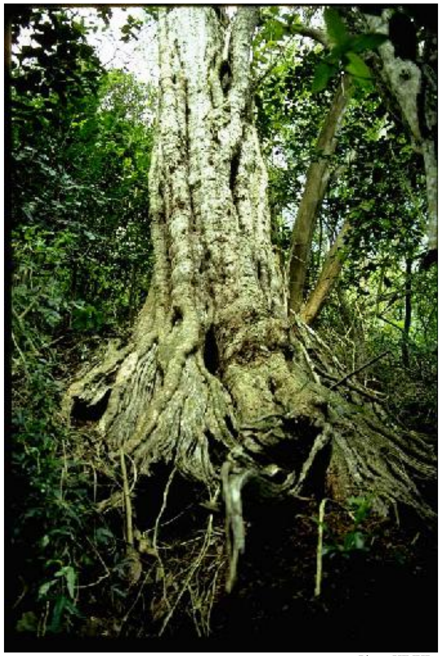


Photo HINHP

Flueggea neowawraea W. Hayden
Common name: Mehamehame
Family: Spurge family (Euphorbiaceae)
Federal status: Endangered (USFWS 1999)
Heritage global rank: G1 (Hawaii Natural Heritage Program 2004)

F. neowawraea is dioecious (the male and female flowers are on separate plants). It is a tree up to 30 meters tall, with a trunk up to 2 meters in diameter. Its leaves are ovate-elliptic, 4 to 14 centimeters long, and 2 to 9 centimeters wide. The small flowers are borne in axillary clusters. The fruits are reddish brown to black, juicy, globose, and 3 to 6 millimeters in diameter (Hayden 1990).

This species has been recorded from Kauai, the Waianae Mountains of Oahu, Molokai, East Maui, and Hawaii in mesic forests from 365 to 855 meters (1197 to 2805 feet) in elevation (Hawaii Natural Heritage Program 2004).

Photo J. Obata

Hedyotis parvula (A. Gray) Fosb.
Common name: No common name
Family: Coffee family (Rubiaceae)
Federal status: Listed endangered (USFWS 1999)
Heritage global rank: G1 (Hawaii Natural Heritage Program 2004)

H. parvula is small, erect to sprawling, many-branched shrub. The lanceolate to ovate-cordate leaves are 1 to 4 centimeters long and 0.7 to 2.3 centimeters wide. The leaves have slightly revolute margins and are usually closely spaced and overlapping. The flowers are perfect or pistillate (containing only female parts), in narrow corymbose inflorescences that may sometimes be grouped together to give the appearance of one large inflorescence. The flowers are white with a purplish-pink tinge toward the tips (Wagner et al. 1990).

This species is endemic to the Waianae Mountains of Oahu. It is found on steep, mesic cliffs from 600 to 855 meters (1969 to 2805 feet) in elevation (Hawaii Natural Heritage Program 2004).

Photo J. Obata

Lepidium arbuscula Hillebr.
Common name: Anaunau, naunau, kunana
Family: Mustard family (Brassicaceae)
Federal status: Category 2 candidate (USFWS 1999)
Heritage global rank: G1 (Hawaii Natural Heritage Program 2004)

L. arbuscula is a shrub 0.6 to 1.2 meters tall. The leaves are crowded at the ends of the branches, and are 2.6 to 6.0 centimeters long and 0.8 to 1.8 centimeters wide. The small white flowers are borne on one to three erect, simple racemes 7 to 15 centimeters long (Wagner et al. 1990).

The species is endemic to the Waianae Mountains of Oahu from 350 to 915 meters in elevation. It occurs in dry to mesic habitats, in open shrubby or grassy areas, sparsely vegetated cliffs, and sometimes in scrubby forest (Hawaii Natural Heritage Program 2004).

Photo HINHP

Lipochaeta lobata (Gaud.) DC var. *leptophylla* Degener and Sherff
Common name: Nehe
Family: Aster family (Asteraceae)
Federal status: Listed endangered (USFWS 1999)
Heritage global rank: G2T1 (Hawaii Natural Heritage Program 2004)

L. lobata var. *leptophylla* is a somewhat woody, perennial herb, with stems arching or decumbent. The leaves are closely spaced, lanceolate to linear lanceolate, and up to 9.7 centimeters long. Flowers are borne in heads with 20 to 65 disk florets and 8 to 15 yellow ray florets (Wagner et al. 1990).

L. lobata is endemic to Niihau, Oahu, and West Maui. There are two varieties of *L. lobata*. The variety *leptophylla* is endemic to the leeward side of the Waianae Mountains of Oahu. It has been recorded at elevations of 455 to 760 meters (1497 to 2493 feet) in dry to mesic habitats, on open, grassy or shrubby ridges and cliffs (Hawaii Natural Heritage Program 2004).

Photo HINHP

Lobelia niihauensis St. John
Common name: Oha, haha, oha wai
Family: Bellflower family (Campanulaceae)
Federal status: Listed endangered (USFWS 1999)
Heritage global rank: G2 (Hawaii Natural Heritage Program 2004)

L. niihauensis is a branched shrub with branches 20 to 40 centimeters long. Each branch bears an apical rosette of leaves 7 to 15 centimeters long and 0.7 to 1.8 centimeters wide. The unbranched inflorescences, 12 to 15 centimeters long, bear magenta flowers (Lammers 1990).

The species is endemic to Niihau, Kauai, and the Waianae Mountains of Oahu. It is typically found growing on cliffs in dry and mesic habitats, from 150 to 730 meters (492 to 2395 feet) in elevation (Hawaii Natural Heritage Program 2004).

Photo M. Bruegmann

Marsilea villosa Kaulf.
Common name: Ihiihi, ihi laau
Family: Water-clover family (Marsileaceae)
Federal status: Listed endangered (USFWS 1999)
Heritage global rank: G1 (Hawaii Natural Heritage Program 2004)

M. villosa is an aquatic fern with creeping rhizomes. The stipes are in clusters of 2-65 per node. The fronds bear four fan-shaped pinnae 2 to 2.5 cm long and 22-23 millimeters wide that arise closely from a short rachis, giving an appearance of a "four-leaved clover." The sori are contained in hard, nut-like sporocarps (spore-bearing structures) borne at the stipe bases. The sporocarps bear two types of spores: microspores and larger megaspores (Palmer 2003).

M. villosa is endemic to Niihau, Oahu, and Molokai. It is found in dry areas, usually in depressions that flood during heavy winter rains and dry out completely during the summer. Populations of this species have been recorded from 3 to 170 meters (11 to 558 feet) in elevation (Hawaii Natural Heritage Program 2004).

Photo HINHP

Neraudia angulata R. Cowan
Common name: Maaloa, maoloa, oloa
Family: Nettle family (Urticaceae)
Federal status: Listed endangered (USFWS 1999)
Heritage global rank: G1T1 (Hawaii Natural Heritage Program 2004)

N. angulata is an erect shrub 1.5 to 3.0 meters tall. Its leaves are elliptic, elliptic-ovate, or ovate, 1 to 15 centimeters long and 3.0 to 5.5 centimeters wide. The leaf undersides are hairy, and the leaf margins are sometimes coarsely toothed above the middle. The plants are unisexual, bearing either female or male flowers. The flowers are small, and tightly clustered in the leaf axils. The fruit is also small, and conspicuously angled and ridged (Wagner et al. 1990).

Neraudia angulata is endemic to the Waianae Mountains of Oahu, and has been found from 360 to 825 meters (1181 to 2706 feet) in elevation. It occurs in dry to mesic forests and shrublands, often on cliffs (Hawaii Natural Heritage Program 2004).

The species includes two varieties: var. *angulata* and var. *dentata*. However, there may not be a clear separation between the two varieties.

Photo HINHP

Nototrichium humile Hillebr.
Common name: Kului
Family: Amaranth family (Amaranthaceae)
Federal status: Listed endangered (USFWS 1999)
Heritage global rank: G2 (Hawaii Natural Heritage Program 2004)

N. humile is a shrub with erect to decumbent stems that are 1 to 5 meters long. Its leaves are ovate to oblong, 3 to 9 centimeters long, and 2 to 5 centimeters wide. Its small, inconspicuous flowers and fruits are borne on slender spikes 3 to 14 centimeters long (Wagner et al. 1990).

With the exception of a single collection from leeward East Maui, *N. humile* has been recorded only from the Waianae Mountains of Oahu. It occurs in dry and mesic forests from 60 to 700 meters (200 to 2,300 feet) in elevation (Hawaii Natural Heritage Program 2004).

Photo HINHP

Schiedea hookeri A. Gray
Common name: No common name
Family: Pink family (Caryophyllaceae)
Federal status: Endangered (USFWS 1999)
Heritage global rank: G1 (Hawaii Natural Heritage Program 2004)

S. hookeri is a sprawling or clumped perennial herb, with stems 30 to 50 centimeters long. The leaves are opposite, narrowly lanceolate to narrowly elliptic, 3 to 8 centimeters long, and 0.4 to 1.5 centimeters wide. The inconspicuous flowers are borne in open paniculate cymes 5 to 22 centimeters long. The fruit is a capsule about 2.5 to 3.0 millimeters long (Wagner et al. 1990).

With the exception of a single collection from East Maui, *S. hookeri* has been recorded only from the central and northern Waianae Mountains of Oahu. It is known from dry and mesic forests from 365 to 900 meters (1197 to 2953 feet) in elevation (Hawaii Natural Heritage Program 2004).

Photo R. Hobdy

Spermolepis hawaiiensis Wolff
Common name: No common name
Family: Parsley family (Apiaceae)
Federal status: Endangered (USFWS 1999)
Heritage global rank: G2 (Hawaii Natural Heritage Program 2004)

S. hawaiiensis is a slender, erect annual herb 5 to 20 centimeters tall, and is essentially hairless. Its leaves are finely dissected, and measure from1 to 4 cm long. The small white flowers are borne in compound umbels. The fruits are ovoid, 3 to 4 millimeters long, 2 to 4 millimeters wide, and are covered with irregularly arranged tubercles, some of which bear slender hooked bristles (Wagner et al. 1990).

The species has been recorded from Kauai, Oahu, Molokai, Maui, Lanai, and the island of Hawaii. It occurs in dry shrublands and forests from 305 to 1950 meters (1000 to 6398 feet)elevation (Hawaii Natural Heritage Program 2004).

Photo J. Lau

Tetramolopium filiforme Sherff
Common name: No common name
Family: Sunflower family (Asteraceae)
Federal status: Listed endangered (USFWS 1999)
Heritage rank: G1T1 (Hawaii Natural Heritage Program 2004)

T. filiforme is a shrub 5 to 15 centimeters tall. Its leaves are 10 to 20 mm long and 0.4 to1.2 to mm wide. The flower heads are borne on peduncles 2 to 4.7 cm long, and are solitary or 2-4 in an inflorescence. There are 35 to 52 ray florets and 18 to 30 disk florets in the flower head, and the rays are white or pale lavender (Wagner et al. 1990).

T. filiforme is narrowly endemic to the leeward northern Waianae Mountains of Oahu, from the Makua Military Reservation in the north to Puukumakalii, which is north of Kolekole Pass. More than 95 percent of the total number of *T. filiforme* plants is located on Ohikilolo Ridge on the Makua Military Reservation. The species is known from dry to mesic habitats, usually on exposed, sparsely vegetated ridge tops and cliff faces. It has been found from 305 to 930 meters (1000 to 3051 feet) in elevation (Hawaii Natural Heritage Program 2004).

The species is divided into two varieties, var. *filiforme* and var. *polyphyllum*, primarily on the basis of leaf morphology. However, there does not seem to be a clear-cut separation of the two varieties, and in some areas plants that are intermediate between typical plants of the two varieties can be found.

Photo HINHP

Viola chamissoniana Ging. subsp. *chamissoniana*
Common name: Pamakani
Family: Violet family (Violaceae)
Federal status: Listed endangered (USFWS 1999)
Heritage global rank: G3T1 (Hawaii Natural Heritage Program 2004)

V. chamissoniana subsp. *chamissoniana* is a small, branched shrub with leaves about 2 to 4 centimeters long. One to two white flowers are borne per peduncle. The fruit is a capsule 10 to 20 millimeters long (Wagner et al. 1990).

V. chamissoniana is found on Kauai, Oahu, Molokai, and Maui. The subspecies *chamissoniana*, one of three subspecies comprising the species, is endemic to the Waianae Mountains of Oahu. It is found in mesic habitats, usually on exposed steep slopes and cliffs, and ranges from 700 to 925 meters (2297 to 3034 feet) in elevation (Hawaii Natural Heritage Program 2004).

Invertebrates

Photo W. Mull

Achatinella mustelina Mighels
Common name: Oahu tree snail, kahuli, pupu-kani-oe
Federal status: Endangered (USFWS 1999)
Heritage global rank: G1 (Hawaii Natural Heritage Program 2004)

The shells of mature *A. mustelina* are shiny, measure 1.8 to 2.8 centimeters long and 0.8 to 1.5 centimeters wide, and have seven whorls. The shells can be either sinistral or dextral. Shell colors and patterns are variable, depending on the population and the particular individual. Shell patterns include spiral banding, longitudinal streaks, and sometimes chevron-shaped lines or zigzag lines. Shell colors are often white, gray, black, or various shades of brown. Less commonly shell colors can include shades of orange, yellow, and pink. (Welch 1938).

A. mustelina has been recorded from throughout the Waianae Mountains. It has disappeared from portions of its historical range, particularly from the lower, drier parts. The elevations where *A. mustelina* is currently found ranges from 610 to 1220 meters (2001 to 4003 feet). The species occurs in mesic to wet forests and shrublands, and it can be found on ridge tops, gulch slopes, or in gulch bottoms (Hawaii Natural Heritage Program 2004)..

Birds

Photo E. Vanderwerf

Chasiempis sandwichensis ibidis
Common name: Oahu Elepaio
Family: Monarchidae
Federal Status: Listed endangered
Heritage Global Rank: G3T1 (Hawaii Natural Heritage Program 2004)

C. sandwichensis ibidis is a small monarch flycatcher, approximately 12.5 grams, dark brown above and white below, with light brown streaks on the breast (VanderWerf 1998). The tail is long and often held up at an angle. The population on Oahu is fragmented into several populations. It can be found in native as well as non-native habitat (Conant 1977) in the Koolau and Waianae Mountains from approximately 100 to 850 meters (328 to 2789 feet) elevation.

Candidates for listing as endangered or threatened species

Plants

Photo S. Gon

Platydesma cornuta Hillebr. var. *decurrens* B. Stone
Common name: Pilokea
Family: Rue family (Rutaceae)
Federal status: Candidate (USFWS 1999)
Heritage global rank: G2T2 (Hawaii Natural Heritage Program 2004)

P. cornuta var. *decurrens* is an erect, sparingly branched shrub, usually 1 to 2 meters tall, with leaves clustered at the branch tips. The leaves are 12 to 40 centimeters long and 5 to 13 centimeters wide. Its flowers are borne in short axillary inflorescences on the bare stems below the leaves. The flowers are white with petals 9 to 16 millimeters long (Wagner et al. 1990).

P. cornuta is endemic to Oahu and consists of two varieties. The variety *decurrens* is endemic to the Waianae Mountains, and the variety *cornuta* to the Koolau Mountains. The variety *decurrens* has been found from 610 to 890 meters (2001 to 2920 feet) in elevation in mesic forests (Hawaii Natural Heritage Program 2004).

Photo HINHP

Pleomele forbesii Degener
Common name: Halapepe
Family: Agave family (Agavaceae)
Federal status: Candidate (USFWS 1999)
Heritage global rank: G1 (Hawaii Natural Heritage Program 2004)

P. forbesii is a tree 3 to 7 meters tall and usually sparingly branched. The leaves are 24 to 37 centimeters long and 0.5 to 1.2 centimeters wide. The panicles are about 15 to 35 centimeters long, bearing greenish-yellow flowers 52 to 60 millimeters long. The berries are red and about 10 to 11 millimeters long (Wagner et al. 1990).

This species is endemic primarily to the Waianae Mountains of Oahu, with a single collection from the Koolau Mountains. It occurs in dry to mesic forests from 245 to 885 meters (803 to 2903 feet) in elevation (Hawaii Natural Heritage Program 2004).

Species of Concern
Plants

Photo J. Obata

Bobea sandwicensis (A. Gray) Hillebr.
Common name: Ahakea
Family: Coffee family (Rubiaceae)
Federal status: SOC
Heritage global rank: G1 (Hawaii Natural Heritage Program 2004)

B. sandwicensis is a tree up to 10 meters tall with leaves 6.5 to 11.5 centimeters long. Its trumpet-shaped flowers are either perfect (having both male and female parts) or functionally unisexual. The male and perfect flowers are borne in cymes of three to seven flowers. The female flowers are solitary or, rarely, with two or three per cyme. The leaf-like calyx lobes are usually unequal. Its fruits are somewhat round and 6 to 10 millimeters wide (Darwin and Chaw 1990).

B. sandwicensis grows in dry to mesic forests between 90 and 915 meters (295 to 3002 feet) in elevation on Oahu, Molokai, Lanai, and Maui (Hawaii Natural Heritage Program 2004).

Photo K. Nagata

Labordia kaalae C. Forbes
Common name: Kamakahala
Family: Logania family (Loganiaceae)
Federal status: SOC
Heritage global rank: G1 (Hawaii Natural Heritage Program 2004)

L. kaalae is a shrub or a small tree 2 to 6 meters tall. Its leaves are 6 to 17 centimeters long and 2.5 to 7.0 centimeters wide. The small green to yellowish-green flowers are borne in open inflorescences, with 9 to 25 flowers per inflorescence. The fruits are two-valved, broadly ovoid capsules 12 to 20 millimeters long (Wagner et al. 1990).

The species is endemic to the Waianae Mountains of Oahu. It has been recorded from mesic forests from elevations ranging from 580 to 1160 meters (1903 to 3806 feet) (Hawaii Natural Heritage Program 2004).

Photo J. Obata

Lobelia yuccoides Hillebr.
Common name: Panaunau
Family: Bellflower family (Campanulaceae)
Federal status: SOC
Heritage global rank: G2 (Hawaii Natural Heritage Program 2004)

L. yuccoides has erect stems 1.5 to 2.0 meters long, with a dense apical rosette of leaves. The leaves are linear, 24 to 35 centimeters long, and 0.5 to 1.5 centimeters wide. The leaf undersides are covered with matted white hairs. The terminal inflorescence is unbranched and 60 to 100 centimeters long. The corolla of the flower is blue to lilac, 36 to 40 millimeters long, and 3 to 5 millimeters wide (Wagner et al. 1990).

L. yuccoides is endemic to Kauai and the Waianae Mountains of Oahu. It has been found from 700 to 1,230 meters (2297 to 4035 feet) in mesic forests and shrublands (Hawaii Natural Heritage Program 2004).

Melanthera tenuis (Degener and Sherff) W. L. Wagner and H. Rob.
Common name: Nehe
Family: Sunflower family (Asteraceae)
Federal status: SOC (USFWS 1999)
Heritage global rank: G2 (Hawaii Natural Heritage Program 2004)

M. tenuis is a somewhat woody perennial herb, with stems decumbent, 0.3 to 1.5 meters long. Its leaves are ovate to deltate, 2.2 to 4.4 centimeters long and 1.0 to 2.1 centimeters wide, sometimes with two or four basal lobes. Its flowers are borne in heads with 30 to 60 disk florets and 8 to 12 yellow ray florets (Wagner et al. 1990).

Melanthera tenuis is found only in the central Waianae Mountains. It occurs in dry to mesic habitats, often in shrublands and grasslands on open exposed ridges, from 310 to 950 meters (1017 to 3117 feet) in elevation (Hawaii Natural Heritage Program 2004).

Photo J. Obata

Neraudia melastomifolia Gaud.
Common name: Maaloa, maoloa, oloa
Family: Nettle family (Urticaceae)
Federal status: SOC
Heritage global rank: G2 (Hawaii Natural Heritage Program 2004)

N. melastomifolia is a shrub or small tree up to 4 meters tall. Its leaves are elliptic, elliptic-ovate, ovate, or lanceolate; and are 5 to 24 centimeters long and 1.5 to 7.0 centimeters wide. The plants are unisexual, bearing either female or male flowers. The flowers and fruits are small, and tightly clustered in the leaf axils (Wagner et al. 1990).

The species is endemic to Kauai, Oahu, Molokai, and West Maui. It has been recorded from 275 to 1,220 meters (902 to 4003 feet) in elevation from mesic and sometimes wet forests (Hawaii Natural Heritage Program 2004).

Photo J. Lau

Schiedea pentandra W. L. Wagner and E. M. Harris
(Formerly known to botanists as *S. pubescens* Hillebr. var. *purpurascens* Sherff)
Common name: No common name
Family: Pink family (Caryophyllaceae)
Federal status: SOC
Heritage global rank: G1 (Hawaii Natural Heritage Program 2004)

S. pentandra is a reclining or weakly climbing vine, with stems 1 to 6 meters long. The leaves are opposite, narrowly lanceolate, 4.5 to 15.5 centimeters long and 0.8 to 5.5 centimeters wide, and sometimes purple-tinged. The inflorescences are open paniculate cymes 30 to 150 centimeters long, with small, inconspicuous flowers. The fruit is a capsule 2.5 to 3.5 millimeters long (Wagner and Harris 2000).

S. pentandra is endemic to the Waianae Mountains of Oahu. It is known from mesic and wet forests from 535 to 975 meters (1755 to 3198 feet) (Hawaii Natural Heritage Program 2004).

Invertebrates

Photo J. Lau

Amastra cylindrica Newcomb
Common name: no common name
Federal status: SOC
Heritage global rank: G1

The shells of mature *A. cylindrica* range from 18 to 21 millimeters long, and 9 to 12 millimeters wide. As with almost all species of *Amastra*, the shells of *A. cylindrica* are dextrally coiled. The shell can be solid-colored, or can also be spirally banded. Shell color is variable, ranging from white through dark brown, and is sometimes yellowish, reddish, or purplish. The shell is covered by a brownish to blackish periostracum (Pilsbry and Cooke 1912-1914).

A. cylindrica is endemic to the Waianae Mountains. It has been recorded from gulch slopes and gulch bottoms in mesic forests.

Appendix 3. Native, rare, threatened and endangered taxa observed at Naval Magazine Pearl Harbor, Lualualei Branch in 1994 and in 2004

Species Name	Common Name	Federal Status	HINHP Rank	Status 1994	Status 2004
Plants					
Abutilon sandwicense	None known	LE	G1	A total of 13 individuals was seen at two sites in Mikilua and at one site in Halona. Two mature plants were seen at the northern site in Mikilua. Four mature plants were seen at the southern site in Mikilua. At the Halona site seven mature plants were seen.	At the northern site in Mikilua, two mature plants and 39 immature plants were seen. They are within an exclosure fence built after the 1994 survey. No plants could be found at the southern site in Mikilua, although it is possible that the exact location of the plants was missed. At the Halona site, which was fenced in the 1990s after the 1994 survey, two mature and seven immature plants were seen.
Alectryon macrococcus var. *macrococcus*	Alaalahua, mahoe	LE	G1T1	Two nearly dead individuals were observed in the Mikilua subdistrict in a hanging gulch on Puuhapapa.	Neither tree on Puuhapapa could be found. They most likely died since they were observed to be nearly dead in 1994. A previously unrecorded, relatively healthy tree was found in one of the hanging gulches on the western face of Puukaua.
Bobea sandwicensis	Ahakea	SOC	G1	11 mature trees were seen at various locations from Kolekole Pass to Halona.	Additional trees were found from 2002 to 2004. The number of trees is declining significantly. In PH LLL, as with the Waianae Mountains in general, most of the trees are partially dead, or recently dead. No young trees have been noted anywhere in PH LLL.

Species Name	Common Name	Federal Status	HINHP Rank	Status 1994	Status 2004
Bonamia menziesii	None known	LE	G1	One plant was seen in Halona, and another was seen in Mikilua.	The Halona plant was found to be dead in 2002. A small exclosure fence had been built around the plant in the 1990s. The site of the plant seen in 1994 in Mikilua was visited. This site is within a patch of forest that had been fenced in the 1990s. The plant could not be found, but was seen flowering by Navy staff in 2003. At a second location in Mikilua, two mature plants were found in 2002.
Chamaesyce kuwaleana	Akoko, koko, ekoko, kokomalei	LE	G1	More than 1,000 plants were observed.	The plants on Kauaopuu appeared to be less common than in 1994. Many appeared to have been recently defoliated by caterpillars when seen in March 2004, and a number of plants appeared to have died as a result. A brushfire had burned through parts of the occurrence prior to 2004.
Diellia unisora	None known	LE	G1	Not yet discovered.	A solitary individual was found off the Waianae summit ridge between Pohakea Pass and Palikea in Halona. Another solitary plant had been found nearby in 2003.
Flueggea neowawraea	Mehamehame	LE	G1	Three trees were found, one each in Mikilua, Kauhiuhi, and in Halona. A fourth tree reported from Halona in 1994 was determined in 2004 to be just outside the PH LLL boundary.	All three trees were found to be still alive. The Mikilua tree, which is within a patch of forest fenced in the 1990s, was only barely alive. The tree in Kauhiuhi was mostly dead. The tree in Halona was still relatively healthy, with most of its crown still alive. All three trees exhibited signs of black twig borer infestation.

Species Name	Common Name	Federal Status	HINHP Rank	Status 1994	Status 2004
Hedyotis parvula	None known	LE	G1	*Hedyotis parvula* was first recorded from PH LLL on the 1994 HINHP biological survey, when four plants were seen on the top of a ridge extending from the Waianae summit ridge into Halona (HINHP 1994).	The site of the *H. parvula* plants in Halona was visited, but no attempts were made to count the plants on the cliff since a recent count was available. In July 2003, during a rare plant survey conducted for the Army Directorate of Public Works, Environmental Division, only a single mature plant could be found on the ridge top, but 11 mature plants were discovered on the previously unsurveyed cliff below the ridge top (J. Lau, pers. comm.).
Labordia kaalae	Kamakahala	SOC	G1	Scattered plants were observed in the Puuhapapa area..	Plants were seen in the same areas as in 1994. There was no obvious change in abundance.
Lepidium arbuscula	Anaunau, naunau, kunana	LE	G1	More than 700 plants were seen on Puukaua (in Kauhiuhi and Pahoa) and in Halona.	Plants were seen in Halona and on Puukaua in 2004. There has been no obvious change in abundance since 1994.
Lipochaeta lobata var. leptophylla	Nehe	LE	G2T1	A total of at least 140 plants were seen in Mikilua and Kauhiuhi.	No obvious change in abundance. Many more plants were seen in Mikilua in 2004 than in 1994 due to additional areas being covered in the 2004 survey. More than 300 plants in Mikilua are estimated.
Lobelia niihauensis	Oha, haha, oha wai	LE	G2	More than 90 plants were found in many locations in PH LLL.	No obvious change in abundance. Several new locations have been found since 1994 in the Puhawai and Mikilua subdistricts.
Lobelia yuccoides	Panaunau	SOC	G2	About eight plants were seen in Halona near the summit ridge of the Waianae Mountains between Pohakea Pass and Palikea.	Plants were seen in the same area of Halona. There was no obvious change in their abundance.

Species Name	Common Name	Federal Status	HINHP Rank	Status 1994	Status 2004
Marsilea villosa	Ihiihi, ihi laau	LE	G1	It was estimated that there were 100-150 plants in a single patch of plants in the lowlands on the western side of PH LLL.	The main patch of plants looked unchanged. Two small patches about 1 meter across were found downstream of the main patch.
Melanthera tenuis	Nehe	SOC	G1	About 1,500 plants were seen in various parts of PH LLL.	No obvious change in abundance. Plants were found for the first time south of Pohakea Pass.
Neraudia angulata	Maaloa, maoloa, oloa	LE	G1	About 24 plants were found at several spots in Mikilua, on Puukaua, and in Halona.	About 14 mature plants were seen at three spots in Halona.
Neraudia melastomifolia	Maaloa, maoloa, oloa	SOC	G2	Four plants were seen in an area in Halona not far below the summit ridge of the Waianae Mountains.	Two plants were seen in the same area in Halona.
Nototrichium humile	Kului	LE	G2	A total of about 20 plants were seen on Puukaua and in Mikilua.	No obvious change in abundance.
Platydesma cornuta var. *decurrens*	Pilokea	C	G1T1	One plant was seen on Puuhapapa.	No plants were encountered on Puuhapapa but the one seen in 1994 may have been missed.
Pleomele forbesii	Halapepe	C	G1	About 50 scattered mature plants were seen.	No obvious change in abundance.
Schiedea hookeri	None known	LE	G1	About 20 plants were seen in Mikilua and on Puukaua.	About 20 plants were seen in Mikilua and about 12 were seen on Puukaua. No obvious change in abundance.
Schiedea pentandra	None known	SOC	G1	A group of plants was seen on the Waianae summit ridge south of Puuhapapa. One of the plants in this group was within the PH LLL boundary.	The group of plants seen in 1994 was visited. Two plants were seen whose branches extend into PH LLL. A new group of about five plants was found on the north side of Puuhapapa.

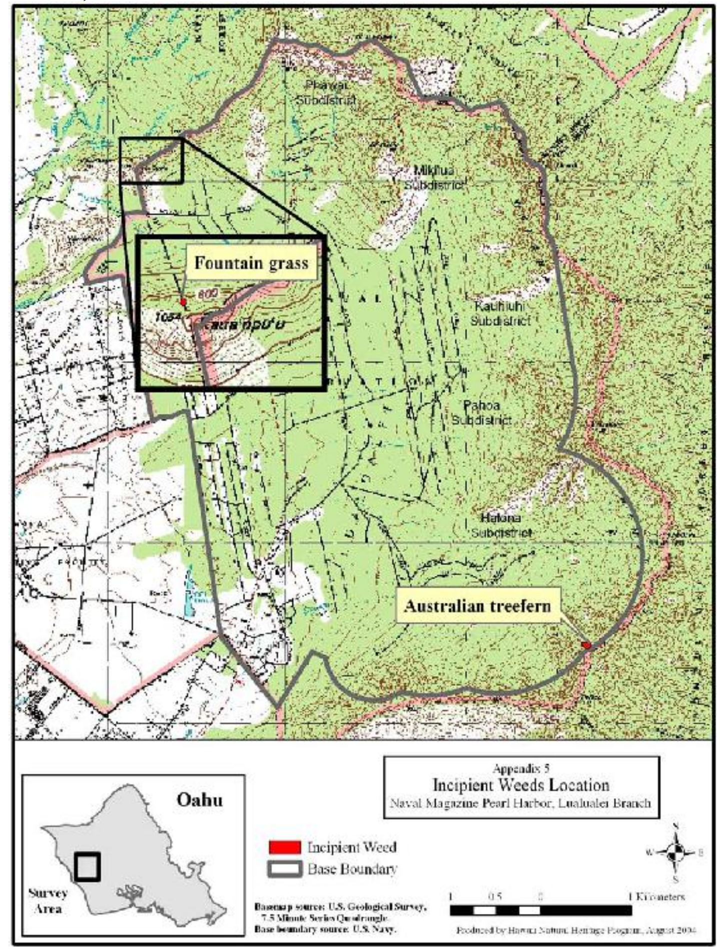
Species Name	Common Name	Federal Status	HINHP Rank	Status 1994	Status 2004
Spermolepis hawaiiensis	None known	LE	G2	Not yet discovered.	This annual species was found for the first time on PH LLL during the 2004 survey. Only two individuals were seen within the PH LLL boundary, but hundreds more were seen within a few meters beyond the boundary.
Tetramolopium filiforme	None known	LE	G1	The *T. filiforme* site on Puukumakalii was not visited in 1994. Two small plants had been seen there around 1986. They were thought to represent *T. lepidotum* subsp. *lepidotum*.	Seven mature plants and one immature plant were seen at the site. The plants were examined a few years prior to 2004, and were identified as *T. filiforme*. The species is divided into two varieties, var. *filiforme* and var. p*olyphyllum*. However, there does not seem to be a clear-cut separation of the two varieties, and many plants, including the PH LLL plants are intermediate between typical plants of the two varieties.
Viola chamissoniana subsp. *chamissoniana*	Pamakani	LE	T1	*Viola chamissoniana* subsp. *chamissoniana* was first recorded from PH LLL on the 1994 HINHP biological survey, when three plants were seen on the top of a ridge extending from the Waianae summit ridge into Halona (HINHP 1994). The cliff below the ridge top was not surveyed.	The site of the *Viola chamissoniana* subsp. *chamissoniana* plants in Halona was visited, but no attempts were made to count the plants on the cliff since a recent count was available. In July 2003, during a rare plant survey conducted for the Army Directorate of Public Works, Environmental Division, no plants could be found on the ridge top, but 32 mature and 3 immature plants were discovered on the previously unsurveyed cliff below the ridge top (J. Lau, pers. comm.).

Species Name	Common Name	Federal Status	HINHP Rank	Status 1994	Status 2004
Invertebrates					
Achatinella mustelina	Oahu tree snail, kahuli, pupu-kani-oe	LE	G1	No individuals of *A. mustelina* were reported to be clearly within the PH LLL boundaries, but a number of individuals were found in the PH LLL boundary area or just outside the PH LLL boundary.	A total of 22 individuals was seen within the PH LLL boundaries in the Puukumakalii and Puuhapapa areas. Additionally, two individuals were seen within two meters of the PH LLL boundary at a spot along the summit ridge south of Puuhapapa.
Amastra cylindrica	None known	SOC	G1	Not yet discovered.	The snails appeared to be less abundant than when they were seen in 2002. A landslide impacted part of the colony during the survey period.
Vertebrates					
Asio flammeus sandwichensis	Pueo, Hawaiian Owl		G5T2	One individual was observed west of Puukumakalii.	One individual was observed on the ground next to bunker 10-L-29 off of Guadalcanal Road.
Chasiempis sandwichensis ibidis	Oahu Elepaio	LE	G3T1	Two to six individuals were observed, all were located in the Kauhiuhi subdistrict.	Five individuals were sited on this survey in the Kauhiuhi subdistrict. All individuals observed were male.
Falco peregrinus	Peregrine Falcon		G4	One to two individuals detected below Pohakea Pass.	Not detected. No longer on endangered species list.
Hemignathus flavus	Oahu Amakihi		G3	Noted as detected. Density or number of individuals observed not indicated.	One individual was observed in the Halona subdistrict. Six individuals were observed on the Waianae summit ridge between Puuhapapa and Puukanehoa.
Himatione sanguinea	Apapane		G3	None noted as observed.	Individuals observed on the ridge trail between Palikea and Pohakea Pass. Because access is outside of NAVMAG property, detections within property could not be confirmed.
Phaethon lepturus	White-tailed tropicbird		G4	Noted as detected. Density or number of individuals observed not indicated.	One individual was observed in the Kauhiuhi subdistrict.

Appendix 4. *Achatinella concavospira* and *A. mustelina* shells

This photograph shows the differences in the morphology of shells of *Achatinella concavospira* and *A. mustelina* from the Halona area of Lualualei. These old shells were found under a single olopua (*Nestegis sandwicensis*) tree. In the top row are the shells of *A. mustelina*, and in the bottom row are those of *A. concavospira*.

Appendix 5. Locations of Incipient Weeds at Naval Magazine Pearl Harbor, Lualualei Branch



Appendix 6. Banded Male Oahu Elepaio Number One

The photograph below is of the male Elepaio banded on 18 March in the Kauhiuhi Subdistrict of Naval Magazine Pearl Harbor, Lualualei Branch, within the boundary. The band combination for this bird is left leg: white over white, right leg: white over aluminum.

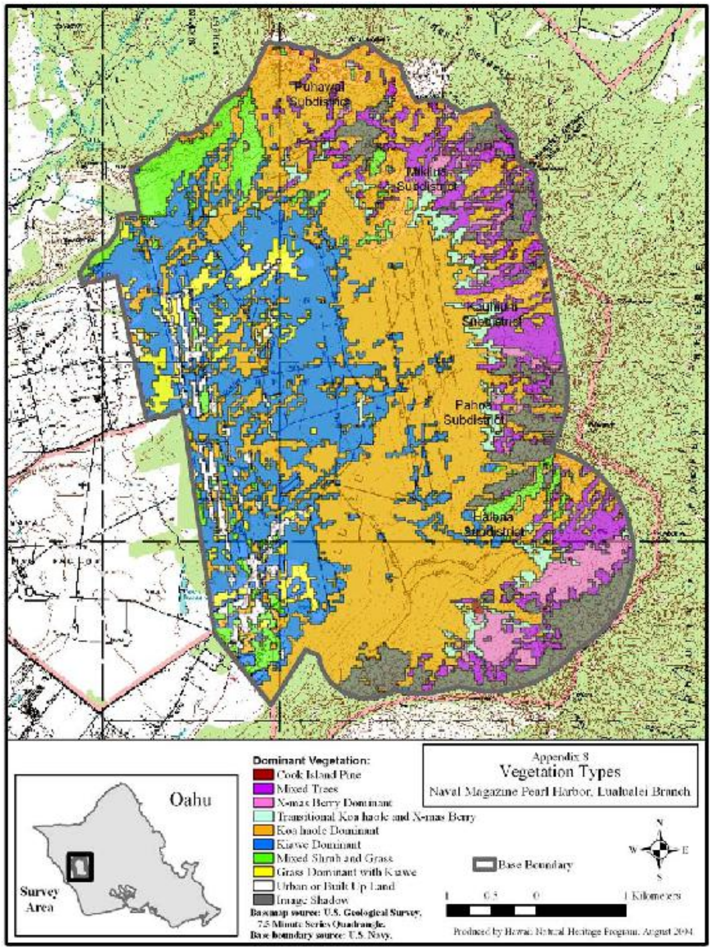
Photo E. Vanderwerf

Appendix 7. Banded Male Oahu Elepaio Number Two

The photograph below is of the male Elepaio banded on 18 March in the Kauhiuhi Subdistrict of Naval Magazine Pearl Harbor, Lualualei Branch, approximately 0.25 kilometers east of the boundary. The band combination for this bird is left leg: white over aluminum, right leg: white over green.

Photo E. Vanderwerf

Appendix 8. Dominant Vegetation Types at Naval Magazine Pearl Harbor, Lualualei Branch



Methods used to Classify Dominant Vegetation

The vegetation community layer was derived from recent Landsat 7 satellite imagery that was determined to have the least amount of clouds and shadows within Naval Magazine Pearl Harbor, Laualualei Branch. Parameters for the chosen source image are listed below.

IMAGE USED:
Sensor: Landsat Enhanced Thematic Mapper + Sun Illumination / Tasseled Cap
Satellite: Landsat 7
Path: 065 Row: 045
Date of Acquisition: 19Dec2000
Correction Level: Sun Illumination
Format: ERDAS Imagine
Projection: Albers Equal Area

The vegetation community classes were derived from the Landsat image using ERDAS Imagine 8.6 image processing software. Draft landcover maps were created using ESRI ArcGIS 8.3 software and the final map was created using ArcGIS 9. A Trimble Pro XR Mapping Grade GPS unit with TSCe Datalogger and TerraSync mapping software was used to record ground truth coordinates within large homogenous areas of each selected class.

Process Summary

Step 1. In ERDAS 8.6:
A subset of Naval Magazine Pearl Harbor, Lualualei Branch was created from the original Tasseled Cap and Reflectance Landsat bands. An ISODATA unsupervised classification was run on the Tasseled Cap bands to generate 31 initial spectral classes. Parameters were set as follows: standard deviation of 0.5 using the Principal Axis, running a maximum of 10 iterations.

Step 2. In ArcGIS 8.3:
Several overview and close-up field maps were created by overlaying the unsupervised classification map over the USGS 7.5' quadrangle as a background. Several areas (polygons) were pre-selected as training and verification sites before conducting fieldwork.

Step 3. Fieldwork:
A Trimble Pro XR GPS was used to record ground truth coordinates and vegetation data within the pre-selected polygons. Field notes and photos describing the immediate area surrounding the GPS location were taken.

Step 4. Post-Processing of GPS Data:
Trimble's Pathfinder Office 2.90 was used to differentially correct the recorded field data to increase spatial accuracy. Points were then exported to ArcView shapfiles with coordinate system NAD83 UTM Zone4.

Step 5. In ERDAS:

The unsupervised classification image was re-classified to combine spectral classes representing the same land cover types using the points collected with the GPS. Some pixels were reclassified to delineate the Cook Pine plantations by examining USGS Digital Orthophoto Quarter Quadrangles (DOQQ). The Clump and Eliminate functions were then used to achieve a minimum mapping unit (polygon size) of 3600 square meters. The new re-classified land cover map was then re-projected from Albers Equal Area to NAD83 UTM Zone4.

Step 6. In ArcGIS:
The land cover map was converted from raster to vector format using ESRI ArcToolbox. The map was renamed according to SDSFIE convention, and the appropriate SDSFIE attribute table joined. This dataset was then imported into the ArcGIS geodatabase.

Note: Due to shadow from topography we were not able to classify the more native dominant areas within Naval Magazine Pearl Harbor, Lualualei Branch.

FINAL CLASSES

Dominant Vegetation	**Definition**
Cook Island Pine	Cook Island Pine Dominant (*Casuarina equisetifolia*)
Mixed Trees	Higher Elevation: Mixed Native & Non-Native (no dominant species)
	Lower Elevation: Mixed Non-Native (no dominant species)
Christmas Berry Dominant	Christmas Berry Dominant (*Schinus terebinthifolia*)
Transitional Koa haole and Christmas Berry	Evenly distributed split between Koa haole & Christmas Berry dominant species
Koa haole Dominant	Koa haole Dominant (*Leucaena leucocephala*)
Kiawe Dominant	Kiawe Dominant (*Prosopis pallida*)
Mixed Shrub and Grass	Mixed Shrub and Grass (no dominant species)
Grass Dominant with Kiawe	Grass Dominant with Kiawe
Urban or Built Up Land	Urban or Built Up Land
Image Shadow	Image Shadow (Unclassified)

This page is intentionally left blank.

C3 – A SURVEY OF ALECTRYON MICROCOCCUS VAR. MICROCOCCUS AND FLUEGGEA NEOWAWRAEA IN LUALUALEI VALLEY, WAI‘ANAE MOUNTAINS, O‘AHU, HAWAI‘I (HNHP 2003)

A Survey for *Alectryon macrococcus* var. *macrococcus* and *Flueggea neowawraea* in Lualualei Valley, Waianae Mountains, Oahu, Hawaii

April 2003
Final

Prepared for:

Commander, Navy Region Hawaii
Regional Environmental Division (COMNAVREG HI)

Under contract to:

PACNAVFACENGCOM PLN23
Environmental Planning Division

Prepared by:

Hawaii Natural Heritage Program
Center for Conservation Research and Training
University of Hawaii at Manoa
677 Ala Moana BLVD, STE 705
Honolulu, HI 96813

TABLE OF CONTENTS

Summary

Presented in this report are the results of a rare plant survey conducted in November 2002 in Lualualei Valley in the Waianae Mountains of Oahu. Also included are management recommendations based on the results of the survey. The field survey was conducted by biologists from the Hawaii Natural Heritage Program (HINHP) for the Commander, Navy Region Hawaii, Regional Environmental Division (COMNAVREG HI). The survey areas included undeveloped inland portions of the Naval Magazine Pearl Harbor, Lualualei Branch (NAVMAGPH LLL), and adjoining lands owned by the state of Hawaii. The rare plant survey was focused on two tree species federally listed as Endangered Species: *Alectryon macrococcus* var. *macrococcus* and *Flueggea neowawraea*. One primary goal of the survey was for a survey team that included one or more Navy biologists to visit the recorded individuals of the two tree species in Lualualei not already familiar to the Navy biologists. Another primary goal was to search for additional unrecorded individuals of the two tree species. Information was also gathered on rare plants and animals encountered incidental to the survey for the two targeted tree species. No *A. m.* var. *macrococcus* trees were observed on the survey, and no previously unrecorded live individuals of *F. neowawraea* were located, but significant new information was obtained regarding the sex and reproductive capacity of two of the known trees of *F. neowawraea*. Both of the trees were found to be female. One of them was fruiting sparingly, and the other was flowering profusely. Finds of non-target rare plants and animals included a new record for Lualualei of the rare vine *Sicyos lanceoloideus*. It was found at two locations, one of which is at the boundary of NAVMAGPH LLL. Also, within the boundary of the naval magazine, on Puu Hapapa, the only known population of the native land snail *Amastra intermedia* was confirmed to be still surviving, and fresh shells of the federally listed endangered tree snail *Achatinella mustelina* were found, indicating that the population of the species likely still survives.

I. Background

A. Introduction

The only major previous survey for rare plants in NAVMAGPH LLL was conducted in 1994 (HINHP 1994). Biological surveys of lands adjoining NAVMAGPH LLL, such as Schofield Barracks Military Barracks and The Nature Conservancy's Honouliuli Preserve have resulted in additional observations of rare plants along the edge of NAVMAGPH LLL.

Most of the recently known individuals of *A. macrococcus* var. *macrococcus* and *F. neowawraea* in NAVMAGPH LLL were discovered on the 1994 survey.

In order to obtain current data on these two taxa, the Navy decided to resurvey certain specific areas within NAVMAGPH. Subsequently, COMNAVREGHI DAMD17-02-2-0064 was submitted and funded in FY02. HINHP was selected for this contract and field work was initiated and completed in the first quarter of FY03.

B. Methodology

The fieldwork for this survey was conducted on seven days from November 4, 2002 through November 20, 2002. The survey was led by botanist Joel Q. C. Lau of the Hawaii Natural Heritage Program, who was accompanied by Navy biologists Vanessa E. Pepi, Julie A. Rivers, and Scott R. Vogt of the Pacific Division, Naval Facilities Engineering Command (PACNAVFACENGCOM), Environmental Planning Division; Lea M. Wakabayashi, an Engineering Intern; and Randy M. Miyashiro of the U.S. Navy, Hawaii Regional Environmental Department. Table 1 lists the survey dates, survey areas, participants, and the primary target species for each day.

Survey areas included undeveloped inland portions of the NAVMAGPH LLL, and lands owned by the state of Hawaii. The boundary between the Navy-owned and state-owned lands is unmarked. Access to the survey areas was by foot from the network of roads on the naval magazine. The survey areas were reached via previously established trails, or by going cross-country in areas where trails did not exist. Map 1 shows the survey routes for this survey.

Global Positioning System (GPS) units were used to record the survey routes and rare plant and animal locations. However, in many places, too few satellites were available to obtain adequate GPS readings, in which case routes and locations were determined through the use of topographical maps, altimeters, and compasses.

Prior to commencement of the 2002 survey it was determined by the Navy biologists that the survey would be focused on the rare native trees *A. m.* var. *macrococcus* and *F. neowawraea*. Known trees not already familiar to Navy biologists were to be visited and new trees would be sought. Since NAVMAGPH LLL has relatively little *A. m.* var. *macrococcus* habitat, only one field day was spent surveying for it. The other six days were spent surveying for *F. neowawraea*.

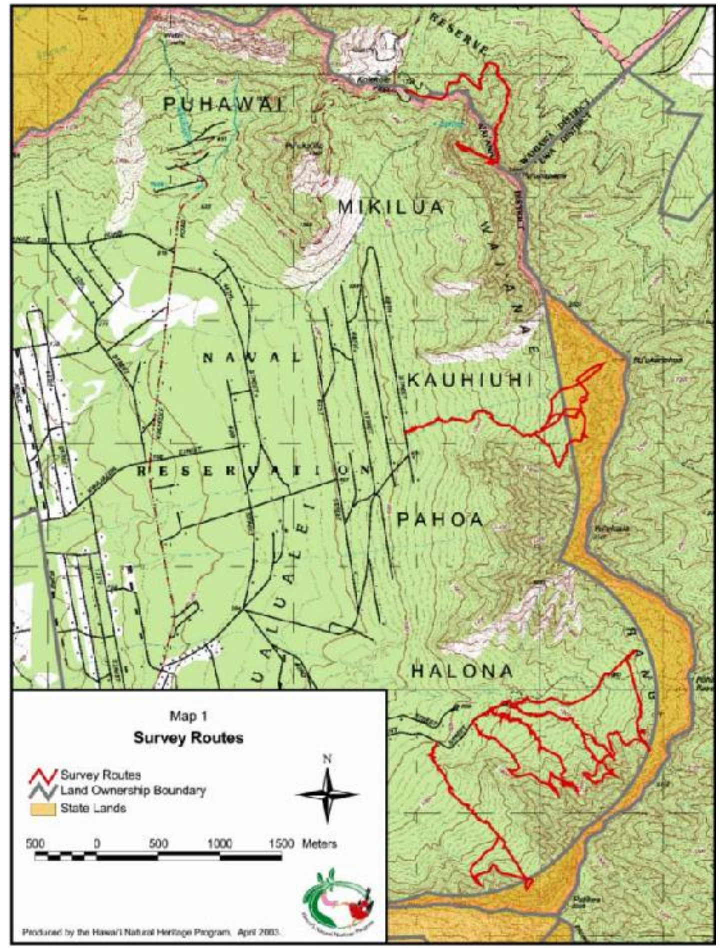
In order to find new trees, favorable habitat was sought for exploration, especially in areas not covered in the 1994 botanical survey. *A. m.* var. *macrococcus*'s most favorable habitat in NAVMAGPH LLL is the mesic native forest patches on the steep sides of the valley. The taxon is usually found growing on north-facing slopes in gulch bottoms and the lower gulch slopes.

Flueggea neowawraea's most favorable habitats in NAVMAGPH LLL are the dry to mesic forests in the gulches below the cliffs bordering the inland portions of the valley. The species is typically found on the north-facing sides of the gulches, usually in the gulch bottoms or on the lower gulch slopes. *Flueggea neowawraea* trees are sometimes conspicuous from afar since they often project above the level of the native forest canopy. Upon arriving at a promising looking forest patch, a good vantage point was sought, and binoculars were used to scan the forest patch for any of the conspicuous individuals.

Locations of the wooden remains of dead *F. neowawraea* were also recorded. The species' hard wood lasts in the field for many decades, and is often easily identified based on the rotting pattern of the wood, and the wood's color and grain. The wooden remains can be found in the form of standing dead trees, snags, stumps, logs on the ground, and pieces of wood. The locations of these remains serve as documentation of *F. neowawraea*'s former geographical and ecological ranges in Hawaii. Knowledge of these ranges will be useful if and when reintroduction of the species becomes feasible.

Table 1. Survey Chronology

Date	Survey Area	Participants	Primary Target
Nov. 4, 2002	Puu Hapapa	J. Lau, R. Miyashiro, V. Pepi, J. Rivers	*Alectryon macrococcus* var. *macrococcus*
Nov. 6, 2002	Halona	J. Lau, R. Miyashiro, V. Pepi	*Flueggea neowawraea*
Nov. 7, 2002	Kauhiuhi	R. Miyashiro	*Flueggea neowawraea*
Nov. 8, 2002	Kauhiuhi	V. Pepi	*Flueggea neowawraea*
Nov. 12, 2002	Halona	R. Miyashiro V. Pepi	*Flueggea neowawraea*
Nov. 14, 2002	Halona	R. Miyashiro V. Pepi	*Flueggea neowawraea*
Nov. 20, 2002	Halona	R. Miyashiro, S. Vogt, L. Wakabayashi	*Flueggea neowawraea*



II. Survey Results

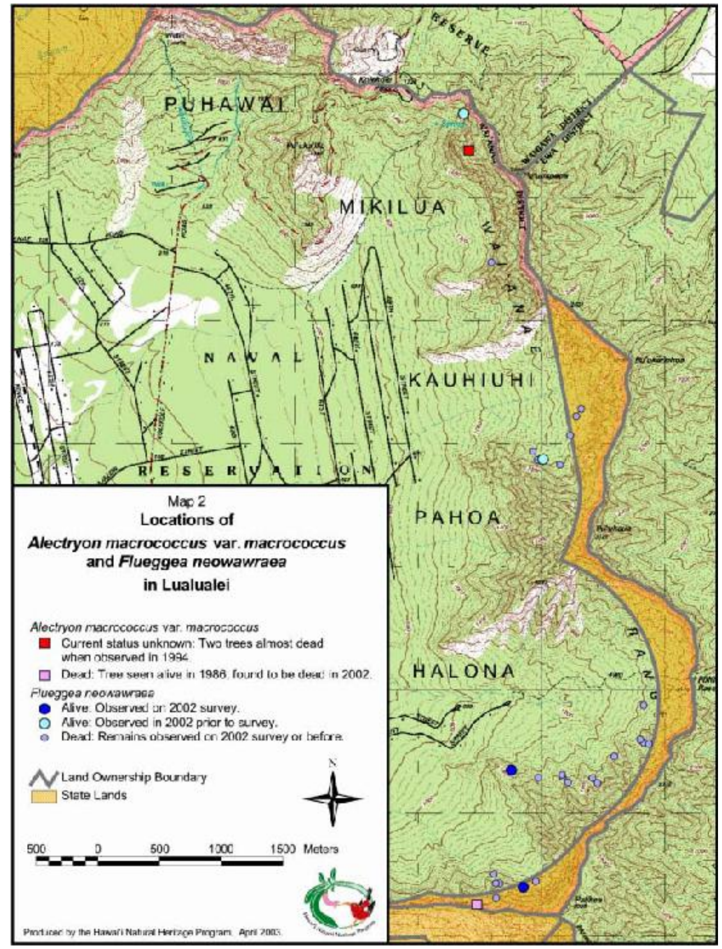
A. *Alectryon macrococcus* var. *macrococcus*

Alectryon macrococcus, whose Hawaiian names are *mahoe* and *`ala`alahua*, is the only member of its genus native to Hawaii. It is a tree in the soapberry family (Sapindaceae) endemic to the islands of Kauai, Oahu, Molokai, and Maui. The species is divided into two varieties. Variety *macrococcus* includes the trees of Kauai, Oahu, Molokai, and West Maui (Wagner et al. 1990). Variety *macrococcus* is most common on Kauai and Oahu, and is very rare on Molokai and West Maui. The trees occurring on East Maui comprise the second variety of the species, var. *auwahiensis*. On Oahu the taxon was historically found in both the Waianae and Koolau Mountains. *A. macrococcus* is now extirpated in the Koolau Mountains, but can still be found throughout its historical range in the Waianae Mountains. There are approximately 300 trees left in the Waianaes (HINHP 2003). Most individuals, however, are old trees in poor health. Many are partially or mostly dead. Young trees and saplings are uncommon.

The decline of the taxon can be attributed largely to the black twig borer (*Xylosandrus compactus*), a tiny beetle that was first recorded in Hawaii in 1961, when it was found on Oahu (Nelson and Davis 1972). All known wild *A. m.* var. *macrococcus* trees are being affected by the black twig borer.

Aside from a single 1932 collection of a specimen of *A. m.* var. *macrococcus* from Kauhiuhi (*Christophersen 3698*, BISH), the taxon has been documented in NAVMAGPH LLL at only two locations, one in Halona in the south, and one in the north on Puu Hapapa near Kolekole Pass. The Halona tree was found in 1986, and was not revisited until October 2002, when it was found to be dead (J. Lau, pers. comm. 2002). Two trees were found in a hanging gulch on Puu Hapapa on the 1994 biological survey. During the November 2002 survey, one day was spent reaching the area of the Puu Hapapa trees and searching for them. No evidence of them, either alive or dead, was found. However, the area could not be thoroughly searched due to time constraints. If the trees have died their remains should still be recognizable, as the trunks of *A. m.* var. *macrococcus* are quite distinctive due to their sinewy appearance. The trees' multi-trunked habit is also helpful in identifying dead individuals. The trees may now be dead, as they were already in poor condition in 1994 (J. Lau, pers. comm. 2002). The Halona and Puu Hapapa *A. m.* var. *macrococcus* sites are shown on Map 2.

Although there is still some chance that some undocumented *A. m.* var. *macrococcus* individuals remain to be located in NAVMAGPH LLL, there would be no more than a few widely scattered trees. If any still survive in NAVMAGPH LLL, they are relatively unimportant in the conservation of the taxon in the Waianae Mountains since there are still a number of large concentrations of trees elsewhere in the mountain range. There is relatively little of *A. m.* var. *macrococcus* 's mesic forest habitat in NAVMAGPH LLL since most of the mesic habitat in the valley is situated on the steep cliffs that border the valley. Most of the area on the cliffs is vegetated with shrubs. Forests on these cliffs are



limited to small pockets of relatively gentle terrain such as ledges and hanging gulches. Furthermore, the patches of mesic forest in NAVMAGPH LLL constitute marginal habitat for the taxon since they are generally drier than the mesic forests where the largest *A. m.* var. *macrococcus* concentrations are located.

B. *Flueggea neowawraea*

Flueggea neowawraea, or *mehamehame*, is a member of the spurge family (Euphorbiaceae) (Hayden 1990), and is the sole representative of its genus in Hawaii. It has been documented from Kauai, the Waianae Mountains of Oahu, Molokai, East Maui, and the leeward side of the island of Hawaii. In the Waianaes it has been recorded throughout the mountain range. About 30 living trees are known in the Waianae Mountains (HINHP 2003). The locations of *F. neowawraea* trees known to be alive in NAVMAGPH LLL and the locations of dead remains of *F. neowawraea* are shown on Map 2.

Flueggea neowawraea is one of the most massive of the native Hawaiian trees, and it often projects above the native tree canopy. Most wild trees of *F. neowawraea* are partially dead, although in many cases, they have been able to survive in such a state for decades. The species is dioecious, with some of the trees bearing only male flowers and the other trees bearing only female flowers. However, exceptional individuals have been reported bearing both fertile female and male flower parts (D. Chung, pers. comm. 1995).

The four *F. neowawraea* found on the 1994 biological survey were confirmed to be surviving in 2002, either during the November 2002 survey or on previous surveys in 2002. The northernmost of the known trees in NAVMAGPH LLL is in Mikilua, just south of Kolekole Pass. It is within an exclosure fence built by Navy personnel, and was already familiar to the Navy biologists. It had been observed to be surviving earlier in 2002 (J. Rivers, pers. comm. 2002), so it was not included among the trees to be visited. Further south in Kauhiuhi, which is the land section on the northern side of Puu Kaua, is another tree found on the 1994 biological survey. The tree was revisited in September 2002 by a team including the Navy's biologists Julie Rivers and Vanessa Pepi and was found to be in very poor condition. It was judged to be close to death (J. Lau, pers. comm. 2002). Since this tree had already been observed by Navy biologists, it was not included among the trees identified for visitation during the November 2002 HINHP survey.

The two recorded *F. neowawraea* trees in Halona were observed to be surviving during the November 2002 survey. Both were found bearing female flowers or fruits. The southern tree was observed on the survey to be mostly dead. It was already in that condition when discovered in 1994. The living portions of the tree are in poor condition, and the tree is perhaps close to death. Competition with the surrounding alien trees for space and sunlight seems to be a major factor in the tree's decline. The decline and death of many individuals of the species can be at least partially attributed to such competition.

In contrast to the condition of the southern tree in Halona, the northern one is one of the healthiest of the remaining *F. neowawraea* trees in the Waianae Mountains. It is growing out in the open, with minimal competition from other trees. It still has a full crown, and most of its bark is still alive.

C. Other observed non-target rare plants and animals

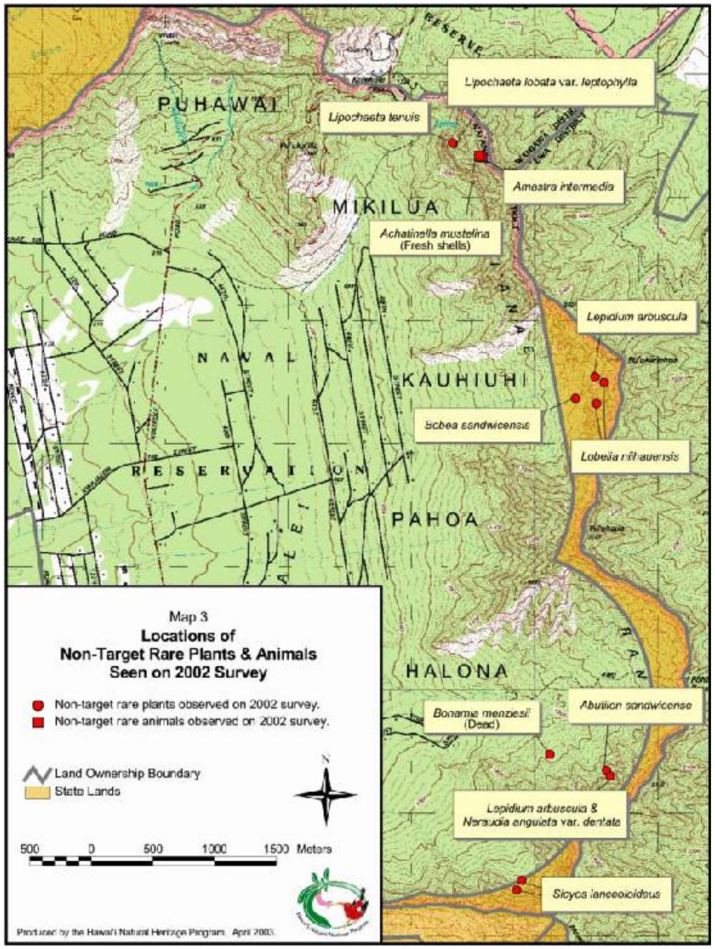
Several rare plant taxa were observed on the November 2002 survey besides the primary targets *A. m.* var. *macrococcus* and *F. neowawraea*. These incidentally observed plants include the federally listed endangered species *Abutilon sandwicense*, *Bonamia menziesii* (found to be dead), *Lepidium arbuscula*, *Lipochaeta lobata* var. *leptophylla*, *Lobelia niihauensis*, and *Neraudia angulat*a var. *dentata* (USFWS 1999). Also seen were four species considered to be species of concern by the Pacific Islands Ecoregion of the U.S. Fish and Wildlife Service: *Bobea sandwicensis*, *Lipochaeta tenuis*, *Pleomele forbesii*, and *Sicyos lanceoloideus.*

An incidentally observed rare animal was the ground-dwelling land snail *Amastra intermedia*, which is considered a species of concern by the Pacific Islands Ecoregion of the U.S. Fish and Wildlife Service. Also, fresh shells of the endangered tree snail *Achatinella mustelina* were found.

The locations of the rare non-target plants and animals seen on survey are depicted on Map 3. [Note: One of the non-target rare plant species, *Pleomele forbesii*, was seen on survey but is not included on the map since it occurs as widely scattered individuals in much of NAVMAGPH LLL. Also, three species, *Panicum beecheyi*, *Schiedea ligustrina*, and *Schiedea mannii*, which were included in the 1994 NAVMAGPH LLL report as rare plants, are now known to be more abundant than previously thought.]

Sicyos lanceoloideus (*Sicyos* sp. A in Wagner et al. 1990) is a rare vine in the cucumber family (Cucurbitaceae) recorded from Kauai and the Waianae Mountains of Oahu. No plants are currently known on Kauai. There are fewer than 100 known plants in the Waianaes, and of this number, fewer than 20 are in the southern Waianae Mountains south of Kolekole Pass (HINHP 2003). Unlike most of the Hawaiian species of *Sicyos*, which are annuals, *S. lanceoloideus* is perennial. On this survey, the species was found for the first time in Lualualei, at two spots on either side of the southern *F. neowawraea* in Halona. There is at least one mature plant at each spot. One of these spots is on state-owned land, and the other is at the NAVMAGPH LLL boundary.

Amastra intermedia is a ground-dwelling land snail of the Hawaiian endemic family Amastridae. Out of the more than 100 species in the genus *Amastra*, only three are known to persist in the wild. Two additional species are no longer known in the wild, but survive in captivity (D. Chung, pers. comm. 2002). The *A. intermedia* population at Puu Hapapa, which was first noted in 1995 (Chung undated), was confirmed to be still surviving on the 2002 survey. It is the only population of *A. intermedia* known to be extant. The population is very localized, as evidenced by the lack of fresh shells outside the small area. Within this area, however, live snails are not hard to find. Many of the



snails at the site are being predated upon by rats, as evidenced by numerous fresh shells with signs of rat predation. Fresh shells of another serious predator of native Hawaiian land snails, the introduced snail *Euglandina rosea*, were found in and near the *A. intermedia* colony.

The portion of Puu Hapapa within the Schofield Barracks Military Reservation supports additional populations of rare native snails, including the tree snails *Achatinella mustelina* and *Laminella sanguinea*, as well as *Amastra micans*, a snail that can be found either on the ground or on vegetation. In an effort to reduce predation by rats, staff of the Environmental Division of the Directorate of Public Works, United States Army Garrison, Hawaii have implemented a rat control plan in the part of Puu Hapapa under Army jurisdiction.

Achatinella mustelina is a tree snail endemic to the Waianae Mountains. The entire genus is federally listed as endangered species (USFWS 1993). In 1995 Daniel Chung (Chung undated) reported five live individuals of *A. mustelina* in the same gulch on Puu Hapapa where the *A. intermedia* population is located. On the 2002 survey several fresh *A. mustelina* shells were found near the *A. intermedia* site, indicating that the species is probably still persisting in the area. The persistence of the *A. mustelina* population in the gulch should be confirmed. If confirmed to be extant, the population would be the only one of the species wholly within the boundaries of the naval magazine. Other recently recorded *A. mustelina* populations of the naval magazine are located only along the naval magazine's boundaries.

II. Recommendations

A. *Alectryon macrococcus* var. *macrococcus*

If any *A. macrococcus* var. *macrococcus* remain in NAVMAGPH LLL, they are relatively unimportant with respect to the conservation of the taxon as a whole in the Waianae Mountains since there are relatively large populations elsewhere in the mountain range growing in habitat more favorable for the taxon than the habitat in NAVMAGPH LLL. In any case, there would be little that could be done to halt their decline as long as the black twig borer remains a serious threat to their survival. Conservation efforts would best be directed towards other rare plant taxa in NAVMAGPH LLL, including *F. neowawraea*.

B. *Flueggea neowawraea*

.

Flueggea neowawraea is in a more precarious position than *A. macrococcus* var. *macrococcus*, and action must be taken soon to ensure the preservation of whatever genetic variability the NAVMAGPH LLL trees might contribute in the conservation of the species as a whole. The Army has already begun implementing a genetic diversity preservation plan for the species throughout its range in Hawaii, and efforts on the part of the Navy environmental offices with respect to the NAVMAGPH LLL trees would help in achieving the goals of this plan.

Propagation of the NAVMAGPH LLL trees that are on the verge of dying is especially urgent. One urgent action is to collect fruit from the trees in Halona that were observed to be fertile on the survey, and to promptly convey them to a seed storage or propagation facility. Based on the November 2002 survey observations, it was estimated that the fruits of the southern tree would be ripe sometime in December 2002 or January 2003, and those of the northern tree perhaps in January or February 2003. The southern tree bore only a moderate number of fruits. Collecting most or all of the fruits on this tree would not harm the population since there is little chance for successful regeneration of the species under the current conditions. The Mikilua tree should be visited to determine if it is also fruiting this year. With respect to any of the female trees in NAVMAGPH LLL, if no seeds are harvested this year from the tree, or if the tree's seeds fail to germinate, the tree should be monitored for subsequent crops of fruits until a sufficient number of progeny is secure in *ex situ* collections. For all of the NAVMAGPH LLL trees, vegetative propagation by air-layering should be attempted by an experienced plant propagator. If there are a sufficient number of living branches on a given tree, propagation using cuttings should also be attempted.

Alien trees were observed to be crowding and shading the southern tree in Halona. The alien trees should be gradually trimmed away from the *F. neowawraea*, and the tree's response to the change should be closely monitored. The other *F. neowawraea* trees in NAVMAGPH LLL may also benefit from the control of competing plants, including both alien species and common native species.

NAVMAGPH LLL contains some of the best remaining examples of *Sapindus oahuensis* dry forests. Throughout the Waianae Mountains, this forest type once supported fairly large numbers of *F. neowawraea* as evidenced by the abundant wooden remains within these forests in addition to the few remaining live trees. The perpetuation of this forest type in NAVMAGPH LLL through active management will be valuable for the long-term survival of *F. neowawraea* when outplanting of the species becomes possible.

By now, much of NAVMAGPH LLL has been surveyed for rare plants, but it is still possible that the valley contains unrecorded live individuals of *F. neowawraea* that further searching could uncover.

C. Others

Achatinella mustelina has been provided a certain level of protection as a listed endangered species, whereas *Amastra intermedia* has no such status. However, from the biological standpoint, the conservation of the Puu Hapapa *A. intermedia* population is of more immediate concern than the *A. mustelina* population on Puu Hapapa, as it is the only population known of its species, and its entire genus is on the verge of extinction. The population will eventually be extirpated if threats to it are not controlled. At several rare snail sites in the Waianae Mountains, including sites on the Army-controlled portion

of Puu Hapapa, rat control programs have been instituted. Similar efforts on the Navy-controlled portion of Puu Hapapa might be coordinated with the Army's rat control program. Means of controlling *E. rosea* in the field are not yet available.

The *A. intermedia* population should be monitored periodically. If a significant decline in the number of individuals is noted, a few snails should be collected in order to establish a captive population that would serve as a hedge against the extinction of the species. The captive stock could also be used to reintroduce the species in protected areas where threat abatement measures have been implemented. The feasibility of maintaining captive *Amastra* populations has already been demonstrated, as several species of the genus have been successfully kept in captivity for generations (Chung 1996).

D. Conservation of *Alectryon macrococcus* var. *macrococcus* and *Flueggea neowawraea* in NAVMAGPH LLL

For both tree species, the most serious threat factor in their decline is probably the black twig borer. Evidence of infestation can be found on all wild mature individuals of the two tree taxa. The female black twig borer tunnels into the center of living twigs and lays her eggs in the hollowed twigs. The physical damage caused by tunneling coupled with the introduction of pathogens often results in the death of the twigs. Chronic infestation leads to a gradual weakening of the tree, and eventual premature death. Very often, the weakened trees produce basal suckers, but the suckers are usually killed by the twig borers before long. Regeneration of *A. m.* var. *macrococcus* in the wild is occurring, but at a very low rate. Seedlings are occasionally observed in the wild, but only a few are able to grow to maturity due to the black twig borer. With *F. neowawraea*, regeneration is almost unheard of. The only record of immature plants to date is the report of a pair of plants in Pahole Gulch in the northern Waianaes in the 1970's (Nagata 1980). One plant was reported to be a tree 6.1 m (20 ft) tall, with a main trunk measuring 5.1 cm (2 in) in diameter; and the other plant a sapling about 1.5 m (5 ft) tall with a trunk measuring 2.5 cm (1 in) in diameter.

Since the wild populations of the two rare tree taxa are steadily being extirpated, and since there are currently no means available for controlling the black twig borer in the wild, preservation of the taxa in settings outside of the wild, or *ex situ*, needs to be carried out if the taxa are to survive. This would be done with the hope that sometime in the future, means of controlling the black twig borer in the wild will be developed. If and when black twig borer control is available, genetic variability among the plants used for reestablishing populations in the wild may be essential for the long-term survival of the reintroduced species. Preservation of the various stocks can be accomplished by a number of ways, including storage of viable seeds, storage of living tissue in laboratories, and maintaining collections of cultivated plants.

The need for implementing a genetic diversity preservation program is especially urgent for *F. neowawraea* since the few remaining trees are rapidly declining in number. Biologists of the Environmental Division of the Directorate of Public Works, United

States Army Garrison, Hawaii have, within the past year, begun implementing a plan aimed at preserving the genetic variability present in the remaining *F. neowawraea* trees through *ex situ* means (K. Kawelo, pers. comm. 2002).

Flueggea neowawraea has proven to be easy to germinate when seeds from ripe fruits are planted. Fruiting has been recorded primarily from October through January. Fruits can be found on many of the female trees in the wild, but the trees need to be monitored frequently to obtain ripe fruits since the fruiting period of any given tree is rather brief (J. Lau, pers. comm. 2002). In addition to germinating seeds of *F. neowawraea* from ripe fruits in the conventional manner, seeds from green fruits can sometimes be germinated by excising the embryos from the seeds and growing them in or on a nutrient-rich medium (N. Sugii, pers. comm. 2002)

Cultivated specimens of the species have been successfully propagated by air-layering their stems (M. Keir, pers. comm. 2002, J. Lau, pers. comm. 2002). Air-layering should be tried in the propagation of the wild trees. It is also possible to root cuttings of *F. neowawraea*, but the success rate to date has been low (J. Lau, pers. comm. 2002). However, an increase in the success rate can be expected as propagators gain experience working with the species. When the Kauhiuhi tree, which is in poor condition, was visited in September 2002, cuttings were collected from it for propagation by the horticulturist of the Environmental Division of the Directorate of Public Works, United States Garrison, Hawaii. It is not yet known whether the cuttings have successfully rooted, and the final results of the propagation attempt may not be known for several months.

IV. References

Chung, D. Undated. Letter to Joel Uribe [Moribe] regarding snails found on July 19, 1995.

Chung, D. 1996. Raising amastrid landsnails in captivity. Hawaiian Shell News 44: 3-4.

Hawaii Natural Heritage Program (HINHP). 1994. Biological Inventory and Management Needs Assessment, Naval Magazine, Headquarters, Lualualei, Oahu, Hawaii.

Hawaii Natural Heritage Program. 2003. Database of Rare and Endangered Plants, Animals, and Natural Communities of the Hawaiian Islands. University of Hawaii at Manoa, Honolulu, HI.

Hayden, J. W. 1990. *Flueggea*. Pp. 420-489 *in* W. L. Wagner, D. R. Herbst and S. H. Sohmer, Manual of the Flowering Plants of Hawai`i, 2 Vols. Univ. Hawaii Press and Bishop Museum, Honolulu (Bishop Museum Special Publication 83).

Nagata, K. M. 1980. The phytogeography of Pahole Gulch, Waianae Mountains, Oahu. Master's thesis, Univ. of Hawaii. Honolulu. 293 pp.

Nelson, R. E., and C. J. Davis. 1972. Black twig borer, a tree killer in Hawaii. USDA Forest Service Research Note PSW 274. U. S. Dept of Ag., Berkeley, CA.

U.S. Fish and Wildlife Service. 1993. Recovery plan for the Oahu tree snails of the genus *Achatinella*. U.S. Fish and Wildlife Service, Portland, Oregon. 64 pp + 64 pp as appendices.

U.S. Fish and Wildlife Service [USFWS]. 1999. Endangered and threatened wildlife and plants. 50 CFR 17.11 and 17.12, December 1999. U. S. Dept. of Interior, Washington, DC. 55 pp.

Wagner, W. L., D. R. Herbst, and S. H. Sohmer. 1990. Manual of the Flowering Plants of Hawai`i, 2 Vols. Univ. Hawaii Press and Bishop Museum, Honolulu (Bishop Museum Special Publication 83).

V. Preparers and Contributors

Leilani Durand Biologist	Hawaii Natural Heritage Program 677 Ala Moana Blvd. Honolulu, HI 96813
Joel Lau Botanist	Hawaii Natural Heritage Program 677 Ala Moana Blvd. Honolulu, HI 96813
Dwight Matsuwaki GIS specialist	Hawaii Natural Heritage Program 677 Ala Moana Blvd. Honolulu, HI 96813

This page is intentionally left blank.

C4 – LIST OF PLANTS AT NAVMAG PH LUALUALEI AND WEST LOCH BRANCHES (CNRH 2001B)

LIST OF PLANTS AT NAVAL MAGAZINE LUALUALEI

					Lualualei Branch							
Family	Scientific name	Common names	Status	Federal Status	Native vegetation			Alien vegetation			West Loch	Waikele
					1	2	3	1	2	3		
FERNS AND FERN ALLIES												
ADIANTACEAE	*Adiantum radianum* Presl	Maidenhair fern	A							•		
	Cheilanthes decipiens W.H. Wagner	Kumuniu	E		•	•				•		
	Cheilanthes subdecipiens W.H. Wagner	Kumuniu	E		•	•				•		
	Pellaea viridis (Forssk.) Prantl	Green Cliffbrake	A			•				•		
	Pteris cretica L.		I			•						
	Pteris x hillebrandii Copel. (*P. cretica* L. x *P. irregularis* Kaulf.)		E			•						
	Pteris irregularis Kaulf.	Mana, 'ahewa	E			•						
APIACAEA	*Cryptotaenia canadensis* (L.) DC	Honeywart	A						•			
	Hydrocotyle sibthorpioides Lam.	Marsh pennywort	A						•			
ASPLENIACEAE	*Asplenium acuminatum* Hook. & Arnott		E				•					
	Asplenium adiantum-nigrum L.		I							•		
	Asplenium contiguum Kaulf.		E				•					
	Asplenium horridum Kaulf.		E			•	•					
	Asplenium macraei Hook. & Arnott		E			•	•					
	Asplenium nidus L.	'Ekaha, bird's nest fern	I			•				•		
	Asplenium paraemorsum Sw.		I				•					
BLECHNACEAE	*Blechnum occidentale* L.		A		•	•	•		•	•		
	Doodia kunthiana Gaud.	'Okupukupulau'i'i	E			•	•			•		
	Sadleria cyatheoides Kaulf.	'Ama'u, ma'u	E			•	•					
CYATHEACEAE	*Cibotium chamissoi* Kaulf.	Hapu'u pulu, treefern	E			•	•			•		
	Cyathea cooperi (Hook. ex F. Huell.) Domin	Australian treefern	A			•	•					
DENNSTAEDTIACEAE	*Microlepia speluncae* (L.) T. Moore	Palapalai	I			•						
	Microlepia x adulterina W.H. Wagner	Palapalai	E			•				•		
	Microlepia strigosa (Thunb.) Presl	Palapalai	I		•	•	•			•		
	Odontosoria chinensis (L.) J. Sm.	Pala'a	I		•	•	•			•		
	Pteridium decompositum Gaud.		E			•						
DRYOPTERIDACEAE	*Cyrtomium caryotideum* Presl	Ka'ape'ape	I			•						
	Cyrtomium falcatum (L. fils.) Presl		A			•						

LIST OF PLANTS AT NAVAL MAGAZINE LUALUALEI

					Lualualei Branch							
Family	Scientific name	Common names	Status	Federal Status	Native vegetation			Alien vegetation			West Loch	Waikele
					1	2	3	1	2	3		
	Deparia fenzliana (Luerss.) M. Kato		E			•						
	Deparia petersenii (Kunze) M. Kato		A			•	•			•		
	Diplazium sandwichianum (Presl) Diels	Ho'i'o, pohole	E			•	•			•		
	Dryopteris fusco-atra (Hillebr.) Rob.		E			•						
	Dryopteris nuda Underw.		E				•					
	Dryopteris unidentata (Hook. & Arnott) C. Chr.		E			•						
	Elaphoglossum aemulum (Kaulf.) Brack.		E			•						
	Elaphoglossum alatum Gaud.		E			•	•					
	Elaphoglossum crassifolium (Gaud.) Anders. & Crosby		E			•	•					
	Elaphoglossum paleaceum (Hook. & Grev.) Sledge		I			•	•					
	Nephrolepis exaltata (L.) Schott var. *hawaiiensis* W.H. Wagner var. nov. ined.	Kupukupu, ni'ani'au	E				•					
	Nephrolepis multiflora (Roxb.) Jarrett ex Morton	Kupukupu, ni'ani'au	A		•	•				•	•	•
	Tectaria cicutaria (L.) Copel. ssp. *gaudichaudii* (Brack.) W.H. Wagner comb. nov. ined.	'Iwa'iwa lau nui	E			•				•		
GLEICHENIACEAE	*Dicranopteris linearis* (N.L. Burm.) Underw.	Uluhe	I			•	•					
GRAMMITIDACEAE	*Adenophorus tamariscinus* (Kaulf.) Hook. & Grev.	Wahine noho, mauna	E				•					
	Grammitis tenella Kaulf.						•					
HYMENOPHYLLACEAE	*Gonocormus minutus* (Blume) v. d. Bosch		I			•				•		
	Vandenboschia davalliodes (Gaud.) Copel.		E			•						
MARSILEACEAE	*Marsilea villosa* Kaulf.		E	E				•				
POLYPODIACEAE	*Lepisorus thunbergianus* (Kaulf.) Ching	Pakahakaha, 'ekaha, 'akolea	I		•	•	•			•		
	Phlebodium aureum (L.) J. Sm.	Hare's-foot fern, laua'e haole	A			•				•		

LIST OF PLANTS AT NAVAL MAGAZINE LUALUALEI

Family	Scientific name	Common names	Status	Federal Status	Lualualei Branch: Native vegetation 1	Native vegetation 2	Native vegetation 3	Alien vegetation 1	Alien vegetation 2	Alien vegetation 3	West Loch	Waikele
	Phymatosorus scolopendria (Burm.) Pic.-Ser.	Laua'e	A			•				•		
	Polypodium pellucidum Kaulf.	'Ae	E		•	•	•			•		
PSILTACEAE	*Psilotum nudum* (L.) Beauv.	Moa	I		•	•	•		•	•		
SELAGINELLACEAE	*Selaginella arbuscula* (Kaulf.) Spring	Lepelepe-a-moa	E			•	•			•		
THELYPTERIDACEAE	*Christella dentata*	Downy wood fern, pai'i'iha	A				•		•	•	•	
	Macrothelypteris torresiana (Gaud.) Ching		A			•						
	Thelypteris hudsoniana (Brack.) Reed		E							•		
	Thelypteris parasitica (L.) Fosberg		A			•	•			•		•
GYMNOSPERMS												
ARAUCARIACEAE	*Araucariaceae heterophylla* (Salisb.) Franco	Norfolk Island pine	A							•		
CUPRESSACEAE	*Juniperus* sp.	Juniper	A				•					
FLOWERING PLANTS: DICOTS												
ACANTHACEAE	*Asystasia gangetica* (L.)	Asystasia, Chinese violet	A					•	•	•	•	•
	Barleria cristata L. forma alba Deg. & Deg.	White-flowered barleria	A									•
	Ruellia graecizans Backer		A							•		
	Ruellia sp.		A									•
AIZOACEAE	*Trianthema portulacastrum* L.		A								•	
AMARANTHACEAE	*Achyranthes aspera* L.		A							•	•	•
	Achyranthes indica (L.) Mill.		A					•	•	•		
	Alternathera pungens Kunth	Khaki weed	A					•	•	•	•	•
	Amaranthus spinosus L.	Spiny amaranth, pakai kuku	A							•	•	•
	Amaranthus viridis L.	Slender amaranth, pakai	A					•	•		•	•

Family	Scientific name	Common names	Status	Federal Status	Lualualei Branch: Native vegetation 1	Native vegetation 2	Native vegetation 3	Alien vegetation 1	Alien vegetation 2	Alien vegetation 3	West Loch	Waikele
	Charpentiera obovata Gaud.	Papala	E			•				•		
	Nototrichium humile Hillebr.	Kulu'i	E	E	•	•				•		
ANACARDIACEAE	*Mangifera indica* L.	Mango	A					•			•	•
	Schinus terebinthifolius Raddi	Christmas berry, wilelaiki	A		•	•	•		•	•	•	•
APOCYNACEAE	*Alyxia oliviformis* Gaud.	Maile	E		•	•	•			•		
	Cascabela thevetia (L.) Lippold	Be-still tree, yellow oleander	A								•	
	Plumeria rubra L.	Plumeria	A									•
	Rauvolfia sandwicensis A. DC	Hao	E		•	•				•		
AQUIFOLIACEAE	*Ilex anomala* Hook. & Arnott	Kawa'u	E			•	•					
ARALIACEAE	*Cheirodendron trigynum* (Gaud.) A. Heller ssp. *trigynum*	'Olapa	E			•	•					
	Reynoldsia sandwicensis A. Gray	'Ohe-o-kai, 'ohe kukuluae'o	E		•					•		
	Schefflera actinophylla (Endl.) Harms	Octopus tree	A			•				•	•	•
	Tetraplasandra oahuensis (A. Gray) Harms	'Ohe mauka	E			•	•					
ARISTOLOCHIACEAE	*Aristolochia littoralis* Parodi	Calico flower	A							•		
ASCLEPIADACEAE	*Asclepias curassavica* L.	Milkweed, butterfly weed	A						•			
	Stapelia gigantea N.E.Br.	Carrion flower, Zulu-giant, giant toad plant	A						•			
ASTERACEAE	*Ageratina adenophora* (Spreng.) R. King & H. Robinson	Maui pamakani	A		•	•	•			•		
	Ageratina riparia (Regel) R. King & H. Robinson	Hamakua pamakani	A		•	•	•			•		
	Ageratum conyzoides L.	Maile hohono	A		•	•				•	•	•
	Artemesia australis Less.	Hinahina, hinahina kuahiwi	E		•	•				•		

LIST OF PLANTS AT NAVAL MAGAZINE LUALUALEI

Family	Scientific name	Common names	Status	Federal Status	Lualualei Branch: Native vegetation			Alien vegetation			West Loch	Waikele
					1	2	3	1	2	3		
	Baltimora recta L.		A							•		
	Bidens cervicata Sherff	Ko'oko'olau, koko'olau	A			•				•		
	Bidens cynapiifolia Kunth	Spanish needle, beggartick	A							•		
	Bidens pilosa L.	Spanish needle, beggartick	A			•				•	•	•
	Bidens torta Sherff	Ko'oko'olau, koko'olau	E		•	•	•			•	•	
	Calyptocarpus vialis Less.	Hierba del cabello	A						•			•
	Centaurea melitensis L.	Thistle	A						•			
	Conyza bonariensis (L.) Cronq.	Hairy horseweed, ilioha	A		•	•	•			•	•	•
	Conyza canadensis (L.) Cronq.	Canadian flea bane	A					•	•		•	•
	Crassocephalum crepidiodes (Benth.) S. Moore		A							•		
	Cyanthillium cinereum (L.) H. Rob.	Little ironweed	A					•	•			•
	Dubautia plantaginea Gaud. ssp. *plantiginea*	Naenae	E				•					
	Eclipta alba (L.) Hassk.	False daisy	A									•
	Emilia fosbergii Nicolson	Flora's paintbrush	A			•	•	•	•	•	•	•
	Emilia sonchifolia (L.) DC	Flora's paintbrush	A			•			•	•		
	Erechtitus hieracifolia (L.) Raf.	Fireweed	A					•	•			
	Flaveria trinervia (Spreng.) C. Mohr		A								•	
	Erigeron karvinskianus DC	Daisy fleabane	A			•	•			•		
	Galinsoga parviflora Cav.		A			•				•		
	Gamochaeta purpureum (L.) Cabrera	Purple cudweed	A				•					
	Hypochoeris radicata L.	Hairy cat's ear, gosmore	A		•							
	Lactuca scariola L.	Wild lettuce	A								•	
	Lipochaeta lobata (Gaud.) DC var. *leptophylla* Degener & Sherff	Nehe	E	E	•	•				•		
	Lipochaeta tenuis Degener & Sherff	Nehe	E	SOC	•	•	•			•		
	Montonoa hibiscifolia Benth.	Tree daisy	A			•	•		•	•		
	Pluchea carolinensis (Mill.) Gillis	Sourbush	A		•	•			•	•	•	•
	Pluchea indica (L.) Less	Indian pluchea, sourbush	A					•	•	•	•	

LIST OF PLANTS AT NAVAL MAGAZINE LUALUALEI

Family	Scientific name	Common names	Status	Federal Status	Lualualei Branch: Native vegetation			Alien vegetation			West Loch	Waikele
					1	2	3	1	2	3		
	Sonchus oleraceus L.	Sow thistle, pualele	A					•	•	•	•	•
	Synedrella nodiflora (L.) Gaertn.	Nodeweed	A					•	•	•		•
	Tridax procumbens L.	Coat buttons	A					•	•		•	•
	Tetramolopium lepidotum (Less.) Sherff ssp. *lepidotum*		E	E	•		•					
	Verbesina enceliodies B. & H. ex Gray	Golden crown beard	A					•	•		•	•
	Wedelia trilobata (L.) Hitchc.	Wedelia	A						•			•
	Xanthium strumarium L. var. *canadense* (Mill.) Torr. & A. Gray	Cocklebur, kikania	A					•	•	•		
	Xanthium sp.		A									•
	Youngia japonica (L.) DC	Oriental hawksbeard	A			•				•		
BASELLACEAE	*Andredera cordifolia* (Ten.) Steenis	Madeira vine, 'uala hupe	A			•				•		
BEGONIACEAE	*Begonia* sp.	Begonia	A							•		
BIGNONIACEAE	*Spathodea campanulata* P. Beauv.	African tulip tree	A							•	•	•
	Tecoma sp.				•	•				•		
	Tecomella undulata (Roxb.) Seem.	Lahura	A						•			
BORAGINACEAE	*Cordia subcordata* Lam.	Kou	A								•	
	Heliotropium curassavicum L.	Hinahina	I					•	•			
	Heliotropium procumbens Mill. var. *depressum* (Cham.) Fosb.		A							•	•	•
BRASSICACEAE	*Capsella rubella* (L.) Medik	Shepherd's purse	A						•			
	Coronopus didymus (L.) Sm.	Swinecress	A			•				•		
	Lepidium arbuscula Hillebr.	'Anaunau, naunau, kunana	E	E	•	•						
	Lepidium virginicum L.	Wild peppergrass	A						•		•	•
BUDDLEJACEAE	*Buddleia asiatica* Lour.	Dogtail	A							•	•	•

LIST OF PLANTS AT NAVAL MAGAZINE LUALUALEI

Family	Scientific name	Common names	Status	Federal Status	Lualualei Branch: Native vegetation 1	Native vegetation 2	Native vegetation 3	Alien vegetation 1	Alien vegetation 2	Alien vegetation 3	West Loch	Waikele
CACTACEAE	*Hylocereus undatus* (Haw.)	Night-blooming cereus	A									•
	Opuntia ficus-indica (L.) Mill.	Prickly pear, panini	A		•	•		•	•	•		•
CAMPANULACEAE	*Cyanea lanceolata* ssp. *calycina* (Gaudich.) Lammers, Givnish & Sytsma	'Oha, haha, 'ola wai	E	E			•					
	Lobelia niihauensis St. John	'Oha, haha, 'ola wai	E	E	•							
	Lobelia yuccoides Hillebr.	Panaunau	E				•					
CAPPARACEAE	*Cleome gynandra* L.	African spider-flower, honohina	A								•	
CARICACEAE	*Carica papaya* L.	Papaya						•				
CARYOPHYLLACEAE	*Cerastium fontanum* Baumg. ssp. *triviale* (Link) Jalas	Common mouse-ear chickweed	A			•				•		
	Drymaria cordata (L.) Willd.	Pipili, pilipili	A				•					
	Schidea hookeri A. Gray		E	E	•							
	Schidea ligustrina Cham. & Schlechtend.		E		•	•				•		
	Schidea mannii St. John		E				•					
	Schidea pubescens Hillebr var. purpurascens *Sherff*		E	C		•	•					
	Stellaria media (L.) Vill.	Common chickweed	A							•		
CASUARINACEAE	*Casuarina equisetifolia* L.	Common ironwood, paina	A					•	•	•	•	
CELASTRACEAE	*Perrotteria sandwicensis* A. Gray	Olomea	E				•					
CHENOPODIACEAE	*Atriplex semibaccata* R. Br.	Australian salt bush	A					•	•		•	•
	Chenopodium album L.	Pig weed	A					•	•			
	Chenopodium murale L.	Nettle-leaved goosefoot, pigweed	A								•	
	Chenopodium oahuense (Meyen) Aellen	'Aheahea, 'aweoweo	E		•					•		

LIST OF PLANTS AT NAVAL MAGAZINE LUALUALEI

Family	Scientific name	Common names	Status	Federal Status	Lualualei Branch: Native vegetation 1	Native vegetation 2	Native vegetation 3	Alien vegetation 1	Alien vegetation 2	Alien vegetation 3	West Loch	Waikele
CONVOLVULACEAE	*Bonamia menziesii* A. Gray		E	E		•						
	Ipomaea alba L.	Moonflower	A								•	
	Ipomoea cairica (L.) Sweet	Ivy-leaved morning glory, koali 'ai	A			•					•	•
	Ipomaea indica (J. Burm.) Merr.	Koali 'awa, koali 'awahia	I					•			•	•
	Ipomaea obscura (L.) Ker-Gawl.	Morning glory	A					•	•	•	•	•
	Jacquemontia sandwicensis Gray	Pa'u-o-hi'iaka	E					•	•		•	
	Merremia aegyptia (L.) Urban	Hairy merremia	A					•	•		•	•
	Merremia tuberosa (L.) Rendle	Woodrose, wooden rose	A									•
CURCURBITACEAE	*Citrullus lanatus* (Thunb.) Matsum & Nakai	Watermelon, ipu 'ai-maka	A							•		
	Coccinia grandis (L.) Voigt	Scarlet-fruited gourd	A							•		
	Cucumis dipsaceus Ehrenb. Ex Spach	Hedgehog gourd, teasel gourd	A					•	•	•	•	
	Cucumis melo L.	Cantelope	A								•	
	Momordica charantia L.	Bittermelon	A					•	•		•	•
	Sicyos erostratus St. John	'Anunu, kupala	E		•	•				•		
	Sicyos microcarpus Mann.	Kupala gourd	E								•	
	Sicyos pachycarpus Hook. & Arnott	'Anunu, kupala	E		•	•				•		
EBENACEAE	*Diospyros hillebrandii* (Seem.) Fosb.	Lama, elama	E			•						
	Diospyros sandwicensis (A. DC) Fosb.	Lama, elama	E		•	•				•		
ELAEOCARPACEAE	*Elaeocarpus bifidus* Hook. & Arnott	Kalia	E			•						
EPICRIDACEAE	*Styphelia tameiameiae* (Cham. & Schlechtend.) F. v. Muell.	Pukiawe	I		•	•	•			•		
ERICACEAE	*Vaccinium dentatum* Sm.	'Ohelo	E			•	•					
EUPHORBIACEAE	*Aleurites moluccana* (L.) Willd.	Candlenut, kukui	A		•	•						

LIST OF PLANTS AT NAVAL MAGAZINE LUALUALEI

Family	Scientific name	Common names	Status	Federal Status	Lualualei Branch: Native vegetation 1	2	3	Alien vegetation 1	2	3	West Loch	Waikele
	Antidesma platyphyllum H. Mann. var. *platyphyllum*	Hame, mehame	E			•	•					
	Antidesma pulvinatum Hillebr.	Hame, mehame	E			•				•		
	Chamaesyce celastroides (Boiss.) Croizat & Degener var. *amplectens* (Sherff) Degener & I. Degener	'Akoko, koko, kokomalei	E		•	•	•			•		
	Chamaesyce glomerifera L. C. Wheeler	Spurge	A					•	•			•
	Chamaesyce hirta (L.) Millsp.	Hairy spurge, garden spurge, koko kahiki	A					•	•	•	•	•
	Chamaesyce hypericifolia (L.) Millsp.	Graceful spurge	A							•		
	Chamaesyce kuwaleana (Degener & Sherff) Degener & I. Degener	'Akoko, koko, kokomalei	E	E	•	•				•		
	Chamaesyce multiformis (Hook. & Arnott) Croizat & Degener var. multiformis	'Akoko, koko, kokomalei	E			•	•			•		
	Chamaesyce prostrata (Aiton) Sm.	Prostrate spurge	A					•	•		•	•
	Claoxylon sandwicense Mull. Arg.	Po'ola	E			•						
	Euphorbia cyathophora Murr.		A								•	
	Euphorbia denticulata		A								•	
	Euphorbia cf. *graminea*		A								•	
	Euphorbia heterophylla L.	Summer poinsettia, fire plant	A								•	
	Flueggea neowawraea W. Hayden	Mehamehame	E	E		•						
	Macaranga mappa (L.) Mull. Arg.	Bingabing	A						•			
	Macaranga tanarius (L.) Mull. Arg.		A									•
	Manihot glaziovii Mull. Arg.	Ceara rubber tree	A									•
	Mallotus philippensis (Lam.) Mull. Arg.					•				•		
	Phyllanthus debilis Klien ex Willd.	Phyllanthus weed	A					•	•			•
	Phyllanthus distichus Hook. & Arnott	Pamakani mahu	E				•					
	Ricinus communis L.	Castor bean, pa'aila, koli	A				•				•	•
FABACEAE	*Acacia confusa* Merr.	Formosan koa	A		•	•				•		•
	Acacia farneseniana (L.) Willd.	Klu, kolu	A		•	•		•	•	•	•	•
	Acacia koa A. Gray	Koa	E			•	•			•		
	Albizia lebbeck (L.) Benth.	Albizia, Siris tree	A									•
	Alysicarpus vaginalis (L.) DC		A									•

Family	Scientific name	Common names	Status	Federal Status	Lualualei Branch: Native vegetation 1	2	3	Alien vegetation 1	2	3	West Loch	Waikele
	Caesalpinia bonduc (L.) Roxb.	Kakalaioa	A						•	•		
	Caesalpinia major (Medlik.) Dandy & Exell	Yellow nickers, kakalaioa	A						•	•		•
	Canavalia cathartica Thouars	Mauna-loa	A									•
	Canavalia galeata (Gaud.) Vogel	'Awikiwiki, puakauhi	E		•	•				•		
	Canavalia sp.		A?									•
	Chamaecrista nictitans (L.) Moench ssp. *patellaria*	Partridge pea, lauki	A		•	•		•	•	•	•	•
	Crotolaria incana L.	Fuzzy rattle-box	A					•	•		•	
	Crotolaria pallida Aiton	Smooth rattlepod	A					•	•	•		•
	Crotolaria retusa L.	Rattle-box	A					•	•			
	Desmanthus pernambucanus (L.) Thell.	Slender mimosa, virgate mimosa	A						•		•	•
	Desmodium incacum DC	Spanish clover, ka'imi	A					•	•			
	Desmodium sandwicense E. Mey.	Spanish clover, ka'imi	A							•		
	Desmodium triflorum (L.) DC	Three-flowered beggarweed	A					•	•	•		•
	Desmodium uncinatum (Jacq.) DC	Spanish clover	A					•	•			
	Erythrina sandwicensis Deg.	Wiliwili	E			•			•	•		•
	Haematoxylum campechianum L.	Logwood	A						•			
	Indigofera spicata Forsk.	Dwarf indigo	A								•	
	Indigofera suffruticosa Mill.	Indigo	A					•	•	•	•	•
	Leucaena leucocephala (Lam.) de Wit	Haole koa, koa haole, ekoa	A		•	•		•	•	•	•	•
	Macroptilium atropurpureum (DC) Urb.	Wild bushbean	A								•	•
	Macroptilium lathyroides (L.) Urb.	Wild bean, cow pea	A							•	•	•
	Mimosa pudica L.	Sensitive plant	A					•	•			•
	Neonotonia wightii (Wight & Arn.) Lackey		A							•		
	Peltophorum inerme (Roxb.) Naves	Yellow poinciana	A						•			
	Phaseolus lathyroides L.	Cow pea	A					•	•			•
	Pithecellobium dulce (Roxb.) Benth	Madras thorn	A							•	•	
	Prosopis pallida HBK.	Algaroba, mesquite, kiawe	A					•	•		•	•
	Pterocarpus indicus Willd.	Narra	A							•		

LIST OF PLANTS AT NAVAL MAGAZINE LUALUALEI

Family	Scientific name	Common names	Status	Federal Status	Lualualei Branch: Native vegetation 1	2	3	Alien vegetation 1	2	3	West Loch	Waikele
	Senna pendula (Humb & Bonpl. Ex Willd.) H. Irwin & Barneby		A					•	•			
	Senna surattensis (N.L. Burm.) H. Irwin & Barneby	Kolomona	A									•
	Samanea saman Merr.	Monkeypod	A					•	•		•	•
FLACOUTIACEAE	*Xylosma hawaiiense* Seem.	Maua	E			•						
GENTIANACEAE	*Centaurium erythraea* Raf. ssp. *erythraea*	Bitter herb, European centaury	A		•		•			•		
GESNERIACEAE	*Cyrtandra waianaeensis* St. John & Storey	Hai'wale, kanawao ke'oke'o	E				•					
GOODENIACEAE	*Scaevola gaudichaudiana* Cham.	Naupaka kuahiwi	E			•	•					
	Scaevola mollis Hook. & Arnott	Naupaka kuahiwi	E				•					
HYDRANGEACEAE	*Broussaisia arguta* Gaud.	Kanawao, pu'ahanui	E				•					
LAMIACEAE	*Hyptis pectinata* (L.) Poit.	Comb hyptis	A		•	•		•	•	•	•	•
	Leonotis nepetifolia (L.) R. Br.	Lion's ear	A			•		•	•		•	
	Ocimum gratissimum L.	Basil	A					•	•		•	
	Plectranthus parviflorus Willd.	'Ala'ala wai nui	I		•	•			•	•		
	Salvia cocinea Juss. ex J. A. Murray	Scarlet sage, liliehua	A			•						
	Salvia occidentalis Sw.	West Indian sage	A			•				•		•
	Stachys arvensis L.	Staggerweed	A							•		
	Stenogyne kaalae Wawra		E		•		•					
LAURACEAE	*Cassytha filiformis* L.	Kauna'oa pehu	I								•	
	Persea americana Mill.	Avocado	A						•			•
LOGANIACEAE	*Labordia kaalae* C. Forbes	Kamakahala	E			•	•					
LYTHRACEAE	*Cuphea ignea* A. DC.	Cigar flower	A									•

LIST OF PLANTS AT NAVAL MAGAZINE LUALUALEI

Family	Scientific name	Common names	Status	Federal Status	Lualualei Branch: Native vegetation 1	2	3	Alien vegetation 1	2	3	West Loch	Waikele
	Cuphea carthagenensis (Jacq.) MacBride	Tarweed, Columbian cuphea, Puakamoli	A						•			
	Lythrum maritimum Kunth	Pukamole	I			•	•					
MALVACEAE	*Abutilon grandifolium* (Willd.) Sweet	Hairy abutilon, Ma'o	A		•	•		•	•	•	•	•
	Abutilon incanum (Link) Sweet	Hoary abutilon, Ma'o	I						•		•	•
	Abutilon sandwicense (Deg.) Christoph.		E	E		•				•		
	Hibiscus arnottianus A. Gray ssp. *arnottianus*	Koki'o ke'oke'o	E		•	•				•		
	Hibiscus tiliaceus L.	Hau	I							•		
	Hibiscus sp. (hybrid)	Red hibiscus	A									•
	Malachra alceaefolia Jacq.	Malachra	A									•
	Malva parviflora L.	Cheese weed	A					•	•	•	•	
	Malvastrum coromandelianum (L.) Garcke	False mallow	A			•		•	•	•	•	•
	Sida cordifolia L.	Pantropic sida	A					•	•			
	Sida fallax Walp.	'Ilima	I		•	•		•	•	•	•	•
	Sida rhombifolia L.	Cuba jute	A					•	•			
	Sida spinosa L.	Prickly sida	A					•	•		•	•
	Thespesia populnea (L.) Correa	Milo	I								•	
MELASTOMATACEAE	*Clidemia hirta* (L.) D. Don var. *hirta*	Koster's curse, clidemia	A		•	•	•			•		•
MELIACEAE	*Cedrela fissilis* Vell.		A					•	•			
	Melia azedarach L.	Chinaberry, Pride-of-India	A			•			•			•
	Toona ciliata M. Roem. var. *australis* (F. v. Muell.) C. DC	Australian red cedar	A		•	•				•		
MENISPERMACEAE	*Cocculus trilobus* (Thunb.) DC	Huehue	I		•	•	•			•		•
MORACEAE	*Broussonetia papyrifera* (L.) Venten.	Paper mulberry, wauke	A							•		
	Ficus benghalensis L.	Banyan	A						•	•		
	Ficus elastica Roxb. Ex Hornem.	Rubber tree	A								•	•

LIST OF PLANTS AT NAVAL MAGAZINE LUALUALEI

Family	Scientific name	Common names	Status	Federal Status	Lualualei Branch: Native vegetation 1	Native vegetation 2	Native vegetation 3	Alien vegetation 1	Alien vegetation 2	Alien vegetation 3	West Loch	Waikele
	Ficus forsteni Miq.	Banyan	A						•	•		
	Ficus indica L.	Banyan	A						•	•		
	Ficus macrophylla Desf.	Moreton Bay fig	A			•			•	•		•
	Ficus microcarpa L. fil.	Chinese banyan, Malayan banyan	A		•	•			•	•	•	•
	Streblus pendulinus (Endl.) F. v. Muell.	A'ia'i	I			•				•		
MYRICACEAE	*Myrica faya* Aiton	Fire tree	A		•	•	•			•		
MYRSINACEAE	*Myrsine emarginata* (Rock) Hosaka	Kolea	E				•					
	Myrsine lanaiensis Hillebr.	Kolea	E			•						
	Myrsine lessertiana A. DC	Kolea	E			•	•					
	Myrsine sandwicensis A. DC	Kolea lau li'i	E				•					
MYRTACEAE	*Eucalyptus camaldulensis* Dehnh	Murray red gum	A						•			
	Eucalyptus globulus Labill.	Blue gum	A									•
	Eucalyptus resinifera Sm.	Kinogum eucalyptus	A						•			
	Eucalyptus robusta Sm.	Swamp mahogany	A			•	•		•			
	Eugenia reinwardtiana (Blume) DC	Nioi	I			•				•		
	Metrosideros polymorpha Gaud.	'Ohi'a lehua, 'ohi'a, lehua	E		•	•	•			•		
	Psidium cattleianum Sabine	Strawberry guava, waiawi	A		•	•	•			•		
	Psidium guajava L.	Guava, kuawa	A		•	•	•		•	•	•	•
	Syzygium cumini (L.) Skeels	Java plum	A			•			•	•		•
NYCTAGINACEAE	*Boerhavia coccinea* Mill.	Red boerhavia	A						•		•	•
	Boerhavia glabrata Blume	Alena	I						•			
	Boerhavia repens L.	Alena	I						•	•		
	Mirabilis jalapa L.	Four o' clock, nani-ahiahi	A								•	•
	Pisonia brunoniana Endl.	Papala kepau	I			•				•		
	Pisonia sandwicensis Hillebr.	Aulu	E			•				•		
	Pisonia umbellifera (G. Forster) Seem.	Papala kepau	E			•				•		
OLEACEAE	*Fraxinus uhdei* (Wenzig) Lingelsh.	Tropical ash	A		•	•				•		

LIST OF PLANTS AT NAVAL MAGAZINE LUALUALEI

Family	Scientific name	Common names	Status	Federal Status	Lualualei Branch: Native vegetation 1	Native vegetation 2	Native vegetation 3	Alien vegetation 1	Alien vegetation 2	Alien vegetation 3	West Loch	Waikele
	Nestegis sandwicensis (A. Gray) Degener, I. Degener & L. Johnson	Olopua, pua	E			•				•		
	Olea europaea L.	Olive	A						•			
ONAGRACEAE	*Ludwigia octivalvis* (Jacq.) Raven	Primrose willow	A						•			•
OXALIDACEAE	*Oxalis corniculatus* L.	Yellow wood sorrel, 'ihi makole	A		•	•		•	•		•	•
PASSIFLORACEAE	*Passiflora edulis* Sims	Passion fruit, liliko'i	A				•		•	•		•
	Passiflora foetida L.	Love-in-a-mist	A					•	•		•	•
	Passiflora suberosa L.	Huehue haole	A		•	•	•	•	•	•		
PHYTOLACCACEAE	*Phytolacca dioica* L.	Bella sombra	A					•	•			
	Rivina humilis L.	Coral berry, rogue plant	A			•			•	•		•
PIPERACEAE	*Peperomia blanda* (Jacq.) Kunth var. *floribunda* (Miq.) H. Huber	'Ala'ala wai nui	I		•	•			•			•
	Peperomia latifolia Miq.	'Ala'ala wai nui	E			•	•					
	Peperomia membranacea Hook. & Arnott	'Ala'ala wai nui	E			•	•					
	Peperomia tetraphylla (G. Forster) Hook. & Arnott	'Ala'ala wai nui	I		•	•	•		•	•		
PITTOSPORACEAE	*Pittosporum confertiflorum* A. Gray	Ho'awa	E				•					
	Pittosporum glabrum Hook. & Arnott	Ho'awa	E			•						
PLANTAGINACEAE	*Plantago lanceolata* L.	Narrow leaved plantain	A						•			
	Plantago major L.	Broad leaved plantain, laukahi	A						•			
PLUMBAGINACEAE	*Plumbago auriculata* Lam.	Blue plumbago	A									•
	Plumbago zeylanica L.	'Ilie'e	I			•		•	•	•	•	•
POLYGONACEAE	*Antigonon leptopus* H. & A.	Mexican creeper	A								•	
	Rumex albescens Hillebr.	Hu'ahu'ako	E		•	•	•			•		

LIST OF PLANTS AT NAVAL MAGAZINE LUALUALEI

Family	Scientific name	Common names	Status	Federal Status	Lualualei Branch: Native vegetation 1	Native vegetation 2	Native vegetation 3	Alien vegetation 1	Alien vegetation 2	Alien vegetation 3	West Loch	Waikele
PORTULACACEAE	*Portulaca cyanosperma* Egler	'Ihe	E					•	•			
	Portulaca oleraceae L.	Pigweed, 'Ihe	A		•	•			•	•	•	•
	Portulaca pilosa L.	Pigweed, 'Ihe	A		•	•			•	•		
PRIMULACEAE	*Lysimachia hillebrandii* J.D. Hook. ex A. Gray		E		•	•	•					
PROTEACEAE	*Grevillea robusta* A. Cunn ex R. Br.	Silk oak, silver oak	A		•	•	•		•	•		•
ROSACEAE	*Osteomeles anthyllidifolia* (Sm.) Lindl.	'Ulei	I		•	•			•	•		
	Rubus rosifolius Sm.	Thimbleberry	A		•	•	•			•		
RUBIACEAE	*Bobea brevips* A. Gray	'Ahakea	E			•						
	Bobea sandwicensis (A. Gray) Hillebr.	'Ahakea	E			•				•		
	Coprosma foliosa A. Gray	Pilo	E			•	•					
	Coprosma longifolia A. Gray	Pilo	E			•	•					
	Hedyotis acuminata (Cham. & Schlechtend.) Steud.	Au	E			•	•					
	Hedyotis parvula (A. Gray) Fosb.		E	E	•							
	Hedyotis schlechtendahliana Steud. var. *schlechtendahliana*	Kopa	E		•	•	•					
	Hedyotis terminalis (Hook. & Arnott) W.L. Wagner & Herbst	Manono	E			•	•					
	Psychotria hathewayi Fosb.	Kopiko, 'opiko	E		•	•				•		
	Psychotria mariniana (Cham. & Schlechtend.) Fosb.	Kopiko, 'opiko	E			•				•		
	Psydrax odoratum (G. Forst.) A. C. Sm. & S. P. Darwin	Alahe'e	I		•	•			•	•		
	Spermacoce assurgens R. & P.	Buttonwood	A									•
RUTACEAE	*Citrus sinensis* (L.) Osbeck	Orange	A						•	•		
	Melicope clusiifolia (A. Gray) T. Hartley & B. Stone	Alani	E				•					
	Melicope pendunculans (H. Lev.) T. Hartley & B. Stone	Alani	E			•	•			•		
	Murraya exotica L.	Mock orange	A									•

Family	Scientific name	Common names	Status	Federal Status	Lualualei Branch: Native vegetation 1	Native vegetation 2	Native vegetation 3	Alien vegetation 1	Alien vegetation 2	Alien vegetation 3	West Loch	Waikele
	Platydesma cornuta Hillebr. var. *decurrens* B. Stone	Pilo kea	E			•						
	Zanthoxylum dipetalum H. Mann var. *dipetalum*	Kawa'u	E			•						
SANTALACEAE	*Santalum ellipticum* Gaud.	'Iliahi, sandalwood	E			•				•		
SAPINDACEAE	*Alectryon macrococcus* Radlk. var. *macrococcus*	'Ala'alahua, mahoe	E	E			•			•		
	Dodonaea viscosa Jacq.	'A'ali'i	I		•	•			•	•		•
	Harpullia pendula Planch ex. F. Muell.	Tulipwood	A						•			
	Sapindus oahuensis Hillebr. ex Radlk.	Lonomea, aulu	E			•			•	•		
SAPOTACEAE	*Bumelia buxifolia* Willd. Ex HBK.	Bumelia										•
	Chrysophyllum oliviforme L.	Satin leaf, caimitillo	A						•	•		
	Pouteria sandwicensis (A. Gray) Baehni & Degener	'Ala'a	E			•				•		
SCROPHULARIACEAE	*Linaria canadensis* (L.) Dum. Cours. var. *texana* (Scheele) Pennell	Blue toadflax	A		•					•		
SOLANACEAE	*Capsicum frutescens* L.	Red pepper	A						•		•	
	Datura stramonium L.	Jimson weed	A								•	
	Nicandra physalodes (L.) Gaertn.	Apple of Peru	A					•	•	•	•	•
	Nicotonia glauca Grah.	Tree tobacco	A								•	
	Nothocestrum longifolium A. Gray	'Aiea	E			•				•		
	Physalis peruviana L.	Cape gooseberry, poha	A			•				•		
	Solanum americanum Mill.	Glossy nightshade, popolo	I			•		•	•	•		•
	Solanum linnaeanum Hepper & P. Jaeger	Potato vine	A						•			
	Solanum lycopersicum Mill.	Tomato	A							•		
	Solanum lycopersicum L. var. *cerasiforme* (Dunal) Spooner, G. J. Anderson & R. K. Jansen	Currant tomato	A							•		•
	Solanum melongena L.	Eggplant	A								•	
	Solanum nigrum L.	Popolo	I?								•	•

LIST OF PLANTS AT NAVAL MAGAZINE LUALUALEI

Family	Scientific name	Common names	Status	Federal Status	Lualualei Branch: Native vegetation 1	2	3	Alien vegetation 1	2	3	West Loch	Waikele
	Solanum seaforthianum Andr.	Apple of Sodom	A						•		•	•
STERCULIACEAE	*Waltheria indica* L.	'Uhaloa, hi'aloa	I		•	•		•	•	•	•	•
TILIACEAE	*Heliocarpus popayanensis* Kunth	Moho, white moho	A						•			
	Triumfetta semitriloba Jacq.	Sacramento bur	A			•			•	•		
ULMACEAE	*Trema orientalis* (L.) Bl.	Gunpowder tree	A									•
URTICACEAE	*Boehmeria grandis* (Hook. & Arnott) A. Heller		E			•				•		
	Neraudia angulata R. Cowan var. *dentata* Deg. & R. Cowan	Ma'aloa, ma'oloa, 'oloa	E	E	•					•		
	Neraudia melastomifolia Gaud.	Ma'aloa, ma'oloa, 'oloa	E			•						
	Pilea peploides (Gaud.) Hook. & Arnott		I		•	•				•		
	Pipturus albidus (Hook. & Arnott) A. Gray	Mamaki	E		•	•	•		•	•		
	Urera glabra (Hook. Arnott) Wedd.	Opuhe	E			•						
VERBENACEAE	*Lantana camara* L.	Lantana	A		•	•	•	•	•	•	•	•
	Stachytarpheta australis Moldenke	Oi	A		•	•	•			•		•
	Stachytarpheta cayennensis (Rich.) Vahl		A					•	•	•		
	Stachytarpheta jamaicensis (L.) Vahl	Jamaica vervain, oi	A		•	•				•	•	•
	Verbena litoralis Kunth	Ha'uoi, oi	A		•		•		•			•
VIOLACEAE	*Viola chamissoniana* Ging. ssp. *chamissoniana*	Pamakani	E	E	•							
	Viola chamissoniana Ging. ssp. *tracheliifolia* W.L. Wagner, Herbst & Sohmer	Pamakani	E		•	•	•			•		
VISCACEAE	*Korthalsella cylindrica* (Tiegh.) Engl.	Hulumoa, kaumahana	E			•	•					
ZYGOPHYLLACEAE	*Guaiacum officinale* L.	Lignum vitae	A						•			
	Tribulus terrestris L.	Puncture vine	A								•	

LIST OF PLANTS AT NAVAL MAGAZINE LUALUALEI

Family	Scientific name	Common names	Status	Federal Status	Lualualei Branch: Native vegetation 1	2	3	Alien vegetation 1	2	3	West Loch	Waikele
FLOWERING PLANTS: MONOCOTS												
AGAVACEAE	*Cordyline fruticosa* (L.) A. Chev.	Ti, ki	A			•	•			•	•	
	Furcraea foetida (L.) Haw.	Mauritius hemp, malina	A			•				•		
	Pleomele forbesii Deg.	Halapepe	E		•	•				•		
	Sansevieria trifasciata Prain	Bowstring hemp	A								•	
	Sansevieria zeylanica Willd.		A								•	
ARECACEAE	*Phoenix* sp.	Wild date palm	A									•
AMARYLLIDACEAE	*Agave sisalana* Perrine ex Engelm.	Sisal	A						•			•
	Pancratium sp.		A									•
ARACEAE	*Alocasia macrorrhiza* (L.) Schott	'Ape	A							•		
	Colocasia esculenta (L.) Schott	Taro, kalo	A						•	•		
	Epipremnum pinnatum (L.) Engl.	Taro vine	A						•	•		
CANNACEAE	*Canna* sp.	Indian-shot	A									•
COMMELINACEAE	*Commelina benghalensis* L.	Hairy honohono	A			•		•	•	•	•	
	Commelina diffusa N.L. Burm.	Honohono	A						•			•
CYPERACEAE	*Carex meyenii* Nees		I		•	•	•			•		
	Carex wahuensis C.A. Mey. ssp.		E		•	•	•			•		
	Cyperus alternifolius L.	Ahu'awa haole	A									•
	Cyperus phleoides Nees ex Kunth (Hillebr.)		E			•				•		
	Cyperus gracilis R. Br.	McCoy grass	A					•	•	•		
	Cyperus rotundus L.	Nut grass	A								•	•
	Kyllinga bervifolia Rottb.	Kili'o'opu	A				•			•		
	Mariscus hillebrandii (Boeck.) T. Koyama		E		•	•	•			•		
JUNACACEAE	*Luzula hawaiiensis* Buchenau var. *oahuensis* (Deg. & Fosb.) Deg. & I Deg.	Wood rush	E				•					
LEMNACEAE	*Lemna perpusilla* Torr.	Duckweed	A?								•	
LILIACEAE	*Aloe vera* L.	Aloe	A								•	

LIST OF PLANTS AT NAVAL MAGAZINE LUALUALEI

Family	Scientific name	Common names	Status	Federal Status	Lualualei Branch: Native vegetation			Alien vegetation			West Loch	Waikele
					1	2	3	1	2	3		
	Astelia menziesiana Sm.	Pa'iniu	E				•					
	Dianella sandwicensis Hook. & Arnott	'Uki'uki	I		•	•	•					
MUSACEAE	*Musa x paradisiaca* L.	Banana, mai'a	A							•		•
	Strelitzia sp.		A									•
ORCHIDACEAE	*Epidendrum x obrienianum* Rolfe	Scarlet orchid, butterfly orchid	A				•			•		
	Spathoglottis plicata Blume	Malayan ground, orchid	A							•		•
PANDANACEAE	*Freycinetia arborea* Gaud.	'Ie'ie	I			•				•		
POACEAE	*Agrostis avenacea* J.G. Gmelin	He'upueo	I		•	•				•		
	Aira caryophyllea L.	Silver hairgrass	A		•					•		
	Andropogon virginicus L.	Broomsedge, yellow bluestem	A		•		•			•		
	Bothriochloa pertusa (L.) A. Camus	Pitted beardgrass	A					•	•	•		
	Brachiaria mutica (Forsk) Staph.	Paragrass, California grass	A					•	•			•
	Bromus hordeaceus L.	Soft chess	A		•					•		
	Cenchrus ciliaris L.	Buffelgrass	A		•	•		•	•	•	•	•
	Cenchrus echinatus L.	Common sandbur	A					•	•		•	•
	Chloris barbata (L.) Sw.	Swollen fingergrass, mau'u lei	A					•	•		•	•
	Chloris divaricata R. Br.	Stargrass	A					•	•			•
	Chloris radiata (L.) Sw.	Radiate fingergrass	A					•				
	Chloris virgata Sw.	Feather fingergrass	A								•	
	Chrysopogon aciculatus (Retz.) Trin.	Golden beardgrass, manienie 'ula, pilipili	A				•			•		
	Coix lachryma-jobi L.	Job's tears, Pu'ohe'ohe	A									•
	Cynodon dactylon (L.) Pers.	Bermuda grass	A					•	•		•	•
	Dactyloctenium aegyptium (L.) Willd.	Beach wiregrass	A			•				•		
	Dicanthelium cf. *blahdii*		A									•
	Dicanthelium cf. *pertusum*	Hurricane grass	A								•	

Family	Scientific name	Common names	Status	Federal Status	Lualualei Branch: Native vegetation			Alien vegetation			West Loch	Waikele
					1	2	3	1	2	3		
	Digitaria ciliaris (HBK) Henr.	Henry's crab grass	A					•	•			
	Digitaria fuscescens (K. Presl) Henr.	Creeping kukaepua'a	A					•	•	•		
	Digitaria insularis (L.) Mez ex Ekman	Sourgrass	A			•		•	•	•	•	•
	Echinochloa crus-galli (L.) P. Beauv.	Barnyard grass	A						•	•		
	Eleusine indica (L.) Gaertn.	Wiregrass	A							•	•	•
	Eragrostis cilianensis (All.) Link	Stinkgrass	A								•	
	Eragrostis grandis Hillebr.	Kawelu	E		•	•	•			•		
	Eragrostis pectinacea (Michx.) Nees	Carolina lovegrass	A								•	
	Eragrostis tenella (L.) Beauv.	Lovegrass	A					•	•		•	•
	Heteropogon contortus (L.) P. Beauv. Ex Roem. & Schult.	Pili, twisted beardgrass	I		•	•			•	•		
	Leptochloa uninervia (Pres) Hitchc. & Chase	Judd grass	A								•	
	Melinis minutiflora Beauv.	Molasses grass	A		•	•	•		•	•		
	Melinis repens (Willd.) Zizka	Natal redtop	A		•	•	•	•	•	•	•	•
	Oplismenus hirtellus (L.) P. Beauv.	Basketgrass, honohono kukui	A		•	•	•	•	•	•		
	Panicum beecheyi Hook. & Arnott		E		•	•				•		
	Panicum maximum Jacq.	Guinea grass	A			•		•	•	•	•	•
	Panicum nephelophilum Gaud.	Konakona	E			•				•		
	Panicum sp.		A								•	•
	Paspalum conjugatum Bergius	Hilo grass	A		•	•	•		•	•		•
	Paspalum fimbriatum Kunth	Fimbriate paspalum	A						•	•		
	Paspalum scrobiculatum L.	Ricegrass	I			•			•	•		
	Pennisetum polystachion (L.) Schult.	Feathery pennisetum	A									•
	Pennisetum purpuraeum Schumach	Napier grass	A									•
	Setaria parviflora (Poir.) Kerguélen	Yellow foxtail	A		•	•	•	•	•	•		
	Setaria verticullata (L.) P. Beauv.	Bristly foxtail	A					•	•	•	•	
	Sporobolus diander (Retz.) Beauv.	Indian dropseed	A						•			
	Sporobolus indicus (L.) R. Br.	Smutgrass, West Indian dropseed	A		•					•		
	Vulpia bromoides (L.) S.F. Gray	Brome fescue	A		•	•	•			•		
SMILACEAE	*Smilax melastomifolia* Sm.	Hoi kuahiwi	E			•	•					

LIST OF PLANTS AT NAVAL MAGAZINE LUALUALEI

					Lualualei Branch							
Family	Scientific name	Common names	Status	Federal Status	Native vegetation			Alien vegetation			West Loch	Waikele
					1	2	3	1	2	3		
TYPHACEAE	*Typha* sp.	Cattail	A								*	

Status:
A – Alien (Exotic, Non-indigenous)
I – Indigenous
E – Endemic

Federal Status:
E – Endangered
T – Threatened
C – Candidate (Threatened or Endangered)
PT/PE – Proposed Threatened or Proposed Endangered
SOC – Species of Concern

Native Vegetation:
1 – Cliff Communities
2 – Lowland Forest/Shrubland
3 – Summit Crest Vegetation

Alien Vegetation:
1 – Kiawe/Koa Haole Scrub
2 – Koa Haole Forest
3 – Mixed Alien Forest

C5 – O‘AHU ‘ELEPAIO SURVEYS NAVAL MAGAZINE, LUALUALEI BRANCH HAWAI‘I (NAVFAC PAC 2003E)

This page is intentionally left blank.

O‘ahu ‘Elepaio Surveys
Naval Magazine, Lualualei Branch, Hawaii

Spring 2003

Prepared by:
Environmental Planning Division
Pacific Division Naval Facilities Engineering Command

Prepared for:
Commander, Navy Region Hawaii

This page is intentionally left blank.

Introduction

The O'ahu 'elepaio (*Chasiempis sandwichensis ibidis*) is a monarch flycatcher endemic to O'ahu (Figure 1). These birds were once widespread in a variety of forest types at all elevations on the island, but are now found only in mid-elevation forests in portions of the Koolau and Waianae Mountains. Within these forests, they are found mostly in habitat along streambeds that support trees offering a tall canopy, with lower vegetation providing a well-developed understory. 'Elepaio have adapted relatively well to disturbed forests dominated by introduced plants, so forest structure, rather than species composition, appears to be more important for the birds (VanderWerf *et*. *al*. 1997, VanderWerf 1998, VanderWerf *et*. *al*. 2001).

The most common native plants where 'elepaio occur are ohia (*Metrosideros polymorpha*), papala kepau (*Pisonia umbellifera*), lama (*Diospyros sandwicensis*), mamaki (*Pipturus albidus*), lonomea (*Sapindus oahuensis*), hama (*Antidesma platyphyllum*), and alaa (*Pouteria sandwicensis*). The most common introduced plants are guava (*Psidium guajava*), strawberry guava (*P. cattleianum*), kukui (*Aleurites moluccana*), mango (*Mangifer indica*), christmasberry (*Schinus terebinthifolius*), and ti (*Cordyline terminalis*) (VanderWerf *et*. *al*. 1997, VanderWerf 1998).

The number of O'ahu 'elepaio has decreased to a point where it is now thought to occupy less than four percent (about 4,464 hectares (11,600 acres)) of its original range. The reasons for this decline include disease (predominantly avian pox and malaria) and predation of eggs, nestlings, and incubating females by introduced mammals, especially rats. Other known threats include storms with high winds that destroy nests, and habitat degradation and loss caused by human impacts and wild, non-native pigs. The total population on O'ahu in 2001 was estimated to be 1,982, with 458 birds estimated by the U. S. Fish and Wildlife Service (USFWS) to live on Naval Magazine Pearl Harbor, Lualualei Branch (NAVMAG LLL) lands. In response to documented declining populations and in accordance with the Endangered Species Act, USFWS listed the species as endangered in April 2000 and, subsequently, designated critical habitat in December 2001.

The critical habitat designation recognizes five distinct "units" of critical habitat for the O'ahu 'elepaio totaling 26,661 hectares (65,879 acres). Unit 1 (Northern Wai'anae Mountains) comprises a total of 4,454 hectares (11,005 acres); and Unit 2 (Southern Wai'anae Mountains) comprises a total of 2,422 hectares (5,985 acres). Although portions of NAVMAG LLL lie within both units, Unit 2 contains the second largest O'ahu 'elepaio population on the O'ahu (USFWS 2001), and it is believed to contain the greatest number of 'elepaio found on Navy lands. Accordingly, this survey focuses on those lands within Unit 2. The area of Unit 2 critical habitat that extends into NAVMAG LLL is 616 hectares (1,522 acres), and is "… is bounded on the north by Kolekole Pass, and on the east, west and south by forest edge created by human actions" (USFWS 2001).

In order to meet objectives specified in the Integrated Natural Resource Management Plans (INRMP) for NAVMAG LLL, ‘elepaio surveys for range and numbers should be conducted and recovery actions implemented. Currently, there is no USFWS Recovery Plan, however there is a USFWS Draft Revised Recovery Plan for Hawaiian Forest Birds (Version: August, 2003). According to the Draft Recovery Plan, recovery actions for O’ahu ‘elepaio should include, but are not limited to: control of alien nest predators, protection of remaining forest from development and fire, research on disease resistance and transmission, and population surveys and monitoring.

Methodology

‘Elepaio are highly territorial, especially during the months of January through May (the nesting season). A male will generally maintain his territory by challenging any other male who sings within that territory or nearby. This behavior provides a means whereby the birds can be counted. The survey methodology employed in this survey follows techniques developed by Dr. Eric VanderWerf of USFWS (VanderWerf, et. al. 2001), a well recognized ‘elepaio expert. ‘Elepaio song is played from a handheld tape player every 100 to 150 meters along a transect line. On hearing the recorded song, males come to investigate the “intruder,” making them easier for the surveyor to observe.

Accordingly, the Naval Magazine surveys were conducted during February, March and April of 2003 in the Kauhiuhi subdistrict. Throughout all surveys, Trimble GeoExplorer CE Global Positioning Units (GPS) were used to map transects walked. Whenever an ‘elepaio was observed or heard, a GPS waypoint was recorded and the dominant vegetation in the surrounding area was described.

Results

Surveys for O‘ahu ‘elepaio were conducted on 3 February; 3, 4, 7, 10 - 13, and 19 March; and 17 April 2003. A total of five elepaio (3 auditory, 2 visual) were recorded during the survey (Figure 1).

The most commonly seen native plant species observed in areas where ‘elepaio were recorded are kaulu (*Sapindus oahuensis*), alahee (*Psydrax odorata*), olopua (*Nestegis sandwichensis*), and papala (*Charpentiera obovata*). The most commonly observed introduced plants are kukui (*Aleurites moluccana*), Australian red cedar (*Toona ciliata*), christmasberry (*Schinus terebinthifolius*), and ti (*Cordyline terminalis*).

Discussion and Recommendations

The areas where ‘elepaio were observed are dominated by introduced plant species, indicating that these birds can survive in sub-optimal habitat. U. S. Department of Agriculture, Wildlife Services (WS) personnel had observed several birds the previous year (2002) in the same areas where ‘elepaio were observed during this 2003 study. It is a good possibility that these areas are territories of individual ‘elepaio. It is

recommended that additional surveys be conducted during the months of December, January, and February of FY04 and FY05, employing the same methods outlined above, to determine if these areas are the territory of a breeding pair or a territory of a bachelor ‘elepaio. If these territories harbor breeding pairs, efforts should be made to locate and monitor the actual nests. Given that it has been shown that rodent control decreases predation on artificial tree nests by 45 percent (VanderWerf 2000), predator control methods could then be directly targeted to areas immediately around the nest. WS is prepared to control rodents during FY04 within LLL with snap traps and diphacinone (an anticoagulant rodenticide) bait stations (FY03 cost = $11,981). In tandem with predator control, population surveys should be conducted to determine the effectiveness of the actions. These efforts are necessary to assist in the recovery of O‘ahu ‘elepaio because, in experimental trials elsewhere on O‘ahu, these rodent control actions have resulted in an 85 percent increase in the nest success and a 127 percent increase in fledglings per pair compared to control areas (VanderWerf 1999).

Literature Cited

Shallenberger, R. J. and G. K. Vaughn. 1978. Avifaunal survey in the central Ko‘olau Range, Oahu. Ahuimanu Production, Honolulu, Hawaii.

United States Fish and Wildlife Service. 2001. Endangered and threatened wildlife and plants: determination of critical habitat for the Oahu elepaio (Chasiempis sandwichensis ibidis): Final Rule. Federal Register 66(237): 63751-63782.

VanderWerf E. A. 1998. ‘Elepaio (Chasiempis sandwichensis). *In* The Birds of North America, no. 344 (A. Poole and F. Gill, Eds.). The Academy of Natural Sciences, Philadelphia, PA, and the American Ornithologists’ Union, Washington, D.C.

VanderWerf, E. A. 1999. Predator control, disease, and demography of the O‘ahu ‘elepaio. I*n* Hawaii Non-Game Management Program, Job Progress Report, 1 August 1998 through 31 July 1999. Division of Forestry and Wildlife, Hawaii. 18pp.

VanderWerf, E. A. 2000. Rodent control decreases predation on artificial nest in O‘ahu ‘elepaio habitat. Journal of Field Ornithology, 72(3):448-457.

VanderWerf, E. A., A. Cowell, and J. L. Rohere. 1997. Distribution, abundance, and conservation of O‘ahu ‘Elepaio. Wilson Bulletin 113: 10-16

VanderWerf E. A., Joby L. Rohrer, David G. Smith, and Matthew D. Burt. 2001. Current distribution and abundance of the O‘ahu ‘elepaio. Wilson Bulletin 113(1): 10-16.

Figure 1. Adult O‘ahu ‘elepaio (*Chasiempis sandwichensis*).

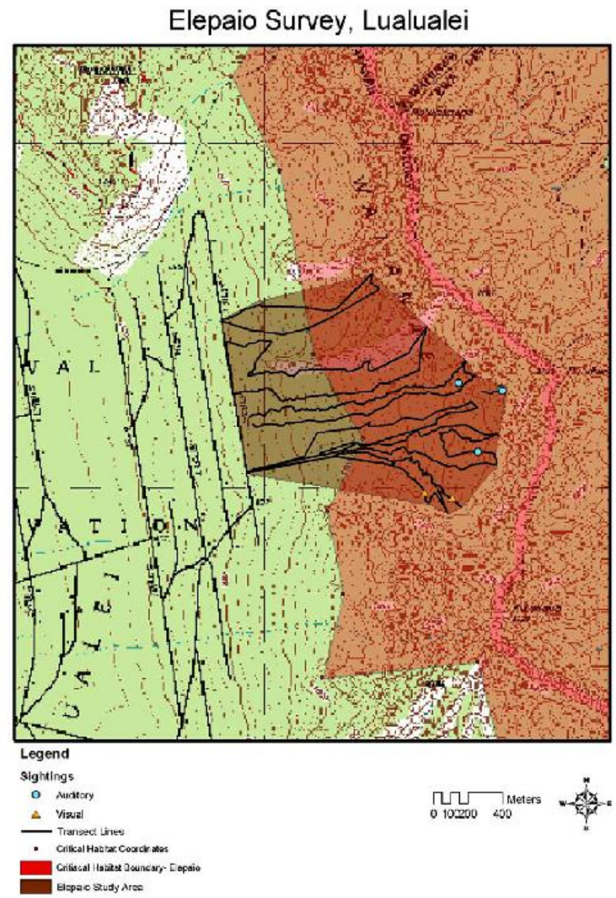


Figure 2. Locations of ‘elepaio study area, transect lines and sightings within NAVMAG LLL. The red-shaded area is the critical habitat boundary that encompasses the study area.

C6 – NAVAL MAGAZINE LUALUALEI ARTHROPOD REPORT (NAVFAC PAC 2007A)

This page is intentionally left blank.

Naval Magazine Lualualei Arthropod Report
March 2007
Cory Campora, NAVFAC Pacific

Introduction

Naval Magazine (NAVMAG) Lualualei contains more arthropod species endemic to Hawaii than any other property owned by the Navy. A year long arthropod study conducted at NAVMAG Lualualei in 1995 by entomologists from the Bishop Museum found that 21 percent of the 637 total insects and related arthropods collected were native to Hawaii (Bishop Museum 1997). The results from the 1995 survey also indicated that Halona Valley supports the greatest amount of native insects when compared to other areas surveyed within NAVMAG Lualualei. Of specific interest at Halona Valley is *Rynchogonus welchii*, a rare weevil that has never been collected anywhere else in the world and has not been found alive since 1976 (Samuelson 2003).

Puhawai Valley, also located in Lualualei, is significant due to the fact that it currently contains the area's only permanent stream. This location was also surveyed by the Bishop Museum in 1995. Although no native Hawaiian damselflies (genus *Megalagrion*) were detected at Puhawai Stream, the upper reaches of the stream were found to be free of poeciliid fish (family Poeciliidae, e.g. mosquito fish), one of the major predators of *Megalagrion* (Englund 1999). The upper portions of Puhawai Stream are therefore considered ideal habitat for *native Hawaiian damselflies.*.

Presented in this report are results from surveys conducted in 2006 at NAVMAG Lualualei by Naval Facilities Engineering Command (NAVFAC) Pacific. Halona valley was surveyed for arthropods, and the Puhawai Falls area was surveyed for endemic Hawaiian damselflies.

Methods

Halona Valley

Exoskeletal fragments of *R. welchii* were searched for in the *Sapindus oahuensis* leaf litter for a period of approximately 2 hours on 21 March 2006.

A malaise trap was set up on 28 June 2006 in a clearing at the top end of the Halona exclosure. Ten pitfall traps were also set up uniformly throughout the exclosure on 28 June 2006. Antifreeze was used as the killing agent in all pitfall traps. After a period of 7 days, the malaise trap was dismantled and pitfall traps were taken out of the ground. All trapped insects were preserved in methanol, and taken back to the laboratory for identification.

Puhawai Stream

Puhawai stream was hiked from the bridge at Kokole Road up to Puhawai Falls (see Figure 1) on 30 August 2006. Observations were made along the stream every 10-20 meters on the presence/absence of adult damselfies and damselfly predators (poeciliid fish, prawns, and frogs). Portions of the stream above Puhawai falls were surveyed in similar fashion on 30 October 2006.

Results

Halona Valley

No exoskeletal fragments or other evidence of *R. welchii* were found in the *Sapindus* leaf litter and soil.

All arthropods collected from the traps in the Halona exclosure are listed in Table 1. A total of 102 species from 14 orders were collected. Many specimens were not able to be identified beyond the taxonomic level of family, and in some cases order, due to the limited time and resources available. A conservative estimate of the percentage of endemic and indigenous arthropods collected from the survey is 8 percent.

Further confirmation is needed on identification; however, the following arthropods represent possible new records for Halona Valley: 1) *Talitroides topitum*, alien terrestrial amphipod, 2) *Anthrax distigma,* alien bee fly, 3) Entomobryidae sp, elongate bodied springtails (possibly endemic), 4) *Solenopsis papuana*, alien ant species, 5) *Hyposmocoma* sp., small endemic moth, 6) Thiraptera sp., alien thrip, and 7) *Lasioglossum smeathmanellum*, an alien solitary bee from the family Halictidae.

Puhawai Stream

No adult damselflies, alien or endemic, were observed along Puhawai Stream from the Kolekole Road bridge up to Puhawai Falls. A damselfly was sighted near the stream above the falls; however a determination on the species could not be made.

The Tahitian prawn, *Macrobrachium lar*, was seen in the stream near the Kolekole Road bridge, but was not detected further than 10 meters upstream from this location (see Figure 1). Approximately 100 meters upstream from the bridge, the stream flowed over exposed rock. This apparently acts as a fish barrier since no fish were observed upstream from this location. The wrinkled frog, *Rana rugosa*, was common throughout the stream up to Puhawai Falls. The frog was not observed in the stream above the falls.

Table 1. Arthropods collected at Halona Valley during 2006 survey.

No.	Taxonomic ID	Common Name	Origin	Method Trapped	Notes
	Class: Arachnida				
	Order: Araneae	spiders			
1	Araneae sp. (A)		?	pitfall	
2	Araneae sp. (B)		?	pitfall	
3	Araneae sp. (C)		?	pitfall	
4	Araneae sp. (D)		?	pitfall	
5	Araneae sp. (E)		?	pitfall	
6	Araneae sp. (F)		?	malaise	
7	Araneae sp. (G)		?	malaise	
	Family: Linyphiidae				
8	Linyphiidae sp.		?	pitfall	(*Orsonwelles* sp.?)
	Class: Crustacea	crustaceans			
	Order: Amphipoda	amphipods			
	Family: Talitridae	landhoppers			
9	Genus species: *Talitroides topitotum*		alien	pitfall	new record for Halona
	Order: Isopoda	isopods, sowbugs			
	Family: Philosciidae				
10	Genus species: *Australophiloscia societatis*		indigenous	pitfall	
	Class: Insecta	insects			
	Order: Blattaria	cockroaches			
	Family: Blaberidae				
11	Genus species: *Pycnoscelus indicus*	burrowing cockroach	alien	malaise	
	Order: Coleoptera	beetles			
12	Coleoptera sp		?	pitfall	

No.	Taxonomic ID	Common Name	Origin	Method Trapped	Notes
	Family: Coccinellidae	Ladybird beetles, ladybugs			
13	Genus species: *Halmus chalybeus*		alien	malaise	
14	Genus species: *Olla v-nigrum*		alien	malaise	
15	Genus species: *Nephus bilucernarius*		alien	malaise	
	Family: Elateridae	click beetles			
16	Elateridae sp.		?	malaise	
	Family: Mycetophagidae	hairy fungus beetles			
17	Mycetophagidae sp.		?	pitfall	
	Family: Nitidulidae	sap beetles			
18	Nitidulidae sp. (A)		?	pitfall	
19	Nitidulidae sp. (B)		?	pitfall	
	Family: Staphylinidae	rove beetles			
20	Staphylinidae sp.		?	pitfall	
	Order: Collembola	springtails			
	Family: Entomobryidae	elongate bodied springtails			
21	Entomobryidae sp. (A)		?	pitfall	possible new record for Halona
22	Entomobryidae sp. (B)		?	pitfall	possible new record for Halona
	Order: Diptera	flies			
	Suborder: Brachycera	short horned flies (e.g. fruit flies, house flies, etc.)			
23	Brachycera sp. (A)		?	malaise	
24	Brachycera sp. (B)		?	malaise	
25	Brachycera sp. (C)		?	malaise	

No.	Taxonomic ID	Common Name	Origin	Method Trapped	Notes
26	Brachycera sp. (D)		?	malaise	
27	Brachycera sp. (E)		?	malaise	
28	Brachycera sp. (F)		?	malaise	
29	Brachycera sp. (G)		?	malaise	
30	Brachycera sp. (H)		?	malaise	
31	Brachycera sp. (I)		?	malaise	
32	Brachycera sp. (J)		?	malaise	
33	Brachycera sp. (K)		?	malaise	
34	Brachycera sp. (L)		?	pitfall	
	Family: Bombyliidae	bee flies			
35	Genus species: *Anthrax distigma*		alien	malaise	New record for Halona
	Family: Calliphoridae	blow flies			
36	Calliphoridae sp.		alien	pitfall	
	Family: Dolichopodidae	long legged flies			
37	Dolichopodidae sp. (A)		?	pitfall	(*Campscinemus* sp.?)
38	Dolichopodidae sp. (B)		?	malaise	
	Family: Tachinidae	tachinid flies			
39	Tachinidae sp. (A)		alien	pitfall	
40	Tachinidae sp. (B)		alien	malaise	
41	Tachinidae sp. (C)		alien	malaise	
42	Tachinidae sp. (D)		alien	malaise	
43	Tachinidae sp. (E)		alien	malaise	
44	Tachinidae sp. (F)		alien	malaise	
	Family: Syrphidae				
45	Syrphidae sp. (A)		?	malaise	
46	Syrphidae sp. (B)		?	malaise	
47	Syrphidae sp. (C)		?	malaise	

No.	Taxonomic ID	Common Name	Origin	Method Trapped	Notes
	Suborder: Nematocera	long horned flies (e.g. gnats, midges, mosquitoes, etc.)			
48	Nematocera sp. (A)		?	malaise	
49	Nematocera sp. (B)		?	malaise	
50	Nematocera sp. (C)		?	malaise	
51	Nematocera sp. (D)		?	pitfall	
52	Nematocera sp. (E)		?	pitfall	
	Family Chironomidae	midges			
53	Chironomidae sp.		?	malaise	
	Family: Culicidae	mosquitoes			
54	Culicidae sp.		alien	malaise	(not *Aedes albopictus*)
	Order: Hemiptera	true bugs			
	Family: Miridae	plant bugs			
55	Miridae sp (A)		?	malaise	
56	Miridae sp (A)		?	malaise	
	Family: Nabidae	damsel bugs			
57	Nabidae sp.		?	malaise	
	Order: Homoptera	hoppers, whiteflies, aphids, scale insects, etc.			
	Family: Cicadellidae	leafhoppers			
58	Cicadellidae sp. (A)		?	malaise	
59	Cicadellidae sp (B)		?	pitfall	
60	Genus species: *Nesosophryne* sp.		endemic	malaise	
61	Genus species: *Sophonia rufofascia*	two spotted leafhopper	alien	malaise	
	Family: Cixiidae	cixiid planthoppers			
62	Genus species: *Oliarus* sp.		endemic	pitfall and malaise	
	Family: Delphacidae	delphacid planthoppers			

No.	Taxonomic ID	Common Name	Origin	Method Trapped	Notes
63	Delphacidae sp.		?	malaise	
	Family: Flatidae	flatid planthoppers			
64	Flatidae sp.		?	malaise	
	Family: Psyllidae	psyllids			
65	Psyllidae sp.		?	malaise	
	Family: Tingidae	lace bugs			
66	Tingidae sp.		?	malaise	
	Order: Hymenoptera	bees, wasps, ants, etc…			
	Superfamily: Evanoidea, Ichneumoidea, Chalcidoidea, Cyniooide, and Proctotrupoidea	parasitic wasps			
67	sp. (A)		?	malaise	
68	sp. (B)		?	malaise	
69	sp. (C)		?	malaise	
70	sp. (D)		?	malaise	
71	sp. (E)		?	malaise	
72	sp. (F)		?	malaise	
73	sp. (G)		?	malaise	
74	sp. (H)		?	malaise	
75	sp. (I)		?	malaise	
76	sp. (J)		?	malaise	
77	sp. (K)		?	malaise	
78	sp. (L)		?	malaise	
79	sp. (M)		?	malaise	
80	sp. (N)		?	malaise	
81	sp. (O)		?	malaise	
82	sp. (P)		?	malaise	
83	sp. (Q)		?	malaise	
84	sp. (R)		?	malaise	

No.	Taxonomic ID	Common Name	Origin	Method Trapped	Notes
85	sp. (S)		?	malaise	
86	sp. (T)		?	malaise	
87	sp. (U)		?	pitfall	
88	sp. (V)		?	pitfall	
89	sp. (W)		?	pitfall	
	Family: Apidae	honey bees, bumble bees			
90	Genus species: *Apis mellifera*	honey bee	alien	malaise	
	Family: Halictidae	yellow faced bees			
91	Genus species: *Lasioglossum smeathmanellum.*	solitary bee	alien	malaise	new record for Lualualei Valley
	Family: Formicidae	ants			
92	Genus species: *Solenopsis papuana*		alien	pitfall	new record for Halona
	Family: Vespidae	wasps and hornets			
93	Vespidae sp.		?	malaise	
	Order: Lepidoptera	butterflies and moths			
	(Microlepidoptera)	very small moths			
94	sp. (A)		?	malaise	
95	sp. (B)		?	malaise	
96	sp. (C)		?	malaise	
97	sp. (D)		?	pitfall	
	Family: Cosmopterigidae				
98	Genus species: Hyposmocoma sp.		end.	pitfall	possible new record for Halona
	Order: Nueroptera	lacewings, antlions, snakeflies			
	Family: Chrysopidae	green lacewings			
99	Chrysopidae sp.		?	malaise	

No.	Taxonomic ID	Common Name	Origin	Method Trapped	Notes
	Family: Hemerobiidae	brown lacewings			
100	Hemerobiidae sp.		?	malaise	
	Order: Orthoptera	grasshoppers, crickets			
	Family: Tettigoniidae	katydids			
101	Tettigoniidae sp.		alien	malaise	
	Order: Thiraptera	thrips			
102	Thiraptera sp.			pitfall	new record for Halona

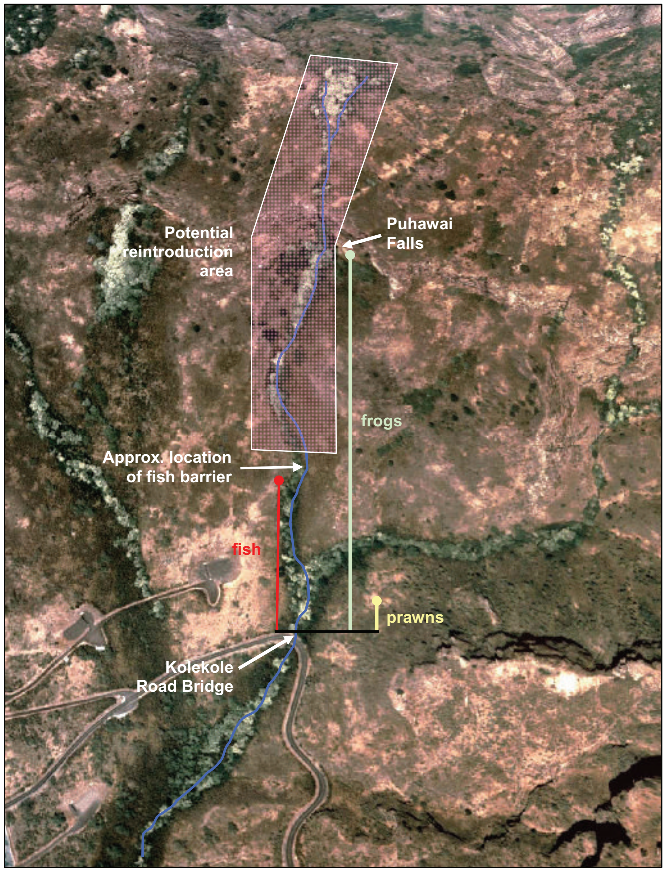


Figure 1. Distribution of damselfly predators in Puhawai Stream near Puhawai Falls and potential reintroduction area of *Megalagrion xanthomelas*.

Discussion

The occurrence of native Hawaiian insects is in general highly correlated to the presence of significant stands of native Hawaiian plants (Bishop Museum 1997). The 2001 NAVMAG Pearl Harbor Integrated Natural Resources Management Plan (INRMP) states that, in Halona Valley, certain patches of land up to an acre can be 60-70 percent vegetated by native plants. This is undoubtedly one of the factors that contributes to Halona Valley's high percentage of native insect fauna. A small fence, or exclosure, was constructed on one of the ridges in Halona Valley in 1994 to protect a forest of native trees and a stand of the endangered plant *Abutilon sandwicense*. The one acre exclosure prevents feral ungulates (e.g. goats and pigs) from entering and degrading the area, and it is a site for various ongoing management programs such as the outplanting of other native Hawaiian species and the mechanical and chemical control of invasive plants. These activities also benefit the native arthropods in the area.

The only species of Hawaiian arthropods currently listed as endangered are 1) *Manduca balckburni*, Blackburn's sphinx moth; 2) *Adelocosa anops*, the Kauai cave wolf spider; 3) *Spelaeorchestia koloana*, the Kauai cave amphipod; and 4) eleven species of Hawaiian picture-winged flies (*Drosophila algaia*, *Drosophila hemipeza*, *Drosophila montgomeryi*, *Drosophila obatai*, *Drosophila substenoptera*, *Drosophila tarphytrichia*, *Drosophila heteroneura*, *Drosophila ochrobasis*, *Drosophila mulli*, *Drosophila musaphilia*, and *Drosophila differens*.) Over a hundred years ago, the Blackburn's sphinx was common on Oahu and probably did occur in some lowland areas of Lualualei; however, today it is only found on Hawaii, Maui, and Kahoolawe. The Kauai cave wolf spider and cave amphipod are limited to Kauai. Seven of the endangered Hawaiian picture-winged flies occur on Oahu, but none have been documented to occur within NAVMAG Lualualei. Some species, however, do occur in the Waianae Range and have host plants that occur in Lualualei. Due to the fact that the collection of these species requires very specific techniques and that no one has ever specifically searched for them in Lualualei, there is a remote possibility that some of the federally listed Hawaiian *Drosophila* species may be present at Lualualei.

Rynchogonus welchii is not endangered, but it is extremely rare. It is believed to still be alive in Halona Valley based on the fact that in 1995 entomologists from the Bishop Museum found many fragments of the adult weevils' exoskeletons and estimated their age to be less than a year old. It is disconcerting that no fragments were found in 2006, however, this is not necessarily conclusive evidence that *R. welchii* is extinct. It could be that searching was not extensive enough, since in 1995 the Bishop Museum spent 30 man-hours searching the soil and in 2006 NAVFAC Pacific spent only 2 man-hours. Nonetheless, this native Hawaiian weevil does face many threats, perhaps the greatest of which is predation by invasive species. Peafowl are common in Halona Valley, and even though *R. welchii* is nocturnal, its larvae, or grubs, live in the soil where the peafowl forage. Unfortunately, the fence does not exclude peafowl from the managed area of Halona Valley, so *R. welchii* remains at risk within the exclosure. Another concern is the arrival of the invasive ant, *Solenopsis papuana*, in Halona Valley. This ant species can form large populations of interconnected colonies that occupy acres of land and can potentially have significant negative impacts on the forest environment. While large-scale management of invasive ants in forest systems is extremely difficult and impractical; it may be possible to control them in a small area such as the Halona exclosure. Continued monitoring of *S. papuana* and other ant species and their impacts on the native arthropod fauna will provide valuable information as to the need for their control in this area.

Puhawai stream has been described as one of the most pristine permanent mountain streams that exists in the Waianae Range today (D. A. Polhemus, Hawaii DLNR, Aquatic Resources, pers. comm. 2006). At least five species of native Hawaiian damselflies formerly occurred at Lualualei, although none have been found there in recent years. Our surveys indicated that the upper reaches of Puhawai stream are ideal habitat for species of *Megalagrion* due to the natural fish barrier that is present about 100 meters upstream from the Kolekole Road bridge. The wrinkled frog is present in the stream up to Puhawai Falls; however, it not considered a primary predator of damselflies (Englund 1999).

One of the species that is particularly suited for Puhawai Stream is *Megalagrion xanthomelas*, the Hawaiian orangeblack damselfly. This species is currently considered a candidate species, meaning that it has been identified as possibly eligible for protection under the Endangered Species Act (ESA) and that scientific review is underway. Should it be determined that such protection is warranted, it will be “proposed” for listing as endangered or threatened under that Act. As a candidate species it receives no statutory protection under the ESA. Should the species be listed as proposed or endangered, the upper reaches of Puhawai Stream may be considered for designation as “Critical Habitat” even though *M. xanthomelas* is not currently established there. This would result in the application of restrictive land use policies that are not presently required. Timely conservation efforts on behalf of *M. xanthomelas* may obviate the need for ESA listing.

In their 1997 report, entomologists from the Bishop Museum recommended the introduction of *M. xanthomelas* to Puhawai Stream because on Oahu it is limited to a single population that tenuously exists within a drainage ditch at Tripler Army Medical Center (TAMC). Translocation efforts of *M. xanthomelas* from TAMC to Puhawai Stream were initiated, but ultimately they were never brought to fruition due to regulatory concerns. The Bishop Museum has recently submitted another proposal to the U.S. Fish and Wildlife Service to translocate *M. xanthomelas* from TAMC to sites in Waimea and Kalaeloa, and they have also expressed interest again in introducing them to Puhawai Stream. The translocation of *M. xanthomelas* to Puhawai Stream would provide an excellent opportunity for the Navy to be involved in Cooperative Conservation as mandated by Executive Order Facilitation of Cooperative Conservation (August 2004) because it would

involve collaborative actives between the U.S. Navy, U.S. Army, U.S. Fish and Wildlife Service, State Department of Land and Natural Resources, and the Bishop Museum. This project would also satisfy the State of Hawaii’s goal of interagency cooperation in developing vision and policies for stream conservation actions (Hawaii DLNR 2005). The actual translocation of adults and nymphs of *M. xanthomelas* to Puhawai Stream would be carried out by the Bishop Museum. The Navy’s role would most likely be to coordinate access to the site and assist in the translocation and subsequent monitoring.

Recommendations

1. Continue conservation projects for native plants in Halona Valley.

2. Conduct more extensive surveys for *Rynchogonus welchii* and determine its status in Halona Valley.

3. Monitor the spread of invasive ants in Halona Valley and their impact on the valley’s native Hawaiian insects.

4. Conduct surveys for endangered Hawaiian picture-winged flies in Lualualei (Note: Commander Navy Region Hawaii has allocated $23,000 for these surveys. Work is anticipated to begin in fiscal year 2008)

5. Introduce *Megalagrion xanthomelas* into the designated predator-free area of Puhawai Stream through participation in an interagency Hawaiian damselfly translocation working group.

References Cited

Bishop Museum 1997. Diversity of insects and related arthropods of the naval magazine Lualualei, Headquarters Branch, Oahu, Hawaii. 15 August. Report prepared for the U.S. Navy120 pp + 50 pp as appendices.

Englund, R. A. 1999. The impacts of introduced poecoliid fish and Odonata on the endemic *Megalagrion* (Odonata) damselfies of Oahu Island, Hawaii. Journal of Insect Conservation 3:225-243.

Hawaii Department of Land and Natural Resources 2005. Hawaii’s Comprehensive Wildlife Conservation Strategy. 734 pp.

Samuelson, G. A. 2003. Review of *Rhynchogonus* of the Hawaiian Islands (Coleoptera: Curculionidae). Bishop Museum Bulletins in Entomology 11. 107 pp.

C7 – SNAIL FAUNA OF LUALUALEI
(NAVFAC PAC 2007B)

This page is intentionally left blank.

Snail Fauna of Lualualei
March 2007
Prepared by Cory Campora, NAVFAC Pacific

Backround

Hawaii was once home to over 750 species of native land snails. Most of these species are now extinct due to shell collectors, habitat loss, and predation by invasive species. Virtually all native terrestrial snails of Hawaii are rare and in danger of extinction; however, only one genus of land snail, *Achatinella*, is federally listed as endangered. Navy-owned areas on Oahu documented to contain native snails may be found in the upper elevations of the Waianae Mountains surrounding Lualualei Naval Magazine. A number of different species of native Hawaiian snails have been discovered living in the mountains of Lualualei, (see Table 1) but perhaps the most notable of these species are the endangered snail *Achatinella mustellina*, and the extremely rare snail *Amastra cylindrica*.

Achatinella mustellina

Snails of the genus *Achatinella* are restricted to the island of Oahu. All 41 species within the genus were federally listed as endangered in 1981. As of 1993, only 20 species were still in existence (USFWS 1993). Of these surviving species, *A. mustellina* is considered the most common; however, it is not found outside of the Waianae Range, and it is still at risk of decline due to habitat loss and predation. *Achatinella mustellina* lives in trees, actively feeding on fungus from the surface of leaves at night and sealing itself to leaves or trunks for dormancy during the day. Although its historic range included lowlands, today *A. mustellina* occurs only at elevations above 400 m (1,312 ft) (HNHP 2004). It is found primarily on native trees, but may occasionally be seen on non-native plants as well. Adult snails give birth to 1 to 4 young per year. Snails are born with a shell and measure about 4.5 mm (.18 in) at birth. Growth continues for about 7 years, at which point the snail reaches sexual maturity and shell growth ceases. Mature snails have shells approximately 17-24 mm (1 in) in length with seven whorls. Whorls may either revolve to the right (dextral) or the left (sinistral). The shell color of *A. mustellina* is variable, but the typical

Figure 1. Achatinella mustellina. (Photo courtesy of: http://www.weichtiere.at/Mollusks/Schnecken/land/achat.html)

Table 1. Checklist of snails collected at NAVMAG Lualualualei, Oahu, Hawaii.

Species	Origin	Status	Areas Found[1]	Habitat	References
Achatinella mustellina	Native	Endangered	5	Native trees, some exotic trees	HNHP 1994, HNHP 2004
Achatina fulica	Exotic	Invasive	1, 2	soil	Shank 1984, HNHP 1994
Amastra cylindrica	Native	IUCN Red listed	5	*Pisonia* leaf litter, soil	HNHP 2004, NAVFACPAC Apr 2006
Bradybaena sp. (*similaris*)	Exotic	-	1, 2, 3, 5	soil	Shank 1984, HNHP 1994, HNHP 2004, NAVFACPAC Apr 2006
Euglandina rosea	Exotic	Invasive	1, 2, 5	soil	Shank 1984, HNHP 1994, HNHP 2004
Gastrocopta servilis	Exotic	-	1, 2	Leaf litter, soil	Shank 1984
Hawaiia minuscula	Exotic	-	1, 2, 3	Leaf litter, soil	Shank 1984, HNHP 1994
Lamellidea sp.	Exotic	-	1, 2, 3	Leaf litter, soil	Shank 1984,
Lamellaxis clavulinum	Exotic	-	1, 2, 3	Leaf litter, soil	Shank 1984, HNHP 1994
Lepachatina (2 species)	Native	(*L. lepida* is Red listed)	1, 2, 3, 5	Leaf litter, soil	Shank 1984, NAVFACPAC Apr 2006
Lymneidae sp.	Native (presumed)		4	Freshwater stream	NAVFACPAC Oct 2006
Melanoides tuberculata	Exotic	-	1, 3, 4	Freshwater stream, seep	Shank 1984, NAVFACPAC Oct 2006
Philonesia sp.	Native	-	1	Leaf litter of *Osmanthus sandwichensis*	Shank 1984, HNHP 1994
Physa virgata	Exotic	-	1	Freshwater seep, damp soil	Shank 1984
Prosopeas achatinaceum	Exotic	-	1, 2, 3	Leaf litter, soil	Shank 1984
Succinea caduca	Native	-	1, 2, 3	Leaf litter, soil	Shank 1984, HNHP 1994
Tornatellides sp.	Native	-	1, 2, 3	Leaf litter, soil, dead logs	Shank 1984, HNHP 1994

[1] 1 = Mikiula subdistrict, 2 = Kauhiuhi subdistrict, 3 = Lower Puhawai subdistrict, 4 = Upper Puhawai subdistrict, 5 = PuuHapapa

appearance is shown in Figure 1 – dark brown with a light revolving band. The longest documented lifespan of *A. mustellina* is 11 years (Hadfield and Mountain 1980). Survey results from Lualualei Valley indicate that there are no *A. mustellina* at intermediate to low elevations within the valley (Shank 1984). The endangered snail has been found only at various high elevation locations along the Waianae summit ridge (see Figure 2). Two of these locations fall within the boundaries of Lualualei Naval Magazine: Puu Hapapa and Puu Kumakalii (Hadfield and Mountain 1980, HNHP 1994, HNHP 2004).

Amastra Cylindrica

Amastra cylindrica, was thought to be extinct up until 1995 when it was discovered in a small area within a hanging gulch on the Pearl Harbor Naval Magazine Lualualei side of Puuhapapa (HNHP 2004). Currently it is not known to occur anywhere else outside of this area, and it is being considered for inclusion on the endangered species list (Vincent Costello, pers. comm.). This species is considered a ground dwelling snail, often found within the leaf litter of the forest floor or among rocks where it feeds on decaying leaves. Live snails have uniformly dark brown shells (see Figure 3) and are sometimes covered with dirt, rendering them camouflaged against the substrate. As with other terrestrial snails, after the snail has died its shell begins to lose color. This whitening starts with a spiraling band and slowly expands over time until the entire shell is pale gray or white. The color of a remnant shell is consequently a good indicator of how long the shell has been empty. Studies conducted in the laboratory on the life history of *A. cylindrica* indicate that they require approximately 2 years to reach maturity, after which they produce offspring at a rate of one snail every 12 days. Under controlled conditions they were found to have a total life span of at least 4 years.

The area of Puuhapapa where *A. cylindrica* has been found is relatively small, measuring approximately 15 by 15 meters, and is dominated by a few large *Pisona umbellifera* which create a dense canopy (see Figure 4.). Surveys of the *Amastra* population at this site were conducted in February and April of 2004 by the Hawaii Natural Heritage Program (HNHP). After the February survey, a rock slide occurred at the site and had an apparent negative impact on the snail population. The 2004 HNHP report states that the average time it took to find a living *Amastra* was 11 minutes on the first visit and 14 minutes on the second visit. It was also reported that evidence of rat predation was seen in some of the empty *Amastra* shells and an empty shell of *Euglandina rosea*, another predator of *Amastra*, was found. Surveys conducted in 2006 by NAVFAC Pacific at the site confirmed that the population of *Amastra* was still viable, however it took much longer to find living snails (18-30 minutes per snail). Numerous empty *Amastra* shells were also found, some of which, judging from the color, had been empty less than year. It was also noted in 2006 that the site was under increasing pressure from invasive weeds. Furthermore, the snails found in 2006

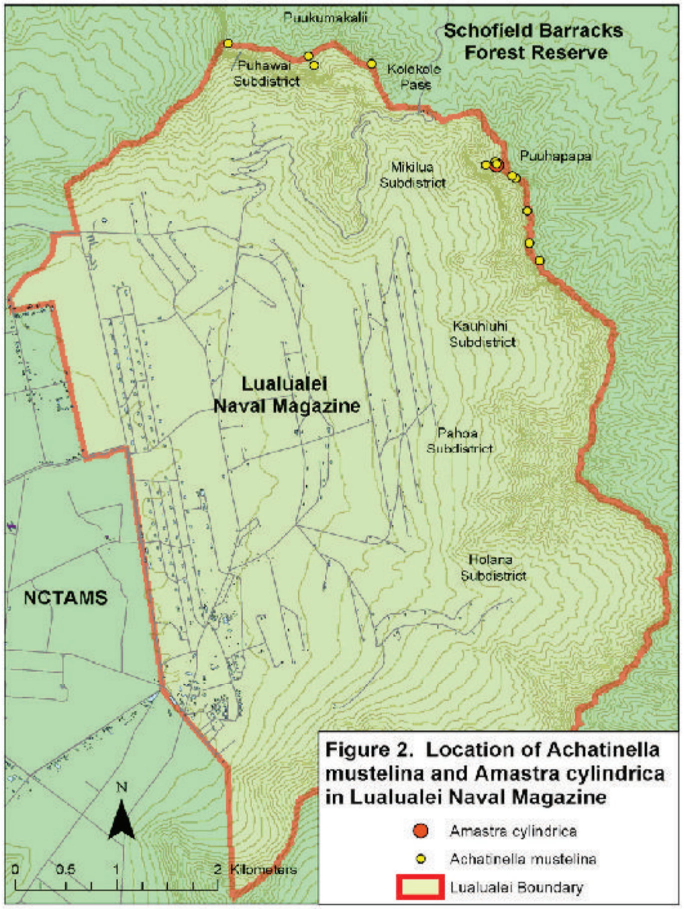


Figure 2. Location of Achatinella mustelina and Amastra cylindrica in Lualualei Naval Magazine

Note: Locations based on GIS data from the 2004 Hawaii Natural Heritage Program Report

Figure 3. Empty shells (approx. 1 year or less) of *Amastra cylindrica*.

Figure 4. Site of the *Amastra cylindrica* population at Puuhapapa, Lualualei.

were all juveniles, providing additional evidence that larger adult snails may be under severe pressure from predation by rodents.

Conservation

The greatest threats to the populations of *A. mustellina* and *A. cylidnrica* at Puuhapapa are predation from rodents and habitat degradation from invasive weeds. These threats are particularly severe to the *Amastra* due to the fact that Puuhapapa is the only known location of an extant population for this species. If no measures are implemented to lessen the risks from predation and habitat loss, evidence from recent surveys suggests that *A. cylindrica* could possibly face extinction. It is therefore recommended to fund and implement a long term predator control program at Puuhapapa. Additionally it is recommended to continue periodic monitoring of the *Amastra* and *Achatinella* populations and habitat quality and adjust the predator control program or conduct habitat improvements as necessary.

Commander Navy Region Hawaii has funded a predator control program at Puuhapapa, and has provided additional funds for snail monitoring and habitat improvements. Baiting and trapping of rodents at Puuhapapa for a period of one year has been contracted to Pono Pacific, an environmental conservation company that provides ecosystem restoration services, and was initiated in March 2007. Naval Facilities Engineering Command (NAVFAC) Pacific biologists will continue to monitor the population of *A. cylindrica* and provide control of invasive weeds in the area.

References Cited

Hadfield, M. G. and B. S. Mountain. 1980. A field study of vanishing species, *Achatinella mustellina* (Gatropoda, Pulmonata), in the Waianae Mountains of Oahu. Pacific Science 34: 345-358.

Hawaii Natural Heritage Program (HNHP). 1994. Biological inventory and management needs assessment, naval magazine, headquarters, Lualualei, Oahu, Hawaii. Hawaii Natural Heritage Program, University of Hawaii, Center for Conservation Research and Training, Honolulu, Hawaii. 105 pp + 35 pp as appendices.

Hawaii Natural Heritage Program (HNHP). 2004. Flora and fauna survey of naval magazine Pearl Harbor, Lualualei branch, Lualualei Valley, Oahu, Hawaii. Hawaii Natural Heritage Program, University of Hawaii, Center for Conservation Research and Training, Honolulu, Hawaii. 37 pp + 58 pp as appendices.

Shank, B. 1984. Malacological survey of naval magazine Lualualei, Hawaii. *In* Flora and Fauna Report of The Naval Magzine Lualualei, Oahu, Hawaii *by* Botanical Consultants, Honolulu, Hawaii. 115 pp.

U. S. Fish and Wildlife Service. 1993. Recovery plan for Oahu tree snails of the genus *Achatinella*. U.S. Fish and Wildlife Service, Portland, Oregon. 64 pp + 64 pp as appendices.

C8 – LIST OF ANIMALS AT NAVMAG PH LUALUALEI BRANCH (DON 2001B)

APPENDIX C – LIST OF ANIMALS AT NAVMAG PEARL HARBOR LUALUALEI BRANCH

Family	Scientific name	Common names	Status	Native vegetation			Alien vegetation		
				1	2	3	1	2	3
SNAILS									
ACHATINELLIDAE	*Achatinella mustellina*	Oahu Tree Snail, Pupu kuahiwi	E			•			
	Auricullela ambusta	Achatinellid land snail	E		•	•			•
	Auricullela sp.	Achatinellid land snail	E		•	•			•
	Elasmius sp.	Achatinellid land snail	E						
	Tornatellides sp.	Achatinellid land snail	E		•			•	•
ACHATINIDAE	*Achatina fulica*	Giant African snail	A		•	•		•	•
BRADYBAENIDAE	*Bradybaena similaris*	Bradybaenid land snail	A		•	•	•	•	•
HELICARIONIDAE	*Philonesia* sp.	Helicarionid land snail	E		•	•			•
STREPTAXIDAE	*Euglandina rosea*	Cannibal Snail	A		•	•	•	•	•
SUBULINIDAE	*Lamellaxis* sp.	Subulinid land snail	E						
	Unidentified subulinid snail								
SUCCINEIDAE	*Succinea* sp.	Succineid land snail	E						
ZONITIDAE	*Hawaiia minuscula*	Zonitid land snail							
ARTHROPODS (ACARI)									
ACARIDAE	*Tyrophagus putrescentiae* (Schrank)		A		•				•
ASCIDAE	*Asca aphidioides* (Linnaeus)		A		•				•
	Asca duosetosa Fox		A		•				•
	Asca quinquesetosa		A						•
BDELLIDAE	*Bdella captiosa* Atyeo		A		•				•
	Bdella distincta Baker & Balock		A		•				•
	Bdella mexicana Baker & Balock		A		•				•
	Spinibdella depressa (Ewing)		A		•				•
	Spinibdella sp.		?						•
BRACHYCTHONIIDAE	*Sellnickthonius* sp.		?						•
CALIGONELLIDAE	*Coptocheles solanii* Swift		E?						•
	Neognathus spectabilis (Summers & Schlinger)		A						•
CEPHEIDAE/ ANDREMAEIDAE	gen. sp.		?		•				•
CHEYLETIDAE	*Hemicheyletia wellsi* (Baker)		A		•				•
CRYPTOGNATHIDAE	*Favognathus goffi* Swift		E?		•				•
	Favognathus pictus (Summers & Chaudhri)		A		•				•
CTENACARIDAE	*Ctenacarus araneolus* (Grandjean)		A						•
CUNAXIDAE	*Pulaeus* n. sp.		E?		•				•
DIGAMASELLIDAE	*Dendroseius* sp.		?						•
EREYNETIDAE	*Ereynetes* ? sp.		?		•				•
EUPHTHIRACARIDAE	*Euphthiracarus* sp.		?		•				•
EUPHODIDAE	*Eupodes sigmoidensis* Strandtmann & Goff		E		•				•
GALUMNIDAE	*Pergalumna hawaiiensis* (Jacot)		E		•				•

Family	Scientific name	Common names	Status	Native vegetation			Alien vegetation		
				1	2	3	1	2	3
LAELAPIDAE	*Pseudoparasitus trincisus* Hunter		A		•				
MACROCHELIDAE	*Macrocheles muscaedomesticae* (Scopoli)		A		•				•
	Macrocheles sp. Nr. *rodriguezi* (Oliver & Krantz)		A		•				•
NANORCHESTIDAE	*Nanorchestes* sp. 1		?		•				•
	Nanorchestes sp. 2		?		•				•
NOTHRIDAE	*Nothrus* sp.		?		•				•
OLGAMASIDAE	*Gamasiphis* sp.		?		•				•
OPPIIDAE	gen. spp. (3)		?		•				•
ORIBATIDAE	gen. sp.		?		•				•
PARATYDEIDAE	*Paratydeus* sp.		?						•
PODOCINIDAE	*Podocinum sagax* (Berlese)		A		•				•
POLYASPIDIDAE?	gen. sp.		?		•				•
PYGMEPHORIDAE	*Pygmephorus* sp.		?						•
RAPHIGNATHIDAE	*Raphignathus* n. sp.		?						•
RHAGIDIIDAE	*Shibaia longisensilla* (Shiba)		A						•
SCHELORIBATIDAE	*Scheloribates* sp. nr. *oahuensis* Jacot		?		•				•
	Scheloribates spp.		?		•				•
STIGMAEIDAE	*Eustigmaeus microsegnis* (Chaudhri)		A		•				•
	Eustigmaeus ornatus Ueckermann & Meyer		A		•				•
	Eustigmaeus segnis grp.		A		•				•
	Stigmaeus n. sp.		E?		•				•
TARSONEMIDAE	*Hemitarsonemus* sp.		?						•
TYDEIDAE	*Tydeus* sp.		?						•
UROPODIDAE	gen. sp.		?		•				•
VEIGAIIDAE	*Veigaia nemorensis* (C.L. Koch)		A		•				•
ARTHROPODS (AMPHIPODA)									
TALITRIDAE	*Talitoides topitopum* Burt		A						•
ARTHROPODS (ARANEAE)									
	Thelacantha brevispina		A						
ARANEIDAE	*Argiope appensa* (Walckenaer)		A						
	Gasteracantha mammosa C.L. Koch		A						
	Neoscona sp.		?						•
CLUBIONIDAE	*Cheiracanthium mordax* L. Koch		A						
DYSDERIDAE	*Dysdera crocota* C.L. Koch		A						

Family	Scientific name	Common names	Status	Native vegetation			Alien vegetation		
				1	2	3	1	2	3
GNAPHOSIDAE	*Camillina elegans* (Bryant)		A						
LINYPHIIDAE	*Labulla* sp.		E						
NESTICIDAE	*Eidmanella pallida* (Emerton)		A		•				•
OONOPIDAE	*Oonopinus hunus* Suman		E						
	Oonopinus n. sp.		E						
	Opopaea lena Suman		E						
	Orchestina sp.		E						•
PHOLCIDAE	*Pholcus phalangioides* (Fuesslins)		A						
SALTICIDAE	*Hasarius adansoni* (Audouin)		A						
	Phintella versicolor (C.L. Koch)		A						•
TETRAGNATHIDAE	*Tetragnatha* n. sp.		E		•				•
THERIDIIDAE	*Argyrodes argyrodes* (Walckenaer)		A						
	Latrodectus geometricus C.L. Koch		A						
	Steatoda grossa (C.L. Koch)		A						
	Theridon melanostictum (Pickard-Cambridge)		A						•
THOMISIDAE	*Misumenops* sp. A		E?						
	Misumenops sp. B		E		•				•
	Misumenops sp. C		E		•				•
ARTHROPODA (CHILOPODA)									
GEOPHILIDAE	gen. sp.		?						•
LITHOBIIDAE	*Lithobius* sp.		E?		•				•
SCOLOPENDRIDAE	gen. sp. [immatures]		?		•				•
	Scolopendra subspinipes Leach		A		•				•
ARTHROPODA (COLEOPTERA)									
AGLYCYDERIDAE	*Proterhinus blackburni blackburni* Sharp		E		•				
	Proterhinus deceptor Perkins		E						
	Proterhinus spp. (not *blackburni* group)		E		•				
ALLECULIDAE	*Pseudocistela* sp.		E						
ANTHRIBIDAE	*Araecerus fasciculatus* (DeGreer)		A						•
	Araecerus levipennis Jordan		A		•				•
	Araecerus vieillardi (Montrouzier)		A						•
	Exillis lepidus Jordan		A						•
	gen. sp.		A		•				•
BOSTRICHIDAE	*Amphicerus cornutus* (Pallas)		A						•
	Xylopsocus religiosus (Boisduval)		A		•				•
BRUCHIDAE	*Acanthoscelides macrophthalmus* (Schaeffer)		A		•				•
	Lithraeus atronotatus (Pic)		A		•				•
	Stator pruininus (Horn)		A						
	gen. sp.		?						
BUPRESTIDAE	*Chrysobothris oceaniae* Le Conte		A						•
CANTHARIDAE	*Caccodes oceaniae* (Bourgeois)		A						•
CARABIDAE	*Colpodes buchannani* Hope		A						•

Family	Scientific name	Common names	Status	Native vegetation			Alien vegetation		
				1	2	3	1	2	3
	Gnathaphanus picipes (Macleay)		A		•				•
	Gnathaphanus upolensis (Csiki)		A		•				•
	Stenolophus sp.		A		•				•
CERAMBYCIDAE	*Ceresium unicolor* (Fabricius)		A		•				•
	Curtomerus flavus (Fabricius)		A		•				•
	Gelonaetha hirta (Fairmaire)		A		•				•
	Oopsis nutator (Fabricius)		A		•				•
	Phoracantha semipunctata (Fabricius)		A		•				•
	Placosternus crinicornis (Chevrolat)		A		•				•
	Pterolophia camura Newman		A		•				•
	Sybra alternans (Wiedemann)		A		•				•
CHRYSOMELIDAE	*Diachus auratus* (Fabricius)		A		•				•
	Octotoma scabripennis Guerin-Meneville		A		•				•
	Uroplata girardi Pic		A		•				•
CIIDAE	gen. sp. B		A						
	gen. sp. A		A		•				•
COCCINELLIDAE	*Cryptolaemus montrouzieri* Mulsant		A		•				•
	Curinus coeruleus (Mulsant)		A		•				•
	Halmus chalybeus (Boisduval)		A						
	Nephus bilucernarius (Mulsant)		A		•				•
	Olla v-nigrum (Mulsant)		A		•				•
	Orcus australasiae (Boisduval)		A		•				•
	Rhyzobius forestieri (Mulsant)		A		•				•
	Scymnus sp.		?		•				•
	Sticholotis ruficeps Weise		A						•
	Telsimia nitida Chapin		A						•
COLYDIIDAE	*Penthelispa rufipennis* (Montrouzier)		A						
CORYLOPHIDAE	*Gronevus rotundus* (Sharp)		E?						•
	Grovenus? sp.		E?						
	Orthoperini? sp. (not *O. aequalis* Sharp)		E?						•
	Sericoderus pubipennis Sharp		E?		•				•
CURCULIONIDAE	*Anotheorus*? sp.		E?						•
	Asynonychus godmanni Crotch		A		•				•
	Dryophthorus distinguendus Perkins		E		•				•
	Oodemas punctulatissimum? Perkins		E		•				•
	Oxydema fusiforme Wollaston		A		•				•
	Pholidophorus advena Zimmerman		A		•				•
	Rhyncogonus welchii Perkins		E		•				
	Sibinia sp.		A						•
DERMESTIDAE	*Orphinus terminalis* (Sharp)		I						•
DYTISCIDAE	*Rhantus pacificus* (Boisduval)		E						
	Rhantus pseudopacificus Balke		E		•				•
ELATERIDAE	*Chalcolepidius erythroloma* Candeze		A						
	Conoderus exsul (Sharp)		A		•				•
ENDOMYCHIDAE	*Eidoreus minutus* Sharp		E						•
HYDROPHILIDAE	*Cryptopleurum minutum* (Fabricius)		A						•
	Enochrus sayi Gundersen		A						
	Helochares sp.		A						
	Tropisternus lateralis humeralis Motschulsky		A						

Family	Scientific name	Common names	Status	Native vegetation			Alien vegetation		
				1	2	3	1	2	3
JACOBSONIIDAE	*Derolathrus atomus* Sharp		E		•				•
LANGURIIDAE	*Cryptophilus integer* (Heer)		A						•
LATHRIDIIDAE	*Corticaria longicollis*? (Zetterstedt)		A		•				•
MYCETOPHAGIDAE	*Litargus vestitus* Sharp		I						•
NITIDULIDAE	*Carpophilus hemipterus* (Linnaeus)		A						
	Carpophilus humeralis (Fabricius)		A		•				•
	Carpophilus mutilatus Erichson		A						•
	Haptoncus mundus Sharp		A		•				•
	Haptoncus ocularis (Fairmaire)		A		•				•
	Nesopeplus roridus Sharp		E						•
	Soronia variegata? Macleay		A		•				•
PTILIIDAE	*Ptiliodes* sp.		E?						•
	gen. sp.		A						•
RHIZOPHAGIDAE	*Hesperobaenus capito* (Fairmaire)		I?						•
SCARABAEIDAE	*Adoretus sinicus* Burmeister		A		•				•
	Copris incertus prociduus Say		A		•				•
	Onthophagus incensus Say		A		•				•
SCIRTIDAE	gen. sp.		A		•				•
SCOLYTIDAE	*Hypothenemus birmanus* (Eichhoff)		A						•
	Hypothenemus crudiae (Panzer)		A						
	Hypothenemus eruditus (Westwood)		A						•
	Xyleborinus saxeseni (Ratzeburg)		A						•
	Xyleborus affinus Eichoff		A						•
	Xyleborus ferrugineus (Fabricius)		A		•				•
	Xyleborus interjectus Blandford		A						•
	Xyleborus lanaiensis Perkins		E		•				•
	Xyleborus perforans (Wollaston)		A		•				•
SILVANIDAE	*Cryptamorpha desjardinsi* (Guerin-Meneville)		A		•				•
	Psammoechus sp.		A						
STAPHYLINIDAE	*Atheta coriaria* (Kraatz)		A						•
	Atheta sp. (not *coriaria*)		A						•
	Coproporus sp.		A						•
	Ctenandropus sp.		A						•
	Philonthus discoideus (Gravenhorst)		A						•
	Philonthus longicornis Stephens		A		•				•
	Philonthus sp.		A						
	Philonthus sp. (Newton sp. 1)		A		•				•
	Sunius sp.		A		•				•
	Thyreocephalus albertisi (Fauvel)		A						•
	gen. sp.		A						
	gen. sp. (Piestinae)		A		•				•
TENEBRIONIDAE	*Blapstinus dilatatus* Le Conte		A		•				•
	Gnathocerus cornutus (Fabricius)		A						
	Platydema subfascia (Walker)		A						•
	ARTHROPODA (COLLEMBOLA)								
ENTOMOBRYIDAE	*Entomobrya nyhusae* Christiansen & Bellinger		E						
HYPOGASTRURIDAE	*Neanura*? sp.		?						

Family	Scientific name	Common names	Status	Native vegetation			Alien vegetation		
				1	2	3	1	2	3
NEELIDAE	*Neelus minutus* Folsom		A						
SMITHURIDAE	gen. spp. (2)		?						
	ARTHROPODA (DERMAPTERA)								
CARCINOPHORIDAE	*Euborellia annulipes* (Lucas)		A		•				•
	Euborellia eteronoma (Borelli)		E		•				•
CHELISOCHIDAE	*Chelisoches morio* (Fabricius)		A						
LABIIDAE	*Sphingolablis hawaiiensis* (Bormans)		A						
	Spirolabia dubronyi (Hebard)		A		•				
	ARTHROPODA (DICTYOPTERA)								
BLABERIDAE	*Diploptera punctata* (Eschscholtz)		A		•				•
	Pycnoscelus indicus (Fabricius)		A						•
BLATTELLIDAE	*Balta similis* (Saussure)		A		•				•
	Balta sp. (not *similis*)		A		•				•
	Blattella germanica (Linnaeus)		A		•				•
	Blattella lituricollis (Walker)		A						•
BLATTIDAE	*Periplaneta americana* (Linnaeus)		A						
	Periplaneta australasiae (Fabricius)		A						•
	Platyzosteria soror (Brunner)		A		•				•
POLYPHAGIDAE	*Euthyrrhapha pacifica* (Coquebert)		A						•
	ARTHROPODA (DIPLOPODA)								
CAMBALIDAE	*Nannolene* sp.		E?		•				•
PARADOXOSOMATIDAE	*Asiomorpha coarctata* (Saussure)		A						•
	Oxidus gracilis (C.L. Koch)		A						
POLYXENIDAE	*Polyxenus* sp.		?						
PYRGODESMIDAE	*Aporodesminus wallacei* Silvestri		A						•
SPIROBOLIDAE	*Spirobolellus immigrans* (Chamb.)		A						•
	ARTHROPODA (DIPTERA)								
AGROMYZIDAE	*Amauromyza maculosa* (Malloch)		A						•
	Liriomyza sp. nr. *sativae* Blanchard		A		•				•
	Melanagromyza metallica? Thomson		A						•
	Phytoliriomyza montana Frick		E?		•				•
	Pseudonapomyza spicata (Malloch)		A						•
ANTHOMYIIDAE	*Anthomyia vicarians* Schiner		A						•
ASTEIIDAE	*Asteia sabroskyi* Hardy & Delfinado		E		•				•
CALLIPHORIDAE	*Calliphora vomitora* (Linnaeus)		A						
	Chrysomya megacephala (Fabricius)		A		•				•
	Dyscritomyia cuprea James		E		•				•
	Dyscritomyia fasciata (Grimshaw)		E		•				•
	Dyscritomyia limbipennis (Thomson)		E		•				•
	Lucilia sp. nr. *cuprina* (Wiedemann)		A						•
	Lucilia sericata (Meigen)		A						
	Melinda pusilla (Villeneuve)		A						•
	Rhinia apicalis (Wiedemann)		A						•
CECIDOMYIIDAE	*Dasineura mangiferae* Felt		A						•

Family	Scientific name	Common names	Status	Native vegetation			Alien vegetation		
				1	2	3	1	2	3
CERATOPOGONIDAE	*Forcipomyia hardyi* Wirth & Howarth		E		•				•
CHIRONOMIDAE	*Chironomus hawaiiensis* Grimshaw		E?						•
	Corynoneura sp.		A						•
	Cricotopus bicinctus (Meigen)		A						•
	Orthocladius sp. nr. *wirthi* Hardy		E?						•
	Orthocladius williamsi Hardy		E		•				•
CHLOROPIDAE	*Conioscinella formosa* (Becker)		A		•				•
	Gaurax bicoloripes (Malloch)		A		•				•
	Rhodesiella scutellata (Meijere)		A		•				•
CRYPTOCHETIDAE	*Cryptochetum iceryae* (Williston)		A		•				•
CULICIDAE	*Aedes albopictus* (Skuse)		A						•
DIXIDAE	*Dixa longistyla* Takahashi		A						•
DOLICHOPODIDAE	*Campsicnemus glorius* Van Duzee		E						•
	Campsicnemus halonae Evenhuis		E		•				•
	Campsicnemus miser Parent		E		•				•
	Campsicnemus patellifer Grimshaw		E		•				•
	Campsicnemus planitibia Parent		E		•				•
	Chrysosoma globiferum (Wiedemann)		A		•				•
	Chrysotus longipalpis Aldrich		A						•
	Eurynogaster sp.		E						•
	Medetera grisescens Meijere		E						•
	Pelastoneurus lugubris Loew		A		•				•
	Syntormon flexibile Becker		A						•
	Tachytrechus sp.		A						•
DROSOPHILIDAE	*Chymomyza procnemis* (Williston)		A		•				
	Dettopsomyia formosa Lamb		A		•				
	Drosophila immigrans Sturtevant		A		•				
	Drosophila sulfurigaster bilimbata Bezzi		A		•				
	Drosophila suzukii (group) (Matsumura)		A		•				•
	Drosophila tamashiroi Hardy		E		•				•
	Scaptomyza buccata Hackman		E						•
	Stegana sp.		A						•
EMPIDIDAE	*Hemerodromia stellaris* Melander		A						•
EPHYDRIDAE	*Brachydeutera hebes* Cresson		E						•
	Donaceus nigronotatus Cresson		A						•
	Hydrellia williamsi Cresson		A						•
	Nostima niveivenosa Cresson		A						•
	Scatella hawaiiensis Grimshaw		E						•
KEROPLATIDAE	*Tylparua hawaiiensis* (Grimshaw)		E						•
LAUXANIIDAE	*Homoneura unguiculata* (Kertesz)		A		•				•
	Poecilominettia sexseriata Hendel		A		•				•
LONCHAEIDAE	*Lonchaea polita* Say		A						•
MICROPEZIDAE	*Taeniaptera angulata* (Loew)		A						•
MILICHIIDAE	*Desmometopa inaurata* Lamb		A		•				•
MUSCIDAE	*Atherigona orientalis* Schiner		A		•				•
	Atherigona reversura Villeneuve		A		•				•

NAVMAG Pearl Harbor
Final INRMP

November 2001
U.S. Navy

Family	Scientific name	Common names	Status	Native vegetation			Alien vegetation		
				1	2	3	1	2	3
	Brontaea quadristigma (Thomson)		A		•				•
	Haematobia irritans (Linnaeus)		A						•
	Lispocephala sp.		E						•
	Stomoxys calcitrans (Linnaeus)		A						•
NERIIDAE	*Telostylinus lineolatus* (Wiedemann)		A						•
OTITIDAE	*Acrosticta apicalis* (Williston)		A		•				•
	Euxesta stigmatais Loew		A		•				•
	Notogramma cimiciforme Loew		A						•
PHORIDAE	*Chonocephalus* sp.		E						•
	Dohrniphora cornuta (Bigot)		A						•
	Megaselia (Megaselia) sp.		?						•
	Philiciphora sp.		A		•				•
PSYCHODIDAE	*Psychoda* sp. nr. *wirthi* Quate		E						•
SARCOPHAGIDAE	*Helicobia morionella* (Aldrich)		A		•				•
	Johnsonia elegans Coquillett		A		•				•
	Parasarcophaga ruficornis (Fabricius)		A						•
	Sarcophagula occidua (Fabricius)		A		•				•
	Seniorwhitea reciproca (Walker)		A						•
SCENOPINIDAE	*Scenopinus adventicius* Hardy		A		•				•
	Scenopius lucidus Becker		A						•
SCIARIDAE	*Bradysia molokaiensis*? (Grimshaw)		E						•
	Ctenosciara hawaiiensis (Hardy)		E						•
SEPSIDAE	*Sepsis* sp.		A		•				•
	Sepsis thoracica (Robineau-Desvoidy)		A						•
SPHAEROCERIDAE	*Leptocera abdominiseta* (Duda)		A						•
	Leptocera (Coproica) sp.		A		•				•
	Poecilosomella punctipennis (Wiedemann)		A						•
STRATIOMYIDAE	*Gobertina picticornis* Bigot		A						•
	Hermetia illucens (Linnaeus)		A		•				•
	Merosargus sp.		A						•
SYRPHIDAE	*Allograpta exotica* (Wiedemann)		A						•
	Allograpta obliqua (Say)		A						•
	Copestylum apicale (Loew)		A		•				•
	Copestylum tamaulipanum (Townsend)		A		•				•
	Eristalinus arvorum (Fabricius)		A						•
	Eumerus aurifrons (Wiedemann)		A						•
	Ornidia obesa (Fabricius)		A		•				•
	Toxomerus marginatus (Say)		A		•				•
TACHINIDAE	*Archytas cirphis* Curran		A		•				•
	Chaetogaedia monticola (Bigot)		A						•
	Eucelatoria armigera (Coquillett)		A		•				•
	Lespesia archippivora (Riley)		A		•				•
	Trichopoda pilipes (Fabricius)		A		•				•
TEPHRITIDAE	*Acinia picturata* (Snow)		A		•				•
	Bactrocera cucurbitae (Coquillett)		A		•				•
	Ensina sonchi (Linnaeus)		A						•
	Eutreta xanthochaeta Aldrich		A						•
	Procecidochares alani Steyskal		A						•
	Tetraeuaresta obscuriventris (Loew)		A						•

Family	Scientific name	Common names	Status	Native vegetation			Alien vegetation		
				1	2	3	1	2	3
TIPULIDAE	*Limonia hawaiiensis* (Grimshaw)		E		•				•
	Limonia jacoba (Alexander)		E						•
	Limonia perkinsi (Grimshaw)		A		•				•
	Limonia swezeyi (Alexander)		E						•
	ARTHROPODS (EMBIIDINA)								
OLIGOTOMIDAE	*Oligotoma saundersii* (Westwood)		A		•				•
	ARTHROPODS (HETEROPTERA)								
ANTHOCORIDAE	*Paratriphleps laeviusculus* Champion		A						•
CYDNIDAE	*Geotomus pygmaeus* (Dallas)		A		•				•
	Rhytidoporus indentatus Uhler		A		•				•
LYGAEIDAE	*Metrarga nuda*? White		E		•				•
	Nysius communis Usinger		E						
	Pachybrachius sp.		A		•				•
MIRIDAE	*Halticus bractatus* (Say)		A		•				•
	Hyalopeplus pellucidus (Stal)		E		•				•
	Kamehameha n. sp.		E						
	Koanoa n. sp.		E						
	Lygus (*prob.*) sp. (not *elisae*)		A		•				•
	Nesidiorchestes hawaiiensis Kirkaldy		E		•				•
	Orthotylus n. sp. A [sensu Asquith]		E						
	Orthotylus n. sp. B [sensu Asquith]		E						
	Orthotylus n. sp. C [sensu Asquith]		E						
	Orthotylus n. sp. D [sensu Asquith]		E						
	Orthotylus spp.		E						•
	Rhinacloa forticornis Reuter		A						•
	Stenotus sp. (not *binotatus*)		A		•				•
	Taylorilygus (prob.) *pallidulus* (Blanchard)		A		•				•
NABIDAE	*Nabis blackburni* White		E		•				•
	Nabis sp.?		E?		•				•
PENTATOMIDAE	*Nezara viridula* (Linnaeus)		A		•				•
	Plautia stali Scott		A		•				•
PLATASPIDAE	*Coptosoma xanthogramma* (White)		A		•				•
REDUVIIDAE	*Empircoris rubromaculatus* (Blackburn)		A		•				•
	Haematoloecha rubescens Distant		A		•				•
	Zelus renardii Kolenati		A						
RHOPALIDAE	gen. sp.		A		•				•
TINGIDAE	*Corythucha morrilli* Osborn & Drake		A		•				•
	Leptobyrsa decora Drake		A		•				•
	Teleonemia scrupulosa Stal		A		•				•
VELIIDAE	*Microvelia vagans* White		E						
	ARTHROPODS (HOMOPTERA)								
APHIDIDAE	*Aphis gossypii* Glover		A						•
	Aphis sp.		A						
APHROPHORIDAE	*Clasoptera xanthocephala* Germar		A		•				•
CICADELLIDAE	*Carneocephala sagittifera* (Uhler)		A		•				•
	Linnavouriella sp.		A						•
	Nesosophryne sp. nr. *myrsines* Kirkaldy		E		•				•

Family	Scientific name	Common names	Status	Native vegetation			Alien vegetation		
				1	2	3	1	2	3
	Sophonia rufofascia (Kuoh & Kuoh)		A		•				•
CIXIIDAE	*Oliarus discrepans* Giffard		E						•
	Oliarus kaiulani Giffard		E		•				•
	Olianus sp. prob. *olympus* Giffard		E		•				•
	Olianus sp.		E		•				•
COCCIDAE	*Ceroplastes rubens* Maskell		A						
DELPHACIDAE	*Aloha artemesiae* (Kirkaldy)		E						
	Aloha campylothecae Muir		E						
	Aloha swezeyi Muir		E						
	Dictyophorodelphax mirabilis Swezey		E						
	Nesosydne sp.		E						
	Nesothoe terryi Kirkaldy		E		•				•
	Perkinsiella saccharicida Kirkaldy		A						
FLATIDAE	*Melormenis basalis* (Walker)		A		•				•
	Siphanta acuta (Walker)		A		•				•
MEMBRACIDAE	*Vanduzeea segmentata* (Fowler)		A						•
PSYLLIDAE	*Heteropsylla mimosae* Crawford		A						
	Heteropsylla sp.		A		•				•
	Kuwayama pisonia Caldwell		E						
	Trioza sp.		E						
	ARTHROPODS (HYMENOPTERA)								
AGAONIDAE	*Pleistodontes* sp.		A						•
	gen. sp. (Epichrysomallinae)		A		•				•
ANTHOPHORIDAE	*Xylocopa sonorina* F. Smith		A						•
APHELINIDAE	*Aphelinus* sp.		A		•				•
APHIDIIDAE	*Lysiphlebus*? *testaceipes* (Cresson)		A		•				•
	Aphidius smithi? Sharma & Rao		A		•				•
APIDAE	*Apis mellifera* Linnaeus		A		•				•
BETHYLIDAE	*Epyris extraneus* Bridwell		A		•				•
	Epyris sp. (not *extraneus*)		A						•
	Sierola sp.		E		•				•
	gen. sp.		?						•
BRACONIDAE	*Apanteles* sp.		A						•
	Apanteles trifasciatus Muesebeck		A		•				•
	Aphaereta pallipes (Say)		A						•
	Glyptocolastes sp.		A						
	Macrocentrus calacte? Nixon		A		•				•
	Meteorus laphygmae Viereck		A		•				•
	Ontsira palliatus (Cameron)		A		•				•
	Opius dissitus Muesebeck		A		•				•
	Opius incisi Silvestri		A		•				•
	Opius lantanae Bridwell		A						
	Phanerotoma hawaiiensis Ashmead		A		•				•
	Phanerotoma myeloisae Fullaway		A		•				•
	Rhaconotus vagrans (Bridwell)		A		•				•
	Spathius prusias Nixon		A		•				•
	Stenocorse bruchivora (Crawford)		A		•				•
CERAPHRONIDAE	*Ceraphron plebeius* Perkins		A						•

Family	Scientific name	Common names	Status	Native vegetation 1	Native vegetation 2	Native vegetation 3	Alien vegetation 1	Alien vegetation 2	Alien vegetation 3
CHALCIDIDAE	*Anthrocephalus apicalis* (Walker)		A						•
	Conura sp.		A		•				•
	Dirhinus anthracia Walker		A		•				•
	Dirhinus sp.		A						•
CHRYSIDIDAE	*Trichrysis*? *triacantha* (Mocsary)		A						•
COLLETIDAE	*Hylaeus* spp.		E		•				•
DIAPRIIDAE	*Stylaclista* sp.		A						•
	Trichopria sp.		E		•				•
ENCYRTIDAE	*Aenasius advena* Compere		A		•				•
	Anagyrus sp.		?						•
	Blepyrus? sp.		A?						•
	Cheiloneuromyia javensis Girault		A						•
	Copidosoma sp.		A		•				•
	Encyrtus sp.		A		•				•
	Homalotylus? sp.		A						•
	Microterys flavus? (Howard)		A						•
	Prochiloneura rex? (Girault)		A						•
EUCOILIDAE	gen. sp.		?						•
EULOPHIDAE	*Euderus* sp. nr. *metallicus* (Ashmead)		A		•				•
	Euplectrus platyhypenae Howard		A		•				•
	Setelacher fasciatus Boucek		A						•
	Sympiesis sp.		?						•
	gen. sp. (Enedoninae)		?						•
	gen. sp. (Tetrastichinae)		?		•				•
EUPELMIDAE	gen. #1 sp.		?						•
	gen. #2 sp.		?						•
	gen. #3 sp.		?						•
	Anastatus sp.		?		•				•
	Eupelmus sp.		?		•				•
	Reikosiella melina Yoshimoto		A		•				•
EURYTOMIDAE	*Eurytoma tephritidis* Fullaway		A		•				•
	Sycophila sp.		A						•
EVANIIDAE	*Evania* sp. prob. *appendigaster* (Linnaeus)		A						•
FORMICIDAE	*Anoplolepis longipes* (Jerdon)		A		•				•
	Pheidole megacephala (Fabricius)		A		•				•
	Pseudomyrmex gracilis mexicanus (Roger)		A						•
	Technomyrmex albipes (F. Smith)		A		•				•
	gen. sp. A		A		•				•
	gen. sp. B		A						•
HALICTIDAE	*Halictus* sp.		A						•
HELORIDAE	*Helorus ruficornis* Foerster		A		•				•
ICHNEUMONIDAE	*Barichneumon californicus* Heinrich		A		•				•
	Casinaria infesta (Cresson)		A		•				•
	Diadegma blackburni (Cameron)		A		•				•
	Echthromorpha agrestoria fuscator (Fabricius)		E		•				•
	Echthromorpha sp. (not*fuscator*)		E		•				•
	Enicospilus sp.		E		•				•
	Gotra sp.		A		•				•

NAVMAG Pearl Harbor
Final INRMP
November 2001
U.S. Navy

Family	Scientific name	Common names	Status	Native vegetation 1	Native vegetation 2	Native vegetation 3	Alien vegetation 1	Alien vegetation 2	Alien vegetation 3
	Hyposoter exiguae (Viereck)		A		•				•
	Pachysomoides stupidus (Cresson)		A						•
	Pimpla punicipes Cresson		A		•				•
	Pristomerus sp.		?						•
	Rubicundiella perturbatrix Heinrich		A?						
	Trathala flavoorbitalis (Cameron)		A		•				•
	Tromatobia ovivora (Boheman)		A		•				•
	gen. sp. (Gelinae)		A						•
MYMARIDAE	*Gonatocerus dolichocerus*		A						•
	Polynema sp.		?		•				•
PLATYGASTRIDAE	gen. #1 sp.		?						•
	gen. #2 sp.		?						•
	gen. #3 sp.		?						•
	gen. #4 sp.		?		•				•
POMPILIDAE	*Anoplius luctuosus* (Cresson)		A						
	Tachypompilus analis (Fabricius)		A						
PROCTOTRUPIDAE	*Brachyserphus hawaiiensis* (Ashmead)		A?						•
PTEROMALIDAE	*Callocleonymus swezeyi* (Yoshimoto & Ishii)		A						•
	Pteromalus sp.		?						
	Trichomalus? sp.		?						
SCELIONIDAE	*Anteromorpha dubosia* (Perkins)		A						•
	Aporophlebus sp.		A						•
	Baryconus sp.		A						•
	Caenoteleia elegans (Perkins)		A						
	Telenomus sp. A		A?		•				•
	Telenomus sp. B		A?						•
	Trissolcus basalis		A		•				•
SPHECIDAE	*Ampulex compressa* (Fabricius)		A		•				•
	Chalybion bengalense (Dahlbom)		A						
	Dolichurus stantoni (Ashmead)		A						•
	Ectemnius sp. A		E		•				•
	Ectemnius sp. B		E		•				•
	Ectemnius sp. C		E		•				•
	Isodontia mexicana (Saussure)		A						•
	Pison insulare F. Smith		A		•				•
	Pison iridipenne F. Smith		A		•				•
	Tachysphex apicalis Fox		A						
	Tachysphex morosus (F. Smith)		A		•				•
	Trypoxylon bicolor F. Smith		A						•
	Trypoxylon philippenense Ashmead		A						•
	gen. sp. (Pemphredoninae)		A?						•
TORYMIDAE	*Megastigmus transvaalensis* (Hussey)		A		•				•
	Megastigmus sp.		A		•				•
	Torymus advenus (Osten Sacken)		A		•				•
TRICHOGRAMMATIDAE	gen. sp.		?						•
VESPIDAE	*Delta campaniforme campaniforme* (Fabricius)		A						•
	Delta curvata (Saussure)		A						•
	Delta pyriformis philippinense (Bequaert)		A						•
	Odynerus pseudochromoides Perkins		E			•			•
	Odynerus sp.		E			•			•
	Odynerus sp. nr. *waianaeanus*		E						•
	Pachyodynerus nasidens (Latreille)		A						

Family	Scientific name	Common names	Status	Native vegetation			Alien vegetation		
				1	2	3	1	2	3
	Polistes aurifer Saussure		A		•				•
	ARTHROPODA (ISOPODA)								
ARMADILLIDAE	*Reductoniscus costulatus* Kesselyak		A						•
PHILOSCIIDAE	*Australophiloscia societatis* (Maccagno)		I		•				•
	Burmoniscus meeusi (Holthuis)		A						
	Burmoniscus okiawaensis (Nunomura)		A		•				•
PLATYARTHRIDAE	*Trichorhina tomentosa* (Budde-Lund)		A		•				•
PORCELLIONIDAE	*Porcellio laevis* Latreille		A		•				•
	Porcellio scaber Latreille		A						•
	Porcellionides pruinosus (Brandt)		A		•				•
STYLONISCIDAE	*Clavigeroniscus riquieri* (Arcaneli)		A		•				•
	Styloniscus spinosus (Patience)		A		•				•
TRACHELIPIDAE	*Nagurus cristatus* (Dollfus)		A						
	ARTHROPODA (ISOPTERA)								
KALOTERMITIDAE	*Neotermes connexus* Snyder		A		•				•
RHINOTERMITIDAE	*Coptotermes formosanus* Shiraki		A						•
	ARTHROPODA (LEPIDOPTERA)								
ALUCITIDAE	*Alucita objurgatella* (Walshingham)		A		•				•
COSMOPTERIDAE	*Hyposmocoma* sp. A		E						
	Hyposmocoma sp. B		E						
	Hyposmocoma sp. C		E						
CRAMBIDAE	*Euchromius ocelleus* (Haworth)		A		•				•
	Eudonia geraea (Meyrick)		E						
	Eudonia n. sp. 1 [of Monroe]		E		•				•
	Eudonia n. sp. 2 [of Monroe]		E		•				•
	Eudonia n. sp. 3 [of Monroe]		E						
	Eudonia ombrodes (Meyrick)		E						
	Glyphodes sp. nr. *cyanomichla* Meyrick		E		•				•
	Herpetogramma licarsisalis (Walker)		A		•				•
	Mestolobes sp. prob. *miniscula* (Butler)		E		•				•
	Nomophila noctuella (Denis & Schiffermueller)		A		•				•
	Orthomecyna sp. nr. *exigua* (Butler)		E						
	Orthomecyna spp.		E		•				•
	Salbia haemorrhoidalis Guenee		A		•				•
	Spoladea recurvalis (Fabricius)		A		•				•
	Tamsica sp. nr. *oxyptera* (Meyrick)		E						
	Tamsica sp.		E		•				•
GELECHIIDAE	*Crasimorpha infuscata* Hodges		A						
GEOMETRIDAE	*Anacamptodes fragilaria* (Grossbeck)		A		•				•
	Cyclophora nanaria (Walker)		A						•
	Euacidalia brownsvillea Cassino		A		•				•
	Eupithecia sp.		E						
	Macaria abydata Guenee		A		•				•
HESPERIIDAE	*Hylephila phyleus* (Drury)		A						
LYCAENIDAE	*Strymon bazochii* (Godart)		A						•
	Urada blackburni (Tuely)		E		•				•

NAVMAG Pearl Harbor
Final INRMP

November 2001
U.S. Navy

Family	Scientific name	Common names	Status	Native vegetation			Alien vegetation		
				1	2	3	1	2	3
NOCTUIDAE	*Achaea janata* (Linnaeus)		A		•				•
	Agrotis ipsilon (Hufnagel)		A		•				•
	Anomis flava (Fabricius)		A		•				•
	Ascalapha odorata (Linnaeus)		A						•
	Athetis thoracica (Moore)		A		•				•
	Callopistria maillardi Guenee		A						•
	Chrysodeixis eriosoma (Doubleday)		A		•				•
	Elaphria nucicolora (Guenee)		A		•				•
	Hypena laceratalis Walker		A		•				•
	Leacania striata Leech		A		•				•
	Lycophotia porphyrea (Denis & Schiffermueller)		A		•				•
	Megalographa biloba (Stephens)		A						•
	Melipotis indomita (Walker)		A		•				•
	Neogalea sunia (Guenee)		A		•				•
	Ophiusa disjungens (Walker)		A		•				•
	Pandesma anysa Guenee		A		•				•
	Penicillaria jocosatrix Guenee		A		•				•
	Spodoptera mauritia (Boisduval)		A		•				•
NYMPHALIDAE	*Agraulis vanillae* (Linnaeus)		A						•
	Danaus plexippus (Linnaeus)		A		•				•
	Vanessa sp. (*cardui* or *virginiensis*)		A		•				•
	Vanessa cardui (Linnaeus)		A		•				•
	Vanessa tameamea Eschscholtz		E						
OECOPHORIDAE	*Stoeberhinus testaceus* Butler		A		•				
	Thyrocopa sapindiella Swezey		E						
	Thyrocopa sp.		E						
PAPILIONIDAE	*Papilio xuthus* Linnaeus		A		•				•
PIERIDAE	*Pieris rapae* (Linnaeus)		A		•				•
PSYCHIDAE	*Brachycyttarus griseus* De Joannis		A						
SPHINGIDAE	*Agrius cingulata* (Fabricius)		A		•				•
	Hyles calida (Butler)		E		•				•
	Hyles lineata (Fabricius)		A						•
	Hyles wilsoni perkinsi (Swezey)		E		•				•
	Macroglossum pyrrhosticum (Butler)		A		•				•
	Psilogramma menephron (Cramer)		A		•				•
TINEIDAE	*Decadarchis simulans* (Butler)		A		•				•
	Opogona omoscopa (Meyrick)		A						•
	Opogona sp.		A						
TORTRICIDAE	*Amorbia emigratella* Busck		A		•				•
	Cryptophlebia illepida (Butler)		A		•				•
	Cydia sp.		E						
	Eccoptocera sp.		E		•				•
	Episimus utilis Zimmerman		A		•				•
	Platynota stultana Walsingham		A		•				•
	Spheterista sp.		E						
	ARTHROPODA (MANTODEA)								
MANTIDAE	*Brunneria borealis* Scudder		A						
	ARTHROPODA (NEUROPTERA)								
CHRYSOPIDAE	*Anomalochrysa* sp.		E		•				•
	Anomalochrysa sylvicola Perkins		E		•				•
	Mallada basalis (Walker)		A		•				•

Family	Scientific name	Common names	Status	Native vegetation			Alien vegetation		
				1	2	3	1	2	3
HEMEROBIIDAE	*Micromus timidus* Hagen		A						•
	Micromus vagus (Perkins)		E		•				•
ARTHROPODA (ODONATA)									
AESHNIDAE	*Anax junius* (Drury)		I						•
	Anax strenuus Hagen		A						•
COENAGRIONIDAE	*Ischnura posita* (Hagen)		A						•
	Ischnura ramburii (Selys-Longchamps)		A						
LIBELLULIDAE	*Orthemis furruginea* (Fabricius)		A						•
	Pantala flavescens (Fabricius)		I						
	Tramea abdominalis (Rambur)		A						•
ARTHROPODA (ORTHOPTERA)									
ACRIDIDAE	*Oedaleus abruptus* (Thunberg)		A						
	Schistocerca nitens (Thunberg)		A						
GRYLLIDAE	*Gryllus bimaculatus* DeGeer		A						•
	Laupala sp. nr. *hapapa* Otte		E						
TETRIGIDAE	*Paratettix mexicanus*? (Saussure)		A						
TETTIGONIIDAE	*Conocephalus saltator* (Saussure)		A		•				•
	Elimaea punctifera (Walker)		A						
	Euconocephalus nasutus (Thunberg)		A		•				•
	Phaneroptera furcifera Stal		A						•
	Xiphidiopsis lita Hebard		A		•				•
ARTHROPODA (PSEUDOSCORPIONIDA)									
Undetermined family	gen. sp.		E		•				•
ARTHROPODA (PSOCOPTERA)									
ECTOPSOCIDAE	*Ectopsocus* sp.		A						
ARTHROPODA (SCHIZOMIDA)									
SCHIZOMIDAE	*Schizomus siamensis* (Hansen)		A						•
ARTHROPODA (STREPSIPTERA)									
ELENCHIDAE	*Elenchus* sp.		A		•				•
ARTHROPODA (TRICHOPTERA)									
HYDROPSYCHIDAE	*Cheumatopsyche pettiti* (Banks)		A						•
HYDROPTILIDAE	*Oxyethira maya* Denning		A						•
BIRDS									
PHAETHONITIDAE	*Phaethon lepturus dorotheae*	Koa'e kea, White-tailed Tropicbird	I	•		•			
ARDEIDAE	*Nyctcorax nycticorax hoactli*	Black-crowned Night-heron, Auku'u	I				•	•	•
FALCONIDAE	*Falco perigrinus*	Peregrine Falcon	V	•		•			
PHASIANIDAE	*Francolinus erckelii*	Erckel's Francolin	A		•			•	•
	Phasianus colchicus	Ring-necked Pheasant	A		•		•	•	•
CHARADRIIDAE	*Pluvialis fulva*	Kolea, Pacific Golden Plover	I				•		

Family	Scientific name	Common names	Status	Native vegetation			Alien vegetation		
				1	2	3	1	2	3
COLUMBIDAE	*Columba livia*	Rock Dove	A	•	•	•	•	•	•
	Geopelia strata	Zebra Dove, Barred Dove	A		•		•	•	•
	Streptopelia chinensis	Spotted Dove	A	•	•	•	•	•	•
TYTONIDAE	*Tyto alba*	Barn owl	A				•	•	•
STRIGIDAE	*Asio flammeus sandwichensis*	Pueo, Short-eared Owl, Hawaiian Owl	E	•		•	•		
PYCNONOTIDAE	*Pycnonotus cafer*	Red-vented Bulbul	A	•	•	•	•	•	•
MUSCICAPIDAE	*Cettia diphone*	Japanese Bush-warbler	A		•	•			•
	Chasiempis sandwichensis ibidis	Oahu 'Elepaio	E		•				•
	Copsychus malabaricus	White-rumped Shama	A		•	•	•	•	•
	Leiothrix lutea	Red-billed Leiothrix	A					•	
STURNIDAE	*Acridotheres tristis*	Common Myna	A				•	•	
ZOSTEROPIDAE	*Zosterops japonicus*	Japanese White-eye	A		•	•	•	•	•
EMBERIZIDAE	*Cardinalis cardinalis*	Northern Cardinal	A		•		•	•	•
	Paroaria coronata	Red-crested Cardinal	A						•
	Passer domesticus	House Sparrow	A						•
FRINGILLIDAE	*Hemignathus virens chloris*	Oahu 'Amakihi	E		•	•			
ESTRILDIDAE	*Lonchura punctulata*	Nutmeg Mannikin	A		•		•	•	•
FRINGILLIDAE	*Carpodacus mexicanus*	House Finch	A		•	•	•		
MAMMALS									
CANIDAE	*Canis familiaris*	Domestic dog (feral)	A		•		•	•	•
FELIDAE	*Felis silvestris*	House cat (feral)	A				•	•	•
SUIDAE	*Sus scrofa*	Pig (feral)	A		•	•	•	•	•
BOVIDAE	*Capra hircus*	Domestic Goat (feral)	A			•			

C9 – LIST OF ANIMALS AT NAVMAG PH WEST LOCH BRANCH (DON 2001C)

This page is intentionally left blank.

APPENDIX D – LIST OF ANIMALS AT NAVMAG PEARL HARBOR WEST LOCH BRANCH AND WAIKELE BRANCH

Family	Scientific name	Common names	Status	Federal Status	West Loch	Waikele
		BIRDS				
ARDEIDAE	*Nycticorax nycticorax hoactli*	Black-crowned Night-heron, Auku'u	I		*	*
	Bulbulcus ibis	Cattle Egret	A		*	*
PHASIANIDAE	*Phasianus colchicus*	Ring-necked Pheasant	A		*	
ANATIDAE	*Anas wyvilliana*	Hawaiian Duck, Koloa	E	E	*	
RALLIDAE	*Gallinula chloropus sandvicensis*	Hawaiian moorhen, 'Alae 'ula		E	*	
	Fulica americana alai	Hawaiian coot, 'Alae ke'o ke'o		E	*	
RECURVIRIOSTRIDAE	*Himantopus mexicanus knudseni*	Hawaiian stilt, Ae'o		E	*	
CHARADRIIDAE	*Pluvialis fulva*	Kolea, Pacific Golden Plover	I		*	*
COLUMBIDAE	*Columba livia*	Rock Dove	A		*	*
	Geopelia strata	Zebra Dove, Barred Dove	A		*	*
	Streptopelia chinensis	Spotted Dove	A		*	*
TYTONIDAE	*Tyto alba*	Barn owl	A		*	*
STRIGIDAE	*Asio flammeus sandwichensis*	Pueo, Short-eared Owl, Hawaiian Owl	E		*	*
ALAUDIDAE	*Alauda arvensis*	Eurasian Skylark	A		*	
MIMIDAE	*Mimus polyglottos*	Northern Mockingbird	A		*	
PYCNONOTIDAE	*Pycnonotus cafer*	Red-vented Bulbul	A		*	*
MUSCICAPIDAE	*Copsychus malabaricus*	White-rumped Shama	A		*	*
	Cettia diphone	Japanese Bush-warbler	A			*
	Leiothrix lutea	Red-billed Leiothrix	A		*	
STURNIDAE	*Acridotheres tristis*	Common Myna	A		*	*
ZOSTEROPIDAE	*Zosterops japonicus*	Japanese White-eye	A		*	*
EMBERIZIDAE	*Cardinalis cardinalis*	Northern Cardinal	A		*	*
	Paroaria coronata	Red-crested Cardinal	A		*	
EMBERIZIDAE	*Passer domesticus*	House Sparrow	A		*	
ESTRILDIDAE	*Amandava amandava*	Red Avadavat, Strawberry finch	A		*	
	Padda oryzivora	Java Sparrow	A		*	
	Estrilda melpoda	Orange-cheeked waxbill	A		*	*
	Lonchura malacca	Chestnut Mannikin	A		*	*
	Lonchura punctulata	Nutmeg Mannikin	A		*	*
FRINGILLIDAE	*Carpodacus mexicanus*	House Finch	A			*

C10 – BIRD SPECIES OBSERVED AT NCTAMSPAC WAHIAWA AND NRTF LUALUALEI (FROM HNHP 2004B)

This page is intentionally left blank.

Table 1: Summary of Bird Species Observed at NAVMAG PH Lualualei Branch

Common Name	Hawaiian Name	Latin Binomial	Comments
Regulatory Status: Federalyl- and State-listed endangered			
O'ahu 'elepaio	O'ahu 'Elepaio	*Chasiempis sandwichensis ibidis*	Endemic
Regulatory Status: State-listed endangered			
Short-eared owl	pueo	*Asio flammeus sandwichensis*	Endemic
Regulatory Status: MBTA			
White-tailed tropicbird	koa'ekea	*Phaethon lepturus*	Indigenous
Cattle egret		*Bubulcus ibis*	Introduced
Pacific golden plover	kōlea	*Pluvialis fulva*	Indigenous
Regulatory status: not protected			
Erckel francolin		*Francolinus erckelii*	Introduced
Common peafowl		*Pavo cristatus*	Introduced
Rock dove		*Columa livia*	Introduced
Spotted dove		*Streptopelia chinensis*	Introduced
Zebra dove		*Geopelia striata*	Introduced
Eurasian skylark		*Alauda arvensis*	Introduced
Red-vented bulbul		*Pycnonotus cafer*	Introduced
Japanese bush-warbler		*Cettia diphone*	Introduced
White-rumped shama		*Copsychus malabaricus*	Introduced
Melodious laughingthrush		*Garrulax canorus*	Introduced
Red-billed leothrix		*Leothrix lutea*	Introduced
Japanese white-eye		*Zosterops japonicus*	Introduced
Northern mockingbird		*Mimus polyglottos*	Introduced
Common myna		*Acridotheres tristis*	Introduced
Red-crested cardinal		*Paroaria coronata*	Introduced
Northern cardinal		*Carinalis cardinalis*	Introduced
House finch		*Carpodacus mexicanus*	Introduced
'Amakihi	'amakihi	*Hemignathus flavus*	Endemic
'Apapane	'apapane	*Himatione sanguinea*	Endemic
House sparrow		*Passer domesticus*	Introduced
Common waxbill		*Estrilda astrild*	Introduced
African silverbill		*Lonchura cantans*	Introduced
Nutmeg mannikin		*Lonchura punctulata*	Introduced
Java sparrow		*Padda oryzivora*	Introduced

Source: HNHP 2004a.

Table 2: Summary of Bird Species Observed at NAVMAG PH West Loch Branch

Common Name	Hawaiian Name	Latin binomial	Comments
Regulatory Status: Federally-listed as Endangered Species			
Hawaiian stilt	āe'o	*Himantopus mexicanus knudsensi*	Found at West Loch
Regulatory Status: State-listed Endangered Species			
Hawaiian owl	pueo	*Asio flammeus*	Found at Waipi'o Peninsula.
Regulatory Status: MBTA-protected Species			
Cattle egret		*Bubulcus ibis*	Found at West Loch and Waipi'o Peninsula.
Black-crowned night heron*	'auku'u	*Nycticorax nycticorax*	Found at West Loch and Waipi'o Peninsula.
Pacific golden plover	kōlea	*Pluvialis fulva*	Found at West Loch and Waipi'o Peninsula.
Ruddy turnstone*	'akekeke	*Arenaria interpres*	Found at West Loch.
Osprey		*Pandion haliaetus*	Found at Waipi'o Peninsula.
Regulatory Status: Not protected			
Ringed-neck pheasant		*Phasianus colchicus*	Found at Waipi'o Peninsula.
Gray francolin		*Francolinus pondicerianus*	Found at West Loch and Waipi'o Peninsula.
Spotted dove		*Streptopelia chinensis*	Found at West Loch and Waipi'o Peninsula.
Zebra dove		*Geopelia striata*	Found at West Loch and Waipi'o Peninsula.
Red-vented bulbul		*Pycononotus cafer*	Found at West Loch and Waipi'o Peninsula.
Red-whiskered bulbul		*Pycnonotus jocosus*	Found at Waipi'o Peninsula.
White-rumped shama		*Copsychus malabaricus*	Found at West Loch.
Common myna		*Acridotheres tristis*	Found at West Loch and Waipi'o Peninsula.
Japanese white-eye		*Zosterops japonicus*	Found at West Loch and Waipi'o Peninsula.
Northern cardinal		*Cardinalis cardinalis*	Found at West Loch and Waipi'o Peninsula.
Red-crested cardinal		*Paroaria coronata*	Found at West Loch.
House finch		*Carpodacus mexicanus*	Found at Waipi'o Peninsula.
Yellow-fronted canary		*Serinus mozambicus*	Found at Waipi'o Peninsula.
Common waxbill		*Estrilda astrild*	Found at West Loch and Waipi'o Peninsula.

Table 2: Summary of Bird Species Observed at NAVMAG PH West Loch Branch (Continued)

Common Name	Hawaiian Name	Latin binomial	Comments
Red avadavat		*Amandava amandava*	Found at West Loch and Waipi'o Peninsula.
Warbling silverbell		*Lonchura malabarica*	Found at West Loch.
Chestnut mannikin		*Lonchura Malacca*	Found at West Loch.

Source: NAVFAC PAC 2006a

C11 – PUHAWAI FALLS SITE VISIT 15 AUGUST 2006 (NAVFAC PAC 2006F)

Puhawai Falls Site Visit Report

Date of Visit: 15 Aug 2006

Attendance:

Dan Polhemus, Entomologist, Division of Aquatic Resources, Hawaii DLNR; David Preston, Entomologist, Bishop Museum; Myra McShane, Research Assistant, Bishop Museum; Lorena Wada, Invertebrate Biologist, U.S. Fish and Wildlife Service; and Cory Campora, Entomologist, NAVFAC Pacific, U.S. Navy.

Purpose:

The purpose of this visit was to determine the location of the permanent stream in the Puhawai Valley of Lualualei that had been previously identified as a potential translocation site for *Megalagrion xanthomelas* (Sélys-Longchamps) in a 1997 Insect Diversity Study conducted by the Bishop Museum. Currently, the last remaining Oahu population of *M. xanthomelas* resides in a 100 meter reach of stream located on the grounds of Tripler Army Medical Center.

Summary of Activities:

All those in attendance hiked up the stream beginning at the point where it passes under Kolekole Road. David, Cory, and Lorena stopped at the first major rock overflow. Small piscoliid fish and the wrinkled frog, *Rana rugosa,* were seen in the stream up to this point. Dan and Myra continued up into an area of the stream dominated by Kukui, but did not proceed all the way to the origin of the stream.

Conclusion/Recommendations:

The group agreed that Navy needs to perform further survey work on the stream to determine: 1) what is the distribution of predators in the stream, 2) identify the origin of the stream, and 3) obtain some GPS data on the location of the stream. It was also recommended that the Navy work with the Army Department of Public Works (DPW) Natural Resources Staff during stream survey.

C12 – PUHAWAI FALLS SITE VISIT 30 AUGUST 2006 (NAVFAC PAC 2006L)

Puhawai Falls Site Visit Report

Date of Visit: 30 Aug 2006

Attendance:

Vince Costello, Natural Resource Specialist, Army DPW; Stephan Lee, Entomologist, NAVFAC Pacific, U.S. Navy; and Cory Campora, Entomologist, NAVFAC Pacific, U.S. Navy.

Purpose:

The purpose of this visit was to hike the length of Puhawai Stream from the point where it passes under Kolekole Road up to its source and to determine the distribution of predators in this portion of the stream. It was also intended that GPS data be obtained for stream.

Summary of Activities:

All those in attendance hiked up the stream. While traveling up the stream bed, periodic observations were made on the presence/absence of potential damselfly predators such as fish, frogs, and prawns. Sightings of damseflies were also recorded. A Trimble® GeoXM™ handheld GPS unit was used to obtain spatial reference data for the stream and latitude/longitude coordinates of areas containing damselfly predators.

Findings:

Due to the terrain surrounding the stream, the GPS unit was not able to locate enough satellites to calculate spatial coordinates.

In the area of the stream under the Kolekole Road bridge, we observed the Tahitian prawn, *Macrobrachium lar*, the wrinkled frog, *Rana rugosa*, and Poeciliid fish.

Moving farther up the stream we did not observe any more prawns, but the Poeciliid fish and the wrinkled frog were present all the way up to an area of the stream where the water flowed over a steep portion of exposed rock (see Figure 1). This was

Figure 1. Fish barrier approximately 100 m upstream from Kolekole Road.

approximately 100 meters upstream from the bridge. Beyond this point we observed no more fish in the stream, but wrinkled frogs were present all the way up to a large waterfall approximately 30 to 50 meters in height (see Figure 2). No damselflies, native or alien, were observed during the survey.

The distance from the first rock overflow, or fish barrier, to the large waterfall was approximately 200 m. It was not possible to proceed beyond the large waterfall from within the stream bed. The only way to get to the area of the stream above the falls was to hike up the hillside from a location with a more gradual slope and then cross over to the area above the falls (Figure 3). Time did not permit this endeavor to be undertaken on this site visit.

Recommendations:

1. Hike around to the upper portion of the stream and continue survey for damselfly habitat and predators.

2. Explore the possibility of introducing *Megalagrion xanthomeles* into Puhawai stream above the first barrier.

Figure 2. Puhawai Falls.

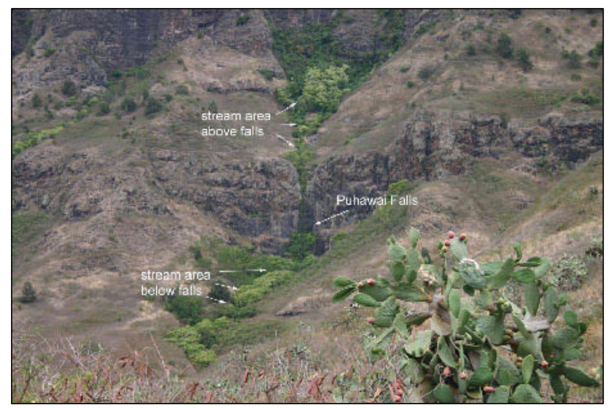


Figure 3. Puhawai Stream above and below Puhawai Falls.

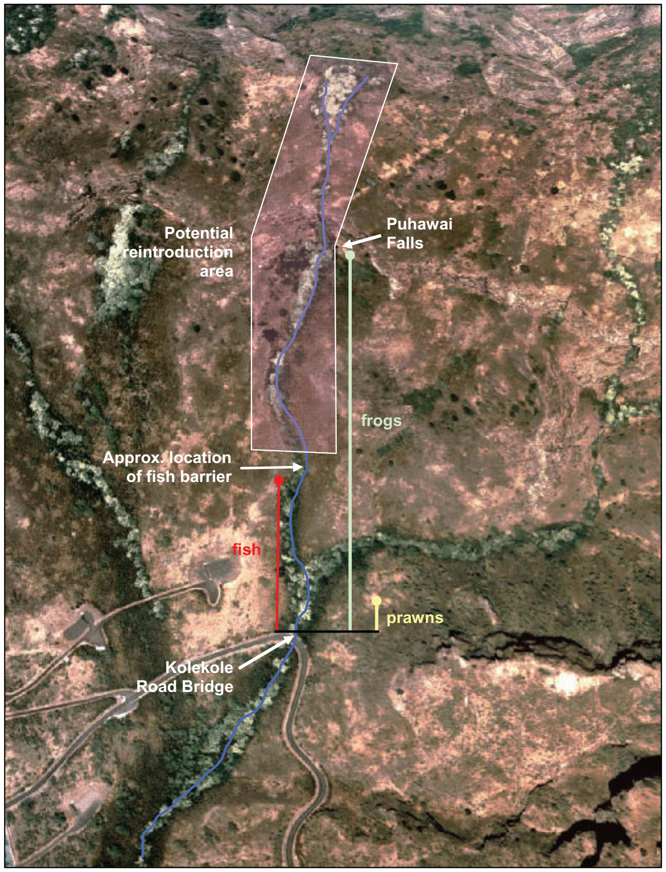


Figure 4. Range of alien damselfly predators in Puhawai Falls.

C13 – PUHAWAI FALLS SITE VISIT 30 OCTOBER 2006 (NAVFAC PAC 2006M)

Puhawai Falls Site Visit Report

Date of Visit: 30 Oct 2006

Attendance:

Vince Costello, Natural Resource Specialist, Army DPW; Lucas Morgan, Natural Resource Specialist, Army DPW; and Cory Campora, Entomologist, NAVFAC Pacific, U.S. Navy.

Purpose:

To survey the upper portion (above the falls) of Puhawai Falls Stream for suitable *Megalagrion xanthomelas* habitat.

Summary of Activities:

All those in attendance hiked up the mountainside neighboring Puhawai Falls stream following the route shown in Figure 1.

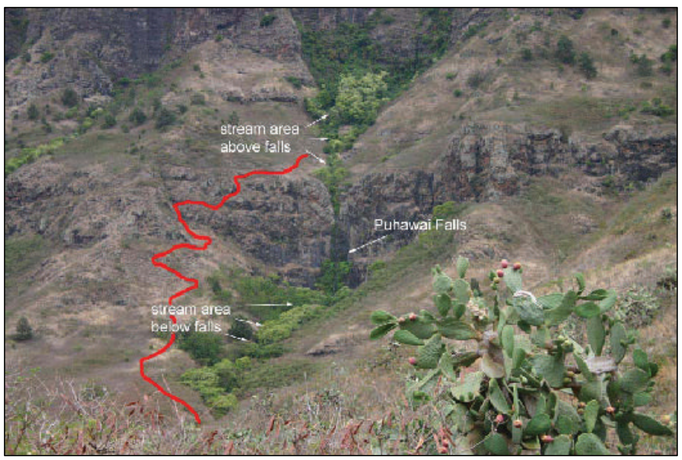
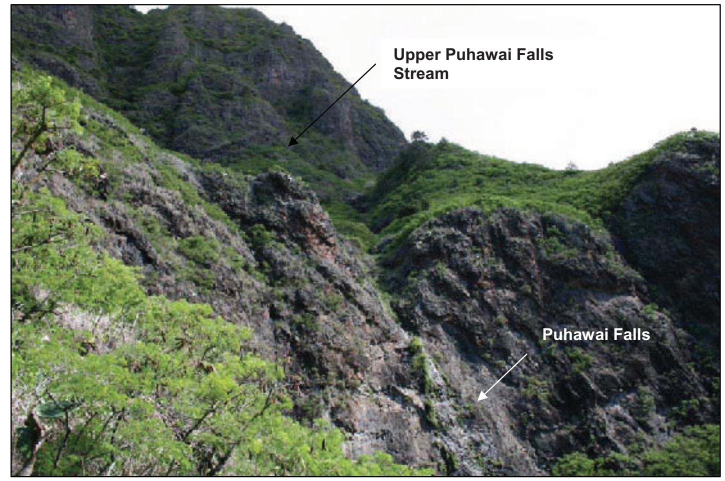


Figure 1. Route (shown in red) to upper Puhawai Falls Stream

Upon arrival above Puhawai Falls, the stream was surveyed for damselflies and potential damselfly habitat.

Findings:

The route chosen to upper Puhawai Falls Stream required some advanced climbing ability and was not easily accessible to the average person. Only Vince and Luke were able to safely negotiate this route.



There was one fork in the main stream, and beyond this neither stream originated from a single source, but rather they came from a variety of seeps and waterfalls coming from another cliff higher up towards the ridge. At least one pig and evidence of pig disturbance were observed in the upper Puhawai Falls Stream. Most of the vegetation in the area consisted of weed species, except for a native hibiscus and some mamaki, or *Pipturis albidus*, and was not remarkably different compared to the plants along the stream below the falls. The area was found to provide suitable Megalagrion habitat. One damselfly was observed, but it was not identified. Vince described the damselfly as being a brownish color. A few aquatic snails were collected in the stream and taken to the University of Hawaii for identification. It was determined by Brandon Holland (Assistant Researcher, Center for Conservation Research & Training, Pacific Biosciences Research Center) that there were two species represented in the snail specimens, one from the genus *Melanoides* and one from the genus *Lymnaea*. It is likely that the *Melanoides* sp. is non-native and the *Lymnaea sp.* is native. The latter snail may be rare, and further work is underway to determine the species.

C13 – PUHAWAI FALLS SITE VISIT 30 OCTOBER 2006 (NAVFAC PAC 2006M)

Endangered Plant Survey
NCTAMS Radio Transmitting Facility
Lualualei, HI

Prepared by
Laura L. Williams
Justin Fujimoto
Naval Facilities Engineering Command Pacific
Pearl Harbor, HI

Prepared for
Naval Facilities Engineering Command Hawaii
Pearl Harbor, HI

Introduction

Comprehensive Flora and Fauna surveys of the Lualualei Radio Transmitting Facility (LLL RTF) were conducted in 2004 by the Hawaii Natural Heritage Program (HNHP) and then regularly as part of the natural resource management program by biologists at Naval Facilities Engineering Command Hawaii and Pacific (NAVFAC HI and NAVFAC PAC, respectively). These surveys identified several of the currently monitored populations within the LLL RTF. Since 2004, populations of three endangered species have been identified within LLL RTF as follows: four *Marsilea villosa* populations (Figure 1); nine *Abutilon menziesii* individuals in three separate population areas (Figure 2); and two populations of *Cyperus trachysanthos* (Figure 3).

The *M. villosa* populations vary in size seasonally and between locations. The *M. villosa* in the southern corner of LLL RTF (Figure 4) has no canopy cover and is the largest population at approximately 22,744 m^2 (Figure 5). The western population is under a Kiawe (*Prosopis pallid*) canopy and covers approximately 547 m^2. A small population of *M. villosa* is also located on the south-southeast portion of the open field of LLL RTF and comprises approximately 356 m^2. The remaining population occurs in the open western field and is much smaller, at approximately 37 m^2 (Figure 6). A U.S. Navy grant was provided to University of Hawaii Doctoral candidate Marian Chou to conduct dissertation research on *M. villosa* at LLL RTF, which has been completed. Her dissertation investigates the associated plant community, canopy cover and soil in relation to *M. villosa* population, and will include a *M. villosa* management plan for the LLL RTF.

The *A. menziesii* populations all occur under Kiawe canopy. One solitary individual is located near the Niulii Ponds. East of the Niulii Ponds are two populations with five and three individuals, respectively (Figure 7).

Figure 1. *Marsilea villosa* population near LLL RTF.

The northern most population of *C. trachysanthos* consists of one small group that was last observed in 2009. The second population is located in a drainage way on the southeast section of the RTF that is approximately 719 m^2 (Figure 4).

The purpose of this report is to present results of surveys conducted at LLL RTF and Naval Magazine from January through October 2011.

Figure 2. *Abutilon menziesii* flower from an individual at LLLRTF

Figure 3. *Cyperus trachysanthos* from LLL RTF.

Figure 4. Area surveyed in January-February 2011 at LLL RTF and adjacent portion of the Naval Magazine with locations for populations of endangered plants *Marsilea villosa*, *Cyperus trachysanthos*, and *Abutilon menziesii.* (newly identified *M. villosa*)

Methods

Surveys to identify new populations of endangered plants were conducted between January 5 and February 4, 2011 at the Lualualei Radio Transmitting Facility (LLL RTF) and adjacent forested regions of the Naval Magazine at Lualualei (Figure 4). The forested area within the Naval Magazine to the east of the Niulii ponds were not surveyed in 2004 (HNHP), but consists of habitat similar and contiguous with the existing *A. menziesii* individuals. Non-permanent parallel transects spaced between 10-20 m were surveyed for endangered plants simultaneously by between 2 and 4 observers. All endangered plants and populations were recorded with a geographic positioning system (GPS) Garmin map76.

Additional measurements were made on *A. menziesii* individuals as follows; crown diameter, stem diameter, canopy cover, reproductive status, and health. Canopy cover was calculated according to Meueller-Dombois and Ellenberg (2002) with the following equation $(D_1+D_2/4)^2\,\pi$. Monthly surveys were conducted through October of existing and previously known locations to detect growth later in the season.

Figure 5. The largest *Marsilea villosa* habitat (prior to 2010) located in the southern corner of the LLL RTF, March 2010.

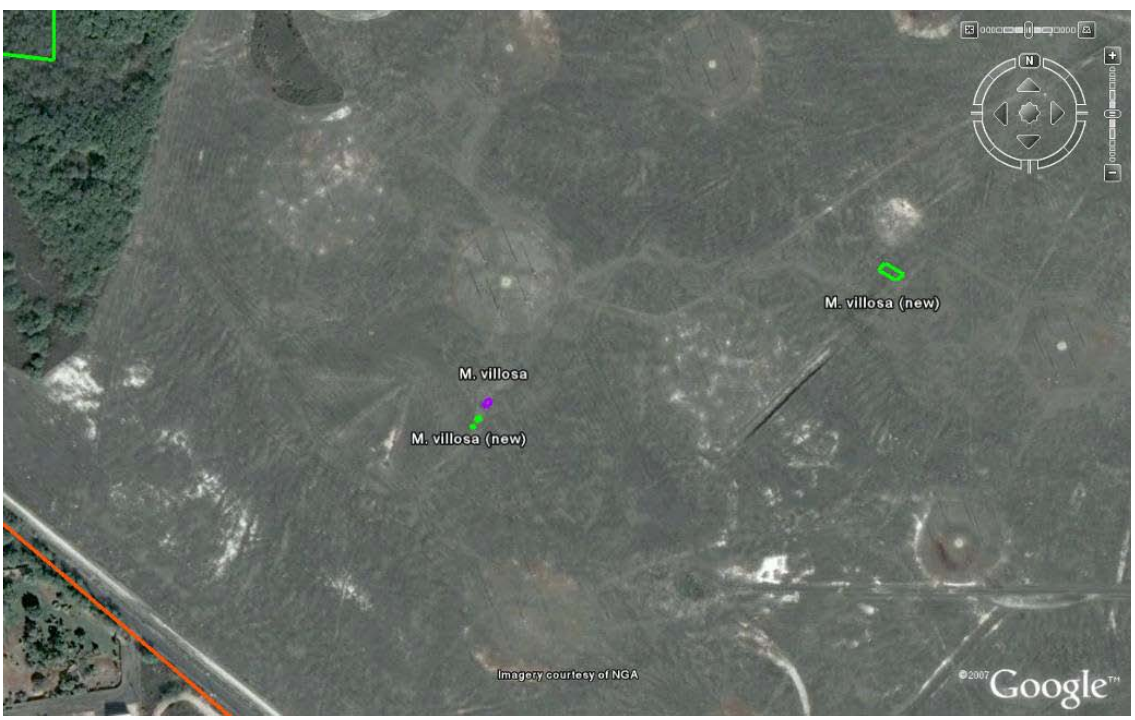


Figure 6. *Marsilea villosa* new (▬) and previously identified populations within the field habitat at LLL RTF.

Results

Several previously unidentified *Marsilea villosa* populations were found during the 2011 surveys. Two small populations (covering less than a 10x30 m area) were located in the western field of LLL RTF, one adjacent to and the other about 150 m from the existing field population (Figure 6). The second population was found in the west forested corner of the RTF, inland from the previously-known population which is located near the road (Figure 8). The largest of this population is located approximately 100 meter from the road in a low-depression area. The smaller populations are closer to the road. The larger population of *M. villosa* covered an area at least 10,130 m^2 (Figure 9). The exact area will be delineated within Marian Chou's dissertation and resulting publications.

There were no previously unidentified *A. menziesii* individuals or C. *trachysanthos* populations found during these 2011 surveys. Table 1 provides measurement data for the nine *A. menziessi* individuals at LLL RTF.

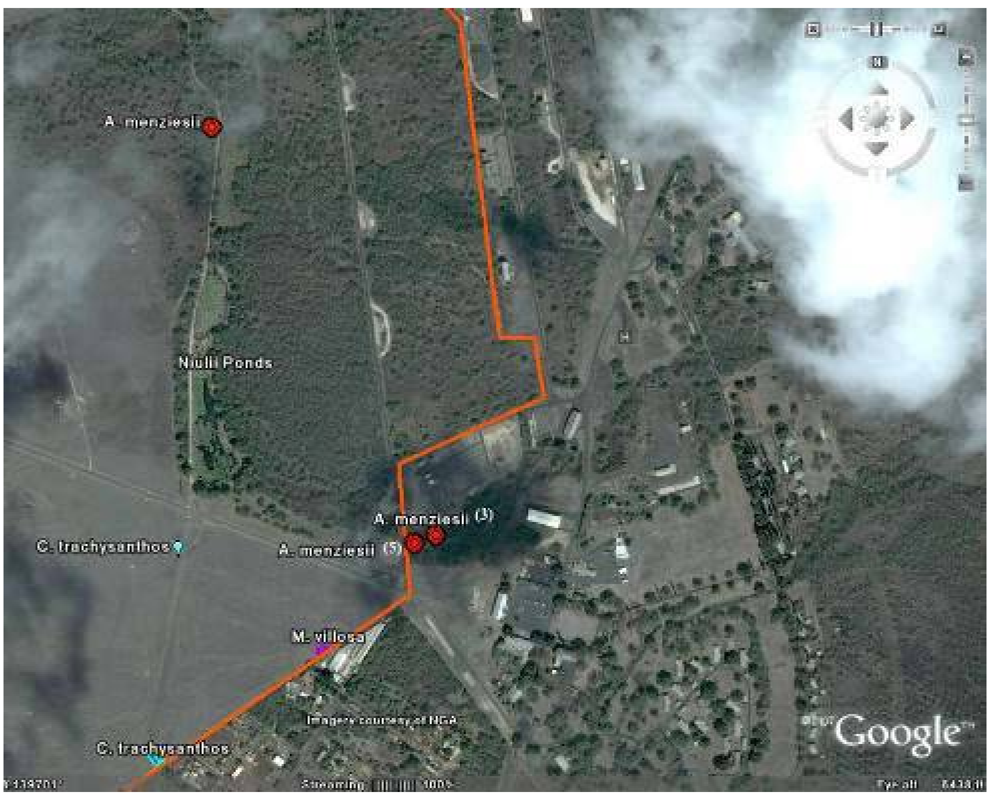


Figure 7. The nine *Abutilon menziesii* individuals located in three areas: north of the Niulii Ponds (1 individual); and two populations clustered south east of the Niulii ponds (5 and 3 individuals, respectively).

Discussion

The previously undocumented field populations (Figure 6) of *M. villosa* present potentially intriguing questions with regard to dispersal and reproduction. It is possible that *M. villosa* had spread from the other adjacent field population or it could have been dormant during previous surveys, as it is known to be ephemeral and dependant on environmental conditions (Wester et al 2006). The large previously-unidentified *M. villosa* population (Figure 8 & 9) was found in an area that had been suspected of being potential habitat; however individuals had not previously been observed (2004 HNHP). This population, which has not yet been completely mapped, represents a large important component of the whole *M. villosa* Oahu population.
The data collected on *A. menziesii* represent baseline data to monitor growth and health of existing populations over time. These baseline surveys should be expanded and incorporated into a larger management plan developed in collaboration with stakeholders and the U.S. Fish and Wildlife Service. Such a plan would include additional baseline monitoring parameters and data to be collected, intervals for surveys, as well as habitat restoration and improvement projects, invasive species control, and adaptive management plans.

Table 1. Summary of baseline data collected from nine *A. menziesii* individuals on LLL RTF, January 2011. Individual #1 is located adjacent to the Niulii ponds, #2-6 southwest and #7-9 are south east (Figure 7).

	***Abutilon menziesii* individuals**								
Identification	1	2	3	4	5	6	7	8	9
Crown cover (m2)	191.04	158.29	120.70	339.62	211.13	72.35	66.44	Dead	32.15
Height (m)	1.8	2.2	3	2.6	2.5	2.5	0.25		1.2
# stems	4	4	8	11	12	4	3		4
Diameter	12.74	11.31	21.02	27.55	25.64	7.80	5.73		10.19

Figure 8. New (▬) and previously identified *M. villosa* populations in western area of LLL RTF.

Figure 9. A previously unobserved *M. villosa* population in the western section of LLL RTF (January 2010). Note the dense green matt of *M. villosa* under the Kiawe trees.

References

Hawaii Natural Heritage Program. 2004. Flora and fauna survey of the naval computer and telecommunications area master station Pacific, Oahu, Hawaii. University of Hawaii. Pp 37.

Mueller-Dombois, D. and H. Ellenberg. 2002. Aims and methods of vegetation ecology. Blackburn Press, New Jersey.

Wester, L., J. Delay, L. Hoang, B. Iida, N. Kalodimos, and T. Wong. 2006. Population dynamics of *Marsilea villosa* (Marsileaceae) on O'ahu, Hawai'i. Pacific Science: 60(3): 385-402.

Recommedations:

1. Find an easier and safer route to the upper stream area.

2. Until an easier route is found to the upper stream area, do not include the upper stream area in the *M. xanthomelas* relocation proposal.

3. When an easier route to the upper stream is established, conduct more rigorous surveys for damselflies and aquatic snails.

4. Survey lower stream for native aquatic snails.

In the area of the stream under the Kolekole Road bridge, we observed the Tahitian prawn, *Macrobrachium lar*, the wrinkled frog, *Rana rugosa*, and Poeciliid fish.

Moving farther up the stream we did not observe any more prawns, but the Poeciliid fish and the wrinkled frog were present all the way up to an area of the stream where the water flowed over a steep portion of exposed rock (see Figure 1). This was approximately 100 meters upstream from the bridge. Beyond this point we observed no more fish in the stream, but wrinkled frogs were present all the way up to a large waterfall approximately 30 to 50 meters in height (see Figure 2). No damselflies, native or alien, were observed during the survey.

The distance from the first rock overflow, or fish barrier, to the large waterfall was approximately 200 m. It was not possible to proceed beyond the large waterfall from within the stream bed. The only way to get to the area of the stream above the falls was to hike up the hillside from a location with a more gradual slope and then cross over to the area above the falls (Figure 3). Time did not permit this endeavor to be undertaken on this site visit.

Recommendations:

1. Hike around to the upper portion of the stream and continue survey for damselfly habitat and predators.

2. Explore the possibility of introducing *Megalagrion xanthomeles* into Puhawai stream above the first barrier.

APPENDIX D
NCTAMSPAC WAHIAWA AND NRTF LUALUALEI PLANT AND ANIMAL SURVEYS

D1 – FLORA AND FAUNA SURVEY OF NAVAL COMPUTER AND TELECOMMUNICATIONS AREA MASTER STATION PACIFIC, O‘AHU, HAWAI‘I (HNHP 2004B)

This page is intentionally left blank.

Flora and Fauna Survey of the Naval Computer and Telecommunications Area Master Station Pacific, Oahu, Hawaii.

Prepared for
Commander,
Navy Region Hawaii

Prepared by
Hawaii Natural Heritage Program
University of Hawaii at Manoa
Center for Conservation Research and Training
677 Ala Moana Blvd., Suite 705
Honolulu, HI 96813

October 2004

This page is intentionally left blank.

Executive Summary

The Hawaii Natural Heritage Program (HINHP) conducted a flora and fauna survey at the Naval Computer and Telecommunications Area Master Station Pacific (NCTAMSPAC) facilities during the first half of 2004. The two facilities surveyed were NCTAMS Wahiawa (NCTAMS Wahiawa), and NCTAMS Radio Transmitting Facility, Lualualei (RTF LLL). The objective of the survey was to conduct biological surveys for native, rare, threatened, and endangered flora and fauna and to identify areas of significant native dominated habitat in order for the Navy to meet objectives in the Integrated Natural Resources Management Plan.

The two facilities are several miles apart and differ in topography and habitat. NCTAMS Wahiawa is located within an agricultural setting and contains two deep forested gulches. RTF LLL is adjacent to Naval Magazine Pearl Harbor, Lualualei Branch and is an open, relatively flat area that is regularly mowed.

Searches for native, rare, threatened, and endangered plant species were conducted in the gulches of NCTAMS Wahiawa. No threatened or endangered species were located, though some native-dominated areas were documented.

Prior to this survey, two endangered plant species were known to be at RTF LLL, *Marsilea villosa* and *Abutilon menziesii*. One additional species was discovered during our survey, *Cyperus trachysanthos*.

Forest bird surveys were conducted at NCTAMS Wahiawa in Poamoho Gulch and the Unnamed Gulch. No native species were observed. Eighteen non-native species were detected in forested areas, and an additional five bird species were found in open habitat. The absence of native avifauna can be attributed to several factors including inadequate habitat, mosquito-borne disease, depredation by non-native mammals, and competition from non-native bird species.

A wetland area called Niulii Ponds Wildlife Refuge occurs on RTF LLL. Surveys for the four endangered waterbird species resulted in confirmed observation of all but the Hawaiian duck. On Oahu populations of Hawaiian duck are considered hybridized with mallards. Field identification guidelines for pure Hawaiian ducks versus hybrids are still in development so the ducks observed at Niulii Ponds Wildlife Refuge could not be confirmed as definitively Hawaiian ducks or hybrids. Coot chicks were observed, and stilt nests and breeding behavior by moorhens was observed.

Acknowledgments

The input, guidance, and assistance of several individuals and organizations aided The Hawaii Natural Heritage Program during this survey. In particular, we note the efforts of Stefan Kropidlowski, who provided assistance in the field.

Navy staff at Navy Region Hawaii, NAVFAC Pacific and at NCTAMSPAC provided invaluable assistance. Stan Kato, Randy Miyashiro, Julie Rivers, and Tim Sutterfield aided us by providing information pertinent to the survey area and by coordinating access onto the station.

Table of Contents

List of Tables

List of Figures

This page is intentionally left blank.

Introduction

The Hawaii Natural Heritage Program (HINHP) was contracted in September 2003 by Naval Facilities Engineering Command, Pacific to conduct biological surveys for native, rare, threatened and endangered flora and fauna on the Naval Computer and Telecommunications Area Master Station Pacific (NCTAMSPAC). The station consists of two locations; NCTAMS Wahiawa (NCTAMS Wahiawa) and NCTAMS Radio Transmitting Facility, Lualualei (RTF LLL). The purpose of this work was to update the species database so that the Navy can meet management objectives in its Integrated Natural Resources Management Plan for NCTAMSPAC. The objective of the biological surveys was to identify native, rare, threatened, and endangered species as well as areas of significant native dominated habitat.

NCTAMS Wahiawa is located in Central Oahu in the plain between the Waianae and Koolau Mountains (Figure 1). The facility is a combination of residential and office buildings and mowed antenna fields. The northern boundary is defined in part by a large branch of Poamoho Gulch, and the southwest boundary is delineated by a smaller branch of Poamoho Gulch which also bisects the southern eastern portion of the base. The southeastern boundary of the facility follows the edge of the North Kaukohaua Gulch. No rare plants are known to occur in NCTAMS Wahiawa. The gulches are generally forested, but most of these forests are dominated by alien plants, though some pockets of vegetation are still native-dominated, particularly in parts of Poamoho Gulch. No native bird populations at NCTAMS Wahiawa have been documented since at least 1986.

RTF LLL is directly adjacent to Naval Magazine Pearl Harbor, Lualualei Branch (Figure 2). Habitat is primarily open grass that is regularly mowed. It also contains a few small, unmaintained areas consisting of mainly alien trees, shrubs, and grasses. At the initiation of this study, two endangered plant species were known from RTF LLL: three locations of *Marsilea villosa* and a single plant of *Abutilon menziesii*.

Five native bird species were known to occur on RTF LLL prior to this survey, four are Federally endangered waterbirds: Hawaiian stilt (*Himantopus mexicanus knudseni*), Hawaiian moorhen (*Gallinula chloropus sandvicensis*), Hawaiian coot, (*Fulica alai*), and Hawaiian duck (*Anas wyvylliana*). The other species is the Hawaiian owl, or pueo (*Asio flammeus sandwichensis*), which is considered endangered by the State of Hawaii.

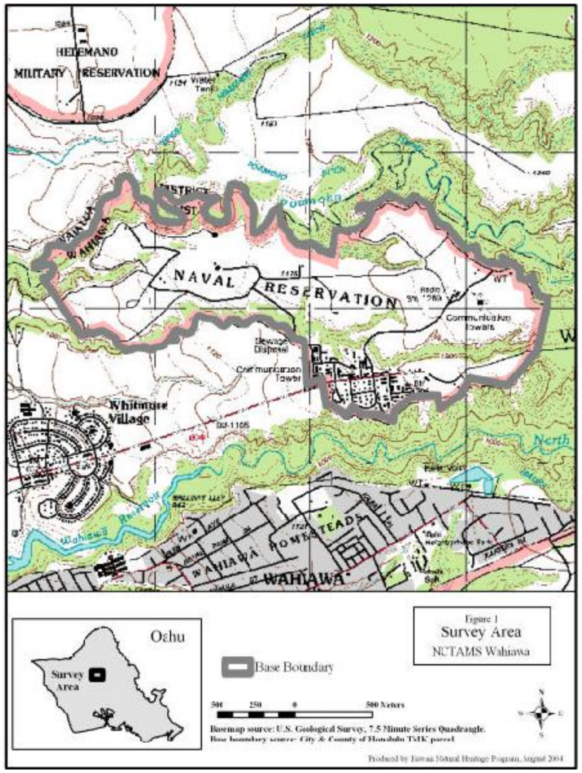


Figure 1
Survey Area
NCTAMS Wahiawa

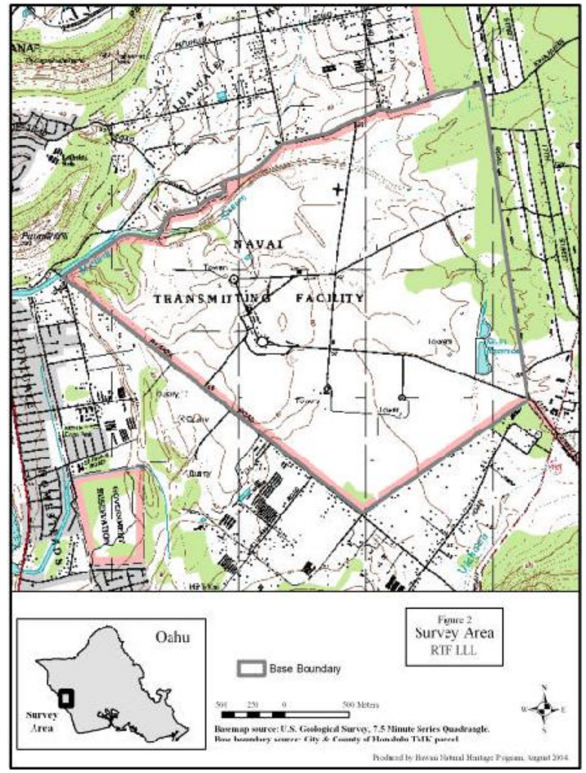


Figure 2
Survey Area
RTF LLL

Methods

Botanical Survey

NCTAMS Wahiawa
At NCTAMS Wahiawa, the potential for finding naturally occurring rare and endangered plants was limited to the forested gulches. In some portions of the gulches the vegetation is still native dominated. In other portions of the gulches the vegetation is now dominated by alien plants, but still contains native remnants, so there remains some possibility that rare plants continue to persist in these stretches of the gulches. We searched for rare plants in the two branches of Poamoho Gulch during March 2004.

RTF LLL
The survey period included the latter part of the wet season, in the months of January through June 2004. This was of particular importance for surveying RTF LLL, since one of the known endangered species, *M. villosa*, is most readily noticed in the wet season when the plant's fronds are large and green. In the dry season its fronds are usually dead and brown, and thus more difficult to detect. Additionally, there are a few dryland plant taxa potentially occurring at RTF LLL that may be difficult to detect in the dry season. These include the few annual species in the Hawaiian flora that are alive only in the wet season, and a few perennial species that either die back to the roots or whose leaves are shed at the onset of the dry season.

The three known populations of *M. villosa* were visited, and additional locations for the species were sought. The search for *M. villosa* centered on areas that flood during rainstorms. The species most often grows in areas where water ponds after being flooded.

The sedge *Cyperus trachysanthos*, which was discovered partway through the survey, grows in the same habitat that *M. villosa* requires. Both of these species potentially occur even in the parts of RTF LLL where the grass is regularly mowed.

The third listed endangered species known from RTF LLL, *A. menziesii*, was sought mostly in higher areas not subjected to periodic flooding, and particularly in the portions of RTF LLL not regularly mowed.

Lists of the native and naturalized plants were compiled for both NCTAMS Wahiawa and RTF LLL (Appendix 1, Appendix 2).

Bird Survey

NCTAMS Wahiawa
We surveyed over several non-consecutive days during March 2004. We entered the gulches at accessible points, walked along the bottom of the gulch and stopped approximately every 10 minutes to listen and look for bird species. Species observed were recorded into notebooks. The number of individuals of each species detected was not noted. In order to

detect species that may utilize the tree canopy, portions of the rim of both gulches were surveyed using the same method. Because pueo frequent open areas as well as forested areas (Berger 1981), surveys for this species focused on both open areas and forested areas.

RTF LLL
Species present at Niulii Ponds Wildlife Refuge were observed on two occasions. The number of individuals of each species was recorded. Because 2004 was exceptionally rainy, we drove through the facility to see if additional “pothole wetlands” were being utilized by waterbirds. We also looked for pueo at this time.

Data Management and Summary

Survey routes were recorded with a Trimble ProXR GPS unit and TSCe Datalogger using TerraSync™. The boundaries of the rare plant populations were recorded, and point locations of individuals or small groups of individuals were also recorded. In cases where satellite reception was poor or nonexistent, locations were approximated on USGS 7.5 minute Quadrangle Maps in ArcView GIS upon return from the field.

GPS data were downloaded from the Trimble unit into Pathfinder Office software and were differentially corrected to increase the accuracy of the data recorded in the field. The corrected data were exported as shapefiles for use in creation of maps in ArcView.

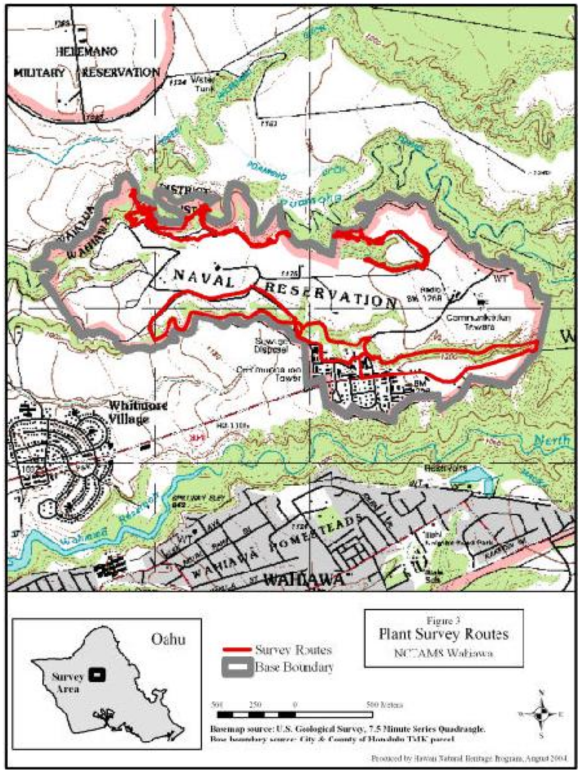
Results

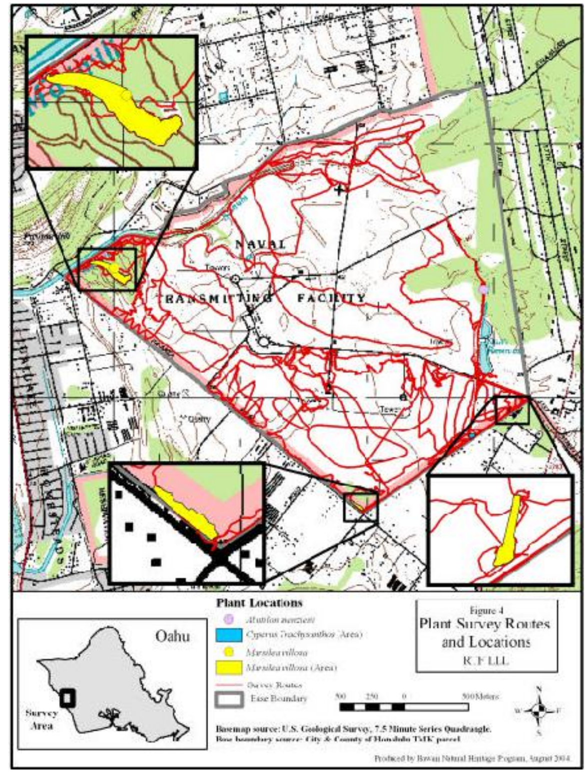
Botanical Survey

NCTAMS Wahiawa
No rare plants were found at NCTAMS Wahiawa, although some portions of the gulches, especially the main branch of Poamoho Gulch on the north side of the installation, are still native-dominated. Survey routes are shown in Figure 3.

RTF LLL
We detected three endangered plant species during our survey (Figure 4). One of these species, *C. trachysanthos* was newly recorded for the area. No new areas of *M. villosa* were observed.

The sole known individual of *A. menziesii* on RTF LLL was visited. All of the plant's larger branches were dead. It appears that the drought conditions over the past few years had taken a toll on the plant. However, the plant had several young, vigorously growing basal suckers. No seedlings or immature plants were seen in the area around the mature plant.


HELEMANO
MILITARY RESERVATION
NAVAL RESERVATION
Whitmore Village
WAHIAWA HOMESTEADS
WAHIAWA
Oahu
Survey Area
Survey Routes
Base Boundary
Figure 3
Plant Survey Routes
NCTAMS Wahiawa
500 250 0 500 Meters
Basemap source: U.S. Geological Survey, 7.5 Minute Series Quadrangle.
Base boundary source: City & County of Honolulu TMK parcel
Produced by Hawaii Natural Heritage Program, August 2004


NAVAL
TRANSMITTING FACILITY
Plant Locations
Abutilon menziesii
Cyperus trachysanthos (Area)
Marsilea villosa
Marsilea villosa (Area)
Survey Routes
Base Boundary
Oahu
Survey Area
Figure 4
Plant Survey Routes
and Locations
RTF LLL
500 250 0 500 Meters
Basemap source: U.S. Geological Survey, 7.5 Minute Series Quadrangle.
Base boundary source: City & County of Honolulu TMK parcel
Produced by Hawaii Natural Heritage Program, August 2004

C. trachysanthos was recorded for the first time on RTF LLL during this survey. The plants were found in two adjacent areas. One group was found in a low-lying drainage ditch and the other group was found on higher ground near the ditch. The lower group of plants is in a part of the drainage ditch where the ditch widens out, and where water pools after heavy rains. When the *C. trachysanthos* plants were discovered on Feb. 24, 2004, the central portion of this area was an open mud flat, much of which was still under water. Most of the *C. trachysanthos* plants at this lower site were located on this central mud flat. The mud flat portion of the pool is bordered by a thick growth of tall alien grasses, mostly barnyard grass (*Echinochloa colona*) and Wilder grass (*Dichanthium aristatum*). Seventy-eight *C. trachysanthos* plants were counted in this lower site when the plants were first found. Seventy were mature, and eight were immature. The mature plants were large and vigorous, and were flowering profusely. When the site was observed again on June 7, the mud flat was completely dry, and a significant amount of *Chamaesyce hieracifolia*, an alien herb, had grown on the dry mud. The mature *C. trachysanthos* plants had grown significantly, and all of the plants observed to be immature earlier in the year had matured and were fertile.

The second group of *C. trachysanthos* plants was discovered on March 24, 2004. This group of plants is near the first group, but is on higher ground that is flooded only shallowly and briefly. At the time of discovery of this group, there was no standing water at the site. These plants are in the portion of RTF LLL grounds that had been mowed periodically. When these plants were found, the area had been mowed within the previous two weeks, and the upper portions of the plants, including leaves and inflorescences, had been cut off. However, there was no evidence of any of the plants dying as a result of having been mowed. Most of the plants at this site were immature when first found. The mature plants at this location were much smaller and younger than those at the first spot. By June 7, when the plants were observed again, many of the plants that were immature earlier in the year had matured. We counted 292 mature plants and 174 immature plants.

M. villosa is known on RTF LLL from three widely separated areas along RTF LLL's periphery. All three of these sites were visited on this survey. No new *M. villosa* areas were found. One of the previously known sites is next to Mailiili Stream at the western corner of RTF LLL. The second site is at the southern corner of RTF LLL. Both of these sites support large numbers of plants. The third site, which is next to the southeastern boundary, has fewer plants of *M. villosa* than the other two sites.

Bird Survey

NCTAMS Wahiawa

Twenty-three bird species were observed during the survey of NCTAMS Wahiawa, no native species were observed (Table 1, Figure 5).

RTF LLL

Twenty-two bird species were observed at RTF LLL. Three of the five target species were observed (Table 2). These were the waterbirds Hawaiian stilt, coot, and moorhen at Niulii Wildlife Refuge. Ducks were also observed at Niulii Wildlife Refuge, but they were likely koloa hybridized with feral mallards, since it is generally thought that most koloa on Oahu

are hybrids. The genetic status of the ducks at RTF LLL could not be confirmed from solely field observation. Immature downy coot chicks and moorhen were observed, as were stilt nests. Two stilt were observed outside Niulii Ponds in a flooded area (Figure 6). No pueo were observed during the survey. Security personnel reported seeing a pair of pueo on the Lualualei access road, and found a dead pueo on the side of the road under the antenna fields of the RTF LLL. The observer thought the dead pueo appeared to have been hit by a car, but no necropsy was performed.

Table 1. List of vertebrate species observed at NCTAMS Wahiawa in 2004.

Species Name	Common Name	Residency Status*	Federal Status**	HINHP Rank***
Bubulcus ibis	Cattle Egret	An		G5
Phasianus colichicus	Ring-necked Pheasant	Al		G5
Pavo cristatus	Common Peafowl	An		G5
Pluvialis fulva	Pacific Golden Plover, Kolea	Vc		G5
Columba livia	Rock Dove	Al		G5
Streptopelia chinensis	Spotted Dove	Al		G5
Geopelia striata	Zebra Dove	Al		G4G5
Alauda arvensis	Eurasian Skylark	Al		G5
Pycnonotus cafer	Red-vented Bulbul	An		G5
Cettia diphone	Japanese Bush-warbler	Al		G5
Copsychus malabaricus	White-rumped Shama	Al		G5
Leothrix lutea	Red-billed Leothrix	Al		G4G5
Zosterops japonicus	Japanese White-eye	Al		G5
Mimus polyglottis	Northern Mockingbird	Al		G5
Acridotheres tristis	Common Myna	Al		G5
Paroaria coronata	Red-crested Cardinal	Al		G4G5
Cardinalis cardinalis	Northern Cardinal	Al		G5
Carpodacus mexicanus	House Finch	Al		G5
Passer domesticus	House Sparrow	Al		G5
Estrilda astrild	Common Waxbill	An		G5
Lonchura cantans	African Silverbill	An		G5
Lonchura punctulata	Nutmeg Mannikin	Al		G5
Padda oryzivora	Java Sparrow	An		G5
Sus scrofa scrofa	Feral Pig			G5
Herpestes auropunctatus	Mongoose			G5
Felis catus	Feral Cat			G5
Canis domesticus	Dog			

* Avian taxonomic name and residency status from Pyle 2002. Al=Alien; long established and breeding since before 1945; An=Alien; new introduction since 1945; apparently established; Re=Resident; endemic species; not extinct; Ri=Resident; indigenous species; Hawaiian population is not endemic; Vc=Visitor; common migrant to Hawaii.
**Federal Status- Official U.S. Fish and Wildlife Service, Endangered Species Act (ESA) categories for endangered and candidate endangered taxa (species, subspecies, & varieties) according to the Federal Register February 28, 1996. Listed Endangered (LE)=Taxa formally listed as endangered; Listed Threatened (LT)=Taxa formally listed as threatened; Proposed Endangered (PE)=Taxa proposed to be formally listed as endangered; Proposed Threatened (PT)=Taxa proposed to be formally listed as threatened; Candidate (C)=Taxa for which substantial information on biological vulnerability and threat(s) support proposals to list them as endangered or threatened; Species of Concern (SOC)= Taxon that is not listed or a candidate for endangered or threatened status, but is nevertheless of conservation concern.
*** HINHP Rank. G1 (or T1 for subspecific taxa)=Critically imperiled globally. 1-5 occurrences and/or fewer than 1,000 individuals remaining; or more abundant but facing extremely serious threats range-wide.
G2 (or T2 for subspecific taxa)=Imperiled globally. 6-20 occurrences and/or 1,000-3,000 individuals remaining; or more abundant but facing serious threats range - wide.
G3 (or T3 for subspecific taxa)=Moderately imperiled globally. 21-100 occurrences and/or 3,000-10,000 individuals remaining; or more abundant but facing moderate threats range-wide; or restricted in range.
G4 (or T4 for subspecific taxa)=Widespread, abundant, and apparently secure, but with cause for long-term concern.
G5 (or T5 for subspecific taxa)=Demonstrably widespread, abundant, and secure.
The Global Rank (Grank) is an international ranking system developed by the Natural Heritage network. It determines the rarity of a species worldwide, and guides agencies to set priorities for protection. The ranking system is based on an element's (taxa or ecosystem) number of occurrences and individuals, health, threats, etc. It is independent from the U.S. Fish and Wildlife Federal List of Endangered Species, but the USFWS often cites the Heritage Global Rank to help express how rare and imperiled a species is .

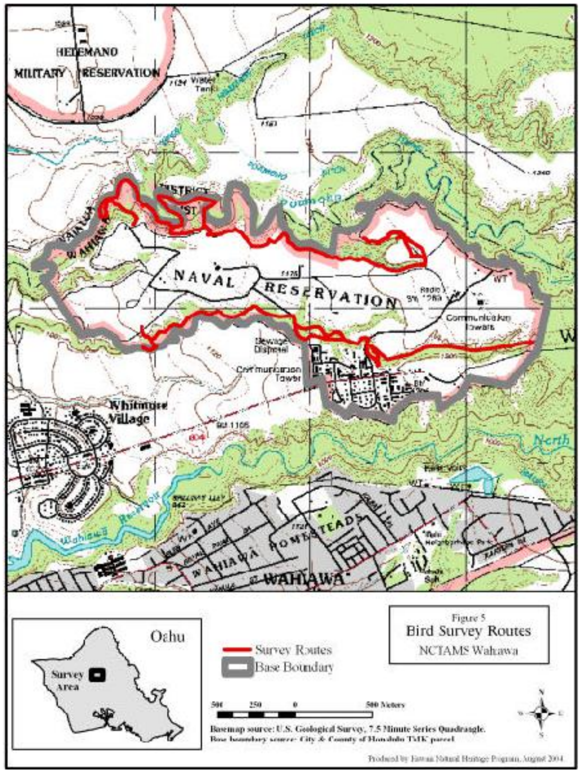
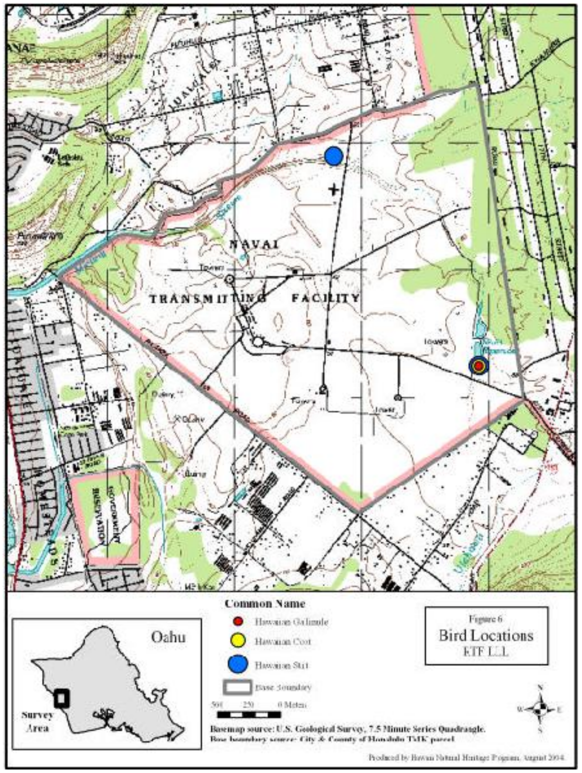


Table 2. List of vertebrate species observed at RTF LLL in 2004.

Species Name	Common Name	Residency Status*	Federal Status**	HINHP Rank***
Bubulcus ibis	Cattle Egret	An		G5
Nycticorax nycticorax	Black-crowned Night Heron	Ri		G4
Phasianus colichicus	Ring-necked Pheasant	Al		G5
NSN	Koloa (mallard hybrid ?)	N/A		N/A
Gallinula chloropus sandvicensis	Hawaiian Moorhen	Res	LE	G5T2
Fulica alai	Hawaiian Coot	Re	LE	G2
Himantopus mexicanus knudseni	Hawaiian Stilt	Res	LE	G5T2
Pluvialis fulva	Pacific Golden Plover, Kolea	Vc		G5
Streptopelia chinensis	Spotted Dove	Al		G5
Geopelia striata	Zebra Dove	Al		G4G5
Alauda arvensis	Eurasian Skylark	Al		G5
Pycnonotus cafer	Red-vented Bulbul	An		G5
Zosterops japonicus	Japanese White-eye	Al		G5
Mimus polyglottis	Northern Mockingbird	Al		G5
Acridotheres tristis	Common Myna	Al		G5
Paroaria coronata	Red-crested Cardinal	Al		G4G5
Cardinalis cardinalis	Northern Cardinal	Al		G5
Carpodacus mexicanus	House Finch	Al		G5
Passer domesticus	House Sparrow	Al		G5
Estrilda astrild	Common Waxbill	An		G5
Lonchura cantans	African Silverbill	An		G5
Lonchura punctulata	Nutmeg Mannikin	Al		G5
Padda oryzivora	Java Sparrow	An		G5
Herpestes auropunctatus	Mongoose			G5
Felis catus	Feral Cat			G5

* Avian taxonomic name and residency status from Pyle 2002. Al=Alien; long established and breeding since before 1945; An=Alien; new introduction since 1945; apparently established; Re=Resident; endemic species; not extinct; Ri=Resident; indigenous species; Hawaiian population is not endemic; Vc=Visitor; common migrant to Hawaii.
**Federal Status - Official U.S. Fish and Wildlife Service, Endangered Species Act (ESA) categories for endangered and candidate endangered taxa (species, subspecies, & varieties) according to the Federal Register February 28, 1996. Listed Endangered (LE)= Taxa formally listed as endangered; Listed Threatened (LT)=Taxa formally listed as threatened; Proposed Endangered (PE)=Taxa proposed to be formally listed as endangered; Proposed Threatened (PT)=Taxa proposed to be formally listed as threatened; Candidate (C)=Taxa for which substantial information on biological vulnerability and threat(s) support proposals to list them as endangered or threatened; Species of Concern (SOC)= Taxon that is not listed or a candidate for endangered or threatened status, but is nevertheless of conservation concern.
*** HINHP Rank. G1 (or T1 for subspecific taxa)=Critically imperiled globally. 1-5 occurrences and/or fewer than 1,000 individuals remaining; or more abundant but facing extremely serious threats range-wide.
G2 (or T2 for subspecific taxa)=Imperiled globally. 6-20 occurrences and/or 1,000-3,000 individuals remaining; or more abundant but facing serious threats range-wide.
G3 (or T3 for subspecific taxa)=Moderately imperiled globally. 21-100 occurrences and/or 3,000-10,000 individuals remaining; or more abundant but facing moderate threats range-wide; or restricted in range.
G4 (or T4 for subspecific taxa)=Widespread, abundant, and apparently secure, but with cause for long-term concern.
G5 (or T5 for subspecific taxa)=Demonstrably widespread, abundant, and secure.
The Global Rank (Grank) is an international ranking system developed by the Natural Heritage network. It determines the rarity of a species worldwide, and guides agencies to set priorities for protection. The ranking system is based on an element's (taxa or ecosystem) number of occurrences and individuals, health, threats, etc. It is independent from the U.S. Fish and Wildlife Federal List of Endangered Species, but the USFWS often cites the Heritage Global Rank to help express how rare and imperiled a species is.



Discussion

Botanical Survey

NCTAMS Wahiawa
At NCTAMS Wahiawa, some portions of Poamoho Gulch on the northern side of the survey area are still vegetated in native-dominated forest. This type of lowland native forest is not uncommon, and can be found throughout the gulches in this zone of the Koolau Mountains.

RTF LLL
A. menziesii has only recently been recorded growing wild on the island of Oahu. A single wild plant was found in the Ewa Plains in 1981. Then in 1996, a number of plants were found scattered over a large expanse of land formerly planted in sugarcane in the Kapolei area of the Ewa Plains. Also in 1996, the solitary plant on the RTF LLL was discovered by Navy staff (Herbarium Pacificum Staff, 1999). The first wild collection from the Ewa Plains was considered to represent an escape from cultivation (Bates 1990). However, wild plants are now known at additional sites from the Ewa Plains area, and most of them are located away from residential areas, and the general consensus is that the Oahu plants are not descended from cultivated plants, but rather represent naturally occurring, previously undetected populations or individuals (J. Lau, pers. comm.).

Comment [j1]: Page: 13
Not sure what this is trying to say

The plant at Lualualei is the only wild *A. menziesii* plant discovered thus far on Oahu aside from the plants in the Ewa Plains area, and its genetic material may be important for the conservation of the Oahu population of the species. Material from this plant has been collected and propagated by State of Hawaii Department of Land and Natural Resources staff. A thick layer of tall grass that surrounds the plant likely precludes the successful recruitment of seedlings and increases the risk of the plant being killed by a brushfire.

Most of the *C. trachysanthos* plants in the drainage ditch were already large mature plants when discovered on Feb. 24, 2004. They seemed to be too large to have germinated earlier in the 2003-2004 wet season, but probably germinated in a previous wet season. In contrast to the plants in the drainage ditch, all of the plants in the higher site were either small mature or immature individuals when they were discovered on March 24, 2004, and it appeared likely that most, if not all, had germinated earlier in the 2003-2004 wet season. *C. trachysanthos* is reported to be a perennial (Degener 1932, Koyama 1990), but some plant species that are normally perennial can behave as annuals under extreme environmental conditions.

The much higher percentage of immature plants in the upper site, as compared to the lower site was striking. This may indicate that germination and establishment of immature plants is optimal where there is only a moderate amount of flooding, and that prolonged deep flooding prevents the establishment of immature plants of the species. If this is the case, then perhaps the edges of the lower site, which are flooded to a lesser degree than the center of the site, would have originally been the zone with the highest rate of recruitment for the species. This zone is now thickly overgrown with tall alien grasses and competition from the grass probably limits *C. trachysanthos* recruitment.

The *M. villosa* population near Mailiili Stream and the one at the southern corner of RTF LLL are two of the three largest known populations of the species. There are significant differences between the two sites. At Mailiili, the thickest growth of *M. villosa* is in the shade of kiawe (*Prosopis pallida*) trees, while at the southern corner the thickest growth is in the full sun, and the *M. villosa* there does not extend very far into the kiawe thickets. At the Mailiili site, most of the weed cover (aside from the kiawe) consists of alien dicots such as lion's ear (*Leonotis nepetifolia*), spiny amaranth (*Amaranthus spinosa*), and slender mimosa (*Desmanthus virgatus*), while most of the site at the southern corner of RTF LLL is covered by the alien Wilder grass (*Dichanthium aristatum*).

It appears that the site in the southern corner of RTF LLL becomes flooded to a greater degree after heavy rains than does the Mailiili site. Prolonged flooding apparently kills most of the plant species that compete with *M. villosa* . The Wilder grass, however, is evidently able to tolerate the flooding.

Bird Survey

<u>NCTAMS Wahiawa</u>
No native birds were observed in the 1986 survey, so it is not surprising that we did not detect native birds during this survey. No documentation refers to the last time any native bird species was observed in that area. No suitable habitat for native birds exists in the cultivated lands west of NCTAMS Wahiawa or on the facility. The closest suitable forest bird habitat is to the east in the Koolau Mountains, but no native birds have been recorded in the adjacent region for the past twenty years (Hawaii Natural Heritage Program 2004).

RTF LLL
The expected waterbird species were observed during this survey, and successful breeding by coots and moorhens was also noted. We observed koloa-like ducks at Niulii Ponds; however, the general consensus is that Hawaiian ducks on Oahu are actually hybridized with feral mallards. Techniques for field identification of pure Hawaiian ducks versus hybrids are being developed (A. Englis, pers. comm.), so the true genetic status of the ducks at Niulii Ponds Wildlife Refuge is unknown. Plans for removal of hybrid ducks from each of the main islands are being developed. Once reintroduction of pure koloa lineages on Oahu occurs, they would likely use Niulii Ponds in the same way as past pure koloa populations did and the current alleged hybridized population presently does.

Pueo were not observed on RTF LLL during this survey, although one was observed during the concurrent surveys of NAVMAG PH, Lualualei Branch, less than one kilometer from RTF LLL. Since pueo have a large home range, the observed individual likely utilizes RTF LLL. Security personnel also have recently observed a pair of owls along Lualualei Access Road. A dead owl was found along one of the roads adjacent to the antenna fields on RTF LLL in the recent past. The mortality was attributed to being hit by a car, though no necropsy was performed.

Traps for feral cats (*Felis catus*) and mongoose (*Herpestes auropunctatus*) are maintained within Niulii Ponds. Despite this effort, fresh cat scat was observed within the fenced area.

At the initiation of this survey, we observed feeding of feral or domestic cats near the guard station.

Literature Cited

Bates, D.M. 1990. Malvaceae. pp. 868-903 *in* W.L. Wagner, D. R. Herbst and S.H. Sohmer. Manual of the Flowering Plants of Hawai`i, 2 Vols. University of Hawaii Press and Bishop Museum, Honolulu (Bishop Museum Special Publication 83).

Berger, A.J. 1981. Hawaiian birdlife. Second Edition. Honolulu. University of Hawaii Press, Honolulu.

Degener, O. 1932. Flora Hawaiiensis, fam. 48. *Cyperus trachysanthos*. Publ. priv., 2 pp., Rep., 1946.

Hawaii Natural Heritage Program. 2004. Database of rare and endangered plants, animals, and natural communities of the Hawaiian Islands. University of Hawaii at Manoa, Honolulu.

Herbarium Pacificum Staff. 1999. New Hawaiian plant records for 1998. Bishop Museum Occasional Papers 58: 3-11.

Koyama, T. 1990. Cyperaceae. pp. 1381-1436 *in* W.L. Wagner, D.R. Herbst and S.H. Sohmer, Manual of the Flowering Plants of Hawai`i, 2 Vols. University of Hawaii Press and Bishop Museum, Honolulu (Bishop Museum Special Publication 83).

Palmer, D.D. 2003. Hawai`i's Ferns and Fern Allies. University of Hawaii Press, Honolulu.

Pyle, R.L. 2002. Checklist of the birds of Hawaii 2002. Elepaio 62:135-148.

U.S. Fish and Wildlife Service. 1999. Endangered and threatened wildlife and plants. 50 CFR 17.11 and 17.12, December 1999. U. S. Dept. of Interior, Washington, DC. 55 pp.

Wagner, W.L., D.R. Herbst, and S.H. Sohmer. 1999. Manual of the flowering plants of Hawai`i, revised edition with Manual Supplement by Wagner, W.L. and D.R. Herbst, University of Hawaii Press, 1919 pp. in 2 volumes. (Bishop Museum Special Publication 97).

List of Preparers and Contributors

Hawaii Natural Heritage Program

Director
Dr. Barbara Gibson (beginning June 2004)
Shannon McElvaney (through November 2003)

Biologists
Joel Lau (Botanist)
Megan Laut (Zoologist)
Michele Harman (Assistant Biologist)
Mark Luke (Assistant Biologist)

Production Staff
Jennifer Ho (Administrative Assistant)
Roy Kam (Database Manager, Acting Director)
Dwight Matsuwaki (GIS Specialist)

Contract Biologists
Stefan Kropidlowski (Assistant Biologist)

Appendices

Appendix 1. NCTAMS Wahiawa Vascular Plant Species List.

The following is a list of the native and naturalized vascular plants observed during the 2004 Hawaii Natural Heritage Program survey of NCTAMS Wahiawa. The taxonomy and nomenclature of the flowering plants are according to the *Manual of the flowering plants of Hawai`i*, revised edition with Manual Supplement (Wagner et al. 1999); and *Hawai`i's ferns and fern allies* (Palmer 2003) for the ferns and fern allies.

Symbols:
\+ = Rare
A = Alien (Introduced, Non-native)
NNE = Native, not endemic (Native to Hawaii and elsewhere)
E = Endemic (Occurs naturally only in Hawaii)
? = Status uncertain

STATUS	TAXON	COMMON NAME
	FERNS AND FERN ALLIES	
	Aspleniaceae	
NNE	*Asplenium contiguum* Kaulf.	
	Blechnaceae	
A	*Blechnum occidentale* L.	
E	*Doodia kunthiana* Gaud.	Okupukupulauii
	Cyatheaceae	
A	*Sphaeropteris cooperi* (Hook. ex F. Muell.) R. M. Tryon	Australian treefern
	Dicksoniaceae	
E	*Cibotium chamissoi* Kaulf.	Hapuu pulu, treefern
	Dennstaedtiaceae	
E	*Pteridium aquilinum* (L.) Kuhn var. *decompositum* (Gaudich.) R. M. Tryon	
	Dryopteridaceae	
E	*Deparia prolifera* (Kaulf.) Hook. and Grev.	
E	*Nephrolepis exaltata* (L.) Schott subsp.	Kupukupu, nianiau

STATUS	TAXON	COMMON NAME
	hawaiiensis W. H. Wagner	
A	*Nephrolepis multiflora* (Roxb.) F. M. Jarrett ex C. V. Morton	Kupukupu, nianiau
	Gleicheniaceae	
NNE	*Dicranopteris linearis* (N. L. Burm.) Underw.	Uluhe
	Hymenophyllaceae	
NNE	*Gonocormus minutus* (Blume) v. d. Bosch	
	Lindsaeaceae	
NNE	*Sphenomeris chinensis* (L.) Maxon	Palaa
	Lomariopsidaceae	
E	*Elaphoglossum crassifolium* (Gaud.) Anders. and Crosby	
	Marattiaceae	
A	*Angiopteris evecta* (G. Forst.) Hoffm.	Mule's-foot fern, giant fern
	Polypodiaceae	
NNE	*Lepisorus thunbergianus* (Kaulf.) Ching	Pakahakaha, ekaha akolea
A	*Phlebodium aureum* (L.) J. Sm.	Hare's-foot fern, lauae haole
A	*Phymatosorus scolopendria* (Burm.) Pic.-Ser.	Lauae
	Psilotaceae	
NNE	*Psilotum nudum* (L.) Beauv.	Moa
	Pteridaceae	
A	*Adiantum raddianum* Presl	Maidenhair fern
	Thelypteridaceae	
A	*Christella parasitica* (L.) H. Lev.	
	GYMNOSPERMS	
	Araucariaceae	
A	*Araucaria columnaris* (Forst. fil.) Hook.	Cook pine

STATUS	TAXON	COMMON NAME
A	*Araucaria cunninghamii* Sweet	Hoop pine
	Cupressaceae	
A	*Callitris* sp.	Cypress-pine
A	*Juniperus* sp.	Juniper
	FLOWERING PLANTS: DICOTS	
	Anacardiaceae	Mango family
A	*Mangifera indica* L.	Mango
A	*Schinus terebinthifolius* Raddi	Christmas berry, wilelaiki
	Apiaceae	Parsley family
A	*Centella asiatica* (L.) Urb.	Asiatic pennywort, pohe kula
	Apocynaceae	Dogbane family
E	*Alyxia oliviformis* Gaud.	Maile
E	*Rauvolfia sandwicensis* A. DC	Hao
	Araliaceae	Ginseng family
A	*Schefflera actinophylla* (Endl.) Harms	Octopus tree
	Asteraceae	Sunflower family
A	*Ageratina riparia* (Regel) R. King and H. Robinson	Hamakua pamakani
A	*Ageratum conyzoides* L.	Maile hohono
A	*Bidens alba* (L.) DC var. *radiata* (Schultz-Bip.) Ballard ex Melchert	
E	*Bidens torta* Sherff	Kookoolau, kokoolau
A	*Conyza bonariensis* (L.) Cronq.	Hairy horseweed, ilioha
A	*Eclipta alba* (L.) Hassk.	False daisy
A	*Emilia fosbergii* Nicolson	Flora's paintbrush
A	*Emilia sonchifolia* (L.) DC	Flora's paintbrush
A	*Gnaphalium purpureum* L.	Purple cudweed
A	*Pluchea symphytifolia* (Mill.) Gillis	Sourbush
A	*Wedelia trilobata* (L.) Hitchc.	Wedelia
	Bignoniaceae	Bignonia family

STATUS	TAXON	COMMON NAME
A	*Jacaranda mimosifolia* D. Don	Jacaranda
A	*Spathodea campanulata* P. Beauv.	African tulip tree
A	*Tabebuia heterophylla* (DC.) Britton	Pink tecoma
	Casuarinaceae	She-oak family
A	*Casuarina equisetifolia* L.	Common ironwood, paina
	Cecropiaceae	Cecropia family
A	*Cecropia obtusifolia* Bertol.	Guarumo, trumpet tree
	Combretaceae	Indian almond family
A	*Terminalia myriocarpa* Van Heurck and Mull. Arg.	Jhalna
	Convolvulaceae	Morning glory family
NNE	*Ipomoea indica* (J. Burm.) Merr.	Koali awa, koali awahia
	Cucurbitaceae	Gourd family
A	*Momordica charantia* L.	Balsam pear
	Ebenaceae	Ebony family
E	*Diospyros sandwicensis* (A. DC) Fosb.	Lama, elama
	Epacridaceae	Epacris family
NNE	*Styphelia tameiameiae* (Cham. and Schlechtend.) F. v. Muell.	Pukiawe
	Euphorbiaceae	Spurge family
A	*Aleurites moluccana* (L.) Willd.	Candlenut, kukui
	Fabaceae	Pea family
A	*Acacia confusa* Merr.	Formosan koa
E	*Acacia koa* A. Gray	Koa
A	*Caesalpinia decapetala* (Roth) Alston	Wait-a-bit, Mysore thorn
A	*Chamaecrista nictitans* (L.) Moench subsp. *patellaria* (DC ex Collad.) H. Irwin and Barneby var. *glabrata* (Vogel) H. Irwin and Barneby	Partridge pea, lauki
A	*Crotalaria pallida* Aiton	Smooth rattlepod
A	*Desmanthus virgatus* (L.) Willd.	Slender mimosa, virgate mimosa

STATUS	TAXON	COMMON NAME
A	*Desmodium incanum* DC	Spanish clover, kaimi
A	*Indigofera suffruticosa* Mill.	Indigo
A	*Leucaena leucocephala* (Lam.) de Wit	Haole koa, koa haole, ekoa
A	*Mimosa pudica* L. var. *unijuga* (Duchass. and Walp.) Griseb.	Sensitive plant, pua hilahila
A	*Paraserianthus falcataria* (L.) I. Nielsen	
	Goodeniaceae	Goodenia family
E	*Scaevola gaudichaudiana* Cham.	Naupaka kuahiwi
	Lauraceae	Laurel family
A	*Persea americana* Mill.	Avocado
	Malvaceae	Mallow family
NNE?	*Hibiscus tiliaceus* L.	Hau
	Melastomataceae	Melastoma family
A	*Arthrostema ciliatum* Pav. ex D. Don	
A	*Clidemia hirta* (L.) D. Don var. *hirta*	Koster's curse
	Meliaceae	Mahogany family
A	*Toona ciliata* M. Roem. var. *australis* (F. v. Muell.) C. DC	Austrailian red cedar
	Menispermaceae	Moonseed family
NNE	*Cocculus trilobus* (Thunb.) DC	Huehue
	Moraceae	Mulberry family
A	*Ficus macrophylla* L. fil.	Moreton Bay fig
A	*Ficus microcarpa* L. fil.	Chinese banyan, Malayan banyan
A	*Ficus rubiginosa* Desf.	Port Jackson fig
	Myrsinaceae	Myrsine family
A	*Ardisia crenata* Sims	Hilo holly, hens eyes
A	*Ardisia elliptica* Thunb.	Shoebutton ardisia
	Myrtaceae	Myrtle family
A	*Eucalyptus robusta* Sm.	Swamp mahogany
A	*Eucalyptus* sp.	Eucalyptus

STATUS	TAXON	COMMON NAME
NNE	*Eugenia reinwardtiana* (Blume) DC	Nioi
A	*Lophostemon confertus* (R. Br.) Peter G. Wilson and Waterhouse	Vinegar tree, Brisbane box, brush box
A	*Melaleuca quinquenervia* (Cav.) S. T. Blake	Paperbark
E	*Metrosideros polymorpha* Gaud. var. *glaberrima* (H. Lev.) St. John	Ohia, ohia lehua, lehua
E	*Metrosideros polymorpha* Gaud. var. *incana* (H. Lev.) St. John	Ohia, ohia lehua, lehua
A	*Pimenta dioica* (L.) Merr.	Allspice
A	*Psidium cattleianum* Sabine	Strawberry guava, waiawi
A	*Psidium guajava* L.	Guava, kuawa
A	*Syzygium cumini* (L.) Skeels	Java plum
A	*Syzygium jambos* (L.) Alston	Rose apple
	Nyctaginaceae	Four-oclock family
E	*Pisonia sandwicensis* Hillebr.	Papala kepau, aulu
	Oleaceae	Olive family
E	*Nestegis sandwicensis* (A. Gray) Degener, I. Degener and L. Johnson	Olopua, pua
	Oxalidaceae	Wood sorrel family
A?	*Oxalis corniculata* L.	Yellow wood sorrel, ihi makole
	Passifloraceae	Passion flower family
A	*Passiflora edulis* Sims	Passion fruit, lilikoi
A	*Passiflora suberosa* L.	Huehue haole
	Plantaginaceae	Plantain family
A	*Plantago lanceolata* L.	Narrow-leaved plantain
A	*Plantago major* L.	Broad-leaved plantain, laukahi
	Proteaceae	Protea family
A	*Grevillea robusta* A. Cunn. ex R. Br.	Silk oak
	Rosaceae	Rose family
NNE	*Osteomeles anthyllidifolia* (Sm.) Lindl.	Ulei
A	*Rubus rosifolius* Sm.	Thimbleberry
	Rubiaceae	Coffee family

STATUS	TAXON	COMMON NAME
E	*Bobea elatior* Gaud.	Ahakea
A	*Coffea arabica* L.	Arabian coffee
E	*Psychotria mariniana* (Cham. and Schlechtend.) Fosb.	Kopiko, opiko
	Santalaceae	Sandalwood family
E	*Santalum freycinetianum* Gaud. var. *freycinetianum*	Iliahi, sandalwood
	Sapindaceae	Soapberry family
NNE	*Dodonaea viscosa* Jacq.	Aalii
	Sapotaceae	Sapodilla family
A	*Chrysophyllum oliviforme* L.	Satin leaf, caimitillo
	Solanaceae	Nightshade family
A	*Cestrum* sp.	
	Sterculiaceae	Cacao family
NNE?	*Waltheria indica* L.	Uhaloa, hialoa
	Thymelaeaceae	Akia family
E	*Wikstroemia oahuensis* (A. Gray) Rock var. *oahuensis*	Akia
	Tiliaceae	Linden family
A	*Heliocarpus popayanensis* Kunth	Moho, white moho
	Ulmaceae	Elm family
A	*Trema orientalis* (L.) Blume	Gunpowder tree, charcoal tree
	Verbenaceae	Verbena family
A	*Citharexylum caudatum* L.	Fiddlewood
A	*Lantana camara* L.	Lantana
A	*Stachytarpheta dichotoma* (Ruiz and Pav.) Vahl	Oi
A	*Stachytarpheta jamaicensis* (L.) Vahl	Jamaica vervain, oi

FLOWERING PLANTS: MONOCOTS

STATUS	TAXON	COMMON NAME
	Agavaceae	Agave family
A	*Cordyline fruticosa* (L.) A. Chev.	Ti, ki
A	*Furcraea foetida* (L.) Haw.	Mauritius hemp, malina
E	*Pleomele halapepe* St. John	Halapepe
	Araceae	Philodendron or aroid family
A	*Xanthosoma sagittifolium* (L.) Schott	Tannia, yautia
	Arecaceae	Palm family
A	*Phoenix dactylifera* L.	Date palm
A	Roy*stone*a sp.	Royal palm
	Cyperaceae	Sedge family
NNE	*Carex meyenii* Nees	
E	*Carex wahuensis* C. A. Mey. subsp. wa*huens*is	
E	*Gahnia aspera* Spreng. subsp. gl*obosa* (H. Mann) J. Kern	
	Liliaceae	Lily family
NNE	*Dianella sandwicensis* Hook. and Arnott	Ukiuki
	Musaceae	Banana family
A	*Musa x paradisiaca L.*	Banana, maia
	Orchidaceae	Orchid family
A	*Arundina graminifolia* (D. Don) Hochr.	Bamboo orchid
A	*Epidendrum x obrienianum* Rolfe	Scarlet orchid, butterfly orchid
A	*Spathoglottis plicata* Blume	Malayan ground orchid,
	Pandanaceae	Screw pine family
NNE	*Freycinetia arborea* Gaud.	Ieie
	Poaceae	Grass family
A	*Andropogon virginicus* L.	Broomsedge, yellow bluestem
A	*Axonopus fissifolius* (Raddi) Kuhlm.	Narrow-leaved carpet grass
A	*Brachiaria mutica* (Forssk.) Stapf	California grass, para grass
NNE?	*Chrysopogon aciculatus*(Retz.) Trin.	Golden beardgrass, manienie ula, pilipili
A	*Melinus minutiflora* P. Beauv.	Molasses grass
A	*Melinus repens*(Willd.) Zizka	Natal redtop

STATUS	TAXON	COMMON NAME
A	*Oplismenus hirtellus* (L.) P. Beauv.	Basketgrass, honohono kukui
A	*Panicum maximum* Jacq.	Guinea grass
A	*Paspalum conjugatum* Bergius	Hilo grass
A	*Paspalum dilatatum* Poir.	Dallis grass
A	*Paspalum fimbriatum* Kunth	Fimbriate paspalum
NNE?	*Paspalum scrobiculatum* L.	Ricegrass
A	*Pennisetum polystachion* (L.) Schult.	Feathery pennisetum
A	*Pennisetum purpureum* Schumach.	Elephant grass, Napier grass
A	*Setaria gracilis* Kunth	Yellow foxtail
A	*Setaria palmifolia* (J. Konig) Stapf	Palmgrass
A	*Sporobolus africanus* (Poir.) Robyns and Tournay	Smutgrass, African dropseed
	Zingiberaceae	Ginger family
A	*Hedychium coronarium* J. Konig	White ginger, awapuhi keokeo
A	*Zingiber zerumbet* (L.) Sm.	Shampoo ginger, awapuhi kuahiwi

Appendix 2. RTF LLL Vascular Plant Species List.

The following is a list of the native and naturalized vascular plants observed during the 2004 Hawaii Natural Heritage Program survey of RTF LLL . The taxonomy and nomenclature of the flowering plants are according to the *Manual of the flowering plants of Hawai`i*, revised edition with Manual Supplement (Wagner et al. 1999); and *Hawai`i's ferns and fern allies* (Palmer 2003) for the ferns and fern allies.

Symbols:

+ = Rare
A = Alien (Introduced, Non-native)
NNE = Native, not endemic (Native to Hawaii and elsewhere)
E = Endemic (Occurs naturally only in Hawaii)
? = Status uncertain

	STATUS	TAXON	COMMON NAME
		FERNS AND FERN ALLIES	
		Marsileaceae	
+	E	*Marsilea villosa* Kaulf.	Ihiihi, ihi laau
		FLOWERING PLANTS: DICOTS	
		Aizoaceae	Fig-marigold family
	A	*Trianthema portulacastrum* L.	
		Amaranthaceae	Amaranth family
	A	*Achyranthes aspera* L. var. *aspera*	
	A	*Amaranthus spinosus* L.	Spiny amaranth, pakai kuku
		Asteraceae	Sunflower family
	A	*Ageratum conyzoides* L.	Maile hohono
	A	*Bidens cynapiifolia* Kunth	Spanish needle, beggartick
	A	*Bidens pilosa* L.	Spanish needle, beggartick
	A	*Conyza bonariensis* (L.) Cronq.	Hairy horseweed, ilioha
	A	*Crassocephalum crepidioides* (Benth.) S. Moore	
	A	*Emilia fosbergii* Nicolson	Flora's paintbrush
	A	*Emilia sonchifolia* (L.) DC	Flora's paintbrush
	A	*Lactuca serriola* L.	Prickly lettuce
	A	*Parthenium hysterophorus* L.	False ragweed, Santa Maria

STATUS	TAXON	COMMON NAME
A	*Pluchea symphytifolia* (Mill.) Gillis	Sourbush
A	*Pluchea* x *fosbergii* Cooperr. and Galang	Sourbush
A	*Sonchus oleraceus* L.	Sow thistle, pualele
A	*Tridax procumbens* L.	Coat buttons
A	*Verbesina encelioides* (Cav.) Benth. and Hook.	Golden crown-beard
A	*Vernonia cinerea* (L.) Less. var. *parviflora* (Reinw.) DC	Little ironweed
A	*Xanthium strumarium* L. var. *canadense* (Mill.) Torr. and A. Gray	Cocklebur, kikania
	Bataceae	Saltwort family
A	*Batis maritima* L.	Pickleweed, akulikuli kai
	Bignoniaceae	Bignonia family
A	*Tecoma castanifolia* (Don) Melch.	Chestnutleaf trumpetbush
	Boraginaceae	Borage family
A	*Heliotropium procumbens* Mill. var. *depressum* (Cham.) Fosb.	
	Chenopodiaceae	Goosefoot family
A	*Atriplex semibaccata* R. Br.	Australian saltbush
A	*Atriplex suberecta* Verd.	Saltbush
	Convolvulaceae	Morning glory family
E	*Jacquemontia ovalifolia* (Choisy) H. Hallier subsp. *sandwicensis* (A. Gray) K. Robertson	Pau-o-Hiiaka
A?	*Merremia aegyptia* (L.) Urb.	Hairy merremia
	Cucurbitaceae	Gourd family
A	*Coccinia grandis* (L.) Voigt	Scarlet-fruited gourd
A	*Cucumis dipsaceus* Ehrenb. ex Spach	Hedgehog gourd, teasel gourd
A	*Momordica charantia* L.	Balsam pear
	Euphorbiaceae	Spurge family
A	*Chamaesyce hirta* (L.) Millsp.	Hairy spurge, garden spurge, koko kahiki
A	*Chamaesyce hypericifolia* (L.) Millsp.	Graceful spurge
A	*Chamaesyce prostrata* (Aiton) Small	Prostrate spurge

	STATUS	TAXON	COMMON NAME
		Fabaceae	Pea family
	A	*Acacia farnesiana* (L.) Willd.	Klu, kolu
	A	*Crotalaria incana* L.	Rattlepod
	A	*Desmanthus virgatus* (L.) Willd.	Slender mimosa, virgate mimosa
	A	*Desmodium incanum* DC	Spanish clover, kaimi
	A	*Indigofera spicata* Forssk.	Creeping indigo
	A	*Indigofera suffruticosa* Mill.	Indigo
	A	*Leucaena leucocephala* (Lam.) de Wit	Haole koa, koa haole, ekoa
	A	*Macroptilium lathyroides* (L.) Urb.	Wild bean, cow pea
	A	*Mimosa pudica* L. var. *unijuga* (Duchass. and Walp.) Griseb.	Sensitive plant, pua hilahila
	A	*Prosopis pallida* (Humb. and Bonpl. ex Willd.) Kunth	Algaroba, mesquite, kiawe
		Gentianaceae	Gentian family
	A	*Centaurium erythraea* Raf. subsp. *erythraea*	Bitter herb, European centaury
		Lamiaceae	Mint family
	A	*Hyptis pectinata* (L.) Poit.	Comb hyptis
	A	*Leonotis nepetifolia* (L.) R. Br.	Lion's ear
	A	*Ocimum gratissimum* L.	Basil
		Malvaceae	Mallow family
	A	*Abutilon grandifolium* (Willd.) Sweet	Hairy abutilon, mao
	NNE?	*Abutilon incanum* (Link) Sweet	Hoary abutilon, mao
+	E	*Abutilon menziesii* Seem.	Koolo aula
	E	*Gossypium tomentosum* Nutt. ex Seem.	Mao
	A	*Malva parviflora* L.	Cheese weed
	A	*Malvastrum coromandelianum* (L.) Garcke subsp. *coromandelianum*	False mallow
	A	*Sida ciliaris* L.	
	NNE	*Sida fallax* Walp.	Ilima
	A	*Sida spinosa* L.	Prickly sida
		Nyctaginaceae	Four-o'clock family
	A	*Boerhavia coccinea* Mill.	
	NNE	*Boerhavia repens* L.	Alena

	STATUS	TAXON	COMMON NAME
		Portulacaceae	Purslane family
	A	*Portulaca oleracea* L.	Pigweed, ihi
	A	*Portulaca pilosa* L.	Pigweed, ihi
		Scrophulariaceae	Figwort family
	NNE	*Bacopa monnieri* (L.) Wettst.	Aeae, water hyssop
		Solanaceae	Nightshade family
	A	*Datura stramonium* L.	Jimson weed
	A	*Lycopersicon pimpinellifolium* (Jusl.) Mill.	Currant tomato
	A	*Nicandra physalodes* (L.) Gaertn.	Apple of Peru
	A	*Nicotiana glauca* R. C. Graham	Tree tobacco
	NNE?	*Solanum americanum* Mill.	Glossy nightshade, Popolo
		Sterculiaceae	Cacao family
	NNE?	*Waltheria indica* L.	Uhaloa, hialoa
		Verbenaceae	Verbena family
	A	*Stachytarpheta jamaicensis* (L.) Vahl	Jamaica vervain, oi
		FLOWERING PLANTS: MONOCOTS	
		Commelinaceae	Spiderwort family
	A	*Commelina benghalensis* L.	Hairy honohono
		Cyperaceae	Sedge family
	A	*Cyperus rotundus* L.	Nut grass, kilioopu
+	E	*Cyperus trachysanthos* Hook. and Arnott	Puukaa
	NNE?	*Eleocharis calva* Torr.	Kohekohe, pipiwai, spikerush
		Lemnaceae	Duckweed family
	A?	*Lemna perpusilla* Torr.	Duckweed
		Poaceae	Grass family
	A	*Bothriochloa pertusa* (L.) A. Camus	Pitted beardgrass
	A	*Brachiaria mutica* (Forssk.) Stapf	California grass, para grass

STATUS	TAXON	COMMON NAME
A	*Brachiaria plantaginea* (Link) Hitchc.	
A	*Cenchrus ciliaris* L.	Buffelgrass
A	*Cenchrus echinatus* L.	Common sandbur, umealu
A	*Chloris barbata* (L.) Sw.	Swollen fingergrass, mauu lei
A	*Cynodon dactylon* (L.) Pers.	Bermuda grass, manienie
A	*Dactyloctenium aegyptium* (L.) Willd.	Beach wiregrass
A	*Dichanthium aristatum* (Poir.) Hubb.	Wilder grass
A	*Digitaria insularis* (L.) Mez ex Ekman	Sourgrass
A	*Echinochloa colona* (L.) Link	Jungle-rice
A	*Echinochloa crus-galli* (L.) P. Beauv.	Barnyard grass
A	*Eleusine indica* (L.) Gaertn.	Wiregrass
A	*Eragrostis cilianensis* (All.) Link	Stinkgrass
A	*Eragrostis tenella* (L.) P. Beauv ex Roem. and Schult.	Japanese lovegrass
A	*Melinus repens* (Willd.) Zizka	Natal redtop
A	*Panicum maximum* Jacq.	Guinea grass
A	*Setaria verticillata* (L.) P. Beauv.	Bristly foxtail
A	*Sporobolus africanus* (Poir.) Robyns and Tournay	Smutgrass, African dropseed

Appendix 3. Species Information

Background information of all Federally endangered, threatened, and species of concern observed on Navy property at Radio Transmitting Facility, Lualualei.

Plants

Photo R. Hobdy

Abutilon menziesii Seem.
Common name: Kooloa ula
Family: Mallow family (Malvaceae)
Federal status: Endangered (USFWS 1999)
Heritage global rank: G1 (Hawaii Natural Heritage Program 2004)

A. menziesii is a shrub up to 2 meters tall. Its leaves are heart-shaped and 3 to 10 centimeters long. The flowers are solitary in the leaf axils, pendulous, and bear maroon petals 1.5 to 2.5 centimeters long. The fruits are cylindrical and are 8 to10 millimeters long (Bates 1990).

The species has been recorded from the leeward side of Oahu, Lanai, West Maui, East Maui, and the South Kohala region on the island of Hawaii. It occurs in dry shrublands and forests at elevations from 20 meters to 430 meters (98 to 1477 feet).

Photo J. Lau

Cyperus trachysanthos Hook and Arnott
Common name: Puukaa
Family: Sedge family (Cyperaceae)
Federal status: Endangered (USFWS 1999)
Heritage global rank: G1 (Hawaii Natural Heritage Program 2004)

C. trachysanthos is a densely tufted perennial sedge with short rhizomes. The stems are 20 to 45 centimeters long, and are leafy at the base. The leaves are longer than the stems, and are 2.5-3.5 millimeters wide. The inflorescences are 5-9 centimeters long and 6-12 centimeters wide (Koyama 1990).

C. trachysanthos is endemic to the islands of Niihau, Kauai, Oahu, Molokai, and Lanai. It has been recorded from 3 to 61 meters (9 to 200 feet) in elevation. It occurs mostly in dry regions, usually on the leeward sides of the islands, in wet sites such as at pond margins, and at sites that are only intermittently wet (Hawaii Natural Heritage Program 2004).

Photo M. Bruegmann

Marsilea villosa Kaulf.
Common name: Ihiihi, ihi laau
Family: Water-clover family (Marsileaceae)
Federal status: Listed endangered (USFWS 1999)
Heritage global rank: G1 (Hawaii Natural Heritage Program 2004)

M. villosa is an aquatic fern with creeping rhizomes. The stipes are in clusters of 2-65 per node. The fronds bear four fan-shaped pinnae 2 to 2.5 centimeters long and 2.2 to 2.3 centimeters wide that arise closely from a short rachis, giving the frond the appearance of a four-leaf clover. The sori are contained in hard sporocarps (spore-bearing structures) borne at the stipe bases. The sporocarps bear two types of spores: microspores and larger megaspores (Palmer 2003).

M. villosa is endemic to Niihau, Oahu, and Molokai. It is found in dry areas, usually in depressions that flood during heavy winter rains and dry out completely during the summer. Populations of this species have been recorded from 3 to 170 meters (9 to 558 feet) in elevation (Hawaii Natural Heritage Program 2004).

Birds

Photo credit unknown

Gallinula chloropus sandvicensis
Common name: Hawaiian moorhen, alae ula
Family: Rallidae
Federal Status: Listed endangered (USFWS 1999)
Heritage global rank: G5T2 (Hawaii Natural Heritage Program 2004)

The Hawaiian moorhen is a gray bird with a darker head and neck, white streaks on the flanks and white undertail. The frontal shield and bill are red, with a yellow tip on the bill. It is most often found in freshwater ponds, marshes, reservoirs, and aquaculture sites. It remains closer to vegetation, and is wary.

G. chloropus sandvicensis were formerly more widespread and abundant in the Hawaiian Islands, but now they are represented by several hundred individuals occurring mainly on Kauai and Oahu. The population fluctuates with habitat conditions. Historic habitat has been drastically reduced and predation by introduced mammalian predators poses a threat.

Photo R. Shallenberger

Fulica alai
Common name: Hawaiian coot, alae keokeo
Family: Rallidae
Federal status: Listed endangered
Heritage global rank: G2 (Hawaii Natural Heritage Program 2004)

F. alai adults are solid dark gray with a white bill and frontal shield. White undertail feathers are visible when swimming. They are found in fresh and brackish bodies of water. The population fluctuates with habitat conditions. Historic habitat has been drastically reduced and predation by introduced mammalian predators may be a problem.

Photo credit unknown

Himantopus mexicanus knudseni
Common name: Hawaiian stilt, aeo
Family: Recurvirostridae
Federal status: Listed endangered (USFWS 1999)
Heritage global rank: G5T2 (Hawaii Natural Heritage Program 2004)

The Hawaiian stilt is an endemic race of the Black-necked stilt. It is a tall, slender bird with a black back, neck, and head. The legs are orange and the bill is black.

Hawaiian stilts frequent mudflats along or near natural or human-made ponds and wetlands, often near coastal areas. Loafing areas generally are mudflats, mats of pickleweed, or open pasture where visibility is good and predators are few.

D2 – LIST OF PLANTS AT NCTAMSPAC WAHIAWA AND NRTF LUALUALEI (CNRH 2001C)

APPENDIX 5 -
PLANTS OF NAVAL COMPUTER AND TELECOMMUNICATION AREA MASTER STATION PACIFIC

Family	Scientific name	Common names	Status	Federal Status	Wahiawa	RTF LLL
FERNS AND FERN ALLIES						
ADIANTACEAE	*Adiantum radianum* Presl	Maidenhair fern	A			
	Cheilanthes decipiens W.H. Wagner	Kumuniu	E			
	Cheilanthes subdecipiens W.H. Wagner	Kumuniu	E			
	Pellaea viridis (Forssk.) Prantl	Green Cliffbrake	A		*	
	Pteris cretica L.		I			
	Pteris x *hillebrandii* Copel. (*P. cretica* L. x *P. irregularis* Kaulf.)		E			
	Pteris irregularis Kaulf.	Mana, ʻahewa	E			
ASPLENIACEAE	*Asplenium acuminatum* Hook. & Arnott		E			
	Asplienium adiantum-nigrum L.		I			
	Asplenium contiguum Kaulf.		E			
	Asplenium horridum Kaulf.		E			
	Asplenium macraei Hook. & Arnott		E			
	Asplenium nidus L.	ʻEkaha, bird's nest fern	I		*	
	Asplenium paraemorsum Sw.		I			
BLECHNACEAE	*Blechnum occidentale* L.		A		*	
	Doodia kunthiana Gaud.	ʻOkupukupulauʻiʻi	E		*	
	Sadleria cyatheoides Kaulf.	ʻAmaʻu, maʻu	E			
CYATHEACEAE	*Cibotium splendens* (Gaud.) Krajins ex. Skottsb.	Hapuʻu, treefern	E		*	
DENNSTAEDTIACEAE	*Microlepia speluncae* (L.) T. Moore	Palapalai	I			
	Microlepia x *adulterina* W.H. Wagner	Palapalai	E			
	Microlepia strigosa (Thunb.) Presl	Palapalai	I			
	Odontosoria chinensis (L.) J. Sm.	Palaʻa	I		*	
	Pteridium decompositum Gaud.	Kilau	E		*	
DRYOPTERIDACEAE	*Cyrtomium caryotideum* Presl	Kaʻapeʻape	I			
	Cyrtomium falcatum (L. fils.) Presl		A			
	Deparia fenzliana (Luerss.) M. Kato		E			
	Deparia petersenii (Kunze) M. Kato		A			
	Diplazium sandwichianum (Presl) Diels	Hoʻiʻo, pohole	E			
	Dryopteris fusco-atra (Hillebr.) Rob.		E			
	Dryopteris nuda Underw.		E			
	Dryopteris unidentata (Hook. & Arnott) C. Chr.		E			
	Elaphoglossum aemulum (Kaulf.) Brack.		E			
	Elaphoglossum alatum Gaud.		E			
	Elaphoglossum crassifolium (Gaud.) Anders. & Crosby		E			
	Elaphoglossum paleaceum (Hook. & Grev.) Sledge		I			
	Nephrolepis exaltata (L.) Schott var. *hawaiiensis* W.H. Wagner var. nov. ined.	Kupukupu, niʻaniʻau	E		*	
	Nephrolepis multiflora (Roxb.) Jarrett ex Morton	Kupukupu, niʻaniʻau	A		*	*

PLANTS OF NAVAL COMPUTER AND TELECOMMUNICATION AREA MASTER STATION PACIFIC

Family	Scientific name	Common names	Status	Federal Status	Wahiawa	RTF LLL
	Tectaria cicutaria (L.) Copel. ssp. *gaudichaudii* (Brack.) W.H. Wagner comb. nov. ined.	'Iwa'iwa lau nui	E			
GLEICHENIACEAE	*Dicranopteris linearis* (N.L. Burm.) Underw.	Uluhe	I		*	
	Hicriopteris pinnata (G. Kunze) Ching.		I		*	
GRAMMITIDACEAE	*Adenophorus tamariscinus* (Kaulf.) Hook. & Grev.	Wahine noho, mauna	E			
	Grammitis tenella Kaulf.					
HEMIONITIDACEAE	*Pityrogramma austroamericana*	Golden fern	A		*	
HYMENOPHYLLACEAE	*Gonocormus minutus* (Blume) v. d. Bosch		I		*	
	Vandenboschia davalliodes (Gaud.) Copel.		E			
HYPOLEPIDACEAE	*Pteridium aquilinum* (L.) Kuhn var. *decompositum* (Gaud.)	Kilau	E		*	
LYCOPODIACEAE	*Lycopodium cernuum* L.	wawae'iole	I		*	
MARSILEACEAE	*Marsilea villosa* Kaulf.		E	E		*
POLYPODIACEAE	*Lepisorus thunbergianus* (Kaulf.) Ching	Pakahakaha, 'ekaha, 'akolea	I			
	Phlebodium aureum (L.) J. Sm.	Hare's-foot fern, laua'e haole	A			
	Phymatosorus scolopendria (Burm.) Pic.-Ser.	Laua'e	A		*	
	Pleopeltis thunbergiana Kaulf.	Pakahakaha	I		*	
	Polypodium pellucidum Kaulf.	'Ae	E		*	
PSILOTACEAE	*Psilotum nudum* (L.) Beauv.	Moa	I		*	
SELAGINELLACEAE	*Selaginella arbuscula* (Kaulf.) Spring	Lepelepe-a-moa	E			
THELYPTERIDACEAE	*Christella dentata*	Downy wood fern, pai'i'iha	A			
	Macrothelypteris torresiana (Gaud.) Ching		A			
	Thelypteris hudsoniana (Brack.) Reed		E			
	Thelypteris parasitica (L.) Fosberg		A		*	
GYMNOSPERMS						
ARAUCARIACEAE	*Araucariaceae heterophylla* (Salisb.) Franco	Norfolk Island pine	A		*	
CUPRESSACEAE	*Juniperus* sp.	Juniper	A		*	
		Monterey cypress	A		*	
FLOWERING PLANTS: DICOTS						
ACANTHACEAE	*Asystasia gangetica* (L.)	Asystasia, Chinese violet	A			*
	Ruellia prostrata Poir.		A		*	

PLANTS OF NAVAL COMPUTER AND TELECOMMUNICATION AREA MASTER STATION PACIFIC

Family	Scientific name	Common names	Status	Federal Status	Wahiawa	RTF LLL
AMARANTHACEAE	*Achyranthes aspera* L. var. *aspera*		A			
	Achyranthes indica (L.) Mill.		A			*
	Alternathera repens (L.) Ktze.	Khaki weed	A			*
	Amaranthus spinosus L.	Spiny amaranth, pakai kuku	A			*
	Amaranthus viridis L.	Slender amaranth, pakai	A			*
	Charpentiera obovata Gaud.	Papala	E			
	Nototrichium humile Hillebr.	Kulu'i	E	E		
ANACARDIACEAE	*Mangifera indica* L.	Mango	A		*	
	Schinus terebinthifolius Raddi	Christmas berry, wilelaiki	A		*	
APIACEAE	*Centella asiatica* (L.) Urban	Asiatic pennywort	A		*	
	Ciclospermum leptophyllum (Pers.)	Fir-leaved celery	A		*	
	Cryptotaenia canadensis (L.) DC	Honeywart	A		*	
	Hydrocotyle sibthorpioides Lam.	Marsh pennywort	A		*	
APOCYNACEAE	*Allamanda cathartica* L.	Allamanda, lani-ali'I	A		*	
	Alyxia oliviformis Gaud.	Maile	E		*	
	Ochrosia compta K. Schrum.	Holei	E		*	
	Rauvolfia sandwicensis A. DC	Hao	E			
AQUIFOLIACEAE	*Ilex anomala* Hook. & Arnott	Kawa'u	E			
ARALIACEAE	*Cheirodendron trigynum* (Gaud.) A. Heller ssp. *trigynum*	'Olapa	E			
	Reynoldsia sandwicensis A. Gray	'Ohe-o-kai, 'ohe kukuluae'o	E			
	Schefflera actinophylla (Endl.) Harms	Octopus tree	A		*	
	Tetraplasandra oahuensis (A. Gray) Harms	'Ohe mauka	E			
ARISTOLOCHIACEAE	*Aristolochia littoralis* Parodi	Calico flower	A			
ASCLEPIADACEAE	*Asclepias curassavica* L.	Milkweed, butterfly weed	A			
	Stapelia gigantea N.E.Br.	Carrion flower, Zulu-giant, giant toad plant	A			
ASTERACEAE	*Acanthospermum australe* (Loefl.) Kuntze	Spiny bur	A		*	
	Ageratina adenophora (Spreng.) R. King & H. Robinson	Maui pamakani	A			
	Ageratina riparia (Regel) R. King & H. Robinson	Hamakua pamakani	A		*	
	Ageratum conyzoides L.	Maile hohono	A		*	
	Artemesia australis Less.	Hinahina, hinahina kuahiwi	E			
	Baltimora recta L.		A			
	Bidens alba (l.) DC		A		*	
	Bidens cervicata Sherff	Ko'oko'olau, koko'olau	A			

PLANTS OF NAVAL COMPUTER AND TELECOMMUNICATION AREA MASTER STATION PACIFIC

Family	Scientific name	Common names	Status	Federal Status	Wahiawa	RTF LLL
	Bidens cynapiifolia Kunth	Spanish needle, beggartick	A		*	
	Bidens pilosa L.	Spanish needle, beggartick	A		*	*
	Bidens torta Sherff	Koʻokoʻolau, kokoʻolau	E		*	
	Calyptocarpus vialis Less.	Hierba del caballo	A		*	
	Centaurea melitensis L.	Thistle	A			
	Conyza bonariensis (L.) Cronq.	Hairy horseweed, ilioha	A		*	
	Conyza canadensis (L.) Cronq.	Canadian flea bane	A		*	*
	Crassocephalum crepidiodes (Benth.) S. Moore		A		*	
	Cyanthillium cinereum (L.) H. Rob.	Little ironweed	A		*	*
	Dubautia plantaginea Gaud. ssp. *plantiginea*	Naenae	E			
	Eclipta alba (L.) Haask.	False daisy	A		*	
	Emilia fosbergii Nicolson	Flora's paintbrush	A		*	
	Emilia sonchifolia (L.) DC	Flora's paintbrush	A		*	
	Erechtitus hieracifolia (L.) Raf.	Fireweed	A			*
	Erechtitus valerianaefolia (Wolf) DC.		A		*	
	Erigeron karvinskianus DC	Daisy fleabane	A			
	Galinsoga parviflora Cav.		A			
	Gamochaeta purpureum (L.) Cabrera	Purple cudweed	A		*	
	Hypochoeris radicata L.	Hairy cat's ear, gosmore	A			
	Lipochaeta lobata (Gaud.) DC var. *leptophylla* Degener & Sherff	Nehe	E	E		
	Lipochaeta tenuis Degener & Sherff	Nehe	E	SOC		
	Montonoa hibiscifolia Benth.	Tree daisy	A			
	Pluchea carolinensis (Mill.) Gillis	Sourbush	A		*	*
	Pluchea indica (L.) Less	Indian pluchea, sourbush	A			*
	Sonchus oleraceus L.	Sow thistle, pualele	A			*
	Synedrella nodiflora (L.) Gaertn.	Nodeweed	A			
	Tridax procumbens L.	Coat buttons	A			*
	Taraxacum officinale (L.)	Dandelion, lau-lele	A		*	
	Tetramolopium lepidotum (Less.) Sherff ssp. *lepidotum*		E	E		
	Verbesina enceliodies B. & H. ex Gray	Golden crown beard	A			*
	Wedelia trilobata (L.) Hitchc.	Wedelia	A		*	
	Xanthium strumarium L. var. *canadense* (Mill.) Torr. & A. Gray	Cocklebur, kikania	A			*
	Youngia japonica (L.) DC	Oriental hawksbeard	A			
BASELLACEAE	*Andredera cordifolia* (Ten.) Steenis	Madeira vine, ʻuala hupe	A			
BEGONIACEAE	*Begonia* sp.	Begonia	A			
BIGNONIACEAE	*Spathodea campanulata* P. Beauv.	African tulip tree	A			*
	Tecoma sp.					
	Tecomella undulata (Roxb.) Seem.	Lahura	A			

PLANTS OF NAVAL COMPUTER AND TELECOMMUNICATION AREA MASTER STATION PACIFIC

Family	Scientific name	Common names	Status	Federal Status	Wahiawa	RTF LLL
BORAGINACEAE	*Heliotropium curassavicum* L.	Hinahina	I			
	Heliotropium procumbens Mill. var. *depressum* (Cham.) Fosb.		A		*	
BRASSICACEAE	*Capsella rubella* (L.) Medik	Shepherd's purse	A			
	Coronopus didymus (L.) Sm.	Swinecress	A			
	Lepidium arbuscula Hillebr.	'Anaunau, naunau, kunana	E	E		
	Lepidium virginicum L.	Wild peppergrass	A			
BUDDLEJACEAE	*Buddleia asiatica* Lour.	Dogtail	A		*	*
CACTACEAE	*Opuntia ficus-indica* (L.) Mill.	Prickly pear, panini	A			*
CAMPANULACEAE	*Cyanea lanceolata* ssp. *calycina* (Gaudich.) Lammers, Givnish & Sytsma	'Oha, haha, 'ola wai	E	E		
	Lobelia niihauensis St. John	'Oha, haha, 'ola wai	E	E		
	Lobelia yuccoides Hillebr.	Panaunau	E			
CAPPARACEAE	*Cleome gynandra* L.	Wild spider flower	A			*
CARICACEAE	*Carica papaya* L.	Papaya				
CARYOPHYLLACEAE	*Cerastium fontanum* Baumg. ssp. *triviale* (Link) Jalas	Common mouse-ear chickweed	A			
	Drymaria cordata (L.) Willd.	Pipili, pilipili	A			
	Schidea hookeri A. Gray		E	E		
	Schidea ligustrina Cham. & Schlechtend.		E			
	Schidea mannii St. John		E			
	Schidea pubescens Hillebr var. purpurascens *Sherff*		E	C		
	Stellaria media (L.) Vill.	Common chickweed	A			
CASUARINACEAE	*Casuarina equisetifolia* L.	Common ironwood, paina	A		*	
CECROPIACEAE	*Cecropia obtusifolia* Bertol.	Guarumo	A		*	
CELASTRACEAE	*Perrotteria sandwicensis* A. Gray	Olomea	E			
CHENOPODIACEAE	*Atriplex semibaccata* R. Br.	Australian salt bush	A			*
	Chenopodium album L.	Pig weed	A			*
	Chenopodium oahuense (Meyen) Aellen	'Aheahea, 'aweoweo	E			
CONVOLVULACEAE	*Bonamia menziesii* A. Gray		E	E		
	Ipomoea cairica (L.) Sweet	Ivy-leaved morning glory, koali 'ai	A			*
	Ipomaea indica (J. Burm.) Merr.	Koali 'awa, koali 'awahia	I			*
	Ipomeaa obscura (L.) Ker-Gawl.	Morning glory	A			*
	Jacquemontia sandwicensis Gray	Pa'u-o-hi'iaka	E			*
	Merremia aegyptia (L.) Urban	Hairy merremia	A			*

PLANTS OF NAVAL COMPUTER AND TELECOMMUNICATION AREA MASTER STATION PACIFIC

Family	Scientific name	Common names	Status	Federal Status	Wahiawa	RTF LLL
CURCURBITACEAE	*Citrullus lanatus* (Thunb.) Matsum & Nakai	Watermelon, ipu 'ai-maka	A			
	Coccinia grandis (L.) Voigt	Scarlet-fruited gourd	A			
	Cucumis dipsaceus Ehrenb. Ex Spach	Hedgehog gourd, teasel gourd	A			*
	Momordica charantia L.	Bittermelon	A			*
	Sicyos erostratus St. John	'Anunu, kupala	E			*
	Sicyos pachycarpus Hook. & Arnott	'Anunu, kupala	E			*
EBENACEAE	*Diospyros hillebrandii* (Seem.) Fosb.	Lama, elama	E			
	Diospyros sandwicensis (A. DC) Fosb.	Lama, elama	E		*	
ELAEOCARPACEAE	*Elaeocarpus bifidus* Hook. & Arnott	Kalia	E			
EPICRIDACEAE	*Styphelia tameiameiae* (Cham. & Schlechtend.) F. v. Muell.	Pukiawe	I		*	
ERICACEAE	*Vaccinium dentatum* Sm.	'Ohelo	E			
EUPHORBIACEAE	*Aleurites moluccana* (L.) Willd.	Candlenut, kukui	A		*	
	Antidesma platyphyllum H. Mann. var. *platyphyllum*	Hame, mehame	E			
	Antidesma pulvinatum Hillebr.	Hame, mehame	E			
	Chamaesyce celastroides (Boiss.) Croizat & Degener var. *amplectens* (Sherff) Degener & I. Degener	'Akoko, koko, kokomalei	E			
	Chamaesyce glomerifera L. C. Wheeler	Spurge	A		*	*
	Chamaesyce hirta (L.) Millsp.	Hairy spurge, garden spurge, koko kahiki	A		*	*
	Chamaesyce hypericifolia (L.) Millsp.	Graceful spurge	A			
	Chamaesyce kuwaleana (Degener & Sherff) Degener & I. Degener	'Akoko, koko, kokomalei	E	E		
	Chamaesyce multiformis (Hook. & Arnott) Croizat & Degener var. multiformis	'Akoko, koko, kokomalei	E			
	Chamaesyce prostrata (Aiton) Sm.	Prostrate spurge	A		*	*
	Claoxylon sandwicense Mull. Arg.	Po'ola	E			
	Flueggea neowawraea W. Hayden	Mehamehame	E	E		
	Macaranga mappa (L.) Mull. Arg.	Bingabing	A			*
	Mallotus philippensis (Lam.) Mull. Arg.					
	Phyllanthus debilis Klien ex Willd.	Phyllanthus weed	A		*	
	Phyllanthus distichus Hook. & Arnott	Pamakani mahu	E		*	
	Ricinus communis L.	Castor bean, pa'aila, koli	A		*	*
FABACEAE	*Acacia confusa* Merr.	Formosan koa	A			
	Acacia farneseniana (L.) Willd.	Klu, kolu	A		*	*
	Acacia koa A. Gray	Koa	E		*	
	Albizia lebbeck (L.) Benth.	Albizia, Siris tree, woman's toungue	A		*	
	Caesalpinia bonduc (L.) Roxb.	Kakalaioa	A			*
	Caesalpinia major (Medlik.) Dandy & Exell	Yellow nickers, kakalaioa	A			
	Canavalia galeata (Gaud.) Vogel	'Awikiwiki, puakauhi	E			

PLANTS OF NAVAL COMPUTER AND TELECOMMUNICATION AREA MASTER STATION PACIFIC

Family	Scientific name	Common names	Status	Federal Status	Wahiawa	RTF LLL
	Cassia fistula L.	Yellow shower	A			*
	Chamaecrista nictitans (L.) Moench ssp. *patellaria*	Partridge pea, lauki	A		*	*
	Crotolaria incana L.	Fuzzy rattle-box	A			*
	Crotolaria pallida Aiton	Smooth rattlepod	A			
	Crotolaria retusa L.	Rattle-box	A		*	
	Desmanthus pernambucanus (L.) Thell.	Slender mimosa, virgate mimosa	A		*	
	Desmodium incacum DC	Spanish clover, ka'imi	A		*	*
	Desmodium sandwicense E. Mey.	Spanish clover, ka'imi	A		*	
	Desmodium triflorum (L.) DC	Three-flowered beggarweed	A		*	
	Desmodium uncinatum (Jacq.) DC	Spanish clover	A			
	Desmodium virgatus (L.) Willd.	Virgate mimosa	A			*
	Erythrina sandwicensis Deg.	Wiliwili	E			
	Haematoxylum campechianum L.	Logwood	A			
	Indigofera suffruticosa Mill.	Indigo	A			*
	Leucaena leucocephala (Lam.) de Wit	Haole koa, koa haole, ekoa	A		*	*
	Lotus sp.	Lotus	A		*	
	Macroptilium lathyroides (L.) Urb.	Wild bean, cow pea	A			
	Medicago lupulina L.		A		*	
	Medicago minima L.		A			*
	Mimosa pudica L.	Sensitive plant	A		*	*
	Neonotonia wightii (Wight & Arn.) Lackey		A			
	Paraserianthes falcataria (L.) Nielsen	Albizia	A		*	
	Peltophorum inerme (Roxb.) Naves	Yellow poinciana	A			
	Phaseolus lathyroides L.	Cow pea	A			*
	Pithecellobium dulce (Roxb.) Benth	Madras thorn	A			
	Prosopis pallida HBK.	Algaroba, mesquite, kiawe	A			*
	Pterocarpus indicus Willd.	Narra	A			
	Senna pendula (Humb & Bonpl. Ex Willd.) H. Irwin & Barneby		A			
	Samanea saman Merr.	Monkeypod	A			*
FLACOUTIACEAE	*Xylosma hawaiiense* Seem.	Maua	E			
GENTIANACEAE	*Centaurium erythraea* Raf. ssp. *erythraea*	Bitter herb, European centaury	A		*	
GESNERIACEAE	*Cyrtandra waianaeensis* St. John & Storey	Hai'wale, kanawao ke'oke'o	E			
GOODENIACEAE	*Scaevola gaudichaudiana* Cham.	Naupaka kuahiwi	E		*	
	Scaevola mollis Hook. & Arnott	Naupaka kuahiwi	E			
HYDRANGEACEAE	*Broussaisia arguta* Gaud.	Kanawao, pu'ahanui	E			
LAMIACEAE	*Hyptis pectinata* (L.) Poit.	Comb hyptis	A			
	Leonotis nepetifolia (L.) R. Br.	Lion's ear	A			*
	Ocimum gratissimum L.	Basil	A			*

PLANTS OF NAVAL COMPUTER AND TELECOMMUNICATION AREA MASTER STATION PACIFIC

Family	Scientific name	Common names	Status	Federal Status	Wahiawa	RTF LLL
	Plectranthus parviflorus Willd.	'Ala'ala wai nui	I			
	Salvia cocinea Juss. ex J. A. Murray	Scarlet sage, liliehua	A			
	Salvia occidentalis Sw.	West Indian sage	A			
	Stachys arvensis L.	Staggerweed	A			
	Stenogyne kaalae Wawra		E			
LAURACEAE	*Persea americana* Mill.	Avocado	A			
LOGANIACEAE	*Labordia kaalae* C. Forbes	Kamakahala	E			
LYTHRACEAE	*Cuphea carthagenensis* (Jacq.) MacBride	Tarweed, Columbian cuphea, Puakamoli	A		*	*
	Lythrum maritimum Kunth	Pukamole	I			
MALVACEAE	*Abutilon grandifolium* (Willd.) Sweet	Hairy abutilon, Ma'o	A			*
	Abutilon incanum (Link) Sweet	Hoary abutilon, Ma'o	I			
	Abutilon sandwicense (Deg.) Christoph.		E	E		
	Gossypium sandvicensis Parl.	Hawaiian cotton, Ma'o	E			*
	Hibiscus arnottianus A. Gray ssp. *arnottianus*	Koki'o ke'oke'o	E			
	Hibiscus rosa-sinensis L.	Red hibiscus	A		*	
	Hibiscus tiliaceus L.	Hau	I		*	
	Malva parviflora L.	Cheese weed	A			*
	Malvastrum coromandelianum (L.) Garcke	False mallow	A			*
	Malvaviscus penduliflorus DC	Turk's cap	A		*	
	Sida cordifolia L.	Pantropic sida	A			
	Sida fallax Walp.	'Ilima	I			*
	Sida rhombifolia L.	Cuba jute	A			*
	Sida spinosa L.	Prickly sida	A			*
MELASTOMATACEAE	*Arthrostema ciliatum* Pav. Ex D. Don	Pearl flower	A		*	
	Clidemia hirta (L.) D. Don var. *hirta*	Koster's curse, clidemia	A		*	
	Pterolepis glomerata (Rottb.) Miq.		A		*	
MELIACEAE	*Cedrela fissilis* Vell.		A			
	Melia azedarach L.	Chinaberry, Pride-of-India	A			
	Toona ciliata M. Roem. var. *australis* (F. v. Muell.) C. DC	Australian red cedar	A			
MENISPERMACEAE	*Cocculus trilobus* (Thunb.) DC	Huehue	I		*	
MORACEAE	*Broussonetia papyrifera* (L.) Venten.	Paper mulberry, wauke	A			
	Ficus benghalensis L.	Banyan	A			
	Ficus forsteni Miq.	Banyan	A			
	Ficus indica L.	Banyan	A			
	Ficus macrophylla Desf.	Moreton Bay fig	A			
	Ficus microcarpa L. fil.	Chinese banyan, Malayan banyan	A		*	
	Ficus rubiginosa Desf.	Port Jackson fig	A		*	

PLANTS OF NAVAL COMPUTER AND TELECOMMUNICATION AREA MASTER STATION PACIFIC

Family	Scientific name	Common names	Status	Federal Status	Wahiawa	RTF LLL
	Ficus retusa L.	Banyan	A			*
	Streblus pendulinus (Endl.) F. v. Muell.	A'ia'i	I			
MYRICACEAE	*Myrica faya* Aiton	Fire tree	A			
MYRSINACEAE	*Ardisia elliptica* Thumb.	Shoebutton ardisia	A		*	
	Myrsine emarginata (Rock) Hosaka	Kolea	E			
	Myrsine lanaiensis Hillebr.	Kolea	E			
	Myrsine lessertiana A. DC	Kolea	E			
	Myrsine sandwicensis A. DC	Kolea lau li'i	E			
MYRTACEAE	*Eucalyptus camaldulensis* Dehnh	Murray red gum	A			
	Eucalyptus globulus Labill.	Eucalyptus	A		*	
	Eucalyptus resinifera Sm.	Kinogum eucalyptus	A			
	Eucalyptus robusta Sm.	Swamp mahogany	A			
	Eugenia reinwardtiana (Blume) DC	Nioi	I			
	Melaleuca quinquenervia (Cav.) S. T. Blake	Paperbark, Melaleuca	A		*	
	Metrosideros polymorpha Gaud.	'Ohi'a lehua, 'ohi'a, lehua	E		*	
	Psidium cattleianum Sabine	Strawberry guava, waiawi	A		*	
	Psidium guajava L.	Guava, kuawa	A		*	
	Syzygium cumini (L.) Skeels	Java plum	A		*	
	Syzygium jambos (L.) Alston	Rose apple	A		*	
	Syzygium sandwicensis (A. Gray) Nied	Ohi'a ha	E		*	
NYCTAGINACEAE	*Boerhavia coccinea* Mill.	Red boerhavia	A			*
	Boerhavia glabrata Blume	Alena	I			
	Boerhavia repens L.	Alena	I			
	Pisonia brunoniana Endl.	Papala kepau	I		*	
	Pisonia sandwicensis Hillebr.	Aulu	E			
	Pisonia umbellifera (G. Forster) Seem.	Papala kepau	E			
OLEACEAE	*Fraxinus uhdei* (Wenzig) Lingelsh.	Tropical ash	A			
	Nestegis sandwicensis (A. Gray) Degener, I. Degener & L. Johnson	Olopua, pua	E			
	Olea europaea L.	Olive	A			
ONAGRACEAE	*Ludwigia octivalvis* (Jacq.) Raven	Primrose willow	A			*
OXALIDACEAE	*Oxalis corniculatus* L.	Yellow wood sorrel, 'ihi makole	A		*	*
	Oxalis corymbosa DC.	Pink wood sorrel	A		*	
PASSIFLORACEAE	*Passiflora edulis* Sims	Passion fruit, liliko'i	A		*	
	Passiflora foetida L.	Love-in-a-mist	A		*	*
	Passiflora suberosa L.	Huehue haole	A		*	
PHYTOLACCACEAE	*Phytolacca dioica* L.	Bella sombra	A			
	Rivina humilis L.	Coral berry, rogue plant	A		*	*
PIPERACEAE	*Peperomia blanda* (Jacq.) Kunth var. *floribunda* (Miq.) H. Huber	'Ala'ala wai nui	I			

PLANTS OF NAVAL COMPUTER AND TELECOMMUNICATION AREA MASTER STATION PACIFIC

Family	Scientific name	Common names	Status	Federal Status	Wahiawa	RTF LLL
	Peperomia latifolia Miq.	'Ala'ala wai nui	E			
	Peperomia membranacea Hook. & Arnott	'Ala'ala wai nui	E			
	Peperomia tetraphylla (G. Forster) Hook. & Arnott	'Ala'ala wai nui	I			
PITTOSPORACEAE	*Pittosporum confertiflorum* A. Gray	Ho'awa	E			
	Pittosporum glabrum Hook. & Arnott	Ho'awa	E			
PLANTAGINACEAE	*Plantago lanceolata* L.	Narrow leaved plantain	A		*	
	Plantago major L.	Broad leaved plantain, laukahi	A		*	
PLUMBAGINACEAE	*Plumbago zeylanica* L.	'Ilie'e	I			*
POLYGONACEAE	*Antipogon leptopus* L.	Mexican creeper	A			*
	Rumex albescens Hillebr.	Hu'ahu'ako	E			
PORTULACACEAE	*Portulaca cyanosperma* Egler	'Ihe	E			*
	Portulaca oleraceae L.	Pigweed, 'Ihe	A			*
	Portulaca pilosa L.	Pigweed, 'Ihe	A			
PRIMULACEAE	*Anagallis arvensis* L.	Scarlet pimpernel	A		*	*
	Lysimachia hillebrandii J.D. Hook. ex A. Gray		E			
PROTEACEAE	*Grevillea robusta* A. Cunn ex R. Br.	Silk oak, silver oak	A		*	
ROSACEAE	*Osteomeles anthyllidifolia* (Sm.) Lindl.	'Ulei	I		*	
	Rubus rosifolius Sm.	Thimbleberry	A		*	
RUBIACEAE	*Bobea brevips* A. Gray	'Ahakea	E		*	
	Bobea sandwicensis (A. Gray) Hillebr.	'Ahakea	E			
	Coprosma foliosa A. Gray	Pilo	E			
	Coprosma longifolia A. Gray	Pilo	E			
	Hedyotis acuminata (Cham. & Schlechtend.) Steud.	Au	E			
	Hedyotis parvula (A. Gray) Fosb.		E	E		
	Hedyotis schlechtendahliana Steud. var. *schlechtendahliana*	Kopa	E			
	Hedyotis terminalis (Hook. & Arnott) W.L. Wagner & Herbst	Manono	E			
	Psychotria hathewayi Fosb.	Kopiko, 'opiko	E			
	Psychotria kaduana (Cham. & Schlechtend.) Fosb.	Kopiko kea	E		*	
	Psychotria mariniana (Cham. & Schlechtend.) Fosb.	Kopiko, 'opiko	E			
	Psydrax odoratum (G. Forst.) A. C. Sm. & S. P. Darwin	Alahe'e	I			
	Richardia brasiliensis Gomes		A		*	
	Spermacoce assurgens Ruiz & Pav.	Buttonweed	A		*	
RUTACEAE	*Citrus sinensis* (L.) Osbeck	Orange	A			
	Melicope clusiifolia (A. Gray) T. Hartley & B. Stone	Alani	E			

PLANTS OF NAVAL COMPUTER AND TELECOMMUNICATION AREA MASTER STATION PACIFIC

Family	Scientific name	Common names	Status	Federal Status	Wahiawa	RTF LLL
	Melicope penduncularis (H. Lev.) T. Hartley & B. Stone	Alani	E			
	Platydesma cornuta Hillebr. var. *decurrens* B. Stone	Pilo kea	E			
	Zanthoxylum dipetalum H. Mann var. *dipetalum*	Kawa'u	E			
SANTALACEAE	*Santalum freycinetianum* Gaud.	'Iliahi, sandalwood	E		*	
SAPINDACEAE	*Alectryon macrococcus* Radlk. var. *macrococcus*	'Ala'alahua, mahoe	E	E		
	Cardiospermum haliccacabum L.	Ballon vine	A			*
	Dodonaea viscosa Jacq.	'A'ali'i	I		*	
	Harpullia pendula Planch ex. F. Muell.	Tulipwood	A			
	Sapindus oahuensis Hillebr. ex Radlk.	Lonomea, aulu	E			
SAPOTACEAE	*Chrysophyllum oliviforme* L.	Satin leaf, caimitillo	A		*	
	Pouteria sandwicensis (A. Gray) Baehni & Degener	'Ala'a	E		*	
SCROPHULARIACEAE	*Linaria canadensis* (L.) Dum. Cours. var. *texana* (Scheele) Pennell	Blue toadflax	A			
SOLANACEAE	*Capsicum frutescens* L.	Red pepper	A			*
	Nicandra physalodes (L.) Gaertn.	Apple of Peru	A			
	Nothocestrum longifolium A. Gray	'Aiea	E			
	Physalis peruviana L.	Cape gooseberry, poha	A			
	Solanum americanum Mill.	Glossy nightshade, popolo	I			
	Solanum linnaeanum Hepper & P. Jaeger	Potato vine	A			
	Solanum lycopersicum Mill.	Tomato	A			
	Solanum lycopersicum L. var. *cerasiforme* (Dunal) Spooner, G. J. Anderson & R. K. Jansen	Currant tomato	A			
	Solanum seaforthianum Andr.	Apple of Sodom	A			
STERCULIACEAE	*Waltheria indica* L.	'Uhaloa, hi'aloa	I		*	*
TILIACEAE	*Heliocarpus popayanensis* Kunth	Moho, white moho	A			
	Triumfetta semitriloba Jacq.	Sacramento bur	A			
	Wikstroemia oahuensis (A. Gray) Rock	`Akia	E		*	
ULMACEAE	*Trema occidentalis* (L.) Blume	Gunpowder tree	A		*	
URTICACEAE	*Boehmeria grandis* (Hook. & Arnott) A. Heller		E			
	Neraudia angulata R. Cowan var. *dentata* Deg. & R. Cowan	Ma'aloa, ma'oloa, 'oloa	E	E		
	Neraudia melastomifolia Gaud.	Ma'aloa, ma'oloa, 'oloa	E			
	Pilea peploides (Gaud.) Hook. & Arnott		I			
	Pipturus albidus (Hook. & Arnott) A. Gray	Mamaki	E			
	Urera glabra (Hook. Arnott) Wedd.	Opuhe	E			

PLANTS OF NAVAL COMPUTER AND TELECOMMUNICATION AREA MASTER STATION PACIFIC

Family	Scientific name	Common names	Status	Federal Status	Wahiawa	RTF LLL
VERBENACEAE	*Citharexylum caudatum* L.	Fiddle wood	A		*	
	Lantana camara L.	Lantana	A		*	*
	Stachytarpheta australis Moldenke	Oi	A		*	
	Stachytarpheta cayennensis (Rich.) Vahl		A		*	
	Stachytarpheta jamaicensis (L.) Vahl	Jamaica vervain, oi	A		*	*
	Verbena litoralis Kunth	Ha'uoi, oi	A		*	
VIOLACEAE	*Viola chamissoniana* Ging. ssp. *chamissoniana*	Pamakani	E	E		
	Viola chamissoniana Ging. ssp. *tracheliifolia* W.L. Wagner, Herbst & Sohmer	Pamakani	E			
VISCACEAE	*Korthalsella cylindrica* (Tiegh.) Engl.	Hulumoa, kaumahana	E		*	
ZYGOPHYLLACEAE	*Guaiacum officinale* L.	Lignum vitae	A			
FLOWERING PLANTS: MONOCOTS						
AGAVACEAE	*Cordyline fruticosa* (L.) A. Chev.	Ti, ki	A		*	
	Furcraea foetida (L.) Haw.	Mauritius hemp, malina	A			
	Pleomele halapepe H. St. John	Halapepe	E		*	
AMARYLLIDACEAE	*Agave sisalana* Perrine ex Engelm.	Sisal	A		*	
ARACEAE	*Alocasia macrorrhiza* (L.) Schott	'Ape	A			
	Colocasia esculenta (L.) Schott	Taro, kalo	A			
	Epipremnum pinnatum (L.) Engl.	Taro vine	A			
	Xanthosoma roseum Schott	'Ape	A		*	
AREACACEA	*Phoenix dactylifera* L.	Date palm	A		*	
	Roystonia elata (W. Bart.) F. Harper	Royal palm	A		*	
COMMELINACEAE	*Commelina benghalensis* L.	Hairy honohono	A			*
	Commelina diffusa N.L. Burm.	Honohono	A		*	
CUPRESSACEAE	*Cupressus macrocarpa* Hartweg ex Gordon	Monterey cypress	A		*	
CYPERACEAE	*Carex meyenii* Nees		I		*	
	Carex wahuensis C.A. Mey. ssp.		E		*	
	Cyperus phleoides Nees ex Kunth (Hillebr.)		E			
	Cyperus gracilis R. Br.	McCoy grass	A			
	Fimbristylis dichotoma (L.) Vahl.	Tall fringe rush	I		*	
	Gahnia aspera Spreng. ssp. *globosa* (H. Mann) J. Kern	Uki, 'Uki'uki	E		*	
	Kyllinga bervifolia Rottb.	Kili'o'opu	A		*	
	Mariscus hillebrandii (Boeck.) T. Koyama		E			
	Pycreus polystachyos (Rottb.) Beauv.		I		*	
	Rhynchospora rugosa (Vahl) Gale	Pu'uko'a	I		*	

PLANTS OF NAVAL COMPUTER AND TELECOMMUNICATION AREA MASTER STATION PACIFIC

Family	Scientific name	Common names	Status	Federal Status	Wahiawa	RTF LLL
	Rhynchospora chinensis Nees & Mey. ssp. *spiciformis*	Pu'uko'a	I			
JUNACACEAE	*Luzula hawaiiensis* Buchenau var. *oahuensis* (Deg. & Fosb.) Deg. & I Deg.	Wood rush	E			
LILIACEAE	*Astelia menziesiana* Sm.	Pa'iniu	E			
	Dianella sandwicensis Hook. & Arnott	'Uki'uki	I		*	
MUSACEAE	*Musa x paradisiaca* L.	Banana, mai'a	A		*	
ORCHIDACEAE	*Epidendrum x obrienianum* Rolfe	Scarlet orchid, butterfly orchid	A		*	
	Arundina bambusaefolia (Roxb.) Lindl.	Bamboo orchid	A		*	
	Spathoglottis plicata Blume	Malayan ground, orchid	A		*	
PANDANACEAE	*Freycinetia arborea* Gaud.	'Ie'ie	I		*	
POACEAE	*Agrostis avenacea* J.G. Gmelin	He'upueo	I			
	Aira caryophyllea L.	Silver hairgrass	A			
	Andropogon virginicus L.	Broomsedge, yellow bluestem	A		*	
	Axonopus compressus (Sw.) Beauv.	Broad-leaved carpetgrass	A		*	*
	Bothriochloa pertusa (L.) A. Camus	Pitted beardgrass	A			
	Brachiaria mutica (Forsk) Staph.	Paragrass, California grass	A		*	*
	Bromus hordeaceus L.	Soft chess	A			
	Cenchrus ciliaris L.	Buffelgrass	A			*
	Cenchrus echinatus L.	Common sandbur	A		*	*
	Chloris barbata (L.) Sw.	Swollen fingergrass, mau'u lei	A			*
	Chloris divaricata R. Br.	Stargrass	A			
	Chloris radiata (L.) Sw.	Radiate fingergrass	A			*
	Chrysopogon aciculatus (Retz.) Trin.	Golden beardgrass, manienie 'ula, pilipili	A		*	
	Cynodon dactylon (L.) Pers.	Bermuda grass	A		*	*
	Coix lachryma-jobi L.	Job's tears, Pu'ohe'ohe	A		*	
	Dactyloctenium aegyptium (L.) Willd.	Beach wiregrass	A			
	Digitaria ciliaris (HBK) Henr.	Henry's crab grass	A		*	*
	Digitaria fuscescens (K. Presl) Henr.	Creeping kukaepua'a	A			
	Digitaria insularis (L.) Mez ex Ekman	Sourgrass	A			*
	Digitaria pentzii Stent	Pangola grass	A		*	
	Digitaria cf. *violascens* Link	Kukaipua'a uka	A		*	
	Echinochloa crus-galli (L.) P. Beauv.	Barnyard grass	A			*
	Eleusine indica (L.) Gaertn.	Wiregrass	A		*	*
	Eragrostis grandis Hillebr.	Kawelu	E			
	Eragrostis tenella (L.) Beauv.	Lovegrass	A		*	*
	Heteropogon contortus (L.) P. Beauv. Ex Roem. & Schult.	Pili, twisted beardgrass	I			
	Melinis minutiflora Beauv.	Molasses grass	A		*	

PLANTS OF NAVAL COMPUTER AND TELECOMMUNICATION AREA MASTER STATION PACIFIC

Family	Scientific name	Common names	Status	Federal Status	Wahiawa	RTF LLL
	Melinis repens (Willd.) Zizka	Natal redtop	A		*	*
	Oplismenus hirtellus (L.) P. Beauv.	Basketgrass, honohono kukui	A		*	
	Panicum beecheyi Hook. & Arnott		E			
	Panicum maximum Jacq.	Guinea grass	A		*	*
	Panicum nephelophilum Gaud.	Konakona	E			
	Paspalum conjugatum Bergius	Hilo grass	A		*	
	Paspalum dilitatum Michx.	Browntop millet	A		*	
	Paspalum fimbriatum Kunth	Fimbriate paspalum	A		*	
	Paspalum scrobiculatum L.	Ricegrass	I		*	
	Paspalum cf. *plicatulum* Michx.	Browntop millet	A		*	
	Paspalum urvillei Steud.	Vaseygrass	A		*	
	Pennisetum clandestinum Chiov.	Kikuya grass	A		*	
	Pennisetum purpureum Schumach.	Elephant grass	A		*	
	Sacciolepis indica (L.) Chase	Glenwood grass	A		*	*
	Setaria gracilis Kunth	Foxtail grass	A		*	
	Setaria palmifolia (J. Konig) Stapf	Palmgrass	A		*	
	Setaria parviflora (Poir.) Kerguélen	Yellow foxtail	A		*	
	Setaria verticullata (L.) P. Beauv.	Bristly foxtail	A			*
	Sorghum halepense (L.) Pers.	Johnson grass	A		*	*
	Sporobolus cf. *africanus* (Poir.) Robyns & Tournay	African dropseed, rattail grass	A		*	
	Sporobolus diander (Retz.) Beauv.	Indian dropseed	A		*	
	Sporobolus indicus (L.) R. Br.	Smutgrass, West Indian dropseed	A		*	
	Vulpia bromoides (L.) S.F. Gray	Brome fescue	A			
ZINGIBERACEAE	*Hedychium coronarium* J. Konig	White ginger	A		*	

Status:
A – Alien (Exotic, Non-indigenous)
I – Indigenous
E – Endemic

Federal Status:
E – Endangered
T – Threatened
C – Candidate (Threatened or Endangered)
PT/PE – Proposed Threatened or Proposed Endangered
SOC – Species of Concern

Native Vegetation:
1 – Cliff Communities
2 – Lowland Forest/Shrubland
3 – Summit Crest Vegetation

Alien Vegetation:
1 – Kiawe/Koa Haole Scrub
2 – Koa Haole Forest
3 – Mixed Alien Forest

D3 – REPORT ON WATERBIRDS USING NIULI`I PONDS WITHIN THE NIULI`I WILDLIFE REFUGE, O‘AHU, HAWAI‘I (NAVFAC PAC 2006C)

This page is intentionally left blank.

REPORT ON WATERBIRDS USING NIULI‘I PONDS WITHIN THE NIULI‘I WILDLIFE REFUGE

NAVAL AND COMPUTER TELECOMMUNICATIONS AREA MASTER STATION PACIFIC, RADIO TRANSMITTING FACILITY, LUALUALEI, OAHU, HAWAII

Prepared by
Vanessa E. Pepi
Fish and Wildlife Biologist
NAVFAC Pacific

February 2006

This page is intentionally left blank.

Niuli‘i Wildlife Refuge is located at Naval Computer and Telecommunications Area Master Station Pacific, Radio Transmitting Facility, Lualualei, Oahu, Hawaii (NCTAMSPAC RTF LLL). The 88.4-acre (35.8-hectare) wildlife refuge was established on January 13, 1972, and included 9.6 acres (3.9 hectares) of stabilization and oxidation ponds. These ponds, called Niuli‘i Ponds, are dependent on the flow of storm water runoff and wastewater effluent from the Naval Magazine Pearl Harbor Lualualei Branch. Personnel are no longer housed on the base, so the inflow of water has decreased significantly. During the past five years or so, these ponds have been fed by minimal flows from the Naval Magazine and from a solar-powered ground water pump. On average, the standing water at the ponds had been reduced to an area of approximately 1 acre (0.4 hectares).

Four species of endemic waterbirds are known to use Niuli‘i Ponds: Hawaiian black-necked stilt (*Himantopus mexicanus knudseni*), common moorhen (*Gallinula chloropus sandvicensis*), Hawaiian coot (*Fulica alai*), and Hawaii duck (*Anas wyvilliana*). All four are listed as endangered species under the Endangered Species Act (ESA) and, sometime after the Wildlife Refuge was established, two ponds were fenced to assist in protecting these birds from non-native predators such as rats and dogs.

This report provides information only on the endangered waterbirds and issues associated with their protection at Niuli‘i Ponds. This report provides a description of the each of the protected species that may be observed, a discussion of the species monitored, and a discussion of the current status at the Niuli‘i Ponds area of the wildlife refuge. The surveys were conducted October 2002 – September 2003, January 2004, August 2004 – October 2005, and December 2005. The numbers of birds observed were averaged for each month (the number of surveys per month varied from 1 – 3) for the Species Discussion.

Species Descriptions

Hawaiian duck (*Anas wyvilliana*) or Koloa Maoli

The Hawaiian duck is a medium sized duck that is closely related to the mallard. The males weigh approximately 1.3 lbs (604 g) with the females weighing approximately 1.01 lbs (460 g). Adult males are dark brown with variable spots, mottling and distinctive darker brown chevrons on the breast, flank and back feathers. Their speculums are emerald green to blue with anterior black borders and the male’s bill is olive. Adult females, on average, are smaller in size than the males. They are also lighter in color, have no chevrons, and their speculums are duller in color with no anterior black border. Adult female bills are pale olive with the tip flesh-colored. Hawaiian duck plumage may be confused with the female and basic-plumage male of the introduced mallard (*Anas platyrhynchos*) (Engilis, *et al*., 2002).

Historically, the Hawaiian duck was found on all of the main Hawaiian Islands except Lana‘i and Kaho‘olawe. Due to a variety of reasons (hunting, habitat loss, predation by introduced predators), the populations’ declined and the species was extirpated from every island except Kaua'i (Engilis and Pratt 1993). Hawaiian ducks were re-established on O'ahu after mallards had been introduced. While Hawaiian ducks are genetically distinct from mallards, it is supposed that mallards are the ancestral stock of the Hawaiian anatids (Browne, *et al*., 1993). Hybridization between Hawaiian ducks and mallards does occur; therefore, a genetically intact Hawaiian duck population probably does not exist on O'ahu (Browne, *et al*., 1993). Hybridization is now considered the single biggest threat to the survival of the Hawaiian duck (Engilis, *et al*., 2002; USFWS 2005). Hawaiian and hybridized ducks are regularly found on O'ahu at James Campbell and Pearl Harbor National Wildlife Refuges, Hamakua Marsh and Kawai Nui Marsh Wildlife Sanctuaries (Engilis, *et al*., 2002) (Fig. 1).

Figure 1. Probable koloa/mallard hybrid observed October 2005.

Hawaiian ducks are known to prefer/utilize the habitats near montane streams. It is believed that they eat aquatic invertebrates, aquatic plants, seeds, grasses and tadpoles (Engilis, *et al*., 2002) and feeding has been recorded in waters less than 9.4 inches (24 cm) deep (USFWS 2005). Hawaiian ducks are mostly seasonal nesters, with the peak from March to January, but have been recorded nesting during all months of the year (Engilis, et. al. 2002). They may breed their first year, and their nests are constructed on the ground and may be near water (USFWS 2005). Hawaiian ducks lay an average of 8 eggs per nest with an incubation period (recorded from captive birds) of approximately 26-30 days. Fledging is estimated to occur after 65 days (Engilis, *et al*., 2002).

Counts on Oahu have been difficult due to the hybridization (Engilis and Pratt 1993). During the biannual counts of the past 5 years, there has been a decreasing trend for the Hawaiian duck on Oahu and hybrids have increase (USFWS 2005).

Common moorhen (*Gallinula chloropus sandvicensis*) 'Alae 'Ula

Moorhens weigh approximately 0.68 – 1.0 lb (310 - 456 g), with males typically larger and heavier than females. Adults of both sexes are primarily black, lightening to gray (or slate blue) on the upper back, sides and flanks, with a white flank stripe (Fig. 2). The scapulars, wings and rumps are brownish and the lateral undertail coverts are white with

the middle black. Moorhens have a red bill with a yellow tip (Bannor and Kiviat 2002) and their unlobed feet and legs are a yellowish green (USFWS 2005). Hawaiian moorhen were formerly found on all main islands except Lana'i and Kaho'olawe. Presently, they are now found only on O'ahu and Kaua'i (Bannor and Kiviat 2002; USFWS 2005). Optimal habitat for Hawaiian moorhen appears to be water depths of 5.9 – 47.2 inches (15 - 120 cm). They prefer fresh over brackish water (Bannor and Kiviat 2002), grassy wetlands, and dense vegetation to forage in (Engilis and Pratt 1993). There is very little information regarding their diet, but they may forage upon grass seed, sedge seed, mollusks, aquatic insects and algae (Bannor and Kiviat 2002; USFWS 2005). Natural habitats for moorhen in the islands may have been degraded by introduced mangrove and California grass (*Brachiaria mutica*), but they respond very well to manmade wetlands (Engilis and Prat 1993). According to the USFWS Draft Recovery Plan (2005), the key features for moorhen habitat areas are:

- dense stands of robust emergent vegetation near open water;
- floating or barely emergent mats of vegetation;
- water depth less than 3.3 feet (1 meter); and
- fresh water as opposed to saline or brackish water.

Breeding occurs year round, but peaks from March through August. The age of first breeding is the first year after hatching (Bannor and Kiviat 2002) and appears to be influenced by water levels and the amount of vegetation (USFWS 2005). Moorhen generally nest in areas near standing fresh water less that 24 inches (60 cm) deep (USFWS 2005) with dense shoreline-type vegetation around their nests (e.g., cattails, grass-like vegetation or taro) (Bannor and Kiviat 2002). They build nests by folding emergent vegetation into a platform. Hawaiian moorhen lay approximately 5-7 eggs in a nest with an incubation period of approximately 19-22 days (Bannor and Kiviat 2002).

Figure 2. Common moorhen.

Hawaiian moorhen are very secretive and thus, hard to monitor (Engilis and Pratt 1993). They appear to be highly sedentary and it is not known whether or not they move between islands (Bannor and Kiviat 2002). In the past, winter counts have suggested a relatively stable population (Engilis and Pratt 1993; Bannor and Kiviat 2002) and peaks occur with increased rainfall (Engilis and Pratt 1993). During the past 5 years, Oahu has recorded half of the state's populations of moorhens (USFWS 2005).

Hawaiian coot (*Fulica alai*) or 'Alae Ke'oki'o

Hawaiian coots are smaller in size than American coots with males slightly larger than the females (Brisbin and Mowbray 2002; USFWS 2005). Coots are a plump, chicken-like bird with no sexual dimorphism. The adults are a dark, slate-gray color, with white under tail coverts and yellow-green to yellow-orange legs and feet (Brisbin and Mowbray 2002). Their bills are white and their frontal shields are large and bulbous compared to the American coot. While the majority of Hawaiian coot frontal shields are white, approximately 3-16% have dark red shields (Pratt and Brisbin 2002) and a deep maroon marking on the tip of their bill (USFWS 2005) (Figs 3 & 4).


Figure 3. Coot with white shield.


Figure 4. Coot with red shield.

Hawaiian coots historically occurred on all of the main Hawaiian Islands except for Lana'i and Kaho'olawe (USFWS 2005). Today, Hawaiian coots live on all of the main islands except Kaho'olawe and are most numerous on O'ahu, Maui and Kaua'i. Coots are a coastal plain inhabitant and prefer fresh water. They typically forage in water less than 12 inches (30.5 cm) deep, but can dive down to 48 inches (120 cm). They like more open water than moorhens. Coots appear to be generalist foragers, but it has been reported that they eat seeds, leaves, the stems of aquatic plants and lagoon mollusks.

Hawaiian coots normally breed from March to September (Engilis and Pratt 1993), but may breed during all months of the year. They breed on natural, freshwater ponds and wetlands. Hawaiian coots will build nests on the water's surface by constructing floating nests of aquatic vegetation or semi-floating nests anchored to emergent vegetation (USFWS 2005). The incubation period is approximately 25 days with fledging time unkown (Pratt and Brisbin 2002).

The coot population on Oahu has fluctuated between approximately 500 and 1000 individuals in recent years (USFWS 2005). It is suspected that past reports of coot numbers that have been higher than average came during high rainfall years (Engilis and Pratt 1993).

Hawaiian black-necked stilt (*Himantopus mexicanus knudseni*) or Ae'o

Hawaiian black-necked stilts are slim wading birds that are approximately 16 inches (40 cm) tall (Robinson *et al*., 1999) with black above and white below and long pink legs (USFWS 2005). Their back feathers differentiate males and females with males having black and females having brownish feathers (Fig. 5). Historically, Hawaiian black-necked stilts were on all of the major islands except Lana'i and Kaho'olawe. Currently, they live on all of the islands except Kaho'olawe (USFWS 2005). Known nesting colonies on Oahu are found at Pearl Harbor, Marine Corps Base Kaneohe, and Kahuku wetlands (Hawaii Audubon Society, 1997).


Figure 5. Hawaiian black-necked stilt.

Stilts, in general, prefer wetland habitat with depths less than 9 inches (24 cm) and perennial vegetation; however they loaf in open grassy areas (golf courses, agricultural and antenna fields). Hawaiian black-necked stilts like to feed in shallow flooded wetlands with an optimal foraging water depth of 5 inches (13 cm). They are opportunistic feeders, eating aquatic invertebrates (insects, snails, crabs), fish and tadpoles (USFWS 2005).

The breeding season of the Hawaiian black-necked stilt normally runs from mid-February through late August, with peak nesting varying among years. They prefer to nest on freshly exposed fresh or brackish mudflats along a shore or manmade island interspersed with low growing vegetation. Their nest is a scrape; because of these exposed nest sites, they appear to be more susceptible to avian predators such as dogs, cats and mongooses than the other Hawaiian waterbirds (USFWS 2005). They breed at approximately two years of age, lay 3 or 4 eggs in a nest over a 4-5 day period, and have an incubation period of approximately 23-26 days (Robinson *et al*. 1999; USFWS 2005). Long-term census data suggests that populations statewide are stable or slightly increasing and that O'ahu has the largest number of black-necked stilts (USFWS 2005).

Species Discussion

The water levels at Niulii Ponds appear to affect the numbers of birds that use the refuge. In recent years the first pond has gone from almost completely dry to almost full (Figs. 6 & 7) with the second pond having no standing water. Looking through pictures taken over the past several years, it is noticeable that the wildlife refuge received more rain in 2004 than in 2003 by comparing Figures 6 & 8.

Figure 6. Photo taken in September 2003 looking towards the pipe near the entrance gate. Note the lack or water and the overgrown condition.

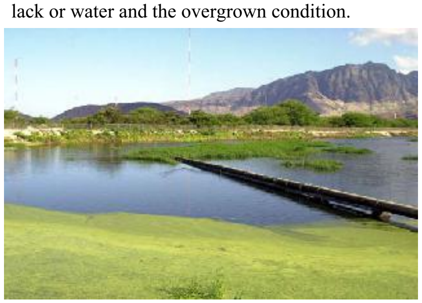


Figure 7. Photo taken in July 2005 looking down the sewer effluent pipe towards the middle of the pond (entrance gate (not shown) is on the left. The waterline was installed in April 2005 (not shown). Note that the water level is up to the pipe and that the vegetation is greatly reduced (the green at the bottom of the photo is a combination of algae and duckweed on the water's surface).

Figure 8. Photo taken in August 2004 looking towards the pipe. Note that the water level is only a few inches deep.

The following is a description for each species Please see Appendix A for a table of the monthly average number of birds observed during the surveys.

Hawaiian duck

Due to the general belief that most of the ducks have been hybridized on Oahu and consequently that there are no pure Hawaiian ducks on island, we note all Hawaiian duck-looking and known hybrids as koloa/mallard hybrids (Fig. 9). The average number of ducks observed from October 2002 through September 2003 was one or two ducks observed in most months and a maximum of 3 ducks observed in December and March. The number of ducks observed in 2004 remained approximately the same as in 2003. In 2005, numbers observed, in general increased and ranged from 2-16 with ducklings observed in February and April.

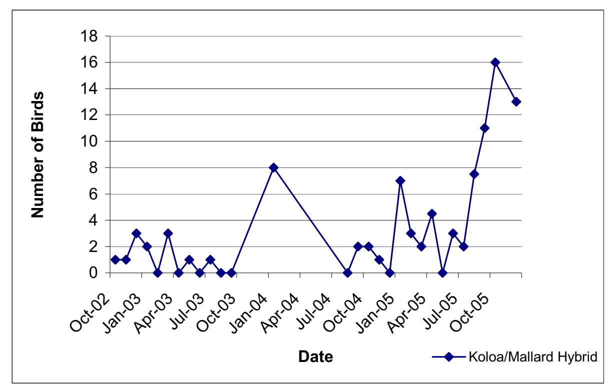


Figure 9. Monthly average number of koloa/mallard hybrids observed at Niuli'i Ponds.

Common moorhen

Moorhen prefer habitats with dense vegetation to forage in and water depths less than 3.3 feet (1 meter). With the increase of water in the past year, moorhen have been increasingly observed along the edges of the water and along the dirt road that encircles the pond. They have also been observed foraging on the outside of the fence and along the fence line (Fig. 10).

Figure 10. Moorhen on fence line at Niuli‘i Ponds.

The greatest average number observed at any one time was in August 2004 (34 adults; 14 sub-adults) when there was a small amount of water within the pond area, dense vegetation, and a greater amount of protected area (within the fenceline) to forage in than at the present. During 2005 with the increased water levels, average adult moorhen numbers ranged from 3 - 22 during all months surveyed and 1 – 6 sub-adult moorhen January through October with a peak in June (Fig. 11).

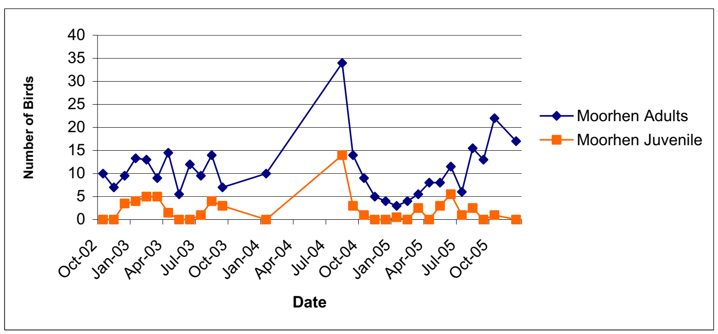


Figure 11. Monthly average number of common moorhen adults and juveniles observed at Niuli‘i Ponds.

Hawaiian coot

From October 2002 – September 2003, average coot numbers ranged from 0 –10. The greatest numbers of coots were observed during the winter (or wetter) months (Oct. 2002 – Apr. 2003) and were in very low numbers in the summer to no coots observed when there was little to no water in August and September 2003 (reference Fig. 6). Average coot adult and sub-adult numbers also peaked in August 2004 (25 adults; 9 sub-adults) and then were not observed during November and December.

In January 2005, there was an increase of water in the area and for the rest of the year the average number of adult coots has ranged from 5 – 100. The sub-adult coots were observed April through December 2005 and their average numbers ranged from 1 – 27 (Fig. 12). It is readily apparent that coots have responded to the increase in open water at the refuge, many more forage, nest and raise broods when water levels are higher (Figs. 13 &14).

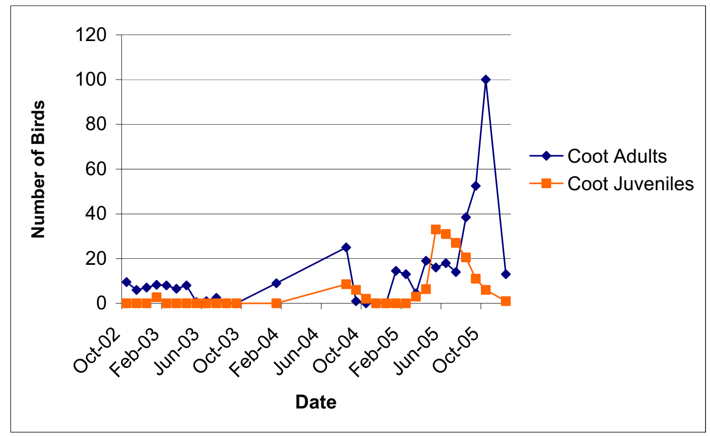


Figure 12. Monthly average number of common moorhen adults and juveniles observed at Niuli‘i Ponds.

Figure 13. Hawaiian coot on nest with chicks.

Figure 14. Sub-adult Hawaiian coot.

Hawaiian black-necked stilt

Hawaiian black-necked stilts prefer habitats with standing water; as a result, their use of the Refuge occurs only when there is enough water to suit their needs. Stilts were commonly observed from December 2002 – July 2003. Their average numbers ranged from 0 – 6 (Fig. 15). In April and May, stilts were observed exhibiting nesting behavior, and in June, five juvenile stilts were observed. When there was little to no water in August and September 2003, stilts were not observed at the refuge. Hawaiian black-necked stilts were recorded only in January and August of 2004, but this may be due to the fact that no surveys were conducted from February through July.

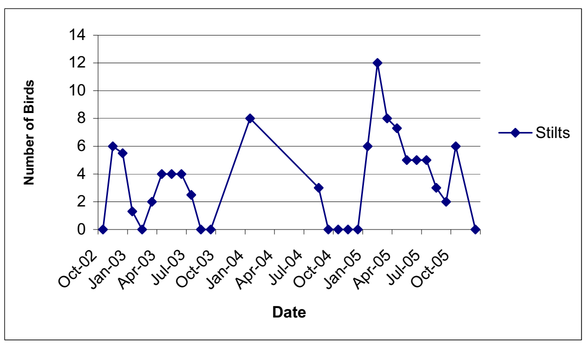


Figure 15. Monthly average number of Hawaiian black-necked stilt adults observed at Niuli‘i Ponds.

In general, occupancy of the ponds by stilts increased in 2005. They were observed every month from January through October, and the average number ranged from 2 – 12 (Fig. 16). Nesting-type behavior was observed in April, but it is suspected that nesting did not occur due to a rookery of cattle egrets literally looming over the adults.

Figure 16. Hawaiian black-necked stilts on the pipe.

Cattle egret (*Bubulcus ibis*)

Cattle egrets are common on O‘ahu and like to use the area within NCTAMS RTF LLL (Fig. 17). The antenna fields are mowed regularly and cattle egrets follow behind mowers and forage for insects. Niuli‘i Wildlife Refuge is surrounded by a stand of kiawe (*Prosopsis pallida*) and there are several trees that they like to roost in, one of them adjacent to the refuge. Cattle egrets predate on Hawaiian black-necked stilt chicks and control of cattle egrets near refuges has been effective in improving nesting success of stilts (USFWS 2005). As mentioned above, cattle egret control at the refuge began in 2001 and the most recent control action occurred in the late spring of 2005 after large numbers of cattle egrets were recorded (Fig. 18).

Figure 17. Cattle egret flying above the refuge in February 2005.

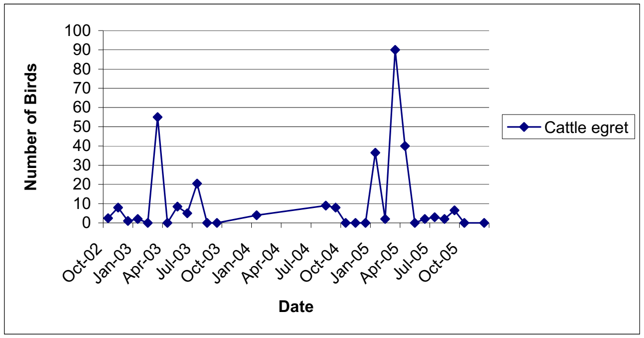


Figure 18. Monthly average number of cattle egrets observed at Niuli‘i Ponds.

Black-crowned night heron (*Nycticorax nycticorax hoactli*) or ‘Auku‘u

Black-crowned night herons are found on all islands and are considered indigenous (arrived and established themselves unassisted by humans) (Fig. 19). They are observed on an irregular basis at the refuge. However, since water levels were increased in 2005, herons were observed more frequently at the refuge (Fig. 20).


Figure 19. Black-crowned night heron (Photo from www.birdsasart.com/ bn139.htm).

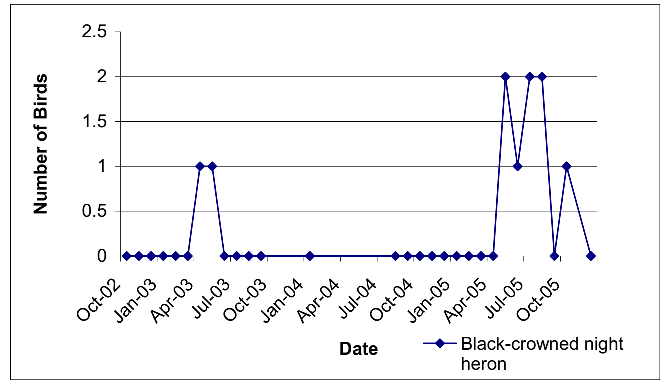


Figure 20. Monthly average number of black-crowned night herons observed at Niuli‘i Ponds.

Refuge Discussion

The Second Draft Revised Recovery Plan (USFWS 2005) lists Niuli‘i Ponds as a supporting wetland on O‘ahu. A supporting wetland is defined as an additional area that provides habitat important for smaller waterbird populations or that provides habitat needed seasonally by segments of the waterbird populations during a part of their life cycle. To obtain the goal of delisting native waterbirds, recovery actions have been recommended for supporting wetlands. The recovery actions recommended by the Second Draft Revised Recovery Plan for Niuli‘i Ponds are shown in bold followed by the current status of the ponds (USFWS 2005).

- **Implement management plans supporting wetlands.**

A management plan for Niuli‘i Ponds should be developed covering:

1) Maintenance/regulation of water level in the ponds.
2) Enhancement of the physical habitat by encouraging native plant species and controlling non-native, undesirable species.
3) Monitoring of waterbird numbers and breeding success.

- **Secure water sources and manage water levels to maximize nesting success, brood survival, food availability, and recruitment of waterbirds.**

A well was dug and a solar water pump was installed between ponds one and two in 1998. Periodically, the pump becomes corroded and must be replaced. The most recent replacement occurred in January 2005 (Fig. 21). In April 2005, a waterline (connected from an existing waterline) was installed into the first pond (Fig. 22).


Figure 21. Solar water pump.


Figure 22. New waterline w/ manual shut on/shut off.

- **Manage vegetation to maximize nesting success, brood survival, food availability, and recruitment of waterbirds.**

This action must be incorporated in the upcoming management plan.

- **Eliminate or reduce and monitor predator populations.**

A fence was built some time in the early 1990's around the first two ponds at Niulii Ponds to prevent cattle, pigs and dogs from entering the refuge area. Predator control by trapping (mongoose, cats, and rats) at Niuli'i Ponds was begun in 1994 and cattle egret control (by shooting) began in 2001 (INRMP 2001). The U.S. Department of Agriculture, Animal and Plant Health Inspection Services, Wildlife Services (USDA, APHIS, WS) provides the Navy's predator control services at the wildlife refuge. The work involves a trapping operation within the confines of the ponds' enclosure (Fig.23). The traps are checked every 48 hoursand all animals caught are recorded (Tble. 1).


Figure 23. Small mammal cage trap used at Niuli'i Ponds.

Table 1. Numbers of animals removed from Niuli'i Wildlife Refuge FY04, FY05.

Animal	FY04	FY05
Feral/Free Ranging Cats	8	24
Feral/Free Ranging Dogs		6
Cattle Egrets	1	175
Mice/Rats Mixed		2
Indian Mongoose	106	459
Black (Roof) Rats		6
Polynesian Rats	3	11

In FY04 one moorhen was unintentionally trapped and then freed. Additionally, tilapia were observed within the first pond during the summer of 2005 after a stable amount of water was established. It is unknown how they got into the pond and it will be difficult to remove them.

- **Minimize human disturbance to waterbirds and their habitats.**

The area is fenced off and the gate locked along with a posted sign identifying it as a refuge (Fig. 24). Entry into the fenced area is limited to authorized personnel who provide refuge maintenance, predator control, or survey and monitoring. There is no agriculture or aquaculture occurring at NCTAMS PAC RTF LLL.

Figure 24. Niuli‘i Ponds Wildlife Refuge (photo Sept 03).

- **Monitor and control avian disease.**

Groundskeepers notify NAVFAC Pacific biologists or the natural resources POC of NCTAMS RTF LLL of any noticeable and different occurrences regarding any birdlife. Additionally, NAVFAC biologist conduct regular monitoring of bird populations (at least once a month) at Niuli‘i ponds.

- **Minimize contamination of waterbird habitat by toxic substances**

An Integrated Pest Management Plan, prepared in 2003, has been implemented to control pesticide use on the base. Additionally, the Refuge is not located near areas where pesticides or other toxicants or pollutants are used.

- **Monitor all populations of endangered waterbirds**

There are semi-regular, standardized surveys occurring at the ponds.

- **Remove the threat of mallard-Hawaiian duck hybridization on all islands where Hawaiian ducks occur.**

This will occur when the protocol has been developed and approved by all wetland stakeholders and managers.

Literature Cited

Bannor, Brett K. and Erik Kiviat. 2002. Common Moorhen. The Birds of North America 685: 27 pgs.

Brisbin, I. Lehr, Jr. and Thomas B. Mowbray. 2002. American Coot. The Birds of North America 697:1-32.

Browne, Robert A., Curtice R. Griffin, Paul R. Chang, Mark Hubley and Amy E. Martin. 1993. Genetic divergence among populations of the Hawaiian duck, Laysan duck and mallard. The Auk 110(1):49-56.

Editor. 2005. 2004-2005 Christmas bird count. ‘Elepaio 65:5 1-3.

Engilis, Andrew, Jr. and Thane K. Pratt. 1993. Status and population trends of Hawaii’s native waterbirds, 1977-1987. Wilson Bulletin 105:142-158.

Engilis, Andrew, Jr., Kimberly J. Uyehara and Jon G. Giffin. Hawaiian duck. The Birds of North America. 694: 19 pgs.

Hawaii Audubon Society. 1997. Hawaii’s birds. Hawaii Audubon Society. Honolulu. 112 pgs.

Pratt, H. Douglas and I. Lehr Brisbin, Jr. 2002. Hawaiian coot. The Birds of North America 697:33-43.

Robinson, Julie A., J. Michael Reed, Joseph P. Skorupa, and Lewis W. Oring. 1999. Black-necked stilt. The Birds of North America 449: 30 pgs.

USN. 1987. Natural Resources Management Plan NAVCAMS EASTPAC, November 1987. The Traverse Group Inc.

U.S. Fish and Wildlife Service. 2005. Draft revised recovery plan of Hawaiian waterbirds, second draft of second revision. U.S. Fish and Wildlife Service, Portland, Oregon. 155pp.

Appendix A: Monthly average numbers of specific birds monitored at Niuli'i Ponds.

Date	Coot Adults	Coot Juveniles	Moorhen Adults	Moorhen Juveniles	Stilts	Koloa/Mallard Hybrids	Black-crowned night herons	Cattle egrets
Oct-02	9.5	0	10	0	0	1	0	2.5
Nov-02	6	0	7	0	6	1	0	8
Dec-02	7	0	9.5	3.5	5.5	3	0	1
Jan-03	8.3	2.7	13.3	4	1.3	2	0	2
Feb-03	8	0	13	5	0	0	0	0
Mar-03	6.5	0	9	5	2	3	0	55
Apr-03	8	0	14.5	1.5	4	0	1	0
May-03	0.5	0	5.5	0	4	1	1	8.5
Jun-03	1	0	12	0	4	0	0	5
Jul-03	2.5	0	9.5	1	2.5	1	0	20.5
Aug-03	0	0	14	4	0	0	0	0
Sep-03	0	0	7	3	0	0	0	0
Jan-04	9	0	10	0	8	8	0	4
Aug-04	25	8.5	34	14	3	0	0	9
Sep-04	1	6	14	3	0	2	0	8
Oct-04	0	2	9	1	0	2	0	0
Nov-04	0	0	5	0	0	1	0	0
Dec-04	0	0	4	0	0	0	0	0
Jan-05	14.5	0	3	0.5	6	7	0	36.5
Feb-05	13	0	4	0	12	3	0	2
Mar-05	4.5	3	5.5	2.5	8	2	0	90
Apr-05	19	6.3	8	0	7.3	4.5	0	40
May-05	16	33	8	3	5	0	2	0
Jun-05	18	31	11.5	5.5	5	3	1	2
Jul-05	14	27	6	1	5	2	2	3
Aug-05	38.5	20.5	15.5	2.5	3	7.5	2	2
Sep-05	52.5	11	13	0	2	11	0	6.5
Oct-05	100	6	22	1	6	16	1	0
Dec-05	13	1	17	0	0	13	0	0

This page is intentionally left blank.

D4 – LIST OF ANIMALS AT NCTAMSPAC WAHIAWA AND NRTF LUALUALEI (CNRH 2001C)

APPENDIX 6 -
LIST OF ANIMALS, NAVAL COMPUTER AND TELECOMMUNICATIONS AREA MASTER STATION

Family	Scientific name	Common names	Status	Federal Status	Wahiawa	RTF LLL
BIRDS						
ARDEIDAE	*Nycticorax nycticorax hoactli*	Black-crowned Night-heron, Auku'u	I			*
	Bulbulcus ibis	Cattle Egret	A		*	*
PHASIANIDAE	*Phasianus colchicus*	Ring-necked Pheasant	A		*	*
ANATIDAE	*Anas wyvilliana*	Hawaiian Duck, Koloa	E	E		*
RALLIDAE	*Gallinula chloropus sandvicensis*	Hawaiian moorhen, 'Alae 'ula	E	E		*
	Fulica americana alai	Hawaiian coot, 'Alae ke'o ke'o	E	E		*
RECURVIRIOSTRIDAE	*Himantopus mexicanus knudseni*	Hawaiian stilt, Ae'o	E	E		*
CHARADRIIDAE	*Pluvialis fulva*	Kolea, Pacific Golden Plover	I		*	*
COLUMBIDAE	*Columba livia*	Rock Dove	A		*	*
	Geopelia strata	Zebra Dove, Barred Dove	A		*	*
	Streptopelia chinensis	Spotted Dove	A		*	*
TYTONIDAE	*Tyto alba*	Barn owl	A		*	*
STRIGIDAE	*Asio flammeus sandwichensis*	Pueo, Short-eared Owl, Hawaiian Owl	E		*	*
ALAUDIDAE	*Alauda arvensis*	Eurasian Skylark	A		*	
MIMIDAE	*Mimus polyglottos*	Northern Mockingbird	A		*	
PYCNONOTIDAE	*Pycnonotus cafer*	Red-vented Bulbul	A		*	*
MUSCICAPIDAE	*Copsychus malabaricus*	White-rumped Shama	A		*	*
	Cettia diphone	Japanese Bush-warbler	A		*	
	Leiothrix lutea	Red-billed Leiothrix	A		*	

APPENDIX 6 -
LIST OF ANIMALS, NAVAL COMPUTER AND TELECOMMUNICATIONS AREA MASTER STATION

Family	Scientific name	Common names	Status	Federal Status	Wahiawa	RTF LLL
STURNIDAE	*Acridotheres tristis*	Common Myna	A		*	*
ZOSTEROPIDAE	*Zosterops japonicus*	Japanese White-eye	A		*	*
EMBERIZIDAE	*Cardinalis cardinalis*	Northern Cardinal	A		*	*
	Paroaria coronata	Red-crested Cardinal	A		*	*
EMBERIZIDAE	*Passer domesticus*	House Sparrow	A		*	*
ESTRILDIDAE	*Padda oryzivora*	Java Sparrow	A		*	
	Lonchura malacca	Chestnut Mannikin	A		*	
	Lonchura punctulata	Nutmeg Mannikin	A		*	*
FRINGILLIDAE	*Carpodacus mexicanus*	House Finch	A		*	

Status:
A – Alien (Exotic, Non-indigenous)
I – Indigenous
E – Endemic

Federal Status:
E – Endangered
T – Threatened
C – Candidate (Threatened or Endangered)
PT/PE – Proposed Threatened or Proposed Endangered
SOC – Species of Concern

D5 – BIRD SPECIES OBSERVED AT NCTAMSPAC WAHIAWA AND NRTF LUALUALEI (FROM HNHP 2004B)

This page is intentionally left blank.

Table 1: Summary of Bird Species Observed at NCTAMSPAC Wahiawa

Common Name	Hawaiian Name	Latin Binomial	Recorded During 2004 Survey	Recorded During 1986 Survey	Comments
Regulatory Status: State-listed Endangered Species					
Short-eared owl	pueo	*Asio flammeus*	No	No	May utilize forested areas in gulches
Regulatory Status: MBTA					
Pacific golden plover	kōlea	*Pluvialis fulva*	Yes	Yes	Common
Cattle egret		*Bubulcus ibis*	Yes	Yes	Introduced to Hawai'i and not covered under MBTA in Hawai'i
Regulatory Status: Not protected					
O'ahu 'amakihi		*Hemignathus virens chloris*	No	No	Thought to utilize habitat in gulches
'Apapane		*Himatione sanguinea*	No	No	Thought to utilize habitat in gulches
Ring-necked pheasant		*Phasianus colichicus*	Yes	Yes	Introduced species
Common peafowl		*Pavo cristatus*	Yes	No	Introduced species
Rock dove		*Columba livia*	Yes	Yes	Introduced species
Spotted dove		*Streptopelia chinensis*	Yes	Yes	Introduced species
Zebra dove		*Geopelia striata*	Yes	Yes	Introduced species
Eurasian skylark		*Alauda arvensis*	Yes	Yes	Introduced species
Red-vented bulbul		*Pycnonotus cafer*	Yes	Yes	Introduced species
Japanese bush warbler		*Cettia diphone*	Yes	Yes	Introduced species
White-rumped shama		*Copsychus malabaricus*	Yes	Yes	Introduced species
Red-billed leothrix		*Leothrix lutea*	Yes	Yes	Introduced species
Japanese white-eye		*Zosterops japonicus*	Yes	Yes	Introduced species
Northern mockingbird		*Mimus polyglottis*	Yes	Yes	Introduced species
Common myna		*Acridotheres tristis*	Yes	Yes	Introduced species
Red-crested cardinal		*Paroaria coronata*	Yes	Yes	Introduced species

Table 1: Summary of Bird Species Observed at NCTAMSPAC Wahiawa (Continued)

Common Name	Hawaiian Name	Latin Binomial	Recorded During 2004 Survey	Recorded During 1986 Survey	Comments
Northern cardinal		*Carinalis cardinalis*	Yes	Yes	Introduced species
House finch		*Carpodacus mexicanus*	Yes	Yes	Introduced species
House sparrow		*Passer domesticus*	Yes	Yes	Introduced species
Common waxbill		*Estrilda astrild*	Yes	No	Introduced species
African silverbill		*Lonchura cantans*	Yes	No	Introduced species
Nutmeg mannikin		*Lonchura punctulata*	Yes	Yes	Introduced species
Java sparrow		*Padda oryzivora*	Yes	Yes	Introduced species
Barn owl		*Tyto alba*	No	Yes	Introduced species

Source: HNHP 2004b; DON 2001c.

Naval Station Pearl Harbor, O'ahu
Integrated Natural Resources Management Plan
Appendix D5
Summary of Bird Species Observed at NCTAMSPAC

Table 2: Summary of Bird Species Observed at NRTF Lualualei

Common Name	Hawaiian Name	Latin binomial	Observed in 1984	Observed in 2004	Comments
Regulatory Status: Federal- and State-listed endangered					
Hawaiian duck	koloa maoli	*Anas wyvilliana*	Yes	Yes	Found at Niuli'i Wildlife Refuge. Probably mallard hybrids.
Common moorhen	ʻalae ʻula	*Gallinula chloropus sandvicensis*	Yes	Yes	Found at Niuli'i Wildlife Refuge.
Hawaiian coot	ʻalae keʻokiʻo	*Fulica alai*	Yes	Yes	Found at Niuli'i Wildlife Refuge.
Hawaiian stilt	āeʻo	*Himantopus mexicanus knudsensi*	Yes	Yes	Found at Niuli'i Wildlife Refuge.
Regulatory Status: State-listed endangered (on Oʻahu)					
Hawaiian owl	pueo	*Asio flammeus*	Yes	Yes	
Regulatory Status: MBTA					
Cattle egret		*Bubulcus ibis*	Yes	Yes	Not protected in Hawai'i. They have been observed preying on endangered waterbird eggs and chicks, and may play an undetermined role as a predator of nesting birds.
Black-crowned night heron	ʻaukuʻu	*Nycticorax nycticorax*	Yes	Yes	Native waterbird
Pacific golden plover	kōlea	*Pluvialis fulva*	Yes	Yes	
Regulatory Status: not protected					
Ringed-neck pheasant		*Phasianus colchicus*	Yes	Yes	Game bird (alien species).
Rock dove		*Columba livia*	Yes	No	Game bird (alien species).
Spotted dove		*Streptopelia chinensis*	Yes	Yes	Game bird (alien species).
Zebra dove		*Geopelia striata*	Yes	Yes	Game bird (alien species).
Barn owl		*Tyto alba*	Yes	No	Alien species.
Eurasian skylark		*Alauda arvensis*	No	Yes	Alien species.
Red-vented bulbul		*Pycononotus cafer*	Yes	Yes	Alien species.
White-rumped shama		*Copsychus malabaricus*	Yes	No	Alien species.
Japanese white-eye		*Zosterops japonicus*	Yes	Yes	Alien species.
Northern mockingbird		*Mimus polyglottos*	No	Yes	Alien species.
Common myna		*Acridotheres tristis*	Yes	Yes	Alien species.
Red-crested cardinal		*Paroaria coronata*	Yes	Yes	Alien species.
Northern cardinal		*Cardinalis cardinalis*	Yes	Yes	Alien species.
House finch		*Carpodacus mexicanus*	No	Yes	Alien species.

Table 2: Summary of Bird Species Observed at NRTF Lualualei (Continued)

Common Name	Hawaiian Name	Latin binomial	Observed in 1984	Observed in 2004	Comments
House sparrow		*Passer domesticus*	Yes	Yes	Alien species.
Common waxbill		*Estrilda astrild*	No	Yes	Alien species.
African silverbell		*Lonchura cantans*	No	Yes	Alien species.
Nutmeg mannikin		*Lonchura punctulata*	Yes	Yes	Alien species.
Java sparrow		*Padda oryzivora*	No	Yes	Alien species.

APPENDIX E

NAVY-RETAINED LANDS AT KALAELOA PLANT AND ANIMAL SURVEYS

E1 – BARBERS POINT NAVY-RETAINED LANDS BOTANICAL SURVEY (NAVFAC PAC 2006K)

This page is intentionally left blank.

BARBERS POINT NAVY RETAINED LAND
Botanical Survey

INTRODUCTION

All of the natural areas at Barbers Point were most recently surveyed in 2000 for the Ford Island Environmental Impact Statement. Since this time, Barbers Point Naval Air Station went through the Base Realignment and Closure (BRAC) process and the Navy only retained a few natural areas.

Botanical surveys were conducted on four areas of Navy Retained Land for this Barbers Point update – 1) White Plains Beach Park, 2) Nimitz Beach Park, 3) the small parcel near the Biosolids Treatment Facility at the intersection of Coral Sea Rd and Lake Chaplain Street, and 4) the areas surrounding the horse stables and golf course. All four areas have been disturbed in the past, but still contain small natural areas. Complete species lists were not compiled again for this update, rather, walk through surveys were conducted to further search for rare, threatened and endangered species, and to update any changes in the vegetation due to development, invasive species or other factors.

Two areas of interest in the vicinity that were not surveyed are the Barbers Point Lighthouse and the former Northern Trap and Skeet Range (NTSR). These areas are not Navy Retained Lands under BRAC, however, the NTSR is still under the control of the Navy as the transfer is has not been completed. The Barbers Point Lighthouse parcel is owned by the Coast Guard and leased by the Navy. Within this leased area, is a small fenced area containing native coastal vegetation and a small population of the federally endangered *Achyranthes splendens var. rotundata* (NCN) (Photo 1). The population fluctuates; eight individuals were observed in September 2006. Non-native species in the exclosure are periodically cleared from immediately around the *A. splendens* to allow for natural recruitment.

In 2002, remediation occurred at the NTSR to remove remaining lead and arsenic in the soil. As the NTSR also provides habitat for the federally endangered `akoko (*Chamaesyce skottsbergii var kalaeloana*) (Photo 2), a five year `akoko conservation program was initiated along with the cleanup, to mitigate the loss of an estimated 100-200 hundred wild `akoko plants. The five-year conservation plan obligates the Navy to establish three populations of `akoko at Barbers Point. The NTSR and an adjacent area provide two of those areas; the other one is located at the USFWS Kalaeloa National Wildlife Refuge. Each area must contain three hundred adult and self-sustaining individuals over five years. A contractor was hired in 2002 to conduct this effort, and as of September 2006, the Navy had exceeded the goals for adult `akoko. Quarterly reports are provided to the Navy and more information on this conservation effort can be found elsewhere in the INRMP.

METHODS

All available literature and survey reports were reviewed before surveys were conducted. Areas that had been described as having the most intact native vegetation were targeted with a walk-through survey method. Notes were taken on species composition, associations, and distribution. Photos were also taken of all communities and individual species for report use and future identification. Any plants that could not be identified in the field were photographed and collected for off-site identification using several field guides. Zigzag transects were also used to survey areas with thick mid-canopy or high levels of native vegetation. A complete species list was not compiled, however, table 1 is provided for species that were noted in the four areas.

RESULTS AND DISCUSSION

Table 1 provides a dominant species list for those found at the four Barbers Point parcels.

No threatened or endangered species were found at any of the four parcels of Navy Retained Land, although one unusual sedge, kaluha (*Bolboschoenus maritimus paludosus*) was found in the camping area at White Plains Beach Park.

Areas adjacent to those surveyed contain federally endangered and species of concern, so more comprehensive transect surveys should be conducted prior to any development at the horse stable and beach park parcels.

1.) <u>White Plains Beach Park</u>:

White Plains Beach Park is a narrow strip of land containing cabins and shelters for day use picnic areas, several buildings used for a snack bar and beach rentals and an area maintained for tent camping. The forest is mixed native and non-native coastal vegetation with kiawe (*Prosopis pallida*), ironwood (*Casuarina equisitifolia*), milo (*Thespesia populnea*), kamani (*Calophyllum inophyllum*) and hau (*Hibiscus tiliaceus*) overstory. The coastal strand includes common native species `ilima (*Sida fallax*), `uhaloa (*Waltheria indica*), naupaka, aki`aki (*Sporobolous virginicus*), and beach morning glory (*Ipomoea pes-caprae*). Non-native species such as coral berry (*Ravina humilis*), *Portulaca pilosa*, swollen fingergrass (*Chloris barbata*), and beggers tick (*Bidens alba*) were also observed.

An interesting sedge, kaluha (*Bolboschoenus maritimus paludosus*), was found in a salt marsh at the camping area (Photo 3 and 4). The Hawaiian populations of this species are referred to as the indigenous subspecies *paludosus*, characterized by the pale brown glumes and rounded and abruptly contracted spikelet apex (Wagner, 1999). This subspecies is distributed in temperate North America throughout southern Canada and northern U. S. as well as Hawaii. This species is not federally protected, however, it is rarely observed on Oahu (personal communication, Joel Lau), and its habitat should be left undisturbed.

2). <u>Nimitz Beach Park:</u>

Nimitz Beach Park is a narrow coastal strip of land, containing cabins and shelters for day use picnic areas. Most of the areas are mowed and developed, with small pockets of forest and coastal strand. The forest is mixed native and non-native coastal vegetation with kiawe,

ironwood, milo (*Thespesia populnea*) and kamani overstory. *Cassytha filiformis* also covers portions of the canopy. The coastal strand includes many common indigenous species including `ilima, `uhaloa, naupaka, aki`aki, and beach morning glory.

3.) <u>Area adjacent to Biosolids Treatment Facility:</u>

The parcel containing the Biosolids Treatment Facility and oil farm is the most disturbed of the four areas surveyed. This area is mostly used for the facilities and on the day the survey was conducted, a new area was being bulldozed and cleared. The oil farm is a storage facility and is cleared and fenced. The natural areas are fragmented by gravel roads and contain old, collapsed concrete structures, metal frames and other signs of modification. The vegetation in this area is typical of highly disturbed areas in the Ewa Plain. Kiawe (*Prosopis pallida*) and manila tamarind (*Pithocellobium dulce*) comprise the dominant overstory. The midstory is also typical, containing koa haole (*Leucaena leucocephala*), india fleabane (*Pluchea indica*), sourbush (*Pluchea carolinensis*). `Ilima and `uhaloa are two indigenous species that were observed; both are common in dry, lowland areas in the islands.

4) <u>Area adjacent to the horse stables and golf course</u>

This parcel contains the Navy golfcourse and horse stables. There are pockets of remnant forest in along the golfcourse edge and between the revetments and paddocks, however this area has been highly altered from its original state. The forested area west of the golfcourse was surveyed most recently in 2001 (Rivers, 2001) and its current state is the same. The area immediately surrounding the stables was surveyed in 2000 (Char, 2000) and 2001, and was also found in the same condition. The overstory vegetation consists primarily of kiawe and manila tamarind, midcanopy is koa haole, sourbush, klu (*Acacia farnesiana*) and agave (*Agave sisalana*). There were also small patches of endemic coastal sandalwood (*Santalum ellipticum*) which should be preserved. The ground cover consists primarily of bufflegrass (*Cenchrus ciliarus*) with scattered ilima.

The vegetation in this area is consistent with that which is found in parcels directly to the southwest, which contain the endangered akoko (*Chamaesyce skottsbergii var kalaeloana*). Twenty meter north-south transects were surveyed through the savanna areas of this parcel, however, no akoko were observed. This area should be surveyed again using 10m transects prior to any alteration or development.

REFERENCES

Char, Winona. 2000. Botanical Survey, Navy Retention Parcels, Naval Air Station Barbers Point, Oahu. Unpublished report prepared for Belt Collins Hawaii.

Lau, Joel. June 19, 2006. Personal communication via email.

Rivers, Julie. 2001. `Akoko Survey: on 55 acre Navy Potential Sale Land Parcel at Kalealoa (formerly Barbers Point Naval Air Station).

Wagner, W.L., D. R. Herbst and S. H. Sohmer. 1999. Manual of the Flowering Plants of Hawaii, revised edition, two volumes. University of Hawaii Press and Bishop Museum Press, Honolulu, Bishop Museum Special Publication; 97.

Table 1 - Partial plant list for Barbers Point survey areas

SCIENTIFIC NAME	COMMON NAME	White Plains Beach Park	Nimitz Beach Park	Coral Sea/Lake Champlain St parcel	Stables/Golf Course	STATUS
Abutilon grandifolium	Hairy Abutilon			X	X	Alien
Alternathera pungens	Khaki weed		X	X		Alien
Amaranthus spinosus	Spiny Amaranth			X	X	Alien
Amaranthus virdis	Slender Amaranth	X		X	X	Alien
Asystacia gangetica	Chinese violet	X	X	X	X	Alien
Bidens alba	Beggers tick	X	X	X		Alien
Bolboschoenus maritimus paludosus	Kaluha or bulrush	X				Indigenous
Calophyllum inophyllum	Kamani	X	X			Indigenous
Cassytha filiformis	Kauna`oa pehu		X	X		Indigenous
Casuarina equisitifolia	Ironwood	X	X			Alien
Cenchrus ciliaris	Bufflegrass	X	X	X	X	Alien
Chamaesyce hirta	Garden spurge		X	X		Alien
Chamaesyce prostrate	Prostrate spurge			X		Alien
Chloris barbata	Swollen fingergrass	X		X	X	Alien
Coccinia grandis	Ivy gourd			X		Alien
Crassocephalulm crepidiodes	NCN	X				Alien
Emelia fosbergii	Floras paintbrush			X		Alien
Ficus microcarpa	Chinese banyan			X	X	Alien
Heliotropum		X	X	X		Alien
Hibiscus tiliaceus	Hau	X				Indigenous
Ipomoea carica	Ivy leaved morning glory				X	Alien
Ipomoea obscura	NCN		X	X	X	Alien
Ipomoea pes-caprae	Beach morning glory	X	X			Indigenous
Leonitis nepetifolia	Lion's ear			X		Alien

Leucaena leucocephala	Haole koa	X	X	X	X	Alien
Lycopersicon sp.	Cherry tomato		X			Alien
Nicotiana glauca	Tree tobacco		X	X		Alien
Phyllanthus debilis	NCN			X		Alien
Pithecellobium dulce	Manila tamarind			X	X	Alien
Pluchea carolinensis	Sour bush	X	X		X	Alien
Pluchea indica	India fleabane	X	X		X	Alien
Portluca pilosa	NCN					Alien
Prosopis pallida	Kiawe	X	X	X	X	Alien
Ravina humilis	Coral berry	X				Alien
Ricinus communis	Castor bean			X	X	Alien
Scaevola sericea	Naupaka	X	X			Indigenous
Sida fallax	Ilima	X	X	X	X	Indigenous
Sonchus oleraceus	Sow thistle					Alien
Sporobolous virginicus	Aki aki	X	X			Alien
Thespesia populnea	Milo	X	X			Indigenous
Tridax procumbens	Coat buttons	X	X			Alien
Verbesina encelioides	Golden crown beard		X		X	Alien
Waltheria indica	`Uhaloa	X	X	X	X	Indigenous


Photo 1 – Endangered *Achyranthes splendens* var *rotundata* at Barbers Point lighthouse


Photo 2 – Endangered `akoko (*Chamaesyce skottsbergii* var *kalaeloana*) at Barbers Point

Photo 3 - *Bolboschoenus maritimus paludosus* habitat at White Plains Beach Park camping area

Photo 4 - *Bolboschoenus maritimus paludosus* at White Plains Beach Park camping area

E2 – BOTANICAL SURVEY NAVY RETENTION PARCELS NAVAL AIR STATION BARBERS POINT (CHAR 2000D)

This page is intentionally left blank.

BOTANICAL SURVEY
NAVY RETENTION PARCELS
NAVAL AIR STATION BARBERS POINT, O'AHU

by

Winona P. Char

CHAR & ASSOCIATES

Botanical Consultants
Honolulu, Hawai'i

Prepared for: **BELT COLLINS HAWAII**

JULY 2000

BOTANICAL SURVEY
NAVY RETENTION PARCELS
NAVAL AIR STATION BARBERS POINT, O'AHU

INTRODUCTION

The Barbers Point Navy retained lands total 870 acres. The golf course lands cover 346 acres and include the golf course, stable area, and unmaintained areas. The housing and support facilities lands comprise about 524 acres; several unmaintained parcels are scattered between the housing areas and the other facilities. The unmaintained/undeveloped portions support koa haole/kiawe scrub and smaller areas with rudetal or weedy vegetation.

Field studies to assess the vegetation on the unmaintained portions of the retained lands were conducted on 05 and 06 July 2000 by a team of two botanists. The primary objectives of the field studies were to:

1) provide a description of the vegetation on the unmaintained sections;
2) inventory the flora; and
3) search for threatened and endangered species as well as species of concern.

SURVEY METHODS

Prior to undertaking the field studies, a search was made of the pertinent literature to familiarize the principal investigator with other botanical studies conducted in the general area. The station plot plan as well as very recent, colored aerial photographs were examined to determine vegetation cover patterns, terrain characteristics, access, boundaries, and reference points (street names).

A walk-through survey method was used. Notes were made on plant associations and distribution, past and present disturbances, substrate types, drainage, exposure, topography, etc. Plant identifications were made in the field; plants which could not be positively identified were collected for later determination in the herbarium, and for comparison with the recent taxonomic literature. The survey focused on the unmaintained/undeveloped parcels as these areas were more likely to harbor native plant communities and rare plants.

The species recorded are indicative of the season ("rainy" vs. "dry") and the environmental condtions at the time of the survey. A survey taken at a different time of the year and under varying environmental conditions would no doubt yield slight variations in the species list, especially of the weedy, annual plants.

Ruderal vegetation is composed primarily of grasses and annual to short-lived weedy species. These include buffelgrass, swollen fingergrass *(Chloris barbata)*, prickly lettuce *(Lactuca serriola)*, spiny amaranth *(Amaranthus spinosus)*, 'aheahea *(Chenopodium murale)*, Spanish needle *(Bidens pilosa)*, lovegrass *(Eragrostis amabilis)*, and *Heliotropium procumbens*. A few shrubs of sourbush *(Pluchea carolinensis)*, klu *(Acacia farnesiana)*, and koa haole, 1 to 5 feet (0.3 to 1.5 meters) tall, as well as kiawe tree saplings, are also found on these disturbed areas.

Golf Course Lands

Koa Haole/Kiawe Scrub: This vegetation type is found on the western portion of the golf course lands. On the portion which includes the old airfield, the koa haole shrubs are from 5 to 10 feet (1.5 to 3 meters) tall, and the kiawe trees, 15 to 30 feet (5 to 9 meters) tall. In some places, 'opiuma is co-dominant, that is, it occurs in about equal numbers as the koa haole shrubs and kiawe trees. Ground cover in areas with soil support somewhat dense clumps of buffelgrass. Where the substrate is crushed coral, 'ilima *(Sida fallax)* is locally abundant. In other places where there is thin layer of broken asphalt, the ground cover is patchy and consists of scattered clumps of buffelgrass, swollen finger-grass, 'ilima, and *Achyranthes aspera*.

The koa haole/kiawe scrub around the stable area supports fewer 'opiuma trees. Scattered throughout this area are bulldozed piles of soil and rubble; exposed coral outcroppings are also encountered. Again, areas with soil support rather dense buffelgrass, while coralline substrates support scattered clumps of plants, primarily buffelgrass and 'ilima.

Ruderal vegetation: The old runway is composed of a very thick layer of asphalt and has not been overgrown for the most part. A few weedy clumps of plants can be found only along the edges of the runway where some litter and soil has accumulated or where there are a few cracks in the asphalt.

Low mats of Bermuda grass *(Cynodon dactylon)* are common in this area. Other species which are restricted to this area or occur here in greater numbers include Florida beggarweed *(Desmodium tortuosum)*, pitted beardgrass *(Bothriochloa pertusa)*, *Sida ciliaris*, creeping indigo *(Indigofera hendecaphylla)*, coat buttons *(Tridax procumbens)*, *Boerhavia coccinea*, and prickly sida *(Sida spinosa)*.

DISCUSSION AND RECOMMENDATIONS

The vegetation on the unmaintained portions of the retained lands is dominated by introduced species such as koa haole, kiawe, and buffelgrass. Introduced species are all those plants which were brought to the islands by humans, intentionally or accidentally, after Western contact, that

LITERATURE CITED

Botanical Consultants. 1984. Flora and fauna report of Naval Air Station Barbers Point, Oahu, Hawaii. Contract No. N6274284-C-0082.

Evenhuis, N.L. and S.E. Miller, eds. 1995-1998. Records of the Hawaii Biological Survey. Bishop Museum Occasional Papers Nos. 41-56.

Evenhuis, N.L. and L.G. Eldredge, eds. 1999. Records of the Hawaii Biological Survey. Bishop Museum Occasional Papers Nos. 58-59.

The Traverse Group, Inc. 1988. Natural Resources Management Plan, Naval Air Station Barbers Point. Contract No. N6274286-C-0538.

U.S. Fish and Wildlife Service. 1982. Endangered and threatened wildlife and plants; determination that *Euphorbia skottsbergii* var. *kalaeloana* ('Ewa Plains 'akoko) is an endangered species. Federal Register 47: 36846-36849.

U.S. Fish and Wildlife Service. 1999. U.S. Fish and Wildlife Service species list, plants. March 23, 1999. Pacific Islands Ecoregion Office, Honolulu, HI.

Wagner, W.L., D.R. Herbst, and S.H. Sohmer. 1990. Manual of the flowering plants of Hawai'i. 2 vols. University of Hawai'i Press and Bishop Museum Press, Honolulu, HI. Bishop Museum Special Publication 83.

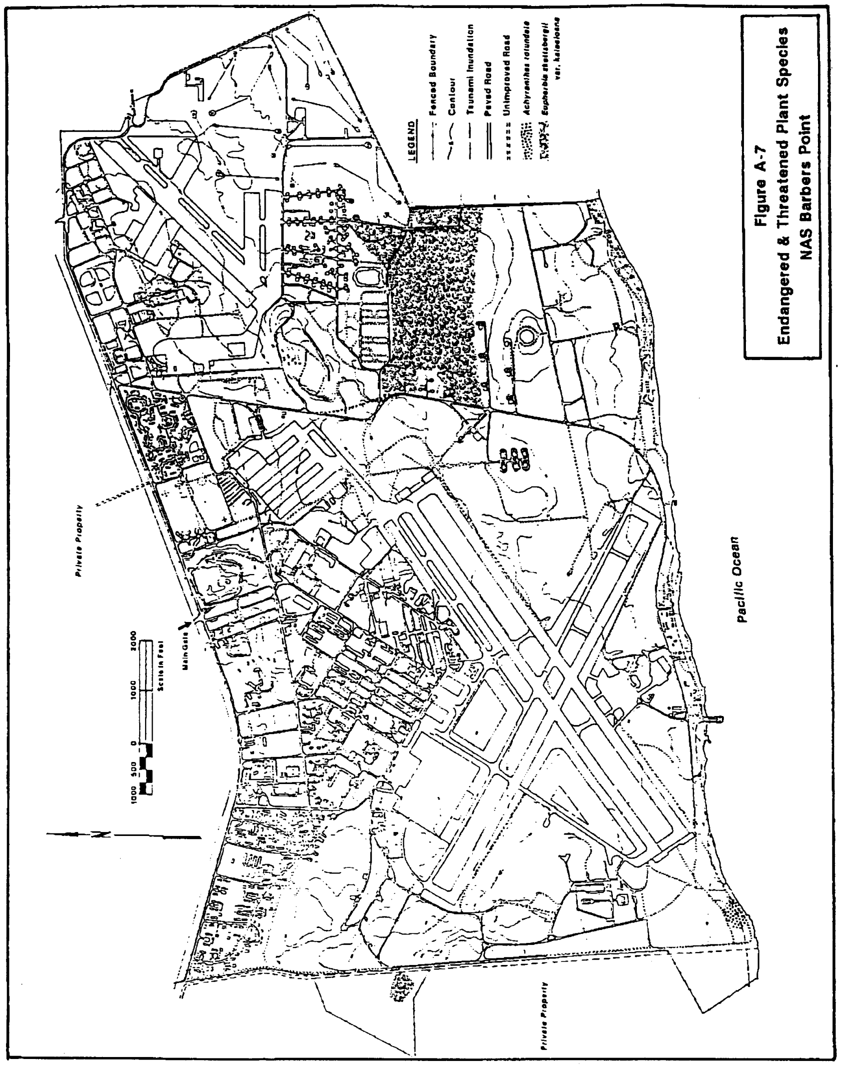
Scientific name	Common name	Status	Vegetation Type	
			k	r
FLOWERING PLANTS				
DICOTS				
ACANTHACEAE (Acanthus family)				
Asystasia gangetica (L.) T. Anderson	Chinese violet, coromandel	X	+	+
AMARANTHACEAE (Amaranth family)				
Achryanthes aspera L.		X	+	+
Alternanthera pungens Kunth	khaki weed	X	-	+
Amaranthus spinosus L.	spiny amaranth, pakai kuku	X	+	+
ANACARDIACEAE (Mango family)				
Mangifera indica L.	mango, manako	X	+	-
Schinus terebinthifolius Raddi	Christmas berry	X	+	-
APOCYNACEAE (Dogbane family)				
Cascabela thevetia (L.) Lippold	be-still tree	X	+	-
ASCLEPIADACEAE (Milkweed family)				
Stapelia gigantea N.E. Brown	carrion flower, Zulu giant	X	+	-
ASTERACEAE (Daisy family)				
Bidens cynapiifolia Kunth	West Indian beggar's tick	X	+	-
Bidens pilosa L.	Spanish needle, ki, ki nehe	X	-	+
Lactuca serriola L.	prickly lettuce	X	-	+
Pluchea carolinensis (Jacq.) G. Don	sourbush, pluchea	X	+	+
Pluchea indica (L.) Less.	Indian pluchea	X	+	-
Sonchus oleraceus L.	sowthistle, pualele	X	-	+

Scientific name	Common name	Status	Vegetation Type k	r
CUCURBITACEAE (Gourd family)				
Coccinia grandis (L.) Voigt	coccinia, ivy gourd	X	+	+
Momordica charantia L.	wild bittermelon	X	+	+
EUPHORBIACEAE (Spurge family)				
Chamaesyce hirta (L.) Millsp.	hairy spurge, garden spurge	X	-	+
Chamaesyce hypericifolia (L.) Millsp.	graceful spurge	X	-	+
Chamaesyce prostrata (Aiton) Small	prostrate spurge	X	-	+
Euphorbia neriifolia L.	Indian spurge tree	X	+	-
Ricinus communis L.	castor bean, koli	X	+	+
FABACEAE (Pea family)				
Acacia farnesiana (L.) Willd.	klu	X	+	+
Crotalaria incana L.	fuzzy rattlepod, kukaehoki	X	-	+
Desmanthus pernambucanus (L.) Thellung	slender mimosa, virgate mimosa	X	+	+
Desmodium tortuosum (Sw.) DC	Florida beggarweed	X	-	+
Falcataria moluccana (Miquel) Barneby & Grimes	albizia	X	+	-
Indigofera hendecaphylla Jacq.	creeping indigo	X	-	+
Leucaena leucocephala (Lam.) de Wit	koa haole	X	+	+
Pithecellobium dulce (Roxb.) Benth.	'opiuma	X	+	+
Prosopis pallida (Humb. & Bonpl. ex Willd.) Kunth	kiawe	X	+	+
Samanea saman (Jacq.) Merr.	monkeypod	X	+	-
Tamarindus indicus L.	tamarind	X	+	-
LAMIACEAE (Mint family)				
Leonotis nepetifolia (L.) R. Br.	lion's ear	X	+	+

Scientific name	Common name	Status	Vegetation Type k	r
SOLANACEAE (Nightshade family)				
Nicotiana glauca R.C. Graham	tree tobacco	X	-	+
Solanum americanum Mill.	popolo, glossy nightshade	I?	+	+
STERCULIACEAE (Cacao family)				
Waltheria indica L.	'uhaloa, hi'aloa, kanakaloa	I?	+	+
VERBENACEAE (Verbena family)				
Stachytarpheta jamaicensis (L.) Vahl	Jamaica vervain, owi, oi	X	-	+
Vitax trifolia var. subtrisecta (Ktze.) Mold.	vitex, polinalina	X	+	-

MONOCOTS

Scientific name	Common name	Status	k	r
AGAVACEAE (Agave family)				
Agave sisalana Perrine	sisal, malina	X	+	-
Sansevieria trifasciata Prain	snake plant, mother-in-law's tongue	X	+	-
ARECACEAE (Palm family)				
Cocos nucifera L.	coconut, niu	P	+	-
COMMELINACEAE (Spiderwort family)				
Commelina benghalensis L.	hairy honohono	X	+	+
CYPERACEAE (Sedge family)				
Cyperus alternifolius ssp. flabelliformis (Rottb.) Kukenth.	umbrella plant, 'ahu'awa haole	X	+	-



is, Cook's discovery of the Hawaiian Islands in 1778. Of a total of 84 species inventoried during the field studies, the vast majority, 78 (93%), are introduced plants. One (1%) plant, coconut *(Cocos nucifera)*, is originally of Polynesian introduction prior to Western contact. Five (6%) species are indigenous, that is, they are native to Hawai'i and elsewhere; these are the 'ilima, kaunaoa pehu, popolo *(Solanum americanum)*, 'uhaloa *(Waltheria indica)*, and 'ilie'e *(Plumbago zeylanica)*. All of the unmaintained parcels show evidence of past disturbances and uses such as concrete foundations, roadways, remnant landscape plantings, fire, etc.

The only area of concern is the koa haole/kiawe scrub in the area around the stables. The endangered 'Ewa Plains 'akoko *(Chamaesyce skottsbergii)* is known from the koa haole/kiawe scrub bordering the stable area and golf course area (U.S. Fish and Wildlife Service 1982; Botanical Consultants 1984; The Traverse Group, Inc. 1988); see Figure 1. Since the field work for this study was conducted during the dry summer months under drought conditions, any 'akoko plants, if present, could remain undetected; the plants drop their leaves during the summer months. It is recommended that this area be resurveyed during the rainy season if it is developed.

The other unmaintained parcels on the retained lands do not support threatened and endangered species or species of concern (U.S. Fish and Wildlife Service 1999). Any proposed uses for these parcels are not expected to have a significant negative impact on the botanical resources.

E3 – BARBERS POINT NAVAL AIR STATION BOTANICAL SURVEY REPORT CHECKLIST (CNRH 1997)

BARBER'S POINT NAVAL AIR STATION BOTANICAL SURVEY REPORT CHECKLIST OF PLANTS

FAMILY	SCIENTIFIC NAME	COMMON NAMES	STATUS	STRAND	SCRUB	ABUNDANCE
		FERNS AND ALLIES				
DAVALLIACEAE:	Nephrolepis exaltata (L.) Scott.	Sword fern, pamoho	A			L
PSILOTACEAE:	Psilotum nudum (L.) Griseb.	Moa	I		X	R
		MONOCOTYLEDONES				
			A		X	L
AMARYLLIDACEAE:	Agave americana L.	Century plant, malina	A		X	L
	A. sisalana Perrine ex Engelm	Sisal, malina	A		X	O
COMMELINACEAE:	Commelina benghalensis L.	Hairy honohono	I		X	O
CYPERACEAE:	Cyperus javanicus Houtt	Ahu'awa, 'ehu'awa	I		X	U
	C. laevigatus L.	Ehu'awa, makaloa	A		X	L
	C. rotundus L.	Nut Grass, kili'o'opu	A		X	L
	Eleocharis geniculata (L.) R&S		A		X	O
	Fimbristylis camplanata (Retz.) Link		A		X	O
	F. pycnocephala Hbd.		I	X		U
	Scirpus maritimus L. var. Paludosus Kuk.	Rock's bullrush	I		X	U
GRAMINEAE(POACEAE):	Andropogan pertusus (L.) Willd	Nose hair grass	A	X	X	C
	Brachiaria mutica (Forsk.) Stapf	California grass, paragrass	A		X	L
	Cenchrus ciliaris L.	Buffelgrass	A	X	X	O
	Cenchrus echinatus L.	Common sandbur, 'ume'alu	A	X	X	C
	Chloris inflata Link	Swollen fingergrass, mau 'ulei	A	X	X	L
	C. radiata (L.) Dw.	Radiate fingergrass	A		X	L
	Cynodon dactylon (L.) Pers	Bermuda grass, manienie	A	X	X	O
	Dactyloctenium aegyptium (L.) Willd.	Beach wiregrass	A	X		O
	Digitaria adscendens (HBK.) Henr.	Henry's crabgrass	A	X	X	O
	Eleusine indica (L.) Gaertn.	Wire grass, manienie-ali'i	A	X	X	O
	Eragrostis ciliaris (L.) R. Br.	Ciliate love grass	A	X	X	O
	E. tenella (L.) Beauv. R.&S.	Japanese lovegrass	A		X	O
	Panicum maximum Jacq.	Guinea grass	A	X	X	O
	Paspalum conjugatum Berg	Hilo grass	A	X	X	O
	Pennisetum setosum (Sw.)L.C.Rich	Feathery pennisetum	A	X	X	O
	Rhynchelytrum repens (Willd.) C.E.Hubb	Natal redtop	A	X	X	O
	Setaria verticillata (L.)Beauv.	Bristly Foxtail, mau'u pilipili	A	X	X	O
	Sporobolus virginicus (L.) Kunth	Beach dropseed, 'aki'aki	I	X		L
	Tricachne insularis (L.) Ness	Sourgrass	A		X	O
					X	C
LILIACEAE:	Aloe vera L.	Aloe, panini'awa'awa	A		X	U
	Cordyline terminalis (L.) Kunth	Ti, ki	P	X	X	U
	Sansevieria thyrsiflora Thunb	African bow string hemp	A		X	L
PALMAE (ARECACEAE):	Cocos nucifera L.	Coconut, niu	P	X	X	U

FAMILY	SCIENTIFIC NAME	COMMON NAME	STATUS	STRAND	SCRUB	ABUNDANCE
		DICOTYLEDONES				
ACANTHACEAE:	Asystasia gangetica (L.) T.Anders	Chinese violet	A	X	X	C
	Barleria cristata L.	Philipine violet	A		X	L
AIZOACEAE:	Ruellia repens L.		A		X	O
	Sesuvium portulacastrum (L.) L.	Akulikuli	I		X	L
AMARANTHACEAE:	Achyranthes indica (L.) Mill		A		X	L
	A. splenders var. rotundata Hbd.		E	X	X	L
	Alternanthera repens (L.) Ktze.	Khaki weed	A	X	X	L
	Amaranthus spinosus L.	Spiny amaranth, pakai-kuku	A	X	X	L
	A. viridus L.	Slender amaranth, pakai	A	X	X	O
ANACARDIACEAE:	Mangifera indica L.	Mango	A	X	X	U
	Schinus terbinthifolius Raddi	Christmas berry	A	X	X	C
APOCYNACEAE:	Thevetia peruviana (Pers.) K. Schum.	Be-still tree, noho-mkie	A	X	X	C
ARALIACEAE:	Brassaia actinophylla Endl.	Umbrella tree, octopus tree	A	X	X	O
ASCLEPIADACEAE:	Cryptostegia madagascariensis Boj.	Madagascar rubber	A	X	X	U
BATIDACEAE:	Batis maritima L.	Slatwort, pickle weed	A	X		O
BORAGINACEAE:	Cordia Sebestena L.	Foreign kou,kou-hale	P	X	X	L
	C. subcordata Lam.	Kou	P	X	X	R
	Heliotropium anomalum var.argenteum Gray	Hinahina-kahakai	E	X		L
	H. curassavicum L.	Hinahina, kipukai, nena	I	X	X	L
	Messerschmidia argentea (L.f.) Johnston	Tree helicopter	I	X		U
CACTACEAE:	Opuntia megacantha Salm-Dyck	Prickly pear, pa-nini	A		X	O
CAPPARACEAE:	Capparis sandwichiana var. zoharyi Deg.	Maiapilo, pua-pilo	E	X	X	L
	Gynandropsis gynadra (L.) Briq.	African spider flower, honohina	A	X	X	O
CARICACEAE:	Carica papaya L.	Papaya, mikan	A	X	X	R
CARYOPHYLLACEAE:	Spergularia mariana (L.) Griseb.	Saltmarsh sand spurry	A	X		U
CASARINACEAE:	Casuarina equisetifolia Stickm	Common ironwood, paina	A	X	X	L
	C. glauca Sieb	Salt mash ironwood, swamp oak	A	X		U
CHENOPODIACEAE:	Atriplex muelleri Benth.		A	X		O
	A. sembaccata R. Br.	Australian salt bush	A	X	X	O

FAMILY	SCIENTIFIC NAME	COMMON NAME	STATUS	STRAND	SCRUB	ABUNDANCE
	Chenopodium album L.	Lamb's quarters, aheahea	A	X	X	O
	C. carinatum R. Br.	Keeled goosefoot	A	X		O
	C. murale L.	Nettle-leaved goosefoot	A	X	X	U
COMPOSITAE:	Ageratum conyzoides L.	Ageratum, maile-honohono	A	X		L
(Asteracaea)	Bidens cynapifolia HBK.	West Indian beggar's tick	A	X	X	O
	B. pilosa L.	Spanish needle, beggar's tick	A	X	X	L
	Eclipta alba (L.) Hassk.	False daisy	A	X	X	O
	Emilia sonchifolia (L.) DC	Lilac pualele	A	X	X	O
	Eupatorium riparium Regel	Pamakani	A	X		L
	Flaveria trinervia Juss.		A		X	L
	Pluchea indica (L.) Less.	Indian pluches	A	X	X	C
	P. odorata (L.) Cass	Pluches	A	X	X	C
	Reichardia picroides (L.) Rogh	Picridium	A	X		U
	Sonchus oleraceus L.	Sow thistle, pua-lele		X	X	O
	Synedrella calyrtecarpus		A	X	X	O
	Tridax procumbens L.	Coat buttons	A	X	X	O
	Verbesina encelioides (Cav.)	Golden crown-beard	A	X	X	L
	Veronica cinerea (L.) Less	Ironweed	A	X	X	C
	Xanthium saccharatum Wallr.	Cocklebur	A	X	X	O
	Youngia japonica (L.) DC	Oriental hawksbeard	A	X		L
CONVOLUVULACEAE:	Cuscuta sandwichiana Choisy	Kauna 'oa	E	X	X	O
	Ipomoea alba L.	Moon flower, koali, loali-pehu	A	X		C
	I. brasiliensis (L.) Sweet	Pohuehue	I	X		O
	I. cairica (L.) Sweet	Koali-'ai	A	X	X	L
	I. congesta R. Br.	Koali'awania, loali-awa	A	X	X	O
	I. obscura (L.) Ker-Gawl		A	X		O
	I. stolonifera (Cyrill.)	Huna-kai	I	X		L
	I. triloba L.	Little bell	A	X	X	O
	Jacquemontia sandwicensis Gray	Pa'u-o-hi'i-aka	E	X	X	O
	Merremia aegyptia (L.) Urban	Hairy merremia, koali-kua-hula	A	X	X	O
CUCURBITACEAE:	Cucumis dipsaceus Spach.	Wild cucumber	A	X	X	O
	Momordica charantia var. pavel Crantz	Balsam apple, ku kua	A	X		O
	Sicyos microcarpus Mann	Kupala	E	X	X	L
EUPHORBIACEAE:	Chamaesyce skottsbergii var. skottsbergii Sherff	Akoko	E		X	C
	Euphorbia geniculata Ortega	Wild spurge, kaliko	A	X	X	O
	E. glomerifera (Millsp.) L.C. Wheeler		A	X		O
	E. heterophylla L.	Fire plant	A	X	X	L
	E. hirta L.	Hairy spurge	A	X	X	L
	E. tirucalli L.	Pencil tree	A		X	R
	Ricinus communis L.	Castor bean koli	A	X	X	L

FAMILY	SCIENTIFIC NAME	COMMON NAME	STATUS	STRAND	SCRUB	ABUNDANCE
GOODENIACEAE:	Scaevola taccada (Geartn.) Roxb.	Naupaka-khakai, naupaka	E	X		L
HYDROPHYLLACEAE:	Nama sandwicensis Gray	Nama	E	X		L
LAVIATAE:	Hyptic pectinata (L.) Poit	Comb hyptis	A	X	X	
(Lamiaceae)	Leonotic nepetaefolia (L.) Ait. f.	Lion's-ear	A	X	X	L
	Ocimum gratissmimum L.	Basil	A	X	X	L
	Stachys arvensis L.	Staggerweed	A	X	X	L
LAURACEAE:	Cassytha filiformis L.	Kauna'oa-peha	I	X	X	O
	Persea americana Mill	Avacado	A	X	X	U
LEGUMINOSAE:	Acacia decurrens (L.) Willd.	Klu	A		X	O
(Favaceae)	A. farnesiana (L.) Willd.	Wattle	A		X	O
	Caesalpinia bonduc (L.) Roxb.	Kakalaioa	A		X	U
	Canavalia cathartica Thouars	Mauna-loa, pua-kauhi	A	X		R
	Cassia leschenaultiana DC.	Partridge pea, lauki	A	X	X	O
	Crotalaria incana L.	Fuzzy rattle-pod	A	X	X	O
	Desmanthus virgatus (L.) Willd.	Virgate mimiosa	A		X	O
	Desmodium uncinatum (Jacq.) DC.	Spanish clover	A		X	O
	Erythrina sandwicensis Deg.	wiliwili	E		X	O
	Indigofera hendacaphylla Jacq.		A		X	L
	I. suffruticosa Mill.	Indigo	A	X	X	L
	Leucaena leucocephala (Lam.) de Wit	Koa-haole	A	X	X	A
	Phaseolus lathyroides L.	cow pea papapa	A		X	O
	Pithecellobium dulce (Roxb.) Benth.	Madras thorn, 'opiuma	A		X	L
	Prosopis pallida (Willd.) HBK	Algaroba, kiawe	A	X	X	A
	Samanea saman (Jacq.) Merr.	Monkeypod	A	X	X	R
LOGANIACEAE:	Buddleja asiatica Lour.	Asiatic butterfly bush	A	X	X	L
MALVACEAE:	Abutilon grandifolium (Willd.) Sweet	Hairy abutilon, mao	A	X	X	R
	A. incanum (link)Sweet	Hoary abutilon, kooloa	A		X	O
	Malva parviflora L.	Little mallow, cheese weed	A		X	O
	Malvastrum coromandelianum (L.) Garcke	False mallow	A	X	X	O
	Sida fallax Walp.	Ilima	I	X	X	C
	S. rhombifolia L.	Cuba Jute	A	X	X	O
	S. spinosa L.	Prickly sida	A	X	X	O
	Thespesia pipulnea (L.) Correa	Milo	P	X		O
MENISPERMACEAE:	Cocculus ferrandianus Gaud.	Huehue, hue'ie	E	X	X	O
MORACEAE:	Ficus elastica Roxb. ex Hornem.	Indian rubber tree	A		X	R
	F. microcarpa L. f.	Chinese banyan	A		X	O

FAMILY	SCIENTIFIC NAME	COMMON NAME	STATUS	STRAND	SCRUB	ABUNDANCE
MYOPORACEAE:	Myoporum sandwicense var. stellatum Web.	Naio	E		X	L
MYRTACEAE:	Eucalyptus sp.		A	X	X	U
	Psidium guajava L.	Guava, kuawa	A		X	R
NYCTAGINACEAE:	Boerhavia coccinea Mill.		E	X		O
	B. diffusa L.	Alena	E	X		O
PASSIFLORCEAE:	Passiflora foetida L.	Poha poha	A	X	X	O
	P. suberosa L.	Huehue-haole	A		X	O
PHYTOLACCACEAE:	Rivina humilis L.	Rouge plant, coral berry	A		X	O
PLANTAGINACEAE:	Plantago major L.	Common plantain	A	X		O
PLUMBAGINACEAE:	Plumbago zeylanica L.	Illie'e, hilie'e	I	X	X	L
POLYGONACEAE:	Antigonon leptopus H.&P.	Mexican creeper	A		X	L
	Coccoloba uvifera (L.) L.	Sea grape	A	X		U
PORTULACACEAE:	Portulaca cyanosperma Egler	Ihi	E	X	X	L
	P. oleracea L.	Common Purslane, 'akulikuli kula	A	X	X	O
PRIMULACEAE:	Anagallis arvensis L.	Scarlet pimprenel	A	X	X	O
RHIZOPHORACEAE:	Rhizophora mangle L.	American mangrove	A	X	X	L
RUBIACEAE:	Morinda cirtrifolia L.	Noni	P	X	X	U
RUTACEAE:	Murraya paniculata (L.) Jack	Mock orange	A		X	R
SANTALACEAE:	Santalum ellipticum Gaud. var. ellipticum	'Ili-ahi-a-lo'e	E		X	O
	S. freycinetianum Guad.	'Ili-ahi	E		X	S
SOLANACEAE:	Capsicum annum L.	Red pepper, nioi	A		X	R
	Lycium sandwincense Gray	'Ohelo-kai, 'ae 'ae	E	X	X	L
	Nicandra physalodes (L.) Gaertn.	Apple of Peru	A		X	O
	Nicotaina glauca Grah.	Tree tabaco, makahala	A		X	S
	Solanum nigrum L.	Black nightshade, popolo	I	X	X	O
STERCULIACEAE:	Waltheria americana L.	Hi'aloa uha-loa	P	X	X	O
VERBENACEAE:	Lantana camara L.	Lanatana lakana	A	X	X	L
	Stachytarpheta indica Vahl	False vervain	A		X	O
	S. jamaicensis (L.) Vahl		A		X	O
	Verbena litoralis HBK.	Weed verbena, ha'ouwi, owi	A	X		O
	Vitex trifolia L.	Pohinahina, polinalina	A	X		L
	Tribulus cistoides L.	Nohu	E	X		R

LEGEND: In the checklist of plants found at NASBP the following information is provided for each taxon:

1. The family name.
2. The scientific name.
3. The common and/or Hawaiian name if they are available.
4. The status of each species:

A = Alien or weed species. These are plants which have accidentally or purposely been introduced to Hawaii. Some have become pests.

E = Endemic to the Hawaiian Islands and found nowhere else in the world.

I = Indigenous or native to the Hawaiian Islands and to other places. Distribution of these taxa is not due to human intervention.

P = Polynesian introduction. Those plants brought to Hawaii by the aboriginal people. These are mostly food plants.

5. The abundance ratings are for this study only and are provided for each vegetation type.

A = Abundant. The taxon is a dominant species.

C = Common within the vegetation type in large numbers.

L = Locally common, that is the taxon may be found in large numbers in restricted areas.

O = Occasional. These plants are found in low numbers over a wide area.

U = Uncommon is the designation for taxa of which ten individuals were found.

R = Rare taxa were seen from 2 to 10 times during the survey.

S = A single individual was seen in the vegetation zone.

A total of 170 taxa were found during the survey. Of this number 77 percent are alien species, 7 percent are polynesian introductions, 8 percent are indigenous and 8 percent are endemics or found only in the Hawaiian islands.

E4 – BARBERS POINT NAVAL AIR STATION BIRD CHECKLIST (CNRH 1997)

Appendix C-1: **BIRD SPECIES FOUND AT NAS BARPT, OAHU**

Common Name	Scientific Name	Status	*% Occur
'Elepaio	Chasiempis sandwichensis	Endemic	3
Black-crowned Night-Heron	Nycticorax nycticorax hoactli	Indigenous	3
Great Frigatebird	Fregata minor palmerstoni	Indigenous	2
Lesser Golden Plover	Pluvialis fulva	Mig. Visitor	39
Sanderling	Calidris alba	Mig. Visitor	2
Ruddy Turnstone	Arenaria interpres	Mig. Visitor	2
Zebra Dove	Geopelia striate	Introduced	92
Japanese White-eye	Zosterops japonicus	Introduced	89
Northern Cardinal	Cardinalis cardinalis	Introduced	42
Red-crested Cardinal	Paroaria coronata	Introduced	41
Red-vented Bulbul	Pyononotus cafer	Introduced	27
Common Myna	Acridotheres tristis	Introduced	23
Spotted Dove	Streptopelia chinensis	Introduced	16
House Finch	Carpodacus mexicanus	Introduced	16
Northern Mockingbird	Mimus polyglottos	Introduced	9
House sparrow	Passer domesticus	Introduced	6
Common Waxbi	Estrilda astrild	Introduced	6
Chestnut Mannikin	Lonchura malacca	Introduced	5
Nutmeg Mannikin	Lonchura punctulata	Introduced	2
Orange-cheeked Waxbi	Estrilda melpoda	Introduced	2
Cattle Egret	Bulbulcus ibis	Introduced	2
Common Barn Owl	Tyto alba	Introduced	2
White-rumped Shama	Copsychus malabaricus	Introduced	2

% Occurrence = Percent of stations at which a given species was observed

This page is intentionally left blank.

E5 – BIRD SPECIES OBSERVED AT NAVY-RETAINED LAND AT KALAELOA (FROM NAVFAC PAC 2006A)

This page is intentionally left blank.

Table 1: Summary of Bird Species Observed at Navy-Retained Lands at Kalaeloa

Common Name	Hawaiian Name	Latin Binomial	Observed in 1984			Observed in 2006			Comments
			BPGC&S	N&WP	BTF	BPGC&S	N&WP	BTF	
Regulatory Status: Federal- and State-Listed Bird Species									
Black-necked stilt		*Himantopus mexicanus knudsensi*	no	no	no	yes	no	yes	Endemic, endangered
Regulatory Status: MBTA-Protected									
Cattle egret		*Bubulcus ibis*	yes	yes	yes	no	no	yes	Introduced
Black-crowned night heron		*Nycticorax nycticorax*	yes	yes	yes	yes	yes	yes	Indigenous
Pacific golden plover		*Puvialis fulva*	yes	yes	yes	yes	yes	yes	Indigenous
Ruddy turnstone		*Arenaria interpres*	yes	yes	yes	no	no	no	Indigenous
Wandering Tattler		*Heteroscelus incanus*	no	no	no	no	yes	no	Indigenous
Regulatory Status: Not protected									
Barn owl		*Tyto alba*	yes	yes	yes	no	no	no	Introduced
Gray francolin		*Francolinus pondicerianus*	no	no	no	yes	yes	yes	Introduced game bird
Red junglefowl (chicken)	*moa*	*Gallus gallus*	no	no	no	yes	yes	no	Introduced
Spotted dove		*Streptopelia chinensis*	yes	yes	yes	Yes	no	yes	Introduced game bird
Zebra dove		*Geopelia striata*	yes	yes	yes	yes	yes	yes	Introduced game bird
Eurasian skylark		*Alauda arvensis*	no	no	no	no	no	yes	introduced
Red-whiskered bulbul		*Pycnonotus jocosus*	no	no	no	yes	no	no	Introduced
Red-vented bulbul		*Pycnonotus cafer*	yes	yes	yes	yes	yes	yes	Introduced
Northern mockingbird		*Mimus polyglottos*	yes	yes	yes	yes	yes	no	Introduced
White-rumped shama		*Copsychus malabaricus*	yes	yes	yes	yes	yes	yes	Introduced
Common myna		*Acridotheres tristis*	yes	yes	yes	yes	yes	no	Introduced
Japanese white-eye		*Zosterops japonicus*	yes	yes	yes	yes	yes	yes	Introduced
Northern cardinal		*Cardinalis cardinalis*	yes	yes	yes	yes	yes	yes	Introduced
Red-crested cardinal		*Paroaria coronata*	yes	yes	yes	yes	yes	yes	Introduced
House finches		*Carpodacus mexicanus*	yes	yes	yes	yes	no	no	Introduced
Saffron finch		*Sicalis flaveola*	no	no	no	yes	no	no	Introduced
House sparrow		*Passer domesticus*	yes	yes	yes	no	yes	yes	Introduced

Table 1: Summary of Bird Species Observed at Navy-Retained Lands at Kalaeloa (Continued)

Common Name	Hawaiian Name	Latin Binomial	Observed in 1984			Observed in 2006			Comments
			BPGC&S	N&WP	BTF	BPGC&S	N&WP	BTF	
Common waxbill		*Estrilda astrild*	yes	yes	yes	yes	yes	yes	Introduced
Orange-cheeked waxbill		*Estrilda melpoda*	yes	yes	yes	no	no	no	Introduced
Nutmeg mannikin		*Lonchura punctulata*	yes	yes	yes	yes	no	yes	Introduced
Chestnut mannikin		*Lonchura malacca*	yes	yes	yes	no	yes	no	Introduced

Source: NAVFAC 2006a

E6 – BOTANICAL SURVEY FOR ‘AKOKO ON SEVEN PARCELS AT KALAELOA, O‘AHU, HAWAI‘I (WHISTLER 2008)

This page is intentionally left blank.

BOTANICAL SURVEY FOR ‘AKOKO

ON SEVEN PARCELS AT KALAELOA,

O‘AHU, HAWAI‘I

by

Art Whistler, Ph. D.
Isle Botanica
Honolulu, Hawai‘i

Prepared for

Helber Hastert, & Fee, Planners
Honolulu, Hawai‘i

April 2008

This page is intentionally left blank.

INTRODUCTION

In preparation for the transfer of several parcels of surplus Federal land to agencies outside the Federal government, the Navy authorized a botanical survey at the former Naval Air Station, Barbers Point (NASBP), now called Kalaeloa, to determine if any endangered plant species occur on the selected parcels. Only a single Federally-listed endangered species, ‘akoko (*Chamaesyce skottsbergii*), has been recorded at these parcels. While much of the surplus land at the former air station is developed and covered with facilities, roads, and managed land vegetation (e.g., lawns and parks), some of it is still undeveloped and covered with natural (but not native) vegetation. A mixture of native and introduced species typically covers unmanaged and undeveloped lands within Kalaeloa.

‘Akoko (*Chamaesyce skottsbergii*), which was declared a Federally-listed endangered plant in 1982, is an endemic Hawaiian species in the Euphorbiaceae (Spurge Family). It is currently thought to be restricted to northwest Moloka‘i and the ‘Ewa Plain area of O‘ahu, but was formerly recorded from Kaho‘olawe and southern Maui. Two varieties are currently recognized, var. *skottsbergii* from O‘ahu and Moloka‘i, and var. *vaccinioides*, which is restricted to Moloka‘i (Wagner et al. 1999). The species occurs mostly on limestone substrate characterized by sinkholes and coralline rubble, often overlain with thin soils and pockets of humus. No critical habitat has been proposed, but the plant occurs mostly in kiawe (*Prosopis pallida*) forest described by Char and Balakrishnan (1979) in their botanical survey of the ‘Ewa Plain.

Only four populations of ‘akoko are known to exist on O‘ahu, three of them at Kalaeloa and one adjacent to it on private land in Campbell Industrial Park. The largest of these populations at Kalaeloa is situated on lands formerly called the Northern Trap and Skeet Range (Parcel 13058-D). The northern central portion of that parcel was scraped clear of vegetation in 2003 to remove arsenic-containing shotgun pellets, leaving only scattered islands of vegetation where ‘akoko is found. Nearby is an area of out-plantings where hundreds of ‘akoko plants are being maintained through weeding, selective herbicide application, and other horticultural practices.

The present survey was conducted to determine if any ‘akoko plants are found on parcels that are to be transferred from Federal jurisdiction to other agencies (see Figure 1). Parcel 3802-A is located outside the west perimeter of the former base, and is separated from it by a stream channel. Parcel 13068 is east of and contiguous with Parcel 3802-A, and lies on the western boundary of the former base. Parcel 13058-D is the former Northern Trap and Skeet Range, but only the unbulldozed area of this parcel was surveyed. Parcel 13059-C is a former quarry that is currently surrounded by a chain link fence. Parcels 13058-B, 13058-C, and 13059-B are found in the northeast corner of the former NASBP (see Figure 1). They were combined together for the purposes of this study since they are contiguous with each other and difficult to separate, other than that they are slated for transfer to different agencies.

METHODOLOGY

The botanical survey was conducted between 18 December 2007 and 10 February 2008 by a three-person crew from Isle Botanica consisting of the Principal Investigator (PI) Art Whistler and two field assistants. This period coincides with the rainy season in Hawai‘i—the time when

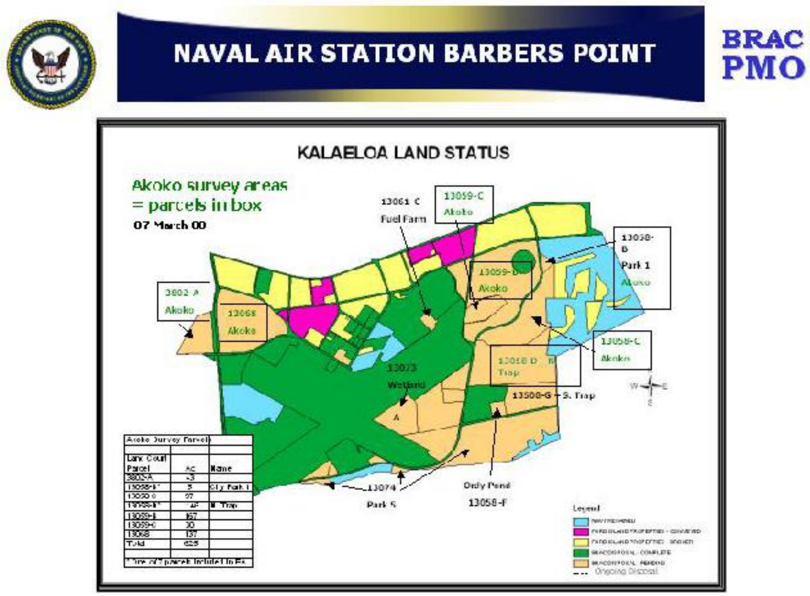


Figure 1. The Seven Parcels Studied for the Presence of ‘Akoko.

the inconspicuous ‘akoko shrubs are leafy and most easily spotted; ‘akoko drops its leaves in the dry season (late spring to late fall) and is hard to identify in its leafless state. During the first part of the survey, the forest was lush and many areas were overgrown with the endemic herbaceous vine kupala (*Sicyos pachycarpa*), but during the latter survey days, this vine nearly disappeared due to the dryer conditions. The survey, called a “100% survey,” was conducted by the two- or three-man crew walking transect lines approximately 10 meters (m) apart through the parcel or part of it. Each pass was marked with colored flagging tape to be used as a boundary for the next pass. When keeping a straight line became difficult, a hand-held GPS unit was used to stay on track. Each parcel presented its own difficulties, either because of its shape, size, or lack of landmarks, and some of the transect lines were run east-west while others were run north-south. When an ‘akoko plant was encountered, its location was determined using a hand-held GPS unit, and recorded in a field book using the UTM parameter. When the plants were found in clusters, as was usually the case, the center of the cluster was used as the reference point. The number and estimated height of the plants were also recorded and the data was tabulated (Table 2).

THE VEGETATION

The vegetation at the site is mostly a kiawe/koa haole forest (= *Prosopis*/*Leucaena* forest) described by Char and Balakrishnan (1979), but in actuality comprises a mosaic of several types of vegetation. The conspicuous kiawe/koa haole forest is dominated by large trees of *Prosopis pallida* (kiawe, mesquite) up to 10 m or more in height, with smaller amounts of shorter and thinner *Leucaena leucocephala* (koa haole). In some places, ‘opiuma (*Pithecellobium dulce*) is common, and the Chinese banyan (*Ficus microcarpa*) is scattered throughout the site. The canopy of the kiawe trees produces a variable shade beneath it, which results in a ground cover dominated by more shade-tolerant plants, such as Guinea grass (*Panicum maximum*), Chinese violet (*Asystasia gangetica*), and kupala.

In wooded areas where the kiawe trees are sparse or absent, koa haole dominates. In this case, the ground cover is typically dominated by the less shade-tolerant buffel-grass (*Cenchrus ciliaris*). The shrubs ‘ilima (*Sida fallax*) and klu (*Acacia farnesiana*) are often common in these sunnier areas. Areas with the combination of koa haole and ‘ilima comprise the prime habitat for ‘akoko plants, which are, however, uncommon in the area. In areas with few or no trees, the vegetation is typically a grassland dominated by buffel-grass, often with scattered koa haole and ilima shrubs. The distinction between the kiawe/koa haole forest, the koa haole forest, and buffel-grass grassland is blurred because they blend into each other.

In addition, the parcels also contain another highly disturbed type of vegetation called “managed land vegetation.” This comprises land that is under periodic or frequent management, such as dirt roads or recently bulldozed tracks, and in the case of the present study site, abandoned airfields and other paved areas. These sites are usually very sunny and are dominated by a number of light-loving weeds. Given enough time, managed land vegetation eventually changes into a more stable type of vegetation dominated by trees, usually with more shade-tolerant herbaceous species underneath.

THE FLORA

A total of 137 plant species was recorded from the parcels. The majority of these are naturalized "alien" plants that were accidentally or intentionally introduced to Hawai'i, but which have now become established in the islands and can spread on their own. The remaining plants, which are termed native species, comprise indigenous and endemic species. Indigenous plants are species that are native to a region or place, but are also found elsewhere. Endemic plants are species restricted to a single region or area, i.e., in the case of Hawai'i, they are found only in Hawai'i. In biodiversity terms, the endemic status is the more important of the two categories, since if a species belonging to it is endangered or threatened in Hawai'i, it would likewise be classified globally. Indigenous species, however, can be rare in Hawai'i, but may be common elsewhere in the Pacific. Over 90% of the native plants in Hawai'i are endemic, one of the highest rates in the world.

Sixteen of the 137 species recorded from the parcels are native—six endemic and ten indigenous species (Table 1). Most of these native species are relatively common in Hawai'i. One species, *Chamaesyce skottsbergii*, is, however, on the Federal list of endangered species. This is the species at which the 100% survey was aimed. A checklist of all species found at the site is shown in the Appendix in Table 3

Table 1. Native Plants encountered during the 2008 Kalaeloa botanical survey for 'akoko.

Scientific Name	Common Name	Plant Family
	Endemic Species	
Capparis sandwichiana	pua pilo	Capparaceae (Caper Family)
Ipomoea tuboides	Hawaiian moon flower	Convolvulaceae (Morning-glory Family)
Sicyos pachycarpus	sicyos, kupala	Cucurbitaceae (Gourd Family)
Chamaesyce skottsbergii	'akoko	Euphorbiaceae (Spurge Family)
Erythrina sandwicensis	wiliwili	Fabaceae (Pea Family)
Santalum ellipticum	'iliahi-a-lo'e	Santalaceae (Sandalwood Family)
	Indigenous Species	
Sesuvium portulacastrum	'akulikuli	Aizoaceae (Carpetweed Family)
Cordia subcordata	kou, cordia	Boraginaceae (Heliotrope Family)
Cassytha filiformis	kauna'oa pehu	Cassythaceae (Cassytha Family)
Abutilon incanum	ma'o, hoary abutilon	Malvaceae (Mallow Family)
Sida fallax	'ilima	Malvaceae (Mallow Family)
Cocculus trilobus	huehue	Menispermaceae (Moonseed Family)
Boerhavia repens	alena, nena	Nyctaginaceae (Four-o'-Clock Family)
Plumbago zeylanica	'ilie'e	Plumbaginaceae (Leadwort Family
Solanum americanum	popolo	Solanaceae (Nightshade Family)
Waltheria indica	'uhaloa	Sterculiaceae (Cacao Family)

RESULTS

The results of the 100% survey are divided up into five sections. The first four correspond to parcels 3802-A, 13068, 13059-C, and 13058-D. The last section is a combination of Parcels 13058-B, 13058-C, and 13059-B. These latter three were grouped together since they were so similar.

Parcel 3802-A

This parcel, which is separated from the rest of the former NASBP by a canal, is the westernmost of the parcels, and comprises 43 acres (17 hectares [ha]) (see Figure 1). The northern portion comprises an abandoned racetrack. South of that is a trapezoid-shaped area covered with low vegetation that apparently was bulldozed in the recent past. It is dominated in some places by buffel-grass (*Cenchrus ciliaris*), in others by a low thicket of koa haole (*Leucaena leucocephala*), and in still others by a combination of the two. Other species common in clearings include 'uhaloa (*Waltheria indica*), Dahlberg daisy (*Dyssodia tenuiloba*), and stinkgrass (*Leptochloa uninervia*). A similar grassland dominated by buffel-grass and scattered koa haole and kiawe (*Prosopis pallida*) covers the southwestern end of the parcel.

The central area is a kiawe/koa haole forest dominated by kiawe (*Prosopis pallida*) and koa haole (*Leucaena leucocephala*). These two species often share dominance, but sometimes one or the other species nearly excludes the other. When the canopy is dense, particularly under kiawe, the ground cover is very light. When the canopy is more open, the ground cover is dominated by Guinea grass (*Panicum maximum*) and Chinese violet (*Asystasia gangetica*). These two species appear to be more shade tolerant than buffel-grass. However, when the canopy is very thin, as in areas dominated by koa haole and in clearings in the forest, buffel-grass usually dominates. Other species found on the forest floor include the native vine kupala (*Sicyos pachycarpus*), and the weedy alien herb lion's ear (*Leonotis nepetifolia*) and the alien herb *Euphorbia graminea*.

Overall, the area is not particularly good habitat for 'akoko, and none was seen there. It is not clear if there were ever any natural populations of 'akoko in this area, but in February of 1979, 218 individuals that had been salvaged from the area where the Barbers Point Deep Draft Harbor was to be constructed were planted here. However, by April of 1981, all of the transplanted individuals were presumed dead. This was not quite true, however, because during a survey in 1992 three living individuals were found (L. Mehrhoff, pers. comm. 1993). In another survey five years later, only two living individuals were found (Whistler 1998). The area may have been unsuitable for 'akoko in the first place, or the increase in weedy ground cover of species like Guinea grass, or an increasingly dense canopy of kiawe, may have eliminated the last few individuals. Consequently, it is likely that 'akoko has disappeared from the parcel, either by competition with alien species for light and moisture, or because the area was unsuited for it in the first place.

Parcel 13068

This parcel, comprising 137 acres (55 ha), is located east of the westernmost parcel, 3802-A, and is east of the canal that forms the western boundary of the former NASBP (see Figure 1). The somewhat triangular-shaped parcel is bounded on the north side by Midway Road and its continuation, Saratoga Road; on the west side by Saratoga Road that runs along the western boundary of the former NASBP; and on the south side by an unmarked boundary south of Attu and Munda Streets.

The southwestern portion of the parcel has recently been cleared, and is now covered with a scrubby vegetation dominated by koa haole (*Leucaena leucocephala*) shrubs up to 1.8 m high, between which is a dense grass cover dominated by buffel-grass (*Cenchrus ciliaris*), with lesser amounts of Guinea grass (*Panicum maximum*) and ‘ilima (*Sida fallax*). The major portion of the parcel is covered with a kiawe/koa haole forest dominated by kiawe (*Prosopis pallida*) and koa haole. Other trees found here, but in much lesser amounts, include the endemic wiliwili (*Erythrina sandwicensis*), the alien Chinese banyan (*Ficus microcarpa*), and the alien ‘opiuma (*Pithecellobium dulce*). The most common shrubs, usually in areas of little or no canopy, include the native ‘ilima (*Sida fallax*) and the alien klu (*Acacia farnesiana*). Other native species include the herb ‘ilie‘e (*Plumbago zeylanica*) and the shrub pua pilo (*Capparis sandwichiana*). The latter is quite rare at Kalaeloa, but more common elsewhere in the islands.

The ground cover in this forest is dominated by four species, the endemic vine kupala (*Sicyos pachycephala*), the alien dicot herb Chinese violet (*Asystasia gangetica*), and the two alien grasses buffel-grass (*Cenchrus ciliaris*) and Guinea grass (*Panicum maximum*). In some places, particularly under a dense kiawe canopy, ground cover is nearly absent. Where the canopy is absent, i.e., where the trees are farther apart, the vegetation is mainly a grassland dominated by buffel-grass, and to a lesser extent, Guinea grass.

There is, or was, a significant amount of suitable habitat for ‘akoko in this parcel, such as exposed areas of rock with little herbaceous ground cover and little or no tree canopy above it. ‘Akoko was previously recorded in this area. Char and Balakrishnan (1979) reported a population of 18 individuals in three small subpopulations in the eastern portion. Twelve years later in 1991, this population was judged to be twenty individuals (Hawaiian Heritage Program 1991), but was probably based on the earlier information. Only two years later, however, a survey by Whistler (1993) recorded only seven individuals in the same eastern third of the property, but this survey was done only in a portion of the larger parcel. Another four plants were found in the general area in the following year (C. Corn, pers. comm. 1994). Six years later, Whistler (1998) recorded a single plant in the same area, and that was judged to be all that remained of the former population (Whistler 1998).

It appears that over the years there has been a continual decline in the number of individuals on this parcel, probably because of competition from alien species for sunlight and moisture. Perhaps the ‘akoko has been unable to reproduce at a sufficient rate to maintain the population, and consequently when the adults have died, the species has disappeared from the parcel. In any case, it appears that ‘akoko is no longer found here.

Parcel 13059-C

This parcel, comprising 30 acres, is the site of a former quarry that in now entirely surrounded by a chain link fence running along the rim. It is situated just to the east of Coral Sea Road, and is almost completely surrounded by Parcel 13059-B. The site has been excavated to a depth of perhaps 10 to 15 m. Because virtually the whole surface has been removed, there is nothing left of the original vegetation. It is currently covered by a mosaic of several types of vegetation. In some places that have been relatively recently bulldozed, the ground is open and dominated by alien herbaceous weeds such buffel-grass (*Cenchrus ciliaris*), swollen fingergrass

(*Chloris barbata*), weedy heliotrope (*Heliotropium procumbens*), and Australian saltbush (*Atriplex semibaccata*). In other places, the two shrubs pluchea (*Pluchea carolinensis*) and Indian pluchea (*Pluchea indica*), and their hybrid *Pluchea* x *fosbergii*, dominate in thickets that are sometimes over 2 m in height.

Most of the quarry bottom is covered with a variation of kiawe/koa haole forest dominated by kiawe (*Prosopis pallida*) and koa haole (*Leucaena leucocephala*), along with ‘opiuma (*Pithecellobium dulcis*). When these trees form a dense canopy, the ground cover is absent to moderate. The most common species occurring here are false mallow (*Malvastrum coromandelianum*) and lesser amounts of buffel-grass and *Achyranthes aspera*. Dense thickets of pluchea (*Pluchea* spp.) are frequent under the canopy, making passage through it difficult (along with the thorny branches of kiawe and ‘opiuma).

There may have been ‘akoko on the site before it was turned into a quarry, but since the surface has been excavated, there is little chance that any ‘akoko plants could have survived or moved into the area. The area is entirely unsuited to the presence or recolonization of ‘akoko. Thus this parcel is judged to currently have no ‘akoko present.

Parcel 13058-D

This parcel, referred to as the former Northern Trap and Skeet Range, was substituted in the study for the former Southern Trap and Skeet Range (13058-G) because the vegetation of the latter had largely been scraped clear by bulldozing to remove lead pellets from the area. Similar bulldozing occurred on the former Northern Trap and Skeet Range, where a semicircular area in the middle of the northern boundary was covered with low vegetation resulting from the recent bulldozing. Consequently, the survey on the former Northern Trap and Skeet Range was carried out only on the areas that were not bulldozed, which comprise the majority of the parcel. No acreage was given for this study area, but it was estimated to be about 106 acres (43 ha).

Except for the bulldozed area, most of the area is covered with a mosaic of kiawe/koa haole forest and buffel-grass /koa haole grassland. There were also a couple of roads and trails through the area, as well as some structures. The overall dominant species in the area is kiawe (*Prosopis pallida*), which in some places forms a closed canopy, as well as thickets of thorny branches near the ground that impede passage through it. The shorter and smaller koa haole (*Leucaena leucocephala*) is usually the second-most dominant species in this forest, sometimes nearly equaling kiawe in cover. The only other significant trees found here, all of them uncommon, are the aliens ‘opiuma (*Pithecellobium dulce*) and Chinese banyan (*Ficus microcarpa*), and the endemic wiliwili (*Erythrina sandwicensis*). In shaded or partially shaded places, the ground cover is dominated by the alien Guinea grass (*Panicum maximum*) and Chinese violet (*Asystasia gangetica*), and the endemic vine kupala (*Sicyos pachycarpa*). When the canopy is scant, the dominant ground cover is buffel-grass (*Cenchrus ciliaris*).

The clearings in the area, which comprise the buffel-grass /koa haole grassland, are completely dominated by buffel-grass, with scattered, relatively short koa haole shrubs or trees. The grass is so thick that it chokes out most other species. But scattered throughout the area are areas with exposed limestone rock. These are often nearly bare when occurring under kiawe

Table 2. ‘Akoko plants found on the Northern Trap and Skeet Range

Locations are cited in UTM. Specimens are listed in order of estimated height in cm. Plants found in the cleared area on the north side of the parcel (most supplied by water pipes), and those cultivated plants found at the USFWS facility, are not included here.

1. E598698 N2357029	18 plants
30, 40, 40, 40, 50, 50, 60, 60, 60, 65, 70, 80, 110, 100, 100, 100, 100, 120	
2. E598701 N2357045	5 plants
40, 45, 45, 45, 75	
3. E598816 N2357129	2 plants
100, 120	
4. E598772 N2357054	10 plants
20, 75, 75, 75, 85, 100, 100, 110, 120, 130	
5. E598843 N2357033	7 plants
85, 100, 105, 125, 135, 135, 140	
6. E598700 N2357029	20 plants
20, 25, 30, 40, 40, 50, 50, 60, 60, 60, 75, 75, 90, 95, 100, 100, 100, 110, 105, 105	
7. E598715 N2356977	4 plants
75, 60, 120, 170	
8. E598751 N2357005	5 plants
50, 80, 95, 100, 110	
9. E598662 N2357094	59 plants
15, 20, 20, 20, 20, 25, 25, 25, 30, 30, 30, 40, 40, 40, 40, 40, 40, 50, 50, 60, 60, 60, 60, 60, 60, 60, 75, 75, 67, 80, 80, 80, 90, 90, 100, 100, 100, 100, 100, 100, 105, 110, 110, 110, 100, 120, 120, 120, 120, 120, 120, 120, 120, 125, 130, 130, 150, 150, 180	
10. E598602 N2357053	6 plants
75, 75, 175, 130, 130, 160	
11. E598602 N2357053	26 plants
10, 15, 15, 20, 25, 25, 25, 25, 30, 35, 40, 45, 50, 75, 75, 75, 75, 75, 80, 80, 110, 120, 120, 130, 140, 150	
12. E598545 N2356975	3 plants
95, 50, 15	
13. E598522 N2356865	8 plants
50, 55, 60, 60, 60, 60, 100, 110	
14. E598439 N2356915	1 plant
90	
15. E598391 N2356846	1 plant
140	
16. E598123 N2357159	1 plant
185	
	TOTAL 176 plants

shade, but when they occur in sunny areas, the alien species, such as golden crownbeard (*Verbesina encelioides*), beggar’s-tick (*Bidens pilosa*), and pigweed (*Portulaca oleracea*), and the native species kupala, ‘uhaloa (*Waltheria indica*), and ‘ilima (*Sida fallax*), are common.

Overall, this area appears to be relatively good habitat for ‘akoko. This shrub is rarely found in the shade of kiawe trees, occurring more often in rocky, sunny areas that comprise much of the buffel-grass /koa haole grassland. This area was surveyed later than the rest of the sites, and by the time it was, with little rainfall in previous few weeks, the kupala was mostly dead and inconspicuous.

Parcel 13058-D was the only parcel surveyed that had any ‘akoko plants. A total of 176 ‘akoko plants were recorded, occurring in sixteen places. These sixteen “clusters” included from 1 to 59 individuals (Table 2), ranging in height from 15 to 185 centimeters (cm). No fresh seedlings were noted in these areas.

Various surveys have been done on the Northern Trap and Skeet Range, but because this survey did not include the area of highest concentration, i.e., the areas with the “islands” of vegetation not scraped clean during the bulldozing, this survey is not comparable to any of them. A figure of 500 individuals was cited for the whole Northern Trap and Skeet Range by Char and Balakrishnan (1979). The USFWS recovery plan (USFWS 1993) noted an estimated 500 individuals. However, this estimate was revised upward to 5,000 in another report later in the same year (Connor et al. 1993), but this figure, based on an unpublished University of Hawai‘i Botany 490 class report, seems too high because it is ten times higher than what any other investigators estimated before or after that time. A map of the distribution of the sixteen clusters is shown in Figure 2.

Parcels 13058-B, 13058-C, and 13059-B

Parcel 13058-B, 13058-C, and 13059-B were surveyed as one area because the parcels are contiguous with each other with no clear boundaries between them. The two larger ones (13058-C and 13059-B) are separated only by a previously planned (but not constructed) road with no visible boundaries on the ground, and the smaller one (13058-B) is a 5-acre (2.3 ha) triangle, also with no visible boundaries on the ground. There were also no significant differences between the parcels, with more variation within the parcels than between them. These were, perhaps, the most disturbed of the areas studied, since major portions of them are paved. These paved areas comprise mostly former runways and taxiways. Other paved areas appear to have been large parking lots. Still other areas are dotted with huge concrete revetments once used to house and protect military aircraft. These revetments are connected by a network of paved taxiways.

The runways and taxiways are covered with what is called “managed land vegetation.” This is dominated in most places by sun-loving weedy plants, such as koa haole (*Leucaena leucocephala*), ‘uhaloa (*Waltheria indica*), and buffel-grass (*Cenchrus ciliaris*), as well as many other less common species. One large paved area, perhaps formerly used for parking, is covered by a forest of ‘opiuma (*Pithecellobium dulce*) along with some koa haole, with scattered clumps of herbaceous species, particularly Guinea grass (*Panicum maximum*) and carrion flower (*Stapelia gigantea*). Amongst the paved areas are limestone areas, probably once bulldozed or managed, that are currently grasslands dominated by buffel-grass. The areas between the runways, the areas around the revetments, and the large area north of San Jacinto are covered with the typical kiawe/koa haole forest described for the other parcels.

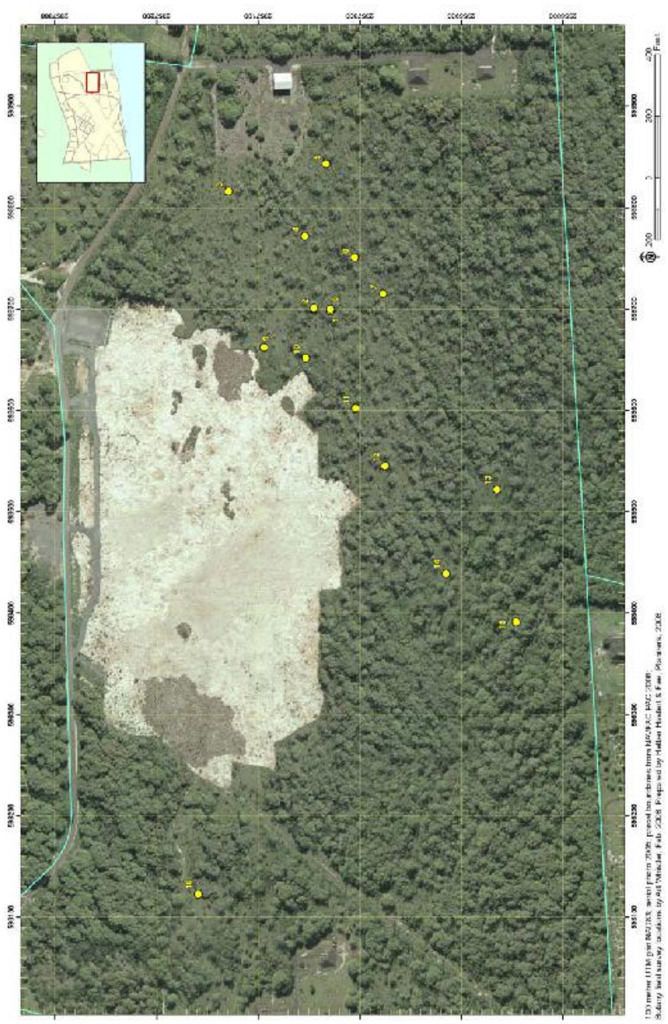


Figure 2. Distribution of ‘akoko on Parcel 13058-D
(former Northern Skeet and Trap Range).

No ‘akoko plants were found on these three parcels, and there is only a single record of any of the plants having been recorded there before (see Discussion). This is probably because of the high degree of disturbance.

DISCUSSION

The only parcel of the seven upon which ‘akoko was found is the former Northern Trap and Skeet Range (Parcel 13058-D). A total of 176 individuals were recorded during the present survey. This does not include the area that once had the highest concentration of ‘akoko, which was bulldozed several years ago to remove heavy metal-contaminated soil. The bulldozing left “islands” of vegetation upon which the ‘akoko plants are situated, as mapped during a 2003 survey (Whistler 2003). That survey turned up 858 plants for the 23-acre (9.3 ha) site. No estimate of the current population there was done during the present survey, since it was beyond the scope of work. The population is also now augmented by several large clusters of transplanted and/or cultivated plants next to Building 1527 on the eastern side of the site (an area also not surveyed during the present study).

Two clusters where individuals had previously been precisely located, either by GPS or by obvious landmarks, were revisited during the present survey. In Parcel 13068, five individuals were found in an exposed limestone clearing in the forest across the street from Building 191 on Attu Road, apparently sometime in 1997 (the data has been lost). When the PI revisited site on 6 January 1998, no trace of the five plants could be found. The same was true when the PI visited the site during the present study.

A second cluster of ‘akoko plants was located at another site on Parcel 13059-B just to the east of Coral Sea Road by the PI on 6 January 1998. Two plants were reported at that time. The site was more precisely located by GPS on 3 April 2002 (PACNAVFACENGCOM 2002), and eleven individuals were reported at that time. The site was revisited during the present survey based on the GPS coordinates, but no sign, living or dead plants, was found of this population. The present survey was six years after that 2002 survey, and the population could have died out naturally in that time. However, for the population located near Building 191 to disappear without a trace over a very short period (probably several months) is unusual and makes one think that someone could have destroyed the population.

In summary, only one parcel of the seven studied, Parcel 13058-D, the former Northern Trap and Skeet Range, was found to have extant populations of ‘akoko. It appears that the other populations on the base have died out. The overall trend has been for the species to become extirpated from all parcels except 13058-D. While it is possible that there are still seeds in the soil in the other parcels, how long they remain viable (able to germinate) in a natural setting is unknown. After several years of exposure to environmental conditions (moisture and temperature fluctuations, possible scavenging by insects and animals, etc.), seeds remaining in the soil may be dead. Tens of thousands of ‘akoko seeds collected from Parcel 13058-D are currently being stored under ideal conditions at Lyon Arboretum.

REFERENCES CITED

Char, W. and N. Balakrishnan. 1979. ‘Ewa Plains Botanical Survey. Unpublished report prepared for the USFWS.

Connor, C., A. Hoevels, L. Kuhn, and B. Pang. 1993. A survey for the endangered ‘akoko

(*Chamaesyce skottsbergii* var. *skottsbergii*) at Barbers Point Naval Air Station, Kalaeloa, O'ahu, with management recommendations for it long-term survival. Unpublished manuscript for U. H. Manoa Science 490 class.

Hawai'i Heritage Program. 1991. Element occurrence records for *Chamaesyce skottsbergii* var. *skottsbergii*. PDEUPOD293. The Nature Conservancy, Honolulu. Unpublished manuscript.

Palmer, D.D. 2003. Hawai'i's Ferns and Fern Allies. University of Hawaii Press, Honolulu. 324 pp.

PACNAVFACENGCOM. 2002. 'Akoko (*Chamaesyce skottsbergii* var. *skottsbergii*) survey on 40-acres of lot 13059B. Unpublished report.

Porter, J. R. 1972. Hawaiian names for vascular plants. University of Hawai'i College of Tropical Agriculture Experimental Station Paper 1: 1–64.

St. John, H. 1973. List and summary of the flowering plants in the Hawaiian Islands. Pacific Tropical Botanical Garden Memoir 1: 1–519.

USFWS 1993. Recovery plan for *Chamaesyce skottsbergii* var. *skottsbergii* and *Achyranthes splendens* var. *rotundata*. USFWS., Portland, OR. 65 pp.

Wagner, W. L., D. Herbst, and S. H. Sohmer. 1999. Manual of the flowering plants of Hawai'i. Bishop Museum and University of Hawaii Press, Honolulu. 2 vols.

Whistler, W. A. 1993. Report on a Barbers Point Naval Air Station 100% survey for *Chamaesyce skottsbergii*. Unpublished report prepared for Belt Collins and Associates.

Whistler, W. A. 1998. *Chamaesyce skottsbergii* botanical survey of the Naval Air Station, Barbers Point, Oahu, Hawai'i. Unpublished report prepared for Belt Collins Hawaii. 10 pp.

Whistler, W. A. 2003. 'Akoko (*Chamaesyce skottsbergii* var. *kalaeloana*) survey of the Northern Trap and Skeet Range at the former Naval Air Station, Barbers Point. Letter to PACNAVFACENGCOM. 4 pp.

APPENDIX
TABLE 3. PLANT SPECIES CHECKLIST

The following is a checklist of the vascular plants inventoried during the field studies on the seven parcels of land at the former BPNAS. The plants are divided into two groups: monocots, and dicots. Within these groups, the species are presented taxonomically by family, with each family and each species in the family in alphabetical order. The taxonomy and nomenclature of the ferns follow Palmer 2003 and the flowering plants (monocots and dicots) follow Wagner *et al*. (1990). In most cases, common English and/or Hawaiian names listed here have been taken from St. John (1973) or Porter (1972).

For each species, the following information is provided:

1. Scientific name with author citation.
2. Common English and/or Hawaiian name, when known.
3. Biogeographic status. The following symbols are used.
   - E = endemic (found only in Hawai'i).
   - I = indigenous (native to Hawai'i as well as other geographic areas).
   - P = Polynesian introduction (introduced to Hawai'i by Polynesians before the advent of the Europeans).
   - X = Introduced or alien (not native, introduced to Hawai'i, either accidentally or intentionally, after the advent of the Europeans).

Species	Common Names	Status	Parcels[1]
MONOCOTS			
AGAVACEAE (Agave Family)			
Agave sisalana Perr.	agave	X	1 -- -- 4 5
Aloe vera L.	aloe	X	1 2 -- -- 5
Cordyline fruticosa (L.) A. Chev.	ti, ki	P	-- -- -- 4 5
Sansevieria fasciata Cornu ex Gérome & Labroy	bowstring hemp	X	-- -- -- -- 5
ARECACEAE (Palm Family)			
Phoenix dactylifera L.	date palm	X	-- -- -- -- 5
COMMELINACEAE (Spiderwort Family)			
Commelina benghalensis L.	hairy honohono	X	1 -- -- -- 5
POACEAE (Grass Family)			
Bothriochloa pertusa (L.) A. Camus	pitted beardgrass	X	-- -- 3 -- 5
Cenchrus ciliaris L.	buffel-grass	X	1 2 3 4 5
Chloris barbata (L.) Sw.	swollen fingergrass	X	1 -- 3 4 5
Cynodon dactylon (L.) Pers.	Bermuda grass	X	1 2 -- -- 5
Digitaria insularis (L.) Mez ex Ekman	sour grass	X	1 -- -- -- --
Eragrostis cilianensis (All.) Link	stink grass	X	1 2 3 4 5
Eragrostis tenella (L.) P. Beauv.	love grass	X	-- -- -- 4 5

Species	Common Names	Status	Parcels[1]
POACEAE (cont'd.)			
Leptochloa uninervia			
(K. Presl) Hitchc. & Chase	----------	X	1 2 3 4 5
Panicum maximum Jacq.	Guinea grass	X	1 2 3 4 5
Rhynchelytrum repens (Willd.) C.E. Hubb.	Natal redtop	X	1 2 3 -- 5
Setaria verticillata (L.) P. Beauv.	bristly foxtail	X	-- -- -- 4 5
Sporobolus diander (Retz.) P. Beauv.	dropseed	X	-- -- 3 -- --
Poaceae indet.	----------	X	-- -- -- 4 5
DICOTS			
ACANTHACEAE (Acanthus Family)			
Asystasia gangetica (L.) T. Anderson	Chinese violet	X	1 2 3 4 5
Barleria cristata L.	Philippine violet	X	1 2 -- -- --
Barleria repens C. Nees	pink ruellia	X	-- 2 -- -- --
AIZOACEAE (Carpetweed Family)			
Sesuvium portulacastrum (L.) L.	ʻakulikuli	I	-- -- 3 -- --
AMARANTHACEAE (Amaranth Family)			
Achyranthes aspera L.	----------	X	1 -- 3 4 5
Amaranthus spinosus L.	spiny amaranth	X	-- 2 -- -- 5
Amaranthus viridis L.	slender amaranth	X	-- -- -- -- 5
ANACARDIACEAE (Mango Family)			
Mangifera indica L.	mango	X	-- -- -- -- 5
Schinus terebinthifolius Raddi	Christmas berry	X	1 2 3 4 5
APOCYNACEAE (Periwinkle Family)			
Cascabela thevetia (L.) Lippold.	be-still tree	X	-- -- -- -- 5
ARALIACEAE			
Schefflera actinophylla (Endl.) Harms	octopus tree	X	1 -- -- -- 5
ASCLEPIADACEAE (Milkweed Family)			
Cryptostegia grandiflora Roxb. ex Br.	panay rubber vine	X	1 -- -- -- --
Stapelia gigantea N.E. Brown	carrion flower	X	1 -- -- 4 5
ASTERACEAE (Sunflower Family)			
Ageratum conyzoides L.	ageratum	X	1 -- -- 4 5
Bidens alba (L.) DC.	beggar's-tick	X	-- -- -- -- 5
Bidens cynapiifolia Kunth	West Indian beggar's-tick	X	1 2 -- -- 5
Bidens pilosa L.	beggar's-tick	X	1 2 -- 4 5
Dyssodia tenuiloba A.P. de Candolle	Dahlberg daisy	X	1 2 -- -- --
Emilia fosbergii Nicolson	red pualele, emilia	X	1 -- -- 4 5
Flaveria trinervia (Spreng.) C. Mohr	----------	X	-- 2 -- -- 5
Pluchea carolinensis (Jacq.) G. Don	pluchea	X	1 -- 3 4 5
Pluchea x *fosbergii* Cooperr. & Galang	hybrid pluchea	X	-- 2 3 4 5
Pluchea indica (L.) Less.	Indian pluchea	X	-- 2 3 4 5
Sonchus oleraceus L.	sow thistle	X	1 2 -- 4 5

Species Common Names Status Parcels[1]

Species	Common Names	Status	Parcels[1]
ASTERACEAE (cont'd.)			
Tridax procumbens L.	coat buttons	X	1 -- 3 4 5
Verbesina encelioides			
(Cav.) Benth. & Hook.	golden crownbeard	X	1 2 3 4 5
Xanthium strumarium L.	cocklebur	X	-- 2 -- -- --
BIGNONIACEAE (Bignonia Family)			
Spathodea campanulata P. Beauv.	African tulip tree	X	1 -- -- 4 5
Tabebuia heterophylla (DC.) Britton	pink tecoma	X	
Tecoma stans (L.) Juss. ex Kunth	yellow elder	X	1 -- -- -- --
BORAGINACEAE (Heliotrope Family)			
Cordia dichotoma Forst. f.	sebestan	X	-- -- -- -- 5
Cordia sebestena L.	Geiger tree	X	-- -- -- -- 5
Cordia subcordata Lam.	kou, cordia	I	1 -- -- -- --
Heliotropium procumbens Mill.	weedy heliotrope	X	1 2 3 4 5
BRASSICACEAE (Mustard Family)			
Lepidium virginicum L.	wild peppergrass	X	1 -- -- -- --
CACTACEAE (Cactus Family)			
Hylocereus undatus (Haw.) Britten & Rose	night-blooming cereus	X	1 -- -- -- 5
Opuntia ficus-indica (L.) Mill.	prickly pear, panini	X	1 -- -- -- --
CAPPARACEAE (Caper Family)			
Capparis sandwichiana DC.	pua pilo	E	1 -- -- -- --
Cleome gynandra L.	African spider flower	X	-- 2 -- -- --
CARYOPHYLLACEAE (Carnation Family)			
Spergularia marina (L.) Griseb.	Saltmarsh sand spurry	X	-- -- 3 -- 5
CASSYTHACEAE (Cassytha Family)			
Cassytha filiformis L.	kaunaʻoa pehu	I	1 2 3 4 5
CASUARINACEAE (Ironwood Family)			
Casuarina equisetifolia L.	ironwood	X	-- 2 3 -- --
CHENOPODIACEAE (Goosefoot Family)			
Atriplex semibaccata R. Br.	Australian saltbush	X	-- -- 3 4 --
Chenopodium ambrosioides L.	Mexican tea	X	-- -- -- -- 5
Chenopodium murale L.	ʻaheahea	X	-- -- -- -- 5
CLUSIACEAE (Mangosteen Family)			
Clusia rosea Jacq.	autograph tree	X	1 -- -- -- --
CONVOLVULACEAE (Morning-Glory Family)			
Ipomoea tuboides Degener & Ooststr.	Hawaiian moon flower	E	-- -- -- -- --
Ipomoea cairica (L.) Sweet	koali	X?	1 2 3 4 5
Ipomoea obscura (L.) Ker-Gawl.	bindweed	X	1 2 3 -- 5
Merremia aegyptia (L.) Urb.	hairy merremia	X?	1 2 -- 4 5

CUCURBITACEAE (Gourd Family)			
Coccinea grandis (L.) Voigt	ivy gourd	X	-- 2 -- -- --
Cucumis dipsaceus Ehrenb. ex Spach	wild cucumber	X	1 -- -- -- --
Momordica charantia L.	wild bittermelon	X	1 2 -- 4 5
Sicyos pachycarpus Hook. & Arnott	kupala, sicyos	E	1 2 3 4 5
CUSCUTACEAE (Dodder Family)			
Cuscuta campestris Yuncker	dotter	X	1 -- -- -- --
EUPHORBIACEAE (Spurge Family)			
Chamaesyce hirta (L.) Millsp.	garden spurge	X	1 2 3 4 5
Chamaesyce hypericifolia (L.) Millsp.	graceful spurge	X	1 2 -- 4 5
Chamaesyce prostrata (Aiton) Small	prostrate spurge	X	1 -- 3 -- 5
Chamaesyce skottsbergii (Sherff) Croizat & Degener	‘akoko	E	-- -- -- 4 --
Euphorbia graminea Jacq	----------	X	1 2 -- 4 5
Euphorbia heterophylla L.	kaliko	X	1 -- -- 4 5
Euphorbia lactea Haw.	milk-stripe spurge	X	1 -- -- -- 5
Pedilanthus tithymaloides (L.) Poit.	slipper plant	X	1 -- -- -- --
Ricinus communis L.	castor bean	X	1 2 3 4 5
FABACEAE (Pea Family)			
Acacia farnesiana (L.) Willd.	klu	X	1 -- -- 4 5
Crotalaria incana L.	fuzzy rattlepod	X	
Desmanthus pernambucanus (L.) Thellung	virgate mimosa	X	-- 2 -- -- 5
Desmodium tortuosum (Sw.) DC.	Florida beggarweed	X	-- 2 -- -- 5
Erythrina sandwicensis Deg.	wiliwili	E	1 -- -- 4 5
Indigofera spicata Forssk.	creeping indigo	X	1 -- -- -- 5
Indigofera suffruticosa Mill.	indigo, ‘iniko	X	1 2 – 4 5
Leucaena leucocephala (Lam.) de Wit	koa haole	X	1 2 3 4 5
Macroptilium atropurpureum (DC) Urb.	wild bushbean	X	-- 2 -- -- 5
Macroptilium lathyroides (L.) Urb.	cow pea	X	1 2 -- 4 5
Pithecellobium dulce (Roxb.) Benth.	‘opiuma, Manila tamarind	X	1 2 3 4 5
Prosopis pallida (Humb. & Bonpl.ex Willd.) Kunth	kiawe, mesquite	X	1 2 3 4 5
Samanea saman (Jacq.) Merr.	monkeypod	X	-- -- -- -- 5
Senna surattensis (N.L. Burm.) H. Irwin & Barneby	kolomona	X	-- -- -- -- 5
Tamarindus indicus L.	tamarind	X	-- -- -- -- 5
GENTIANACEAE (Gentian family)			
Centarium erythraea Raf.	European centaury	X	-- -- -- -- 5
GERANIACEAE (Geranium Family)			
Erodium cicutarium (L.) L’Her.	stork’s bill	X	-- -- -- -- 5

Species	Common Names	Status	Parcels[1]
LAMIACEAE (Mint Family)			

Leonotis nepetifolia (L.) R. Br.	orange lion’s-ear	X	1 2 -- 4 5
Ocimum gratissimum L.	wild basil	X	1 2 -- -- --
LAURACEAE (Laurel Family)			
Persea americana Mill.	avocado	X	-- -- -- -- 5
MALVACEAE (Mallow Family)			
Abutilon grandifolium (Willd.) Sweet	hairy abutilon	X	1 2 3
Abutilon incanum (Link) Sweet	ma‘o, hoary abutilon	I?	-- -- -- -- 5
Malva parviflora L.	cheeseweed	X	1 -- -- 4 5
Malvastrum coromandelianum (L.) Garcke	false mallow	X	1 2 3 -- 5
Sida ciliaris L.	----------	X	1 2 3 4 5
Sida fallax Walp.	‘ilima	I	1 2 3 4 5
Sida spinosa L.	prickly sida	X	1 2 -- 4 5
MENISPERMACEAE (Moonseed Family)			
Cocculus trilobus (Thunb.) DC.	huehue	I	1 -- -- -- --
MORACEAE (Mulberry Family)			
Ficus microcarpa L. f.	Chinese banyan	X	1 2 3 4 5
Ficus cf. *elastica* Hornemann.	Indian rubber tree	X	1 -- -- -- --
NYCTAGINACEAE (Four-o’-Clock Family)			
Boerhavia coccinea Mill.	----------	X	1 -- -- -- 5
Boerhavia repens R. Br.	alena, nena	I	-- -- -- -- 5
Bougainvillea glabra Choisy	bougainvillea	X	-- -- -- -- 5
PASSIFLORACEAE (Passionflower Family)			
Passiflora foetida L.	love-in-a-mist	X	1 -- 3 -- 5
PHYTOLACCACEAE (Pokeweed Family)			
Rivina humilis L.	rouge plant	X	-- -- -- 4 --
PLUMBAGINACEAE (Leadwort Family)			
Plumbago zeylanica L.	‘ilie‘e	I	1 2 -- 4 5
POLYGONACEAE (Buckwheat Family)			
Antigonon leptopus Hook. & Arnott	Mexican creeper	X	-- -- -- -- 5
PORTULACACEAE (Purslane Family)			
Portulaca oleracea L.	common purslane	X	1 2 3 4 5
Portulaca pilosa L.	‘ihi	X	1 -- -- 4 5
RUBIACEAE (Coffee Family)			
Morinda citrifolia L.	Indian mulberry, noni	P	-- -- -- 4 5
Spermacoce assurgens Ruiz & Pav.	buttonweed	X	-- 2 -- -- --
SANTALACEAE (Sandalwood Family)			
Santalum album L.	sandalwood	X	-- -- -- -- 5
Santalum ellipticum Gaud.	‘iliahi-a-lo‘e, coast sandalwood	E	-- -- -- 4 5

Species	Common Names	Status	Parcels[1]
SOLANACEAE (Nightshade Family)			
Lycopersicon pimpinellifolium (Jusl.) Mill.	currant tomato	X	1 2 3 4 5

Nicandra physalodes (L.) Gaertn.	apple of Peru	X	1 -- -- -- 5
Nicotiana glauca R. C. Graham	tree tobacco	X	-- -- 3 -- --
Physalis angulata L.	wild Cape ground cherry	X	1 2 -- -- --
Solanum americanum Mill.	black nightshade, popolo	I?	1 -- -- 4 5
Solanum seaforthianum Andr.	blue potato-vine	X	1 -- -- 4 5
STERCULIACEAE (Cacao Family)			
Waltheria indica L.	‘uhaloa	I	1 2 3 4 5
URTICACEAE (Nettle Family)			
Pilea microphylla (L.) Liebm.	rockweed	X	-- -- -- -- 5
VERBENACEAE (Verbena Family)			
Lantana camara L.	lantana	X	1 2 -- -- --
Stachytarpheta jamaicensis (L.) Vahl	Jamaica vervain, oi, owi	X	1 2 -- -- 5
Vitex trifolia L.	vitex	X	-- -- -- -- 5

[1] Parcel 1=3802-A; Parcel 2=13068; Parcel 3=13059-C; Parcel 4=13058-D; and Parcel 5=13058-B, 13058-C, and 13059-B.

APPENDIX F
LEGAL REQUIREMENTS

F1 – LEGAL REQUIREMENTS

This page is intentionally left blank.

Acronyms and Abbreviations

ARPA	Archaeological Resources Protection Act of 1979
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CFR	Code of Federal Regulations
CNO	Chief of Naval Operations
CWA	Clean Water Act
DOD	Department of Defense
DOH	Department of Health
DON	Department of the Navy
EEZ	Exclusive Economic Zone
EFH	Essential Fish Habitat
EO	Executive Order
ESA	Endangered Species Act
FMPs	fishery management plans
ft	foot (feet)
HAPC	Habitat Area of Particular Concern
INRMP	Integrated Natural Resources Management Plan
km	kilometer(s)
m	meter(s)
MBTA	Migratory Bird Treaty Act of 1918
mi	mile(s)
MMPA	Marine Mammal Protection Act of 1972
MPA	Marine Protected Areas
MSA	Magnuson-Stevens Act
MSFCMA	Magnuson-Stevens Fishery Conservation and Management Act of 1976
NAGPRA	Native American Graves Protection and Repatriation Act
NANPCA	Non-indigenous Aquatic Nuisance Prevention Control Act of 1990
NAVFAC	Naval Facilities Engineering Command
NAVFACINST	NAVFAC Instruction
NAWMP	North American Waterfowl Management Plan
NCP	National Oil and Hazardous Substances Contingency Plan
NHPA	National Historic Preservation Act
nm	nautical mile
NOAA	National Oceanic and Atmospheric Administration

NOAA Fisheries	NOAA National Marine Fisheries Service
NPDES	National Pollutant Discharge Elimination System
PL	Public Law
SAIA	Sikes Act Improvement Amendments
SOH	State of Hawai'i
U.S.	United States
U.S.C.	United States Code
USFWS	U.S. Fish and Wildlife Service
WPRFMC	Western Pacific Regional Fishery Management Council

Table 1: Summary of Sikes Act Improvement Amendments and Related Guidance

Title	Description
Sikes Act Improvement Amendments (SAIA)	
SAIA of 1997 (16 United States Code (U.S.C.) 670a-670o [Public Law {PL} 86-797]	Requires military installations to prepare and implement a plan for the management, conservation, and rehabilitation of their natural resources, while still supporting the military mission, operational and security requirements. Requires all military installations that occupy land and water property suitable for the conservation and management of natural resources to prepare and implement comprehensive Integrated Natural Resources Management Plan (INRMP) by November 2001. INRMP must be continually monitored, reviewed annually, updated if necessary, and reapproved at least every 5 years.
Sikes Act of 1960 (Conservation Programs on Military Reservations)16 U.S.C. 670a-670o (PL 86-797)	Provides framework for management of natural resources on military lands.
Department of Defense (DOD) and Navy Guidance on Natural Resources Management	
Draft Guidelines for Preparing INRMPs for Navy Installations (Naval Facilities Engineering Command [NAVFAC] 2005)	Provides interpretation of the processes necessary to prepare INRMPs so that they comply with federal laws and regulations and provides appropriate stewardship of the natural resources entrusted to the Navy's care and use.
Environmental Conservation Program dated 3 May 1996 DOD Directive 4715.3 (replaces 4700.4)	Outlines procedures for the integrated management of natural and cultural resources on DOD-controlled property. The instruction is consistent with the provisions of SAIA. It states that natural resources under DOD control are to be managed to support and be consistent with military mission, while protecting and enhancing those resources for multiple use, sustainable yield, and biological integrity. It also notes that DOD lands and water shall be made available to the public for educational or recreational use, when access is compatible with military mission activities, ecosystem sustainability and other considerations such as security, safety, and fiscal soundness. This instruction implements policy, assigns responsibilities, and prescribes procedures for integrated management of natural and cultural resources on property under DOD control. Instruction also establishes the DOD Conservation Committee and designates "DOD Executive Agents" to lead DOD implementation of key conservation issues.

Table 1: Summary of Sikes Act Improvement Amendments and Related Guidance (continued)

Title	Description
Real Estate Operations & Natural Resources Management Procedural Manual Volume II, Naval NAVFAC P-73	Provides a comprehensive document addressing all Chief of Naval Operations (CNO) natural resources program requirements, guidelines, and standards. The Land Management chapter specifies that the land management section provide guidance covering soil and water conservation, lake or pond management, surface and subsurface water protection and use, agricultural outleasing, erosion control, landscaping, grounds maintenance, and range management, where applicable. The plan must also provide direction to improve real estate values, reduce maintenance, protect wildlife habitats, protect and improve the natural landscapes, and enhance the appearance of the installation, and it shall identify natural areas for agricultural outleasing.
Economy Act, 31 U.S.C. 1535	Provides for the utilization of non-DOD government agencies and non-profit organizations to perform natural resources work when said work would be less expensive than outsourcing and in-house personnel resources are sufficient.
Land Management Guidance	
NAVFAC Instruction (NAVFACINST) **MO-110.1**	Provides guidance on water and wind erosion. Preventing and correcting erosion problems protects landforms, conserves soil resources, and reduces the negative effects of water and airborne soil particulates.
Outdoor Recreation Management, NAVFACINST **MO-100.4**	Management of natural resources to provide recreation opportunities that are sustainable, within the military mission, within established carrying capacities, and consistent with the natural resources upon which they are based.
Soil Conservation and Domestic Allotment Act of 1963, 16 U.S.C. 590A	Provides for application of soil conservation practices on federal lands.
Watershed and Floodplain Protection, 16 U.S.C. 1001 et seq.	Directs federal government to cooperate with states and their political subdivisions, soil or water conservation districts, flood prevention or control districts, and other local public agencies for the purpose of preventing damages associated with flooding, of further conservation, development, utilization, and disposal of water, and the conservation and utilization of land and thereby of preserving, protecting, and improving the Nation's land and water resources and the quality of the environment.
Wild and Scenic Rivers Act of 1968, 16 U.S.C. 1271-1287 (PL 90-542)	Requires identification and protection of any river or stream that qualifies under the Act.
Fish and Wildlife Guidance	
Fish and Wildlife Management, NAVFACINST **MO-100.3**	A coordinated program of actions designed to preserve, enhance, and regulate indigenous wildlife and it habitats, including conservation of protected species and non-game species, management and harvest of game species, bird aircraft strike hazard reduction, and animal damage control.

Table 1: Summary of Sikes Act Improvement Amendments and Related Guidance (continued)

Title	Description
Animal Damage Control Act of 1931, 7 U.S.C. 426 (PL 102-237)	Act gives Animal and Plant Health Inspection Services the authority to control wildlife damage on federal, state, or private land. PL 102-237 adds Brown treesnakes to list of animals to watch.
Department of Defense Appropriations Act of 1991 (Legacy Program) (PL 10-2-396)	Establishes the Legacy Resources Management Program, a program for the stewardship of biological, geophysical, cultural, and historic resources on DOD lands.
Fish and Wildlife Conservation Act of 1980 (Nongame Act), 16 U.S.C. 2901-2911 (PL 96-366)	Encourages management of non-game species.
Outdoor Recreation Guidance	
Disabled Sportsman's Bill, 1999	Amends the Sikes Act to require military installations to ensure disabled have access to the same recreation facilities as the general public.
Recreational Coordination and Outdoor Recreation –Federal/State Programs Act of 1963 (Organic Act), 16 U.S.C. 4601 (PL 88-29)	Defines a program for managing of lands for outdoor recreation.
Military Construction Authorization Act of 1956– Military Reservations and Facilities and – Hunting, Fishing, and Trapping, 10 U.S.C. 2671 (PL 85-337)	Provides that hunting, fishing, and trapping on military lands will be in accordance with state laws.
Agricultural Outlease Guidance	
Farm Land Protection Policy Act, 7 Code of Federal Regulations (CFR) 658	Requires federal agencies to (a) use the criteria to identify and take into account the adverse effects of their programs on the preservation of farmland, (b) consider alternative actions, as appropriate, that could lessen adverse effects, and (c) ensure that their programs, to the extent practicable, are compatible with State and units of local government and private programs and policies to protect farmland.

Table 2: Summary of Applicable Cultural Resources Laws, Regulations, and Requirements

Title	Description
National Historic Preservation Act (NHPA), 16 U.S.C. 470 (f), PL 89-665	Recognizes the nation's historic heritage and establishes management practices encouraging preservation of historic properties. Sections 106 and 110 of the NHPA convey compliance obligations for federal agencies. Section 106 requires the Navy to consider the effects of proposed undertakings within and outside of the boundaries of the Pearl Harbor National Historic Landmark (PHNHL), and affords the Advisory Council on Historic Preservation (ACHP) the opportunity to comment. In compliance with both NHPA Sections 106 and 110, U.S. Naval Base, Pearl Harbor conducted an inventory of facilities within PHNHL in 1977 and approved a Historic Preservation Plan in 1978. A Memorandum of Agreement (MOA) was executed between the Navy and the ACHP, with the concurrence of the SHPO. The MOA identified procedures to avoid and/or assure appropriate mitigation of any adverse effects resulting from the Navy's missions at the Naval Base. Subsequent updates to the historic property inventory were made in 1983, 1990, and 1998. A Cultural Resources Management Plan (CRMP) was prepared by the Navy in August 2000, an Integrated Cultural Resources Management Plan (ICRMP) in March 2002 (CNRH 2002), and an update to the ICRMP is in progress (HHF 2006). An ongoing effort will replace the 1978 MOA with a Programmatic Agreement.
Archaeological Resources Protection Act of 1979 (ARPA), 16 U.S.C. 470aa-470ll (43 CFR Part 7)	ARPA specifies that no person may excavate, remove, damage, or otherwise alter or deface any archaeological resources located on public lands, unless such activity is undertaken pursuant to a permit issued by an appropriate federal land manager. As prerequisite to the approval of such work, it must be demonstrated that any archaeological resources excavated or removed from public lands will be curated in accordance with the Department of the Interior Final Rule 36 CFR Part 79, Curation of Federally-Owned and Administered Archaeological Collections. It further specifies that it is illegal to sell, purchase, exchange, transport, or receive any archaeological resources that were obtained in violation of the Act.
Native American Graves Protection and Repatriation Act (NAGPRA), 43 CFR Part 10	NAGPRA acknowledges the ownership of certain Native American and Native Hawaiian human remains and cultural items (funerary objects, sacred objects, and objects of cultural patrimony) by Native American or Native Hawaiian organizations, and treats these remains and objects in a way that is agreeable to these organizations. This Act applies to Native Hawaiian human remains and cultural items discovered, either inadvertently or intentionally excavated, during future undertakings. The implementing regulations, 43 CFR Part 10, provide guidance and procedures for notifying and consulting Native Hawaiian organizations; determining affiliation to the remains or objects; and ensuring proper treatment of the remains and objects in accordance with the affiliated organization's wishes.

NAVAL STATION PEARL HARBOR, O'AHU
INTEGRATED NATURAL RESOURCES MANAGEMENT PLAN
APPENDIX F1
LEGAL REQUIREMENTS

Table 3: Summary of Applicable Wetlands and Water Quality Laws, Regulations, and Requirements

Title	Description
Clean Water Act (CWA) 33 U.S.C. 1251-1376 (PL 92-500 [1977])	**Section 319** requires federal agency consistency with State non-point source pollution abatement plans. **Section 401** requires a water quality certification from the State of Hawai'i (SOH) Department of Health (DOH) for activities that may result in the discharge of pollutants into waters of the United States (U.S.). **Section 402** is the basis for the National Pollutant Discharge Elimination System (NPDES) program administered by SOH DOH to control discharges of pollutants into surface waters of the U.S. NPDES General Permit coverage for discharges of storm water associated with construction activity is required for construction projects that result in the disturbance of 1 acre (0.4 hectare) or more. Additionally, NPDES General Permit coverage is required for discharges associated with construction activity dewatering regardless of the size of the construction project. NPDES General Permit coverage is also required for discharge of hydrotesting waters from facilities or activities, which involve a release, or discharge of hydrotesting waters to SOH waters regardless of construction size. **Section 404** prohibits the discharge of dredged or filled materials into U.S. waters, including wetlands, without a Department of the Army permit from the U.S. Army Corps of Engineers.
Executive Order (EO) 11990, Protection of Wetlands	This EO was issued to avoid long- and short-term adverse impacts associated with the destruction or modification of wetlands. A national policy directive that requires that federal agency actions avoid resulting in a net loss of wetlands supports this EO.
Federal Water Pollution Control Act of 1948 (amended by the CWA of 1977), 33 U.S.C. 1251-1376 (PL 845)	See CWA
North American Wetlands Conservation Act of 1989, 16 U.S.C. Section 4401-4414	Funds the North American Waterfowl Management Plan (NAWMP) and the Tripartite agreement on wetlands between Canada, Mexico, and the U.S. The Act directs the Secretary of the Interior to develop and implement a wetlands conservation strategy, and report to Congress on NAWMP project implementation.

Table 4: Summary of Applicable Environmental Contamination Laws, Regulations, and Requirements

Title	Description
Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), 26 U.S.C. 4611-4682 (PL 96-510)	As amended by the Superfund Amendments Reauthorization Act, CERCLA establishes a series of programs for cleanup of hazardous waste disposal and programs for the cleanup of hazardous waste disposal and spill sites nationwide. Requires protection of human health and the environment. Work under this legislation is conducted under the Navy Installation Restoration Program.
Federal Insecticide, Fungicide, and Rodenticide Act , 7 U.S.C. 136 et seq. (PL 92-516)	Governs the use and application of pesticides in natural and resource management program.
Clean Air Act of 1990 (42 U.S.C. 7401-7671)	Advises federal government agencies to protect and enhance the quality of the Nation's air resources so as to promote the public health and welfare and the productive capacity of its population.
Oil Pollution Act of 1990, 33 U.S.C. 2701 et seq. (PL 101-380)	Redefines the requirements of the National Oil and Hazardous Substances Contingency Plan (NCP) to include planning for rescue of, minimization of injury to, and assessment of damages to fish and wildlife resources.
NCP, Designation of Federal Trustees, 40 CFR 300.600	Designates federal officials to act on behalf of the public as trustees in natural resources damage assessments pursuant to the Oil Pollution Act, CERCLA, and CWA.

Table 5: Summary of Applicable Protected Species and Habitat Laws, Regulations, and Requirements

Title	Description
Endangered Species Act (ESA) 16 U.S.C. 1531-1544 (PL 93-205)	Provides for the identification of threatened and endangered species of animals and plants and their critical habitats. Requires federal agencies to insure that any action authorized, funded or carried out is not likely to jeopardize the continued existence of any endangered or threatened species or result in destruction or adverse modification of habitat. Requires biological assessments of any agency action when a listed species may be present in the area(s) affected by the action. Requires federal agencies to carry out programs to protect and conserve federally-listed endangered and threatened plants and wildlife in consultation with and assistance from the U.S. Fish and Wildlife Service (USFWS) and National Oceanic and Atmospheric Administration (NOAA) National Marine Fisheries Service (NOAA Fisheries), which jointly administer the act. Makes the USFWS and NOAA Fisheries responsible for designating and listing species and habitats critical to their survival, issuing expert biological opinions regarding Navy actions which may affect listed species, and for enforcing statutory and regulatory provisions. The INRMP addresses maintenance and improvement of habitat and provides for the long-term conservation of threatened and endangered species. Because of this cooperative approach, it is unlikely that a Section 7 consultation would be necessary. Nevertheless, Section 7 discussions and, if necessary, consultations will be initiated as appropriate.
Fish and Wildlife Service List of Endangered and Threatened Wildlife and Plants, 50 CFR 17.11 &17.12	List of threatened and endangered wildlife and plants protected under the ESA.

Table 5: Summary of Applicable Protected Species and Habitat Laws, Regulations, and Requirements (continued)

Migratory Bird Treaty Act of 1918 (MBTA), 16 U.S.C. 703-712 (PL 65-186)	MBTA is the primary legislation in the U.S. established to conserve migratory birds. It implements the U.S.' commitment to four bilateral treaties, or conventions, for the protection of a shared migratory bird resource. The MBTA prohibits the taking, killing, or possessing of migratory birds unless permitted by regulation. The species of birds protected by the MBTA appears in 50 CFR 10.13. On December 2, 2003, the President signed the 2003 National Defense Authorization Act. The Act provides that the Secretary of the Interior shall exercise his/her authority under the MBTA to prescribe regulations to exempt the Armed Forces from the incidental taking of migratory birds during military readiness activities authorized by the Secretary of Defense. Congress defined military readiness activities as all training and operations of the Armed Forces that relate to combat and the adequate and realistic testing of military equipment, vehicles, weapons, and sensors for proper operation and suitability for combat use. Congress further provided that military readiness activities do not include: (A) the routine operation of installation operating support functions, such as administrative offices, military exchanges, commissaries, water treatment facilities, storage facilities, schools, housing, motor pools, laundries, morale, welfare, and recreation activities, shops, and mess halls; (B) the operation of industrial activities; or (C) the construction or demolition of facilities used for a purpose described in (A) or (B). The final rule authorizing the DOD to take migratory birds during military readiness activities was published in the Federal Register on February 28, 2007. The regulation can be found at 50 CFR Part 21. The regulation provides that the Armed Forces must confer and cooperate with USFWS on the development and implementation of conservation measures to minimize or mitigate adverse effects of a military readiness activity if it determines that such activity may have a significant adverse effect on a population of a migratory bird species. The requirement to confer with the USFWS is triggered by a determination that the military readiness activity in question will have a significant adverse effect on a population of migratory bird species. An activity has a significant adverse effect if, over a reasonable period of time, it diminishes the capacity of a population of a migratory bird species to maintain genetic diversity, to reproduce, and to function effectively in its native ecosystem. A population is defined as “a group of distinct, coexisting, same species, whose breeding site fidelity, migration routes, and wintering areas are temporally and spatially stable, sufficiently distinct geographically (at some point of the year), and adequately described so that the population can be effectively monitored to discern changes in its status.” Assessment of impacts should take into account yearly variations and migratory movements of the impacted species. In addition, the Act was further amended in 2004 to exclude non-native migratory bird species that have been introduced by humans (intentionally or unintentionally) into the U.S. or its territories. The USFWS has published the final list of non-native bird species that are not protected under the MBTA (Federal Register Volume 70 No. 49, March 15, 2005). This list includes the non-native, human-introduced cattle egret. Migratory bird conservation relative to non-military readiness activities is addressed separately in a Memorandum of Understanding developed in accordance with Executive Order 13186, signed January 10, 2001, “Responsibilities of Federal Agencies to Protect Migratory Birds”.

Table 5: Summary of Applicable Protected Species and Habitat Laws, Regulations, and Requirements (continued)

MBTA (continued)	The Memorandum of Understanding between DOD and USFWS was signed on July 31, 2006. DOD responsibilities discussed in the Memorandum of Understanding include, but are not limited to: • Obtaining permits for import and export, banding, scientific collection, taxidermy, special purposes, falconry, raptor propagation, and depredation activities; • Encouraging incorporation of comprehensive migratory bird management objectives in the planning of DOD planning documents; • Incorporating conservation measures addressed in Regional or State Bird Conservation Plans in Integrated Natural Resources Management Plans; • Managing military lands and activities other than military readiness in a manner that supports migratory bird conventions; Developing, striving to implement, and periodically evaluating conservation measures for management actions to avoid or minimize incidental take of migratory birds, and, if necessary, conferring with the USFWS on revisions to these conservation measures.
Application of Migratory Bird Treaty Act, date 08 February 2007, CNO Memorandum	Provides Navy guidance for incidental and intentional taking of birds protected under the MBTA.
List of Migratory Birds, 50 CFR 10.13	List of migratory birds protected under the MBTA.
Fish and Wildlife Coordination Act of 1958, 16 U.S.C. 661-667e (PL 85-624)	Provides mechanism for wildlife conservation to receive equal consideration and be coordinated with water-resource development programs. The Fish and Wildlife Coordination Act of 1958, 16 U.S.C. §662 expanded the instances in which diversions or modifications to water bodies would require consultation with the USFWS. These amendments permitted lands valuable to the Migratory Bird Management Program to be made available to the State agency exercising control over wildlife resources.
Marine Mammal Protection Act of 1972 (MMPA), 16 U.S.C. 1361-1407 (PL 92-522)	Protects taking or harming of marine mammals without the appropriate permit and establishes a marine mammal commission. The Act establishes a federal responsibility to conserve marine mammals in U.S. waters and designates management of cetaceans and pinnipeds to NOAA Fisheries.
Regulations Concerning Marine Mammals, 50 CFR 10, 18 216, 228	Provides direction for marine mammal protection and management.
National Defense Exemption to MMPA, 23 January 2007	A two-year national defense exemptions from requirements of the MMPA for naval activity involving mid-frequency active sonar use, and a new sensor that uses small explosive charges, during major training exercises and on established ranges and operating areas. Authority for the exemption was included by Congress in the National Defense Authorization Act of Fiscal Year 2004.

Table 5: Summary of Applicable Protected Species and Habitat Laws, Regulations, and Requirements (continued)

Magnuson-Stevens Fishery Conservation and Management Act of 1976 16 U.S.C. 1802 et seq. (PL 94-265)	The Magnuson-Stevens Fishery Conservation and Management Act of 1976 (MSFCMA) is the governing authority for all fishery management activities that occur in federal waters within the U.S. 200 nautical mile (nm) and 370 kilometer (km) limit, or Exclusive Economic Zone (EEZ). The MSFCMA was amended in 1986 and 1996. Under the 1996 amendments, the MSFCMA was renamed Magnuson-Stevens Act (MSA) (16 U.S.C. §1855 et seq.) and calls for direct action to stop or reverse the loss of species that are managed under the Act. On 12 January 2007, the President signed the Magnuson-Stevens Fishery Conservation and Management Reauthorization Act of 2006. The new law sets a deadline to end over-fishing; uses market-based incentives to replenish the national fish stocks; strengthens enforcement of fishing laws; creates programs to improve the quality of information for fishery managers; and promotes cooperation between federal, state and local organizations. The NOAA Fisheries is the lead agency for administering the MSA. A system of regional fishery management councils was established to provide a forum for state, industry and public participation. One of the purposes of the 1996 amendments is to promote the protection of Essential Fish Habitat (EFH), which is defined as "those waters and substrate necessary to fish for spawning, breeding, feeding and growth to maturity." An area within the designated EFH that is particularly important and/or sensitive is a Habitat Area of Particular Concern (HAPC). Regional Fishery Management Councils, established under the Act, are responsible for preparing and amending fishery management plans (FMPs) for each fishery under their authority that requires conservation and management. Hawaii's EEZ fisheries are under the jurisdiction of the Western Pacific Regional Fishery Management Council (WPRFMC), which writes FMPs for each fishery under its jurisdiction. FMPs set the levels of total allowable catch in the fishery and identify habitats that are considered essential for the sustainment of managed fisheries. The FMPs are either approved or rejected by the Secretary of Commerce. Once approved, NOAA Fisheries implements the FMPs and the U.S. Coast Guard provides enforcement. WPRFMC has or is in the process of finalizing FMPs for the following fisheries: bottomfish, coral reefs, crustaceans, pelagics, and precious corals. All FMPs are subject to NEPA requirements and require an EIS. The MSA requires that NOAA Fisheries be consulted when a proposed federal action may adversely affect an EFH. EFH designations have been quite broad, encompassing virtually all of the waters of SOH. Slopes and escarpments at a depth of 131 to 918 feet (ft) (40 to 280 meters [m]) are designated as HAPC for bottomfish. All seamounts and banks around islands to a depth of 6,562 ft (2,000 m) are HAPC for pelagic fishes. All the waters around the island of Oahu – including Pearl Harbor – have been designated as EFH for one or more species from the shoreline to the outer limit of the EEZ (200 nm or 370 km) up to a depth of 3,280 ft (1,000 m) (WPRFMC 2004). No HAPC have been designated within Pearl Harbor. According to Smith (2007), no portion of Pearl Harbor meets any of the criteria used to designate HAPC. The DOD Legacy Resource Management Survey (2006) demonstrated that for the fish species compared, Pearl Harbor fishes are both more abundant and larger than those in most other portions of the Main Hawaiian Islands.

Table 5: Summary of Applicable Protected Species and Habitat Laws, Regulations, and Requirements (continued)

Sustainable Fisheries Act of 1996 (amends Magnuson-Stevens Fishery Conservation & Management Act), 16 U.S.C. 1801 (PL 104-297)	Amends the Magnuson-Stevens Act to require Fishery Management Councils to establish guidelines to identify and describe EFH and requires federal agencies to consult on any activity authorized, funded, or undertaken or proposed to be that may adversely affect EFH.
Nonindigenous Aquatic Nuisance Prevention and Control Act of 1990, PL 101-646, as amended.	The Act is aimed at preventing the unintentional introduction of nonindigenous species into the waters of the U.S. and controlling the spread of species already introduced. The Act calls for international cooperation in the prevention of unintentional introductions of aquatic species, prevention and control of aquatic nuisance species, zebra mussel demonstration programs, and state aquatic nuisance species management plans.
EO 13089, Coral Reef Protection dated 11 June 1998	Requires federal agencies to preserve and protect the biodiversity, health, heritage, and social and economic value of U.S. coral reef ecosystems and the marine environment. Establishes a multi-agency Coral Reef Task Force. Under this EO, all federal agencies are required to (1) identify any of their actions that may affect U.S. coral reef ecosystems; (2) utilize their programs to protect and enhance the conditions of such ecosystems; and (3) to the extent permitted by law, ensure that any actions authorized, funded, or carried out do not degrade such ecosystems. The DOD issued its Coral Reef Protection Implementation Plan (October 2000) outlining its responsibilities under the EO.
EO 13112, Invasive Species	Under this EO, all federal agencies whose actions may affect the status of invasive species shall, to the extent practicable and permitted by law, (1) identify such actions; (2) subject to the availability of appropriation, and within Administration budgetary limits, use relevant programs and authorities to address invasive species; and (3) not authorize, fund, or carry out actions that it believes are likely to cause or promote the introduction or spread of invasive species in the U.S. or elsewhere unless, pursuant to guidelines that it has prescribed, the agency has determined and made public its determination that the benefits of such actions clearly outweigh the potential harm caused by invasive species; and that all feasible and prudent measures to minimize the risk of harm will be taken in conjunction with the actions.
EO 13148, Greening the Government Through Leadership in Environmental Management. Part 6, Section 601 of EO 13148, dated 21 April 2000.	This EO requires federal agencies to incorporate the Guidance for Presidential Memorandum on Environmentally and Economically Beneficial Landscape Practices on Federal Landscaped Grounds (60 Federal Register 40837) into their landscaping programs, policies, and practices. The Guidance focuses on (1) the use of regionally native plants for landscaping, (2) construction practices that minimize adverse effects on natural habitat, (3) pollution prevention, (4) water and energy efficient practices, and (5) the creation of outdoor demonstration practices. The INRMP update is consistent with the purpose of the Guidance, which is intended to promote principles of "sustainable landscape design and management."

Table 5: Summary of Applicable Protected Species and Habitat Laws, Regulations, and Requirements (continued)

EO 13158, Marine Protected Areas (MPA), dated 26 May 2000	Directs federal agencies to strengthen the management, protection, and conservation of MPAs and establish new or expanded MPAs. MPAs are defined as areas of the marine environment that have been reserved by federal, state, or local laws or regulations to provide lasting protection for part or all of the natural and cultural resources therein. Directs federal agencies to "enhance and expand protection of existing MPAs and to establish or recommend new MPAs as appropriate." The Secretary of Commerce and the Secretary of the Interior are directed publish and maintain a list of MPAs. There are no MPAs in the vicinity of the NAVSTA PH INRMP study area.
EO 13186, Responsibility of Federal Agencies to Protect Migratory Birds	This EO is designed to assist federal agencies in their efforts to comply with the MBTA, and does not constitute any legal authorization to take migratory birds or otherwise supersede MBTA requirements. The EO directs each federal agency taking actions that have, or are likely to have, a measurable negative impact on migratory bird populations to develop and implement a Memorandum of Understanding with the USFWS for the conservation of migratory bird populations.
Lacey Act Amendments of 1981 (replaces most of the original Lacey Act), 16 U.S.C. 3371-3378	Makes it unlawful to import, export, transport, buy or sell fish, wildlife, or plants taken in violation of federal, state, or tribal laws.
Federal Noxious Weed Act of 1974, 7 U.S.C. 2801 et seq. (PL 93-6290	Establishes control and eradication of noxious weeds and regulates them in interstate and foreign commerce.
Fishery Conservation and Management, 16 U.S.C. 1801 et seq.	Advises federal agencies to conserve and manage the fishery resources found off the coasts of the U.S., and the anadromous species (species that migrate from the sea upstream) and Continental Shelf fishery resources of the U.S.
Marine Protection, Research, and Sanctuaries Act of 1972, 33 U.S.C. 1401-1445 (Title I, II); 16 U.S.C. 1431-1445 (Title III) (PL 92-532)	Establishes regulations relating to dumping specific material into open waters. Title III establishes a program for designation and regulation of national marine sanctuaries.
National Invasive Species Act of 1996 (amends Non-indigenous Aquatic Nuisance Prevention Control Act of 1990 [NANPCA]) 16 U.S.C. 4701 et seq. (PL 104-332)	Reauthorizes and amends the NANPCA to prevent and control infestations of the coastal inland waters of the U.S. by zebra mussel and other non-indigenous aquatic nuisance species, to reauthorize the National Sea Grant College Program, and for other purposes. Establishes an Aquatic Nuisance Species Task Force, a National Ballast Water Clearinghouse, and establishes ballasts water programs (see EO 13112).

References

Chief of Naval Operations (CNO) 2007. *Memorandum: Application of Migratory Bird Treaty Act.* 08 February 2007.

Code of Federal Regulations (CFR) Title 7 Part 658, *Farm Land Protection Policy Act*

_________. Title 40 Part 300.600, National Oil and Hazardous Substances Contingency Plan.

_________. Title 43 Part 10, Native American Graves Protection and Repatriation.

_________Title 50 Parts 17.11 &17.12, Fish and Wildlife Service List of Endangered and Threatened Wildlife and Plants.

_________Title 50 Part 10.3, *List of Migratory Birds.*

_________Title 50 Parts10, 18, 216, 228, *Regulations Concerning Marine Mammals.*

Department of Defense (DOD) 1996. Directive 4715.3 "Environmental Conservation Program." May 1996.

Department of the Navy (DoN) 2005. Draft Guidelines for Preparing INRMPs for Navy Installations. 19 July 2005

Executive Order (EO) 11990 , *Protection of Wetlands*

EO13089, *Coral Reef Protection.* 11 June 1998

EO 13112, Invasive Species.

EO 13148, Part 6, Section 601, Greening the Government Through Leadership in Environmental Management. 21 April 2000.

EO 13158, *Marine Protected Areas*. 26 May 2000

EO 13186, Responsibility of Federal Agencies to Protect Migratory Birds.

Naval Facilities Engineering Command (NAVFAC). Real Estate Operations & Natural Resources Management Procedural Manual Volume II, NAVFAC P-73

_________ Instruction MO-100.3. *Fish and Wildlife Management*

_________. Instruction MO-100.4: *Special Interest Areas*

_________. Instruction MO-110.1.

Public Law (PL) 101-646, as amended, *Nonindigenous Aquatic Nuisance Prevention and Control Act of 1990.*

_________. 10-2-396, Department of Defense Appropriations Act of 1991 (Legacy Program).

United States Code (USC) Title 7 Section 136 et seq. (PL 92-516), *Federal Insecticide, Fungicide, and Rodenticide Act of 1947.*

_________.Title 7 Section 426 (PL 102-237), *Animal Damage Control Act of 1931*

_________. Title 7 Sections 2801 et seq. (PL 93-6290), *Federal Noxious Weed Act of 1974.*

_________. Title 10 Part 2671 (PL 85-337), Military Construction Authorization Act of 1956.

_________. Title 16 Part 470(f), as amended (PL 89-665), *National Historic Preservation Act*

_________. Title 16 Part 470aa-470ll (43 CFR Part 7), *Archaeological Resources Protection Act of 1979*

_________Title 16 Part 590A, Soil Conservation and Domestic Allotment Act of 1963

_________. Title 16 Parts 661-667e (PL 85-624), *Fish and Wildlife Coordination Act of 1958.*

_________Title 16 Part 670, Sikes Act Improvement Amendments

_________. Title 16 Parts 703-712 (PL 65-186), *Migratory Bird Treaty Act of 1918.*

_________Title 16 Part 1001 et seq., *Watershed and Floodplain Protection*

_________Title 16 Part 1271-1287 (PL 90-542), *Wild and Scenic Rivers Act of 1968*

_________. Title 16 Parts 1361-1407 (PL 92-522), *Marine Mammal Protection Act of 1972.*

_________. Title 16 Sections 1401-1445 (Title III) (PL 92-532), *Marine Protection, Research, and Sanctuaries Act of 1972.*

_________. Title 16 Part Part1531-1544 (PL 93-205), *Endangered Species Act.*

_________. Title 16 Sections 1801 et seq. *Fishery Conservation and Management.*

_________. Title 16 Section 1801 (PL 104-297), *Sustainable Fisheries Act of 1996* (amends Magnuson-Stevens Fishery Conservation & Management Act).

_________. Title 16 Parts 1802 et seq. (PL 94-265), Magnuson-Stevens Fishery Conservation and Management Act of 1976.

_________. Title 16 Part 2901-2911 (PL 96-366), Fish and Wildlife Conservation Act of 1980 (Nongame Act).

_________. Title 16 Sections 3371-3378, *Lacey Act Amendments of 1981.*

_________. Title 16 Sections 4401-4414, *North American Wetlands Con*servation Act of 1989.

_________. Title 16 Part 4601 (PL 88-29), Recreational Coordination and Outdoor Recreation – Federal/State Programs Act of 1963.

_________. Title 16 Sections 4701 et seq. (PL 104-332), *National Invasive Species Act of 1996.*

_________. Title 26 Sections 4611-4682 (PL 96-510) Comprehensive Environmental Response Compensation, and Liability Act of 1980.

_________ Title 31 Part 1535, *Economy Act.*

_________. Title 33 Sections 1251-1376 (PL 92-500), *Clean Water Act of 1977*

_________. Title 33 Sections 1251-1376 (PL 845), *Federal Water Pollution Control Act of 1948*

_________. Title 33 Sections 1401-1445 (Title I, II); (PL 92-532) *Marine Protection, Research, and Sanctuaries Act of 1972.*

_________. Title 33 Sections 2701 et seq. (PL 101-380), *Oil Pollution Act of 1990.*

_________. Title 42 Section 7401-7671, *Clean Air Act of 1990*.

APPENDIX G
IMPLEMENTATION STATUS OF 2001 INRMP RECOMMENDATIONS

G1 – IMPLEMENTATION STATUS OF 2001 INRMP RECOMMENDATIONS

Table 1: Status of 2001 INRMP Recommended Actions

Number	Primary Resource Area	Issue or Objective	Fiscal Year Funding	Priority	Recommendation from 2001 INRMP*
Pearl Harbor					
A. Land Management					
1.	LM	Point source pollution	Continued	2	Continue the Navy's policy of pollution reduction for Pearl Harbor, including the identification of sources of pollutants in the harbor and their reduction/elimination. **Estimated cost in 2001:** Not specified
Implementation Status: Implemented.					
2.	LM	Soil stabilization and erosion control	Continued 2		Continue to utilize best management practices during earthwork and construction. **Estimated cost in 2001:** Not specified
Implementation Status: Implemented.					
3.	LM	Soil stabilization and erosion control	Continued 2		Continue to utilize best management practices in design of storm drainage systems. **Estimated cost in 2001:** Not specified
Implementation Status: Implemented.					
4.	LM, FW	Soil stabilization and erosion control	Continued 2		Retain mangrove in all shoreline segments to stabilize shoreline and mitigate siltation, except in designated Enhancement Areas and other selected areas. **Estimated cost in 2001:** Not specified
Implementation Status: Implemented.					
5.	LM, FW	Water/sediment quality and public health	Continued 2		Continue the ongoing Navy RI/FS program to (a) characterize chemicals in the sediments and marine life in the harbor; (b) evaluate potential threat of chemicals to human health and the environment; and (c) identify areas that need clean up. **Estimated cost in 2001:** Not specified
Implementation Status: RI completed and FS is on-going.					
6.	LM	Fishpond Wall Protection Enhancement Areas	2003 2		Designate Loko Pa`aiau, Loko Laulaunui, Loko Pamoku, and Loko Oki'okiolepe as Enhancement Areas for fishpond wall protection. Monitor the growth of mangrove in and immediately around the fishponds, and if necessary, control and manage the vegetation. **Estimated cost in 2001:** Not specified
Implementation Status: Not implemented because the sediments in Pearl Harbor are contaminated, thus requiring that trained personnel do removal actions and, therefore, making the project cost prohibitive.					

Table 1: Status of 2001 NRMP Recommended Actions (continued)

Number	Primary Resource Area	Issue or Objective	Fiscal Year Funding	Priority	Recommendation from 2001 INRMP*
7.	LM	Non-point source pollution	Continued	3a	Continue the Navy's policy of pollution reduction for Pearl Harbor, including the identification of sources of pollutants in the harbor and their reduction/elimination. **Estimated cost in 2001:** Not specified
Implementation Status: Implemented.					
8.	LM	Minimize fire hazards (Red Hill Storage Area)	Continued 3a		Maintain current security fencing and fire breaks to minimize the fire hazard. **Estimated cost in 2001: Not specified**
Implementation Status: Not implemented due to lack of funding.					
9.	LM	Off-site Development (Red Hill Storage Area)	Continued 3a		Monitor adjacent, off-site development for compatibility, to minimize potential fire hazard and to ensure public safety. **Estimated cost in 2001: Not specified**
Implementation Status: Implemented.					
10.	LM	Off-site Development (Waiawa Watershed)	Continued 3a		Monitor private, off-site development, to ensure that adjacent land uses do not have adverse impacts (e.g., flooding, runoff, groundwater pollutants, encroachment, etc.). **Estimated cost in 2001: Not specified**
Implementation Status: Implemented.					
11.	LM, FW, OR	Water/sediment quality and public health	2002	3b	Amend Navy recreation instruction CNBPEARLINST 5510.21B to reference the DOH health advisory. Encourage DOD recreational fishing to be "catch and release." Continue current policy limiting fishing from Navy lands to active duty and retired military personnel and DOD civilians. **Estimated cost in 2001:** Not specified
Implementation Status: Implemented					
12.	LM, FW	Water/sediment quality and public health	Continued	3a	Continue to work with the State of Hawaii, City and County of Honolulu and private landowners within the Pearl Harbor watershed to reduce non-point source pollution into the harbor. **Estimated cost in 2001:** Not specified
Implementation Status: Implemented.					

Table 1: Status of 2001 NRMP Recommended Actions (continued)

Number	Primary Resource Area	Issue or Objective	Fiscal Year Funding	Priority	Recommendation from 2001 INRMP*
13.	LM, FW, OR	Water/sediment quality and public health	NA	3b	Support DOH in continuing and expanding public education regarding the health risks of consuming fish and shellfish from Pearl Harbor. Maintain posted advisories around the harbor shoreline. Encourage and support DOH in its continued public education regarding the health advisory, the importance of non-consumption, and Navy actions being undertaken to clean up the harbor and Navy actions being undertaken to clean up the harbor. **Estimated cost in 2001:** Not specified
Implementation Status: Implemented.					
14.	LM, FW, OR	Water/sediment quality and public health	NA	3b	Support DOH efforts to identify and mitigate public health risk associated with consumptive fishing. These may include epidemiological surveys to identify potentially at-risk groups, quantities consumed, level of risk, etc. Work cooperatively with DOH to share data and identify/implement appropriate mitigation actions. **Estimated cost in 2001:** Not specified
Implementation Status: Implemented.					
15.	LM, FW	Wetlands	2002	3b	Designate Waiawa Upland, Waiawa Sewage Treatment Plant (STP), and Loko Laulaunui as Enhancement Areas for wetland habitat enhancement. Initiate discussions with non-profit organizations (e.g., Ducks Unlimited, Nature Conservancy), willing and able to improve and maintain wetland habitat in these Enhancement Area(s). **Estimated cost in 2001:** Not specified
Implementation Status: Not implemented because of the sediments in Pearl Harbor are contaminated which makes removal difficult and cost prohibitive.					
16.	LM, FW, OR	Coordination of Enhancement Area Efforts	Continued	3b	Coordinate all Enhancement Area efforts with government agencies and community groups involved in the Pearl Harbor area, including the USFWS, DLNR-SHPO, NOAA Fisheries, Leeward Community College, and CCH's Pearl Harbor Historic Trail Group. **Estimated cost in 2001:** Not specified
Implementation Status: Enhancement areas were never designated because of concerns about contaminated sediments in Pearl Harbor.					

Table 1: Status of 2001 NRMP Recommended Actions (continued)

Number	Primary Resource Area	Issue or Objective	Fiscal Year Funding	Priority	Recommendation from 2001 INRMP*
17.	LM, FW, FR, OR	Mangrove Control and/or Enhancement of Native Wetland Species	2002 3b		Develop a long-term plan for controlling mangroves and establishing and/or enhancing native wetland species. This plan shall examine various funding mechanisms and would be done in cooperation with the USFWS, NMFS, and Hawaii DLNR. **Estimated cost in 2001:** Not specified
Implementation Status: Not implemented due to lack of funding.					
18.	LM, FW	Replant eroded areas around water tank (Red Hill Storage Area)	2004 3b		Replant the bare, eroded ridge top (from area near the water tank) with native trees (e.g., Acacia koa) in an effort to restore native forest and control erosion. **Estimated cost in 2001:** Not specified
Implementation Status: Not implemented. During a field check for the INRMP updates areas previously identified as being bare and eroded had established regrowth. These areas should be monitored during periods of low rainfall to see if they reoccur.					
19.	LM, FW	Replant eroded areas at air vents (Red Hill Storage Area)	2005 3b		Replant the bare, eroded portions along the ridge top (around the air vents) with grass. Bare areas should be scarified/disked, and grass sprigs planted to a depth of 3 to 4 inches (7.6 to 10 cm). Temporary surface irrigation system may be required through the establishment period (30 days). Grass could be planted in phases. **Estimated cost in 2001:** Not specified
Implementation Status: Not implemented. During a field check for the INRMP updates areas previously identified as being bare and eroded had established regrowth. These areas should be monitored during periods of low rainfall to see if they reoccur.					
20.	LM, FW	Wetlands	NA	3c	Consider community efforts to restore Loko Pa`aiau as an educational and demonstration project. Restoration activities should be limited to non-consumptive uses. **Estimated cost in 2001:** Not specified
Implementation Status: The Navy did consider and support the project; however, the community group did not move the project forward due to concerns about contaminated sediments in Pearl Harbor.					
21.	LM, FW	Wetlands	Continued	3c	Consider the concept of wetland mitigation banking for small wetland areas. **Estimated cost in 2001:** Not specified
Implementation Status: Implemented					

Table 1: Status of 2001 NRMP Recommended Actions (continued)

Number	Primary Resource Area	Issue or Objective	Fiscal Year Funding	Priority	Recommendation from 2001 INRMP*
NAVMAG PH Lualualei Branch					
A. Land Management					
1.	LM Wetlan	ds	2003, 2005	2	Survey NAVMAG PH wetlands in combination with similar Pearl Harbor Estuary Surveys in order to identify & manage wetlands at NAVMAG PH to maintain no net loss of wetland values. **Estimated cost in 2001:** $90,000
Implementation Status: Implemented.					
2.	LM	Support native plants and control unwanted plants and weeds	2003 2		Verify following President's memo on native/adapted plant material usage; using invasive plants list in order to support growth & survivability of native plant species while controlling unwanted plants and weeds. **Estimated cost in 2001:** $2,000
Implementation Status: Implemented.					
3.	LM	Support native plants and control unwanted plants and weeds	2005	3	Review landscape for consistency with President's memo and use native plants species in landscapes. **Estimated cost in 2001:** $5,000
Implementation Status: Implemented.					
4.	LM	Support native plants and control unwanted plants and weeds	2002-2006 2		Control invasive weeds in higher elevation management areas at LLL Branch in order to support growth & survivability of native plant species while controlling unwanted plants and weeds. **Estimated cost in 2001:** $24,000
Implementation Status: Ongoing.					
5.	LM	Support native plants and control unwanted plants and weeds	2003 2		Develop plan for preservation & maintenance of mature trees in order to support growth & survivability of native plant species while controlling unwanted plants and weeds. **Estimated cost in 2001:** $5,000
Implementation Status: not implemented.					
6.	LM GIS	Mapping	2002-2006	2	Establish and maintain GPS-based GIS natural resources map for the installation for lands beyond landscaped areas to ridge or adjacent property lines. **Estimated cost in 2001:** $28,000
Implementation Status: Ongoing.					

Table 1: Status of 2001 NRMP Recommended Actions (continued)

Number	Primary Resource Area	Issue or Objective	Fiscal Year Funding	Priority	Recommendation from 2001 INRMP*
NAVMAG PH West Loch					
A. Land Management					
1.	LM Wetlan	ds	2002, 2004, 2006	2	Ensure planning staff receives formal training on wetland regulations and policy in order to identify & manage wetlands at NAVMAG PH to maintain no net loss of wetland values. **Estimated cost in 2001:** $15,000
Implementation Status: Implemented.					
2.	LM Wetlan	ds	2003, 2005	2	Survey NAVMAG PH wetlands in combination with similar Pearl Harbor Estuary Surveys in order to identify & manage wetlands at NAVMAG PH to maintain no net loss of wetland values. **Estimated cost in 2001:** $90,000
Implementation Status: Implemented.					
3.	LM Wetlan	ds	2004	3	Establish biota database for wetlands management & conservation plan for Waipio Peninsula in order to identify & manage wetlands at NAVMAG PH to maintain no net loss of wetland values. **Estimated cost in 2001:** $25,000
Implementation Status: Not implemented because inland wetlands associated with sugar cultivation no longer exist since the cessation of these agricultural activities on Waipio Peninsula. All other wetlands at Waipio Peninsula are located on the coastline and have been previously surveyed.					
4.	LM	Support native plants and control unwanted plants and weeds	2003 2		Verify following President's memo on native/adapted plant material usage; using invasive plants list in order to support growth & survivability of native plant species while controlling unwanted plants and weeds. **Estimated cost in 2001:** Included in NAVMAG PH Lualualei Branch Land Management Item #2
Implementation Status: Implemented.					
5.	LM	Support native plants and control unwanted plants and weeds	2005	3	Review landscape for consistency with President's memo and use native plants species in landscapes. **Estimated cost in 2001:** Included in NAVMAG PH Lualualei Branch Land Management Item #3.
Implementation Status: Implemented.					

Table 1: Status of 2001 NRMP Recommended Actions (continued)

Number	Primary Resource Area	Issue or Objective	Fiscal Year Funding	Priority	Recommendation from 2001 INRMP*
6.	LM	Support native plants and control unwanted plants and weeds	2003 2		Develop plan for preservation & maintenance of mature trees in order to support growth & survivability of native plant species while controlling unwanted plants and weeds. **Estimated cost in 2001:** Included in NAVMAG PH Lualualei Branch Land Management Item #4.
Implementation Status: Not implemented.					
7.	LM GIS	Mapping	2002-2006	2	Establish and maintain GPS-based GIS natural resources map for the installation for lands beyond landscaped areas to ridge or adjacent property lines. **Estimated cost in 2001:** Included in NAVMAG PH Lualualei Branch Land Management Item #6.
Implementation Status: Ongoing.					
NCTAMS PAC Wahiawa					
A. Land Management					
1.	LM	Grass & Vegetation Management	2002-2006 N/A		Provide maintenance of grasses in antenna fields in order to implement grass & vegetation management. **Estimated cost in 2001:** Not applicable, funded by operations and maintenance
Implementation Status: Implemented.					
2.	LM/FM	Manage, maintain, and enhance land areas with natural resource value	2002 3		Install signs for protection of native trees/ecosystem in Poamoho Stream gulch in order to continue to manage, maintain, & enhance land areas with natural resource value and to protect pocket-forested areas to proved watershed protection and prevent soil erosion. **Estimated cost in 2001:** $3,000
Implementation Status: Not implemented due to lack of funding (verify).					
3.	LM	Limit encroachment	N/A	NA	Monitor surrounding property development and obtain property rights as may be required in order to limit encroachment to protect natural resources. **Estimated cost in 2001:** Not specified
Implementation Status: Implemented.					

Table 1: Status of 2001 NRMP Recommended Actions (continued)

Number	Primary Resource Area	Issue or Objective	Fiscal Year Funding	Priority	Recommendation from 2001 INRMP*
NRTF Lualualei					
A. Land Management					
1.	LM	Grass & Vegetation Management	2002-2006 N/A		Provide maintenance of grasses in antenna fields in order to implement grass & vegetation management. **Estimated cost in 2001:** Not applicable, funded by operations and maintenance.
Implementation Status: Implemented.					
2.	LM, FW	Support and comply with provisions of Cooperative Agreement	2002-2006 2		Maintain wetland habitat at the Niuli'i Ponds Wildlife Refuge in order to preserve, protect, & enhance wetlands and support & comply with the provisions of the Cooperative Agreement. **Estimated cost in 2001:** $10,000
Implementation Status: Implemented.					
3.	LM	Limit encroachment	N/A	NA	Monitor surrounding property development and obtain property rights as may be required in order to limit encroachment to protect natural resources. **Estimated cost in 2001:** Not specified
Implementation Status: Implemented.					
PHNC					
B. Fish and Wildlife Management					
1.	FW	Alien aquatic species	NA	2	Comply with the UNDS proposed under the Defense Environmental Quality Program, when issued. **Estimated cost in 2001:** Not applicable, funded by operations and maintenance.
Implementation Status: Implemented.					
2.	FW	Alien aquatic species	NA	2	Continue to comply with federal policies and guidelines regarding the discharge of ship's ballast water as well as other appropriate measures to reduce the introduction of alien species into Pearl Harbor. **Estimated cost in 2001:** Not applicable, funded by operations and maintenance
Implementation Status: Implemented.					
3.	FW	Alien aquatic species	NA	2	Support interagency and public-private initiatives to reduce the release of alien aquatic species into upland streams. **Estimated cost in 2001:** Not specified
Implementation Status: Implemented.					

Table 1: Status of 2001 NRMP Recommended Actions (continued)

Number	Primary Resource Area	Issue or Objective	Fiscal Year Funding	Priority	Recommendation from 2001 INRMP*
4.	FW, LM	Management of aquatic resources	Continued 2		Continue ongoing efforts to identify areas of the harbor and sediments that need clean up. **Estimated cost in 2001:** Not specified
Implementation Status: Implemented by on-going Feasibility Study.					
5.	FW	Threatened and endangered species	2002 2		Update the Fleet Guide to include standard operating procedures in case of contact with threatened or endangered marine species within the Pearl Harbor area (e.g., turtles, monk seals, and whales). **Estimated cost in 2001:** Not specified
Implementation Status: Implemented.					
6.	FW	Threatened and endangered species	Continued 2		Continue to comply with the terms of the Cooperative Agreement between the Navy, USFWS, NOAA Fisheries, and DLNR for the Protection, Development and Management of Fish and Wildlife Resources at Naval Base, Pearl Harbor. **Estimated cost in 2001:** Not specified
Implementation Status: Implemented.					
7.	FW	Threatened and endangered species	2002 3a		Promote awareness among Navy personnel of threatened and endangered species through ongoing educational efforts, community service programs, brochures, etc. **Estimated cost in 2001:** Not specified
Implementation Status: Implemented.					
8.	FW Waia	wa Watershed	Continued	3a	Retain Waiawa Watershed parcel as is (i.e., undeveloped) and continue limited public access to maintain the area as an oasis for bird species. **Estimated cost in 2001:** Not specified
Implementation Status: Implemented.					
9.	FW, OR	Estuarine monitoring	2004	3b	Initiate on-going monitoring program for marine biotic resources in the Pearl Harbor estuary. **Estimated cost in 2001:** Not specified
Implementation Status: Implemented as part of the RI.					
10.	FW, OR	Estuarine monitoring	2004	3b	Initiate long-term water quality monitoring program for the Pearl Harbor estuary. **Estimated cost in 2001:** Not specified
Implementation Status: Implemented as part of the RI.					

PEARL HARBOR NAVAL STATION, O'AHU
INTEGRATED NATURAL RESOURCES MANAGEMENT PLAN
APPENDIX G1
IMPLEMENTATION STATUS OF 2001 INRMP RECOMMENDED ACTIONS

Table 1: Status of 2001 NRMP Recommended Actions (continued)

Number	Primary Resource Area	Issue or Objective	Fiscal Year Funding	Priority	Recommendation from 2001 INRMP*
11.	FW, OR	Estuarine monitoring	Continued	3b	Establish ongoing assessment of bioaccumulation of toxic materials in representative organisms throughout Pearl Harbor. **Estimated cost in 2001:** Not specified
Implementation Status: Implemented as part of the RI.					
12.	FW, LM, OR	Management of aquatic resources	NA	3b	Support DOH in continuing and expanding public education regarding the health risks of consuming fish and shellfish from Pearl Harbor. Maintain posted advisories around the harbor shoreline. Encourage and support DOH in its continued public education regarding the health advisory, the importance of non-consumption, and Navy actions being undertaken to clean up the harbor. **Estimated cost in 2001:** Not specified
Implementation Status: Implemented.					
13.	FW, FO, LM	Mangrove and other non native vegetation	Continued 3b		Focus mangrove removal efforts in designated Enhancement Areas. **Estimated cost in 2001:** Not specified
Implementation Status: Mangrove removal was not done in enhancement areas because the sediments in Pearl Harbor are contaminated.					
14.	FW, FO, LM	Mangrove and other non native vegetation	NA 3b		If mangrove removal is proposed outside a designated Enhancement Area, or if more than limited removal is considered in any location, confirm that it will not have adverse ecological impact. Specifically, conduct further study on these potential impacts of mangrove removal: (1) water quality impacts; (2) land management (shoreline erosion, sedimentation, etc.) impacts; and (3) impacts on fish and aquatic invertebrates. **Estimated cost in 2001:** Not specified
Implementation Status: Mangrove removal was done at the Waiawa Unit by USFWS and limited mangrove removal was done near the Aiea Landing – Admiral's Boathouse.					
15.	FW	Threatened and endangered species	Continued	3b	Provide ongoing support and resources as appropriate to manage Enhancement Area habitat. **Estimated cost in 2001:** Not specified
Implementation Status: Enhancement Areas were never designated and habitat in those areas was not managed.					
16.	FW	Threatened and endangered species	Continued 3b		Continue and expand the ongoing Navy community service program providing volunteers to help maintain (i.e., exotic vegetation control) the Waiawa and Honouliuli Units. **Estimated cost in 2001:** Not specified
Implementation Status: Not implemented – Navy volunteer efforts have been geared to Pouhala Marsh vice PHNWR.					

Table 1: Status of 2001 NRMP Recommended Actions (continued)

Number	Primary Resource Area	Issue or Objective	Fiscal Year Funding	Priority	Recommendation from 2001 INRMP*
17.	FW, LM	Threatened and endangered species	Continued 3b		Continue to participate in interagency efforts such as the Wetland Restoration Protection Partnership. **Estimated cost in 2001:** Not specified
Implementation Status: Not implemented.					
18.	FW	Threatened and endangered species	2002 3b		Initiate discussions with non-profit organizations (e.g., Ducks Unlimited, Nature Conservancy) to improve and maintain wetland habitat within designated Enhancement Areas. **Estimated cost in 2001:** Not specified
Implementation Status: Not implemented due to AT/FP security concerns and contaminated sediments in Pearl Harbor.					
19.	FW, LM, OR	Threatened and endangered species	2001 2,	3b	Designate Units as Enhancement Areas for continued waterbird enhancement, landscape restoration, and education. Support USFWS in upkeep and maintenance of NWR Waiawa and Honouliuli Units, when possible within Navy mission requirements and priorities. **Estimated cost in 2001:** Not specified
Implementation Status: Not implemented – volunteer efforts have been geared to Pouhala Marsh vice PHNWR.					
20.	FW	Threatened and endangered species	2002 3b		Work with USFWS to facilitate vehicular access through Navy-controlled roads or property to the NWR Waiawa Unit. **Estimated cost in 2001:** Not specified
Implementation Status: Implemented.					
21.	FW, LM	Fisheries and aquaculture	Continued	3c	Consider community efforts to restore Loko Pa`aiau as an educational and demonstration project. Restoration activities should be limited to non-consumptive uses. **Estimated cost in 2001:** Not specified
Implementation Status: Implemented but the project did not move forward due to concerns about contaminated sediments in Pearl Harbor.					
22.	FW	Fisheries and aquaculture	2004	3c	Monitoring of the native oyster population (*Pinctada radiata* and *Pinctada margaritifera*) will be Included in the biological monitoring of Pearl Harbor. No attempts to artificially stock pearl oysters will be allowed without the review and approval of DLNR Division of Aquatic Resources (DAR) and NOAA Fisheries. **Estimated cost in 2001:** Not specified
Implementation Status: Implemented.					

Table 1: Status of 2001 NRMP Recommended Actions (continued)

Number	Primary Resource Area	Issue or Objective	Fiscal Year Funding	Priority	Recommendation from 2001 INRMP*
23.	FW	Management of aquatic resources	Continued 3c		If water/sediment quality improves and bioaccumulated contaminant levels decrease, consider allowing public fishing from Navy lands, if consistent with Navy security and operational requirements and public safety. **Estimated cost in 2001:** Not specified
Implementation Status: On hold until sediment and water quality improves.					
24.	FW, OR, LM	Public Overlook at PHNWR Waiawa Unit	NA 3c		Support the development of a public overlook at the Waiawa Unit as proposed by the USFWS. The overlook could be developed in conjunction with Pearl Harbor Historic Trail project (see Natural Resource-Related Recreation section). If the overlook is to be located on the adjacent landfill, potential public health concerns must be addressed and adequate mitigation included. Efforts should be coordinated with PACNAVFACENGCOM Code 18. **Estimated cost in 2001:** Not specified
Implementation Status: Not implemented because USFWS has not pursued the overlook.					
NAVMAG PH Lualualei Branch					
B. Fish and Wildlife Management					
1.	FW	Proactively manage known threatened & endangered species	2003 2		Develop prioritized listing of species monitoring for an information database in order to proactively manage known threatened & endangered species at NAVMAG PH. **Estimated cost in 2001:** $2,000
Implementation Status: Implemented.					
2.	FW	Proactively manage known threatened & endangered species	2002-2006 1		Conduct surveys for O'ahu *'elepaio* (range & numbers) and implement recovery actions in order to proactively manage known threatened & endangered species at NAVMAG PH. **Estimated cost in 2001:** $75,000
Implementation Status: Implemented.					
3.	FW	Proactively manage known threatened & endangered species	2004-2006 2		Update ecosystem based management plan to implement priority conservation measures for control and removal of exotic plants in order to proactively manage known threatened & endangered species at NAVMAG PH. **Estimated cost in 2001:** $50,000
Implementation Status: Not implemented due to lack of funding (verify).					

Table 1: Status of 2001 NRMP Recommended Actions (continued)

Number	Primary Resource Area	Issue or Objective	Fiscal Year Funding	Priority	Recommendation from 2001 INRMP*
4.	FW	Proactively manage known threatened & endangered species	2002-2006	2	Evaluate and implement an effective predator control program. **Estimated cost in 2001:** $17,000
Implementation Status: Implemented.					
5.	FW	Expand database on potential listed species	2003, 2004, 2006	2	Conduct flora & fauna survey updates in order to expand the database on potential listed species at NAVMAG PH. **Estimated cost in 2001:** $75,000
Implementation Status: Implemented.					
6.	FW	Expand database on potential listed species	2003 2		Expand existing conservation mapping program in order to expand database on potential listed species at NAVMAG PH. **Estimated cost in 2001:** $35,000
Implementation Status: Implemented.					
7.	FW	Develop program for land/habitat improvements & rehabilitation	2002 2		Update vegetation mapping for all branches in order to develop a program for land/habitat improvements & rehabilitation. **Estimated cost in 2001:** $8,000
Implementation Status: Implemented.					
8.	FW	Develop program for land/habitat improvements & rehabilitation	2002-2006 2		Provide focused annual training for natural resource managers in order to develop a program for land/habitat improvements & rehabilitation. . **Estimated cost in 2001:** $20,000
Implementation Status: Implemented.					
9.	FW	Develop program for land/habitat improvements & rehabilitation	2002-2006 2		Maintain barrier fencing at NAVMAG PH Lualualei Branch management areas in order to develop a program for land/habitat improvements & rehabilitation. **Estimated cost in 2001:** $22,000
Implementation Status: Implemented.					
10.	FW	Develop program for land/habitat improvements & rehabilitation	2002-2006 1		Monitor and control feral ungulate populations at NAVMAG PH Lualualei Branch (including goat eradication). **Estimated cost in 2001:** $58,000
Implementation Status: Not implemented due to lack of funding.					

Table 1: Status of 2001 NRMP Recommended Actions (continued)

Number	Primary Resource Area	Issue or Objective	Fiscal Year Funding	Priority	Recommendation from 2001 INRMP*
NAVMAG PH West Loch Branch					
B. Fish and Wildlife Management					
1.	FW	Proactively manage known threatened & endangered species	2003 2		Develop prioritized listing of species monitoring for an information database in order to proactively manage known threatened & endangered species at NAVMAG PH. **Estimated cost in 2001:** Cost included NAVMAG PH Lualualei Branch Item B1.
Implementation Status: Implemented.					
2.	FW	Proactively manage known threatened & endangered species	2004-2006 2		Update ecosystem based management plan to implement priority conservation measures for control and removal of exotic plants in order to proactively manage known threatened & endangered species at NAVMAG PH. **Estimated cost in 2001:** Cost included NAVMAG PH Lualualei Branch Item B3.
Implementation Status: Not implemented due to lack of funding (verify).					
3.	FW	Proactively manage known threatened & endangered species	2002-2006	2	Evaluate and implement an effective predator control program. **Estimated cost in 2001:** Cost included NAVMAG PH Lualualei Branch Item B4.
Implementation Status: Implemented.					
4.	FW	Expand database on potential listed species	2003, 2004, and 2006	2	Conduct flora & fauna survey updates in order to expand the database on potential listed species at NAVMAG PH. **Estimated cost in 2001:** Cost included NAVMAG PH Lualualei Branch Item B5.
Implementation Status: Implemented.					
5.	FW	Expand database on potential listed species	2003 2		Expand existing conservation mapping program in order to expand database on potential listed species at NAVMAG PH. **Estimated cost in 2001:** Cost included NAVMAG PH Lualualei Branch Item B6.
Implementation Status: Implemented.					
6.	FW	Develop program for land/habitat improvements & rehabilitation	2002 2		Update vegetation mapping for all branches in order to develop a program for land/habitat improvements & rehabilitation. **Estimated cost in 2001:** Cost included NAVMAG PH Lualualei Branch Item B7.
Implementation Status: Implemented.					

Table 1: Status of 2001 NRMP Recommended Actions (continued)

Number	Primary Resource Area	Issue or Objective	Fiscal Year Funding	Priority	Recommendation from 2001 INRMP*
7.	FW	Develop program for land/habitat improvements & rehabilitation	2002-2006 2		Provide focused annual training for natural resource managers in order to develop a program for land/habitat improvements & rehabilitation. **Estimated cost in 2001:** Cost included NAVMAG PH Lualualei Branch Item B8.
Implementation Status: Implemented.					
NCTAMSPAC Wahiawa					
B. Fish and Wildlife Management					
1.	FW	Protect, conserve, and manage terrestrial flora and fauna	2005 2		Conduct fauna survey in order to protect, conserve, & manage terrestrial flora & fauna. **Estimated cost in 2001:** $8,000
Implementation Status: Implemented.					
2.	FW	Protect, conserve, and manage terrestrial flora and fauna	2005 2		Conduct flora survey in order to: (1) protect, conserve, & manage terrestrial flora & fauna; and (2) to identify & protect native and mature trees. **Estimated cost in 2001:** $20,000
Implementation Status: Implemented.					
3.	FW	Protect, conserve, and manage terrestrial flora and fauna	2002-2006 2		Monitor feral ungulates in order to protect, conserve, & manage terrestrial flora & fauna. **Estimated cost in 2001:** $6,500
Implementation Status: Implemented.					
NRTF Lualualei					
B. Fish and Wildlife Management					
1.	FW	Protect, conserve, and manage terrestrial flora and fauna	2005 2		Conduct fauna survey in order to protect, conserve, & manage terrestrial flora & fauna. **Estimated cost in 2001:** Cost included in NCTAMSPAC Wahiawa Item B1.
Implementation Status: Implemented.					
2.	FW	Protect, conserve, and manage terrestrial flora and fauna	2005 2		Conduct flora survey in order to: (1) protect, conserve, & manage terrestrial flora & fauna; and (2) to identify & protect native and mature trees. **Estimated cost in 2001:** Cost included in NCTAMSPAC Wahiawa Item B2.
Implementation Status: Implemented.					

Table 1: Status of 2001 NRMP Recommended Actions (continued)

Number	Primary Resource Area	Issue or Objective	Fiscal Year Funding	Priority	Recommendation from 2001 INRMP*
3.	FW	Protect, conserve, and manage terrestrial flora and fauna	2002-2006 2		Monitor feral ungulates in order to protect, conserve, & manage terrestrial flora & fauna. **Estimated cost in 2001:** Cost included in NCTAMSPAC Wahiawa Item B1.
Implementation Status: Implemented.					
4.	FW	Proactively manage/monitor known threatened and endangered species	2002-2006 2		Monitor known populations of flora & fauna in order to proactively manage /monitor known threatened & endangered species. **Estimated cost in 2001:** $12,000
Implementation Status: Implemented.					
5.	FW	Proactively manage/monitor known threatened and endangered species	2002-2006 2		Conduct predator control at Niuli'i Wildlife Refuge in order to proactively manage /monitor known threatened & endangered species. **Estimated cost in 2001:** $48,000
Implementation Status: Implemented.					
6.	FW	Proactively manage/monitor known threatened and endangered species	2005 2		Research and implement management strategy for *Marsilea villosa*; include interim mowing during dry season when no plants are present to control competitive vegetation in order to proactively manage /monitor known threatened & endangered species. **Estimated cost in 2001:** $15,000
Implementation Status: Implemented.					
7.	FW	Proactively manage/monitor known threatened and endangered species	NA NA		Coordinate feasibility of outplanting *Abutilon menziesii* with appropriate agencies in order to proactively manage/monitor known threatened & endangered species. **Estimated cost in 2001:** Not specified
Implementation Status: Implemented.					
8.	LM, FW	Support and comply with provisions of Cooperative Agreement	2002-2006 2		Maintain wetland habitat at the Niuli'i Ponds Wildlife Refuge in order to preserve, protect, & enhance wetlands and support & comply with the provisions of the Cooperative Agreement. **Estimated cost in 2001:** Included in NRTF Lualualei Item A2
Implementation Status: Implemented.					
9.	FW	Support and comply with provisions of Cooperative Agreement	NA NA		Monitor impacts of reduced water on wetland habitat at the Niuli'i Ponds Wildlife Refuge and continue dialog with USFWS in order to comply with the provisions of the Cooperative Agreement. **Estimated cost in 2001:** Not specified
Implementation Status: Implemented.					

Table 1: Status of 2001 NRMP Recommended Actions (continued)

Number	Primary Resource Area	Issue or Objective	Fiscal Year Funding	Priority	Recommendation from 2001 INRMP*
PHNC					
C. Agricultural Outlease					
1.	AO	Agricultural Outleases	Continued	3a	Continue agricultural outleases on Pearl City Peninsula. **Estimated cost in 2001:** Not specified
Implementation Status: Implemented.					
NAVMAG PH Lualualei Branch					
C. Agricultural Outlease					
1.	LM	Reestablish and continue agricultural outleasing program	2003, 2005	3	Publicize the agricultural outlease program and availability of land in order to reestablish and continue the agricultural outleasing program. **Estimated cost in 2001:** $4,000
Implementation Status: Implemented.					
2.	LM	Reestablish and continue agricultural outleasing program	2003-2006 3		Strengthen efforts to obtain irrigation water in order to reestablish and continue the agricultural outleasing program. **Estimated cost in 2001:** $12,000
Implementation Status: Implemented.					
NAVMAG PH West Loch Branch					
C. Agricultural Outlease					
1.	LM	Reestablish and continue agricultural outleasing program	2003, 2005	3	Publicize the agricultural outlease program and availability of land in order to reestablish and continue the agricultural outleasing program. **Estimated cost in 2001:** Cost included in NAVMAG PH Lualualei Branch Item C1.
Implementation Status: Implemented.					
2.	LM	Reestablish and continue agricultural outleasing program	2003-2006 3		Strengthen efforts to obtain irrigation water in order to reestablish and continue the agricultural outleasing program. **Estimated cost in 2001:** Cost included in NAVMAG PH Lualualei Branch Item C2.
Implementation Status: Implemented.					
NCTAMSPAC Wahiawa					
C. Agricultural Outlease					
No recommendations were made with regard to agricultural outleases.					

Table 1: Status of 2001 NRMP Recommended Actions (continued)

Number	Primary Resource Area	Issue or Objective	Fiscal Year Funding	Priority	Recommendation from 2001 INRMP*
NRTF Lualualei					
C. Agricultural Outlease					
No recommendations were made with regard to agricultural outleases.					
PHNC					
D. Forestry Resources					
1.	FM, LM	Waiawa Watershed	Continued	3a	Minimize fire hazard from adjacent private and public lands by constructing fire breaks and installing adequate fencing to discourage trespassers. **Estimated cost in 2001:** Not specified
Implementation Status: Not implemented due to lack of funding.					
2.	FM, LM	Waiawa Watershed	Continued	3a	Retain existing forested areas along Waiawa and Waimano Streams for erosion control. **Estimated cost in 2001:** Not specified
Implementation Status: Implemented.					
3.	FM	Consultation with ICRMP and Navy Tropical Landscape	2002 3b		Consult the ICRMP for Pearl Harbor for locations of culturally-significant landscape features, and the Navy Tropical Landscape Guide for guidelines on tree maintenance, removal/replacement, and selection on Navy installations. The ICRMP and Navy Tropical Landscape Guide emphasize the retention of mature trees and recommend the use of native vegetation where possible. **Estimated cost in 2001:** Not specified
Implementation Status: Implemented.					
4.	FM	Consult CNRH Landscape Architect regarding mature and significant trees	Continued 3b		Consult CNRH Landscape Architect prior to any action that would damage a mature or significant tree. . **Estimated cost in 2001:** Not specified
Implementation Status: Implemented.					
5.	FM	Standard Provision in Construction Contracts	2002 3b		Include a standard provision in all construction contracts regarding procedures to follow when working near mature trees. **Estimated cost in 2001:** Not specified
Implementation Status: Implemented.					
6.	FM, LM, FW	Preserve mature & significant trees	Continued 3c		Preserve/maintain mature trees in developed areas of the Complex. Develop and utilize a standard definition of a "mature" or "significant" tree. . **Estimated cost in 2001:** Not specified

Table 1: Status of 2001 NRMP Recommended Actions (continued)

Number	Primary Resource Area	Issue or Objective	Fiscal Year Funding	Priority	Recommendation from 2001 INRMP*
Implementation Status: Implemented.					
NAVMAG PH Lualualei Branch					
D. Forestry Resources					
No forestry resources management actions were recommended for NAVMAG PH Lualualei Branch in the 2001 INRMP.					
NAVMAG PH West Loch Branch					
D. Forestry Resources					
No forestry resources management actions were recommended for NAVMAG PH West Loch Branch in the 2001 INRMP.					
NCTAMSPAC Wahiawa					
D. Forestry Resources					
1.	LM/FM	Protect pocket-forested areas to provide watershed protection and prevent soil erosion.	2002 3		Install signs for protection of native trees/ecosystem in Poamoho Stream gulch in order to continue to manage, maintain, & enhance land areas with natural resource value and to protect pocket-forested areas to proved watershed protection and prevent soil erosion. **Estimated cost in 2001:** Costs included in NCTAMSPAC Wahiawa Item A2.
Implementation Status: Not implemented due to lack of funding (verify).					
2.	FM	Enhance native tree populations with planting when feasible.	NA NA		Use native plants in ecosystem restoration. **Estimated cost in 2001:** not provided
Implementation Status: Not implemented.					
3.	FW	Conduct flora survey	2005	2	Conduct flora survey in order to: (1) protect, conserve, & manage terrestrial flora & fauna; and (2) to identify & protect native and mature trees. **Estimated cost in 2001:** Costs included in NCTAMSPAC Wahiawa Item B2
Implementation Status: Implemented.					

Table 1: Status of 2001 NRMP Recommended Actions (continued)

Number	Primary Resource Area	Issue or Objective	Fiscal Year Funding	Priority	Recommendation from 2001 INRMP*
NRTF Lualualei					
D. Forestry Resources					
2.	FM	Enhance native tree populations with planting when feasible.	NA NA		Use native plants in ecosystem restoration. **Estimated cost in 2001:** not provided
Implementation Status: Not implemented.					
3.	FW	Conduct Flora Survey	2005	2	Conduct flora survey in order to: (1) protect, conserve, & manage terrestrial flora & fauna; and (2) to identify & protect native and mature trees. **Estimated cost in 2001:** Costs included in NCTAMSPAC Wahiawa Item B2
Implementation Status: Implemented.					
PHNC					
E. Outdoor Recreation					
1.	OR	Other recreational issues	Continued	3a	Continue current Navy plans for expansion of the Rainbow Bay Marina, including the proposed addition of approximately 56 boat slips and support facilities. **Estimated cost in 2001:** Not specified
Implementation Status: Implemented.					
2.	OR Re	creational boating	Continued	3a	Maintain current Navy recreational boating policies allowing limited use of the harbor by active duty and retired military and DOD civilians. **Estimated cost in 2001:** Not specified
Implementation Status: Implemented.					
3.	OR Re	creational fishing	Continued	3a	Continue the current policy limiting fishing from Navy lands to military personnel and DOD civilians, in light of the DOH health advisory **Estimated cost in 2001:** Not specified
Implementation Status: Implemented.					
4.	OR, FO, LM, FW	Public education	2001	3b	Orient new Navy personnel by providing them information on Pearl Harbor's natural resources. **Estimated cost in 2001:** Not specified
Implementation Status: Implemented; Navy prepared a brochure regarding natural resources that is distributed to incoming personnel.					

Table 1: Status of 2001 NRMP Recommended Actions (continued)

Number	Primary Resource Area	Issue or Objective	Fiscal Year Funding	Priority	Recommendation from 2001 INRMP*
5.	OR, FO, LM, FW	Public education	2003	3b	Implement a public outreach and education program for Pearl Harbor natural resources. The program may include self-guided natural history walking tours, interpretive guides and brochures, natural resource videos, a natural resources web page, Navy natural resource managers as guest lecturers in local schools, and student tours of the NWR units. **Estimated cost in 2001:** Not specified
Implementation Status: Not implemented in part due to AT/FP and security.					
6.	OR Re	creational fishing			Amend COMNAVBASEPEARLINST 5510.21B (recreational fishing instruction) to encourage recreation fishing from Navy lands to be catch and release; furthermore, the instruction will reference the DOH advisory against consumption of fish and shellfish from the harbor. Provide information on the DOH health advisory to Navy personnel. **Estimated cost in 2001:** Not specified
Implementation Status: Implemented.					
7.	LM, FW, OR	Recreational fishing	NA	3b	Support DOH in continuing and expanding public education regarding the health risks of consuming fish and shellfish from Pearl Harbor. Maintain posted advisories around the harbor shoreline. Encourage and support DOH in its continued public education regarding the health advisory, the importance of non-consumption, and Navy actions being undertaken to clean up the harbor and Navy actions being undertaken to clean up the harbor. **Estimated cost in 2001:** Not specified
Implementation Status: Implemented.					
8.	OR Comm	ercial boating	Continued	3c	Maintain commercial boating tours of the harbor. **Estimated cost in 2001:** Not specified
Implementation Status: Not implemented; commercial boating is not permitted at Pearl Harbor due to AT/FP concerns.					
9.	OR	Other recreational issures	Continued	3c	Resume, continue, and expand annual festivals and public events such as canoe regattas, Ford Island Fun Run, etc. **Estimated cost in 2001:** Not specified
Implementation Status: Limited implementation due to AT/FP concerns.					

Table 1: Status of 2001 NRMP Recommended Actions (continued)

Number	Primary Resource Area	Issue or Objective	Fiscal Year Funding	Priority	Recommendation from 2001 INRMP*
10.	OR, LM, FW	Pearl Harbor Historic Trail	NA	3c	Support limited mangrove removal/control that may be proposed in conjunction with the Pearl Harbor Historic Trail project (proposed mangrove removal may be outside designated Enhancement Areas). Approve hand-clearing of mangrove by private landowners and other agencies/entities. Develop standard protocol/procedures to facilitate these requests. **Estimated cost in 2001:** Not specified
Implementation Status: Limited mangrove removal was completed near the Admiral's boat house for AT/FP reasons; however, the Pearl Harbor Historic Trail is not a priority with current CCH administration and, therefore, no removal activities have occurred in conjunction with the trail.					
11.	FW, OR, LM	Pearl Harbor Historic Trail	NA	3c	Support the development of a public overlook at the Waiawa Unit as proposed by the USFWS. The overlook could be developed in conjunction with Pearl Harbor Historic Trail project (see Natural Resource-Related Recreation section). If the overlook is to be located on the adjacent landfill, potential public health concerns must be addressed and adequate mitigation included. Efforts should be coordinated with PACNAVFACENGCOM Code 18. **Estimated cost in 2001:** Not specified
Implementation Status: Not implemented because USFWS has not pursued the overlook.					
12.	OR	Pearl Harbor Historic Trail	NA	3c	Support CCH's efforts to develop the Pearl Harbor Historic Trail. Some identified points of interest on and adjacent to Navy land include the Arizona Memorial, USS Missouri, Rainbow Bay Park, and taro and watercress farms. **Estimated cost in 2001:** Not specified
Implementation Status: CCH has not continued efforts to develop the Pearl Harbor Historic Trail.					
13.	OR Re	creational fishing	Continued	3c	If and when the DOH health advisory is ended, reevaluate recreational fishing policies; at that time, consider permitting public fishing from Navy land. **Estimated cost in 2001:** Not specified
Implementation Status: Not applicable, DOH health advisory was not ended.					

Table 1: Status of 2001 NRMP Recommended Actions (continued)

Number	Primary Resource Area	Issue or Objective	Fiscal Year Funding	Priority	Recommendation from 2001 INRMP*
NAVMAG PH Lualualei Branch					
E. Outdoor Recreation					
1.	OR	Enhance awareness opportunities relating to natural and cultural resources at NAVMAG PH for new personnel and visitors	2003 3		Create a presentation board for NAVMAG PH natural and cultural resources programs for briefing new personnel and visitors. **Estimated cost in 2001:** $5,000
Implementation Status: Not implemented due to lack of funds.					
2.	OR	Enhance awareness opportunities relating to natural and cultural resources at NAVMAG PH for new personnel and visitors	2003 3		Develop procedures and criteria for dealing with tours/field trips and similar requests in order to enhance awareness opportunities relating to natural & cultural resources at NAVMAG PH for new personnel & visitors. **Estimated cost in 2001:** $8,000.
Implementation Status: Implemented.					
3.	OR	Provide outdoor recreational activities for NAVMAG PH personnel and the general public.	2003		Evaluate the impact of an archery hunting program on feral ungulate populations, its recreational value, and program viability in order to provide outdoor recreational activities for NAVMAG PH personnel & the general public. **Estimated cost in 2001:** $6,000.
Implementation Status: Implemented.					
4.	OR	Provide outdoor recreational activities for NAVMAG PH personnel and the general public.	2004 2		Decide on need to continue selective culling of feral ungulates by professional hunters in order to provide outdoor recreational activities for NAVMAG PH personnel & the general public. **Estimated cost in 2001:** $8,000.
Implementation Status: Implemented.					
NAVMAG PH West Loch Branch					
E. Outdoor Recreation					
1.	OR	Enhance awareness opportunities relating to natural and cultural resources at NAVMAG PH for new personnel and visitors	2003 3		Develop procedures and criteria for dealing with tours/field trips and similar requests in order to enhance awareness opportunities relating to natural & cultural resources at NAVMAG PH for new personnel & visitors. **Estimated cost in 2001:** costs included in NAVMAG PH Lualualei Item E2
Implementation Status: Implemented.					

Table 1: Status of 2001 NRMP Recommended Actions (continued)

Number	Primary Resource Area	Issue or Objective	Fiscal Year Funding	Priority	Recommendation from 2001 INRMP*
2.	OR, LM, FW	Provide outdoor recreational activities for NAVMAG PH personnel and the general public.	2003 2		Reevaluate feasibility, safety, and benefits of allowing recreational fishing at West Loch Branch in order to provide outdoor recreational activities for NAVMAG PH personnel & the general public. **Estimated cost in 2001:** $8,000.
Implementation Status: No change in policy due to AT/FP concerns and the DOH advisory on the consumption of fish and shell fish at Pearl Harbor.					
3.	OR	Provide outdoor recreational activities for NAVMAG PH personnel and the general public.	2		Support improved access and wildlife viewing opportunities at the Honouliuli Unit of PHNWR in order to provide outdoor recreational activities to NAVMAG PH personnel & the general public. **Estimated cost in 2001:** $0.00
Implementation Status: Implemented; however, the overlook and access are still in the planning stages.					
NCTAMSPAC Wahiawa					
E. Outdoor Recreation					
1.	OR	Expand public opportunities for natural resource-related outdoor recreation	2005 3		Construct improvements to perimeter trail in order to expand public opportunities for natural resource-related outdoor recreation. **Estimated cost in 2001:** $15,000.
Implementation Status: Not implemented due to AT/FP and security concerns.					
2.	OR	Ensure that the degree of access allowed for outdoor recreation is consistent with conservation of natural resources.	NA	NA	Coordinate all new proposed improvements with appropriate agencies. **Estimated cost in 2001:** Not specified
Implementation Status: Not applicable, no new improvements proposed.					
3.	OR	Promote awareness of natural resources, the importance of resource stewardship, and a sense of pride in the natural environment	NA NA		Allow limited access for scientific study and educational activities in order to promote awareness of natural resources, the importance of resource stewardship, and a sense of pride in the natural environment. **Estimated cost in 2001:** Not specified
Implementation Status: Implemented.					

Table 1: Status of 2001 NRMP Recommended Actions (continued)

Number	Primary Resource Area	Issue or Objective	Fiscal Year Funding	Priority	Recommendation from 2001 INRMP*
4.	OR	Protect important natural and cultural assets at the installation	NA NA		Ensure work plans are reviewed by appropriate staff prior to initiation of work in order to protect important natural and cultural assets. **Estimated cost in 2001:** Not applicable, Cost included in operations and maintenance
Implementation Status: Implemented.					
NRTF Lualualei					
E. Outdoor Recreation					
1.	OR	Ensure that the degree of access allowed for outdoor recreation is consistent with conservation of natural resources.	NA	NA	Coordinate all new proposed improvements with appropriate agencies. **Estimated cost in 2001:** Not specified
Implementation Status: Not applicable; no new improvements proposed.					
2.	OR	Promote awareness of natural resources, the importance of resource stewardship, and a sense of pride in the natural environment	NA NA		Allow limited access for scientific study and educational activities in order to promote awareness of natural resources, the importance of resource stewardship, and a sense of pride in the natural environment. **Estimated cost in 2001:** Not specified
Implementation Status: Implemented.					
3.	OR	Protect important natural and cultural assets at the installation	NA NA		Ensure work plans are reviewed by appropriate staff prior to initiation of work in order to protect important natural and cultural assets. **Estimated cost in 2001:** Not applicable, Cost included in operations and maintenance
Implementation Status: Implemented.					

Note: Code refers to the category of natural resource action proposed:

FY = Fiscal Year LM = Land Management FW = Fish and Wildlife Management OR = Outdoor Recreation.
Priority Abbreviations:

2-Class 2 = Priority 2 Project/Class 2 Funding (Projects required to remain in compliance with legal requirements or to meet established deadlines)

3-Class 3 = Priority 3 Project/Class 3 Funding (Projects are feasible actions that would enhance natural resources, but are not required to comply with laws or regulations. Funding for Class 3 projects is not always readily available. When funds are provided, the Priority 3 projects are initiated in the order proposed by the Natural Resource Manager and approved by appropriate command structure.)

Source: NAVFAC PAC 2001a, b, and c

This page was intentionally left blank

APPENDIX H
CORRESPONDENCE

H1 – FORT KAMEHAMEHA WWTP OUTFALL EXTENSION (NOAA FISHERIES 1997)

UNITED STATES DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
NATIONAL MARINE FISHERIES SERVICE
Southwest Region
501 West Ocean Boulevard, Suite 4200
Long Beach, California 90802-4213

F/SWO33:ETN

DEC -4 1997

Melvin N. Kaku
Director
Environmental Planning Division
Pacific Division
Naval Facilities Engineering Command
Pearl Harbor, Hawaii 96860-7300

Dear Mr. Kaku:

Thank you for your letter regarding a proposed construction and operation of an outfall for the Wastewater Treatment Plant at Fort Kamehameha, Pearl Harbor, Hawaii. The project is intended to replace the current outfall which discharges into nearshore waters at the entrance to Pearl Harbor. The new outfall will discharge into waters 150 feet deep and 2.4 miles offshore.

Based on a review of the Draft Environmental Impact Statement for the Outfall Replacement for Wastewater Treatment Plant at Fort Kamehameha, Navy Public Works Center, Pearl Harbor, Hawaii, and other available information I concur with your determination that the proposed project is not likely to affect any listed species or designated critical habitat under the jurisdiction of the National Marine Fisheries Service, provided that the following conditions proposed by the Navy are implemented.

1. If listed species are sighted in the project area construction activities will cease and resume only after their departure.

2. The Pacific Islands Protected Species Program will be notified of each such occurrence.

This concludes the informal Section 7 consultation process for this project. Consultation must be reinitiated if new species are listed that may be affected by the proposed activity or the activity affects listed species or critical habitat in a manner or to an extent not previously considered. No incidental takes of listed species are authorized for this project. Please contact me directly at 808/973-2987 should there be any further questions.

Sincerely,

Eugene T. Nitta

Eugene T. Nitta
Protected Species Program
Manager

cc: F/SW023 - Naughton

H2 – PEARL HARBOR INRMP
(NOAA FISHERIES AND USFWS 2001)

This page is intentionally left blank.

United States Department of the Interior

FISH AND WILDLIFE SERVICE
911 NE. 11th Avenue
Portland, Oregon 97232-4181

IN REPLY REFER TO
AFR

OCT 30 2001

Melvin N. Kaku
Director, Environmental Planning Division
Department of the Navy
Pacific Division, Naval Facilities Engineering Command
258 Makalapa Drive, Suite 100
Pearl Harbor, Hawaii 96860-3134

Dear Mr. Kaku:

The Fish and Wildlife Service (Service) has reviewed the Revised Final Draft Integrated Natural Resources Management Plan (INRMP) for the Pearl Harbor Naval Complex on Oahu (Pearl Harbor INRMP). The purpose of this letter is to communicate the Service's agreement that the management measures contained in the Pearl Harbor INRMP are consistent with PL 105-85, also known as the Sikes Act Improvement Act of 1997 (SAIA), and should benefit fish and wildlife resources.

In compliance with the SAIA, military installations must prepare INRMPs that provide for conservation and rehabilitation of natural resources, sustainable multipurpose uses of the resources, and public access for use of natural resources, subject to safety requirements and military security. INRMPs are to be prepared in cooperation with the Service and relevant State resource agencies so that each approved INRMP reflects the mutual agreement of the parties concerning conservation, protection, and management of fish and wildlife resources.

The Pearl Harbor INRMP is a programmatic document intended to identify management objectives for natural resources over a 10-year planning horizon. The INRMP may be updated as often as necessary, but at least one update must occur no more than five years from initial approval. Consistent with the SAIA, the Pearl Harbor INRMP is intended to be a guide for future activities that involve the protection, conservation, and management of natural resources occurring within certain areas of Pearl Harbor and at two outlying sites, Waiawa Watershed and the Red Hill Fuel Storage area.

The Service's Pacific Islands Fish and Wildlife Office has reviewed multiple versions of the draft Pearl Harbor INRMP and has shared numerous related concerns with your staff over the course of many meetings. We appreciate the comprehensive manner in which the Navy has responded to our INRMP concerns. Of particular note, discussions with Steve Smith, Marine Ecologist, Naval Facilities Engineering Service Center, and Randy Miyashiro, Environmental Protection Specialist, Navy Region Hawaii, have been very constructive.

As a result of this open dialogue, the Service has been able to contribute to the INRMP planning process and most of our concerns have been resolved, as reflected in the Final Revised Draft.

With regard to the protection of species listed under the Endangered Species Act the Service and Navy completed informal section 7 consultation on August 27, 2001. The Service concurred with the Navy's determination that the Pearl Harbor INRMP is not likely to adversely affect listed species, with the understanding that this concurrence will not preclude the need for further consultations as specific actions associated with projects proposed in the plan become identified. Currently, the designation of critical habitat for listed species is not being proposed for the areas covered by the Pearl Harbor INRMP.

The Service would like to initiate a dialogue with you and the heads of the Navy Environmental Compliance and Environmental Restoration divisions at Pearl Harbor concerning the role of environmental contaminant assessment and remediation in relation to natural resource and/or ecosystem management at this installation. Contaminants adversely affect the quality of habitats and the viability of plant and animal populations. We recommend that yearly reviews and future revisions to this INRMP include a section summarizing known or suspected contaminant-related issues and management actions taken, or identify additional information needed to protect fish and wildlife resources and rehabilitate contaminant-affected habitats. The Service has extensive expertise in assessing environmental contaminant impacts to fish and wildlife and recommending actions to restore habitats adversely affected by contamination. It is our desire to work with the Navy to identify opportunities, consistent with the SAIA, to rehabilitate wildlife habitat in conjunction with contaminated site remediation during implementation of the INRMP.

The Department of Defense and the Service are currently developing a MOU to implement Executive Order 13186, *Responsibilities of Federal Agencies to Protect Migratory Birds*. While the MOU is being developed, the Service encourages continued dialogue between our agencies on cooperative efforts to protect and conserve migratory birds and their habitats, with special emphasis on the species identified in Service's list of birds of conservation concern. During the implementation phase of this INRMP, we would like to work with you to incorporate migratory bird conservation actions on military lands. Programs and recommendations contained in comprehensive migratory bird plans such as the U.S. National Shorebird Plan, North American Waterfowl Management Plan, Partners-in-Flight, and North American Waterbird Conservation Plan should be integrated into management actions on military lands. We also would like to clarify that any action that is undertaken specifically to take, kill or capture migratory birds requires the appropriate migratory bird permit from our Regional Office in Portland, Oregon.

As we move into the implementation phase of the Pearl Harbor INRMP, our agencies should work as closely as possible within the scope of the 1999 Memorandum of Understanding Between the Department of Defense and the Fish and Wildlife Service for the Ecosystem-based Management of Fish, Wildlife, and Plant Resources on Military Lands (MOU). The type of resource management mandated by the SAIA is a shared, long-term responsibility that may be

facilitated through implementation of the MOU and execution of subagreements made pursuant to the MOU. Through this instrument, the Service would be able to ensure that adequate staff time is allocated to working with your staff in areas such as the ongoing development of proposed INRMP project details, project implementation, annual INRMP reviews/updates, and an INRMP revision at least once every five years.

The SAIA and MOU provide clear funding opportunities to support Service and military capabilities in carrying out our SAIA obligations. It is our view that this support may be highly appropriate in the Pacific where a large number of military installations occur and play crucial roles in the recovery of endangered species. Please feel free to contact my Pacific Islands Fish and Wildlife Office Supervisor, Paul Henson, at (808) 541-3441, to discuss our mutual interests in INRMP monitoring and implementation.

Sincerely,

Rowan W. Gould

Regional Director

cc:
Gil Coloma-Agaran, Hawaii Department of Land & Natural Resources
Charles Karnella, National Marine Fisheries Service
Paul Henson, Field Supervisor, Fish and Wildlife Service, Pacific Islands Fish and Wildlife Office, Honolulu, Hawaii
Rich Johnson, Region 1 Sikes Act Coordinator, Fish and Wildlife Service, Portland, Oregon
Jeanette Gallihugh, Branch of Federal Activities, Sikes Act Coordinator, Fish and Wildlife Service, Arlington, Virginia

United States Department of the Interior

FISH AND WILDLIFE SERVICE
Pacific Islands Ecoregion
300 Ala Moana Boulevard, Room 3-122
Box 50088
Honolulu, Hawaii 96850

In Reply Refer To: 1-2-2001-I-107

AUG 27 2001

Mr. Melvin Kaku
Director, Environmental Planning Division
Department of the Navy
Pacific Division
Naval Facilities Engineering Command
258 Makalapa Dr. Ste. 100
Pearl Harbor, HI 96860-3134

Subject: Pearl Harbor Naval Complex Integrated Natural Resources Management Plan (INRMP) Informal Consultation

Dear Mr. Kaku:

The U.S. Fish and Wildlife Service (Service) has reviewed the Navy's request under section 7 of the Endangered Species Act (Act), for concurrence with your determination that the Pearl Harbor Naval Complex INRMP is not likely to adversely affect any listed species. On February 12, 2001, we received your February 7, 2001, letter requesting concurrence, and on March 16, 2001, the Service sent you a letter informing you that we required more information before being able to concur with your determination. Subsequently, numerous meetings were held between the Navy and the Service and on August 22, 2001, Mr. Steve Smith of your office sent us additional information regarding revisions that would be included in the Final Pearl Harbor Naval Complex INRMP.

The Pearl Harbor Naval Complex INRMP describes general actions on a ten-year fiscal plan that will be implemented by the Natural Resources Manager. Broad-based activities include, but are not limited to, wetland enhancement, bird habitat restoration, and vegetation monitoring. The Navy has agreed to develop a long-term plan for controlling mangroves and establishing and/or enhancing native wetland species and have included these actions in your INRMP.

Based on this additional information, the Service concurs with the Navy's determination that the general activities outlined in the INRMP are not likely to adversely affect listed species. However, we recommend that when specific actions are identified for all individual activities, the Navy informally consult with the Service on those projects.

In addition, we would like to be clear that this letter does not constitute our final comments with regard to Service responsibilities under the Sikes Act Improvement Act. We will be sending those comments at a future date which may include, additional comments regarding any environmental contaminant concerns or other trust resources, fish and wildlife management recommendations, and additional recommendations to alleviate threats to native species.

The Service appreciates the opportunity to work with the Navy to ensure that the Pearl Harbor Naval Complex INRMP complies with section 7 of the Act. If you have any questions, please contact Fish and Wildlife Service biologist Lorena Wada (phone: 808/541-3441; fax: 808/541-3470).

Sincerely,

Paul Henson

Paul Henson, Ph.D.
Field Supervisor
Ecological Services

H3 – EHIME MARU RECOVERY (NOAA FISHERIES 2001)

This page is intentionally left blank.

UNITED STATES DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
NATIONAL MARINE FISHERIES SERVICE
Southwest Region
Pacific Island Area Office
1601 Kapiolani Boulevard, Suite 1110
Honolulu, Hawaii 96814-0047

May 31, 2001

Fleet Maintenance Officer
Commander in Chief
U.S. Pacific Fleet
250 Makalapa Drive
Pearl Harbor, HI 96860-7000

Dear Admiral Klemm:

The National Marine Fisheries Service (NMFS) has reviewed the Ehime Maru Draft Environmental Assessment (EA). The purpose of the proposed action is the safe recovery of the crew members, personal effects, and certain unique characteristic components from the *Ehime Maru*. Action areas evaluated include the current location of the vessel at a depth of approximately 2,000 feet, 9 nautical miles south of Diamond Head, the preferred shallow water recovery site located 0.5 to 0.75 nautical miles offshore of the Honolulu Airport reef runway at a depth of approximately 115 ft, and a deep-water relocation site outside of State waters at a depth in excess of 6,000 ft. This letter is provided in accordance with Section 7 of the Endangered Species Act (16 U.S.C. 1531 et. seq.), Section 305(b) of the Magnuson-Stevens Act (16 U.S.C. 1855(b), the Fish and Wildlife Coordination Act (FWCA) and Executive Order No. 13089 pertaining to the protection of coral reefs. We offer the following comments on the draft EA.

NMFS appreciates the efforts made by the Navy to work with the contractors and the resource agencies (NMFS, U.S. Fish and Wildlife Service (FWS), and the State of Hawaii Department of Land and Natural Resources (DLNR)). This cooperative work initiated during the project scoping process has continued throughout the development of the EA.

Coral Reefs, Executive Order No. 13089.

Potential exists for damage to corals during the transit from the vessels current location to the shallow water recovery site as a result of diesel fuel or other petroleum products seeping from the vessel. The EA includes an adequate continency plan for control of inadvertent releases of oil. Incident accident plans have been developed to ensure timely and effective response actions and protection of the environment. The plan would include the use of Naval Sea System Command Emergency response equipment and local commercial response equipment.

Potential also exists for damage to corals from the placement of the *Ehime Maru* and the anchoring of support vessels at the shallow water recovery site. However, through the cooperative multi-agency working group, resource agency biologists from NMFS, FWS, and State DLNR have worked closely with the contractors and the Navy to identify an appropriate primary shallow water recovery site which will minimize damage to coral reefs and other marine resources

Essential Fish Habitat/FWCA

All three of the action areas are located within EFH designated under the following Fisheries Management Plans (FMP):

- Bottomfish and Seamount Groundfish (Amendment 6)
- Pelagic (Amendment 8)
- Crustaceans (Amendment 10)

The EA concludes that the proposed action will not adversely affect EFH designated under the various FMPs. Provided that measures outlined in the EA for the control of inadvertent releases of oil and the protection of bottom habitat are implemented, NMFS concurs that the potential for impacts to EFH are minimal and additional EFH conservation recommendations will not be necessary. A Department of the Army permit issued by the U.S. Army Corps of Engineers will be required for the placement of the vessel at the shallow water recovery site. Further comments may be provided during the permit review period.

Endangered Species Act

In response to your letter of May 29, 2001, requesting informal consultation under section 7 of the Endangered Species Act of 1973, as amended (16 U.S.C. 1531 et seq.) and our review of the EA and related documents, NMFS concurs with your determination that listed species and/or critical habitat are not likely to be adversely affected by the proposed action. Specifically, the EA addresses several species under NMFS jurisdiction: green turtles (*Chelonia mydas*); hawksbill turtles (*Eretmochelys imbricata*); Hawaiian monk seals (*Monachus schauinslandi*); humpback whales (*Megaptera novaeangliae*); and sperm whales (*Physeter macrocephalus*). The EA concludes that, with the Best Management Practices and the implementation of activities as outlined in the Incident Action Plan in the unlikely event of an oil release,

these species and/or critical habitat are not likely to be adversely affected by the recovery and relocation activities. NMFS concurs with this determination and hereby concludes the section 7 consultation process for this action. The reference number for this consultation is I-PI-01-73: MMD. If project plans change or additional information become available, this determination may be reconsidered

Thank you for your consideration. Should you have any questions, please contact John Naughton at 973-2935, extension 211, Alan Everson at 973-2935, extension 212 or Margaret Akamine Dupree at 973-2935 extension 210.

Sincerely,

C. Kanee

Rebecca Lent, Ph.D.
Regional Administrator

Copies Furnished:

Ms. Leona Stevenson, Southwest Region, NMFS, 501 West Ocean Blvd.,Suite 4200, Long Beach, CA 90802-4213
Mr. James Slawson, Southwest Region, NMFS, 501 West Ocean Blvd., Suite 4200, Long Beach, CA 90802-4213
U.S. Environmental Protection Agency, P.O. Box 5003, Honolulu, Hawaii 96850
U.S. Fish and Wildlife Service, Environmental Services, P.O. Box 50088, Honolulu, HI 96850
Clean Water Branch, Environmental Management Division, Hawaii State Department of Health, P.O. Box 3378, Honolulu, HI 96801-3386
Hawaii State Department of Business, Economic Development and Tourism, Office of Planning, Coastal Zone Management Program, P.O. Box 2359, Honolulu, HI 96804
State of Hawaii, Department of Land and Natural Resources, Division of Aquatic Resources, P.O. Box 621, Honolulu, HI 96809
US Army Corps of Engineers, Regulatory Branch, Building 230, Fort Shafter, HI 96858

H4 – NCTAMSPAC INRMP (USFWS 2001)

This page is intentionally left blank.

United States Department of the Interior

FISH AND WILDLIFE SERVICE
911 NE. 11th Avenue
Portland, Oregon 97232-4181

IN REPLY REFER TO:
AFR

NOV 27 2001

Melvin N. Kaku
Director, Environmental Planning Division
Department of the Navy
Pacific Division, Naval Facilities Engineering Command
258 Makalapa Drive, Suite 100
Pearl Harbor, Hawaii 96860-3134

Dear Mr. Kaku:

The Fish and Wildlife Service (Service) has reviewed the Final Draft Integrated Natural Resources Management Plan (INRMP) for the Naval Computer and Telecommunication Area Master Station Pacific on Oahu (NCTAMSPAC INRMP). The purpose of this letter is to communicate the Service's agreement that the management measures contained in the NCTAMSPAC INRMP are consistent with PL 105-85, also known as the Sikes Act Improvement Act of 1997 (SAIA), and should benefit fish and wildlife resources.

In compliance with the SAIA, military installations must prepare INRMPs that provide for conservation and rehabilitation of natural resources, sustainable multipurpose uses of the resources, and public access for use of natural resources, subject to safety requirements and military security. INRMPs are to be prepared in cooperation with the Service and relevant State resource agencies so that each approved INRMP reflects the mutual agreement of the parties concerning conservation, protection, and management of fish and wildlife resources.

The NCTAMSPAC INRMP is a programmatic document intended to identify management objectives for natural resources over a five-year planning horizon. The INRMP may be updated as often as necessary, but at least one update must occur no more than five years from initial approval. Consistent with the SAIA, the NCTAMSPAC INRMP is intended to be a guide for future activities that involve the protection, conservation, and management of natural resources occurring within two main facilities: NCTAMSPAC Wahiawa and NCTAMSPAC Radio Transmitting Facility Lualualei on Oahu. Although NCTAMSPAC is actually comprised of these two facilities and four satellite sites, no significant or unique natural resources occur at any of the satellite sites.

The Service's Pacific Islands Fish and Wildlife Office has reviewed multiple versions of the draft NCTAMSPAC INRMP and has shared numerous related concerns with your staff. We appreciate the comprehensive manner in which the Navy has responded to our INRMP concerns. Of particular note, discussions with Randy Miyashiro, Environmental Protection Specialist, Navy Region Hawaii; and Gerald Gibbons, Environmental Planner, and Julie Rivers, Biologist, Naval Facilities Engineering Command, Pacific Division, have been very constructive. As a result of this open dialogue, the Service has been able to contribute to the INRMP planning process and most of our concerns have been resolved. Resolution of these concerns is reflected in both the final document and in your letter to the Service dated November 14, 2001.

With regard to the protection of species listed under the Endangered Species Act, the Service and Navy completed informal section 7 consultation on August 20, 2001. The Service concurred with the Navy's determination that the NCTAMSPAC INRMP is not likely to adversely affect listed species or their critical habitats, with the understanding that this concurrence will not preclude the need for further consultations as specific actions associated with projects proposed in the plan become identified.

As you know, the Service is drafting a critical habitat proposal for the Oahu elepaio (*Chasiempis sandwichensis ibidis*) and endangered plants reported from the island of Oahu, and we have identified areas covered by the NCTAMSPAC INRMP that may be important for the conservation of one or more listed species. We intend to coordinate very closely with you in the development of conservation planning efforts for listed species at NCTAMSPAC.

The Service would like to initiate a dialogue with you and the heads of the Navy Environmental Compliance and Environmental Restoration divisions at Pearl Harbor concerning the role of environmental contaminant assessment and remediation in relation to natural resource and/or ecosystem management at this installation. Contaminants adversely affect the quality of habitats and the viability of plant and animal populations. We recommend that yearly reviews and future revisions to this INRMP include a section summarizing known or suspected contaminant-related issues and management actions taken, or identify additional information needed to protect fish and wildlife resources and rehabilitate contaminant-affected habitats. The Service has extensive expertise in assessing environmental contaminant impacts to fish and wildlife and recommending actions to restore habitats adversely affected by contamination. It is our desire to work with the Navy to identify opportunities, consistent with the SAIA, to rehabilitate wildlife habitat in conjunction with contaminated site remediation during implementation of the INRMP.

The Department of Defense and the Service are currently developing a Memorandum of Understanding (MOU) to implement Executive Order 13186, *Responsibilities of Federal Agencies to Protect Migratory Birds*. While the MOU is being developed, the Service encourages continued dialogue between our agencies on cooperative efforts to protect and conserve migratory birds and their habitats, with special emphasis on the species identified in the Service's list of birds of conservation concern. During the implementation phase of this INRMP, we would like to work with you to incorporate migratory bird conservation actions on military lands. Programs and recommendations contained in comprehensive migratory bird plans such as the US National Shorebird Plan, North American Waterfowl Management Plan, Partners-in-Flight, and North American Waterbird Conservation Plan should be integrated into management actions on military lands. We also would like to clarify that any action that is undertaken specifically to take, kill, or capture migratory birds requires the appropriate migratory bird permit from our Regional Office in Portland, Oregon.

As we move into the implementation phase of the NCTAMSPAC INRMP, our agencies should work as closely as possible within the scope of the 1999 Memorandum of Understanding Between the Department of Defense and the Fish and Wildlife Service for the Ecosystem-based Management of Fish, Wildlife, and Plant Resources on Military Lands (1999 MOU). The type of resource management mandated by the SAIA is a shared, long-term responsibility that may be facilitated through implementation of the 1999 MOU and execution of subagreements made pursuant to the 1999 MOU.

Through this instrument, the Service would be able to ensure that adequate staff time is allocated to working with your staff in areas such as the ongoing development of proposed INRMP project details, project implementation, annual INRMP reviews/updates, and an INRMP revision at least once every five years.

The SAIA and 1999 MOU provide clear funding opportunities to support Service and military capabilities in carrying out our SAIA obligations. It is our view that this support may be highly appropriate in the Pacific, where a large number of military installations occur and play crucial roles in the recovery of listed species. Please feel free to contact the Pacific Islands Fish and Wildlife Office Supervisor, Paul Henson, at (808) 541-3441, to discuss our mutual interests in INRMP monitoring and implementation.

Sincerely,

Anne Badgley

Regional Director

cc:
Gil Coloma Agaran, Hawaii Department of Land and Natural Resources
Charles Karnella, National Marine Fisheries Service
Paul Henson, Field Supervisor, Fish and Wildlife Service, Pacific Islands Fish and Wildlife Office, Honolulu, Hawaii
Rich Johnson, Region 1 Sikes Act Coordinator, Fish and Wildlife Service, Portland, Oregon
Jeanette Gallihugh, Branch of Federal Activities, Sikes Act Coordinator, Fish and Wildlife Service, Arlington, Virginia

DEPARTMENT OF THE NAVY
PACIFIC DIVISION
NAVAL FACILITIES ENGINEERING COMMAND
258 MAKALAPA DR., STE. 100
PEARL HARBOR, HI 96860-3134

11015.4A8E
Ser PLN231/ 2652

14 NOV 2001

Mr. Paul Henson
U.S. Fish and Wildlife Service
Pacific Islands Ecoregion
Box 50088
Honolulu, HI 96850

Dear Mr. Henson:

Subj: NAVAL COMPUTER AND TELECOMMUNICATION AREA MASTER STATION PACIFIC (NCTAMS PAC) INTEGRATED NATURAL RESOURCES MANAGEMENT PLAN (INRMP)

The Sikes Act Improvement Act (SAIA) of 1997 (P.L. 105-85) requires INRMPs to be prepared in cooperation with the U.S. Fish and Wildlife Service (Service) et al. for ensuring that fish and wildlife management aspects are properly addressed in the plan. We believe this was accomplished by your early involvement in the scoping process and more recently with your review and comments on the Final Draft INRMP for NCTAMS PAC dated August 2001. We responded to your comments and met with your staff on November 8, 2001 to discuss the Service's comments and resolve outstanding issues. The product of that effort is enclosed with this letter. We believe the final adjustments to the document that we are making for the Final INRMP are to our mutual satisfaction.

In order to meet stringent time constraints established by the Congress for completing the INRMP, as well as for issuing an environmental assessment and a Finding of No Significant Impact, the Navy requests to receive from the Service an agreement letter attesting that the management measures contained in the NCTAMS PAC INRMP are consistent with P.L. 105-85 and would benefit the fish and wildlife resources that are at the activity.

If you have questions, please contact Mr. Gerald Gibbons (PLN231GG) at 471-1166/9338 or by facsimile transmission at 474-5909.

Sincerely,

Melvin N. Kaku

MELVIN N. KAKU
Director
Environmental Planning Division

Encl:
(1) Service Comment/Action Matrix

USFWS Comments to Final Draft INRMP NCTAMSPAC, August 2001
Annie Marshall
Date: November 2001

Response POC: R. Miyashiro

	General Comments	NAVY RESPONSE
	There is no Environmental Contaminants Section that includes a description of potential contamination issues, status, and potential environmental effects (see Pages 2-6 and 3-15). How do hazardous issues affect natural resources - 2-10, Figure 2-2)? Insert newly developed contaminants language developed for Pearl Harbor, PMRF, and NAVMAG.	Chapter 2 discusses regulations, policies and constraints that would impact the planning process in the development of the INRMP. The previously agreed upon contaminants language will be incorporated into the document in Section 3.4 in the discussion of environmental concerns affecting natural resources.
	Although the wetland sites are discussed in the text, the sites are not indicated on the first maps. Therefore, when mentioning a site in the text, please refer to a map (or maps) that show the location of the site that is being discussed.	References to figures will be inserted into the text.
	Include a copy of the DOD/DOI MOU in appendix.	MOU will be included in the appendix.
	There should be a separate Alien Species section, particularly including discussion of the browntree snake (*Boiga irregularis*)	Alien species discussed throughout. Discussion of BTS added to Section 4.3.2 & 4.3.3.
	Utilize USFWS listing documents and recovery plans to assist with the development of proposed management.	The recovery plans will be added to the list of references and citations will be provided as required.
	Include a section in the INRMP to address compliance of applicable resource laws.	Section 5.2.4 "Responsibilities" will be revised to state that compliance with regulations is a responsibility of the signatory.
	Include (include list in appendix) a list of native trees, understory and other vegetation appropriate for outplanting to improve habitats. We should be sure that list only includes species that are appropriate for Oahu and for each habitat type. And we should not include only trees, understory and shrub vegetation need to be included to help restore the habitat.	In conjunction with the USFWS a list will be developed for inclusion into the next update of the INRMP.
	Include a list of all migratory species that have been observed at the wetland sites (include list in appendix).	DLNR will be contacted to develop a comprehensive listing of migratory birds observed during semi-annual bird counts. The list will be compiled and incorporated in the INRMP in the next update.
	Many of the references that are cited in the text are not included in the References section A1-1.	Reference list will be appended.

Page	Section	Title	General Comments	NAVY RESPONSE
			Many documents included in the references are not cited in the text – Pages A1-1 to A1-2.	Reference list will be reviewed for accuracy and citations incorporated as required.
			There is a fair amount of repetitive text included in the different sections (For example, ES-3, 1-9, 3-27, and 4-18).	Redundancy of information was added to aid occasional reader. Content will be evaluated and corrected as deemed appropriate.
			The common names for species are written inconsistently (for example see Page 3-20). Pick one format and use for all species.	Text will be checked for consistent reference to species and corrected.
			Scientific names are included inconsistently. The first time a species is mentioned in the text, the scientific name should be included after the common name, with the Hawaiian name if included. Whenever the species is mentioned in the text after this first time, the scientific name (or the Hawaiian name if common name is used) does not need to be included. The text should also be consistent in use of common name or Hawaiian name after first mention.	See previous comment on use of common names.
			Format for personal observations cited in text: (Name, affiliation, date), for instance: (A. Marshall, USFWS, 2001).	Citations will be revised.
			Be consistent with use of acronyms in text.	Acronyms will be corrected.
			There are many vague suggestions for managing resources, but no indication that management plans will be developed working with USFWS and DLNR or that old plans will be updated. Proposed actions are disjointed and split into several areas, Chapter 1 and Chapter 6.	This is a programmatic document and many recommendations intentionally lack specific details. It is our intention to work with USFWS and DLNR on development of specific projects. Actions that may affect listed species will have required section 7 consultation. The text in question in Chapter 1 will be deleted and incorporated into Chapter 6.
			Add list of preparers with names, organization, experience, and education.	List will be appended.
			Check spelling, grammar and check for typos.	Document will be proofread and edited.
Page	**Section**	**Title**	**Specific Comments**	
		Title Page	Title Page reads INRMP for NCTAMSPAC, Wahiawa, Hawaii. Should read: INRMP for NCTAMSPAC, Wahiawa and RTF Lualualei, Hawaii	"Wahiawa, Hawaii" will be deleted from heading.
vii		TOC	Include USFWS as acronym for U.S. Fish and Wildlife Service	Text revised.

			General Comments	NAVY RESPONSE
ES-2		Executive Summary	Figure ES-1 Wahawa incorrect spelling- should be Wahiawa	Spelling corrected.
ES-3			I am confused why the second paragraph, first sentence reads "There are no endangered species critical habitats, natural resources are, or ecological reserve areas at NCTAMSPAC RTF Lualualei," yet, the second sentence reads "There is an 88.4-acre (35.7 hectares) wildlife wildlife refuge (Niuli'i Ponds Wildlife Refuge) located in the southeastern corner of the base." Also see pages 1-9 and 4-19.	Paragraph will be modified to avoid ambiguous statement.
			For following, also see Pages 1-9, 3-27, and 4-18. Should be Hawaiian Coot, not American Coot; the scientific name should be *Fulica alai*, not *Fulica americana alai*, and; the Hawaiian name should be 'alae ke'oke'o, not 'alae ke' oke'o	Text revised.
			For following, also see Pages 1-9, 3-27, and 4-18. ...and migratory waterfowl, including ~~the endemic~~ the Northern Shoveler....	Reference to northern shoveler as an endemic species will be corrected throughout.
			For following also see Page 1-9. ...one plant has been identified within the...... Should read: ...one individual of *Abutilon menziesii* has been identified within the......	Text Revised.
ES-5	Table ES-1		Why are some projects not prioritized? Why are some projects not funded? Reword #7 in Objective II, from "Consider feasibility.........." to read "Conduct feasibility analysis...."	Text will be added to clarify that management priorities are applicable only to projects requiring Navy funding through the EPR budgeting process. Objective II will be revised to "Coordinate feasibility of outplanting Abutilon menziesii with appropriate agencies."
1-3	Chapter 1		....or increasing population,..........should read: ....or increasing populations,.......	Text revised.
1-5:			Figure 1-2 Wahawa incorrect spelling- should be Wahiawa	Spelling corrected.
1-11, 1-12			There are few details on the surveys or methodologies that will be used. It is important to note that different species require different survey methods. For instance the Variable Circular Plot (VCP) method is typically used for forest birds, while playbacks are used for 'Io (*Buteo solitarius*). In addition, different species may need to be surveyed at different times of the year.	The INRMP is a programmatic document. Actual survey methods will be developed in conjunction with appropriate agencies to ensure accurate survey results are obtained.
1-12			Recent reduction in water flow to the ponds - no mechanism to fix this situation. What about trying to remedy this situation. Should agree to develop a plan for the waterbird species that utilize these wetlands and a time line for completion and implementation of the plan. These recommendations could include improving the water flow, planting native wetland vegetation, predator control, etc. (see Recovery Plan, USFWS 1999). Section on wetland habitat and waterbirds does not even cite the waterbird recovery plan (USFWS 1999).	The Navy has been working on this issue for several years now in trying to develop a workable solution to this issue. The problem is the availability of an economically viable non-potable water source in an area with limited rainfall. However, we will continue discussions with your agency to develop potential solutions. Will ensure this language is in the text of the document.

			General Comments	NAVY RESPONSE
1-13			"......future potential realignments, the future viability and disposition on the Niuli'i Ponds Wildlife Refuge and wetland ponds should be studied." - With what end in mind?	See discussion above.
1-9			No organized plan for *Marsilea villosa* We should agree to come up with a plan for managing the species at this site and a time line for finishing the plan. The plan could include things such as; mowing only when the plant is dying back, control grazing and trampling by cattle, control alien plants, and conducting monitoring for presence of the plant after sufficient rains (see Recovery Plan, USFWS 1996). In addition, the delisting process for this species in the recovery plan, includes developing an Endangered Species Management Plan for the Lualualie site. This is an important site as it is one of only 2 sites on Oahu (formerly 3) where this species occurs naturally, and there are only 5 total sites state-wide (USFWS 1996).	The Navy is in the process of developing a management plan, and will coordinate with USFWS and other appropriate agencies on plan development.
1-9			No organized plan for *Abutilon menziesii*. We should also agree to come up with a plan for managing the species at this site and a time line for finishing the plan. This may be a potential outplanting site for this species. We could include protection (such as fencing), monitoring, and propagation and seed storage to ensure the preservation of genetic information.	The Navy is in the process of developing a management plan, and will coordinate with USFWS and other appropriate agencies on plan development.
1-12			Does Navy have/need a permit to control for cattle egrets, which, even though introduced, is a species protected by the MBTA.	USDA-Wildlife Services is contracted for predator controls and has all required permits.
1-13			No organized plan for improving pockets of native forests. Also see pages 3-13, 3-14, 3-15, 4-20, 6-1, and 6-2.	There is no formal plan to protect that specific habitat. A list of recommend actions to protect the habitat and a possibility for a formal plan to be developed in the future. Will insert that information in text of document.
1-13			No organized plan for removal of ungulates and other destructive alien species.	Statement is correct. Nuisance reports are handled on an "as needed" basis because occurrences are infrequent.
2-1	Chapter 2		Interagency relationships Why does this section not include coordination with other federal agencies?	Sentence will be amended to include coordination with other federal, state, and county agencies.
2-3			Include previous studies in appendix or at least reference them.	Source document will be verified. Document will be added to appendix or reference or citation will be added, as applicable.
2-4	Section 2.3		Under 'Protected Species and Habitat,' should include MBTA and Executive Order 13186 with other the federal laws cited.	Recommendation will be incorporated.
2-4 to 2-5	Section 2.3.1		Reword first bullet to read: USFWS has...., including migratory birds, and certain marine species. NMFS has jurisdiction over certain threatened and endangered marine species, including most marine mammals.	Text revised.

			General Comments	NAVY RESPONSE
2-5			Separate out Migratory Bird Treaty Act (recently re-affirmed with executive Order 13186, Jan 10, 2001) from Fish and Wildlife Coordination Act and describe in a similar manner to the other federal statues that apply to protected species. We will be including MBTA language developed for other INRMPs in our letter.	Section will be modified as requested.
2-9, 2-10			How are hazards from electromagnetic radiation to wildlife addressed in Plan?	The intent was to discuss hazards related to personnel safety and health constraints with land use. A clarification will be added that it is unknown to any degree if EMR affects wildlife in the area.
3-2	Chapter 3		At a continuous recording station in Wahaiwa... - sentence unclear	Sentence has been revised.
3-4			Figure 3-2 depiction does not coincide with Figure 3-1?	Figure 3.2 has been reviosed.
3-9			Change deficit to deficiency. Add figures being referred to - text not consistent with Figure 3-2	Text revised. Figure references will be added as applicable.
3-10			Loss of ponds will mean the loss of listed species habitat - How can we improve on getting water to the ponds and what will our strategy be if the pump breaks?	See previous comment for response.
3-14	Section 3.2.5		Last paragraph – could replace alien invasive species with natives to help with fire management.	See previous comment and response for development of list of native plants for outplanting to enhance habitats.
3-19, 3-27, 3-28			There are some incorrect statements that need to be changed, some spelling corrections needed, and some poorly worded sentences.	Misstatements, spelling and grammar will be corrected.
4-6	Chapter 4		No discussion of the effects of cattle grazing and pineapple cultivation on natural resources.	The INRMP does not propose cattle grazing or pineapple cultivation. However, since these actions are discussed as possible future alternatives, a sentence has been added to Section 4.2.2.4 which indicates that prior to implementation of any agriculture outlease land use alternative, the effects of the action on natural resources will be considered.
4-8			Text reads: ".....no improvements for soil and water conservation, watershed and wetland protection are necessary." Yet other parts of the text states that the wetlands are having trouble and that there are some problems with erosion in some of the watershed (gulch areas)	Sentence will be modified to correct conflicting statements.
4-18			Clogged culvert should be unclogged.	Paragraph will be modified to indicate that the situation is not critical at this juncture because of the reduced water level. The culvert will be repaired if

			General Comments	NAVY RESPONSE
				a solution is found to alleviate the low water levels.
4-18			Text repetitive	See previous comment and response regarding repetitive text.
4-20			Wildlife refuge is protected from development by its official status - why not then protected from the main threats to it, which are water loss and alien vegetation? No plans or timetable for monitoring, for developing plans, for planting native species..........	See previous comment and response on repetitive text. Plans and timetable are premature as a workable solution has not been developed.
5-10	Chapter 5		Text repetitive	See previous comment and response regarding repetitive text.
6-1 to 6-9	Chapter 6		There are a lot of sentences that read "X and X should be....." Why do they not read: "X and X will be done or a plan developed within X amount of time to ensure these actions are carried out?" For example, Page 6-4: "Vegetation removal should be preformed (correct to performed) from September to January to avoid peak nesting for waterbirds." Change to: "Vegetation removal will be performed from September to January to avoid peak nesting for waterbirds."	Chapter will be edited as required to avoid passive voice when applicable.
6-4			Consult with USFWS on removal of vegetation - develop a plan?	USFWS will be consulted as required. Will insert that information into text of document.
6-4			"#6 - Monitor and control water levels in ponds to maximize the amount of open water and maintain the reproductive success of the waterbirds" And yet, you are not going to replace the pump or develop an alternative strategy for maintaining water in the ponds or clean out clogged culverts?	See previous comment and response on low water levels.

There are some other less substantive changes that I have not written out in this comment document to save time, but that I noted on the document I reviewed, and I will be happy to work with Navy personnel to include for improving future drafts.

<u>References</u>

U. S. Fish and Wildlife Service. 1996. *Marsilea villosa* Recovery Plan. U. S. Fish and Wildlife Service, Portland, OR. 55 pp.

U. S. Fish and Wildlife Service. 199. Draft revised recovery plan for Hawaiian waterbirds, second revision. Recovery Plan. U. S. Fish and Wildlife Service, Portland, OR. 107 pp.

United States Department of the Interior

FISH AND WILDLIFE SERVICE
Pacific Islands Ecoregion
300 Ala Moana Boulevard, Room 3-122
Box 50088
Honolulu, Hawaii 96850

In Reply Refer To: 1-2-2001-I-26

AUG 20 2001

Mr. Melvin Kaku
Director, Environmental Planning Division
Department of the Navy
Pacific Division
Naval Facilities Engineering Command
258 Makalapa Dr. Ste. 100
Pearl Harbor, HI 96860-3134

Re: Naval Computer and Telecommunications Area Master Station Pacific (NCTAMS PAC), Integrated Natural Resources Management Plan (INRMP) Informal Consultation

Dear Mr. Kaku:

The U.S. Fish and Wildlife Service (Service) has reviewed the Navy's request under section 7 of the Endangered Species Act (Act), for concurrence with your determination that the NCTAMS PAC INRMP is not likely to adversely affect any listed species. On May 18, 2001, we received your May 16, 2001 letter requesting concurrence, and on June 18, 2001, the informal consultation was suspended in a conversation between Mr. Gerald Gibbons of your office and Ms. Lorena Wada of my office in an effort to streamline our review of the NCTAMS PAC INRMP. On June 20, 2001, Mr. Steve Smith of your office spoke to Ms. Wada and requested that the Service send our response as soon as possible. Ms. Wada informed Mr. Smith that we were unable to concur with the Navy's finding at the time and raised some concerns for the listed endangered fern, *Marsilea villosa*, based on grazing and grass cutting activities identified in the INRMP. Mr. Smith then requested that the Service withdraw the Navy's request for concurrence until further notice so that we could discuss our concerns. Subsequently, meetings were held to address the Service's concerns. In a August 16, 2001, letter, the Navy provided additional information on management activities at NCTAMS PAC in relation to *Marsilea villosa* conservation, and again requested concurrence that the NCTAMS PAC INRMP is not likely to adversely affect any listed species. The Service received this letter on August 16, 2001.

The NCTAMS PAC INRMP describes general actions on a ten-year fiscal plan that will be implemented by the Natural Resources Manager. Broad-based activities include, but are not limited to, predator control, ungulate control, and increased education. Based on the Navy's August 16, 2001, letter, the Navy has also provided additional information that no grazing is

currently allowed or taking place on any portion of the NCTAMS PAC property at Lualualei, and that no grazing will be allowed without first consulting with the Service. The Navy has also clarified that grass cutting does not, and will not take place on any portion of the NCTAMS PAC property at Lualualei known to support *Marsilea villosa* until a survey of the area is completed. Grass cutting will only proceed when live plants are not visible or it is otherwise clear that the plants have entered a dormant stage.

Based on this additional information, the Service concurs with the Navy's determination that the general activities outlined in the INRMP are not likely to adversely affect listed species. However, we recommend that when specific actions are identified for all individual activities, the Navy informally consult with the Service on those projects.

In addition, we would like to be clear that this letter does not constitute our final comments with regard to Service responsibilities under the Sikes Act Improvement Act. We will be sending those comments at a future date which may include, additional comments regarding any environmental contaminant concerns or other trust resources, management recommendations, and additional recommendations to alleviate threats to native species.

The Service appreciates the opportunity to work with the Navy to ensure that the NCTAMS PAC INRMP, complies with section 7 of the Act. If you have any questions, please contact Fish and Wildlife Service biologist Lorena Wada (phone: 808/541-3441; fax: 808/541-3470).

Sincerely,

Donald Palawski
for Paul Henson
Field Supervisor
Ecological Services

DEPARTMENT OF THE NAVY
PACIFIC DIVISION
NAVAL FACILITIES ENGINEERING COMMAND
258 MAKALAPA DR., STE. 100
PEARL HARBOR, HI 96860-3134

11015.3B
Ser PLN23/ 1936
16 AUG 2001

Mr. Paul Henson
U.S. Department of the Interior
U.S. Fish and Wildlife Service
Pacific Islands Ecoregion
300 Ala Moana Boulevard, Room 3108
Honolulu, HI 96850

Dear Mr. Henson:

Subj: NAVAL COMPUTER AND TELECOMMUNICATIONS AREA MASTER STATION PACIFIC (NCTAMS PAC), CLARIFICATION TO THE INFORMAL SECTION 7 CONSULTATION FOR THE INTEGRATED NATURAL RESOURCES MANAGEMENT PLAN

On May 16, 2001 the Navy requested initiation of informal Section 7 consultation with your agency, relative to its Integrated Natural Resources Management Plan (INRMP) for NCTAMS PAC. At this time, the Navy wishes to clarify several issues relative to the endangered plant, *Marsilea villosa.*

During telephone conversations with your staff and mine, and meetings held on July 12, July 23, August 2, August 6 and August 14, 2001, issues relative to the INRMP and the Section 7 process were discussed. As a result of these meetings and discussions, and based upon points one through four (below), it is the Navy's understanding that the USFWS now has the necessary information to complete the informal Section 7 process. It is the Navy's determination that implementation of the NCTAMS PAC INRMP is not likely to adversely affect any threatened or endangered species under your jurisdiction.

1. The endangered plant *Marsilea villosa* is present on portions of the NCTAMS PAC property at Lualualei.

2. No grazing is currently allowed, or taking place on any portion of the NCTAMS PAC property at Lualualei.

3. No grazing will be allowed in the future, without first holding discussions, and if appropriate, consultations with USFWS.

4. Grass cutting does not, and will not take place on any portion of the NCTAMS PAC property at Lualualei, known to support *Marsilea villosa,* until a survey of the area is completed. If it is determined that no live *Marsilea villosa* is visible, grass cutting shall be allowed. If the live plants are visible, grass cutting will be postponed until the plants enter a dormant stage.

The Final Draft Version of the NCTAMS PAC INRMP has been revised to clarify points one through four.

The Navy looks forward to receiving your response. If you have any questions, please contact Mr. Steve Smith at 474-5922.

Sincerely,

MELVIN N. KAKU
Director
Environmental Planning Division

DEPARTMENT OF THE NAVY
PACIFIC DIVISION
NAVAL FACILITIES ENGINEERING COMMAND
258 MAKALAPA DR., STE. 100
PEARL HARBOR, HI 96860-3134

11015.3B
Ser PLN23/ 1871
8 AUG 2001

Mr. Richard Johnson
Supervisory Fishery Biologist
Fishery Resource Office
U.S. Fish and Wildlife Service
911 N.E. 11th Avenue
Portland, OR 97232

Dear Mr. Johnson:

Subj: NAVAL COMPUTER AND TELECOMMUNICATION AREA MASTER STATION PACIFIC (NCTAMS PAC) INTEGRATED NATURAL RESOURCES MANAGEMENT PLAN (INRMP) FINAL DRAFT

In accordance with the Sikes Act Improvement Act (SAIA) of 1997, Navy requests your review and comments on enclosure (1), the NCTAMS PAC INRMP Final Draft. We also request your concurrence with the concepts and actions set forth in the NCTAMS PAC INRMP. For your convenience, we have enclosed a draft concurrence letter, [enclosure (2)], which you may wish to use as a template for your response. The Navy respectfully requests your concurrence with the NCTAMS PAC INRMP within 30 days.

During the last two years the Navy has worked with the U.S. Fish and Wildlife Service (USFWS), the Hawaii Department of Land and Natural Resources, other agencies and interested parties to address natural resource concerns and develop programmatic recommendations for the protection and enhancement of NCTAMS PAC's natural resources. The Navy believes that it has successfully integrated all the key concepts advanced by the USFWS and the other partnering agencies into this Final Draft version of the plan.

On May 16, 2001, the Navy provided the USFWS Pacific Islands Ecoregion Honolulu office with a *Pre-Decisional* version of the NCTAMS PAC INRMP. In our transmittal letter, Navy also initiated informal consultation with your agency in accordance the SAIA of 1997, and Section 7 of the Endangered Species Act (ESA) of 1973.

Relative to the informal Section 7 consultation, the Honolulu Office of the USFWS has indicated that subject to receipt of additional information and assurances, they would concur with our determination of 'no adverse effect' for listed species under Section 7 of the ESA. Additionally, since the INRMP is actually a programmatic document intended to identify management objectives for natural resources, we agreed that as projects are fully defined, as appropriate, they will be submitted to the USFWS for comments on individual actions.

At this time, the Navy is also distributing the *Final Draft* version of the *NCTAMS PAC INRMP* for public review. Copies have also been provided to the Hawaii Department of Land and Natural Resources.

The Navy appreciates the input and support your colleagues in Honolulu have provided on the INRMP. We look forward to receiving your concurrence letter and working with you in the future. Should you have any questions about this project or need further information, please contact Mr. Gerald Gibbons at (808) 471-1166 or by facsimile transmission at 474-5909.

Sincerely,

Melvin N. Kaku
MELVIN N. KAKU
Director
Environmental Planning Division

Encl:
(1) Final Draft Pearl Harbor INRMP (2 copies)
(2) Sample concurrence letter

Copy to: (4 copies)
Mr. Paul Henson Field Supervisor
USFWS Pacific Islands Ecoregion
300 Ala Moana Boulevard, Rm 3-122
Honolulu, HI 96850

H5 – PROGRAMMATIC ENVIRONMENTAL IMPACT STATEMENT FOR FORD ISLAND DEVELOPMENT (USFWS 2001)

United States Department of the Interior

FISH AND WILDLIFE SERVICE
Pacific Islands Ecoregion
300 Ala Moana Boulevard, Room 3-122
Box 50088
Honolulu, Hawaii 96850

2001 OCT 31 P 2:43

In Reply Refer To: CMH

J. L. Mustain
Captain, CEC, U.S. Navy
Navy Region Hawaii
517 Russell Avenue, Suite 110
Pearl Harbor, Hawaii 96860-4884

Re: Endangered Species Act Section 7 Concurrence for the Final Programmatic Environmental Impact Statement for the Development of Ford Island, Oahu, Hawaii.

Dear Captain Mustain:

The U.S. Fish and Wildlife Service (Service) has received your October 5, 2001, letter requesting concurrence with your determination that the proposed development of Ford Island, Oahu, Hawaii is not likely to adversely affect any listed endangered or threatened species. In evaluating your request, we reviewed the "Draft Programmatic Environmental Impact Statement (PEIS) - Ford Island Development, Pearl Harbor, Hawaii" and discussed the project with Department of the Navy (Navy) personnel.

Federal legislation was enacted allowing the Navy to sell or lease properties in Hawaii and to use the proceeds for both maintenance, improvement, and rehabilitation of existing Ford Island facilities and for new construction. One of the Navy properties under consideration for sale is the Waikele Branch of the Naval Magazine Pearl Harbor. The Waikele Branch consists of 515 acres of primarily steep hillside or stream floodplain. According to the Draft PEIS, "a plateau area of approximately 32 acres, adjacent to the Waikele residential community, previously accommodated headquarters and housing for personnel stationed at the facility. Access to the plateau site is from the Waikele community. On the remainder of the site, 120 unused munitions tunnels penetrate the valley walls of Kipapa Gulch and Waikele Gulch. Primary access to the valley floor is from a road connecting to Waipahu Street at the southern end of the property." A perimeter road on a narrow terrace forms a loop around the Waikele Stream floodplain. It is unknown what future actions may be proposed in the area after the land has been sold to the selected developer, therefore, we relied on the potential uses described in the Draft PEIS. The Draft PEIS describes the reasonably foreseeable use at Waikele as "sold for potential residential use on the plateau and for cemetery, storage, and agriculture use in the gulch."

One listed species, the endangered Koloa or Hawaiian Duck (*Anas wyvilliana*), occurs in the vicinity of the proposed project. A faunal survey conducted by Philip Bruner in June 2000 flushed two koloa from Waikele Stream. This observation is the only known sighting of Koloa in the area. Critical habitat has not been designated or proposed in the areas affected by any of the alternatives presented in the Draft PEIS.

Although the Koloa were seen within the boundaries of the Waikele property proposed to be transferred, they were not found in that portion identified as having potential for significant future development. The two birds were reported between tunnels A-29 and E-34, approximately 1½ miles upstream (north) of the confluence of Waikele and Kipapa streams. The gulch in the area where the birds were observed is steep-sided and relatively narrow. In this region, Waikele Stream is contained in a floodplain that is several hundred feet wide. The roadway along the perimeter of the floodplain is on a terrace which varies from approximately 5 to 30 feet in elevation above the floodplain. The stream-side shoulder of the road drops abruptly to the floodplain. No activities are expected to occur within the floodplain area, providing a buffer of trees and tall grass between the roadway and the stream and its associated wildlife. The paved roadway is currently used for security patrols in passenger vehicles, vans, and small trucks. The potential use of the tunnels could be reasonably expected to increase vehicle use of the roadway. Noise levels could increase somewhat in both volume and duration. These elevations may startle koloa in the area, but such an effect is expected to be both small and temporary given the current use of the roadway and its distance from the stream.

The potential 32-acre residential development is located on a plateau approximately two miles downstream from the Koloa observation. The potential housing would expand on an existing residential and commercial area, and construction and use of new housing would have no foreseeable effect on koloa or their habitat given the lack of wetlands in this area.

Based on our review of the proposed project, the Service concurs with your determination that the proposed action is not likely to adversely affect federally listed species. If you have any questions regarding this letter, please contact Fish and Wildlife Biologist Colleen Henson of this office by telephone at (808) 541-3441 or by facsimile transmission at (808) 541-3470.

Sincerely,

Paul Henson
Field Supervisor
Ecological Services

cc: David Smith, DOFAW

H6 – NAVMAG INRMP
(USFWS 2001)

This page is intentionally left blank.

United States Department of the Interior

FISH AND WILDLIFE SERVICE
911 NE. 11th Avenue
Portland, Oregon 97232-4181

IN REPLY REFER TO:
AFR

NOV 16 2001

Melvin N. Kaku
Director, Environmental Planning Division
Department of the Navy
Pacific Division, Naval Facilities Engineering Command
258 Makalapa Drive, Suite 100
Pearl Harbor, Hawaii 96860-3134

Dear Mr. Kaku:

The Fish and Wildlife Service (Service) has reviewed the Final Draft Integrated Natural Resources Management Plan (INRMP) for the Naval Magazine Pearl Harbor on Oahu (NAVMAG INRMP). The purpose of this letter is to communicate the Service's agreement that the management measures contained in the NAVMAG INRMP are consistent with PL 105-85, also known as the Sikes Act Improvement Act of 1997 (SAIA), and should benefit fish and wildlife resources.

In compliance with the SAIA, military installations must prepare INRMPs that provide for conservation and rehabilitation of natural resources, sustainable multipurpose uses of the resources, and public access for use of natural resources, subject to safety requirements and military security. INRMPs are to be prepared in cooperation with the Service and relevant State resource agencies so that each approved INRMP reflects the mutual agreement of the parties concerning conservation, protection, and management of fish and wildlife resources.

The NAVMAG INRMP is a programmatic document intended to identify management objectives for natural resources over a ten-year planning horizon. The INRMP may be updated as often as necessary, but at least one update must occur no more than five years from initial approval. Consistent with the SAIA, the NAVMAG INRMP is intended to be a guide for future activities that involve the protection, conservation, and management of natural resources occurring within three NAVMAG branches at three noncontiguous sites on Oahu. These sites include NAVMAG Pearl Harbor Lualualei Branch, NAVMAG Pearl Harbor West Loch Branch, and NAVMAG Pearl Harbor Waikele Branch. This last site is not in use and has been declared available for sale or lease by the Navy.

The Service's Pacific Islands Fish and Wildlife Office (FWO) has reviewed multiple versions of the draft NAVMAG INRMP and has shared numerous related concerns with your staff over the course of several meetings. We appreciate the comprehensive manner in which the Navy has responded to our INRMP concerns. Of particular note, discussions with Randy Miyashiro, Environmental Protection Specialist, Navy Region Hawaii; and Gary Kasaoka, Environmental Protection Specialist, Naval Facilities Engineering Command, Pacific Division, have been very constructive.

As a result of this open dialogue, the Service has been able to contribute to the INRMP planning process and most of our concerns have been resolved. Resolution of these concerns is reflected in both the Final document and in a November 7, 2001, letter to the Service from your office.

With regard to the protection of species listed under the Endangered Species Act, the Service and Navy completed informal section 7 consultation on October 18, 2001. The Service concurred with the Navy's determination that the NAVMAG INRMP is not likely to adversely affect listed species, or their critical habitats with the understanding that this concurrence will not preclude the need for further consultations as specific actions associated with projects proposed in the plan become identified.

As you know, the Service is drafting a critical habitat proposal for the Oahu elepaio (*Chasiempis sandwichensis ibidis*) and endangered plants reported from the island of Oahu, and we have identified areas covered by the NAVMAG INRMP that may be important for the conservation of one or more listed species. We intend to coordinate very closely with you in the development of conservation planning efforts for endangered species at NAVMAG.

The Service would like to initiate a dialogue with you and the heads of the Navy Environmental Compliance and Environmental Restoration divisions at Pearl Harbor concerning the role of environmental contaminant assessment and remediation in relation to natural resource and/or ecosystem management at this installation. Contaminants adversely affect the quality of habitats and the viability of plant and animal populations. We recommend that yearly reviews and future revisions to this INRMP include a section summarizing known or suspected contaminant-related issues and management actions taken, or identify additional information needed to protect fish and wildlife resources and rehabilitate contaminant-affected habitats. The Service has extensive expertise in assessing environmental contaminant impacts to fish and wildlife, and recommending actions to restore habitats adversely affected by contamination. It is our desire to work with the Navy to identify opportunities, consistent with the SAIA, to rehabilitate wildlife habitat in conjunction with contaminated site remediation during implementation of the INRMP.

The Department of Defense and the Service are currently developing a Memorandum of Understanding (MOU) to implement Executive Order 13186, *Responsibilities of Federal Agencies to Protect Migratory Birds*. While the MOU is being developed, the Service encourages continued dialogue between our agencies on cooperative efforts to protect and conserve migratory birds and their habitats, with special emphasis on the species identified in the Service's list of birds of conservation concern. During the implementation phase of this INRMP, we would like to work with you to incorporate migratory bird conservation actions on military lands. Programs and recommendations contained in comprehensive migratory bird plans such as the US National Shorebird Plan, North American Waterfowl Management Plan, Partners-in-Flight, and North American Waterbird Conservation Plan should be integrated into management actions on military lands. We also would like to clarify that any action that is undertaken specifically to take, kill, or capture migratory birds requires the appropriate migratory bird permit from our Regional Office in Portland, Oregon.

As we move into the implementation phase of the NAVMAG INRMP, our agencies should work as closely as possible within the scope of the 1999 Memorandum of Understanding Between the Department of Defense and the Fish and Wildlife Service for the Ecosystem-based Management of Fish, Wildlife, and Plant Resources on Military Lands (1999 MOU). The type of resource management mandated by the SAIA is a shared long-term responsibility that may be facilitated through implementation of the 1999 MOU and execution of subagreements made pursuant to the 1999 MOU. Through this instrument, the Service would be able to ensure that adequate staff time is allocated to working with your staff in areas such as the ongoing development of proposed INRMP project details, project implementation, annual INRMP reviews/updates, and in an INRMP revision at least once every five years.

The SAIA and MOU provide clear funding opportunities to support Service and military capabilities in carrying out our SAIA obligations. It is our view that this support may be highly appropriate in the Pacific, where a large number of military installations occur and play crucial roles in the recovery of listed species. Please feel free to contact the Pacific Islands Fish and Wildlife Office Supervisor, Paul Henson, at (808) 541-3441, to discuss our mutual interests in INRMP monitoring and implementation.

Sincerely,

Regional Director

cc:
Gil Coloma-Agaran, Hawaii Department of Land and Natural Resources
Dr. Charles Karnella, Pacific Islands Area Office, National Marine Fisheries Service
Paul Henson, Field Supervisor, Fish and Wildlife Service, Pacific Islands Fish and Wildlife Office, Honolulu, Hawaii
Rich Johnson, Region 1 Sikes Act Coordinator, Fish and Wildlife Service, Portland, Oregon
Jeanette Gallihugh, Branch of Federal Activities, Sikes Act Coordinator, Fish and Wildlife Service, Arlington, Virginia

STATE OF HAWAII
DEPARTMENT OF LAND AND NATURAL RESOURCES

P.O. BOX 621
HONOLULU, HAWAII 96809

AQUACULTURE DEVELOPMENT PROGRAM
AQUATIC RESOURCES
BOATING AND OCEAN RECREATION
CONSERVATION AND RESOURCES ENFORCEMENT
CONVEYANCES
FORESTRY AND WILDLIFE
HISTORIC PRESERVATION
LAND DIVISION
STATE PARKS
WATER RESOURCE MANAGEMENT

November 7, 2001

LD/NAV
NAVMAGPHINRMP.RCM

Department of the Navy, Pacific Division
Naval Facilities Engineering Command
Melvin N. Kaku, Director
Environmental Planning
258 Makalapa Dr., Ste 100
Pearl Harbor, Hawaii 96860-3134

Attn: Steve Smith

Dear Mr. Kaku:

SUBJECT: Department of Land and Natural Resources (DLNR) Concurrence with Programmatic Objectives and Recommendations of Integrated Natural Resource Management Plan (INRMP) Naval Magazine (NAVMAG) Pearl Harbor, Hawaii

Naval installations are required to prepare integrated natural resources management plans that are in compliance with the Sikes Act Improvement Act (SAIA) of 1997.

The integrated natural resource management plan (INRMP) must provide for the following:

- Conservation and rehabilitation of natural resources
- Sustainable multi-purpose uses of resources, and
- Public access for use of natural resources, subject to the Navy's mission, operational and security requirements

DLNR understands that installation personnel will use the INRMP to guide and prioritize conservation planning actions and projects. Review and updating INRMP allows partnering agencies regular opportunities to contribute to the planning process.

DLNR has worked with the Navy to help define workable management needs for the NAVMAG Pearl Harbor, INRMP. At this time, the DLNR concurs that the objectives and recommendations as presented in the Integrated Natural Resources Management Plan are compatible with the objectives of the SAIA. Furthermore, the DLNR agrees that implementation of present recommendations and subsequent recommendations should protect and enhance those living resources and habitats for which the DLNR has jurisdiction.

The DLNR Divisions of Forestry & Wildlife, Aquatic Resources, Historic Preservation, State Parks and Land look forward to continuing to work with the Navy in defining the programmatic recommendations contained in the INRMP.

We further recommend the following:

- The United States Navy consider committing resources, i. e. funding and organizational infrastructure, needed to accomplish the management strategies and environmental tasks called for in the INRMP.
- The United States Navy consider expanding public recreational opportunities whenever possible.
- The United States Navy consult with the DLNR when the military schedules implementation of recommendations contained in the INRMP.

Attached herewith is a copy of the Division of Forestry and Wildlife (DOFAW) comments.

Thank you for the opportunity to comment on the Objectives and Recommendations of the Integrated Natural Resource Management Plan, Naval Magazine (NAVMAG) Pearl Harbor, Hawaii.

Should you have any questions regarding specific natural resources that you would like to address with DLNR, please feel free to contact any of the following: Brent Liesemeyer, Natural Area Reserve System Manager at 973-9783; David Smith, Oahu Wildlife Program Manager of the Division of Forestry and Wildlife (DOFAW) at 973-9786; Francis Oishi of the Division of Aquatic Resources at 587-0094, Elaine Jourdane of the Historic Preservation Division at 692-8027. To coordinate DLNR review of future INRMP documents, please contact Nicholas A. Vaccaro of the Land Division Support Services Branch at 587-0438.

Sincerely Yours,

G. S. Coloma-Agaran

GILBERT S. COLOMA-AGARAN
Chairperson

c: District Land Office
Division of Forestry and Wildlife
Division of Aquatic Resources
Historic Preservation Division

Division of Forestry & Wildlife

1151 Punchbowl Street, Rm. 325 • Honolulu, HI 96813 • (808) 587-0166 • Fax: (808) 587-0160

August 29, 2001

MEMORANDUM

TO: Nick Vaccaro, Land Agent
Land Division

THRU: Harry Yada, Acting Administrator
Land Division

FROM: Michael G. Buck, Administrator
Division of Forestry and Wildlife

SUBJECT: **Concurrence with Programmatic Objectives and Recommendations of Integrated Natural Resource Management Plan (INRMP), Naval Magazine (NAVMAG) Pearl Harbor, Hawaii.**

As you know, reviewing INRMP for all military installations have been a burdensome process for us considering the armed service's deadline and the impacts they have to our daily natural resource management operations. Despite the added workload to DOFAW, we have worked with the Navy to help them define workable management needs for the NAVMAG Pearl Harbor, INRMP.

DOFAW will concur at this time with the Integrated Natural Resource Management Plan for NAVMAG Pearl Harbor with the following recommendations for their considerations.

1. We asked that NAVMAG Lualualei work with DOFAW on the recovery of *Abutilon menziesii* by providing out-planting sites for the establishment of new populations of this endangered species. We know of areas where wild populations of *Abutilon menziesii* is growing at NCTAMSPAC RTF.
2. We commend NAVMAG Lualualei in their continued efforts to control feral goats. DOFAW will cooperatively assist NAVMAG Lualualei, State unencumbered lands, and Department of Hawaiian Home Lands below Palikea along Nanakuli-Lualualei ridge to control the goat populations there. We are encouraged by the continued support of the Waianae Feral Goat Management Team in addressing this community problem in the area.
3. We encourage NAVMAG Lualualei to work with DOFAW and provide public hunting opportunities at Lualualei. We recommend that public notices of these hunting opportunities are made available to the public which would help community support of NAVMAG activities at Lualualei.

H7 – TRAP AND SKEET RANGE CLEANUP, FORMER NASBP (USFWS 2002-2003)

This page is intentionally left blank.

United States Department of the Interior

FISH AND WILDLIFE SERVICE
Pacific Islands Fish and Wildlife Office
300 Ala Moana Boulevard, Room 3-122
Box 50088
Honolulu, Hawaii 96850

In Reply Refer To:
1-2-02-F-01R

JUN 5 2003

Mr. Mel Kaku
Department of the Navy
Pacific Division
Naval Facilities Engineering Command
258 Makalapa Drive, Suite 100
Pearl Harbor, Hawaii 96860-3134

Subject: Section 7 Consultation for the Decontamination of the Northern Trap and Skeet Range at the Former Naval Air Station Barbers Point, Oahu, Hawaii (Log Number 1-2-02-F-01R)

Dear Mr. Kaku:

This document transmits the biological opinion of the U.S. Fish and Wildlife Service (Service) in response to a request by the U.S. Navy (Navy) to reinitiate formal consultation, in accordance with section 7 of the Endangered Species Act (Act) of 1973, as amended (16 U.S.C. 1531 *et seq*.), regarding potential impacts to the federally endangered *Chamaesyce* (=*Euphorbia*) *skottsbergii* var. *kalaeloana*, or Ewa Plains akoko (akoko), from the proposed soil removal action for decontamination of the Northern Trap and Skeet Range (NTSR) at the former Naval Air Station (NAS) Barbers Point, Oahu, Hawaii. Your November 20, 2002, request for initiation of formal consultation was received on November 21, 2002.

This biological opinion is based on the information provided in the following: (1) "Conservation/Work Plan for Akoko (*Chamaesyce skottsbergii* var. *kalaeloana*)" (Navy 2003); (2) U.S. Navy letter requesting reinitiation of consultation, dated November 20, 2002; (3) the Service's biological opinion for the decontamination of the NTSR, dated March 14, 2002; (4) the Navy's letter requesting initiation of consultation, dated October 25, 2001; (5) Draft Engineering Evaluation/Cost Analysis Addendum No. 2, Former Trap and Skeet Ranges, Former Naval Air Station, Barbers Point, Oahu, Hawaii (Earth Tech 1999); (6) Final Environmental Impact Statement (EIS) for the Disposal and Reuse of Naval Air Station Barbers Point (Navy 1999); (7) Draft Recovery Plan for *Chamaesyce skottsbergii var. skottsbergii* and *Achyranthes splendens* var. *rotundata* (Service 1994); (8) other biological literature (see References), and; (9) various other reports, meetings, and information submitted to the Service and contained in our files. Our

RIo 03-280

log number for this consultation is 1-2-02-F-01R. A complete administrative record of this consultation is on file in this office.

It is the Service's biological opinion that the decontamination of the NTSR, as proposed, is not likely to jeopardize the continued existence of the Ewa Plains akoko. No critical habitat has been designated for this species, therefore, none will be affected.

Consultation History

On October 25, 2001, the Navy proposed to remove lead and arsenic contaminated soil and rock at the NTSR and requested formal consultation regarding impacts to the federally endangered akoko in accordance with section 7 of the Act. On March 14, 2002, the Service issued a biological opinion that concluded that the proposed Navy action was not likely to jeopardize the continued existence of the akoko and would have authorized the loss of several hundred live akoko individuals, dead plant material, and removal of the entire seed bank within the 35-acre (14 hectare (ha)) area. The biological opinion was based on the best scientific information at the time, which concluded that Oahu and Molokai plants of *Chamaesyce skottsbergii* var. *skottsbergii* were not taxonomically distinct. The biological opinion noted the possibility of biological differences between Oahu and Molokai plants of *C. s.* var. *skottsbergii* based on plant habit and ecology.

In May 2002, the Service funded a genetic study by Dr. Cliff Morden, Professor of Botany at the University of Hawaii at Manoa, to assess inter-island and inter-varietal relationships within *Chamaesyce skottsbergii* and to provide information that would benefit akoko recovery. On July 5, 2002, the Service transmitted the preliminary results of the study to the Navy via electronic mail. These results suggested that the Oahu plants represented a distinct variety of *C. skottsbergii*. The Service also conducted scientific peer review of the final report once the genetic study was completed. On July 17, 2002, at a meeting with the Service, and after considering the implications of the genetic study, the Navy presented modifications to the soil removal action that would include protection for the akoko. These options included hand clearing and/or vacuuming soil in areas where akoko were highly concentrated, rather than bulldozing akoko in these areas.

On August 1, 2002, in a letter to the Navy, the Service officially transmitted the preliminary results of the genetic study and recommended that the Navy consider reinitiation of consultation based on the preliminary findings of the genetic study as new information under 50 CFR 402.16. In a meeting on the same day, the Navy agreed to develop conservation actions to improve the species baseline in order to offset impacts to the species from the proposed soil removal action. In the months of August and September, the Navy informed the Service that the soil removal project was on hold pending the results of the genetic study, a decision on the desired course of action for the contaminated area at the NTSR, and the amount of funding available for conservation actions.

On September 23, 2002, the Service sent an electronic copy of the final report of the genetic study (Enclosure 1) to the Navy. In an October 17, 2002, letter, the Service formally transmitted the final report of the genetic study and informed the Navy that it accepted Dr. Morden's treatment of *C. skottsbergii* and recognized three separate entities, *C. skottsbergii* var. *skottsbergii* from Oahu, *C. skottsbergii* var. *skottsbergii* from Molokai, and *C. skottsbergii* var. *vaccinioides* from Molokai pending scientific peer review. The list of peer reviewers was provided to the Navy for review. On November 7, 2002, the Navy delivered a draft letter for reinitiation of consultation to the Service's Pacific Islands Fish and Wildlife Office.

On November 21, 2002, the Service received the Navy's formal request for reinitiation of consultation. The Navy reduced the area of the soil removal action to 23 acres from 35 acres. On December 11, 2002, the Service and the Navy met to discuss the Navy's modified project description and its adequacy in addressing adverse impacts and improvements to species baseline. On December 16, 2002, the Service provided the Navy with comments on the modified project description. The Service's comments included a request for the description of the existing species baseline within the area affected by the cleanup action. The Service also suggested "criteria for stabilization" that could be used to offset adverse impacts to the species baseline by identifying concerns regarding the number and location of sites proposed for increasing species numbers, replacement of the seed bank, management of threats, genetic storage, salvage of recoverable plant material, and monitoring.

On December 27, 2002, via electronic mail, the Navy informed the Service that a 100 percent survey of the entire area to be cleared at the NTSR would be performed in late January or early February 2003. On January 9, 2003, via electronic mail, the Navy responded to the Service's December 16, 2003, comments. On January 23, 2003, via electronic mail, the Navy asked the Service if the Navy's January 9, 2003, proposal avoided jeopardy to akoko, and, if not, agreed to modify the proposal to do so.

At a meeting on January 28, 2003, the Service communicated to the Navy why the Navy's proposal might not avoid jeopardizing the species, and we outlined a set of goals and actions to avoid jeopardy. The Navy's original proposal did not adequately address the reduction in the likelihood of the survival and increase in the risk of extinction for the species. The Service explained its reasoning based on the following factors: (1) the Navy's proposed action would destroy the majority of the largest remaining subpopulation for the species and would seek to establish the estimated number of currently existing individuals at a single and unproven, artificial site; and (2) the Navy's proposed action would eliminate the entire known seed bank within the action area creating a significant reduction in the likelihood of the species' long term survival; and, also, would result in the loss and future unavailability of unique and important genetic individuals that are not currently represented in above-ground plants.

On February 18, 2003, the Navy agreed that the consultation would be on hold until the Service received a revised summary of the scope of consultation. On February 21, 2003, via electronic mail, the Navy provided the Service with a revised scope of the consultation. On March 14-16, 2003, a complete survey was conducted to document the number of akoko plants within the protected "islets" and within the 23-acre (9.3 ha) cleanup area.

At a meeting held on March 19, 2003, the Navy and Service agreed upon a goal for the number of sites and individuals, reproductive status, and duration of conservation actions that would be incorporated into the proposed action. At the meeting, the Navy also presented a draft conservation/work plan to the Service for review. The Navy stated that the conservation actions to avoid jeopardy would need to be accomplished within the $250,000 budget allocated for such activities. The Navy also stated that all project activities needed to occur within a five-year period, and any activities projected beyond five years were unreasonable due to the inability for the Navy to commit to activities that may require funds beyond five years at this point in time. On March 22, 2003, the Service provided comments on the draft conservation/work plan. On April 11, 2003, the Navy and Service agreed upon the terms for collection of genetic material and salvage of plant material to be destroyed. Because the Navy stated that the collection of all recoverable plant material was unreasonable, it was agreed that collection of material "to the maximum extent possible" would be sufficient. On April 16, 2003, the Navy transmitted the final conservation/work plan to the Service via electronic mail. On April 23, 2003, the Service received a copy of the report of the March 2003 NTSR akoko survey.

On May 2, 2003, the Service provided a draft biological opinion to the Navy for review. The Navy submitted comments to the Service on May 9, 2003, and a revised conservation/work plan on May 19, 2003. The Service considered the Navy's comments in preparation of the final biological opinion.

BIOLOGICAL OPINION

DESCRIPTION OF PROPOSED ACTION

The former NAS Barbers Point is located on 3,723 acres (1,506 ha) of the Ewa Plain of Oahu, 13 miles (22 kilometers (km)) west of Honolulu. Campbell Industrial Park borders the facility to the west, the city of Kapolei to the north, Ewa Beach residential communities to the east, and the Pacific Ocean to the south. The NTSR is a 35-acre (14 ha) area of land within a 154-acre (62.3 ha) parcel (Lot 13058-D) on the northeastern side of the former base that was identified as excess property and proposed for reuse as an area for the conservation and recovery of the akoko (Navy 1999) (see Enclosure 2 for maps).

The proposed soil removal action will occur within 23 acres of the former NTSR. Lead shot is generally confined to the top 3 inches (7.5 centimeters (cm)) of soil at the NTSR, therefore, to reduce contaminant levels, the Navy proposes that the top 6 to 12 inches (12 to 25 cm) of soil and rock be removed within the 23 acres (9.3 ha). Rocks larger than approximately two inches (5 cm) in size will be screened from the tailings on site and spread back over the excavated areas

after post-cleanup sampling confirms that cleanup goals have been met. After these large rocks are removed, the remaining soil and rock will be loaded into trucks and hauled to an approved contaminant unit on nearby Navy property where it will eventually be capped in accordance with applicable regulations and standards.

The Navy proposes two methods of soil and rock removal, bulldozing and hand clearing with vacuuming. Bulldozers or similar heavy machinery will scrape the top 6 to 12 inches of soil and loose rock on 22.6 of the 23 acres to be cleared within the NTSR. All vegetation in this area will be bulldozed to remove contaminants associated with plant material (A. Okamura, U.S. Navy, personal communication 2002). Smaller plant material will be removed along with soil, while larger plant material such as trees will be stockpiled on site.

The Navy proposes hand-clearing and vacuuming approximately 0.4 acre (0.16 ha) of the 23 acres. The 0.4 acre represent eight "islets" or areas containing high concentrations of akoko in which bulldozing would not occur. Hand clearing will involve scraping contaminated soil from around adult and juvenile akoko plants followed by vacuuming soil and loose rock. Trees, shrubs, grasses, and other plants will be removed, unless soil testing determines that cleanup goals can be met by leaving them in place.

The Navy will consult with the contracted horticulturalist regarding the origin and nature of the soils and other materials that may be brought to the islet areas for site restoration. No soil or soil-like materials that are significantly different from those found there naturally would be imported to the islets. The contractor has agreed to scrape up, screen, and make available soil from areas immediately north of San Jacinto Road where there are no akoko or other listed species. The soil will not be pretreated to kill seeds.

Implementation of the "Conservation/Work Plan for Akoko (*Chamaesyce skottsbergii* var. *kalaeloana*) in Response to Cleanup in the Former Northern Trap and Skeet Range (NTSR), Former Naval Air Station Barbers Point" (Enclosure 3) is included in the Navy's proposed action. The plan describes various actions to avoid, minimize, and offset project related impacts to the species and its habitat, and are required aspects of the proposed action. The plan identifies specific goals that must be met. Following is a brief summary of the primary components of the plan.

> As specified in the Navy's conservation/work plan, the Navy must maintain an average minimum of 300 adult, self-sustaining, and reproducing individuals per year at each of two sites over a five-year period. At the end of the five-year period, the Navy must ensure a minimum of 300 adult, self-sustaining, and reproducing individuals at each of two sites. The Navy has also agreed to establish a minimum of 100 adult, self-sustaining, and reproducing akoko within the eight "islets" in the cleanup area. Each site must include representation of the maximum genetic diversity allowed by the collection (the maximum number of unique individuals represented from seed or seedlings collected).

The Navy must establish an *ex-situ* collection of akoko seed by collecting 20 percent of the seed from a minimum average of 300 self-sustaining, adult, reproducing plants each year at each site over a five-year period to ensure representation of the genetic diversity of the existing, pre-cleanup, NTSR population. The Navy must coordinate the location, size, and preparation of the outplanting sites with the Service. The two sites proposed by the Navy are areas within Lot 13058-D (154-acre (62.3 ha) parcel) and the Service's Kalaeloa Refuge Unit. The Navy must complete all monitoring and reporting requirements, control of threats to ensure proper care and maintenance of each site, and disposition of material in genetic storage.

Definitions

An adult is defined as a reproducing, woody plant, 24 inches (61 cm) or more in height. A juvenile is a woody plant less than 24 inches in height. A seedling is defined as a two- to four-leafed plant less than 1 inch (2.5 cm) tall. Self-sustaining individuals are defined as adult individuals reproducing without supplemental water or fertilizer. The "genetic diversity of the existing pre-cleanup NTSR population" is defined as all plant material (seeds, seedlings, juveniles, and adults) within the 23-acre area (9.3 ha) at the NTSR prior to clean-up.

STATUS OF THE SPECIES

Taxonomy and Genetics

Chamaesyce (= *Euphorbia*) *skottsbergii* var. *skottsbergii* was first collected on Oahu in 1912 by C.N. Forbes and C.M. Cooke Jr., near Sisal on the Ewa Plain (Service 1994, Hawaii Natural Heritage Program (HINHP) Database 2000). Five more collections were made between Sisal, Pearl Harbor and Barbers Point in the next 24 years. In 1936, Earl Edward Sherff described *Euphorbia skottsbergii* recognizing var. *kalaeloana* from the Ewa Plain of Oahu based on plant habit and leaf characters. He also described two other varieties, var. *audens* and var. *vaccinioides*, from west Molokai (Sherff 1938). Shortly thereafter, Otto Degener and Leon Croizat, convinced that the subgenus *Chamaesyce* was distinct at the generic level, transferred *Euphorbia skottsbergii* to *Chamaesyce* (Degener and Croizat 1936). This combination was retained in the most recent treatment of the Hawaiian members of the genus, but the characters distinguishing varieties *audens* and *kalaeloana* were found to be without taxonomic importance in delimiting the wide variation in growth form and habitat preference observed among inter-island occurrences of this taxon (Koutnik and Huft 1999). These two infraspecific taxa, as well as *Euphorbia multiformis* var. *kapuleiensis* f. *pekelonis*, were included in *Chamaesyce skottsbergii* var. *skottsbergii*, while variety *vaccinioides* was retained.

In 1982, the akoko was listed as endangered under the name *Euphorbia skottsbergii* var. *kalaeloana* (Service 1982). The biological entity on which the listing was based was known only

from the Ewa Plain of Oahu. As discussed above, Koutnik's (1987) taxonomic revision of the genus submerged the listed entity into var. *skottsbergii*, along with var. *audens* and *Euphorbia multiformis* var. *kapuleiensis* f. *pekelonis* which occur on Molokai. Therefore, the akoko was considered to be part of a taxonomic entity whose distribution and range included Oahu and Molokai. Because the taxonomic revision is accepted in Wagner *et. al* (1999), the recognized authority on the native Hawaiian flora, the Service considered the range of *C. skottsbergii* var. *skottsbergii* to include Oahu and Molokai. However, the Service was informally notified that there may be biological differences between Oahu and Molokai plants of *C. skottsbergii* var. *skottsbergii* (W. Char, Char and Associates, personal communication, 1985; B. Koebele, Kaala Farms, personal communication, 2002).

The Service has applied the results of genetic studies using molecular techniques to resolve similar questions of taxonomic recognition of closely related species, varieties, and populations (Service 1996, Service 1999). In May 2002, the Service funded a study to examine genetic variation among populations of *C. skottsbergii* var. *skottsbergii* from Molokai and Barbers Point, Oahu, and to determine the degree of differentiation that has occurred among these populations (Morden 2002). Samples of *C. skottsbergii* var. *vaccinioides* were also compared to establish a baseline level of differentiation among undisputed varieties of *C. skottsbergii*. Random amplified polymorphic DNA (RAPD) procedures were used to analyze genetic differentiation and leaf cross-sections were examined for anatomical differences. Average genetic similarity was measured using Nei and Li's (1979) genetic identity over 340 RAPD markers. Individuals of the two varieties from Molokai, var. *skottsbergii* and var. *vacinnioides*, had the highest genetic similarity (0.349). The individuals with the least average similarity (0.226) are Oahu and Molokai plants of var. *skottsbergii*. Genetic similarity between var. *skottsbergii* on Oahu and var. *vaccinioides* (from Molokai) was 0.258. This level of differentiation parallels the average genetic similarity observed between species (Harper and van Buren 1994, Service 1999) and thus supports their treatment as distinct taxonomic entities.

In accordance with our policy published on July 1, 1994 (Service and National Oceanic and Atmospheric Administration 1994), we solicited independent opinions from 20 knowledgeable individuals with expertise in one or more of the following: familiarity with the species, familiarity with the geographic region that the species occurs in, familiarity with techniques for molecular systematics, and familiarity with Hawaiian plant systematics. We received comments from eight reviewers: seven supported the methodology and conclusions, and one noted that it is not necessary to assign taxonomic rank to all groups with detected genetic differences.

Based on the conclusions of the genetic study and support from scientific peer reviewers, the Service recognizes three distinct entities of *C. skottsbergii*: var. *skottsbergii* from Oahu, var. *skottsbergii* from Molokai, and var. *vaccinioides* from Molokai. Therefore, this consultation concerns only the akoko on Oahu.

Description

Akoko is a perennial, erect to prostrate shrub measuring 1 to 3.3 feet (0.2 to 1 meter (m)) tall (occasionally reaching 6.6 feet (2 m)), with milky sap. Flowering branches and stems are nodose (knobby or knotty). Cyathia (infloresence) are solitary, located in leaf axils, and bell-shaped. Individual cyathium consist of a whorl of fused or distinct bracts surrounding a single female flower and usually five clusters of male flowers. Capsules are green, 0.05 to 0.08 inches (1.5 to 2 millimeters) long, containing three gray to brown seeds. The maturing capsule reorients itself to a vertical position when it is mature and has reached the point of ballistic dispersal of seeds (Koutnik 1987).

Life History and Habitat

The following life history information is based upon a detailed study of akoko population biology, reproductive ecology, phenology, and horticulture (AECOS 1981). Flowering and growth occur with the onset of winter rains and continue through the wet season (typically October to April). The onset of the dry season causes a reduction in these activities, and the plants lose their leaves and become dormant during the peak of the summer drought. The length of the wet season and the intensity of the summer drought are the controlling factors in the population dynamics of the taxon, as survival of the seedlings is extremely dependent on moisture availability.

Pollination studies indicated that pollen vectors are required for successful fertilization (AECOS 1981). The greatest percentage of fruit is set if "flowers" have been cross-pollinated. The akoko seems to have a large number of generalist pollinators, including non-native insects which are widespread throughout leeward Oahu.

On Oahu, akoko are restricted to the Ewa Plain which consists largely of a reef formed during the Pleistocene when sea level was about 25 feet (7.6 m) higher than present. The habitat of akoko consists of limestone topography characterized by sinkholes and coralline rubble. The vegetation of this area is almost entirely dependent on calcareous substrate, as only thin soils and pockets of humus are present (Service 1994). Akoko are found growing out of bare rock and in soils up to 4.8 inches (12 cm) deep (AECOS 1981). Although the entire region suffers from prolonged summer drought, the water table is near the ground surface. The water level in the sinkholes rises and falls with the tide, and ground water is probably brought close to the surface by capillary movement within the porous limestone (AECOS 1981).

As a result of decades of habitat degradation, few native plant communities remain on the Ewa Plain. It is probable that this area was originally covered with a savanna vegetation dominated by wiliwili (*Erythrina sandwicensis*) with an understory of native shrubs such as coastal sandalwood (*Santalum ellipticum*), naio (*Myoporum sandwicense*), ilima (*Sida fallax*), and the Hawaiian caper (*Capparis sandwichiana*) (Earth Tech 1999). Today, akoko exists in open or closed forests dominated by kiawe (*Prosopis pallida*) and in disturbed plant communities

consisting largely of weedy species such as koa haole (*Leucaena leucocephala*), buffel grass (*Cenchrus ciliaris*), feathery pennisetum (*Pennisetum polystachion*), swollen fingergrass (*Chloris inflata*), Australian saltbush (*Artiplex semibaccata*), and Chinese violet (*Asystasia gangetica*) (AECOS 1981, Service 1994).

Presence of a seed bank is necessary to the long-term survival of the akoko. If adult individuals fail to set seed and die, the persistence of the population is entirely dependent on the availability of the existing seed bank (assuming adequate rainfall) to replace individuals. Thus, any loss or reduction in the seed bank coupled with large population fluctuations (loss of mature reproducing individuals) due to stochastic events (*e.g.,* drought), may preclude the long-term survival of akoko.

The seed bank also contains genetic information important to the long-term survival of the species. Loss or reduction in the genetic material in seed bank represents a decrease in the species' ability to evolve in response to changing biological and environmental conditions. The unique environmental conditions (*i.e.,* light, temperature, moisture) under which seeds are formed create unique adaptions that determine their viability, germination and survival in response to changing biological and environmental conditions. Because this species is on the verge of extinction, it is imperative to conserve the existing genetic material (seeds, adults, juveniles, and seedlings) to ensure its survival (Center for Plant Conservation 1991).

Historical Range and Population Status

The akoko has been historically restricted to the arid coral plain of Ewa, Oahu (HINHP Database 2000). It is possible that it was a common element in the original ecosystem that existed on the Ewa Plain, although judging by the paucity of collections made, the population may have been reduced to scattered remnants by the early 1900s. It may have remained rather common in pockets, however, as it was recorded by F.R. Fosberg as "abundant" in one locality in 1936 (HINHP Database 2000). This population is no longer extant. Subsequent to this finding, the taxon was not documented until 1976 in the vicinity of what is now a deep-draft harbor in Ewa. This population was estimated to number up to 2,450 individuals (Char and Balakrishnan 1979). On four separate occasions between 1977 and 1985, a total of 1,300 plants were removed from the vicinity of the planned deep draft harbor and were transplanted, propagated, or distributed to arboreta as part of the mitigation for the impact. By 1989, this population was virtually eliminated (Service 1994). The transplanting effort was unsuccessful due to the lack of proper care and maintenance and only two plants were found during a 1998 survey (AECOS 1981, Whistler 1998). Additional isolated populations and individuals have since been discovered on the Ewa Plain at the former NAS Barbers Point (Service 1994, Whistler 1998).

Historically, direct human-induced loss of habitat is considered the major cause of the decline of akoko on the Ewa Plain of Oahu. The history of human-induced disturbance in this area dates back at least 500 years to the first use of sinkholes for cultivation by native Hawaiians (Cuddihy and Stone 1990). More intensive disturbances have occurred since the 19th century, when diversified agriculture became widespread throughout the Plain. More recently, urbanization and the establishment of a rock quarry, military bases, Campbell Industrial Park, and a deep draft harbor have contributed to the virtual elimination of the original ecosystem.

Current Range and Population Status

Currently, there are five known occurrences of akoko on the island of Oahu totaling less than 1,000 plants (Enclosure 2). All occur in the Ewa Plain region in the vicinity of the former NAS Barbers Point (HINHP Database 2000). Akoko has experienced severe decline in the last 20 years; in 1983, approximately 7,600 individuals were extant while today the lowest estimates place the numbers in the low hundreds. The occurrences on Oahu are within 3 miles (5 km) of each other and it is likely that these represent fragmented subpopulations of a once-larger single population.

Four of the five Oahu subpopulations occur on U.S. Navy land. The subpopulation at the NTSR was estimated to contain 5,000 plants in 1983 (HINHP Database 2000), but has been in decline since then with as few as 100 individuals reported in the mid 1990s (Service 1994). Recent surveys have estimated the size of this subpopulation to be between 100 to 330 individuals (Earth Tech 1999, Service 2001). An additional 32 dead plants and 29 live plants were observed in the areas adjacent to the NTSR (Service 2000). A survey conducted in March of 2003, following significant rainfall during consecutive winter seasons, documented a total of 858 plants within 23 acres (9.3 ha) of the former NTSR (Whistler 2003a).

Another subpopulation at the former NAS Barbers Point numbered 20 plants in 1984 (HINHP Database 2000) but only one plant was observed during a survey conducted in 1998 (Whistler 1998). The third subpopulation, also on the former Barbers Point NAS, numbered only two plants in 1998 and represents the remainder of a failed transplanting effort associated with construction of the deep draft harbor (Service 1994). In the fourth subpopulation, 11 plants (2 adults, 8 juveniles, and 1 dead adult) were documented during a non-exhaustive, walk-through survey of a 40-acre (16 ha) area bounded by Coral Sea, Bismarck and Cabot Roads (Navy 2002). A fifth subpopulation located just west of the former NAS Barbers Point on private land consisted of 30 plants in 1980 (HINHP Database 2000), and was comprised of an unknown number of individuals in 1993 (Service 1994).

Based on the information available to the Service at this time, a total of approximately 900 akoko individuals are known on Oahu. This total likely underestimates the number of akoko on the Ewa Plain. Large areas of suitable habitat where akoko has been previously recorded, such as the second, third, fourth, and fifth subpopulations, have not been surveyed following heavy rainfall. Whistler (1998) suggested that a possible cause of the small populations reported and the apparent rapid decline over the last 18 to 20 years, was the timing of surveys during a period

of drought conditions. Therefore, he recommended future surveys conducted after heavy rainfall would be of importance, particularly in areas where the akoko had already been located.

Today, as the need for urban and industrial sites on Oahu increases, the demand for developable land in the Ewa Plain will also increase. Much of the former agricultural lands have already been converted to residential, commercial, and industrial areas. On the Ewa Plain, approximately seventy-five percent of the undeveloped land with suitable akoko habitat is under federal control. Four of the five remaining subpopulations occur on federal land under control of the Navy. According to the approved reuse plan for the former NAS Barbers Point, four of the five subpopulations where akoko are known to occur are proposed for residential, commercial, or light industrial development (Navy 1999). In a September 16, 2002, letter, the City and County of Honolulu informed the Service of a proposed zoning change that would permit the planned redevelopment and reuse to proceed.

ENVIRONMENTAL BASELINE

Regulations implementing the Act (50 CFR 402.02) define the environmental baseline to include the past and present impacts of all Federal, State, or private actions and other human activities in the action area, the anticipated impacts of all proposed Federal projects in the action area that have already undergone formal or early section 7 consultation, and the impact of State or private actions which are contemporaneous with the consultation in process.

Status of the Species of the Species Within the Action Area

The NTSR contains the largest remaining concentration of akoko on Oahu. In 1983, the 154-acre parcel which includes the 35-acre NTSR, was estimated to contain 5,000 individuals (HINHP Database 2000). This estimate, based on a small sample size, is likely an overestimation (Earth Tech 1999). A 100 percent survey of the NTSR in January 1999 estimated a population size of 330 plants based on the direct count of dead plants (Earth Tech 1999). Using similar methods, in February 2000, an additional 32 dead plants and 28 live plants were recorded in the surrounding area (Service 2000), for a total estimated population size of 362 individuals in the 154-acre parcel. During a survey of the NTSR conducted between May and June 2001 botanists counted a total of 129 live adult and juvenile plants (Service 2001). The number of individuals observed in the 2001 survey is likely an underestimation of the actual number of individuals in the NTSR due to the difficulty in identifying the akoko during the dry season when it is dormant and leafless.

The small number of live akoko plants (in comparison with dead plants) detected and the dramatic decline in plants observed in a study plot at the NTSR (Connor *et al.* 1993, Elvenia *et al.* 1996), seems to indicate an overall decline in the akoko subpopulations at former NAS Barbers Point and presumably elsewhere on the Ewa Plain (Whistler 1998, Earth Tech 1999). Whistler (1998) attributed the recent decline primarily to the record El Nino drought. Rainfall records for the island of Oahu indicate drought conditions over the four years (July 1997 to June 2001) with below normal rainfall levels for the last 20 years (P. Chu, University of Hawaii, personal communication, 2001).

However, drought is not uncommon on the Ewa Plain of Oahu. The Ewa Plain is a desert characterized by an average annual rainfall of 20 inches (50 cm), mean annual temperatures of 22.2 to 25.5 degrees centigrade, and a long summer (mid-March to mid-October) drought with most rain falling during winter "kona" storms (December to February) (AECOS 1981). A common survival tactic for desert plants around the world is to pass through adverse conditions as seeds, which would explain the large population fluctuations observed for this taxon.

In 1999, during a record El Nino drought, Whistler conducted a 100 percent survey of the NTSR and recorded a total 330 dead adult individuals and only 22 live plants (11 adults and 11 juveniles) (Earth Tech 1999). The small number of living akoko plants found during the survey and their ratio to dead individuals raised concern for the well-being of the Ewa Plains subpopulations of akoko. Whistler stated that although there had been a die-off of akoko at the NTSR, there is likely to be seeds present in the soil in the area of dead plants (Earth Tech 1999). Surveys conducted in March 2003 after heavy winter rainfall events in 2000, 2001, and 2002 revealed a significant increase in the total number of plants (852 individuals) in the 23-acre (9.3 ha) cleanup area (Whistler 2003a). This represents an over ten-fold increase in the number of adults, a 40-fold increase in the number of juveniles and seedlings, and near two-fold increase in magnitude of the number of adult and juvenile plants observed during the drought conditions (Enclosure 4). This confirms not only the presence, but the size and significance of the existing seed bank at NTSR. The increase in the number of individuals and age/size class distribution observed also suggests the importance of maintaining the composition of the existing seed bank and representation of age/size classes in the long-term survival of akoko.

Effects of the Action

The effects to the akoko as a result of the proposed soil removal action include: (1) loss of the entire seed bank contained in the top 6 to 12 inches (15 to 30 cm) of soil within the 23-acre (9.3 ha) area subjected to bulldozing, vacuuming, and hand clearing; (2) loss of all genetic material contained in the seed bank and not represented by existing collections; (3) destruction of approximately 61 adults, approximately 330 juveniles, and numerous seedlings in 22.6 acres (9.1 ha) caused by bulldozing; (4) loss of seedlings and decreased survival of 70 adults and approximately 397 juveniles caused by vacuuming and hand clearing of 0.4 acre (0.16 ha); and (5) destruction of 23 acres (9.3 ha) of occupied habitat of the most viable remaining subpopulation.

The proposed soil removal action will destroy from 54 to 100 percent of the individuals of the largest subpopulation (Earth Tech 1999; Service 2000, 2001). And, the proposed soil removal action will destroy approximately 52 to 95 percent of the total number of known akoko plants.

The small number of living akoko plants detected at the NTSR following a drought period, and their ratio to dead individuals raised concern for the well-being of the Ewa Plains subpopulations of akoko. Whistler recommended against soil removal at the NTSR because akoko seeds would be removed in the process (Earth Tech 1999).

Removal of the seed bank includes the loss of individuals not represented by above-ground plants. The seed bank also contains genetic information important to the long-term survival of the species. Loss or reduction in the genetic material contained in the seed bank represents a decrease in the species' ability to evolve in response to changing biological and environmental conditions. The unique environmental conditions (*i.e.,* light, temperature, moisture) under which seeds are formed create unique adaptions that determine their viability, germination and survival in response to changing biological and environmental conditions. Because this species is on the verge of extinction, it is imperative to conserve all recoverable existing genetic material (seeds, adults, juveniles, and seedlings) to ensure its survival (Center for Plant Conservation 1991).

Loss of an undetermined number of seedlings and a decrease in survival of 61 adult and 330 juvenile akoko plants is expected to occur in the 0.4 acre subjected to vacuuming and hand-clearing. Although care will be taken to avoid damage to stems and branches of plants in these areas, it can be expected that disturbance to the root zones of plants will occur. Damage to roots may occur impacting the plant's uptake of water. Removal of soil, and disturbance caused by vacuuming and hand-cleaning may also eliminate beneficial microbial interactions required for plant nutrition.

Implementation of the "Conservation/Work Plan for 'Akoko (*Chamaesyce skottsbergii* var. *kalaeloana*) in Response to Cleanup in the Former Northern Trap and Skeet Range (NTSR), Former Naval Air Station Barbers Point," (Conservation/Work Plan) will increase the species baseline for the akoko. It is imperative that all aspects of the Conservation/Work Plan be implemented for the akoko. As this plan is part of the project description, all identified actions to avoid, minimize, or improve species baseline for the akoko are considered part of the overall evaluation of project related impacts to the species.

As specified in the Navy's Conservation/Work Plan, the Navy must maintain an average minimum of 300 adult, self-sustaining, and reproducing individuals per year at each of two sites over a five-year period. At the end of the five-year period, the Navy must ensure a minimum of 300 adult, self-sustaining, and reproducing individuals at each of two sites. The Navy has also agreed to establish a minimum of 100 adult, self-sustaining, and reproducing akoko within the eight "islets" in the cleanup area. Each site must include representation of the maximum genetic diversity allowed by the collection (the maximum number of unique individuals represented from seed or seedlings collected). The Navy must establish an *ex-situ* collection of akoko seed by collecting 20 percent of the seed from a minimum average of 300 self-sustaining, adult, reproducing plants each year at each site over the five-year period to ensure representation of the genetic diversity of the existing, pre-cleanup, NTSR population. The Navy must coordinate the location size, and preparation of the outplanting sites with the Service. The Navy must complete all monitoring and reporting requirements, and control of threats to ensure proper care and maintenance of each site and material in genetic storage. Thus, overall, the Navy will have established a number of individuals, level of reproduction, and created two artificial sites determined by the Service to offset losses to the species and ensure survival of the species given its current status, distribution, and amount of remaining habitat.

Cumulative Effects

Cumulative effects include the effects of future State, local, or private actions which are reasonably certain to occur in the action area considered in this biological opinion. Future Federal actions that are unrelated to the proposed action are not considered in this section because they require separate consultation pursuant to section 7 of the Act. There are no cumulative effects anticipated within the action area considered in this biological opinion.

CONCLUSION

After reviewing the proposed action, current status of the akoko, the environmental baseline for the action area, the effects of the proposed project, and the cumulative effects, it is the Service's biological opinion that the action, as proposed, is not likely to jeopardize the continued existence of the akoko. No critical habitat has been designated for this species, therefore none will be affected.

CONSERVATION RECOMMENDATIONS

Section 7(a)(1) of the Act directs Federal agencies to utilize their authorities to further the purposes of the Act by carrying out conservation programs for the benefit of endangered and threatened species. Conservation recommendations are discretionary agency activities to minimize or avoid adverse effects of a proposed action on listed species or critical habitat, to help implement recovery plans, or to develop information. The recommendations provided here relate only to the proposed action and do not necessarily represent complete fulfillment of the agency's section 7(a)(1) responsibility for the species.

1) The Service recommends that the Navy conduct surveys using a qualified botanist for all akoko subpopulations on Navy land following periods of average or above average rainfall.

2) The Service recommends that the Navy fund research to determine longevity and viability of seeds under natural conditions in the seed bank and various conditions recommended for long-term genetic storage.

3) The Service recommends that the Navy establish additional populations of akoko on lands with suitable habitat under Navy control such as the former Southern Trap and Skeet Range.

4) The Service recommends that the Navy monitor recruitment and survivorship of new individuals in conservation areas.

5) The Service recommends that the Navy establish and maintain a site that functions as an *in situ* source of seeds for outplanting and genetic storage.

6) The Service recommends the Navy fund research to improve propagation of akoko by cuttings.

7) The Service recommends that the Navy avoid destruction of the coastal sandalwood (*Santalum ellipticum*) and wiliwili (*Erythrina sandvicensis*) which occur in the action area. The wiliwili and coastal sandalwood are the only examples of the native shrub and tree species within the cleanup area and represent one of the few remaining examples of native vegetation on the Ewa Plain.

In order for the Service to be kept informed of actions minimizing or avoiding adverse effects or benefitting listed species or their habitats, the Service requests notification of the implementation of any conservation recommendations.

REINITIATION - CLOSING STATEMENT

This concludes formal section 7 consultation on this action. As required in 50 CFR 402.16, reinitiation of consultation is required where discretionary Federal agency involvement or control over the action has been retained (or is authorized by law) and if: (1) new information reveals effects of the agency action that may affect listed species in a manner or to an extent not considered in this opinion; (2) the agency action is subsequently modified in a manner that causes an adverse affect to the listed species that was not considered in this opinion; or (3) a new species is listed or critical habitat designated that may be affected by this action.

If you have any questions regarding any of the information contained in this biological opinion, please contact either James Kwon, Fish and Wildlife Biologist or Christa Russell, Plant Conservation Program Leader, of my staff (telephone: 808/541-3441; facsimile: 808/541-2756).

Sincerely,

Paul Henson

Paul Henson, Ph.D.
Field Supervisor

cc: DOFAW, Honolulu
USFWS, Consultation and Conservation Planning
USFWS, Law Enforcement

REFERENCES

AECOS 1981. Ecological and horticultural studies of *Euphorbia skottsbergii* at Barbers Point, Oahu, Hawaii. Final Report. 2 vols. Contract DAWC84-80-C-D017. Prepared for U.S. Army Corps of Engineers, Pacific Ocean Division, Honolulu. 168 pp. + appendix.

Center for Plant Conservation. 1991. Genetic sampling guidelines for conservation collections of endangered plants. *In* Falk, D.A. and K.E. Holsinger (eds.) *Genetics and Conservation of Rare Plants*. Oxford University Press, Oxford.

Char, W. 2003. Char and Associates. Personal communication. Honolulu, Hawaii.

Char, W., and N. Balakrishnan. 1979. Ewa Plains botanical survey. Prepared for U.S. Fish and Wildlife Service, Honolulu. 119 pp.

Chu, P. 2001. University of Hawaii. Personal communication. Honolulu, Hawaii.

Connor, J., A. Hoevels, L. Kuhn, and B. Pang. 1993. A survey for the endangered akoko *(Chamaesyce skottsbergii* [sic] var. *skottsbergii)* at Barbers Point Naval Air Station, Kalaeloa, Oahu with management recommendations for its long-term survival. Report prepared for Science 490, University of Hawaii. 7+pp. Unpublished.

Cuddihy, L.W. and C.P. Stone. 1990. Alteration of native Hawaiian vegetation; effects of humans, their activities and introductions. Coop. Natl. Park Resources Stud. Unit, Hawaii, 138 pp.

Degener, O., and L. Croziat. 1936. Flora Hawaiiensis, fam. 190. Euphorbiaceae; Chamaesyce, part 4. Publ. privately 2 pp. Rep,. 1946.

Earth Tech, Inc. 1999. Draft Engineering Evaluation/Cost Analysis Addendum No. 2: Former Trap and Skeet Ranges, Former Naval Air Station, Barbers Point, Oahu, Hawaii. Prepared for Department of Navy, Pacific Division, Naval Facilities Engineering Command, Pearl Harbor.

Elvenia, S., K. Lynch, J. Price, and C. Takasane. 1996. Status report [on] Ewa Plain akoko, *Chamaesyce skottsbergii* var *skottsbergii* (Euphorbiaceae). Report prepared for Biology 490, University of Hawaii. 27+pp. Unpublished.

Harper, K.T., and R. van Buren. 1994. Random amplified polymorphic DNA and resolution of classification problems in *Erigeron* (Asteraceae). American Journal of Botany 81: 197-198 (supplement).

Hawaii Natural Heritage Program Database. 2000. Element Occurrence Records for *Chamaesyce skottsbergii* var. *skottsbergii*, PDEUPOD293. Honolulu. Unpublished.

Koebele, B. 2002. Kaala Farms. Personal communication. Honolulu, Hawaii.

Koutnik, D.L. 1987. A taxonomic revision of the Hawaiian species of the genus *Chamaesyce* (Euphorbiaceae). Allertonia 4: 331-388.

Koutnik, D.L., and M.J. Huft. 1999. *Chamaesyce* S. F. Gray, spurge. *In* Wagner, W.L., D.R. Herbst, and S.H. Sohmer (eds.) *Manual of the flowering plants of Hawaii*, rev. ed. University of Hawaii Press and Bishop Museum Press, Honolulu.

Morden, C.W. 2002. Genetic diversity among Oahu and Molokai populations of *Chamaesyce skottsbergii* (akoko). Prepared for U.S. Fish and Wildlife Service, Ecological Services, Honolulu, Hawaii. 9 pp.

Nei, M., and W.H. Li. 1979. Mathematical model for studying genetic variation in terms of restriction endonucleases. Proceedings of the National Academy of Science USA 76: 5269-5273.

Okamura, A. 2002. Personal communication. BRAC Environmental Coordinator. U.S. Navy, Pacific Division, Naval Facilities, Engineering Command. Honolulu, Hawaii.

Sherff, E.E. 1938. Revision of the Hawaiian species of *Euphorbia* L. Annals of the Missouri Botanical Garden 25 (1): 1-94.

U.S. Fish and Wildlife Service. 1982. Endangered and threatened wildlife and plants; determination that *Euphorbia skottsbergii* var. *kalaeloana* (Ewa Plains akoko) is an endangered species. *Federal Register* 47 (164):36846-36849.

U.S. Fish and Wildlife Service. 1994. Draft Recovery Plan for *Chamaesyce skottsbergii* var. *skottsbergii* and *Achyranthes splendens* var. *rotundata*. U.S. Fish and Wildlife Service, Portland, Oregon. 79 pp. Unpublished.

U.S. Fish and Wildlife Service. 1996. Endangered and threatened wildlife and plants; reclassification of *Erigeron maguirei* (Maguire daisy) from endangered to threatened. *Federal Register* 61 (119): 31054-31058.

U.S. Fish and Wildlife Service. 1999. Endangered and threatened wildlife and plants; withdrawal of proposed rule to list the plant *Rumex orthoneurus* (Chiricahua Dock) as threatened. *Federal Register* 64 (152): 43132-43137.

U.S. Fish and Wildlife Service. 2000. Survey of the 154-acre akoko parcel, February 2000. Unpublished.

U.S. Fish and Wildlife Service. 2001. Survey of the NTSR, May to June 2001. Unpublished.

U.S. Fish and Wildlife Service and National Oceanic and Atmospheric Administration. 1994. Endangered and Threatened Wildlife and Plants: Notice of Interagency Cooperative Policy for Peer Review in Endangered Species Act Activities. *Federal Register* 59: 34270.

U.S. Navy. 1999. Final Environmental Impact Statement for the Disposal and Reuse of Naval Air Station Barbers Point, Hawaii.

U.S. Navy. 2002. Akoko (*Chamaesyce skottsbergii* var. *skottsbergii*) survey on 40 acres of Lot-13059-B. Unpublished.

U.S. Navy. 2003. Conservation/work plan for akoko (*Chamaesyce skottsbergii* var. *kalaeloana*) in response to cleanup in the former Northern Trap and Skeet Range (NTSR), former Naval Air Station Barbers Point.

Wagner, W.L., D.R. Herbst, and S.H. Sohmer (eds.). 1999. *Manual of the flowering plants of Hawaii*, rev. ed. University of Hawaii Press and Bishop Museum Press, Honolulu.

Whistler, A. 1998. *Chamaesyce skottsbergii* Botanical Survey of the Naval Air Station, Barbers Point, Oahu, Hawaii. Prepared for Belt Collins Hawaii. Unpublished.

Whistler, A. 2003a. Akoko (*Chamaesyce skottsbergii* var. *kalaeloana*) survey of the "Northern Trap and Skeet Range" at the former Naval Air Station, Barbers Point. Under Contract DAMD 17-03-2-0022 Part Two, PACNAVFACENGCOM.

Whistler, A. 2003b. Akoko (*Chamaesyce skottsbergii* var. *kalaeloana*) survey of a 15-acre land parcel at the former Naval Air Station, Barbers Point. Under Contract DAMD 17-03-2-0022 Part Two, PACNAVFACENGCOM.

H8 – RENEWAL OF AGRICULTURAL OUTLEASE AT NAVMAG PH LUALUALEI BRANCH (USFWS 2002)

United States Department of the Interior

FISH AND WILDLIFE SERVICE
Pacific Islands Ecoregion
300 Ala Moana Blvd, Rm 3-122
Box 50088
Honolulu, HI 96850

Gary

In Reply Refer To: MLS

MAY 14 2002

Mr. Melvin Kaku
Director, Environmental Planning Division
Department of the Navy
Pacific Division
Naval Facilities Engineering Command
258 Makalapa Dr. Ste. 100
Pearl Harbor, HI 96860-3134

Re: Cattle Grazing at Naval Magazine (NAVMAG) Pearl Harbor, Lualualei Branch, Oahu, Hawaii in an Area Containing the Endangered Fern *Marsilea villosa* Informal Consultation

Dear Mr. Kaku:

The U.S. Fish and Wildlife Service (Service) has reviewed the Navy's request under section 7 of the Endangered Species Act (Act) for concurrence with your determination that continuation of cattle grazing in an outleased portion of Naval Magazine (NAVMAG) Pearl Harbor, Lualualei Branch, Oahu, is not likely to adversely affect the endangered fern, *Marsilea villosa*. We received your letter requesting concurrence on April 17, 2002. In addition, we met to discuss the situation on May 8, 2002, where information was clarified.

This area has been leased as pasture for dairy cattle since 1989. Prior to January, 2002, *Marsilea villosa* had not been seen for 5 years in Paddock 'A' of Agricultural Outlease Unit No. 1. However, after sustained precipitation, the Navy discovered plants in the southwestern portion of the paddock.

Although, cattle are listed as a threat in the final listing rule for this plant (57 FR 27863), the Recovery Plan for *Marsilea villosa* (USFWS 1996) states that "even though trampling may be detrimental to *Marsilea villosa*, cattle may serve to reduce the competition with alien plant species". Cattle previously ranged freely through the former Mailiilii subpopulation at Lualualei, however, following listing of *Marsilea*, cattle were removed from the area. Since then, alien grasses have outcompeted and displaced this particular subpopulation of *Marsilea villosa* (USFWS 1996). Cattle do not appear to feed on *Marsilea villosa*, therefore, the main threat they pose is trampling the plants (USFWS 1996).

Staff biologist for the Navy, Julie Rivers, reported that the cattle do not frequent the area containing the *Marsilea villosa* and did not see them in the vicinity of the population in September 2001, December 2001, or February 2002 site visits. During the wet season, when the *Marsilea villosa* population is visible, the cattle are concentrated in the eastern half of the paddock where their main food source is located. During the dry season, the cattle are concentrated in a corral area that is not in the immediate vicinity of the *Marsilea* population. Service biologist Michelle Stephens visited the site in December 2001 and did not observe any sign of cattle trampling of the plant population.

The Service concurs with the Navy's determination that continued cattle grazing is not likely to adversely affect *Marsilea villosa*. Based on this determination, we believe that the requirements of section 7 of the Act have been satisfied. However, obligations under section 7 of the Act must be reconsidered if: (1) new information reveals impacts of these identified actions that may affect listed species or critical habitat in a manner not previously considered, (2) the identified actions are subsequently modified in a manner that was not considered in this assessment, or (3) a new species is listed or critical habitat determined that may be affected by the identified actions.

If you have any questions regarding our comments, please contact Fish and Wildlife Botanist Michelle Stephens by phone at 808/541-3441 or by facsimile at 808/541-3470.

Sincerely,

Craig Rowland

for Paul Henson
Field Supervisor
Ecological Services

H9 – RIMPAC PROGRAMATIC ENVIRONMENTAL ASSESSMENT (NOAA FISHERIES 2002)

UNITED STATES DEPARTMENT OF COMMER
National Oceanic and Atmospheric Administra
NATIONAL MARINE FISHERIES SERVICE

June 3, 2002

Jeffrey P. Luster, Commander in Chief, U.S. Pacific Fleet (N465)
CPF Environmental Counsel
250 Makalapa Dr.
Pearl Harbor, HI 96860
FAX (808) 474-5494

Re: Rim of the Pacific Exercise (RIMPAC) Programmatic Environmental Assessment (PEA)

Dear CDR Luster:

This responds to your letter (via email) dated May 30, 2002 regarding the Rim of the Pacific Exercise Programmatic Environmental Assessment (RIMPAC PEA). Our comments are provided in accordance with Section 7 of the Endangered Species Act (87 stat. 884 as amended; 16 U.S.C. 1531 et seq.).

The National Marine Fisheries Service (NMFS) has reviewed the PEA and recognizes the prior Section 7 informal consultations addressing the existing military activities covered by the subject PEA. The activities which may affect species under the jurisdiction of NMFS have been previously addressed in the consultation involving the "Report on Military Activities in Hawaiian Waters, April 1995". A comparison review of this document with the current RIMPAC PEA concluded that no significant differences exist.

Following technical discussions, various mitigation measures have been incorporated into the prior approved action to further reduce the likelihood of potential effects to listed species. These measures include:

- Surveying predetermined zones prior to detonation of charges to insure that no protected species are present
- Conducting protected species surveys in the activity area prior to exercises
- Conducting surveys of the activity area following completion of the exercise to identify impacts to protected species
- In the case of amphibious landing exercises, protected species surveys (especially for Hawaiian monk seals) should occur within one hour prior to landing
- NMFS recommends the response plan for seals sighted in landing zones include contacting NMFS Pacific Islands Area Office at (808) 753-0346

Provided the terms and conditions are adhered to during the course of the project activities as stated in the attached section 7 concurrence letter dated September 11, 1995 and the safety zone modeling is implemented for all detonation (which we assume are single charges, not line charges), NMFS concurs with the determination of the Navy that the activities are not likely to adversely affect listed species under the jurisdiction of NMFS. However, any future RIMPAC activities not covered by the PEA may require further section 7 consultation.

If you have any questions regarding this concurrence, please contact Margaret Akamine Dupree of this office at (808) 973-2935 ext 210.

Sincerely,

Rod McInnis
Acting Administrator, Southwest Region

cc: Randy Gallien, Chief, Environmental Policy, Compliance & Remediation U.S. Army Space & Missile Defense Command, FAX (256)955-5074.

Rebecca Hommon, %RADM Robert T. Conway, Jr., USN Commander, Navy Region Hawaii, FAX (808) 473-2783.

Leona Stevenson, NOAA Fisheries, Southwest Region, FAX (562) 980-4027

H10 – BIOLOGICAL OPINION FOR THE REMOVAL AND DETONATION OF LIVE ORDNANCE FROM THE CONSTRUCTION AREA OF FORT KAMEHAMEHA SEWAGE OUTFALL (NOAA FISHERIES 2000)

UNITED STATES DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
NATIONAL MARINE FISHERIES SERVICE
Silver Spring, Maryland 20910

JUL 7 2000

Rear Admiral Charles R. Kubic
Pacific Division
Naval Facilities Engineering Command
258 Makalapa Street, Suite 100
Pearl Harbor, HI 96860-3134

Dear Admiral Kubic;

Enclosed is the National Marine Fisheries Service's (NMFS) biological opinion, issued under the authority of section 7(b) of the Endangered Species Act of 1973, as amended (16 U.S.C. 1536) on the effects of the U.S. Navy's proposal to remove and detonate live ordnance in the construction area of the Fort Kamehameha sewage outall in Pearl Harbor, Hawai'i. Specifically, the biological opinion assesses the effects of proposed action on the endangered humpback whale (*Megaptera novaeangliae*) and green sea turtle (*Chelonia mydas*).

After considering the status of these two endangered species, the environmental baseline of the area, and the direct, indirect, and cumulative effects of the action on threatened and endangered species, NMFS concludes that the proposed action is not likely to jeopardize the continued existence of threatened or endangered species under NMFS' jurisdiction. We included an incidental take statement to address the possible take of green turtles associated with your action; the terms and conditions of this incidental take statement are non-discretionary.

I look forward to continued cooperation with U.S. Navy during future section 7 consultations.

Sincerely,

Don Knowles

Donald R. Knowles
Director,
Office of Protected Resources

NATIONAL MARINE FISHERIES SERVICE
ENDANGERED SPECIES ACT SECTION 7 CONSULTATION
BIOLOGICAL OPINION

AGENCY:	United States Navy (Pacific Engineering Division)
ACTIVITY CONSIDERED:	Underwater explosions for ordnance disposal for the Fort Kamehameha Sewage Outfall Project. (F-PI-00-1:MMD)
CONDUCTED BY:	National Marine Fisheries Service Southwest Region, Pacific Islands Area Office
DATE ISSUED:	Don Knowles 7-7-00

The National Marine Fisheries Service (NMFS) has prepared the following biological opinion on plans for ordnance disposal related to the outfall replacement for wastewater treatment plant at Fort Kamehameha (MCON P-497) to be constructed by the U.S. Navy Public Works Center, Pearl Harbor, for impacts on listed species located in Honolulu County, State of Hawaii. This biological opinion is based on information provided in the (1) Geotechnical Investigation Report Ocean Outfall Extension Wastewater Treatment Plant at Fort Kamehameha, Peal Harbor, Oahu, Hawaii, 1999; (2) Field Survey of Sea Turtles in the Vicinity of Pearl Harbor Entrance Channel December 1999; (3) Technical Report UXO Impact to Coral Habitat and Swim Bladder fish October 1999; (4) various written submissions of information received by NMFS from July 1999 to April 7, 2000; (5) telephone conversations and meetings with members of the Pacific Naval Facilities Division of Engineering (PACDIV) and Navy Region Hawaii from July 1999 to April 2000, (6) field investigations as reported by PACDIV, (7) historical assessments military practices and World War II impacts on Pearl Harbor and (8) other sources of information. A complete administrative record of this consultation is on file in the Pacific Islands Area Office, Honolulu, Hawaii.

Consultation History

On October 17, 1997, the Navy's Pacific Division Engineering Command initiated informal section 7 consultation with the U.S. Fish and Wildlife Service (USFWS) for construction and operation of the proposed project. The action agency advised the USFWS that there was no known nesting habitat for any species of sea turtles within or adjacent to the action area.

The Navy concluded that the construction and operation of the proposed outfall with appropriate mitigation would not have a negative impact on any threatened or endangered species under the jurisdiction of USFWS. In an October 18, 1997, letter, the USFWS concurred with the Navy's conclusion and ended section 7 consultation between those two agencies.

Simultaneous to consultations with the USFWS, the Navy initiated informal consultations with NMFS. Informal consultations were concluded on December 4, 1997, with NMFS' conclusion that the proposed project would not have an adverse impact on any threatened or endangered species. NMFS conditioned its conclusion, however, on the requirement of notification to NMFS and the suspension of construction activities if any listed species were sighted in the construction area. Under this condition, construction activities would resume when the listed species departed from the construction area.

In July 1999 the Navy began to explore the propriety of initiating consultation with NMFS due to new information which was gathered during the initial pre-construction investigation for the project. This new information included the discovery of unexploded ordnance on the sea floor along the outfall alignment and the further discovery of unidentified metallic objects and suspected unexploded ordnance.

On December 7, 1999, the Navy requested initiation of formal section 7 consultation with NMFS for potential effects of the construction on listed marine species occurring in the action area.

To fully assess the possible impacts of ordnance disposal, NMFS had requested the Navy perform a series of habitat and sea turtle surveys along the proposed outfall alignment. NMFS also requested that the Navy provide information regarding the types of ordnance that might be discovered subsequent to the initiation of construction and to estimate the probability of such discovery(ies). NMFS then reviewed the new information and this biological opinion addresses the possible affects to listed sea turtles and humpback whales that may occur if ordnance must be detonated *in situ*.

On February 8, 2000, NMFS received an amended request for reinitiation of formal section 7 consultation. Due to significant changes in the assessments of potential biological impacts of the project, the U.S. Navy amended their request to account for a reformulation of the effects of the proposed action. That information included a revised formulation of detonation zones, estimated likelihood of BIPs, and new mitigation protocols.

BIOLOGICAL OPINION

I. Description of the Proposed Action

The 1997 informal consultation considered the proposed action to construct and operate an outfall replacement for a waste water treatment plant at Fort Kamehameha, Pearl Harbor, County of Honolulu, State of Hawaii. The construction includes the placement of a 3.9 kilometer (2.4 mile) long, 107 centimeter (42 inch) diameter outfall pipe that would terminate in a 200 meter (656 foot)long diffuser at a depth of 46 meters (150 feet). Three construction methods will be employed for pipe placement. These are: (1) open trenching; (2) micro-tunneling; and (3) placement of pile-supports.[1]

[1]Open trenching will be employed on reef flats and also on one area adjacent to the channel base and intermediate to the micro-tunneling segment and the pile-supported distal portion of the outfall alignment. The middle portion of the alignment will employ micro-tunneling. Micro-tunnel methods will be employed to effectively avoid impacting an area of large, established community of live coral. At the eastern end of the entrance channel where the segment of the outfall resurfaces,

During pre-construction surveys conducted in accordance with NMFS 1997 consultation, suspected ordnance items were discovered within the construction corridor. The Navy has determined that there is a likelihood that additional suspected ordnance items will be discovered. To prevent injury to person and property, the Navy proposes to remove and detonate live ordnance. Ordnance that cannot be removed with an acceptable margin of safety must be detonated underwater or "blown-in-place"(BIP).

Potential for BIPs and the proper disposal of relocated ordnance is the action under consideration in this biological opinion. The effects of the construction project are interrelated and interdependent to this action and are, therefore, also considered within this opinion. Insofar as the removal and/or BIP(s) are considered a part of construction activities, this biological opinion addresses the proposed construction project. After reviewing the construction and operation plans for the outfall NMFS concurred with the U.S. Navy's determination that no adverse impacts to protected species would result from the construction or operation activities. The preparation of the construction site, however, may adversely affect listed species.

Summary of Unexploded Ordnance Discovered Within the Action Area

Unexploded ordnance describes a military munition that has been primed, fused, armed or otherwise prepared for detonation, and which has been dropped, launched, projected or placed in such a manner as to constitute a hazard from unintended detonation. Not all ordnance are classified as unexploded ordnance. To overcome the possibility of harm associated with unintended detonation, several methods of treatment of unexploded ordnance are employed by agencies responsible for unexploded ordnance treatment.

One method of treatment is the removal and destruction of unexploded ordnance by specialized personnel with expertise and training in explosives. The Navy maintains personnel trained to deal with Explosive Ordnance Disposal. In preparation for this project, the Navy conducted unexploded ordnance surveys along the proposed outfall alignment. During these surveys, which were conducted in the spring of 1999, six projectiles were discovered within the construction corridor. All the projectiles were six inches in diameter.

One projectile was a dummy round which contained no explosive material. One projectile contained nine pounds of black powder and was fused. The four remaining projectiles contained approximately six pounds of Explosive D and were also fused. The five, fused projectiles containing explosives were categorized as unexploded ordnance. (The dummy round was not considered unexploded ordnance) All the projectiles were examined and removed from the seabed by Explosive Ordnance Disposal personnel. The five unexploded ordnance were transported to Schofield Barracks, Honolulu County, Hawaii, and destroyed.

open-trenching construction techniques will be employed to provide a seaward alignment to the 45 meter terminus. From the 20 meter depth region extending to the 46 meter depth region, the pipeline will be secured to underlying pile caps and tie-beams to stabilize and support the outfall just above the surface of the sea floor. The habitat for this portion of the pipeline is a steep sandy decline. A diffuser will be attached at the terminus from which treated waste-water will be emptied.

Additional surveys determined that one eight to twelve inch diameter projectile is located on the West Side of the entrance channel. Due to the marine growth on this projectile, its exact size is yet to be determined. Likewise, it is not known if this projectile is unexploded ordnance. This projectile is roughly 900 feet from the proposed outfall alignment.

Also, two additional projectiles appear to be six inch rounds and are located on the East Side of the entrance channel. It is not known if they have been fused or fired. One projectile is located approximately 75 feet south southwest of the Number 2 Channel Buoy. It is near and possibly inside the proposed construction corridor. A third projectile is located due East of the Number 2 Channel Buoy, in approximately 70 feet of water. None of these projectiles have been moved, by U.S. Navy personnel, since they were discovered. So far, all the suspected ordnance items appear to be under 20 pounds net explosive weight (NEW). Additive charge of up to 10 lbs NEW has been estimated for as required to instigate detonation. Thus, the NEW for this proposed action could be up to 26 lbs NEW.

An historical survey of the use of the action area and the construction corridor showed that there were four major batteries within the Fort Kamehameha and Gun Park area. Guns used at Fort Kamehameha included guns which fired rounds measuring three, six, and twelve inches. These guns pointed in the direction of the proposed action area, but the calculated minimum range of munitions fired from Fort Kamehameha and the Gun Park fall beyond the construction corridor for the proposed project. That is, the minimum range of the major caliber service practice fire was approximately 4,880 yards (2.8 miles) offshore. The proposed project area is approximately 3,700 yards (2.1 miles) offshore.

Another source of possible unexploded ordnance is the dumping site at the outside of the Pearl Harbor entrance channel. Until the 1970's it was a common practice for Navy vessels to dump overboard unfused and unactuated munitions before returning to port. In this case, there appears to be a munitions dump site approximately 900 meters south of the reef runway. It is unknown at this time whether currents or initial deposition may have placed some of the munitions within the construction area.

Other caliber munitions and practice firing could not be surveyed for lack of data. It is plausible, however, that lower caliber rounds or similar rounds might be found within the proposed construction corridor. Also, the Navy reports that their analysis of World War II bombing of Pearl Harbor indicates that no munitions were dropped in the vicinity of the construction corridor for the proposed action. If discovered, however, these ordnance would need to be examined and treated in preparation for or during construction of the waste-water treatment outfall pipeline.

The treatment methods of these ordnance may affect protected species in the action area. If unexploded ordnance cannot be removed for offsite disposal, it might be detonated in place. Underwater detonations affect the adjacent environment by creating pressure waves which increase with depth, acoustic effects, and physical destruction of animals and habitat in the area. The range of damage/destruction depends on the size and type of explosive and the manner of detonation employed.

C. Proposed Site Preparation and Construction Activities

The site preparation for the proposed construction include benthic surveys for unexploded ordnance (results of surveys conducted to date are described above) and clearing of the construction corridor of unexploded ordnance. The primary reason for clearing unexploded ordnance is to prevent damage to coral from accidental detonation during construction activities. Construction activities are expected to impact a small percentage (0.188%) of the coral in the immediate area. The selected outfall alignment as chosen is predicted to minimize potential impacts to coral, benthic community of reef flats, bird habitat, and marine navigation.

The project construction incorporates three types of construction techniques for extending a 2.4 mile outfall pipeline through the Pearl Harbor entrance channel into the waters of Malama Bay. The first open trench section extends 5, 084 ft from the Wastewater Treatment Plant. The second open-trench section extends the pipeline another 2,624 ft. trenching methods include using a large rubber tired or tracked equipment in water depths of less than 3 ft in the construction corridor. In water depths greater than 3 ft, a barge mounted crane supported by a supply barge and tug boat will be utilized. The construction corridor for the open trench methods is about 50 ft wide. Silt curtains will be employed to minimize turbidity. Micro-tunneling methods include employing a pipe-jacking technique that uses remotely controlled tunnel-boring machines to excavate, while at the same time the pipe is installed by pipe-jacking from a jacking pit. Extracted materials will be used as backfill for the open trench or de-watered and disposed of on land. The third section of the pipeline is open trench and extends the pipeline another 3,149 ft, where it joins a pile supported section running approximately 1,278 ft. Pile supports will be secured to underlying pile caps and tie beams constructed just above the sea floor. Most of this section runs through a steep sandy bottom area. The pile-supported diffuser will be located at the end of the pile-supported segment. The total construction time to complete the project is approximately 18 - 24 months.

D. Description of the Action Area

The action area is located in the waters of the State of Hawaii just offshore of southwestern side of the island of Oahu at approximately 21 degrees, 17 minutes north latitude and 157 degrees 51 minutes west longitude. The proposed construction will take place in the main entrance channel to Pearl Harbor. Pearl Harbor is an estuary system consisting of three lochs. Available geotechnical data indicate that the subsurface conditions along the proposed outfall are extremely heterogeneous, consisting primarily of interbedded marine sediments, coralline deposits, coral reef deposits, estaurine sediments, volcanic truff, and alluvial deposits. Along the mouth of the Pearl Harbor entrance, there are deep erosional channels that range from 3 meters (m) to over 50 m deep.

The proposed construction will extend outward from the Pearl Harbor Entrance into the coastal waters of Mamala Bay outside the entrance channel to Pearl Harbor. Therefore, the action area considered in this biological opinion is the entire entrance channel to Pearl Harbor and the adjacent waters of the mouth of the entrance channel out to 46 meters. (Figure 1)

II Status of the Species

NMFS has determined that the following species may be affected by the proposed action.

Humpback whale	*Megaptera novaeangliae*	Endangered
Green turtle	*Chelonia mydas*	Endangered/threatened

The endangered Hawaiian monk seal (*Monachus schauinslandi*), hawksbill turtle (*Eretmochelys imbricata*), sperm whale (*Physeter macrocephalus*), blue whale (*Balaenoptera musculus*), fin whale (*B. physalus*), sei whale (*B. borealis*), and Hawaiian monk seal (*Monachus schauinslandi*) occur within the waters of Hawaii. However, there are no confirmed reports or observations of these species within the action area. Therefore, NMFS does not believe these species are likely to be affected by the proposed action. No critical habitat has been designated for any of these four whale species or sea turtles. No critical habitat that has been designated for other species in the action area is likely to be adversely affected by the proposed action: designated critical habitat for the endangered Hawaiian monk seal extends west along the Hawaiian Archipelago from Nihoa island, which is outside of the action area.

Background information on the range-wide status of these species and a description of critical habitat can be found in a number of published documents. Additional sources include recent sea turtle status documents (NMFS and USFWS 1995, USFWS 1997), recovery plans for the humpback whale (NMFS 1991a) and green turtle (NMFS and USFWS 1998), the status reports provided by the Marine Turtle Expert Working Group (EWG, 1998 and in prep.) and the 1998 marine mammal stock assessment report (Waring *et al.* 1999). Summary information on the biology of these species is provided below. Extensive background information on green turtles is provided in Eckert (1993).

A. Status of Green Turtle

NMFS has jurisdiction over sea turtles in the marine environment while the USFWS has jurisdiction over sea turtles when the turtles are on shore. Although NMFS has not formally recognized populations or subpopulations of green turtles, these sea turtles are generally grouped by their nesting locations. Based on the most recent reviews of the best scientific and commercial data on the population genetics of green turtles and analyses of their population trends, NMFS treats these green turtle nesting aggregations as distinct sub- populations whose survival and recovery is critical to the survival and recovery of the species. Further, any action that appreciably reduced the likelihood that one or more of these nesting aggregations would survive and recover would appreciably reduce the species' likelihood of survival and recovery in the wild. Consequently, this biological opinion will focus on the four nesting aggregations of green turtles identified in the preceding paragraph (which occur in the action area) and treat them as subpopulations for the purposes of this analysis. This approach is consistent with the Pacific Sea Turtle Recovery Plan for Green Turtles (NMFS and USFWS 1998) and agency policy outlined in the Section 7 Handbook (FWS and NMFS 1998).

Green turtles were listed as threatened, except for breeding populations found in Florida and the

Pacific coast of Mexico, which are listed as endangered on July 28, 1978 (43 FR 32800). The genus *Chelonia* is generally regarded as comprising two distinct subspecies, the eastern Pacific (so-called "black turtle," *C. m. agassizii*), which ranges from Baja California south to Peru and west to the Galapagos Islands, and the nominate *C. m. mydas* throughout the remainder of its range.

Green turtles are declining virtually throughout the tropical Pacific, with the possible exception of Hawaii, as a direct consequence of an historical combination of overexploitation and habitat loss (Eckert, 1993). For at least two decades, sea turtle populations have declined due to several human-caused mortality factors. (National Research Council 1990) These factors include over-harvest of eggs and turtles, incidental mortalities in commercial fishing operations, degradation of nesting habitat, and marine pollution.

Green turtles are a circumglobal and highly migratory species, nesting mainly in tropical and subtropical regions. The reproductive strategy of sea turtles involves producing large numbers of offspring to compensate for low rates of survival to maturity. In Hawaii, green turtles lay up to six clutches of eggs per year (mean of 1.8), and clutches consist of about 100 eggs each. Females migrate to breed only once every two or possibly many more years, although the common remigration intervals reported for several rookeries worldwide are two and three years (Eckert, 1993; NMFS and USFWS, 1998c). They prefer waters that usually remain about 20°C in the coldest month; for example, during warm spells, green turtles may be found considerably north of their normal distribution. They are the only marine turtle with a nearly exclusive herbivorous diet, consisting primarily of sea grass and algae (Wetherall *et al.*, 1993). The non-breeding range of green turtles is generally tropical, and can extend approximately 500-800 miles from shore in certain regions (Eckert, 1993).

In the Pacific, major (> 2,000 nesting females) populations of green turtles occur in Mexico, Australia, and Malaysia. Smaller colonies occur in the insular Pacific islands of Polynesia, Micronesia, and Melanesia (Wetherall *et al.* 1993) and on six small sand islands at French Frigate Shoals, a long atoll situated in the middle of the Hawaiian Archipelago (Balazs 1995).

A genetically discrete population of green turtles inhabits the Hawaiian Archipelago. The migratory routes of breeding age class turtles is thought to be confined to the Hawaiian Archipelago. Presently, more than 90 percent of the breeding and nesting activity of Hawaiian green turtles occurs at French Frigate Shoals, Northwestern Hawaiian Islands, where 200-700 females are estimated to nest annually (NMFS and USFWS 1998). Although there is an annual fluctuation, the nesting population of green turtles in Hawaii appears to have increased over the last 17 years. The total number of mature females in the Hawaiian population is estimated to be 2,100 turtles (J. Wetherall, NMFS Southwest Fisheries Science Center Honolulu Laboratory, personal communication).

Although the population of nesting green turtles appears to be increasing, survival rates of young turtles to maturity are largely unknown. Information on these survival rates is critical to understanding and projecting trends in green turtles because of the problems facing long-lived species that delay sexual maturity in a world replete with threats from a modern, human population (Congdon et al. 1993, Congdon and Dunham 1994, Crouse *et al.* 1987, Crowder *et al.* 1994, Crouse 1999). In general, these reports concluded that animals that delay sexual maturity and reproduction must have high, annual survival as juveniles through adults to ensure that enough juvenile sea turtles survive to reproductive maturity and then reproduce enough times to maintain stable population sizes. This general rule applies to sea turtles because the rule originated in studies of sea turtles (Crouse *et al.* 1987, Crowder *et al.* 1994, Crouse 1999). For example, Crouse (1999) concluded that relatively small changes in annual survival rates of both juvenile and adult loggerhead sea turtles will adversely affect large segments of the total loggerhead sea turtle population; this conclusion probably applies to green turtles as well.

Despite recent increases in the size of some breeding populations, the distribution of green turtles in the Hawaiian Archipelago has been reduced in recent historical times. In the Main Hawaiian Islands some breeding aggregations have been eliminated and some foraging areas no longer utilized. Increased environmental contaminants (e.g. sewage, industrial discharge) which adversely impact near-shore ecosystems, including sea grass and coral reef communities contribute to habitat loss. Any population increase is further tempered by illegal harvest and incidental capture in near shore fisheries (recreational and subsistence net fisheries, hook and line fisheries) and to some extent in pelagic fisheries (green turtles of the Hawaii haplotype have been caught in the Hawaii-based longline fishery). Also, the green turtle population in Hawaii is afflicted with an often fatal disease called fibropapilloma.

Fibropapilloma is a tumor affliction of unknown etiology (NMFS and USFWS 1998; Balazs et al. 1992; Balazs and Pooley 1991). Fibropapillomas are lobulated tumors, which begin as small, localized lesions. They occur on the skin, scales, scutes, eyes, oral cavities and viscera (Balazs and Pooley 1991). In the Hawaiian population of green turtles, tumors often occur in the area of the glottus before occurring elsewhere as the disease progresses. Tumors may grow rapidly, preventing normal life dependent functions of the turtles inflicted. (NMFS and USFWS 1998) There have been some observations of reduction of tumor size, although it is yet unknown if a complete remission or recovery might be possible. A herpes virus is suspected of causing this disease (Herbst, 1994), although this has not been proven. (NMFS and USFWS 1998).

B. Status of the Humpback Whale

NMFS recognizes three stocks of humpback whales in the North Pacific Ocean: (a) a stock that winters off coastal Mexico and Central America and migrates to feeding grounds that extend from coastal California to southern British Columbia; (b) a stock that winters in Hawaiian waters and migrates to the area from northern British Columbia west to Kodiak Island, Alaska; and (c) a stock that winters south of Japan and probably migrates to waters west of Kodiak Island for the summer (the Bering Sea and Aleutian Islands). Humpback whales feed on krill and small schooling fish on their summer grounds. The two known feeding areas for central North Pacific stock are Prince William Sound and southeastern Alaska. In Hawaiian waters, their distribution is almost exclusively within the 1,000 fm isobath and usually within 100 fm (Nitta and Naughton 1989).

A population estimate of 1,407 whales for the North Pacific stock was derived using capture-

recapture methodology (95% CI 1,113 - 1,701) for data collected in 1980-83 (Baker and Herman 1987). Current abundance is unknown because the stock has likely been increasing for the last 12 years, but a reliable estimate of trend in abundance is unavailable. Potential Biological Removal is the level at which individuals can be removed from a population without affecting the population. The potential biological removal calculated for this stock of humpback whales is 2.8 whales.

In 1995 a humpback whale in Maui waters was found trailing numerous lines (not fishery-related) and entangled in mooring lines. The whale was successfully released, but subsequently stranded, attacked and killed by tiger sharks in the surf zone. In 1996 one humpback whale calf was found stranded on Oahu with evidence of vessel collision (propeller cuts) (NMFS unpub. data). In 1991 a humpback whale was observed entangled in longline gear and released alive (Hill et al. 1997).

Commercial fisheries operating in Alaskan waters within the range of the central North Pacific stock of humpback whales that were monitored by observers for incidental take of marine mammals from 1990 - 1995 included the Gulf of Alaska groundfish trawl, longline and pot fisheries. No mortalities of humpback whales were observed in these fisheries. During the four-year period 1990 - 1993 there were no logbook reports of serious injury or mortality of humpback whales from any commercial Alaska fishery operating within the range of this stock of humpback whales.

Marine mammal stranding data from southeast Alaska indicate two fishery-related strandings -- one in 1992 (southeast Alaska salmon drift gill net fishery), and one in 1994 (fishing net with floats; unspecified fishery) (Hill et al. 1997). In 1996 a vessel from Pacific Missile Range Facility on the Island of Kauai rescued an entangled humpback, removing two crabpot floats from the whale. The gear was traced to a recreational fisher from Southeast Alaska (R. Inouye, personal communication).

Although it is not unusual to observe humpback whales during the months of October to May in the near shore waters off of the island of Oahu, including areas adjacent to the action area, the following sighting/observations are the only three instances of humpback whales within the action area. On March 30, 1998 a U.S. Navy submarine was traveling into Pearl Harbor when it collided with an unidentified whale outside of channel buoy marker numbers 3 and 4. Although search vessels were deployed, the whale was not sighted again and it is unknown whether injury to the animal resulted from the collision. In March 1998, a humpback whale and calf entered Pearl Harbor and entered the East Loch. All vessel traffic was halted and the animals departed the area by the following morning. In December 1999, an outward bound submarine reported a whale in the vicinity of the Pearl Harbor channel entrance. This report went unconfirmed and the animal was not observed again.

III. Environmental Baseline

The environmental baseline considers effects of past and ongoing human and natural factors which determine the current status of the species, its habitat (including designated critical habitat), and ecosystem, within the action area. The environmental baseline is a snapshot of a species' health at a specified point in time and includes state, tribal, local and private actions already affecting the species, or that will occur contemporaneously with the consultation in progress. Unrelated Federal actions affecting the same species or critical habitat that have completed formal or informal consultation are also part of the environmental baseline, as are Federal and other actions within the action area that may benefit listed species or critical habitat.

A. Status of the Species Within the Action Area

1. Green Turtles

The range of the Hawaii population of green turtles includes all the near shore waters around the Main Hawaiian Islands and extends to the Northwest Hawaiian Islands. No island-wide surveys have been performed, although spot surveys have been completed for the following areas around Molokai, Lanai, Maui, Hawai'i, and Oahu. In the Northwest Hawaiian Islands surveys have been completed at Lisianski, Laysan, East Island, and Pearl and Hermes Reef. The nesting population at French Frigate Shoals appears to have tripled since 1973. Other areas are known as "turtle areas" and are frequented by tour operators, although these have not been subjected to traditional, statistical sampling. It is believed that these areas, which occur around the Main Hawaiian Islands, serve as resting and foraging habitat for immature and adult green turtles.

NMFS asked the Navy to provide information on sea turtles and their habitat utilization within the action area (Pearl Harbor entrance channel and waters adjacent to the entrance). In response to this request, the Navy conducted a series of field surveys designed to obtain information on sea turtles in the proposed action area. The fieldwork was performed by the PACDIV field biologists and the Navy Mobile Diving Salvage Unit 1 (MDSU 1). The results of the field surveys indicate that the entrance channel serves as a resting area for a resident population of green turtles.

A total of 141 observations of green turtles were made during field surveys conducted over an eight week period during which 50 dives were completed along the construction corridor in the action area. Of a total of 65 observations, 46.1% were female, 8.5% were male. The sexes of 64 turtles (45.4%) could not be determined. PACDIV estimated that these single observations represented a population of green turtles ranging from 8 individuals to 41 individuals.

Twenty-six (26) turtles (18.4%) were estimated to have a total carapace length of less than 0.5 m. 80 turtles (56.8%) were 0.5 - 1.0 m in length and 35 turtles (24.8%) were >1.0 m in length. The largest turtle sighted was a male, with a carapace length in excess of 1.5 m. No tagged turtles were sighted. Eleven observations were of turtles with what is assumed to be fibropapilloma tumors. At least two of these observations were of the same individual. There seemed to be no correlation between green turtle observations and the tidal state or the presence of ship traffic in the Entrance Channel. Of the green turtles observed during dive surveys, 65 (46.1%) were resting, 76 (53.9%) were actively swimming. Green turtles actively swimming or resting on the sea floor were observed at depths ranging from 8 - 20 m (25 - 65 ft.) with most observations at depths between 8 - 12 m (25 - 40 ft.).

At the western edge of the Pearl Harbor entrance channel is a corridor of about 120 m wide, which appears to be utilized with more frequency by green turtles. About two-thirds of all turtles observed were in this area. The western portion of the channel has more limestone and living coral colonies. The eastern edge of the Pearl Harbor entrance channel in a 220 m band appeared to be utilized by green turtles as resting habitat. Overall, approximately 1.44 mi of the West Side and 1.00 mi of the East Side appeared to be regularly utilized by the turtles. During the dive surveys, no green turtles were observed in the middle portion of the channel at depths less than 6 m (20 ft.).

The number of green turtles utilizing the action area appears typical of known resting areas. The range of age classes also appears similar to that found in other resting aggregations. It is posited that the green turtle population numbers in the tens of thousands, although there has never been a baseline calculation for historic population estimates nor has there been a comprehensive survey of current populations. Instead, the status of the species, as measured in population numbers is extrapolated from the number of females estimated to nest annually (FENA). From this, NMFS considers this resting aggregation to represent a small percentage of the adult green turtles in the Hawaiian population and a smaller percentage of the number of juvenile green turtles in that same population.

Despite our inability to estimate the importance of the action area to green turtles, the data suggest that green turtle numbers in the action area are increasing, at least over the short-term. The number of green turtles in the action area is likely to vary with the season, as breeding adults depart the area in the summer months to migrate to French Frigate Shoals to breed and nest. There are no data available that would allow us to determine long-term patterns.

2. Humpback Whales

As discussed previously, at least one humpback whale and its calf traveled throughout the Pearl Harbor entrance channel and into the East Lock (see page 8). Based on the information available, this event is rare and is the first recorded by NMFS in the region. Aerial surveys of the waters around Oahu conducted during the months of January to late April for the years 1990 through 2000, indicate that humpback whales do not frequent the area around the Pearl Harbor entrance channel, but rather are more common from Barber's Point to Keana Point to the west and from Diamond Head to Makapu'u Point to the east. (J. Mobley, personal communication, 2000).

Humpback whales are most likely to occur in the action area during the months of November to May when the whales enter their wintering areas. NMFS has no specific data on the biological significance of the action area for humpback whales, although the small numbers and sporadic use of the area suggest that whales observed in the action area are migrating through the area, rather than migrating to it for a specific reason.

B. Factors affecting the species' environment within the action area

Factors affecting the environment of the species within the action area include vessel traffic within the channel, water quality, channel maintenance dredging, and aircraft and helicopter traffic. An environmental element within the proposed action area which may affect the habitat of the species is vessel traffic. As discussed above, there has been one collision of a submarine and a humpback whale. Although there have been no instances of collision in the channel with any species of sea turtle, vessel collisions elsewhere in the Main Hawaiian Islands occur with some regularity.

Water Quality. The recovery plans for all the Pacific populations of sea turtles, including the green turtle, list the reduction of environmental contaminants as essential to the recovery of the green turtle. Water pollution, such as that resulting from sewage, pesticides, solvents, oily bilge discharge, industrial discharges and agricultural runoff may be responsible for an unknown level of sea turtle mortality and habitat destruction.

As a major transit channel for federal, state, and private vessels, the quality of water within the Pearl Harbor entrance channel is less than pristine. Additionally, the effluent from the current waste-water treatment plant pipeline empties into the Pearl Harbor entrance channel. It is unknown how these pollutants accumulate in the marine environment or how they affect green turtles, humpback whales, or other listed species which may transit the action area.

An extensive review of environmental contaminants in turtles has been conducted by Meyers-Schone and Walton (1994); however, most information relates to freshwater species. High concentrations of chlorobiphenyls and organochlorine pesticides in the eggs of the freshwater snapping turtle, *Chelydra serpentina*, have been correlated with population effects such as decreased hatching success, increased hatchling deformities and disorientation (Bishop *et al.* 1991, 1994). Very little is known about baseline levels and physiological effects of environmental contaminants on marine turtle populations (Witkowski and Frazier 1982; Bishop *et al.* 1991). There are a few isolated studies on organic contaminants and trace metal accumulation in green and leatherback sea turtles (Davenport and Wrench 1990; Aguirre *et al.* 1994). Mckenzie *et. al* (1999) measured concentrations of chlorobiphenyls and organochlorine pesticides in marine turtles tissues collected from the Mediterranean (Cyprus, Greece) and European Atlantic waters (Scotland) between 1994 and 1996.

Omnivorous loggerhead turtles had the highest organochlorine contaminant concentrations in all the tissues sampled, including those from green and leatherback turtles. It is thought that dietary preferences were likely to be the main differentiating factor among species. Decreasing lipid contaminant burdens with turtle size were observed in green turtles, most likely attributable to a change in diet with age. Sakai *et al.* (1995) found the presence of metal residues occurring in loggerhead turtle organs and eggs. More recently, Storelli *et al.* (1998) analyzed tissues from twelve loggerhead sea turtles stranded along the Adriatic Sea (Italy) and found that characteristically, mercury accumulates in sea turtle livers while cadmium accumulates in their kidneys, as has been reported for other marine organisms like dolphins, seals and porpoises by Law *et al.* (1991). Research is needed on the short- and long-term health and fecundity effects of chlorobiphenyl, organochlorine, and heavy metal accumulation in sea turtles.

Maintenance dredging is performed in the Pearl Harbor entrance channel every five to seven

years. All dredging activities are reviewed by NMFS in accordance with section 7 of the ESA for the possible effects on listed species and best management practices are required so that turbidity is minimized and habitat is not disturbed. As hopper dredges are rarely employed in maintenance dredging in the State of Hawaii, the effects associated with dredging usually relate to the effect on the environment and not mortality associated with capture in the dredge.

Aircraft and Helicopter Traffic. Noise from airplanes and helicopters present another source of disturbance for whales. In Hawaii, inter-island commuter traffic and small, private airplanes are the major sources of potential disturbance of whales. These airplanes fly regularly between the islands, often crossing high concentrations of whales at altitudes of 1,000 feet or less. Pilots occasionally divert from their flight paths to circle whales so that passengers can watch or photograph them. Helicopter tour operators also disturb humpback whales by flying low or hovering (Tinney 1988). Noise from low-flying aircraft has declined in the past few years in response to greater awareness and recognition of potential disturbance of whales. Military airplanes can also disturb whales. In Hawaii, aerial exercises are executed from Hickam Air Force Base, Kaneohe Marine Corps Air Station, and Barbers Point Naval Air Station on the Island of Oahu. The proximity of the action area to the Honolulu International Airport increases the likelihood of aircraft and helicopter traffic over the action area.

IV Effects of the Proposed Action

This section includes an analysis of the direct and indirect effects of the proposed action on the species and its interrelated and interdependent activities. The analysis considers whether the direct and indirect effects of the action reasonably would be expected, directly or indirectly, to appreciably reduce the likelihood of both the survival and recovery of a listed species in the wild by reducing the reproduction, numbers, or distribution of the species.

As discussed in the *Consultation History* and *Description of the Proposed Action* sections of this biological opinion, the Navy's proposal to eliminate unexploded ordnance in the action area is related to the construction and operation of an outfall replacement for a waste water treatment plant at Fort Kamehameha, Pearl Harbor, County of Honolulu, State of Hawaii. As discussed in the Environmental Baseline section of this opinion, there are serious water quality issues associated with Pearl Harbor that affect the harbor's value as habitat for living marine resources, including sea turtles. In the long-term, this outfall replacement is expected to improve the quality of waters in the harbor, which would benefit the aquatic ecosystem in the harbor and the organisms that use this ecosystem. As a result, this analysis of effects must consider the potential, short-term effects posed by the proposed action in light of the long-term benefits of replacing the outfall.

For this biological opinion, we will examine the direct and indirect effects of the proposed action on the action area, and identify the likelihood of a sea turtle or whale being injured or killed by the proposed action. NMFS would be concerned about any effects of the action that might kill green turtles or whales, particularly if the those deaths would be expected to reduce the species' likelihood of survival and recovery in the wild. NMFS would also be concerned about injuries that may manifest themselves as animals that fail to feed successfully, breed successfully (which can result from feeding failure), or complete their life cycle because of changes in its behavioral patterns. In the latter two of these examples, injuries to individual animals could harm a population if the individual's breeding success is reduced by the injuries.

A. Analyses for the Effects of the Action

The effects of an underwater explosion on marine mammal and sea turtle species depend on many variables, including the size, type, and depth of both the animal and the explosive, botoom topography and composition, water depth, and the distance from the charge to the animal. Potential impacts can range from brief acoustic effects, tactile perception, and physical discomfort to both non-lethal and lethal injuries. Non-lethal injury includes injury to internal organs and the auditory system; however, delayed lethality can be a result of complications from individual or cumulative sub-lethal injuries. Short term or immediate lethal injury would be a result of massive combined trauma to internal organs as a direct result of proximity to the point of detonation. It is very unlikely that injury would occur from exposure to the chemical by-products released into surface waters (Young 1984; Naval Surface Warfare Center 1992).

The discussion that follows describes the general effects of the underwater detonations on green turtles and humpback whales. Data on the effects of underwater explosions on marine mammals are limited, but even less is known about effects of these explosions on sea turtles.

For marine mammal species the pressure wave from an explosion can impact air cavities, such as lungs and intestines causing instantaneous or proximate mortality. Extensive hemorrhaging of the lungs due to underwater shock waves may cause death to a marine mammal through suffocation (Hill 1978). Other common injuries which may result in mortality include circulatory failure, broncho-pneumonia in damaged lungs, or peritonitis resulting from perforations of the intestinal wall (Hill 1978). The degree of injury associated with impulse is believed to be directly proportional to mammal mass (Yelverton, et al. 1973), therefore, conservative criteria for the impulse effect are based on the lowest possible affected mammalian weight (e.g. dolphin calves)(U.S. Navy 1998).

Non-lethal injuries include slight lung hemorrhage and tympanic membrane rupture from which the mammal is expected to recover (Yelverton et al. 1973; Richmond, et al. 1973). Eardrum damage criteria are based upon a limited number of small charge tests (Yelverton et al. 1973; Richmond et al. 1973). Ranges for the percentage by which tympanic membranes rupture in response to underwater explosions can be calculated by a conservative tympanic membrane damage model (U.S. Navy 1996). General criteria for damage to marine mammal tympanic membranes have been reported to occur at impulse levels down to 20 psi-msec (Yelverton, et al. 1973). Because the hearing anatomy of sea turtles is different from marine mammals, these calculations may not apply to turtles.

Because eardrum (e.g. tympanic membrane) rupture, rather than slight lung hemorrhage usually occurs at lower impulse levels, tympanic membrane rupture is used by NMFS and others to conservatively define the non-lethal injury zone. A maximum impulse of 10 psi-msec is often considered to demarcate the non-lethal injury zone, where a very low instance of blast injuries

are likely to occur (Yelverton et al. 1973). The pressure impulse that would not be expected to kill or injure marine mammals was reported as 5 psi-msec (Yelverton et al. 1973). This level was also used by the Air Force to in obstacle and mine removals.

Most impact analyses have focused on large shipshock explosions in nearshore waters (for example, SEAWOLF) or deep offshore waters (for example, JOHN PAUL JONES and WINSTON S. CHURCHILL). The present Navy action, however, involves smaller charges in shallow water (Pearl Harbor). Data from shipshock trials and other studies are also considered in this opinion.

Based upon information provided in the final environmental impact statement for the USS SEAWOLF shock trial (U.S. Navy 1998), the Navy developed two criteria to determine if signals generated by detonations would acoustically harass marine mammals: (1) an energy-based temporary threshold shift injury criterion of 182 dB re 1 uPa^2-sec derived from bottlenose dolphins (Ridgeway, et al. 1997); and (2) a 12 - lbs/in2 (psi) peak pressure cited by Ketten (1995) as associated with the "safe outer limit (for the 10,000 lb charge for the minimal, recoverable auditory trauma" (i.e., temporary threshold shifts).

The USS JOHN PAUL JONES shock trial analyses predicted safety ranges for smaller charges calculated for distances based on slight lung injury associated with a 10,000 lb charge, slant range, doubled.[2] (NMFS 1993)

Charge Weight (lbs)	Safety Range (feet)	Maximum Pressure (psi)
1	600	18
10	1,500	16
100	3,000	17
1000	6,076	19

There are no comparable data for sea turtles. Therefore, we will assume that these distances represent "safe" distances for sea turtles, since the safety ranges are approximately four times the approximate range for minor injury and three times the non-injury range for a 200-300 lb sea turtle (O'Keefe and Young 1981).[3] .

The injury mortality contours developed for the USS WINSTON S. CHURCHILL ship shock

[2]Each calculation is scaled by the cube root for the different charge weights.

[3]For more information regarding the type of injury associated with charge weight and distance, please see Table 2 of the Environmental Assessment on the Proposed Regulations Governing the Taking of Marine Mammals Incidental to Underwater Detonation of Conventional Explosives in the Offshore Waters of the Outer Sea Test Range of the Naval Air Warfare Center, Pt. Mugu, California. The harassment calculations are based on single pulse level of 160 dB, not the 182 dB level considered in this analysis.

trial also considered the impacts of a 10,000 lb charge at a depth of 1,100 ft. The Navy calculated that, for a 27-lb dolphin calf, the injury criteria should be set at 15 psi and the acoustic harassment threshold was predicted to be 182 dB (U. S. Navy 1999).

For this activity, the charges are expected to be 26 lbs NEW. As this maximum NET is much smaller than 10,000 lbs NEW , the criteria cited above for larger charges should not be applied without modification. This analysis adopts a modified NMFS accepted criteria developed by the Air Force for the small takes of marine mammals incidental to explosive testing of obstacle and mine clearance systems at Eglin, Florida. The criteria were developed to test four systems: Shallow Water Assault Breaching system (SABRE, 10 lb NEW charges at depths of 3 and 10 ft.), the Distributed Explosive Technology system (DET, 42 lbs NEW at a depth of 3 ft.), MK-82 general purpose bombs (192lbs NEW dropped into depths of 6 ft.), and the MK 5 Mine Clearance System (1,750 lbs NEW for whole system detonated at depths of about 550 ft.). For these systems, the Air Force calculated, and NMFS agreed, that an adequate injury/mortality range would include the area from the explosion out to 5 psi-msec. The Air Force calculated that the incidental harassment zone would extend out to a level of 180 dB re 1 uPa^2-sec. Thus, instead of direct application of the criteria developed for ship shock trials, the Air Force criteria accounted for the shallow depths and the smaller amounts of NEW.[4]

For this action, there is a possibility of multiple of in-water detonations of up to 26 lbs NEW of unknown types of explosive material and at unidentified locations. Some in-water detonations may be much smaller than 26 lbs NEW. The shallow water conditions, and the small amount of explosive material, make the standards accepted by the Air Force (working in conjunction with the Navy) most applicable to the proposed action. The incidental harassment zone, however, will be set at 182 dB, rather than 180 dB because there is not much difference between the two criteria (180 dB - 182 dB). Therefore, the injury or mortality zone is expected to extend out to 5 psi, and the incidental harassment zone will extend out to 182 dB.[5] In the absence of specific data on potential sea turtle injuries from detonations, NMFS has employed these levels as surrogates for safety parameter criteria for sea turtles.

Potential Direct Effects on Green Turtles: As discussed above, there are few reports on injuries and virtually no quantitative data concerning the direct effects of underwater explosions on sea turtles. The turtles' auditory systems and internal organs might suffer a range of traumas that might kill them, cause temporary or permanent loss of hearing, or organ ruptures. The following summarizes the information on impacts to turtles from explosions as reported by the National Research Council (1996), U.S. Army at Kwajelein Atoll (Klima et al. 1988), and O'Keeffe and Young (1984).

The National Research Council (1996) reports that two immature green turtles (100 to 150 feet away) were killed when 20 lbs NEW of plastic explosives (C-4) were detonated in open water.

[4] Although some NEW might be large, the explosion is distributed over a large area due to the design of the system.

[5] Data indicate that a level of 182 dB is acceptable for avoiding harassment to marine mammals.

Necropsies revealed extensive internal damage, particularly to the lungs. Water, charge and turtle depths are unknown. Turtle body mass is also unknown, but is assumed the turtles were small or immature.

Reports from a project at Kwajalein Atoll to remove two coral heads from entrance channels to the fuel pier at U.S. Army Kwajalein Atoll (USAKA) indicate that explosive charges of 40 pounds at depths of less than 40 feet can injure or stun small hawksbill turtles of a carapace length of approximately 19 inches at a range of 700 feet (U.S. Army Kwajalein Atoll unpub. memorandum of record, 1992).

Klima *et. al.* (1988) conducted an experiment in which Kemp's ridley and loggerhead turtles were placed in cages at four distances from a oil platform to be removed with explosives. The cages were submerged to a depth of 15 ft over the 30 ft sea bottom just prior to the simultaneous explosion of four 50.75 lb charges of nitromethane placed inside the platform pilings at a depth of 16 ft below the mudline. Loggerhead and Kemp's ridley turtles at 750 ft and 1,200 ft, as well as one loggerhead at 3,000 ft were rendered unconscious. The Kemp's ridley turtle closest to the explosion (range of 750 ft) was slightly injured, with an everted cloacal lining; ridleys at ranges of 1,200 ft, 1,800 ft and 3,000 ft were apparently unharmed. All loggerheads displayed abnormal pink coloration caused by dilated blood vessels at the base of the throat and flippers, a condition that persisted for about 3 weeks.

O'Keeffe and Young (1984) analyzed data from three underwater shock tests carried out off Panama City, Florida in 1981. During each test, a charge equivalent of 1,200 lb of TNT was detonated at mid-depth in water about 120 ft deep. At least three turtles were noted in the area following the detonations. One turtle at a range of 500 to 700 ft was killed. A second turtle at a range of 1,200 ft received minor injuries. A third turtle at 2,000 ft was apparently unaffected. At a depth of 60 ft, calculated shock wave pressures are 239, 161, 85, and 47 psi at ranges of 500, 700, 1,200, and 2,000 ft, respectively.

Based on a parametric evaluation of the effects of charge weight and depth using the Goertner (1982) model, Young (1991) concluded that a conservative safe range for non-injury to a small mammal (representative of a dolphin calf) was approximated by $R=578w^{0.28}$ (R is in feet and w is in pounds of explosive). O'Keeffe and Young (1984) proposed that a safe range for turtles from an underwater explosion could be expressed by $R = 200\ w^{1/3}$, where R is the safe range in feet and w is the charge weight in pounds. This equation was subsequently modified by Young (1991) based on safe ranges established by the NMFS for platform removal operations using explosives. The revised equation is $R = 560\ w^{1/3}$. Applied to the Klima *et. al.* (1988) observations, this equation predicts a safe range of 3,291 ft, which exceeds the greatest distance at which an effect was observed (turtle unconscious at 3,000 ft). Applied to the O'Keeffe and Young (1984) report, this equation predicts a safe range of 5,951 ft, nearly triple the range from the charge of the uninjured turtle.

The safe ranges calculated previously addressed physical injury to sea turtles but did not identify problems associated with detecting damage to sea turtle auditory systems. These effects include physical changes to the auditory system that permanently or temporarily destroy or alter a turtle's hearing. Sea turtles do not have an auditory meatus or pinna that channels sound to the middle ear, nor do they have a specialized eardrum. Instead, they have a cutaneous layer and underlying subcutaneous fatty layer, that function as a tympanic membrane. The subcutaneous fatty layer receives and transmits sound to the extra-columella, a cartilaginous disk, located at the entrance to the columella, a long, thin bone that extends from the middle ear cavity to the entrance of the inner ear or otic cavity (Ridgway et al. 1969). Sound arriving at the inner ear via the columella is transduced by the bones of the middle ear. Sound also arrives by bone conduction through the skull. Low frequency sounds at high source levels can also be detected by vibration-sensitive touch receptors in various other parts of the turtle's body (mechano-reception). Any disruption (permanent or temporary) of a turtle's hearing may kill or injure the turtle. On the other hand, some effects may be temporary or slight and will not have lethal results.

Sea turtle auditory sensitivity has not been well studied. A few preliminary investigations suggest that it is limited to low frequency band-widths, such as the sounds of waves breaking on a beach. The role of underwater low frequency hearing in sea turtles is unclear. It has been suggested that sea turtles may use acoustic signals from their environment as guideposts during migration and as a cue to identify their natal beaches (Moein et al. 1983).

Although it is possible that green turtles in the vicinity of an in-water detonation might experience a temporary or permanent threshold shift, it is not known what energy levels and received levels are necessary to induce threshold shifts. The few studies completed on the auditory capabilities of sea turtles (adult green, loggerhead, and Kemp's ridley *(Lepidochelys kempii)* suggest that they could be capable of hearing low frequency sounds (Ridgway et al. 1969; Moein et al. 1983; Lenhardt,1994) Ridgway *et al.* (1969) reported maximal sensitivity for green turtles occurred at 300 to 400 Hz, with a rapid decline in sensitivity for lower and higher tones. Similarly, Moein *et al.* (1994) reported a hearing range of about 250 to 1,000 Hz for loggerhead sea turtles, and Lenhardt (1994) stated that maximal sensitivity in sea turtles generally occurs in the range from 100 to 800 Hz. Calculated in-water hearing thresholds within the useful range appear to be high (e.g., about 160 to 200 dB re 1 μPa; Lenhardt, 1994). In the absence of more specific information that could be used to determine the acoustic harassment range for sea turtles, the U.S. Navy assumed that frequencies ≥100 Hz (which are the acoustical harassment ranges predicted for odontocetes) would be conservative for sea turtles.

Moein et al. (1983) and O'Hara and Wilcox (1990) indicate that low frequency acoustic sound transmissions at source levels of 141-150 dB could potentially cause increased surfacing behavior and deterrence from the area near a sound source. In this instance, if they surface more frequently, green turtles will not be at a greater risk of collision with vessels transiting the action area because vessel traffic will be halted during detonation operations.

Deterrence from the area could result in temporary or permanent displacement of individuals. Individual green turtles that forage or rest within vicinity of the explosion may relocate due to startle responses from sensing the blast impulse waves through the substrate.

Expected Direct Effects on Green Turtles: The Hawaiian population of green turtles is increasing with gains thought to be mitigated against by the occurrence of fibropapilloma and

other sources of mortality. The Recovery Plan for Pacific Populations of the Green Turtle establishes the recovery criteria of, among other requirements, 5,000 females estimated to nest annually, any removal of breeding age class individuals would slow the recovery of the Hawaiian Island population.

There is a potential for direct effects to green turtles from the proposed action. Surveys discussed show that the action area is utilized as resting habitat for both juvenile and adult green turtles. Resting or transiting green turtles within the detonation zone may be killed or injured. Due to the unknown patterns with which energy would be distributed within Pearl Harbor Entrance Channel and where the unexploded ordnance might be positioned, it is not possible to compute a theoretical level of anticipated take for the purposes of this analysis based on the zone within which 182 dB and 5 psi are exceeded (detonation zone). It is, however, anticipated that all turtles within this detonation zone would be "taken" within the meaning of the ESA. At one extreme, turtles may be killed; at another extreme, turtles will be harmed or injured by experiencing effects of temporary threshold shifts. In any one detonation, the maximum number of turtles that would be killed or injured is about 41 green turtles. Based on the field surveys it conducted, this is the maximum number of animals the U.S. Navy estimates is present within the Pearl Harbor Entrance Channel.

In a worst case scenario, all 41 green turtles would be removed from the breeding population. Of the 41 turtles, the Navy estimates 46% of these turtles would be females. If all the females were of breeding age (a worst case scenario) were killed, this represents a removal of approximately 0.009 of the total nesting population of female sea turtles in Hawaii (which is estimated to be 21,000 animals; J. Wetherall, pers. comm. SWFSC). This translates to a very crude estimate of removal of 13,452 post hatchlings[6] for the total removal of breeding females. These numbers should be construed as very coarse estimates, and are derived from highest average of females estimated to nest annually estimated for French Frigate Shoals in the Northwestern Hawaiian Islands. (Wetherall 1997). As discussed above, FENA counts seem to be experiencing an overall increase despite some years of low nesting numbers and despite the continued increase of strandings in the Main Hawaiian Islands.

In the worst case, the potential death of up to 41 green turtles associated with the proposed action clearly can be expected to reduce the size of this population. Because 19 of those animals are likely to be female, the proposed action can also be expected to reduce the green turtles' reproduction. If the worst case scenario does not occur, we would expect smaller percentages of these 41 green turtles to be killed or injured by the proposed action. In either case, these potential reductions in the number and reproduction of green turtles during the detonation of the ordnance would be offset by improvements in water quality within the action area over the long-term, which would decrease the number of green turtles exposed to and affected by contaminants. Given the current, improving condition of green turtles in the Hawaiian Islands, we would not expect the loss to appreciably reduce the green turtle's likelihood of survival and recovery in the wild because the removal would have a small, but immeasurable effects on the

[6] Hatchlings that survive for one week after hatching are considered surviving hatchlings according to the Wetherall analysis.

green turtle's recovery to the 5,000 FENA goal.

The Navy has stated their intent to institute a pre-detonation monitoring and removal plan which will minimize the anticipated take. The Navy did not provide NMFS with a comprehensive mitigation plan; rather, mitigative measures were embedded in several documents and letters that the Navy transmitted to NMFS, including the initial and amended consultation request letters.

The Navy's mitigation plan, as described in their December 7, 1999, letter, describes Conditions 1-2. Conditions 3-5 are described in the February 8, 2000, letter. Incorporated by reference into the February 8, 2000 letter are conditions 7-16 as described in the notes from the meeting between Navy Explosive Ordnance Disposal and NMFS regarding protocol. Condition 6-7 are mentioned in the *Technical Report Unexploded Ordnance Impact to Coral Habitat and Swim Bladder Fish* in section 5.2 Protection of Threatened or Endangered Sea Turtles, October 1, 1999. Some documents referred to the same mitigation points and are referenced to the last iteration received by NMFS. The resulting plan, as distilled from these various documents, proposes to minimize the adverse effects of the detonations by:

1. Ensuring that detonations take place during stable sea conditions and during daylight hours ((7:30 - 11:00 AM if the detonation zone impacts include the eastern side of the channel) to ensure maximum visibility;
2. Establishing a safety zone[7] for each species based on available data prior to each detonation;
3. Delaying any detonations that have been planned until all animals have left the area of their own accord;
4. Make every effort the clear turtles from the detonation area, if detonations cannot be delayed.
5. Limiting the net explosive weight to the smallest reasonable amount;
6. Monitoring the detonation area immediately after a detonation (using Explosive Ordnance Disposal safety protocols) to search for injured or dead animals. Monitoring will include sub-surface search within the limits of the safety zone.

Although there was general agreement between NMFS and the Navy on the elements of a proper mitigation plan, the Navy plan submitted to NMFS lacked specificity required for analysis of effects and implementation. To remedy this, the necessary specificity is provided in the incidental take statement terms and conditions. Thus, this section does not consider the effects of mitigation of sea turtle take.

In NMFS' other consultations on in-water detonations, monitoring programs have been used to mitigate adverse effects of the detonations on listed species. For example, in oil rig removal operations in the Gulf of Mexico, aerial, dive, and vessel sweeps are conducted before and after

[7] The term "safety zone" is often used to describe an area outside of a non-safe area. That is, the area outside the safety zone is the area that is safe. That area differs depending upon the characteristics of the explosion and the specie(s) considered. This biological opinion employs the term "detonation zone" to define the areas in which it is unsafe for sea turtles and marine mammals to be present during an explosive event.

each detonation. Other U.S. Navy operations have included turtle mitigation plans utilizing similar methods for the shock trials of USS JOHN PAUL JONES and the USS SEA WOLF. Due to the nature of the activity, site selection is not an applicable mitigation measure in the proposed action. Once located and impending detonation is imminent, however, an adequate monitoring protocol should be followed. The monitoring is applicable to the mitigation plan for humpback whales, and, therefore may mitigate also against some take of green turtles.

Effects of the Explosions on Resting Habitat

Explosions may damage the marine environment by physical shattering of substrate and other marine environment elements. Explosions on the seabed cause cratering and disturb bottom sediments over an area estimated roughly to be an area twice the diameter of the crater. (FDM FEIS, Page 4-57) Underwater surveys show many cave/grottos which could serve as sea turtle resting habitat in the event shattering destroys a limited number of caves/grottos that are now utilized by green turtles. The project is expected to have minimal, if any, effect on availability of resting habitat for the Hawaii population of green turtles.

Direct Effects on Humpback Whales: Direct effects of low frequency noise and blast effects on mysticetes include the potential for injury and mortality, auditory permanent threshold shifts, auditory temporary threshold shifts, and behavioral disruption and habituation, including long-term effects.

Potential for physical injury, mortality, or both

Early studies conducted in the 1970s showed that the principal sites for damage in marine mammals from explosives would be the lungs and the hollow viscera. Lung injury is manifested by alveolar ruptures and lacerations resulting in massive hemorrhage. Damage to the viscera is usually limited to the portions of the lower intestine containing gas and is characterized by contusions and rupture of the intestinal walls.

Goertner (1982) modeled safe-ranges for large and small whales for different charge weights and depths. For a 1,200 lb. charge the safe range for a 55 ft. long generic whale was estimated at about 900+ ft. from the charge at 125 ft. depth. For a 20 ft. long whale the safe range extended to 1,800+ ft. The safe ranges become shorter above 125 ft. depth up to a minimum of about 200 ft. horizontal distance at the surface.

Injury contours developed for the Naval vessel USS SEAWOLF ship shock program show a safe range (no injury) of 6,086 ft. for a 10,000 lb. charge at a 100 ft. depth and the cetacean on the bottom. This range is the same for all sizes of cetaceans, from a dolphin calf (27 lbs.) to a large whale (64,800 lbs.). The 50% mortality contour for the same size charge is 2,442 ft. for the dolphin calf and about 1,000 ft. for the large whale.

Injury contours developed for the Naval vessel USS WINSTON S. CHURCHILL ship shock program calculated a safe range for 27 lb dolphin calf of 3.4 nmi for a 10,000 lb. charge at a 1,100 ft. depth and the cetacean on the bottom. The U.S. Navy assumes the injury threshold range is independent of the size of animal, but varies with animal depth. For any size animal, the threshold would be less than or equal to the threshold as calculated for the bottom positioned cetacean. At this threshold (pressure is greater than 15 psi and the energy flux density is greater than 0.06 in-lb/in^2 or 1.1 milli-Joules/cm^2), the injury sustained is predicted to be moderate stings (tactile perception). Since tactile perceptions which could cause behavioral disruption might be considered harassment, the Navy developed a different, more conservative, threshold for marine mammal harassment based on auditory effects. This threshold is calculated so that the maximum dB level caused by the explosion outside the safety range is 182 dB. This distance to the threshold is called the critical distance and it represents the shortest distance at which a Temporary threshold shifts are not expected to occur in marine mammals.

Potential Auditory Effects and Behavioral Disruption of Humpback Whales

To date, there have been no controlled studies on the hearing capabilities of humpback whales. Data from the limited studies on bottlenose dolphins (Ridgeway et al. 1997) and beluga whales (Ridgeway, in press) indicate that the auditory effects of underwater noise on cetaceans differ from the more studied terrestrial mammals. Although marine mammals possess auditory mechanics similar to terrestrial mammals (air filled middle ear), the cetacean ear is adapted to accommodate rapid pressure changes. The extent and result of that accommodation, however, is unknown. At least one researcher has concluded that it is possible that cetaceans, because of their marine adaptations, are more vulnerable to blast injury (Richardson et al. 1995). In 1996 Todd et al. described the effects of construction site underwater explosions on humpback whales. The explosions took place in a narrow, shallow fjord-like area and ranged from charges of 2,200 lb to 12,125 lb. The same 1 nmi detonation unsafe zone was instituted for all explosions. Detonations occurred repeatedly over a period of months. Humpback whales did not display overt behavioral responses, but did, over a period of time, experience an increased entrapment rate in fishing gear. Damage to the eardrums were discovered in the entraped whales. Ketten et al. (1993) concluded that the increased entrapment could have been due to cumulative effects of repeated exposure to explosions, the effects of which were increased in intensity due to the shape and constitution of the blast area.

Other non-lethal, auditory effects might be sustained by cetaceans. Both sensorineural loss (insult, loss of ear hairs) and permanent damage to middle ear mechanics (rupture of ossicles, eardrums) might be sustained. Marine mammals have morphological adaptations to the marine environment whereby energy is conducted through head tissues to the inner ear rather than through the drum and ossicles. Damage to the auditory complex at any pathway may result in either a permanent (non-recoverable) threshold shift or a temporary threshold shift. Threshold shifts affect an animal's ability to hear and, in odontocetes, echolocate. Effects to the auditory systems of marine mammals such as permanent threshold shift or permanent loss of all hearing, may also eventually lead to mortality if sufficiently severe. The loss of ability to hear environmental cues, communicate with conspecifics, or forage could result in compromised body condition, increased susceptibility to entanglement or entrapment, collision with ships, or reduced reproductive success.

Possible short-term reactions of mysticetes disturbed by human-made noise include interruption

of feeding, resting, or social activities, and abrupt diving or swimming away (Finley, 1982; Calkins 1983, Richardson et al. 1995). Various studies and reported observations for a number of different mysticete species indicate variability in the responses to sounds of relatively high intensity (Bowles, et al., 1994; Malme et al., 1984; Maybaum, 1989; Mobley et al., 1988; Richardson et al., 1985; Richardson et al., 1991). In most instances, responses are affected by species, age and sex class, social context, habitat, habituation, and sound-source characteristics. Observed effects are generally fewer and less pronounced with respect to constant and predictable acoustic characteristics.

There is variability in sensitivity and response to human-made noise between and within marine mammal species and a paucity of information about the consequences of short-term disruptions on marine mammals. Disturbance of marine mammals as a result of human-made noise, if intense enough, can result in interruption (at least briefly) of normal behavioral and social interactions, an increase in energy cost (whether or not feeding was disrupted or a flee response was elicited), and displacement to a less preferred habitat. Displacement can also have the benefit of removing the animal from a location where there might be more serious consequences had the animal remained (e.g., by reducing the potential for serious injury and death from the effect of the exploding ordnance or the physiological stress that might continue if the animal remained close to the source).

Although there is little definitive information about the long-term effects of short-term disturbance reactions, isolated disturbances probably have minimal or no lasting effects and the energetic consequences of most single disturbance incidents are likely insignificant.

Summary of Effects on Humpback Whales

The anticipated effects to a humpback whale within the action area during an in-water detonation might include any one or a combination of the following effects: serious injury or mortality, permanent threshold shifts, temporary threshold shifts, and a temporary change in behavior. As there have been only rare observations of humpback whales in the action area, it is not expected that the proposed activity will affect the species. However, in the event that a humpback whale is observed in or near the action area, the suspension of operations/effects of operations within the detonation zone should ensure no také of observed humpback whales.[8] For humpback whale take, however, the Navy "plan" has only one element which is left uncontradicted and has been confirmed by the Navy in subsequent meetings with NMFS. The Navy has stated that it will suspend operations until all marine mammals, including humpback whales, have left the area. Parameters for the area where take may occur are stated in the incidental take statement. Thus, the low likelihood of humpback whale occurrence in the action area, combined with a suspension of operations if one is sighted should effectively negate the possibility of take of humpback whales from *in situ* detonations.

[8] The informal consultation concluded that no effects for marine mammals should occur because all construction operations were to be suspended if a marine mammal was observed in the action area. With the discovery of unexploded ordnance and the potential for its detonation, the action area has expanded beyond the construction corridor, making additional monitoring essential during in-water detonation operations.

V. Cumulative Effects

Cumulative effects include the effects of future state, local, and private actions that are reasonably likely to occur in the action area considered in this biological opinion. Future Federal actions that are unrelated to the proposed action are not considered in this section because they require separate consultation pursuant to section 7 of the ESA.

The near shore gill net fishery is a known source of green turtle mortality in the state of Hawaii. Within the past year two incidents of multiple mortalities per net have been reported to NMFS enforcement (T. Friel, personal communication), and such takes are expected to continue as the State of Hawaii has not yet changed its management scheme of this near-shore fishery. Given the difficulty of determining the cause of death of stranded turtles that may have resulted from net entanglement, especially from the standpoint of forensic pathology, estimates of take and mortality with respect to the use of this gear cannot be made at this time.

NMFS is not aware of any additional future state, local, and private actions that are reasonable likely to occur in the action area at this time.

VI. Conclusion

After reviewing the current status of the green turtle and humpback whale, the environmental baseline for the action area, the direct and indirect effects of the proposed action, and the cumulative effects, it is the biological opinion of NMFS that detonation(s), as proposed, is not likely to jeopardize the continued existence of the green turtle or humpback whale. No critical habitat has been proposed or designated for humpback whales or green turtles in the affected area, therefore the proposed action likely to destroy or adversely modify designated or proposed critical habitat.

Incidental Take Statement

The ESA, as amended, prohibits taking (harass, harm, pursue, hunt, shoot, wound, kill, trap, capture or collect, or attempt to engage in such conduct) of listed species of fish or wildlife without a special exemption. Harm is further defined to include significant habitat modification or degradation that results in death or injury to listed species by significantly impairing behavioral patterns such as breeding, feeding, spawning, rearing, migrating, or sheltering. Incidental take is defined as take that results from, but is not the purpose of, carrying out an otherwise lawful activity by the Federal agency or the applicant. Under the terms of section 7(b)(4) and section 7(o)(2), taking that is incidental to and not intended as part of the agency action is not considered a prohibited taking provided that such taking is in compliance with the terms and conditions of this incidental take statement.

The measures described below are non-discretionary, and must be implemented by the agency so they become binding conditions of any grant or permit issued to the applicant, as appropriate, in order for the exemption in section 7(o)(2) to apply. The U.S. Navy has a continuing duty to

regulate the activity covered by this incidental take statement. If the U.S. Navy (1) fails to require the applicant to adhere to the terms and conditions of the incidental take statement though enforceable terms that are added to the permit or grant document, and/or (2) fails to retain oversight to ensure compliance with these terms and conditions, the protective coverage of section 7(o)(2) may lapse.

Amount or Extent of Incidental Take

In those cases where exact numerical limits on the amount of permissible incidental taking will be difficult to determine, NMFS may specify the extent of anticipated take that will not violate section 7(a)(2) of the ESA (50 CFR 402.14(i)). When estimating the extent of incidental take, we may specify the extent of land or marine area that may be affected by a proposed action. NMFS cannot quantitively estimate the number of sea turtles that are likely to be incidentally taken within the action area as a result of the proposed action and, therefore, will provide an estimate of the area that is likely to be affected by the proposed action.

NMFS will estimate the extent of incidental take based on the area (or volume) of water that will encompass the pressure wave and acoustic effects of the proposed detonations because any turtles caught in this area are likely to be injured or killed incidental to the proposed action:

(1) An area extending out to that area defined by 182 dB re 1 μPa^2/sec which is energy-based temporary threshold shift injury criterion of derived from bottlenose dolphins (Ridgeway et al. 1997); and

(2) An area extending out to that area defined by a peak pressure of 5 psi which is the criterion for evaluating injury/morality distances out to the critical distance boundary for temporary threshold shifts.

Although these are the levels at which NMFS has determined injury and harassment would result for marine mammals, in the absence of reliable data for sea turtles, implementation of these measures will afford sea turtles protection based on conservative safety parameter calculations.

The result of applying the detonation zone model to the effects of the detonation(s) under discussion, together with the mitigation measures described below, should minimize and mitigate injury and/or mortality to sea turtles as well as prevent harassment, injury, mortality to marine mammals.

Effect of the Take

In the accompanying biological opinion, NMFS determined that this level of anticipated take is not likely to jeopardize the continued existence of humpback whales or green turtles.

Reasonable and Prudent Measures

NMFS believes the following reasonable and prudent measures are necessary and appropriate to minimize take of green turtles and eliminate take of humpback whales.

1. The Navy shall use explosives in a such a way as to minimize the possibility of take within the calculated detonation zone(s).
2. The Navy shall develop a plan, in consultation with NMFS, and implement a program to ensure that take is both minimized and monitored.
3. The Navy shall have in place and develop a protocol and a program for removal of sea turtles within the detonation zone to exclude them from the detonation zone.
4. The Navy shall maintain records of sea turtles and marine mammals observed in the action area and these records shall be made available to NMFS.

The reasonable and prudent measures, with their implementing terms and conditions, are designed to minimize incidental take that might otherwise result from the proposed action. The detonation zone and the number of takes per detonation will vary according to the conditions of the detonation. Due to the limited data regarding the position(s)and explosive weight(s) of ordnance or suspected ordnance items in the proposed action area, NMFS cannot calculate incidental take based on a generic detonation. Without the implementation of Reasonable and Prudent Measure 3, NMFS believes there is a possibility that all the turtles resting within the detonation would be taken for each in-water detonation. To mitigate this level of take, NMFS requires that the detonation be postponed until all sea turtles depart the detonation zone and/or a program of removal be initiated for sea turtles that remain in the detonation zone. NMFS expects take from injury and/or mortality can be minimized to (1) one individual turtle for each detonation for between over the course of the proposed activity if this and other measures as prescribed in the Terms and Conditions are followed.

No humpback whales are expected to be incidentally taken by harassment, injury, or mortality. By definition, a marine mammal species or population stock which is threatened or endangered under the ESA is also considered depleted under the MMPA. Although takings of depleted species may be permitted under Section 101(a)(5) of the MMPA, this does not apply because no small take permit has been applied for or issued. Accordingly, no takings of depleted species are authorized under the ESA or the MMPA.

If, during the course of the action, the minimized level of incidental take is exceeded, such incidental take represents new information requiring review of the reasonable and prudent measures provided. The Federal agency must immediately provide an explanation of the causes of the taking and review with NMFS the need for possible modification of the reasonable and prudent measures.

Terms and Conditions

In order to be comply with the ESA, the U.S. Navy must comply with the following terms and conditions, which implement the reasonable and prudent measures described above. The terms and conditions are non-discretionary.

For these construction-related detonations, the following shall apply:

1. The U.S. Navy shall develop a monitoring protocol and implement a monitoring program

which will minimize the take of green turtles and negate the risk to humpback whales in the area to be effected by the in-water detonation. Both pre- and post-detonation diving and surface sweeps must be made to detect green turtle(s) and/or humpback whales within the detonation zone and/or affected area. The U.S. Navy must develop protocols for removal activities with NMFS and, if pre-detonation monitoring locates green turtles within the detonation zone, the U.S. Navy must implement these protocols.

2. The additive charge shall be kept to a minimum explosive weight, and NMFS may require additional detonation minimization techniques such as shielding, bubble curtains, etc. if, after coordination with the Navy, it is deemed necessary to protect listed species in the area.

3. For these construction activities, detonation(s) will be restricted to April 30 through November 30, inclusive, to avoid potential for disturbance to humpback whales. Through consultation with NMFS, this term and condition may be modified and/or waived.

4. Pre-detonation and post-detonation survey sweeps shall be conducted in conditions of sufficient visibility to accurately detect animals in the area. These conditions include, but are not limited to, daylight hours and Beaufort wind scale and associated effects at sea state ≤ 3.

5. The U.S. Navy shall notify NMFS at least 2 days before unexploded ordnance detonation and accommodate NMFS personnel for the purpose of observation of in-water detonation activities.

6. Post-detonation diving and surface sweeps must be made to investigate injury and/or mortality of sea turtle(s) and/or marine mammals, including humpback whales. These surveys shall be conducted adjacent to as well as within the detonation zone. If there is an injury/mortality of federally listed specie(s), a report shall be made to NMFS Pacific Islands Area Office, Protected Species Program by facsimile transmission to 808/973-2941 within one working day of the incident.

7. The U.S. Navy shall identify a veterinarian who is able and available to treat injured animals discovered in post-monitoring sweeps. If any listed species is discovered, the action agency shall ensure that proper veterinary care is forthcoming. If a listed species is killed, the Navy shall ensure that a necropsy is conducted and a full necropsy report made to NMFS. In the event of injury or mortality, the action agency shall contact NMFS Law Enforcement at (808) 541-2727 and make a report of the incident.

8. After the construction related in-water detonation, a post-detonation report shall be submitted to NMFS Pacific Islands Area Office within two weeks of the detonation. The report shall include a description of the operation and pre- and post-detonation monitoring activities. The description of the operation shall include the following:
   A. Modeling of the detonation zone(s), including citations for calculations used for modeling.

B. Rationale for choice of detonation trigger.
C. Rationale for the additive charge required for ordnance/suspected ordnance item detonation.
D. Rationale for detonation in-water and statement of circumstances which disallowed removal of ordnance for disposal elsewhere.
E. Implementation of monitoring protocol and removal protocol for listed species.
F. Other information deemed relevant to the action agency and/or NMFS.

If, during the course of the action, the incidental take is exceeded, such incidental take represents new information requiring reinitiation of consultation. The Navy must immediately provide an explanation of the causes of the taking and review with NMFS the need for possible modification of the reasonable and prudent measures. This incidental take statement does not authorize take of any marine mammal regardless of whether it has been addressed in this biological opinion. If any other federally listed species are observed within the detonation zone, operations shall be suspended until and the U.S. Navy shall reinitiate consultation as to the effects of the proposed action on the species.

Conservation Measures

Section 7(a)(1) of the ESA directs Federal agencies to utilize their authorities to further the purposes of the ESA by carrying out conservation programs for the benefit of endangered and threatened species. Conservation recommendations are discretionary agency activities to minimize or avoid adverse effects of a proposed action on listed species or critical habitat, to help implement recovery plans, or to develop information.

1. The Navy should conduct research to develop an understanding of the effects of in-water detonations on the behavior of animals that utilize the area within the detonation zone and to document the extent and rate of return of animals disturbed by in-water detonation. A written analysis of the results of any such research should be made available to NMFS and other relevant natural resource agencies.

2. The Navy should also work with NMFS to monitor sea turtles in the vicinity of the new position of the sewage outfall diffuser. The number, species, size class, and other information should be recorded during routine and other maintenance dives associated with the operation of the outfall.

3. The Navy should endeavor to collaborate with NMFS and other interested parties to develop and conduct studies related to the auditory capabilities of sea turtles.

4. The Navy should make available to NMFS a most current summary of research into shielding devices which might be employed in the future to mitigate detonation effects.

For NMFS to be kept informed of actions minimizing or avoiding adverse effects or benefitting listed species or their habitats, NMFS requests notification of the implementation of any conservation recommendation(s).

Reinitiation - Closing Statement

This concludes formal consultation on the action outlined in the reinitiation request. As provided in 50 CFR 402.16, reinitiation of formal consultation is required where discretionary Federal agency involvement or control over the action has been retained (or is authorized by law) and if: (1) The amount or extent of incidental take is exceeded; (2) new information reveals the effects of the agency action that may affect listed species or critical habitat in a manner or to an extent not considered in this opinion; (3) the agency action is subsequently modified in a manner that causes an effect to the listed species or critical habitat designated. In instances where the amount or extent of take is exceeded, the U.S. Navy must immediately reinitiate formal consultation on this action.

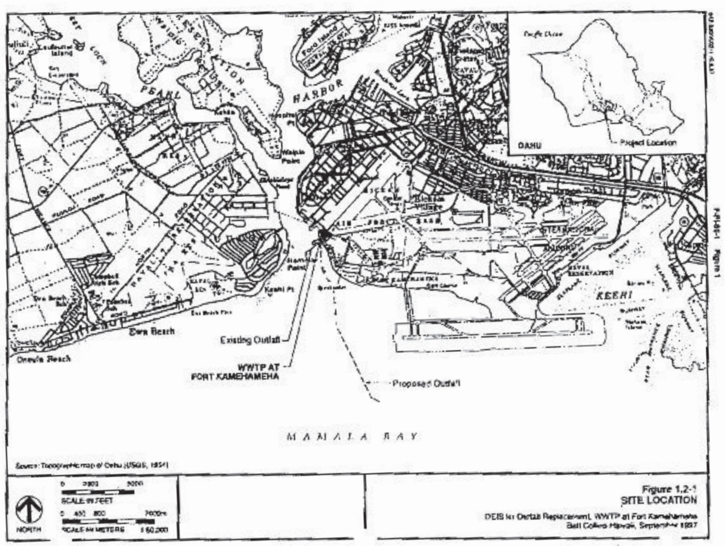


Figure 1.2-1
SITE LOCATION

LITERATURE CITED

Aguirre, A.A., Balazs, G., Zimmerman, B. and F.D. Galey. 1994. Organic contaminants and trace metals in the tissues of green turtles (*Chelonia mydas*) affected with fibropapillomas in the Hawaiian Islands. Marine Pollution Bulletin 28:109-114.

Baker, C.S. and L.M. Herman. 1987. Alternative population estimates of humpback whales (*Megaptera novaeangliae*) in Hawaiian waters. Can. J. Zool. 65:2818-2812.

Balazs, G.H. 1995. Status of sea turtles in the central Pacific Ocean. In Biology and conservation of sea turtles (revised edition), edited by K.A. Bjorndal. Smithsonian Institution Press, Washington, D.C. and London. pp. 243-252.

Balazs, G.h., H. Hirth, P. Kawamoto, E. Nitta, L. Ogren, R. Wass, and J. Wetherall. 1992. Interim Recovery Plan for Hawaiian Sea Turtles. Honolulu Lab., Southwest Fish. Sci. Cent., Natl. Mar. Fish. Serv., NOAA, Honolulu, HI 96822-2396. Southwest Fish. Sci. Cent. Admin. Rep. H-92-01. 76 pp.

Balazs, G.H. and S. Pooley (eds.). 1991. Research plan for marine turtle fibropapilloma. U.S. Dep. Commer., NOAA Tech. Memo. NMFS-SWFSC-156. 113 pp.

Bishop, C.A., Brooks, R.J., Carey, J.H., Ng, P., Norstrom, R.J. and D.R.S. Lean. 1991. The case for a cause-effect between environmental contamination and development in eggs of the common snapping turtle (*Chelydra serpentina*) from Ontario, Canada. Journal of Toxicology and Environmental Health 33:521-547.

Bowles, A.E., M. Smultea, B. Wursig, D.P. DeMaster, and D. Palka. 1994. Relative abundance and behavior of marine mammals exposed to transmissions from the Heard Island Feasibility Test. J. Acoust. Soc. Am. 96(4):2,469-2,484.

Craig, J.C. Jr. 1999. Physical impacts of explosions on marine mammals and turtles. Draft Environmental Impact Statement: Shock Trial of the Winston S. Churchill (DDG 81). Deptartment of the Navy, Naval Surface Warfare Center, Bethesda, MD. App. D1-D43.

Davenport, J. and J. Wrench. 1990. Metal levels in a leatherback turtle. Marine Pollution Bulletin 21:40-41.

Eckert, K.L. 1993. The biology and population status of marine turtles in the North Pacific Ocean. Final Report to SWFSC, NMFS, NOAA Honolulu, HI. 123p.

Eckert, K.L. 1993b. Draft Status Review of Sea Turtles Listed Under the Endangered Species Act of 1973. Leatherback Sea Turtle *Dermochelys coriacea*: Prepared for NMFS, Silver Spring, MD.

Friedl, W.A. and P.O. Thompson. 1981. Measuring acoustic noise around Kahoolawe Island. Technical Report 732, Naval Oceans Systems Center, San Diego, CA. 15 pp.

Goertner, J.F. 1982. Prediction of Underwater Explosion Safe Ranges for Sea Mammals. NSWC/WOL TR 82-188, Naval Ordnance Laboratory, Silver Spring, MD.

Hill, P.S., D.P. DeMaster, and R.J. Small. 1997. Alaska Marine Mammal Stock Assessments, 1996. U.S. Pacific Marine Mammal Stock Assessments: 1996. U.S. Dept. of Commerce, NOAA, Tech. Memo., NMFS, NOAA-TM-NMFS-AFSC-78. 149 p.

Karnella, C. 2000. Impacts of seabird mitigation methods on sea turtles. Department of Commerce, NOAA Memo. NMFS-SWR, Pacific Islands Area Office. 7 pp.

Klima, E.F., G.R. Gitschlag, and M.L. Renaud. 1988. Impacts of the explosive removal of offshore petroleum platforms on sea turtles and dolphins. Marine Fisheries Review, 50(3) pp 33-42.

Law, R.J., Fileman, C.F., Hopkins, A.D., Baker, J.R., Harwood, J., Jackson, D.B., Kennedy, S. Martin, A.R. and R.J. Morris. 1991. Concentrations of trace metals in the livers of marine mammals (seals, porpoises and dolphins) from waters around the British Isles. Marine Pollution Bulletin 22:183-191.

Lenhardt, M.L. 1994. Seismic and very low frequency sound induced behaviors in captive loggerhead marine turtles (*Caretta caretta*). In: Bjorndal, K. A. A. B. Bolton, D. A. Johnson, and P. J. Eliazar (Comps.), Proceedings of the Fourteenth Annual Symposium on Sea Turtle Biology and Conservation, 1-5 March 1994, Hilton Head, SC. U.S. Department of Commerce, National Oceanic and Atmospheric Administration, National Marine Fisheries Service, Southeast Fisheries Science Center, Miami, FL.

McKenzie, C., Godley, B.J., Furness, R.W., and D.E. Wells. 1999. Concentrations and patterns of organochlorine contaminants in marine turtles from Mediterranean and Atlantic waters. Marine Environmental Research 47:117-135.

Moein, S.E., J.A. Musick, and M.L. Lenhardt. 1994. Auditory behavior of the loggerhead sea turtle (*Caretta caretta*). In: Bjorndal, K. A. A. B. Bolton, D. A. Johnson, and P. J. Eliazar (Comps.), Proceedings of the Fourteenth Annual Symposium on Sea Turtle Biology and Conservation, 1-5 March 1994, Hilton Head, SC. U.S. Department of Commerce, National Oceanic and Atmospheric Administration, National Marine Fisheries Service, Southeast Fisheries Science Center, Miami, FL.

Myrick, A.C. Jr., J. Taylor, C.W. Oliver, E.R. Cassano, L.L. Robertson, and A.P. Majors. 1990. Results of underwater tests of double-base smokeless-powder pipebombs on targets to determine physical hazards to swimming dolphins. Administartive report LJ-90-26. Dept. of Commerce, NOAA, Southwest Fisheries Science Center, La Jolla, CA. 16 pp.

National Marine Fisheries Service and U.S. Fish and Wildlife Service. 1998b. Recovery Plan for U.S. Pacific Populations of the Leatherback Turtle. Prepared by the Pacific Sea Turtle Recovery Team. 54p.

National Marine Fisheries Service and U.S. Fish and Wildlife Service. 1998c. Recovery Plan for U.S. Pacific Populations of the Green Turtle. Prepared by the Pacific Sea Turtle Recovery Team. 73p.

National Research Council. 1990. Decline of the sea turtles: Causes and prevention. National Academy Press, Washington, D.C., 259 p.

Nitta, E.T., and J.J. Naughton. 1989. Species profiles: Life histories and environmental requirements of coastal vertebrates and invertebrates, Pacific Ocean Region. Report 2, Humpback whale, *Megaptera novaeangliae*. Technical report EL-89-10, prepared by the National Marine fisheries Service, NOAA, Honolulu, HI, for the U.S. Army Engineer Waterways Experiment Station, MS.

O'Keefe, D.J. and G.A. Young. 1984. Handbook on the environmental effects of underwater explosions. NSWC TR 83-240. Naval Surface Weapons Center, Dahlgren, VA and Silver Spring, MD.

Richardson, W.J., C.R. Greene, Jr., C.I. Malme, and D.H. Thomson. 1995. Marine Mammals and Noise. Academic Press, San Diego. 576 pp.

Richmond, D.R., J.T. Yelverton, and E.R. Fletcher. 1973. Far-field underwater blast injuries produced by small discharges. A final report prepared by the Lovelace Foundation for Medical Education and Research, Albuquerque, NM for the Defense Nuclear Agency, Washington D.C. 89 pp.

Ridgeway, S.H., E.G. Wever, J.G. McCormick, J. Palin, and J.H. Anderson. 1969. Hearing and the giant sea turtle, *Chelonia mydas*. Proc. Nat. Acad. Sci. (USA) 64:884-890.

Ridgeway, S.H., D.A. Cardner, R.R. Smith, T. Kamolnick, C.E. Schlundt, and W.R. Elsberry. 1997. Behavioral responses and temporary shift in masked hearing threshold of bottlenose dolphins, *Tursiops truncatus*, to 1-second tones of 141 to 201 dB re 1uPa. Technical Report 1751, July 1997. Naval Command, Control and Ocean Surveillance Center, RDT&E Division, San Diego, CA. 16 pp + app.

Sakai, H., Ichihashi, H., Suganuma, H., and R. Tatsukawa. 1995. Heavy metal lmonitoring in sea turtles using eggs. Marine Pollution Bulletin 30:347-353.

Sigurdson, J.E. 1999. Criteria for marine mammal auditory threshold shift. Draft Environmental Impact Statement: Shock Trial of the Winston S. Churchill (DDG 81). Deptartment of the Navy, Naval Surface Warfare Center, Bethesda, MD. App. E1-E35.

Storelli, M.M., E.Ceci and G.O. Marcotrigiano. 1998. Distribution of heavy metal residues in some tissues of Caretta caretta (Linnaeus) specimens beached along the Adriatic Sea (Italy). Bulletin of Enviromental Contamination and Toxicology 60:546-552.

Wetherall, J.A., G.H. Balazs, R.A. Tokunaga, and M.Y.Y. Yong. 1993. Bycatch of marine turtles in North Pacific high-seas driftnet fisheries and impacts on the stocks. In: Ito, J. *et al.* (eds.) INPFC Symposium on biology, distribution, and stock assessment of species caught in the high seas driftnet fisheries in the North Pacific Ocean. Bulletin 53(III):519-538. Inter. North Pacific Fish. Comm., Vancouver, Canada.

Witkowski, S.A. and J.G. Frazier. 1982. Heavy metals in sea turtles. Marine Pollution Bulletin 13:254-255.

Wright, D.G. 1982. A discussion paper on the effects of explosives on fish and marine mammals in the waters of the Northwest Territories. Canadian Technical Report of Fisheries & Aquatic Sciences No. 1052. Dept. of Fisheries and Oceans, Western Region, Winnipeg, Manitoba.

Yelverton, J.T., D.R. Richmond, E.R. Fletcher, and R.K. Jones. 1973. Safe distances from underwater explosions for mammals and birds. A final report prepared by the Lovelace Foundation for Medical Education and Research, Albuquerque, NM for the Defense Nuclear Agency, Washington D.C. 67 pp.

Young, G.A. 1984. Dispersion of the chemical products of underwater explosions. NSWC TR 82-404. Naval Surface Weapons Center, Dahlgren, VA and Silver Spring, MD.

Young, G.A. 1991 Consise methods for predicting the effects of underwater explosions on marine life. NAVSWC MP 91-220. Naval Surface Warfare Center, Dahlgren, VA and Silver Spring, MD.

H11 – IMPACT OF MAINTENANCE ACTIVITIES ON *M. VILLOSA* (USFWS 2002)

1195. 1A2P

United States Department of the Interior

FISH AND WILDLIFE SERVICE
Pacific Islands Fish and Wildlife Office
300 Ala Moana Blvd, Rm 3-122
Box 50088
Honolulu, HI 96850

In Reply Refer To:
1-2-2002-I-117

SEP 25 2002

Melvin N. Kaku
Environmental Planning Division
Department of the Navy, Pacific Division
Naval Facilities Engineering Command
258 Makalapa Dr., Ste. 100
Pearl Harbor, Hawaii 96860-3134

Dear Mr. Kaku:

Re: Informal Consultation for Possible Effects of Mowing on *Marsilea villosa* at NCTAMSPAC

The U.S. Fish and Wildlife Service (Service) has reviewed the information in your August 22, 2002, letter concerning a proposal to change the grass mowing strategy within the antennae fields at Naval Computer and Telecomm Area Master Station Pacific (NCTAMSPAC) where a population of the endangered fern, *Marsilea villosa,* is known to occur. Currently, the Navy abides by an agreement with the Service in which the area where *Marsilea villosa* occurs is mowed only after the plants have completely dried and are dormant for the season. The Navy sets the mower blades at a height that allows the mower to cut the invasive grasses, while leaving the *Marsilea villosa* uncut. Under this regime, invasive grasses, that may increase the risk of wildfire, are allowed to seed before mowing occurs. In order to control the reproductive output of invasive grasses, the Navy proposes that, in addition to the late summer mowing, the vicinity will also be mowed during the spring or early summer when *Marsilea villosa* are emergent.

We concur with the Navy's determination that this activity is not likely to adversely affect *Marsilea villosa* or it's proposed critical habitat (see enclosed map), based upon the current mower blade height and the past history of not impacting the *Marsilea villosa* when mowing occurred. While the mowing may occasionally impact a small minority of leaves of *Marsilea villosa* that could grow abnormally high, this is extremely unlikely, and the action will be beneficial to the species, since it will not only be likely to decrease the risk from wildfire, but may also eliminate some competition for light and water from the invasive grasses.

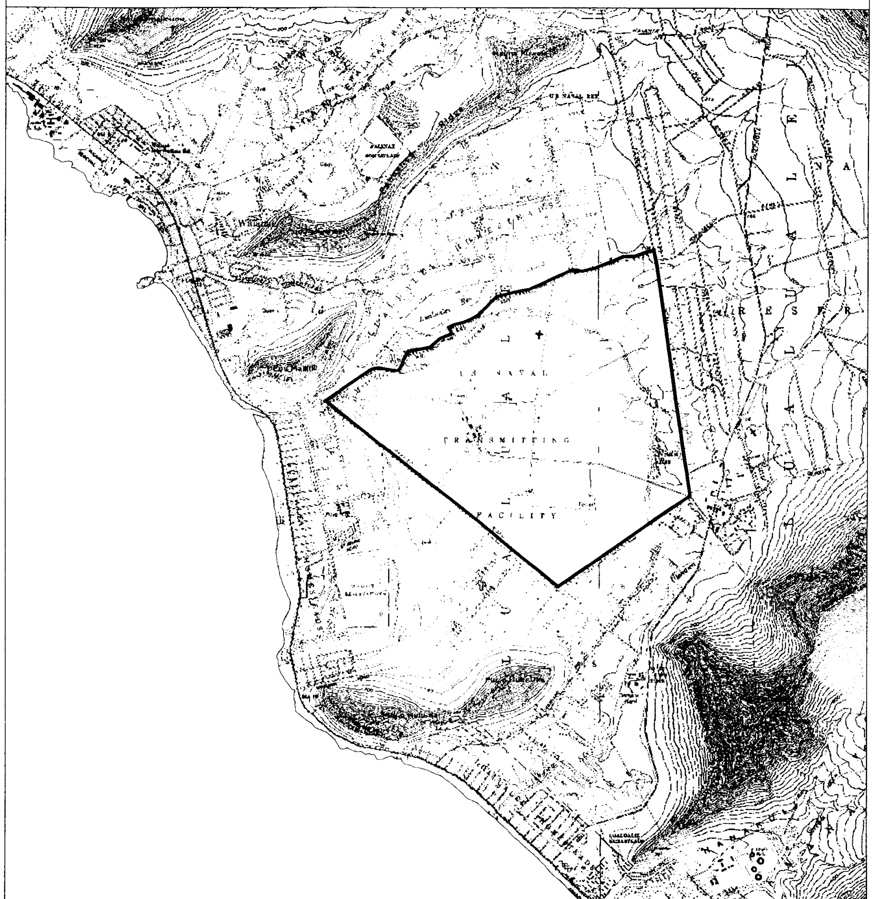
If you have questions or comments, please contact Fish and Wildlife Biologist Christina Crooker at (808) 541-3441.

Sincerely,

Gina Shultz

for Paul Henson
Field Supervisor

Marsilea villosa Proposed Critical Habitat
Lualualei Naval Magazine



Lualualei Naval Magazine

Marsilea villosa Proposed Critical Habitat

Map Location

U.S. Fish and Wildlife Service
Pacific Islands Office

N

0.3 0 0.3 0.6 Miles

Map produced by U.S. Fish and Wildlife Service. Plot date: September 17, 2002

This page is intentionally left blank.

H12 – MANAGEMENT OF *C. TRACHYSANTHOS* AT NCTAMSPAC LUALUALEI (USFWS 2004)

This page is intentionally left blank.

United States Department of the Interior

FISH AND WILDLIFE SERVICE

Pacific Islands Fish and Wildlife Office
300 Ala Moana Boulevard, Room 3-122, Box 50088
Honolulu, Hawaii 96850

In Reply Refer To:
1-2-2004-I-207

SEP 10 2004

Mr. R. M. Wakumoto
Director, Regional Environmental Department
Navy Region Hawaii
850 Ticonderoga Street, Suite 110
Pearl Harbor, Hawaii 96860-5201

Dear Mr. Wakumoto:

Thank you for your July 23, 2004, letter in which you request that the U.S. Fish and Wildlife Service (Service) concur that the activities at the Naval Computer and Telecommunications Area Master Station Pacific may affect, but are not likely to adversely affect the endangered *Cyperus trachysanthos*. This letter was received July 30, 2004. Dr. Greg Koob, of this office, participated in a site visit on July 14, 2004, to observe the *C. trachysanthos* population. During the site visit recommendations were discussed that would allow the Navy to continue its operations and avoid adversely affecting this species.

The Navy proposes to implement the following management actions:

a. install warning signs and markers to delineate plant habitat occurrence(s)
b. brief the maintenance personnel on the location of listed plants and prohibited activities
c. suspend mowing when there is mud in the depression where the plants have been observed
d. monitor the plants by observing seed fall, until at least 50 percent of the seeds have fallen from the plants, and
e. resume mowing when the mud hole is not present and after at least 50 percent of the seeds have fallen.

We reviewed the information you provided and with implementation of the above mentioned management actions, we concur with your determination that the proposed action is not likely to adversely affect *Cyperus trachysanthos*. If you have any questions, please contact Dr. Greg Koob, Fish and Wildlife Botanist (phone: 808/792-9400; fax: 808/792-9580).

Sincerely,

Jeff M. Newman
Acting Field Supervisor

DEPARTMENT OF THE NAVY
COMMANDER
NAVY REGION HAWAII
850 TICONDEROGA ST STE 110
PEARL HARBOR HI 96860-5101

11015
Ser N465/ 00394
23 JUL 2004

Mr. Jeff M. Newman
Acting Field Supervisor
U. S. Fish & Wildlife Service
Pacific Islands Office
300 Ala Moana Boulevard Room 3-122
P. O. Box 50088
Honolulu HI 96850-0001

SUBJECT: INFORMAL CONSULTATION FOR THE MANAGEMENT OF *CYPERUS TRACHYSANTHOS* AT NAVAL COMPUTER AND TELECOMMUNICATIONS AREA MASTER STATION PACIFC (NCTAMSPAC)

Dear Mr. Newman:

This letter is a follow-up regarding our on-site management of *Cyperus trachysanthos* recently found at the Naval Computer and Telecommunications Area Master Station Pacific, Radio Transmitting Facility (RTF) Lualualei (FWS ref number TES-1-2-2004-0036; Navy letter dated May 17, 2004, reference number Ser N465/00279).

On July 14, 2004, Dr. Greg Koob, of your office, participated in a site visit to the *C. trachysanthos* population to observe the plants and discuss recommendations that would allow the Navy to continue its operations at RTF Lualualei with minimal impact to this species.

The Navy proposes to implement the following management actions:

a. Suspend mowing during onset of a "wet season."
b. Installation of warning signs and markers to delineate plant habitat.
c. Brief maintenance personnel of location and prohibited activities.
d. Monitor the plants for seed fall.
e. Resume mowing when mud hole is not present (and after seed fall).

The mud hole in the drainage ditch will be used as an indicator of the "wet season." When the mud hole appears during a rainy season, known sites and adjacent areas will be monitored for *C. trachysanthos*. When present, sites will be marked and mowing ceased in areas currently known to contain this species, or new areas found to contain the species, until the plants have grown, flowered, fruited, and dropped their seeds.

Protection from fire and control of competing alien plants has been determined to be needed recovery actions in the "Recovery Plan for the Multi-Island Plants" (USFWS, 1999). There have been two fires on the installation in the last decade with the latest occurring in July 2003. Due to the inherent risk of fire from the drying vegetation, it is prudent to resume mowing when a qualitative assessment determines that more than 50% of the seeds have fallen. This will ensure establishment of a seed bank for future generations of this species, adequately reduce the risk from fires, and reduce competition from woody plants and other alien vegetation.

This species acts as an annual in seasonally wet areas such as the RTF Lualualei site. After it has grown, flowered, fruited and dropped its seeds the plants will die back during dry times. For example, this species has never been previously recorded in the RTF Lualualei facility and only showed up with the onset of wet weather and the presence of standing water in the current locations. Mowing of the tops of the plants (i.e. removal of the uppermost portions of the drying leaves) after seed drop and during the dry season will not significantly affect the numbers, distribution or reproduction of this species.

It is the Navy's determination that implementation of these management activities may affect, but are not likely to adversely affect *C. trachysanthos*. We request your concurrence with this determination.

Thank you for your cooperation and assistance in developing these management actions. Should you have any questions regarding the information provided, please contact Mr. Randy Miyashiro, at 471-1171, extension 233 or email at: randy.miyashiro@navy.mil.

Sincerely,

R. M. WAKUMOTO
Director
Regional Environmental Department
By direction of
Commander, Navy Region Hawaii

H13 – INVASIVE SPECIES REMOVAL AT NAVMAG PH LUALUALEI BRANCH (USFWS 2004)

This page is intentionally left blank.

vmbm
EV3 MC
Tim AL

United States Department of the Interior

FISH AND WILDLIFE SERVICE

Pacific Islands Fish and Wildlife Office
300 Ala Moana Boulevard, Room 3-122, Box 50088
Honolulu, Hawaii 96850

In Reply Refer To:
1-2-2-5-I-068

DEC 20 2004

Mr. Melvin Z. Waki
Department of the Navy
Naval Facilities Engineering Command, Pacific
258 Makalapa Drive., Suite 100
Pearl Harbor, Hawaii 96860-3134

Dear Mr. Waki:

Thank you for your November 19, 2004, letter regarding removal of invasive species at Naval Magazine Pearl Harbor, Lualualei Branch (NAVMAG LLL). The project proposes to reduce and control non-native invasive plant species in two existing fence exclosures, one in Halona subsdistrict (Halona) and one in the Mikilua subdistrict (Puu Hapapa). Conservation measures in place to reduce potential harmful effects to listed species and critical habitat include using only trained personnel for the project, reducing possible weed seed introductions by following established protocols, and following herbicide application protocols.

According to data from the Hawaii Natural Heritage Program and your letter, *Abutilon sandwicense*, *Flueggea neowawraea*, *Nototrichium humile*, *Bonamia menziesii*, and *Lipochaeta lobata* are or have been in one or the other exclosure. No other endangered or threatened plant or animal species are known to occur in the area of either exclosure. There is critical habitat for *Lipochaeta lobata* var. *leptophylla*, *Sanicula mariversa*, *Schiedea hookeri*, and Oahu elepaio in the area of the Puu Hapapa exclosure and for *Abutilon sandwicense*, *Diellia unisora*, *Lipochaeta lobata*, var. *leptophylla*, *Melicope pallida*, *M. saint-johnii*, *Neraudia angulata*, *Silene perlmanii*, and Oahu elepaio in the area of the Halona exclosure. In addition, there are no species proposed for listing or proposed critical habitat in the project area.

We feel the conservation measures proposed by the Navy are adequate to reduce the likelihood of harming any existing listed plant species in the exclosures. Removal of invasive weed species is beneficial not only for the species, but for their critical habitat as well. We concur with your determination that implementation of the proposed project is not likely to adversely affect any federally listed species or critical habitat.

Mr.Waki 2

Thank you for your efforts to conserve endangered species. If you have any questions, please contact Gregory A. Koob, Botanist (phone: 808/792-9400; fax 808/792-9580).

Sincerely,

Lorena L. L. Wada

for Gina M. Shultz
Acting Field Supervisor

DEPARTMENT OF THE NAVY
NAVAL FACILITIES ENGINEERING COMMAND, PACIFIC
258 MAKALAPA DR., STE. 100
PEARL HARBOR, HAWAII 96860-3134

11015.4A8L
Ser EV32/ 2137
19 NOV 2004

Ms. Gina M. Schultz, Acting Field Supervisor
U. S. Fish and Wildlife Service
Pacific Islands Ecoregion
Box 50088
Honolulu, HI 96850

Dear Ms. Schultz:

Subj: DETERMINATION THAT INVASIVE SPECIES REMOVAL AT NAVAL MAGAZINE PEARL HARBOR, LUALUALEI BRANCH, MAY AFFECT, BUT IS NOT LIKELY TO ADVERSELY AFFECT, FIVE ENDANGERED PLANTS IN NAVAL MAGAZINE LUALUALEI, OAHU, HAWAII

Introduction:

The Navy requests initiation of informal section 7, Endangered Species Act, consultation with the U. S. Fish and Wildlife Service (Service) regarding invasive species removal in Naval Magazine Pearl Harbor Lualualei Branch (NAVMAG LLL) and its possible effect on five species of endangered plants: *Abutilon sandwicense, Flueggea neowawraea, Nototrichium humile*, *Bonamia menziesii*, and *Lipochaeta lobata*. The Navy has considered the possible impact of the action on these plants and has determined that the habitat restoration work may affect, but is not likely to adversely affect, these five species. Because the exclosures are within critical habitat for listed plants, Navy has also considered the potential for adverse impacts to critical habitat. Navy has determined that there would be no adverse modification of that habitat. We seek your concurrence on these determinations.

Background:

The Navy maintains two fenced exclosures in NAVMAG LLL, one in the Halona subdistrict (Halona) and one in the Mikilua subdistrict (Puu Hapapa). The exclosures were constructed in 1994 to protect endangered plants from feral ungulates.

The Halona exclosure is situated on a north-facing slope, at approximately 1,600 feet (488 m). The fence surrounds an approximately one-acre (0.40 ha) portion of a lonomea (*Sapindus oahuensis*) forest, which contains the endangered plant species *Abutilon sandwicense*. Since the fence was installed, invasive plants from outside the exclosure have begun encroaching on the protected plants contained in the exclosure. The adult population of *A. sandwicense* appeared to have dropped from six plants to one between 1994 and 2002. Predominant species in this exclosure are:

a. Native canopy species: lonomea, olopua (Nestigis sandwicensis), hao (Rauvolfia sandwicensis), papala kepau (Pisonia brunoniana), and mehame (Antidesma pulvinatum).

b. Non-native canopy species: Christmas berry (*Schinus terebinthifolius*), silk oak (*Grevillea robusta*), and kukui (*Aleurites moluccana*)

c. Native understory species: papala (*Charpentiera obovata*) and *A. sandwicense*

d. Non-native understory species: Tree daisy (*Montanoa hibiscifolia*), coral berry (*Ravina humilis*), lantana (*Lantana camera*), and passion flower (*Passiflora suberosa*).

The Puu Hapapa exclosure is on a steep, north-facing slope, and surrounds a lama (*Diospyros sandwicensis*) forest. The approximately one-half acre(0.2 ha)parcel contains four known species of endangered plants: mehamehame (*Flueggea neowawraea*), *Bonamia menziesii*, *Nototrichium humile*, and *A. sandwicense*. *Lipochaeta lobata* has not been observed in the exclosure since 1996. This exclosure, like Halona, is also experiencing encroachment by invasive non-native species which are competing with the endangered plants. However, the abundance of invasive species is much lower than Halona. Predominant plant species in the Puu Hapapa exclosure are:

a. Native canopy species: lama, hao, and *Hibiscus arnottianus* var. *arnottianus*

b. Non-native canopy species: Christmas berry and silk oak (*Grevillea robusta*)

c. Native understory species: nioi (*Eugenia reinwardtiana*), halapepe (*Pleomele forbesii*), `awikiwiki (*Canavalia galeata*), *Nototrichium humile, A. sandwicense*, ko`oko`olau (*Bidens torta)* and papala.

d. Non-native understory species: air plant (*Kalanchoe pinnata),* coral berry, and passion flower.

Current Projects and Status:

The Navy has always attempted to control invasive species in the two exclosures. However, management actions in the past have consisted mostly of opportunistic manual weed clearing and fenceline checks.

Beginning in 2002, the Navy contracted Pono Pacific Land Management LLC (Pono) to conduct invasive species removal in the two exclosures. The Navy provided Pono with a restoration plan for each area, along with regular on-site guidance as to how the invasive species removal should proceed.

Halona: In 2002, the Halona exclosure had only one known *A. sandwicense*. This individual stands approximately 10m high and 15m across. Most recently, the plant flowered and seeded in September 2004. Since the Navy began manually removing (pulling) *R. humilis* from around the *A. sandwicense* in 2002, we have found 14

additional seedlings. Most of these plants were discovered while manually removing *R. humilis*, although some have emerged in cleared areas presumably from the existing seedbank. All of the *A. sandwicense* seedlings that have been discovered in the exclosure during the restoration have survived; most of them are 3-6 feet (1-2 m) tall. There are now a total of 15 individuals; only the large original individual has been known to flower and seed.

The restoration process began using only manual removal of invasive species. However, we found that while this worked well for *R. humilis*, it was not adequate for *P. suberosa*, *M. hibiscifolia* and invasive grasses. Therefore, Garlon has been applied to the cut stumps of *P. suberosa* and *M. hibiscifolia* using a drip bottle. Garlon is used on days where the wind is less than 10 mph and is never applied with any other method than a drip bottle.

Once the *M. hibiscifolia* was removed, it was determined that outplanting native ground cover and mid- canopy species would be necessary to replace the alien seedlings. Seeds were collected from native species in Lualualei, grown at local nurseries and then outplanted into two sites in the exclosure – the *M. hibiscifolia* site and an open grassy area. Plants that have been utilized are *Acacia koa, Psydrax odoratum, Dodonea viscosa, C. obovata, S. oahuensis, R. sandwicensis*, and *Plumbago zeylanica*. Hawaii Natural Heritage Program botanist Joel Lau was consulted for outplanting species recommendations.

Current status: (1) As of September 2004, there are 15 individual *A. sandwicense* in the Halona exclosure. One is the large adult and the rest are juveniles; (2) regrowth of *M. hibiscifolia*, *R. humilis* and *P. suberosa* is minimal; and (3) native *Sicyos spp.* fills in seasonally in the 'old' *M. hibiscifolia* area.

Puu Hapapa: In 2002, the Puu Hapapa exclosure had one *F. neowawraea*, one *B. menziesii*, one adult and approximately 75 juvenile *A. sandwicense*, and one *N. humile*. The *F. neowawraea* was quite unhealthy, with only a few small "suckers" coming off the decaying stump. The tree had an active twig borer infestation. *Passiflora* was encroaching on the makai fenceline and had begun to creep over the fence into the exclosure.

Due to the close proximity of the *B. menziesii* to the fenceline and the low abundance of the *P. suberosa*, it was determined that only manual removal of weeds would be used. *R. humilis* was also removed by hand. After initial repeat visits, return visits were conducted on a monthly, then bi-monthly basis, to manually remove new invasive seedlings. This continues to present.

Current status: (1) The *F. neowawraea* appears to have died due to twig borer infestation combined with drought; (2) there are approximately 50 *A. sandwicense*, one is a flowering adult; (3) *Passiflora* has been cleared from inside, along, and directly outside the fenceline; and (4) silk oak trees have been successfully removed from outside the exclosure.

Future plans:

Future plans in the Halona exclosure include continued manual and chemical removal of invasive species and outplanting of appropriate native species until the invasive species are not threatening the survival and natural recruitment of the *A. sandwicense.* The Navy is currently evaluating the implementation of weed barrier cloth to aid in the suppression of grasses in the Halona exclosure, particularly around the *A. koa* seedlings.

For each fiscal year, quarterly visits to Puu Hapapa are planned to manually remove *P. suberosa* and *R. humilis* from the exclosure.

All future plans are subject to the availability of funds; current funding is through March 2005.

Conclusion:

It is the Navy's determination that the invasive species removal actions described in this letter may affect, but are not likely to adversely affect, threatened or endangered species in the Halona and Puu Hapapa exclosures. While it is possible that some listed plants may be inadvertently and unintentionally damaged by having humans in the exclosures (e.g., by misstepping and crushing a young seedling), we believe the overall action has been, and will continue to be, beneficial, especially for *A. sandwicense.* Weed control is recommend in both the Recovery Plan for Multi Island Plants and the Integrated Natural Reserves Management Plan for NAVMAG LLL. We have sought to reduce the chances that a listed plant may be damaged by ensuring that those who enter the exclosures (1) are aware of the status of the protected plants and the purpose of the exclosure, (2) are able to identify those plants, and thus avoid damaging them and (3) take precautions not to introduce weed seeds on clothing, boots, tools, etc. Only qualified and experienced personnel are permitted to use any herbicide within the exclosure; all herbicides are applied in accordance with the labeled restrictions and precautions. Regarding critical habitat, Navy's proposed action does not have the potential to destroy or adversely modify critical habitat. No constituent elements of that habitat will be affected.

We request your written concurrence with Navy's determination that although the described action may affect the aforementioned endangered and threatened plants, they would not be likely to be adversely affected.

Please contact Ms. Julie Rivers of my staff at 472-1407 should you have any technical questions regarding this action.

Sincerely,

MELVIN Z. WAKI, P.E.
Business Line Manager
Environmental

Copy to:
COMNAVREG Hawaii (N465R)

H14 – AVIATOR RECOVERY, UPPER HALAWA VALLEY (USFWS 2005)

United States Department of the Interior

FISH AND WILDLIFE SERVICE

Pacific Islands Fish and Wildlife Office
300 Ala Moana Boulevard, Room 3-122, Box 50088
Honolulu, Hawaii 96850

In Reply Refer To:
1-2-2005-F-172

JUN 14 2005

Mr. Melvin N. Kaku
Acting Business Line Manager, Environmental
Naval Facilities Engineering Command, Pacific
Department of the Navy
258 Makalapa Drive, Suite 100
Pearl Harbor, Hawaii 96860-3134

Dear Mr. Kaku:

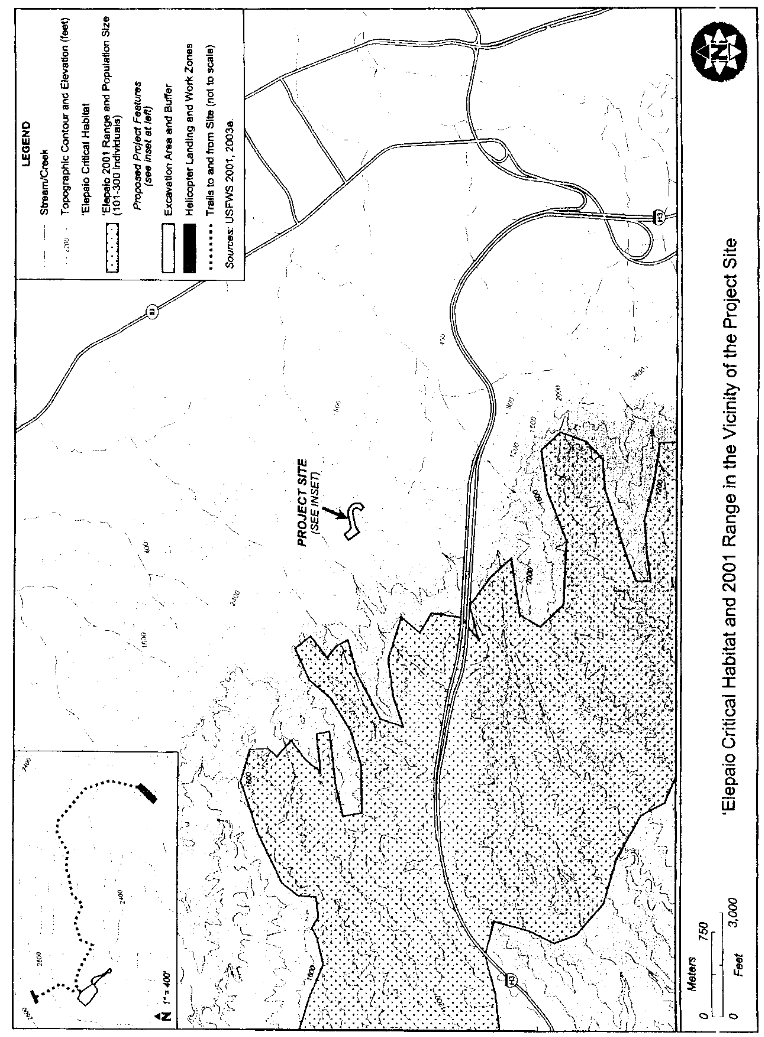
This document transmits the Fish and Wildlife Service's (Service) biological opinion based on our review of the proposed aviator recovery activities in upper Halawa Valley on the island of Oahu, Hawaii, in accordance with section 7 of the Endangered Species Act (Act) of 1973, as amended (16 U.S.C. 1531 et seq.).

Your finding that the proposed project would adversely affect critical habitat for *Cyanea crispa*, *C. st.-johnii*, *Lobelia oahuensis*, *Sanicula purpurea*, *Tetraplasandra gymnocarpa*, *Trematolobelia singularis*, and *Viola oahuensis* and your request for formal consultation was received on March 11, 2005. The proposed project will not affect listed species. This biological opinion is based on (1) your March 10, 2005, letter; (2) the February 2005 Biological Survey Report; (3) the February 2005 Draft Restoration Plan for the Aviator Recovery Site; (4) email communications of April 4 and 5, 2005, between Dr. Gregory A. Koob of the Pacific Islands Fish and Wildlife Service office and William Kramer; (5) email communication between Dr. Koob and Glenn Metzler on April 5, 2005; and, 6) information from our files. A complete administrative record of this consultation is on file at this office.

CONSULTATION HISTORY

September 27, 2004: Dr. Koob, of this office, accompanied Julie Rivers of Navy Environmental and staff of Pono Pacific on a helicopter reconnaissance of the 1944 crash site. The general condition of the site was viewed from the air and from a ridgeline opposite the crash site and was part of a trip to determine how to best conduct vegetation surveys of the site.

March 11, 2005: The service received the Navy's March 10, 2005, letter making a determination that critical habitat for seven plant species (*Cyanea crispa*, *C. st.-johnii*, *Lobelia oahuensis*, *Sanicula purpurea*, *Tetraplasandra gymnocarpa*, *Trematolobelia singularis*, and *Viola*



Enclosure 6

oahuensis) may be adversely affected and requesting formal consultation. A biological survey report and a draft restoration plan for the site were included with the letter.

March 29, 2005: Dr. Koob left a voice message for William Kramer of the Navy asking for more detailed information on some of the conservation measures mentioned in the Navy's March 10, 2005, letter.

March 31, 2005: William Kramer sent an email to Dr. Koob saying that Glenn Metzler of The Environmental Company will be responding to the request for more information on the conservation measures. Dr. Koob called Mr. Metzler, responding to a voice mail message, and reiterated the need for clarification on some of the conservation measures.

April 1, 2005: Dr. Koob emailed Mr. Kramer requesting the electronic versions of the project description, maps, and photos that were included in the Navy's March 10, 2005, letter.

April 4, 2005: Mr. Kramer sent an email to Dr. Koob (including a forwarded message from Mr. Metzler), clarifying some of the conservation measures.

April 5, 2005: Anne Hong of the Navy Environmental Planning Division, for Mr. Kramer, sent an email to Dr. Koob with the final clarifications of the conservation measures and also said that the electronic files requested on April 1, 2005, will be forthcoming.

April 5, 2005: Mr. Metzler sent an email to Dr. Koob with the electronic files of the project description, maps, and photos that were included in the Navy's March 10, 2005, letter.

April 7, 2005: Dr. Koob sent Mr. Kramer and email asking for a review of the project description that will be included in the biological opinion.

April 8, 2005: Mr. Kramer sent Dr. Koob an email with some edits to the project description.

April 14, 2005: The Service sent the Navy a letter confirming the receipt of the reports and initiation of formal consultation on *Cyanea crispa*, *C. st.-johnii*, *Lobelia oahuensis*, *Sanicula purpurea*, *Tetraplasandra gymnocarpa*, *Trematolobelia singularis*, and *Viola oahuensis* critical habitat.

BIOLOGICAL OPINION

DESCRIPTION OF PROPOSED ACTION

The following summary of the proposed action is drawn from the project descriptions in the Navy's March 10, 2005, letter, the Navy's Draft Restoration Plan for the Aviator Recovery Site, and subsequent information received from the Navy. The project site is located in rugged terrain in the upper Halawa Valley, Oahu. Access to the site is very difficult due to its remote location and extremely steep terrain with slopes, perhaps, greater than 70 degrees. The project site consists of vegetated slopes.

The Navy proposes to remove vegetation, and excavate and screen soil to bedrock (an estimated average depth of 15 centimeters (cm) or 6 inches (in)) from an area at the crash site of up to approximately 400 square meters (sq m) (478 square yards (sq yd)) or 0.04 hectares (ha) (0.1 acres (ac)). Personnel will use hand tools to excavate soils. The average 15 cm (6 in) depth over a 400 sq m (478 sq yd) area yields an approximate volume of soil of 60 cubic m (79 cubic yd). In addition, the Navy proposes to establish ancillary support areas by modifying the taller vegetation within an additional 1,420 sq m (1,698 sq yd), or about 0.14 ha (0.35 ac) area. This ancillary area will provide a buffer around an existing helicopter landing pad, an alternative helicopter landing zone, and a footpath from landing zone to the recovery site. In this context, "modifying the taller vegetation" would include cutting taller vegetation at the helicopter landing area to meet safety requirements and unavoidable trampling of vegetation along pathways and at equipment staging areas. Vegetation in these areas may also need to be thinned or cut to allow access. Soils within the ancillary support areas will not be removed or significantly disturbed, but trails from the landing zones to the crash site are likely to be created as a result of frequent and repeated use during the life of the project.

The excavated soils will need to be wet screened, or washed through a 0.6-cm (0.25-in) screen with water, to effectively separate recoverable materials. Soil excavated from the crash site may be moved from the site to the Joint Prisoner of War Missing in Action Accounting Command (JPAC) laboratory at Hickam Air Force Base for wet screening. JPAC is also considering wet screening the excavated soil on-site. Water for wet screening would either be brought in by helicopter or pumped from a stream in the vicinity of the recovery site. After wet screening, the excavated soil will be returned to the remains recovery site.

JPAC anticipates that recovery actions will begin in the summer of 2005 and will take approximately four to six weeks for a crew of up to 15 personnel to complete. The length of the recovery actions is limited to a fixed time period due to seasonal variations in the weather and availability of resources. As the recovery effort proceeds, JPAC personnel will implement temporary erosion control measures, such as anchoring geotextile, burlap, or other soil-stabilizing material over exposed grids, and will place soil-retention barriers down-slope of the disturbed areas. Revegetation and more permanent erosion control will be implemented immediately following the completion of the recovery portion of the project.

CONSERVATION MEASURES

In order to reduce negative impacts to critical habitat the following precautions will be taken:

<u>Non-native Species Control</u>
The Navy will implement the following measures to reduce the introduction and spread of, or where possible, to eradicate non-native species:

1. The Navy will provide specific instructions to recovery crews to brush dirt and other debris from their shoes and from equipment (particularly digging tools) that cannot be stored at the project site prior to entering the project area each work day.

2. Foods with small seeds (such as blackberries) and any other food that may have the potential to introduce weeds will not be allowed at the site.

3. The Navy will prevent the spread of non-native plants from soil disturbance activities by selective herbicide application. A weed suppressant such as RoundStar may be used to help prevent the seed bank from exploding upon removal of the native vegetation. The Navy will eradicate newly dispersed weeds in the project area by spot spraying with herbicides (either Round Up (41 pecent Glyphosphate Isopropylamine Salt) or Garlon 4a (61.6 percent Triclopy Butoxethylester and acid equivalent of 44.3 percent Triclopyr Trienthylamine Salt)). Area-wide herbicide application will not be conducted due to concerns regarding drift and unintentional spraying of native plants.

4. The Navy will ensure that any replenishment soils brought to the site are sterile (*i.e.*, free of seeds).

5. The Navy will prevent the incursion and attraction of mice and rats that feed on the seeds of some native plants by requiring recovery crews to properly bag (*i.e.*, place in a plastic bag and seal) and remove all green trash (*e.g.*, food waste) daily.

6. Water brought in from off-site to wash soils will be procured from uncontaminated (*i.e.*, free of weed seeds) potable sources.

Erosion Control

1. The Navy will implement temporary erosion control measures down-slope of the project area during the recovery activities. These measures may include the implementation of soil retention barriers built of either plywood or tarps. Tarps will be used initially until more permanent barriers are in place.

2. Erosion control materials, such as geotextiles, will be new and unused.

3. The Navy will implement permanent erosion control measures immediately after JPAC has finished soil excavation. Detailed methods for erosion control are included in the February 2005 Draft Restoration Plan for Aviator Recovery Site.

4. Jute matting and decomposing bio stakes will be used to secure sifted soil. This will help to prevent run-off and soil displacement. The matting will keep soil in place and will also allow for natural recruitment of native plants after pre-emergent herbicides wears off.

Habitat Restoration

1. The Navy will remove all equipment and supplies from the project area at the conclusion of the recovery activities.

2. The Navy will implement the following habitat restoration measures at the conclusion of the recovery activities. Native plants will be selected and transplanted into the area in order to reestablish the approximate mix of native vegetation that existed prior to the recovery activities. The plants will be procured from native plant nurseries on Oahu. All plant species used for outplanting will be historically or currently known from the project area.

3. The Navy will ensure that Recovery crews create and use established trails through non-native vegetation whenever possible. The Navy will implement habitat restoration measures for these routes, as described above for the remains recovery site proper.

STATUS OF THE CRITICAL HABITAT

Critical Habitat for *Cyanea crispa* (Haha)

Critical habitat for *Cyanea crispa* was designated on Federal, state, and private land on June 17, 2003, in four separate units totaling 7,326 ha (18,102 ac). Three units (Oahu 20—*Cyanea crispa*—a, Oahu 21—*Cyanea crispa*—c, and Oahu 35—*Cyanea crispa*—d) are currently occupied and one unit (Oahu 20—*Cyanea crispa*—b) is unoccupied. Critical habitat units a and c provide habitat for one population (a minimum of 300 mature, reproducing individuals) each, while units b and d provide habitat for three populations each (68 FR 35950).

The primary constituent elements for these units are slopes, moist gullies, or stream banks in open mesic forests or closed wet forests that are between 56 and 959 m (184 and 3,146 ft) in elevation and contain one or more of the following associated native plant species: *Antidesma platyphyllum* (hame), *Boehmeria grandis* (akolea), *Broussaisia arguta* (kanawao), *Christella cyatheoides* (kikawaio), *Cibotium chamissoi* (hapuu), *Cyrtandra* spp., *Diospyros* sp. (lama), *Dubautia* sp., *Metrosideros polymorpha* (ohia), *Microsorum spectrum* (peahi), *Perrottetia sandwicensis* (olomea), *Pipturus albidus* (mamaki), *Pisonia umbellifera* (papala kepau), *Psychotria* sp. or *Touchardia latifolia* (olona). The plant community, associated species, and elevations are indicative of important features such as soil moisture, nutrient cycling and availability, temperature ranges, and light levels that are included as primary constituent elements of the habitat required for the conservation of this species (68 FR 35950).

The threats to critical habitat for *Cyanea crispa* include habitat destruction and/or degradation by feral pigs and habitat alteration by aggressive non-native plants such as *Arthrostemma ciliatum, Clidemia hirta, Psidium cattleianum* (strawberry guava), *Psidium guajava* (guava), *Pterolepis glomerata, Rubus rosifolius* (thimbleberry), *Schinus terebinthifolius* (Christmas berry), *Setaria palmifolia* (palmgrass), and *Zingiber zerumbet* (awapuhi) (68 FR 35950).

Critical Habitat for *Cyanea st.-johnii* (Haha)

Critical habitat for *Cyanea st.-johnii* was designated on Federal, state, and private land on June 17, 2003, in two separate units (Oahu 20—*Cyanea st.-johnii*—a and Oahu 35—*Cyanea st.-johnii*—b) totaling 832 ha (2,057 ac). Both units are occupied; unit a provides habitat for three populations (of 300 mature reproducing individuals) and unit b provides habitat for six populations (68 FR 35950).

The primary constituent elements for these units are wet, windswept slopes and ridges in *Metrosideros polymorpha* mixed lowland shrubland or *M. polymorpha-Dicranopteris linearis* (uluhe) lowland shrubland that are between 461 and 959 m (1,512 and 3,146 ft) in elevation, and contain one or more of the following associated native plant species: *Alyxia oliviformis* (maile), *Antidesma* sp., *Bidens macrocarpa* (kookolau), *Broussaisia arguta*, *Chamaesyce clusiifolia* (akoko), *Cibotium* sp., *Dubautia laxa*, *Freycinetia arborea* (ieie), *Hedyotis* sp., *Labordia* sp., *Machaerina angustifolia* (uki), *Melicope* sp., *Psychotria* sp., *Sadleria pallida* (amau), *Scaevola mollis* (naupaka kuahiwi), or *Syzygium sandwicensis* (ohia ha). The plant community, associated species, and elevations are indicative of important features such as soil moisture, nutrient cycling and availability, temperature ranges, and light levels that are included as primary constituent elements of the habitat required for the conservation of this species (68 FR 35950).

The threats to critical habitat for *Cyanea st.-johnii* include habitat destruction and/or degradation by feral pigs and habitat alteration by aggressive non-native plants such as *Andropogon virginicus* (broomsedge), *Axonopus fissifolius* (narrow-leaved carpetgrass), *Clidemia hirta*, and *Sacciolepis indica* (Glenwood grass). Rats, slugs, and snails also threaten the habitat by predating on seeds and plant parts of the native vegetation in the habitat (68 FR 35950).

Critical Habitat for *Lobelia oahuensis*

Critical habitat for *Lobelia oahuensis* was designated on Federal, state, and private lands on June 17, 2003, in two separate units (Oahu 20—*Lobelia oahuensis*—a and Oahu 35—*Lobelia oahuensis*—b) totaling 644 ha (1,592 ac). Both units are occupied; unit a provides habitat for seven populations (of 300 mature reproducing individuals) and unit b provides habitat for three populations (68 FR 35950).

The primary constituent elements for these units are steep slopes on summit cliffs in cloudswept wet forests or in lowland wet shrubland that are frequently exposed to heavy wind and rain that are between 415 and 959 m (1,361 and 3,146 ft) in elevation, and contain one or more of the following associated native plant species: *Bidens* sp., *Broussaisia arguta*, *Cheirodendron trigynum* (lapalapa), *Cibotium* sp., *Dicranopteris linearis*, *Dubautia laxa* (naenae pua melemele), *Freycinetia arborea*, *Hedyotis* sp., *Labordia hosakana* (kamakahala), *Lycopodium* sp., *Machaerina angustifolia*, *Melicope* sp., *Metrosideros polymorpha*, *Peperomia* sp., *Phyllostegia* sp., *Sadleria squarrosa*, *Scaevola* sp., *Syzygium sandwicensis*, *Vaccinium* sp., or *Wikstroemia* sp. The plant community, associated species, and elevations are indicative of important features such as soil moisture, nutrient cycling and availability, temperature ranges, and light levels that are included as primary constituent elements of the habitat required for the conservation of this species (68 FR 35950).

The threats to critical habitat for *Lobelia oahuensis* include habitat destruction and/or degradation by feral pigs and habitat alteration by aggressive non-native plants such as *Clidemia hirta*, *Erigeron karvinskianus* (daisy fleabane), *Paspalum conjugatum* (Hilo grass), *Rubus argutus* (prickly Florida blackberry), and *Rubus rosifolius* (68 FR 35950).

Critical Habitat for *Sanicula purpurea* (Snakeroot)

Critical habitat for *Sanicula purpurea* was designated on Federal, state, and private land on June 17, 2003, in four separate units totaling 1,051 ha (2,597 ac). Three units (Oahu 20—*Sanicula purpurea*—a, Maui 17—*Sanicula purpurea*—b, and Maui 17—*Sanicula purpurea*—c) are currently occupied and one unit (Maui 17—*Sanicula purpurea*—a) is currently unoccupied. Critical habitat unit Oahu a provides habitat for four populations (of 300 mature, reproducing individuals), Maui b provides habitat for three populations, and units Maui a and Maui c combined provide habitat for one population (68 FR 25934, 68 FR 35950).

The primary constituent elements for these units are open *Metrosideros polymorpha* mixed montane bogs or windswept shrublands within the cloud zone that are between 415 and 871 m (1,361 and 2,857 ft) in elevation, and contain one or more of the following associated native plant species: *Bidens* sp., *Cheirodendron* sp., *Dichanthelium koolauense*, *Gahnia beecheyi*, *Leptecophylla tameiameiae* (pukiawe), *Lycopodium* sp., *Machaerina angustifolia*, *Plantago pachyphylla* (laukahi kuahiwi), *Sadleria pallida*, or *Vaccinium* sp. The plant community, associated species, and elevations are indicative of important features such as soil moisture, nutrient cycling and availability, temperature ranges, and light levels that are included as primary constituent elements of the habitat required for the conservation of this species (68 FR 35950).

The threats to critical habitat on Oahu for *Sanicula purpurea* include habitat destruction and/or degradation by feral pigs and habitat alteration by aggressive non-native plants such as *Axonopus fissifolius* and *Clidemia hirta* (68 FR 35950).

Critical Habitat for *Tetraplasandra gymnocarpa* (Oheohe)

Critical habitat for *Tetraplasandra gymnocarpa* was designated on Federal, state, and private land on June 17, 2003, in six separate units (Oahu 20—*Tetraplasandra gymnocarpa*—a, Oahu 20—*Tetraplasandra gymnocarpa*—b, Oahu 20—*Tetraplasandra gymnocarpa*—c, Oahu 20—*Tetraplasandra gymnocarpa*—d, Oahu 35—*Tetraplasandra gymnocarpa*—e, and Oahu 35—*Tetraplasandra gymnocarpa*—f) totaling 1,942 ha (4,799 ac). Each is occupied and provides habitat for one population of 100 mature, reproducing individuals (68 FR 35950).

The primary constituent elements for these units are windswept summit ridges, slopes, or gullies in wet or sometimes mesic lowland forests or shrublands that are between 93 and 959 m (305 and 3,146 ft) in elevation, and contain one or more of the following associated native plant species: *Acacia koa* (koa), *Antidesma platyphyllum*, *Bidens* sp., *Bobea elatior* (ahakea lau nui), *Broussaisia arguta*, *Cheirodendron* sp., *Cibotium chamissoi*, *Cibotium* sp., *Cyanea humboldtiana* (haha), *Dicranopteris linearis*, *Diplopterygium pinnatum* (uluhe lau nui), *Dubautia laxa*, *Freycinetia arborea*, *Hedyotis fosbergii* (manono), *H. terminalis* (manono), *Labordia* sp., *Lobelia hypoleuca* (kuhiaikamowahine), *Machaerina angustifolia*, *Melicope* spp., *Metrosideros polymorpha*, *Myrsine fosbergii* (kolea), *Pouteria sandwicensis* (alaa), *Psychotria* spp., *Sadleria* sp., *Syzygium sandwicensis*, *Tetraplasandra oahuensis* (ohe mauka), or *Wikstroemia* sp. The plant community, associated species, and elevations are indicative of important features such as soil moisture, nutrient cycling and availability, temperature ranges, and light levels that are included as primary constituent elements of the habitat required for the conservation of this species (68 FR 35950).

The threats to critical habitat for *Tetraplasandra gymnocarpa* include habitat destruction and/or degradation by feral pigs and habitat alteration by aggressive non-native plants such as *Aleurites moluccana* (kukui), *Araucaria columnaris* (Cook Island pine), *Ardisia elliptica* (shoebutton Ardisia), *Axonopus fissifolius*, *Clidemia hirta*, *Erigeron karvinskianus*, *Eucalyptus* sp., *Paspalum conjugatum*, *Psidium cattleianum*, *Pterolepis glomerata*, *Sacciolepis indica*, and *Setaria palmifolia*. The non-native two-spotted leafhopper (*Saphonia rufofascia*) also threatens the habitat by feeding on and damaging the native vegetation in the habitat (68 FR 35950).

Critical Habitat for *Trematolobelia singularis*

Critical habitat for *Trematolobelia singularis* was designated on Federal, state, and privates lands on June 17, 2003, in five separate units totaling 140 ha (347 ac). Two units (Oahu 20—*Trematolobelia singularis*—a and Oahu 34—*Trematolobelia singularis*—c) are unoccupied, and three units (Oahu 20—*Trematolobelia singularis*—b, Oahu 35—*Trematolobelia singularis*—d, and Oahu 35—*Trematolobelia singularis*—e) are occupied. Unit a provides habitat for two populations (of 300 mature reproducing individuals) and units b through e provide habitat for one population each (68 FR 35950).

The primary constituent elements for these units are steep, windswept cliff faces or slopes in *Metrosideros polymorpha-Dicranopteris linearis* lowland wet shrubland that are between 545 and 953 m (1,788 and 3,126 ft) in elevation, and contain one or more of the following associated native plant species: *Broussaisia arguta*, *Cibotium* sp., *Dubautia laxa*, *Eugenia* sp., *Melicope* sp., *Sadleria* sp., or *Wikstroemia* sp. The plant community, associated species, and elevations are indicative of important features such as soil moisture, nutrient cycling and availability, temperature ranges, and light levels that are included as primary constituent elements of the habitat required for the conservation of this species (68 FR 35950).

The threats to critical habitat for *Trematolobelia singularis* include habitat destruction and/or degradation by feral pigs and habitat alteration by the aggressive non-native plant *Clidemia hirta*. Rats and slugs also threaten the habitat by predating on seeds and plant parts of the native vegetation in the habitat (68 FR 35950).

Critical Habitat for *Viola oahuensis*

Critical habitat for *Viola oahuensis* was designated on Federal, state, and private lands on June 17, 2003, in two separate units totaling 977 ha (2,418 ac). One unit (Oahu 20—*Viola oahuensis*—a) is occupied and one unit (Oahu 35—*Viola oahuensis*—b) is unoccupied. Unit a provides habitat for six populations (of 300 mature reproducing individuals) and unit b provides habitat for one population (68 FR 35950).

The primary constituent elements for these units are exposed, windswept ridges of moderate to steep slope in wet *Metrosideros polymorpha-Dicranopteris linearis* shrublands or *M. polymorpha* mixed montane bogs in the cloud zone that are between 415 and 959 m (1,361 and

3,146 ft) in elevation, and contain one or more of the following associated native plant species: *Antidesma* sp., *Bidens macrocarpa*, *Broussaisia arguta*, *Cibotium* sp., *Dubautia laxa*, *Hedyotis terminalis*, *Labordia* sp., *Machaerina* sp., *Melicope* sp., *Sadleria* sp., *Syzygium sandwicensis*, *Vaccinium* sp., or *Wikstroemia* sp. The plant community, associated species, and elevations are indicative of important features such as soil moisture, nutrient cycling and availability, temperature ranges, and light levels that are included as primary constituent elements of the habitat required for the conservation of this species (68 FR 35950).

The threats to critical habitat for *Viola oahuensis* include habitat destruction and/or degradation by feral pigs and habitat alteration by aggressive non-native plants such as *Axonopus fissifolius*, *Clidemia hirta*, *Paspalum conjugatum*, *Psidium cattleianum*, and *Pterolepis* sp. Military activity also threatens some portions of designated critical habitat (68 FR 35950).

ENVIRONMENTAL BASELINE

The environmental baseline describes the status of the species and factors affecting the environment of the critical habitat in the proposed action area during the consultation process. The baseline usually includes state, local, and private actions that affect a species or its critical habitat at the time the consultation begins. Unrelated Federal actions that have already undergone formal or informal consultations are also a part of the environmental baseline. Federal actions within the action area that may benefit listed species for critical habitat are also included in the environmental baseline; however, no conservation actions are being conducted in the action area. The environmental baseline describes the species' health at a specified point in time, and it does not include the effects of the action under review in this consultation.

Critical Habitat for *Cyanea crispa*

A small amount (0.005 percent (0.18 ha; 0.45 ac)) of critical habitat for *Cyanea crispa* is located in the action area (Figure 1, page 18). The critical habitat in the action area, in combination with approximately 1,831 ha (4,525 ac) of habitat outside the Navy action area, provides for the conservation of three populations of *C. crispa* with 300 mature reproducing individuals (68 FR 35950).

The major threats to the primary constituent elements in the action area are landslides and non-native plants such as *Clidemia hirta*, *Pterolepis glomerata*, and *Rubus rosifolius*. Non-native plants compete for light, space, and nutrients with the associated native plant species.

Critical Habitat for *Cyanea st.-johnii*

A small amount (0.009 percent (0.07 ha; 0.18 ac)) of critical habitat for *Cyanea st.-johnii* is located in the action area (Figure 2, page 19). The critical habitat in the action area, in combination with approximately 697 ha (1,723 ac) of habitat outside the action area, provides for the conservation of three populations of *C. st.-johnii* each with 300 mature reproducing individuals (68 FR 35950).

The major threats to the primary constituent elements of the critical habitat in the action area are landslides and non-native plants such as *Axonopus fissifolius*, *Clidemia hirta*, and *Sacciolepis indica*. Non-native plants compete for light, space, and nutrients with the associated native plant species.

Critical Habitat for *Lobelia oahuensis*

A small amount (0.011 percent (0.07 ha; 0.18 ac)) of critical habitat for *Lobelia oahuensis* is located in the action area (Figure 3, page 20). The critical habitat in the action area, in combination with approximately 493 ha (1,218 ac) of habitat outside the Navy action area, provides for conservation of seven populations of *L. oahuensis* with 300 mature, reproducing individuals.

The major threats to the primary constituent elements of the critical habitat in the action area are landslides and non-native plants such as *Clidemia hirta*, *Erigeron karvinskianus*, and *Paspalum conjugatum*. Non-native plants compete for light, space, and nutrients with the associated native plant species.

Critical Habitat for *Sanicula purpurea*

A small amount (0.042 percent (0.07 ha; 0.18 ac)) of critical habitat for *Sanicula purpurea* is located in the action area) (Figure 3, page 20). The critical habitat in the action area, in combination with approximately 704 ha (1,739 ac) of habitat outside the action area, provides for conservation of four populations of 300 mature reproducing individuals (68 FR 35950).

The major threats to the primary constituent elements of the critical habitat in the action area are landslides and the non-native plant *Axonopus fissifolius*. Non-native plants compete for light, space, and nutrients with the associated native plant species.

Critical Habitat for *Tetraplasandra gymnocarpa*

A small amount (0.009 percent (0.18 ha; 0.45 ac)) of critical habitat for *Tetraplasandra gymnocarpa* is located in the action area (Figure 4, page 21). The critical habitat in the action area, in combination with approximately 362 ha (894 ac) of habitat outside the action area, provides for conservation of one population of 100 mature reproducing individuals (68 FR 35950).

The major threats to the primary constituent elements of critical habitat in the action area are landslides and non-native plants such as *Axonopus fissifolius*, *Clidemia hirta*, *Erigeron karvinskianus*, *Paspalum conjugatum*, *Pterolepis glomerata*, and *Sacciolepis indica*. Non-native plants compete for light, space, and nutrients with associated native plant species.

Critical Habitat for *Trematolobelia singularis*

A small amount (0.023 percent (0.03 ha; 0.08 ac)) of critical habitat for *Trematolobelia singularis* is located in the action area (Figure 5, page 22). The critical habitat in the action area, in combination with approximately 89 ha (219 ac) of habitat outside the action area, provides for conservation of two populations of 300 mature, reproducing individuals (68 FR 35950).

The major threats to the primary constituent elements of critical habitat in the action area are landslides and the non-native plant *Clidemia hirta*. Non-native plants compete for light, space, and nutrients with associated native plant species.

Critical habitat For *Viola oahuensis*

A small amount (0.007 percent (0.07 ha; 0.18 ac)) of critical habitat for *Viola oahuensis* is located in the action area (Figure 3, page 20). The critical habitat in the action area, in combination with approximately 903 ha (2,232 ac) of habitat outside the action area, provides for conservation of six populations of 300 mature reproducing individuals (68 FR 35950).

The major threats to the primary constituent elements of critical habitat in the action area are landslides and non-native plants such as *Axonopus fissifolius*, *Clidemia hirta*, *Paspalum conjugatum*, and *Pterolepis* sp. Non-native plants compete for light, space, and nutrients with associated native plant species.

EFFECTS OF THE ACTION ON CRITICAL HABITAT

General Impact Statement

This section outlines impacts the recovery activities will have on critical habitat for seven plant species. Because the proposed action will impact all critical habitat similarly, we are analyzing the species collectively as a group. We have determined that the proposed action will directly impact the primary constituent elements of soil and associated native plant species. The direct effects to soil include removal, wet screening, and its return to the site or replacement with soil from off-site. The direct effects to the native plant species include their destruction and/or removal, pruning, and trampling in adjacent areas. There may be indirect effects to critical habitat due to removal of soil and vegetation which may trigger landslides and erosion. In addition, movement of recovery crews and equipment at helicopter landing zones, on trails, and on the recovery site proper, may spread seeds of non-native plants that will degrade the habitat. Increased human traffic and trash in critical habitat may attract rodents which feed on plant parts fruits, and seeds. Minimization and avoidance measures for these activities are summarized above.

The proposed project action area is completely contained in critical habitat units Oahu 20—*Cyanea crispa*—b and Oahu 20—*Tetraplasandra gymnocarpa*—d and partially intersects with units Oahu 20—*Cyanea st.-johnii*—a, Oahu 20—*Lobelia oahuensis*—a, Oahu 20—*Sanicula purpurea*—a, Oahu 20—*Trematolobelia singularis*—a, and Oahu 20—*Viola oahuensis*—a (see Figures 1-5). The amount of critical habitat affected by the proposed project ranges from 0.002 to 0.023 percent of the total critical habitat for each species, and 0.008 to 0.050 percent of the individual units affected.

Table 1. Critical habitat affected by the proposed action.

Critical Habitat	Unit's Acres	Statewide acres	Acres Affected	Percent of Unit Affected	Percent State-wide CH Affected
Cyanea crispa	4,525	18,102	0.45	0.010	0.002
Cyanea st.-johnii	1,723	2,057	0.18	0.010	0.009
Lobelia oahuensis	1,218	1,592	0.18	0.015	0.011
Sanicula purpurea	1,739	2,597	0.18	0.010	0.007
Tetraplasandra gymnocarpa	894	4,799	0.45	0.050	0.009
Trematolobelia singularis	219	347	0.08	0.037	0.023
Viola oahuensis	2,232	2,418	0.18	0.008	0.007

The action area contains some primary constituent elements that will be affected by the proposed action, particularly soil and native plant species. The vegetation of the area is mostly comprised of native species (68%), but there are also some non-native species in the area, some that are considered threats to the affected critical habitat units.

The timeframe for the proposed action for the remains recovery and for habitat restoration work, if conducted concurrently, is four to six weeks. This timeframe may lengthen, depending on weather conditions. The proposed action will cause direct adverse effects to the primary constituent elements in the seven critical habitat units with which the action area intersects. These effects include destruction and removal of vegetative primary constituent elements, vegetation trampling and modification (pruning), disruption and removal of soil, soil erosion, and invasive species (weed and rat) introduction or spread.

Effects to Associated Native Plants Species
(a) Removal of Native Plant Species
The native vegetation will be directly adversely affected in three ways. In the 0.04 ha (0.1 ac) remains recovery site proper, vegetation will be removed so that soil can be removed and screened. This will happen in two critical habitat units (20—*Cyanea crispa*—b and Oahu 20—*Tetraplasandra gymnocarpa*—d). Though there will be complete destruction of the existing native plants, the vegetation will be replaced with native plant species within four to six weeks of completion of the remains recovery activities. Only native plant species historically or currently known from the project area will be used for revegetation. It is assumed that the revegetation process will be at least 60 percent successful (US Navy 2005). Minimization measures for this action are outlined in the conservation measures of this biological opinion.

(b) Pruning
Vegetation, both non-native and native, in helicopter landing zone, on trails, and in the remains recovery site proper will be pruned for safety reasons. Cutting of vegetation may provide points of entry for pathogens or insects, and has a dwarfing affect on woody species. However, these impacts are expected to be minimal and temporary in nature. It is assumed for the purpose of this analysis that the naturally dwarfed (wind-pruned) woody species in the action area are adapted to occasional pruning and will recover.

(c) Trampling
Recovery crews can directly crush a plant in and around helicopter landing zones, on the trails, and in the remains recovery site proper. Repeated use of these areas will result in some vegetation death, and may create muddy pathways. Plants that are trampled but not killed outright are expected to recover, similar to those affected by strong winds and rains (a common occurrence in the action area). Measures to minimize trampling of native plants are outlined in the conservation measures section of this biological opinion.

Effects to Soil
Soil will be directly adversely impacted by removal, wet screening, and replacement. In the remains recovery area soil will be removed to a depth of approximately 15 cm (6 in) over an area of approximately 0.04 ha (0.1 ac), totaling approximately 60 cubic m (79 cubic yd). Soil will be removed from units Oahu 20—*Cyanea crispa*—b and Oahu 20—*Tetraplasandra gymnocarpa*—d over a period of approximately four to six weeks. The soil will either be wet screened on-site or off-site. Soil that is wet screened on-site will be returned to the remains recovery site. Soil taken off-site for wet screening will be replaced by soil from an on-site landslide or from an off-site location. Measures to minimize the effects of soil removal and wet screening are outlined in the conservation measures section of this biological opinion. These measures, in combination with the relatively short time period of soil disturbance and small area to be disturbed, reduce the adverse impact to the critical habitat.

Indirect Effects to Primary Constituent Elements
(a) Landslides
Landslides are common in and around the action area as evidenced by the recent landslide adjacent to the action area (Navy 2005), indicating the habitat is adapted to soil disturbance to some degree. It is assumed for the purpose of this analysis that the remains recovery site proper will be similar to a natural landslide during the time of the dig (*i.e.*, temporary loss of vegetation and soil). However, areas that have experienced natural landslides are rarely, if at all, have their soil replaced or are revegetated with native plant species, as the Navy has committed to do in the action area. Additional measures to minimize the effects of landslides are outlined in the conservation measures section of this biological opinion.

(b) Erosion
Altering vegetation by removal, cutting, and pruning at helicopter landing zones and on trails may result in soil compaction, and loss or erosion of soil, particularly during wet weather. Soil erosion may also occur through destabilization of the soil from large-scale vegetation and soil removal in the recovery site proper. Measures to minimize the impacts of soil erosion are outlined in the conservation measures section of this biological opinion.

(c) Non-native species
The proposed project may increase the presence of non-native invasive animal and plant species in the action area.

1) Rats and Mice
Rats and mice may be attracted to trash left on-site. Rodents have been shown to eat plants and the fruits and/or seeds of native plants species, especially plants in the lobelia, palm, and African violet families (Cuddihy and Stone 1990). Rats threaten the associated native plants in critical habitat units Oahu 20—*Cyanea st.-johnii*—a and Oahu 20—*Trematolobelia singularis*—a and are assumed to threaten the other critical habitat units in the action area (68 FR 35950). Measures to minimize the impacts of rats and mice are outlined in the conservation measures section of this biological opinion.

2) Non-native Plants
An increase in non-native plants in the action area may result from the disturbance activities such as soil and vegetation removal, human foot traffic, movement of equipment into the action area, and replacement of excavated soil. Non-native invasive plants compete with native plant species for light, nutrients, and space and impact the associated native plant species both directly through competition and indirectly through alteration of the critical habitat. Measures to minimize the inadvertent introduction of new non-native plants to the action area and to prevent the influx of non-native plants from adjacent areas are outlined in the conservation measures section of this biological opinion. These measures will result in either less or similar concentrations of non-native plants in the action area resulting in either better or similar ability of the habitat to provide for recovery of the species for which the area was designated critical habitat.

Cumulative Effects

Cumulative effects include the effects of future State, local, or private actions that are reasonably certain to occur in the action area considered in this biological opinion. Future Federal actions that are unrelated to the proposed action are not considered in this section because they require separate consultation pursuant to section 7 of the Act. We are unaware of any specific future actions that are or will occur within the action area considered in this biological opinion.

CONCLUSION

After reviewing the current status of the critical habitat for *Cyanea crispa*, *C. st.-johnii*, *Lobelia oahuensis*, *Sanicula purpurea*, *Tetraplasandra gymnocarpa*, *Trematolobelia singularis*, and *Viola oahuensis*, the environmental baseline for critical habitats in the action area, the effects of the proposed aviator recovery activities in upper Halawa Valley on the island of Oahu, and the cumulative effects, it is the Service's biological opinion that the aviator recovery activities, as proposed, are not likely to destroy or adversely modify designated critical habitat for these seven species.

There is an adverse effect to critical habitat and primary constituent elements due to the proposed action. Our determination that adverse modification or destruction of critical habitat should not occur is based largely on the Navy's multiple actions, described in the conservation measures section of this biological opinion, to minimize and reduce the effects of removal of native vegetation and soil, cutting and trampling of native plants, landslides, and erosion; to prevent the inadvertent introduction and spread of non-native species; and to maintain or increase the current

baseline for primary constituent elements of critical habitat through habitat restoration. Any losses that occur after implementation of the proposed action will be short term in nature, occur in a very small percentage of designated critical habitats, and will not result in permanent destruction of the physical and biological features of critical habitat.

CONSERVATION RECOMMENDATIONS

Section 7(a)(1) of the Endangered Species Act directs Federal agencies to utilize their authorities to further the purposes of the Act by carrying out conservation programs for the benefit of endangered and threatened species. Conservation recommendations are discretionary agency activities to minimize or avoid adverse effects of a proposed action on listed species or critical habitat, to help implement recovery plans, or to develop information. The recommendations provided relate only to the proposed action and do not necessarily represent complete fulfillment of the Army's section 7(a)(1) responsibilities for the species.

1) The Navy should manage the vegetation in the restored sites until it is deemed successful.
2) The Navy should photo document and monitor the revegetation efforts and report to the Service.
3) The Navy should identify the existing seed bank from excavated soil.
4) The Navy should survey and monitor for rodents and eradicate, if necessary.
5) The Navy should fund research on slope revegetation methodology.

In order for the Service to be kept informed of actions minimizing or avoiding adverse effects or benefiting listed species or their habitats, the Service requests notifications of the implementation of any conservation recommendations.

REINITATION NOTICE

This concludes formal consultation on this action. As required in 50 CFR § 402.16, reinitiation of consultation is required where discretionary Federal agency involvement or control over the action has been retained (or is authorized by law) and if: (1) the amount or extent of incidental take is exceeded; (2) new information reveals effects of the agency action that may affect listed species or critical habitat in a manner or to an extent not considered in this opinion; (3) the agency action is subsequently modified in a manner that causes an effect to the listed species or critical habitat not considered in this opinion; or (4) a new species is listed or critical habitat designated that may be affected by the action. In instances where the amount or extent of incidental take is exceeded, any operation causing such take must cease pending reinitiation.

As stated in the conclusion (above), the Service's finding of no adverse modification is based in large part on the conservation measures built into the project by the Navy. Should there be a failure to carry out any or all of the described measures, or if the measures are not effective, or if these measures are modified in any way without Service coordination, reinitiation of consultation will be required.

In future communications on this project, please refer to consultation number 1-2-2005-F-172. If you have any questions regarding this biological opinion, please contact Gregory A. Koob or my staff at (808) 792-9400.

Sincerely,

Patrick Leonard

Patrick Leonard
Field Supervisor

This page is intentionally left blank.

Figure 1. Action area and *Cyanea crispa* critical habitat in relation to the proposed remains recovery project.

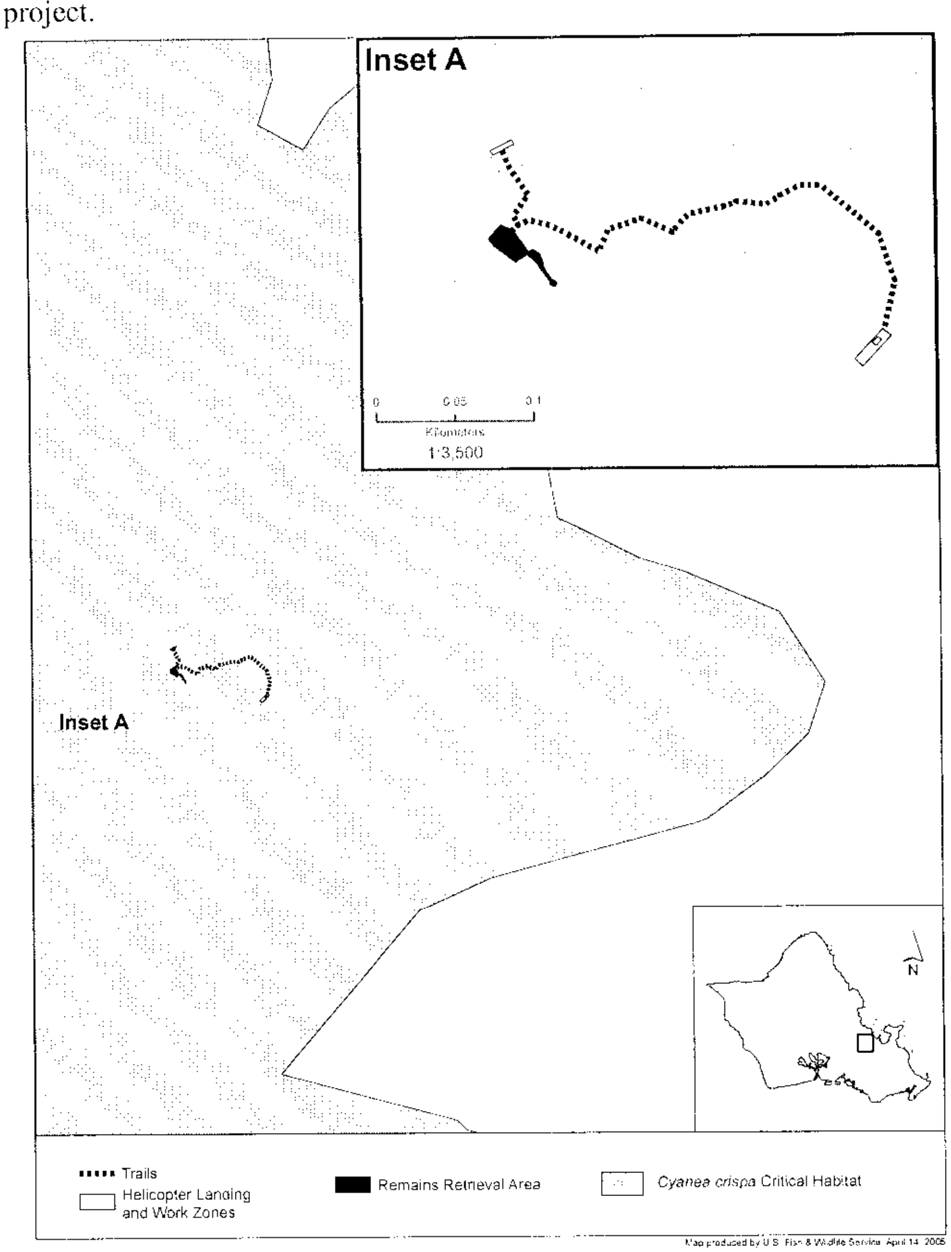


Figure 2. Action area and *Cyanea st.-johnii* critical habitat in relation to the proposed remains recovery project.

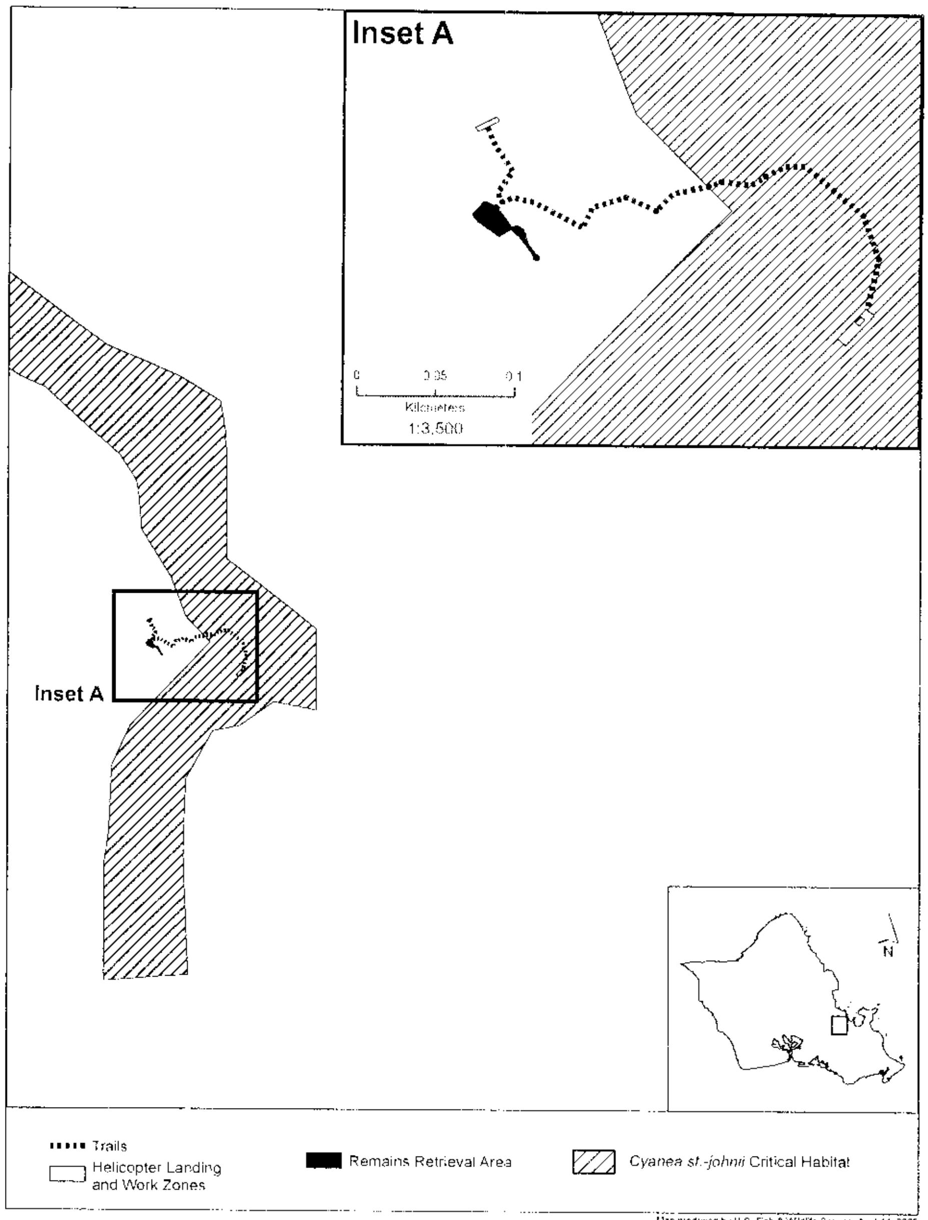


Figure 3. Action area and *Lobelia oahuensis, Sanicula purpurea,* and *Viola oahuensis* critical habitats in relation to the proposed remains recovery project.

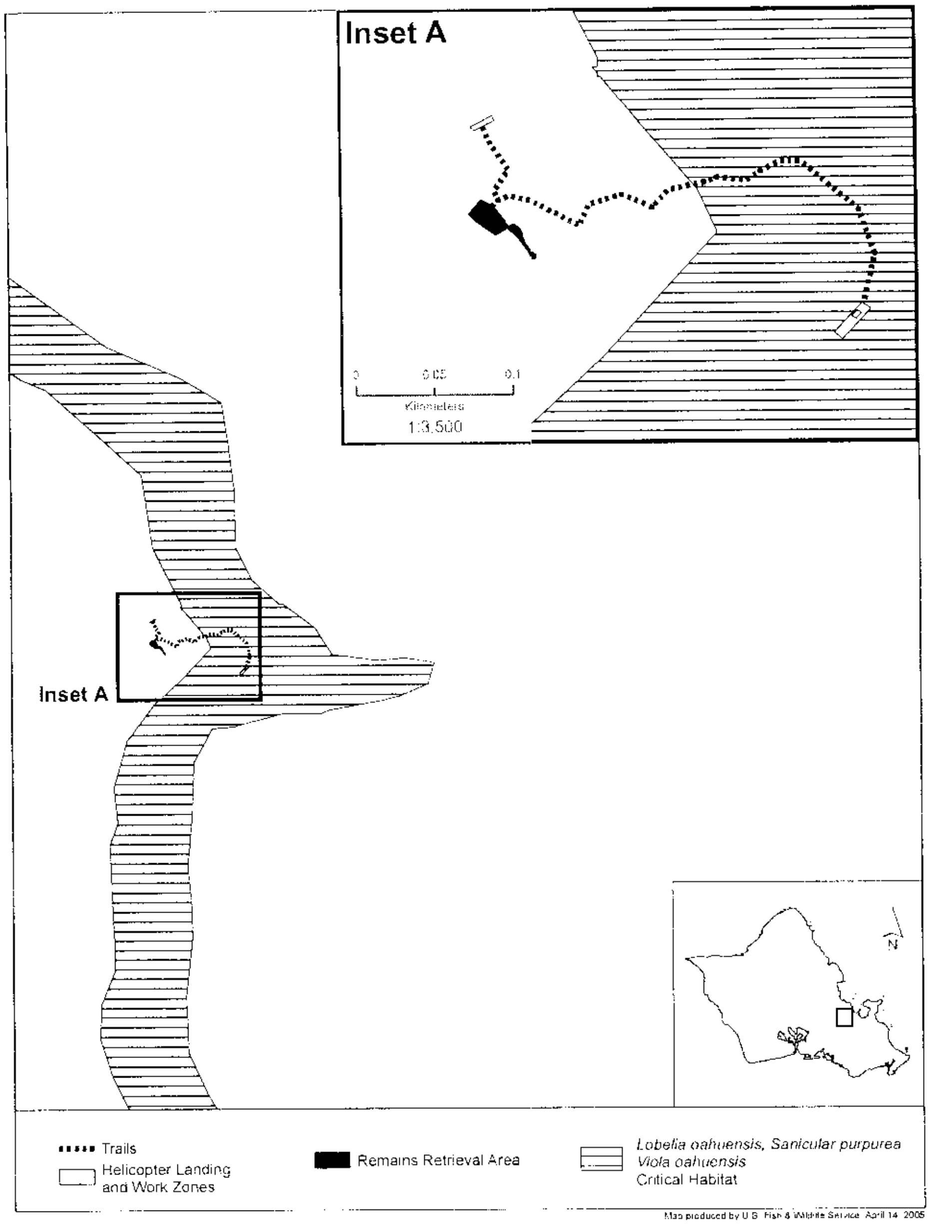


Figure 4. Action area and *Tetraplasandra gymnocarpa* critical habitat in relation to the proposed remains recovery project.

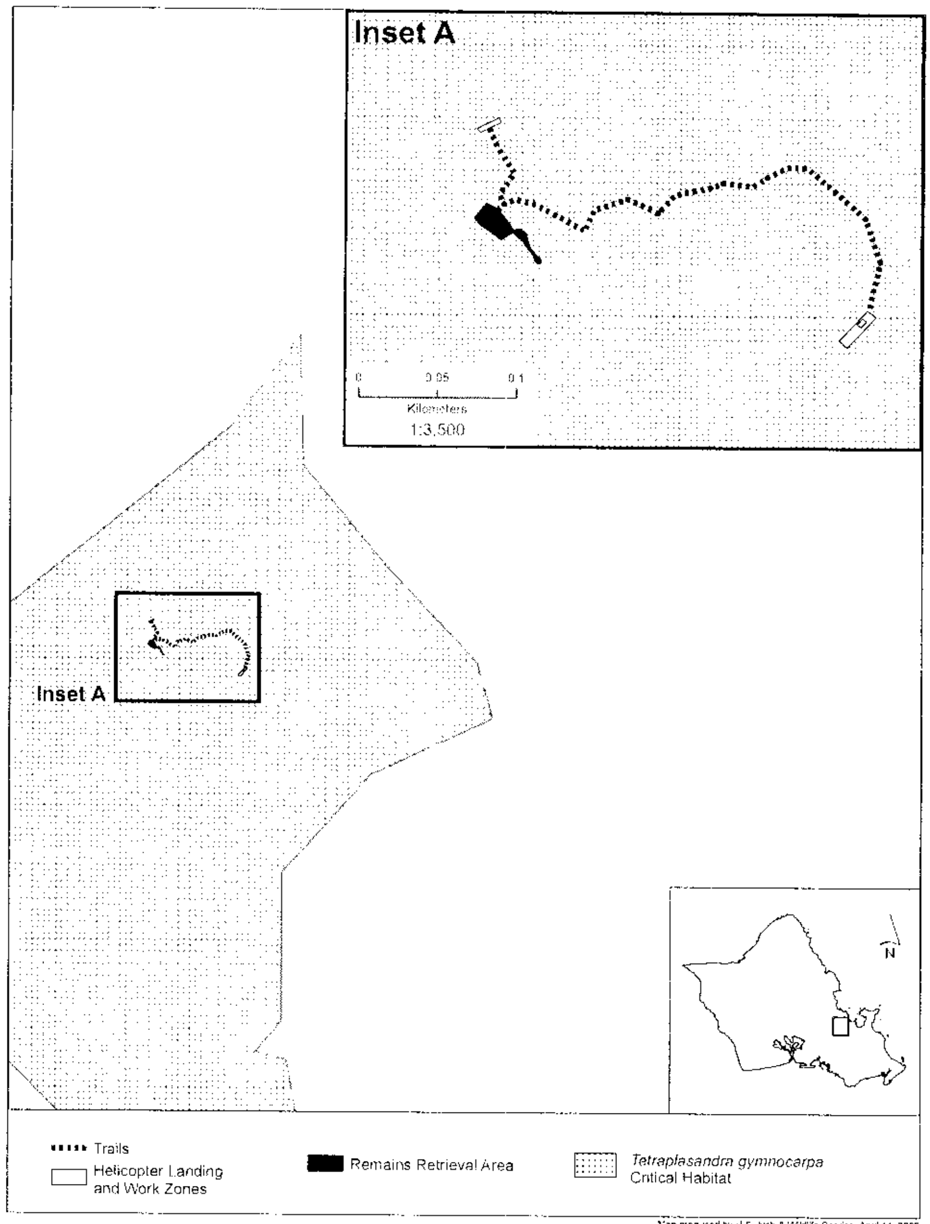
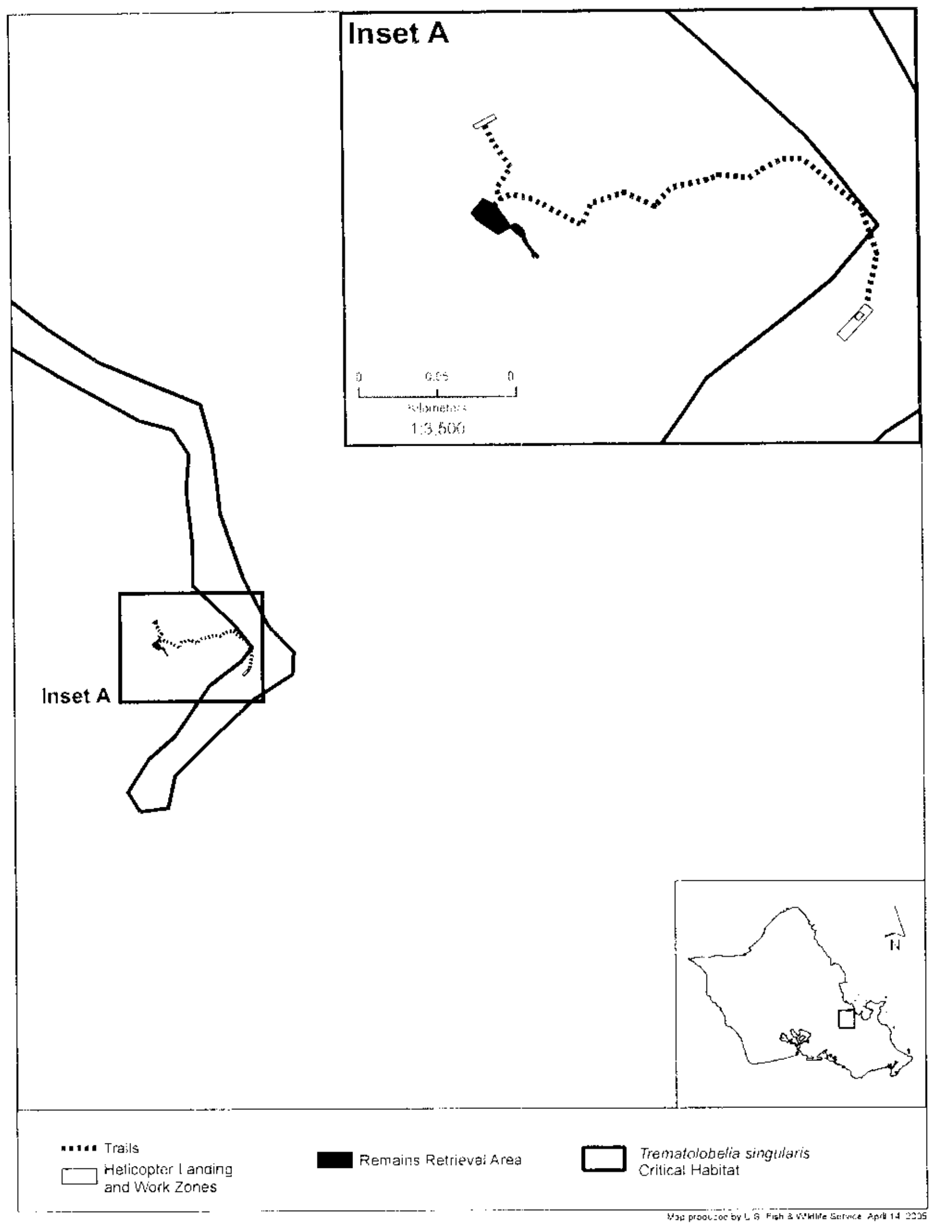


Figure 5. Action area and *Trematolobelia singularis* critical habitat in relation to the proposed remains recovery project.



LITERATURE CITED

Cuddihy, L.W., C.P. Stone. 1990. Alteration of native Hawaiian vegetation. Honolulu, HI: University of Hawaii Cooperative National Park Resources Studies Unit.

U.S. Navy. 2005. Biological Survey Report, Prepared in Support of the Aviator Recovery Environmental Assessment, Kooalu Mountains, Halawa Valley, Oahu, Hawaii. Commander Navy Region Hawaii.

Federal Register Publications

(68 FR 25934) Endangered and threatened wildlife and plants; designation of critical habitat for 60 plant species from the islands of Maui and Kahoolawe, HI; final rule. Department of the Interior, Fish and Wildlife Service, 50 CFR part 17. May 14, 2003. Federal Register 68 (93): 25934.

(68 FR 35950) Endangered and threatened wildlife and plants; final designations or nondesignations of critical habitat for 101 plant species from the island of Oahu, HI; final rule. Department of the Interior, Fish and Wildlife Service, 50 CFR part 17, June 17, 2003. Federal Register 68 (116): 35950.

[This Page Intentionally Left Blank]

DEPARTMENT OF THE NAVY
NAVAL FACILITIES ENGINEERING COMMAND, PACIFIC
258 MAKALAPA DR., STE. 100
PEARL HARBOR, HAWAII 96860-3134

11015.1A2H
Ser EV337 302
10 MAR 2005

Ms. Gina Shultz
Acting Field Supervisor
U. S. Fish and Wildlife Service
Pacific Islands Ecoregion
Box 50088
Honolulu, HI 96850

Dear Ms. Shultz:

Subj: INITIATION OF FORMAL ESA SECTION 7 CONSULTATION: AVIATOR RECOVERY, UPPER HALAWA VALLEY, OAHU, HAWAI'I

The Navy requests initiation of formal consultation with the U.S. Fish and Wildlife Service (Service) in accordance with section 7 of the Endangered Species Act of 1973 (ESA). The Joint Prisoner of War – Missing in Action Accounting Command (JPAC) proposes to recover the remains and personal effects of a Naval aviator who crashed into the Ko'olau Mountains while on a training flight in June 1944. The project site is located in the upper Halawa Valley, below the Ko'olau Mountain ridgeline, north of the Honolulu-side entrance to the Highway 3 (H-3) Tunnel on the island of Oahu, Hawai'i. A topographical map detailing the location of the site is provided as Enclosure (1). The land is in the possession of the State of Hawaii Department of Transportation. The Navy is coordinating environmental compliance for JPAC.

A biological survey of the crash site and its vicinity was completed in February 2005. A copy of the survey report, "Biological Survey Report Prepared In Support Of The Aviator Recovery Environmental Assessment, February 2005," is provided as Enclosure (2). Although no species of plants or animals listed or proposed for listing pursuant to the ESA were discovered, the site falls within areas included with the June 17, 2003, Federal Register final rule designating critical habitat for 99 plant species from the island of Oahu. Because the proposed recovery actions may affect designated critical habitat of 7 of these 99 plants, formal consultation is required.

Background Information and Project Description

The surviving member of the aviator's immediate family has requested, via Senator McCain of Arizona, that the family receive information regarding the incident and that the aviator's remains be recovered and returned to his family. JPAC's mission, mandated by the United States Congress, is to achieve the fullest possible accounting of all Americans missing as a result of our nation's previous conflicts. The Proposed Action is needed to meet United States Congressional mandates and to return the remains and personal effects of the Naval aviator to his family. JPAC is a joint-Service unit headquartered at Hickam Air Force Base. Using formal archival research techniques and archaeological methods and overseen by experienced and professional archaeologists, JPAC ensures that the remains of missing United States service members are identified and recovered in a thorough and scientific manner.

The project site is located in rugged terrain in the upper Halawa Valley. Access to the site is very difficult due to its remote location and slopes to, perhaps, greater than 70 degrees. The project site consists of vegetated slopes. Photographs of the site are provided with Enclosures (2) and (3) for your reference.

In late September 2004, a JPAC team conducted a preliminary reconnaissance of the project area. The purpose of the visit was to determine the approximate position of the aircraft debris field and to delineate the approximate locations of key project area features with flagging material and global positioning system (GPS) data points. In addition, the team documented existing site conditions and terrain characteristics with photographs.

The action will require removal of vegetation and excavation and screening of soil to bedrock (estimated average depth of 6 inches (15 centimeters)) from an area at the crash site of up to approximately 478 square yards (400 square meters), or 0.1 acre (0.04 hectare). Personnel will use hand tools to excavate soils. The average 6-inch depth over a 478-square yard area yields an approximate volume of soil of 79 cubic yards (60 cubic meters). Establishing ancillary support areas will require modifying the taller vegetation within an additional 1698 square yards (1420 square meters), or about 0.35 acre (0.14 hectare). This ancillary area will provide for a buffer around an existing helicopter landing pad, an alternative helicopter landing zone, and a footpath from landing zone to the recovery site. In this context, "modifying the taller vegetation" would include cutting taller vegetation at the helicopter landing area to meet safety requirements and unavoidable trampling of vegetation along pathways and at equipment staging areas. Vegetation in these areas may also need to be thinned or cut to allow access. Soils within the ancillary support areas will not be removed or significantly disturbed, but muddy trails from the landing zones to the crash site would be likely as a result of frequent and repeated use during the life of the project.

Due to the nature of the excavated soils, they will need to be wet screened, or washed through a 0.25-inch (0.6-cm) screen with water, to effectively separate recoverable materials. The proposed action may require soil excavated from the crash site to be moved from the site to JPAC's laboratory at Hickam Air Force Base for wet screening. JPAC is also considering an alternative where the excavated soil would be wet-screened on-site. To accomplish this alternative, water for the washing would either be brought in by helicopter or pumped from a stream in the vicinity of the recovery site. Soil recovered in the alternative proposal would remain on site.

JPAC anticipates that recovery actions will begin in summer 2005 and will take approximately 4 to 6 weeks for a crew of up to 15 personnel to complete. The length of the recovery actions is limited to a fixed time period due to seasonal variations in the weather and availability of resources. As the recovery effort proceeds, JPAC personnel will implement temporary erosion control measures, such as anchoring geotextile, burlap, or other soil-stabilizing material over exposed grids, and will place soil-retention barriers down-slope of the disturbed areas. Revegetation and more permanent erosion control will be implemented immediately following the completion of the recovery portion of the project.

Survey Data

In late 2004 and early 2005, biologists surveyed the crash site and the ancillary support areas While the survey focused primarily on plants and snails, other observations of animals were recorded, as well. Of special concern was whether any federally listed or proposed threatened or endangered plants and animals were potentially present in and around the project area. No such species were found. However, native (but not ESA-listed) plants associated with the primary constituent elements of designated critical habitat for plants on Oahu were identified.

Critical Habitat

A final rule designating critical habitat for 99 species of plants on Oahu was published in 2003. Seven of those plants have critical habitats that (1) include the location and elevation of the Proposed Action area and (2) have one or more of the primary constituent elements that define that critical habitat. Primary constituent elements are those physical and biological features that are essential to the conservation of the species. For the 99 Oahu plants, the primary constituent elements are defined based on the habitat features of the areas from which the plant species are reported. These features are described as the type of plant community, associated native plant species, locale information (e.g., steep rocky cliffs, talus slopes, gulches, stream banks, etc.), and elevation.

The following table lists the seven plant critical habitats and provides a summary of those criteria constituting their primary constituent elements. One or more of the plants that define the primary constituent elements of each of the seven species has been documented as occurring within the entire Proposed Action site. The site of the wreckage and the proposed soil removal and screening falls within two of those critical habitat areas (*Cyanea crispa* and *Tetraplasanara gymnocarpa*). The ancillary action areas fall within all seven critical habitats. Enclosure 4 provides eight maps published in the June 17, 2003, Federal Register; one map shows all critical habitat areas island-wide, and the other seven maps provide locations of the critical habitats of the seven species considered in this consultation. Enclosure 5 provides maps generated specifically to show the Proposed Action and ancillary areas and critical habitat overlaps.

Plant Having Critical Habitat	Primary Constituent Elements
Cyanea crispa 6,506 acres (2,634 ha)	slopes, moist gullies, or stream banks in open mesic forests or closed wet forests containing one or more of the following associated native plant species: *Antidesma platyphyllum, Boehmeria grandis, Broussaisia arguta, Christella cyatheoides, Cibotium chamissoi, Cyrtandra* spp., *Diospyros* sp., *Dubautia* sp., *Metrosideros polymorpha, Microsorum spectrum, Perrottetia sandwicensis, Pipturus albidus, Pisonia umbellifera, Psychotria* sp. *or Touchardia latifolia.* Elevations between 56 and 959 m (184 and 3,146 ft).
Cyanea st.-johnii 5,020 acres (2,031 ha)	wet, windswept slopes and ridges in *Metrosideros polymorpha* mixed lowland shrubland or *Metrosideros polymorpha-Dicranopteris linearis* lowland shrubland and containing one or more of the following associated native plant species: *Alyxia oliviformis, Antidesma* sp., *Bidens macrocarpa, Broussaisia arguta, Chamaesyce clusiifolia, Cibotium* sp., *Dubautia laxa, Freycinetia arborea, Hedyotis* sp., *Labordia* sp., *Machaerina angustifolia, Melicope* sp., *Psychotria* sp., *Sadleria pallida, Scaevola mollis,* or *Syzygium sandwicensis.* Elevations between 461 and 959 m (1,512 and 3,146 ft).
Lobelia oahuensis 3,741 acres (1,514 ha)	steep slopes on summit cliffs in cloudswept wet forests or in lowland wet shrubland that are frequently exposed to heavy wind and rain and containing one or more of the following associated native plant species: *Bidens* sp., *Broussaisia arguta, Cheirodendron trigynum, Cibotium* sp., *Dicranopteris linearis, Dubautia laxa, Freycinetia arborea, Hedyotis* sp., *Labordia hosakana, Lycopodium* sp., *Machaerina angustifolia, Melicope* sp., *Metrosideros polymorpha, Peperomia* sp., *Phyllostegia* sp., *Sadleria squarrosa, Scaevola* sp., *Syzygium sandwicensis, Vaccinium* sp., *or Wikstroemia* sp. Elevations between 415 and 959 m (1,361 and 3,146 ft).
Sanicula purpurea 934 acres (378 ha)	open *Metrosideros polymorpha* mixed montane bogs or windswept shrublands within the cloud zone containing one or more of the following associated native plant species: *Bidens* sp., *Cheirodendron* sp., *Dicanthelium koolauense, Gahnia beechyi, Leptecophylla tameiameiae, Lycopodium* sp., *Machaerina angustifolia, Plantago pachyphylla, Sadleria pallida,* or *Vaccinium* sp. Elevations between 415 and 871 m (1,361 and 2,857 ft).
Tetraplasandra gymnocarpa 217 acres (88 ha)	windswept summit ridges, slopes, or gullies in wet or sometimes mesic lowland forests or shrublands and containing one or more of the following associated native plant species: *Acacia koa, Antidesma platyphyllum, Bidens* sp., *Bobea elatior, Broussaisia arguta, Cheirodendron* sp., *Cibotium chamissoi, Cibotium* sp., *Cyanea humboltiana, Dicranopteris linearis, Diplopterygium pinnatum, Dubautia laxa, Freycinetia arborea, Hedyotis fosbergii, Hedyotis terminalis, Labordia* sp., *Lobelia hypoleuca, Machaerina angustifolia, Melicope* spp., *Metrosideros polymorpha, Myrsine fosbergii, Pouteria sandwicensis, Psychotria* spp., *Sadleria* sp., *Syzygium sandwicensis, Tetraplasandra oahuensis, or Wikstroemia* sp. Elevations between 93 and 959 m (305 and 3,146 ft).
Trematolobelia singularis 25 acres (10 ha)	steep, windswept cliff faces or slopes in *Metrosideros polymorpha- Dicranopteris linearis* lowland wet shrubland and containing one or more of the following associated native plant species: *Broussaisia arguta, Cibotium* sp., *Dubautia laxa, Eugenia* sp., *Melicope* sp., *Sadleria* sp., *or Wikstroemia* sp. Elevations between 545 and 953 m (1,788 and 3,126 ft).
Viola oahuensis 2,232 acres (903 ha)	exposed, windswept ridges of moderate to steep slope in wet *Metrosideros polymorpha-Dicranopteris linearis* shrublands or *Metrosideros polymorpha* mixed montane bogs in the cloud zone and containing one or more of the following associated native plant species: *Antidesma* sp., *Bidens macrocarpa, Broussaisia arguta, Cibotium* sp., *Dubautia laxa, Hedyotis terminalis, Labordia* sp., *Machaerina* sp., *Melicope sp., Sadleria* sp., *Syzygium sandwicensis, Vaccinium* sp., *or Wikstroemia* sp. Elevations between 415 and 959 m (1,361 and 3,146 ft).

Impacts

Critical habitat will be affected by the proposed and ancillary actions. A Restoration Plan has been prepared to assess potential risks and recommend best management practices (BMPs) to mitigate these effects. The following is a summary of BMPs to be taken; a more detailed account is provided in the enclosed Restoration Plan.

1. Weed seeds, shoots or plants not native to the area could be brought into the area by workers, the helicopter, or equipment. Competition by weeds is a significant and pervasive problem that further endangers many native plants.
   - Crews would be instructed about proper cleaning procedures prior to entering the area. Equipment (especially digging tools) will be cleaned.
   - Foods having the potential to introduce weeds, such as blackberries, will not be allowed at the site.
   - Invasive weeds (such as *Clidemia hirta*, Koster's curse) are already present at the site. Disturbing the soil may give weed seeds a competitive advantage over native plants. Selective herbicide application to reduce this weed seed advantage will be implemented.
   - Erosion control materials, such as geotextiles, will be new and unused.
   - Should water be flown in by helicopter from off site to wash soils, it will be procured from uncontaminated potable sources as opposed to, for example, a lake that would likely contain weed seeds.

2. Trash may attract rats. Rats eat the seeds of some native plants.
   - All green trash (e.g., food wastes) will be properly bagged and removed daily.
   - The area will be totally cleaned of all equipment and supplies at the conclusion of the project.

3. Native soils will be lost.
   - A potential 79 cubic yards (60 cubic meters) of soil may be removed from the site for screening at Hickam Air Force Base. Recovery of wet-screened soils is difficult, and any soils that have been at Hickam for any length of time may become contaminated with weed seeds.
   - Should replenishment soils be required to be brought to the site, they will be sterile (not contain weed seeds).
   - As can be seen in Figure 2a of the enclosed Restoration Plan, a slide immediately upslope from the crash site occurred within the past year. It may be possible to use this area as a source of replacement soil.

4. Erosion will be a significant concern. While erosion and eventual revegetation is a natural process in the Ko'olau Mountains, overgrazing in the past and ongoing pig damage has exacerbated it. Because of the nature of the soils, once topsoils have been removed, it is a lengthy but inevitable process to naturally revegetate such areas. However, weeds can gain a "foothold" in disturbed areas and can overwhelm native vegetation.
   - Temporary erosion control measures will be implemented as work progresses.

- Permanent erosion control will be initiated immediately after JPAC has finished with excavation. The enclosed Restoration Plan provides details of how that work would be accomplished.

5. Plant species selected for revegetation is critical.
   - Native plants will be selected and transplanted into the area in order to reestablish the approximate mix of native vegetation that existed prior to the proposed action. The plants will be grown in local native nurseries, as required. Most of the plants that will be planted at the site will be of the same species already established in the area.

6. Impact on habitat.
   - The soil removal action may affect approximately 0.1 acre (0.04 hectare) of critical habitat. However, restoration will aid in returning the area to a condition where native plants have become reestablished and it is once again uniform with its surrounding, undisturbed habitat. JPAC's actions will not permanently remove habitat, such as would be the case if permanent construction or an ongoing use were proposed. Enclosure 5 maps show action areas and critical habitats.
   - The total land area to be affected by actions at the crash site (478 square yards 400 square meters; 0.1 acre; 0.04 hectares) and at the ancillary sites (1698 square yards; 1420 square meters; 0.35 acres; 0.142 hectares) is summarized as a percentage of the total of each of the 7 critical habitats affected in the first table below. The crash site itself is within only 2 of the 7 critical habitats: *Cyanea crispa* and *Tetraplasandra gymnocarpa*. The second table provides greater detail.

Critical Habitat (CH)	Total CH Acreage	% of Total CH Affected At Crash Site	% of Total CH Affected At Ancillary Sites	Total % of CH Affected
C. crispa	6,506	0.002 %	0.01 %	0.012 %
C. st.-johnii	5,020	0.000	0.01	0.01
L. oahuensis	3,741	0.000	0.01	0.01
S. purpurea	934	0.000	0.04	0.04
T. gymnocarpa	217	0.046	0.18	0.226
T. singularis	25	0.000	1.60	1.60
V. oahuensis	2,232	0.000	0.02	0.02

Areas of Critical Habitat within the Proposed Aviator Recovery Site (m², except as noted)(1)

Area		Species						
		Cya cri	*Cya st-j*	*Lob oah*	*San pur*	*Tet gym*	*Tre sin*	*Vio oah*
Southeast LZ(2)	180	180	180	180	180	180	180	80
Southeast Trail	1020	1,020	560	560	560	1,020	140	60
Excavation and Buffer	400	400	0	0	0	400	0	0
North Trail	170	170	0	0	0	170	0	0
North LZ	50	50	0	0	0	50	0	0
Totals (m²)	1820	**1,820**	**740**	**740**	**740**	**1,820**	**320**	**40**
hectares	0.18	**0.18**	**0.07**	**0.07**	**0.07**	**0.18**	**0.03**	**0.07**
yd²	2180	**2,177**	**885**	**885**	**885**	**2,177**	**383**	**85**
acres	0.45	**0.45**	**0.18**	**0.18**	**0.18**	**0.45**	**0.08**	**0.18**

Notes: (1) The total area of the APE or area of potential ground disturbance equals 1,820 m² (2180 yd²). As can be seen in the accompanying figure, there is considerable overlap in areas of designated critical habitat for each species. Therefore, the total area for all species will be greater than the total project area.
(2) The southeast LZ is a remote helicopter landing pad and old bunker area with highly disturbed vegetation and therefore would not likely be considered critical habitat based on the language in the June 17, 2003 Federal Register final rule.

- Landslides in that area of the Ko'olau Mountains are neither uncommon nor a recent phenomenon. Within the last several months, for example, four very large slides have occurred nearby. These can easily be seen from the H-3 highway to the north, just before entering the tunnel in a Kaneohe-bound direction. They cover many times the 0.45 acres that will be affected by the proposed action.

Potential impacts on endangered Oahu elepaio (*Chasiempis sandwichensis ibidis*) and its designated critical habitat were also considered. None of the areas affected by the proposed actions will occur within the forested habitats favored by the bird. Also, the project site lies outside of designated Elepaio Critical Habitat. A map is provided at Enclosure (6). Navy has concluded that actions considered will not affect the bird or its critical habitat.

Two factors are driving the need for commencing the Proposed Action this summer. First, the dry summer months are the only practicable time of the year to do such work. The heavy rains typical of the fall and winter months would not only severely hamper recovery efforts but could generate safety hazards. Second, JPAC's military personnel and equipment (including substantial helicopter support) are available this summer, but may not be available after this opportunity passes. In order to fulfill public notification and review requirements for Chapter 343 of the Hawaii Revised Statutes, the draft Environmental Assessment (EA) for the Proposed Action needs to be completed by April 22, 2005. The conclusions of this consultation would be included in the draft EA. Accordingly, we hope that the consultation can be concluded in a timely manner. If we can be of any assistance in your review and analysis whatsoever, please let us know. The Navy's point of contact for this consultation is Mr. William Kramer. He can be reached by telephone at (808) 472-1426 or by e-mail at William.r.Kramer@navy.mil.

11015.1A2H
Ser EV33/ 302
10 MAR 2005

Thank you for your consideration of this formal consultation request. We would appreciate your sharing a draft of your response with us prior to your completion of the opinion.

Sincerely,

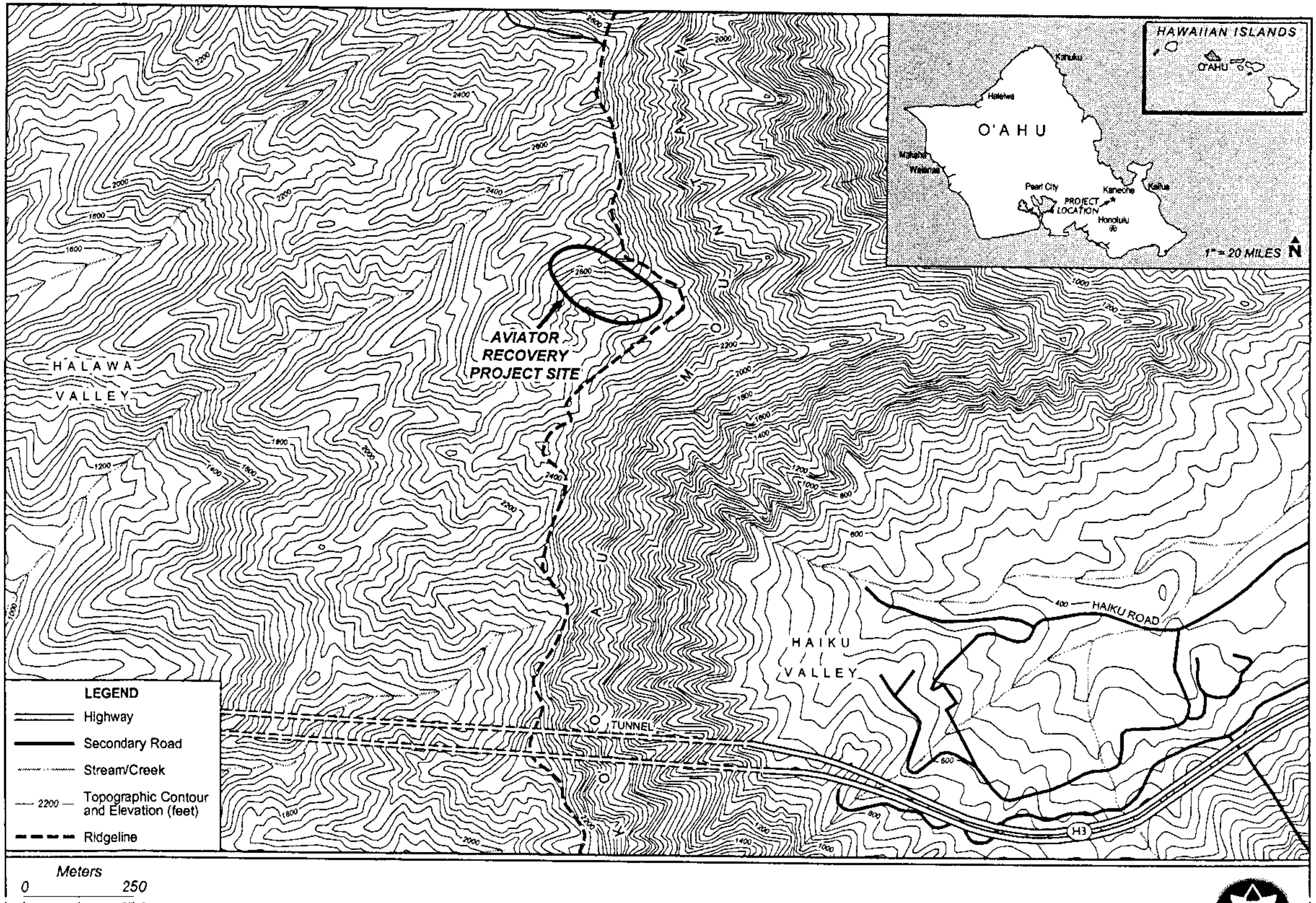
Melvin N. Kaku

MELVIN N. KAKU
Acting Business Line Manager
Environmental

Encl:
(1) Topographic Map of Site
(2) Biological Survey Report of Feb 05
(3) Draft Restoration Plan of Feb 05
(4) Maps of Critical Habitat Areas
(5) Overlay Maps of Critical Habitat
(6) Map of Elepaio Critical Habitat

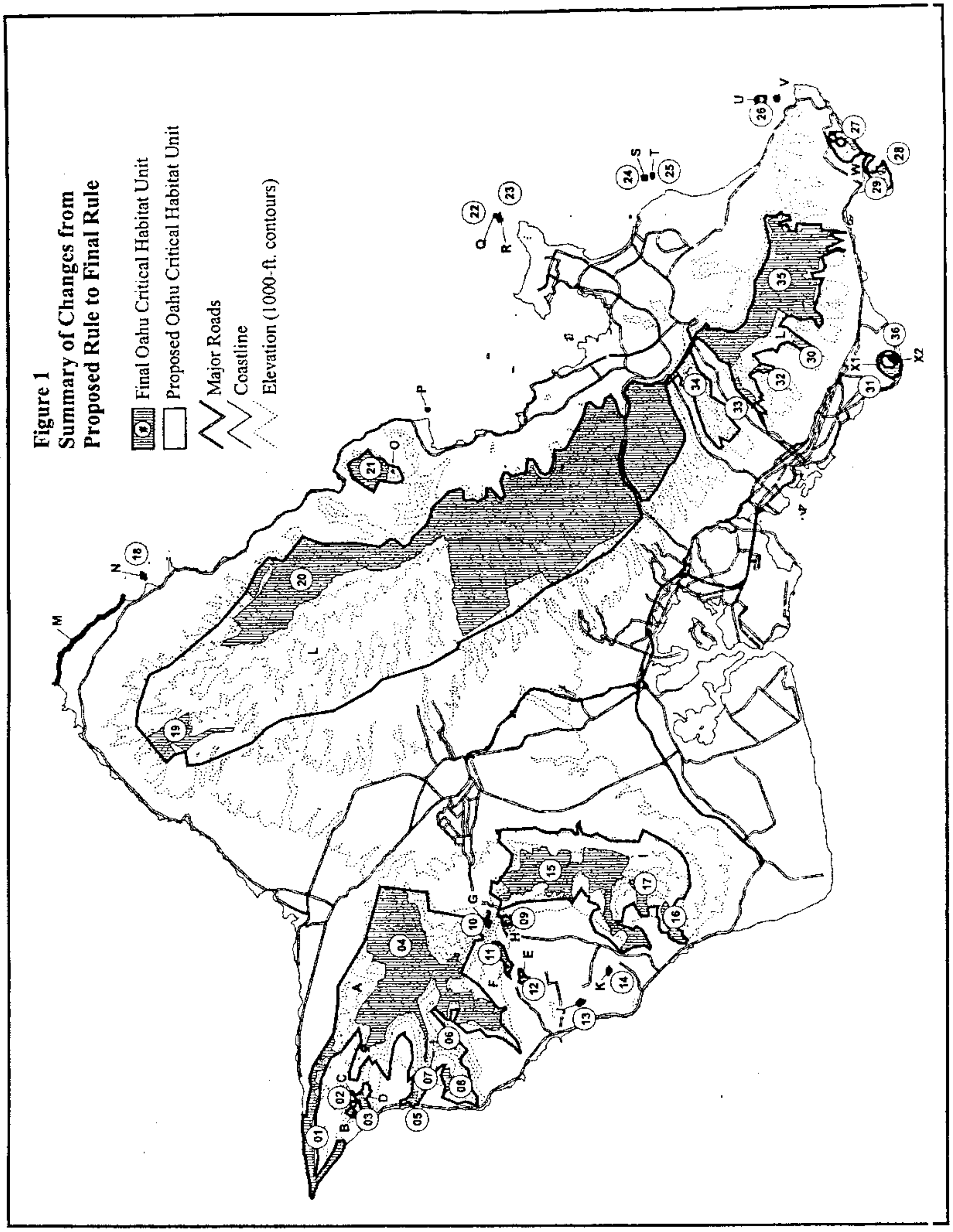
Copy to:
COMNAVREG Hawaii (N465)
(Mr. Randy Miyashiro)

This page is intentionally left blank.



Proposed Project Location

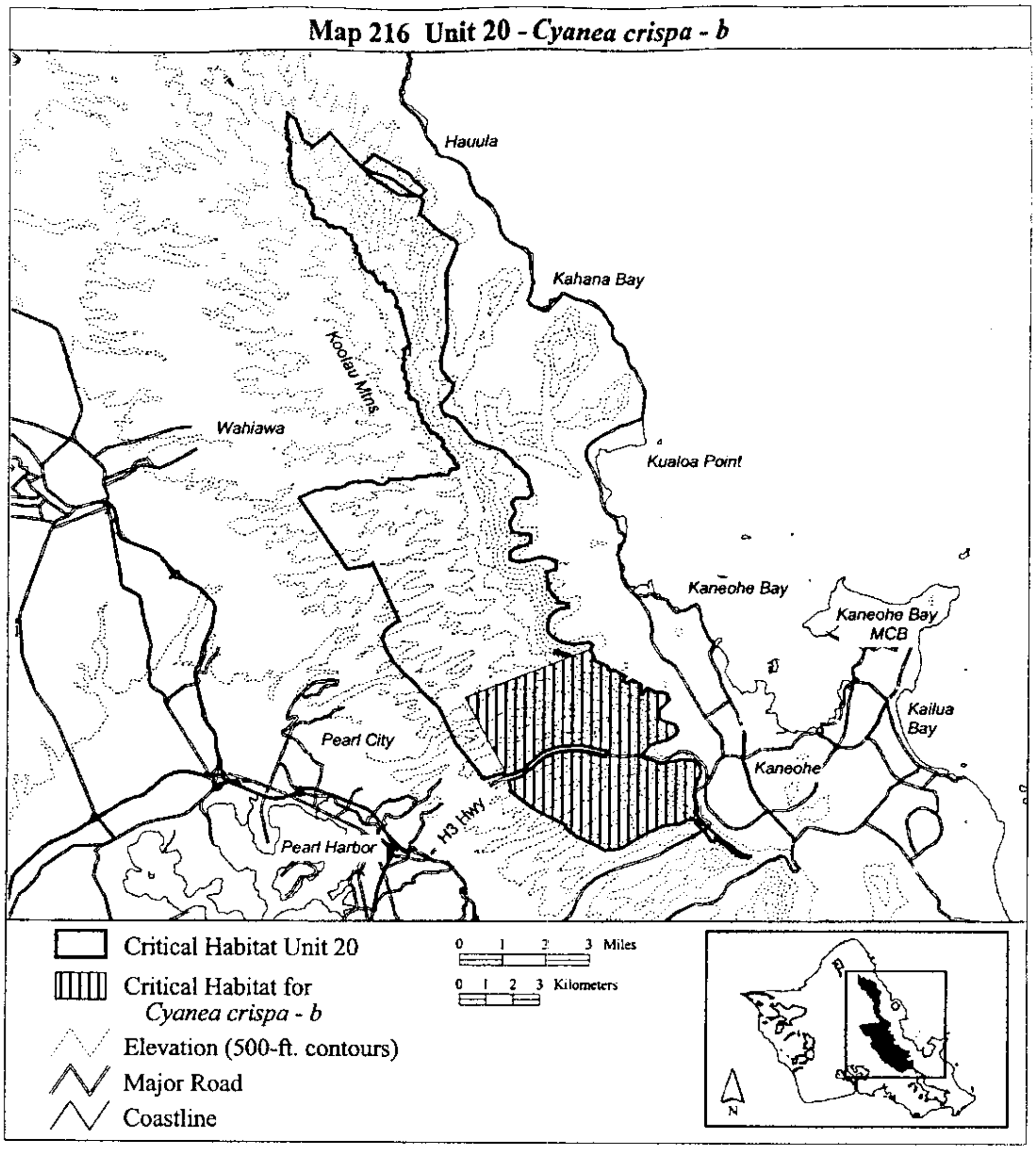
Enclosure 1



Oahu A

This unit was proposed as critical habitat for 65 species: *Abutilon sandwicense, Alectryon macrococcus, Alsinidendron obovatum, Alsinidendron trinerve, Bonamia menziesii, Cenchrus agrimonioides, Centaurium sebaeoides, Chamaesyce celastroides* var. *kaenana, Chamaesyce herbstii, Colubrina oppositifolia, Ctenitis squamigera, Cyanea acuminata, Cyanea grimesiana* ssp. *obatae, Cyanea longiflora, Cyanea superba, Cyperus trachysanthos, Cyrtandra dentata, Delissea subcordata. Diellia falcata,* 2365627; 622664, 2365546; 622731, 2365278; 622707, 2365156; 622707, 2365155; 622708, 2365153; 622641, 2365005; 622145, 2364750; 621489, 2364647; 620825, 2364374; 619887, 2363809; 619327, 2363736; 619306, 2363734; 619289, 2363742; 618843, 2364003; 618621, 2364070; return to starting point.

(ii) **Note:** Map 216 follows:



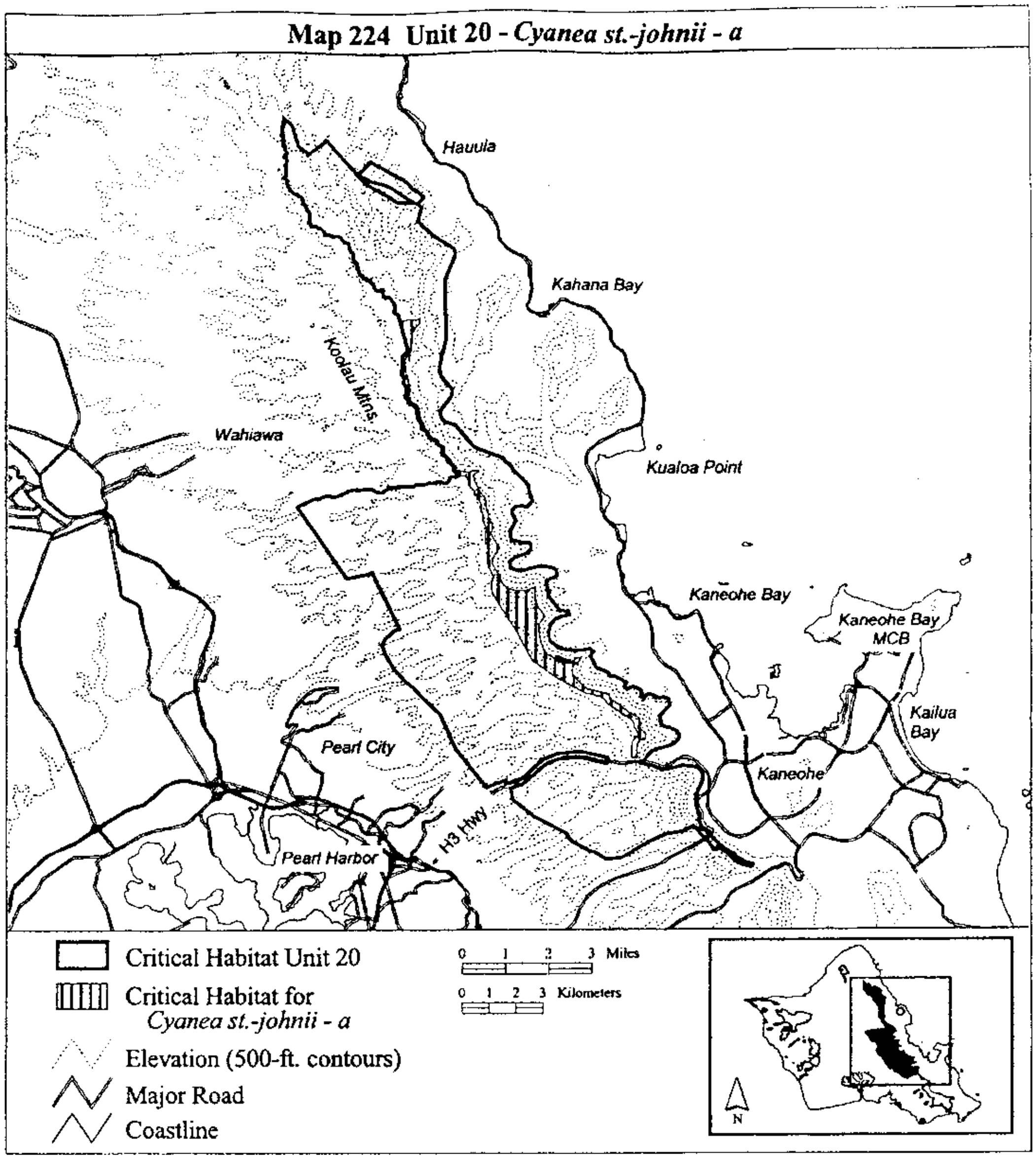
(217) Oahu 20—*Cyanea grimesiana* ssp. *grimesiana*—a (2,634 ha; 6,506 ac)

(i) Unit consists of the following 38 boundary points: Start at 615490, 2366752; 612398, 2369695; 612094, 2370041; 611819, 2370260; 611368, 2370754; 611085, 2371205; 610944, 2371614; 611022, 2371876; 611396, 2372179; 611946, 2372426; 612560, 2372652; 613209, 2372878; 613703, 2373012; 614077, 2373117; 614331, 2373061; 614557, 2372906; 614910, 2372539; 615136, 2372264; 615481, 2371939; 615799, 2371565; 615800, 2371529; 616088, 2371135; 616300, 2370873; 616582, 2370598; 616942, 2370344; 617358, 2370062; 617535, 2369928; 618156, 2369490; 618592, 2369067; 618996, 2368827; 618981, 2368819; 619052, 2368735; 619186, 2368559; 619327, 2368319; 619423, 2368067; 618778, 2367765; 617547, 2367736; 616951, 2367504; return to starting point.

(ii) **Note:** Map 217 follows:

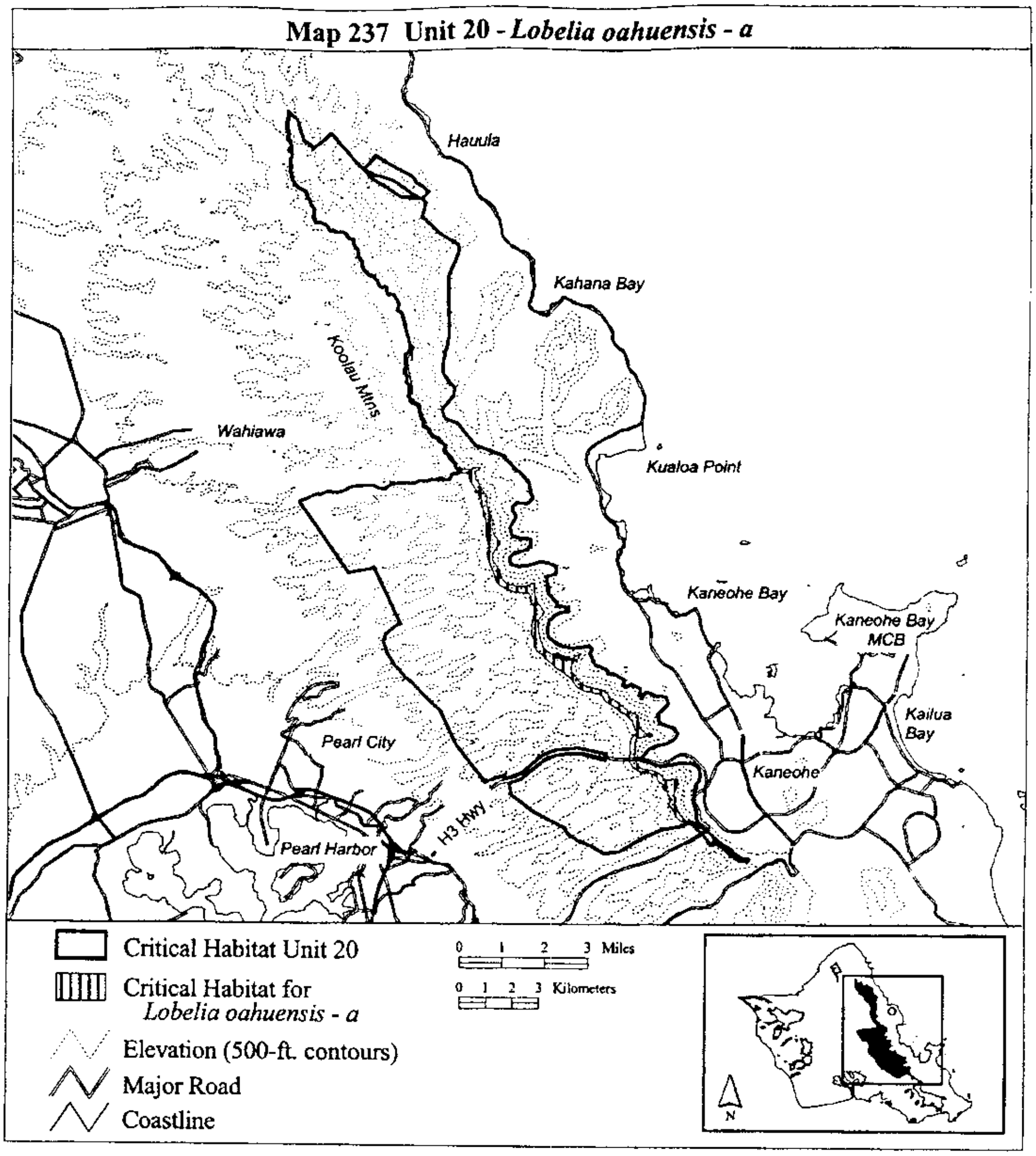
2378090; 613757, 2378093; 613753, 2378093; return to starting point.

(ii) **Note:** Map 224 follows:



(225) Oahu 20—*Cyanea truncata*—a (2,031 ha; 5,020 ac)

(i) Unit consists of the following 164 boundary points: Start at 613602, 2386551; 613659, 2386389; 613631, 2386210; 613273, 2385353; 613273, 2385352; 613274, 2385331; 613268, 2385140; 613280, 2384981; 613312, 2383180; 613250, 2382818; 613195, 2382609; 613088, 2382144; 613082, 2381829; 613080, 2381820; 613080, 2381819; 613080, 2381818; 613087, 2381810; 613208, 2381606; 613344, 2381440; 613533, 2381229; 613545, 2381214; 613505, 2380936; 613087, 2380405; 613087, 2380404; 613089, 2380400; 613115, 2380198; 613237, 2380056; 613239, 2380052; 613240, 2380051; 613646, 2379898; 614360, 2379039; 614361, 2379039; 615437, 2378644; 615510, 2378505; 615637, 2378424; 615841, 2378182; 616058, 2377995; 616346, 2377691; 616360, 2377561; 616377, 2377455; 616437, 2377260; 616441, 2377261; 616504, 2377029; 616326, 2376847; 615911, 2376866; 615753, 2376724; 615753, 2376601; 615853, 2376412; 615876, 2376331; 615830, 2376217; 615657, 2375913; 615739, 2375583; 616002, 2375545; 616017, 2375521; 616413, 2375487; 616454, 2375432; 616454, 2375239; 616289, 2375088; 615349, 2374937; 615671, 2374785; 615684, 2374538; 615946, 2374455; 616023, 2374455; 616049, 2374426; 616159, 2374455; 616248, 2374455; 616439, 2374528; 616726, 2374601; 616315, 2374624; 617102, 2374594; 617234, 2374550; 617314, 2374524; 617376, 2374469; 617417, 2374318; 617399, 2374230; 617371, 2374191; 617349, 2374168; 616881, 2374029; 616743, 2374112; 616317, 2374015; 615712, 2374125; 615423, 2374373; 615244, 2374758; 615423, 2375102; 615506, 2375280; 615437, 2375432; 615285,

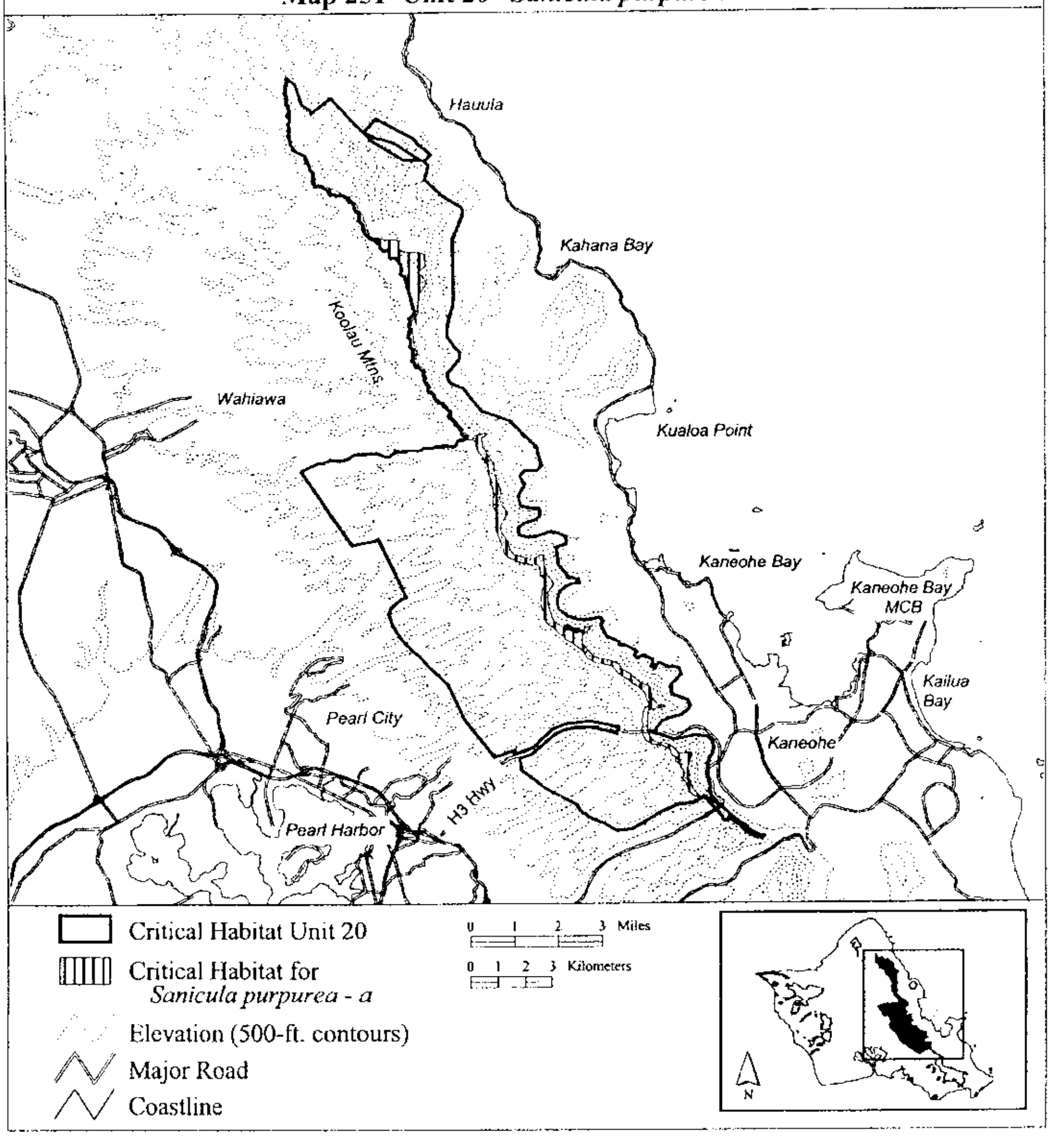


(238) Oahu 20—*Lysimachia filifolia*—a (1,514 ha; 3,741 ac)

(i) Unit consists of the following 333 boundary points: Start at 622547, 2364906; 622392, 2365018; 622231, 2365150; 622133, 2365305; 622037, 2365661; 622013, 2365661; 622019, 2365874; 622064, 2366138; 622093, 2366310; 622156, 2366460; 622128, 2366563; 622082, 2366649; 621950, 2366718; 621645, 2366708; 621496, 2366708; 621369, 2366748; 621214, 2366817; 621053, 2366892; 620818, 2366989; 620582, 2367122; 620553, 2367236; 620553, 2367363; 620542, 2367512; 620571, 2367673; 620663, 2367845; 620743, 2367966; 620898, 2368127; 621042, 2368236; 621082, 2368305; 621053, 2368409; 620910, 2368518; 620818, 2368690; 620720, 2369000; 620617, 2369178; 620462, 2369276; 620345, 2369363; 620061, 2369535; 619852, 2369805; 619545, 2370014; 619336, 2370051; 618992, 2370088; 618685, 2370149; 618414, 2370321; 618242, 2370567; 618193, 2370752; 618107, 2370924; 617996, 2370960; 617578, 2371133; 617050, 2371477; 616829, 2371821; 616902, 2372362; 617038, 2372718; 617025, 2373050; 616853, 2373505; 616607, 2373923; 616030, 2373911; 615648, 2374021; 615403, 2374181; 615317, 2374501; 615329, 2374771; 615403, 2375078; 615415, 2375324; 615267, 2375619; 615292, 2375841; 615317, 2376025; 615317, 2376234; 615009, 2376603; 615009, 2376620; 615004, 2376613; 614843, 2376808; 614325, 2377015; 614825, 2377136; 614670, 2377337; 614492, 2377664; 614372, 2377888; 614331, 2378038; 614349, 2378147; 614084, 2378170; 613740, 2378336; 613533, 2378572; 613401, 2378825; 613429, 2379003; 613326, 2379210; 613016, 2379371; 612780, 2379543; 612648, 2379727; 612487, 2379997; 612372, 2380152; 612372, 2380284; 612408, 2380419; 612389, 2380468; 612286, 2380594; 612039, 2380784; 611999, 2380916; 612033, 2381169; 611918, 2381508; 611355, 2381692; 611867, 2381829; 611372, 2381985; 611872, 2382180; 611930, 2382444; 611976, 2382576; 612102, 2382714; 612114, 2382789; 612114, 2382996; 612114, 2383174; 612160, 2374431; 614870, 2374599; 614819, 2374755; 614819, 2374861; 614816, 2374861; 614810, 2374936; 614828, 2375020; 614861, 2375104; 614852, 2375185; 614861, 2375303; 614825, 2375375; 614765, 2375465; 614762, 2375564; 614762, 2375687; 614756, 2375832; 614777, 2375979; 614762, 2376138; 614723, 2376259; 614641, 2376349; 614641, 2376391; 614641, 2376550; 614617, 2376653; 614590, 2376791; 614602, 2376929; 614602, 2376932; 614530, 2377068; 614482, 2377179; 614434, 2377242; 614365, 2377350; 614323, 2377431; 614211, 2377594; 614115, 2377753; 614115, 2377816; 614088, 2377922; 614(31, 2378000; 613935, 2378000; 613(33, 2377985; 613763, 2378008; 613' 71, 2378068; 613764, 2378090; 613' 57, 2378093; 613753, 2378093; retu n to starting point.

(ii) **Note:** Map 251 follows:

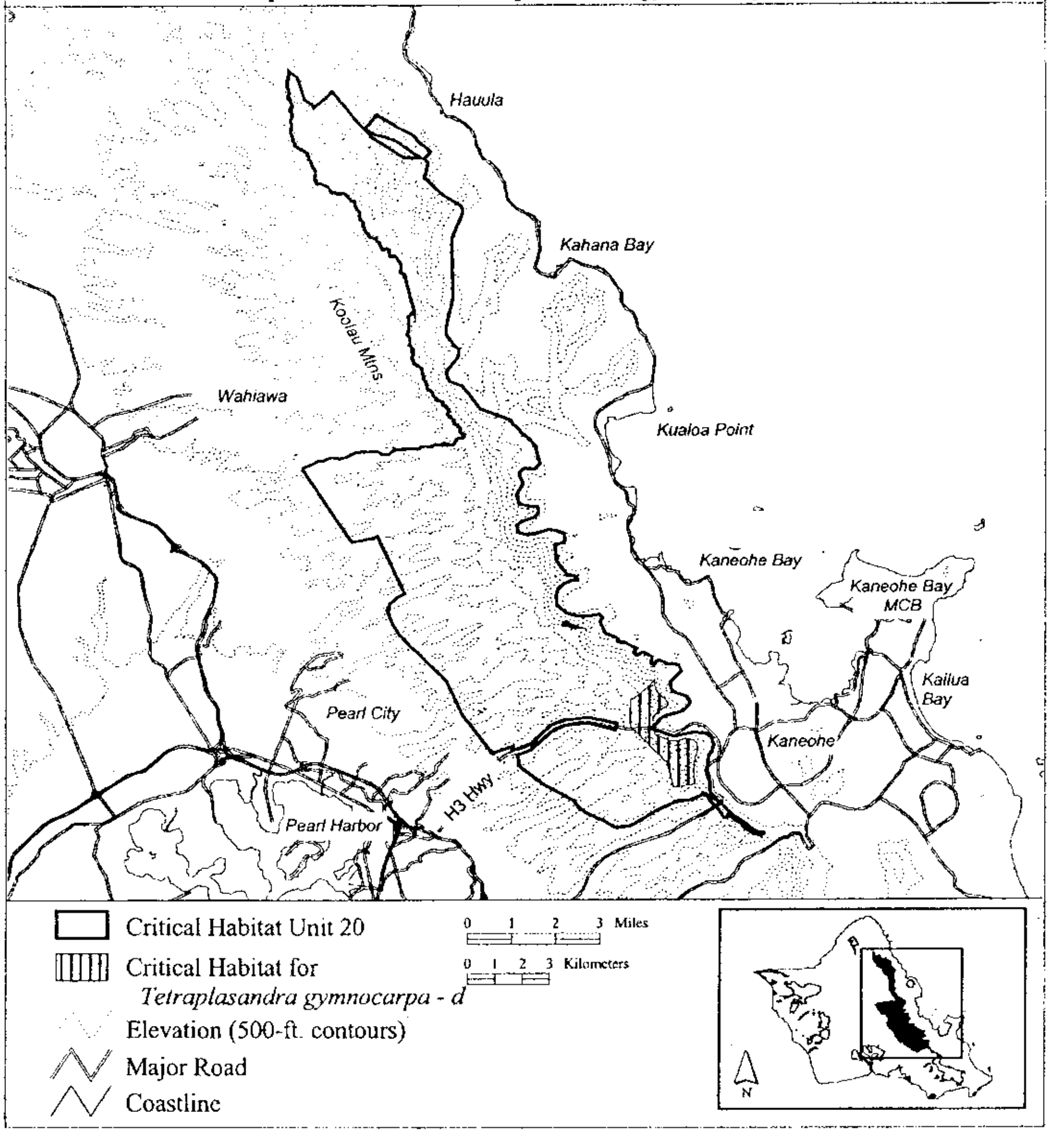
Map 251 Unit 20 - *Sanicula purpurea - a*



(252) Oahu 20—*Schiedea kaalae*—e (378 ha; 934 ac)

(i) Unit consists of the following 100 boundary points: Start at 610262, 2387162; 610252, 2387163; 610196, 2387181; 610159, 2387216; 610133, 2387242; 610063, 2387266; 610077, 2387301; 610149, 2387343; 610210, 2387403; 610168, 2387460; 610107, 2387518; 610058, 2387565; 610063, 2387719; 610159, 2387749; 610222, 2387768; 610273, 2387791; 610320, 2387824; 610336, 2387848; 610325, 2387892; 610299, 2387953; 610259, 2388006; 610259, 2388044; 610266, 2388112; 610252, 2388147; 610222, 2388182; 610178, 2388226; 610114, 2388238; 610000, 2388289; 609981, 2388301; 609999, 2388345; 610027, 2388381; 610054, 2388383; 610098, 2388387; 610124, 2388392; 610140, 2388423; 610168, 2388432; 610222, 2388437; 610278, 2388437; 610318, 2388437; 610348, 2388390; 610402, 2388369; 610446, 2388369; 610486, 2388355; 610504, 2388319; 610504, 2388322; 611095, 2388275; 611810,

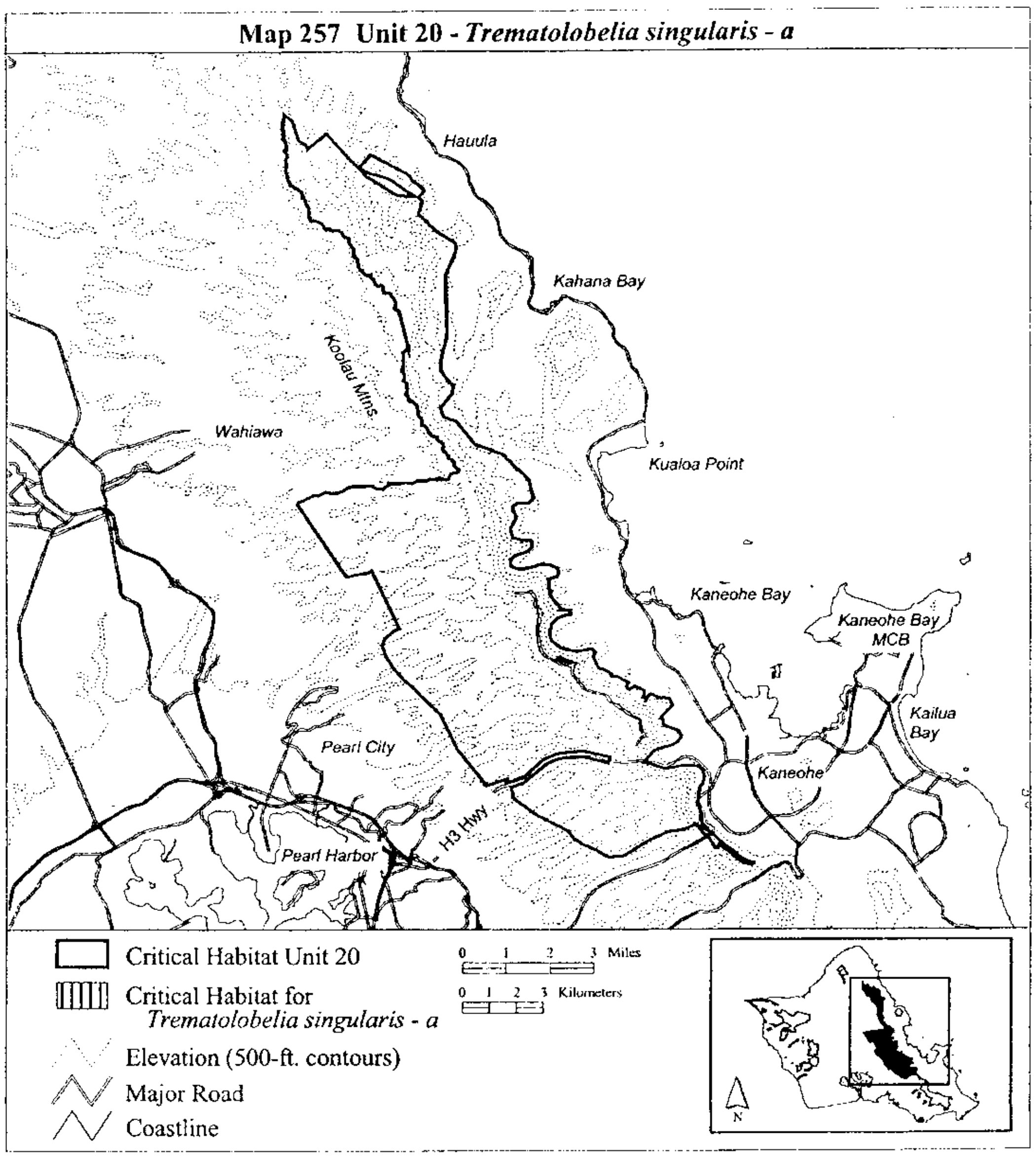
Map 256 Unit 20 - *Tetraplasandra gymnocarpa - d*



(257) Oahu 20—*Trematolobelia singularis*—a (88 ha; 217 ac)

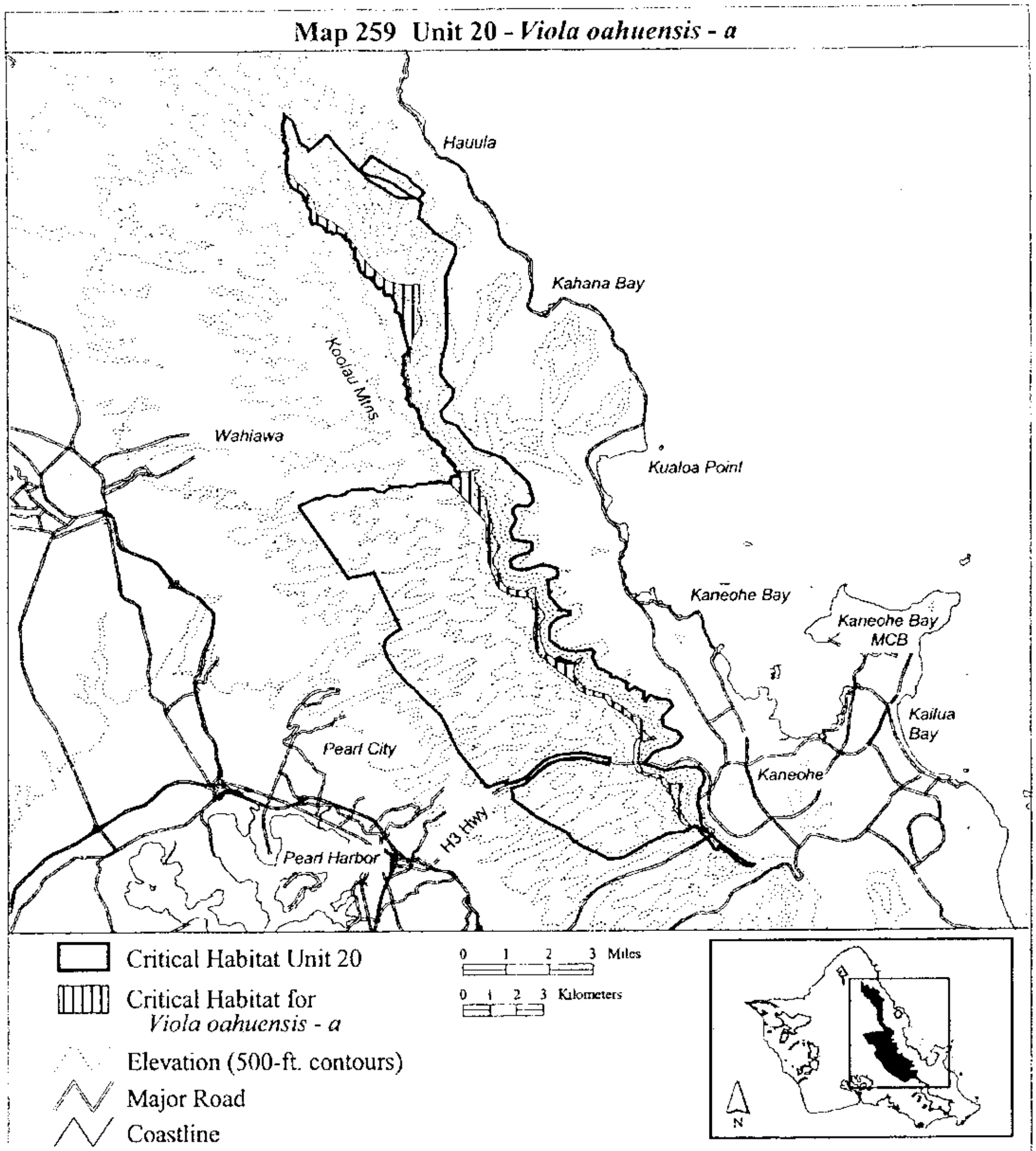
(i) Unit consists of the following 173 boundary points: Start at 619374, 2369581; 619392, 2369559; 619441, 2369499; 619483, 2369472; 619551, 2369457; 619725, 2369358; 619888, 2369229; 620066, 2369093; 620195, 2369010; 620366, 2368938; 620453, 2368904; 620483, 2368794; 620502, 2368623; 620559, 2368456; 620624, 2368335; 620688, 2368271; 620684, 2368214; 620586, 2368153; 620479, 2368054; 620381, 2367956; 620362, 2367873; 620290, 2367865; 620260, 2367914; 620316, 2368001; 620381, 2368058; 620472, 2368187; 620552, 2368248; 620582, 2368282; 620536, 2368339; 620430, 2368437; 620430, 2368547; 620415, 2368684; 620423, 2368775; 620381, 2368839; 620298, 2368862; 620097, 2368972; 619953, 2369059; 619714, 2369248; 619539, 2369351; 619411, 2369430; 619377, 2369472; 619377, 2369458; 619289, 2369552; 619210, 2369659; 619134, 2369731; 619013, 2369783; 618837, 2369792; 618789, 2369792; 618637, 2369862; 618406, 2369919; 618243, 2370004; 618243, 2370068; 618197, 2370144; 618185, 2370171; 618137, 2370183; 618109, 2370220; 618079, 2370301; 617988, 2370408; 617906, 2370492; 617858, 2370556; 617858, 2370623; 617876, 2370687; 617897, 2370796; 617836, 2370808; 617773, 2370817; 617724, 2370838; 617648, 2370859; 617542, 2370859; 617451, 2370902; 617379, 2370941; 617218, 2371026; 617157, 2371064; 617151, 2371055; 617084, 2371122; 616985, 2371134; 616903, 2371185; 616812, 2371264; 616733, 2371359; 616713, 2371457; 616666, 2371619; 616638, 2371785; 616611, 2371942; 616583, 2372108; 616599, 2372266; 616538, 2372415; 616634, 2372423; 616631, 2372565; 616698, 2372672; 616678, 2372739; 616666, 2372806; 616654, 2372908; 616631, 2372964; 616567, 2372999; 616536, 2373078; 616489, 2373161; 616524, 2373236; 616532, 2373310; 616504, 2373381; 616469, 2373445; 616433, 2373496; 616410, 2373563; 616366, 2373579; 616351, 2373567; 616252, 2373543; 616122, 2373523; 615948, 2373519; 615842, 2373516; 615814, 2373594; 615864, 2373580; 615870, 2373618; 616047, 2373606; 616102, 2373606; 616185, 2373606; 616319, 2373634; 616390, 2373665; 616473, 2373638; 616536, 2373535; 616607, 2373405; 616607, 2373255; 616627, 2373137; 616717, 2373042; 616757, 2372960; 616820, 2372829; 616832, 2372707; 616796, 2372605; 616761, 2372522; 616761, 2372419; 616729, 2372348; 616705, 2372195; 616709, 2372096; 616721, 2371958; 616753, 2371836; 616769, 2371714; 616761, 2371674; 616796, 2371548; 616839, 2371473; 616875, 2371371; 616958, 2371280; 617045, 2371209; 617192, 2371133; 617194, 2371135; 617369, 2371041; 617509, 2370969; 617636, 2370923; 617697, 2370908; 617824, 2370908; 617958, 2370938; 618000, 2370956; 618058, 2370984; 618109, 2370993; 618128, 2370956; 618097, 2370929; 618058, 2370868; 618027, 2370799; 617988, 2370714; 617967, 2370641; 617973, 2370568; 618030, 2370492; 618076, 2370438; 618106, 2370408; 618161, 2370368; 618212, 2370256; 618[illegible]37, 2370141; 618385, 2370065; 618431, 2370004; 618546, 2369956; 618[illegible]37, 2369901; 618855, 2369874; 619068, 2369828; 619198, 2369792; 619[illegible]13, 2369707; 619347, 2369643; 619[illegible]74, 2369586; return to starting poin .

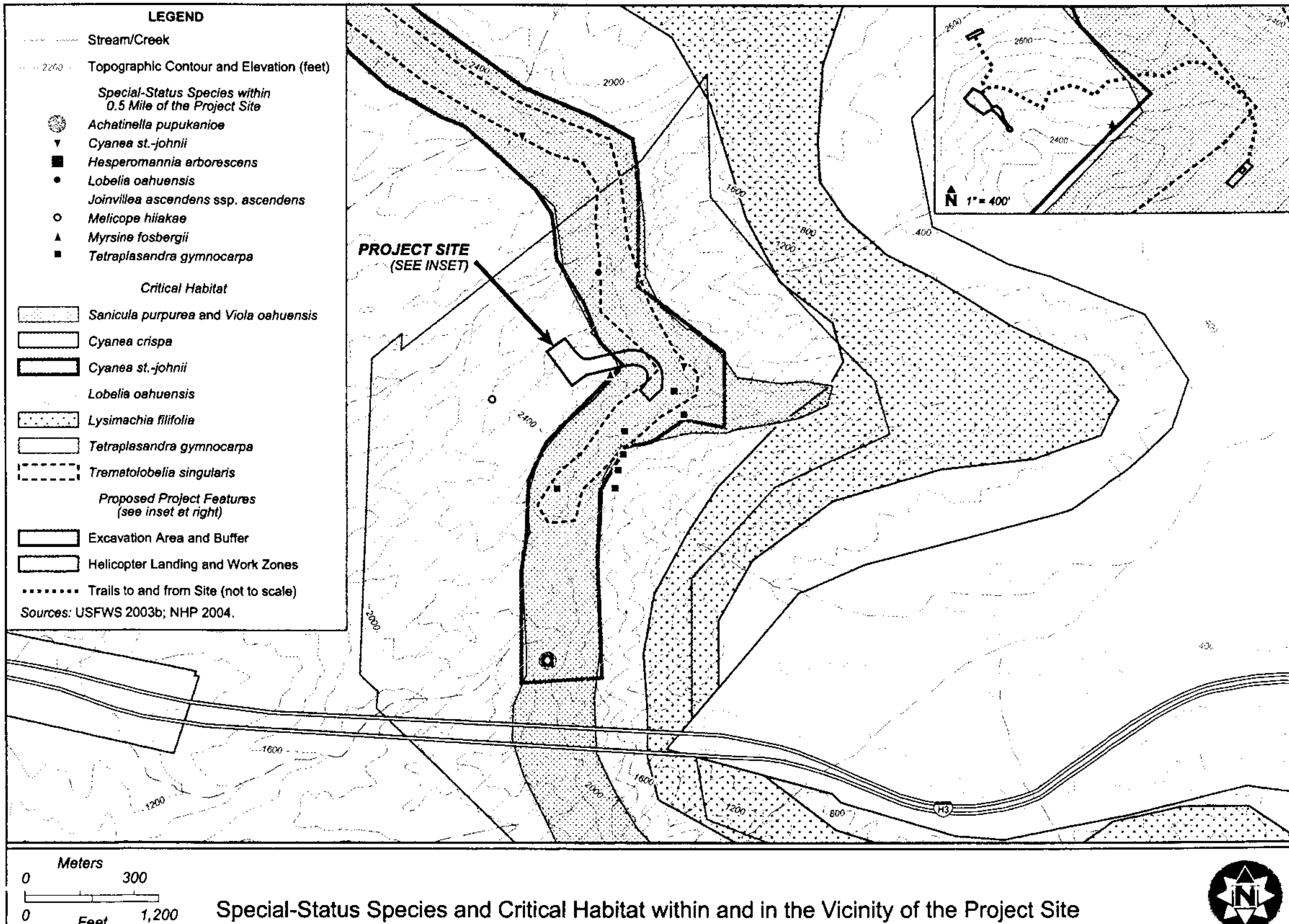
(ii) **Note:** Map 257 follows:



(258) Oahu 20—*Trematolobelia singularis*—b (10 ha; 25 ac)

(i) Unit consists of the following 104 boundary points: Start at 622202, 2365006; 622110, 2365022; 622077, 2365045; 622053, 2365096; 622025, 2365135; 621986, 2365171; 621931, 2365225; 621917, 2365275; 621904, 2365327; 621896, 2365404; 621891, 2365456; 621854, 2365504; 621801, 2365545; 621767, 2365584; 621767, 2365605; 621772, 2365640; 621790,

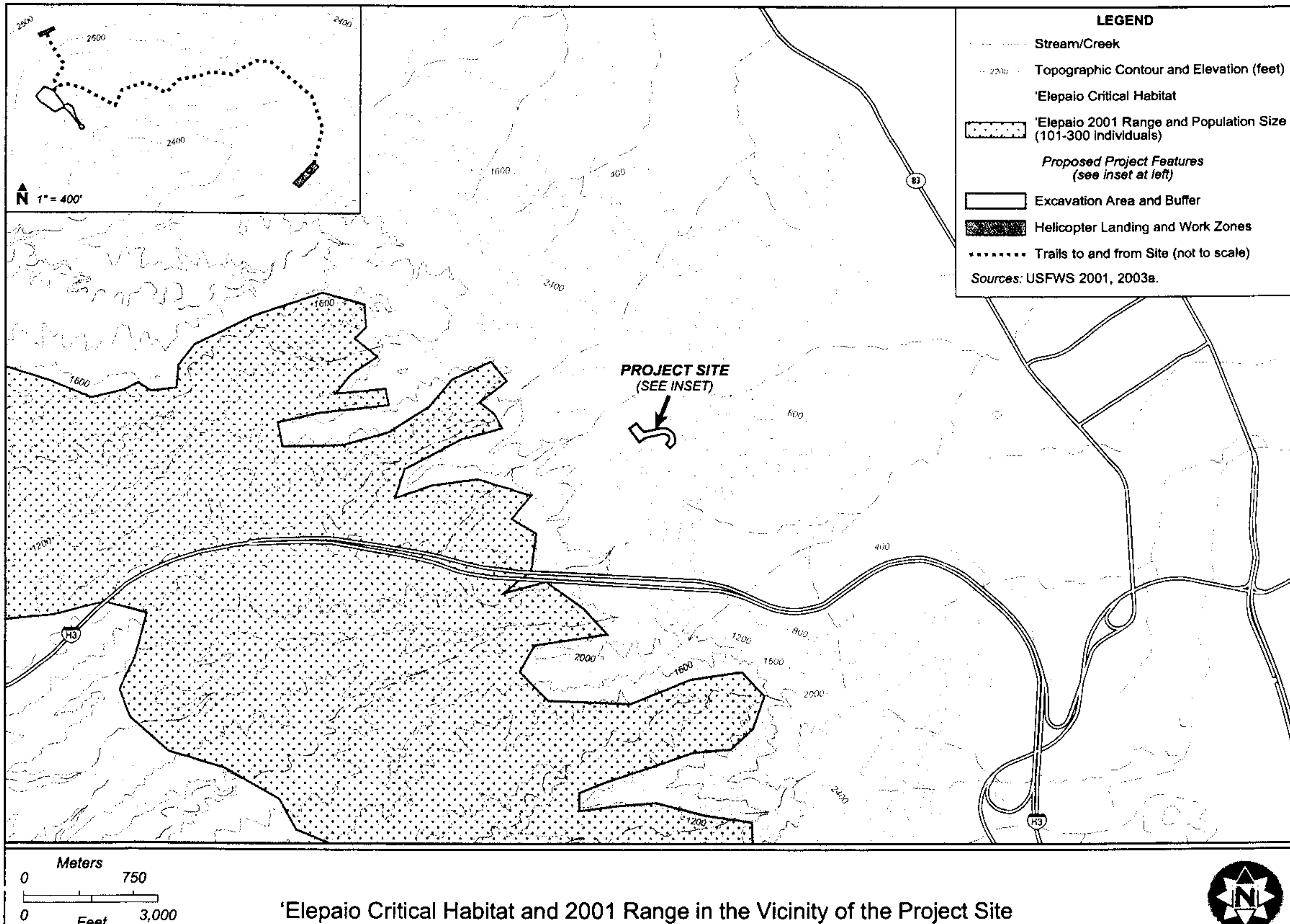

Map 259 Unit 20 - *Viola oahuensis - a*
Hauula
Kahana Bay
Koolau Mtns.
Wahiawa
Kualoa Point
Kaneohe Bay
Kaneohe Bay MCB
Kailua Bay
Kaneohe
Pearl City
H3 Hwy
Pearl Harbor
Critical Habitat Unit 20
Critical Habitat for *Viola oahuensis - a*
Elevation (500-ft. contours)
Major Road
Coastline
0 1 2 3 Miles
0 1 2 3 Kilometers
N



Special-Status Species and Critical Habitat within and in the Vicinity of the Project Site

Enclosure 5

Enclosure 6



'Elepaio Critical Habitat and 2001 Range in the Vicinity of the Project Site

This page is intentionally left blank.

H15 – CONSTRUCTION DREDGING OF WEST LOCH CHANNEL (P-181) (NOAA FISHERIES 2005)

U.S. DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
NATIONAL MARINE FISHERIES SERVICE
Pacific Islands Regional Office
1601 Kapiolani Blvd., Suite 1110
Honolulu, Hawaii 96814-4700
(808) 973-2937 • Fax: (808) 973-2941

March 4, 2005

Department of the Navy
Naval Facilities Engineering Command, Pacific
258 Makalapa Dr., Ste. 100
Pearl Harbor, HI 96860-3134

RE: Proposed construction dredging of the West Loch Channel and related activities, Pearl Harbor, Hawaii
Please refer to Consultation No. I-PI-05-409-TF

To Whom It May Concern:

This letter responds to your request dated on February 24, 2005 regarding a proposal requiring construction dredging of West Loch Channel and bank stabilization and protection at Kekaa Point and Baltimore Point along the West Loch Channel of Pearl Harbor. Your letter indicates that project activities would include: (1) removing a portion of land (approximately 100 feet from the edge) to increase channel width; (2) Stabilizing and protecting Kekaa and Baltimore points using either riprap construction or sheet piles; and (3) disposing of dredged materials at the Environmental Protection Agency designated South Oahu Dredged Material Ocean Disposal Site. Your letter requests concurrence with your determination that the proposed project is not likely to adversely affect Endangered Species Act (ESA) listed species under NOAA Fisheries Service jurisdiction.

ESA-listed species under NOAA Fisheries Service jurisdiction that may be present in the proposed project area include green turtles. However, the likelihood of affecting individual animals is remote given the mitigation measures already included in the project specifications. These include: (1) employing best management practices to decrease pollution levels; (2) monitoring the silt curtain and releasing any trapped sea turtles; and (3) monitoring the area for the presence of sea turtles and postponing blasting until animals voluntarily leave the area. As a result, NOAA Fisheries Service concurs with your determination that the project may affect but is not likely to adversely affect ESA listed species under our jurisdiction.

Thank you for working with NOAA Fisheries Service to protect our nation's living marine resources.

Sincerely,

Tamra Faris

Tamra Faris
Assistant Regional Administrator
Protected Resources Division

H16 – HAWAII CZM FEDERAL CONSISTENCY CONCURRENCE WITH MODIFICATIONS TO DON DE MINIMIS ACTIVITIES IN HAWAII UNDER CZMA (SOH DBEDT 2009)

This page is intentionally left blank.

DEPARTMENT OF THE NAVY
COMMANDER
NAVY REGION HAWAII
850 TICONDEROGA ST STE 110
PEARL HARBOR, HAWAII 96860-5101

5090
Ser N4/ 04163
01 JUN 2009

CERTIFIED MAIL NO. 7007 2560 0002 0326 9580

Mr. Abbey Mayer
Office of Planning
Department of Business, Economic
Development and Tourism
P. O. Box 2359
Honolulu HI 96804

Dear Mr. Mayer:

SUBJECT: REQUEST FOR CONCURRENCE WITH MODIFICATIONS TO THE DEPARTMENT OF THE NAVY DE MINIMIS ACTIVITIES UNDER THE COASTAL ZONE MANAGEMENT ACT (CZMA)

This letter is to request your concurrence with the attached list of Navy/Marine Corps de minimis activities under the CZMA. The attached de minimis list will amend the current de minimis list which was established on April 2, 2007. The new de minimis list will include the Marine Corps, and will cover areas in the Pearl Harbor Naval complex, Naval Magazine Lualualei, Naval Communications and Telecommunications Area Master Station Pacific, Pacific Missile Range Facility on Kauai, Kaneohe Marine Corps Base Hawaii, Camp Smith and all associated installations/facilities/equipment located outside of those Navy/Marine Corps properties.

The Navy and Marine Corps have determined that the listed Proposed Actions have insignificant direct or indirect (cumulative and secondary) coastal effects and should therefore be categorized as de minimis in accordance with the Department of Commerce, National Oceanic and Atmospheric Administration, CZMA Federal Consistency Regulations 15 CFR part 930.33 (3). With the corresponding mitigation and conditions applied, these actions would be exempt from a negative determination or a consistency determination from the State of Hawaii.

Should you have any questions, please contact Mr. Brian Yamada at 472-1449, by facsimile transmission at 474-5419, or by email at brian.yamada@navy.mil.

Sincerely,

Eileen J. D'Andrea

E. J. D'ANDREA
Lieutenant Commander, CEC, U. S. Navy
Assistant Regional Engineer
By direction of the
Commander

Enclosure: 1.Navy De minimis Activities Under CZMA

Navy/Marine Corps De Minimis Activities Under CZMA

***covering areas in Pearl Harbor Naval Complex, Naval Magazine Lualualei, Naval Communications and Telecommunications Area Master Station (NCTAMS) Pacific, Pacific Missile Range Facility (PMRF), Kaneohe Marine Corps Base Hawaii, Camp Smith, and all associated installations/facilities/equipment located outside of these Navy/Marine Corps properties**

No.	Proposed Action	Description	Mitigation / Conditions
1	New Construction	Construction of new facilities and structures wholly within Navy/Marine Corps controlled areas (including land and water) that is similar to present use and, when completed, the use or operation of which complies with existing regulatory requirements.	1, 3, 6, 8, 9, 10, 11, 13, 14, 16
2	Utility Line Activities	Acquisition, installation, operation, construction, maintenance, or repair of utility or communication systems that use rights of way, easements, distribution systems, or facilities on Navy/Marine Corps controlled property. This also includes the associated excavation, backfill, or bedding for the utility lines, provided there is no change in preconstruction contours.	1, 10, 11, 12, 14, 16
3	Repair and Maintenance	Routine repair and maintenance of buildings, ancillary facilities, piers, wharves, dry docks, vessels, or equipment associated with existing operations and activities.	12, 14, 16
4	Aids to Navigation	Includes buoys, beacons, signs, etc. placed within Navy/Marine Corps controlled coasts and navigable waters as guides to mark safe water.	2, 5, 14, 16
5	Structures in Fleeting and Anchorage Areas	The installation of structures, buoys, floats and other devices placed within anchorage or fleeting areas to facilitate moorage of vessels within Navy/Marine Corps controlled property.	2, 5, 14, 16
6	Oil Spill and Hazardous Waste Cleanup	Activities required for the containment, stabilization, removal and cleanup of oil and hazardous or toxic waste materials on Navy/Marine Corps controlled property.	1, 8, 14, 16
7	Maintenance Dredging	Excavation and removal of accumulated sediment for maintenance to previously authorized depths.	2, 3, 4, 5, 7, 8, 9, 13, 14, 16
8	New Dredging	Excavation and removal of material from the ocean floor not to exceed 100 cubic yards below the plane of the ordinary high water mark or the mean high water mark from navigable waters of the US and; excavation and removal of material from the ocean floor within Navy/Marine Corps controlled property. This does not include dredging or degradation through coral reefs.	2, 3, 4, 5, 7, 8, 9, 13, 14, 16
9	Scientific Measuring Devices	The installation of devices which record scientific data (staff gages, tide gages, water recording devices, water quality testing and improvement devices and similar structures) on Navy/Marine Corps controlled property. Devices must not transmit acoustics (certain frequencies) that will adversely affect marine life.	1, 2, 14, 16
10	Studies and Data Collection and Survey Activities	Studies, data and information-gathering, and surveys that involve no permanent physical change to the environment. Includes topographic surveys, wetlands mapping, surveys for evaluating environmental damage, engineering efforts to support environmental analyses, core sampling, soil survey sampling, and historic resources surveys.	2, 3, 6, 8, 9, 11, 12, 13, 14, 16
11	Demolition	Demolition and disposal involving buildings or structures when done in accordance with applicable regulations and within Navy/Marine Corps controlled properties.	1, 11, 12, 14, 16
12	Military Testing and Training	Routine testing and evaluation of military equipment on or over military, or an established range, restricted area or operating area or training conducted on or over military land or water areas in which the impact is not significant.	9, 13, 14, 15, 16
13	Real Estate/Property Transfer	Real estate acquisitions or outleases of land involving new ingrants/outgrants and/or 50 acres or more where existing land use will change.	14, 16
14	Mission Changes	Mission changes, base closures/relocations/consolidations, and deployments that would cause long term population increases or decreases in affected areas.	14, 16
15	Limitation of Access to Property	Permanent closure or limitation of access to any areas that were open previously to public use, such as roads or recreational purposes (provided the access is not required by established agreements with State of Hawaii, private industry, etc.)	14, 16
16	Environmental Management Activities	Environmental management activities within Navy/Marine Corps controlled areas including, but not limited to, activities such as vegetation and mangrove removal, ditch clearing, sediment removal, invasive species removal, construction related to protecting endangered species and wildlife, and actions prescribed by the Integrated Natural Resources Management Plan (INRMP)	2, 13, 14, 16
17	Towers	Installation, operation, and maintenance of towers (such as communication towers, cellular phone antennas, wind-energy towers) within Navy/Marine Corps controlled areas.	1, 2, 6, 8,9 , 12, 13, 14, 16
18	Alternative Energy Research	Installation, operation, replacement, and removal of alternative energy research structures/equipment taking place within Navy/Marine Corps controlled areas.	1, 2, 3, 5, 6, 12, 13, 14, 16
19	Army Corps Nation Wide Permits	Work subject to an Army Corps of Engineers Nationwide permit (which are applicable to Hawaii)	16

ENCLOSURE(1)

Project Mitigation / General Conditions

1) Navy/Marine Corps controlled property refers to land areas, rights of way, easements, roads, safety zones, danger zones, ocean and naval defensive sea areas under active Navy/Marine Corps control

2) If any listed species enters the area during conduct of construction activities, all activities should cease until the animal(s) voluntarily depart the area.

3) Turbidity and siltation from project related work shall be minimized and contained to within the vicinity of the site through appropriate use of effective silt containment devices and the curtailment of work during adverse tidal and weather conditions.

4) Dredging/filling in the marine/aquatic environment shall be scheduled to avoid coral spawning and recruitment periods.

5) All project-related materials and equipment (dredges, barges, backhoes, etc.) to be placed in the water shall be cleaned of pollutants prior to use.

6) No project-related materials (fill, revetment rock, pipe, etc.) should be stockpiled in the water (intertidal zones, reef flats, stream channels, wetlands, etc.).

7) All debris removed from the marine/aquatic environment shall be disposed of at an upland site or EPA approved ocean disposal site, and Best Management Practices shall be followed.

8) No contamination (trash or debris disposal, alien species introductions, etc.) of adjacent marine/aquatic environments (reef flats, channels, open ocean, stream channels, wetlands, etc.) shall result from project-related activities.

9) Fueling of project-related vehicles and equipment should take place away from the water and a contingency plan to control petroleum products accidentally spilled during the project shall be developed. Absorbent pads and containment booms shall be stored on-site, if appropriate, to facilitate clean-up of accidental petroleum releases.

10) Any under-layer fills used in the project shall be protected from erosion with stones (or core-loc units) as soon after placement as practicable.

11) Any soil exposed near water as part of the project shall be protected from erosion (with plastic sheeting, filter fabric, etc.) after exposure and stabilized as soon as practicable (with vegetation matting, hydroseeding, etc.).

12) Section 106, of the National Historic Preservation Act (NHPA), consultation requirements must be met. Also, follow guidelines in the area-specific Integrated Cultural Resources Management Plan (ICRMP) if applicable.

13) Navy/Marine Corps shall evaluate the possible impact of the action on species and habitats protected under the Endangered Species Act (ESA). If the Navy/Marine Corps determines that no such species or habitats will be affected by the action, neither U.S. Fish and Wildlife (FWS) Service nor National Oceanic and Atmospheric Administration (NOAA) concurrence is required. Should it be determined by the Navy/Marine Corps, FWS, or NOAA that the action may affect any such species or habitat, informal or formal consultation will be initiated by the Navy/Marine Corps as required by section 7 (Interagency Cooperation) of the ESA.

14) The National Environmental Policy Act (NEPA) review process will be completed.

15) The training, testing and evaluation will be conducted in accordance with applicable standard operating procedures protective of the environment.

16) Navy or Marine Corps staff shall notify State CZM of de minimis list usage for projects which require an Environmental Assessment (EA). Notification can be sent via email: to JNakagaw@dbedt.hawaii.gov

LINDA LINGLE
GOVERNOR
THEODORE E. LIU
DIRECTOR
MARK K. ANDERSON
DEPUTY DIRECTOR
ABBEY SETH MAYER
DIRECTOR
OFFICE OF PLANNING

DEPARTMENT OF BUSINESS, ECONOMIC DEVELOPMENT & TOURISM

OFFICE OF PLANNING

235 South Beretania Street, 6th Floor, Honolulu, Hawaii 96813
Mailing Address: P.O. Box 2359, Honolulu, Hawaii 96804

Telephone: (808) 587 2846
Fax: (808) 587 2824

Ref. No. P-12644

July 9, 2009

Lieutenant Commander E. J. D'Andrea
Assistant Regional Engineer
Department of the Navy
Commander
Navy Region Hawaii
850 Ticonderoga Street, Suite 110
Pearl Harbor, Hawaii 96860-5101

Attention: Mr. Brian Yamada

Dear Lt. Commander D'Andrea:

Subject: Hawaii Coastal Zone Management (CZM) Program Federal Consistency Concurrence with Modifications to the Department of the Navy De Minimis Activities in Hawaii under the Coastal Zone Management Act (CZMA)

The Hawaii CZM Program has completed the federal consistency review of the proposed modifications to the list of Department of the Navy de minimis activities under the CZMA, including changes to various activity categories, adding new activity categories, and expanding the coverage to Marine Corps Base Hawaii Kaneohe Bay and Camp Smith. The CZM Program conducted a thorough review of the request and a public notice of the CZM review was published in the State of Hawaii Office of Environmental Quality Control's publication, *The Environmental Notice*, on June 23, 2009. The public was provided an opportunity to participate in the review through July 7, 2009. There were no public comments received.

We concur that the activities identified on the modified list entitled, "Navy/Marine Corps De Minimis Activities Under CZMA" are expected to have insignificant direct or indirect (cumulative and secondary) coastal effects, and should not be subject to further review by the Hawaii CZM Program on the basis and condition that the listed activities are subject to and bound by full compliance with the corresponding "Project Mitigation / General Conditions."

The Hawaii CZM Program reserves the right to review, amend, suspend, and/or revoke the "Navy/Marine Corps De Minimis Activities Under CZMA" list whenever it finds that a listed activity or activities will have reasonably foreseeable coastal effects. CZM consistency

concurrence does not convey approval with any other regulations administered by any State or County agency.

Modifying and expanding the list of Navy de minimis activities under the CZMA was a cooperative effort between our Office and Mr. Brian Yamada from the Department of the Navy, who interned with the Hawaii CZM Program in September 2008. We appreciate the efforts of Mr. Yamada in working with our CZM staff. The de minimis activities list will result in more efficient compliance with CZMA federal consistency requirements for both the Navy and the Hawaii CZM Program.

If you have any questions, please call John Nakagawa of our CZM Program at 587-2878.

Sincerely,

Abbey Seth Mayer
Director

c: U.S. Army Corps of Engineers, Regulatory Branch (w/ copy of de minimis list)
Ms. Rebecca Hommon, Region Counsel, Navy Region Hawaii

H17– RESPONSE TO OCCL REGARDING MANAGEMENT PLANS AND CONTACT INFORMATION FOR FISHPOND SITES WITHIN PHNC (JUNE 2009)

This page is intentionally left blank.

11015
Ser EV2/471
18 JUN 2009

Mr. Sam Lemmo
Hawaii Department of Land and Natural Resources
Office of Conservation and Coastal Lands
Kalanimoku Building
1151 Punchbowl St., Room 131
Honolulu, HI 96813

Dear Mr. Lemo:

SUBJECT: MANAGEMENT PLANS AND CONTACT INFORMATION FOR FISHPOND SITES WITHIN THE PEARL HARBOR COMPLEX

We received your response letter of February 9, 2009, and we thank you for reviewing the November 2008 draft Naval Station Pearl Harbor Integrated Natural Resources Management Plan. We appreciate the time and efforts of you and your staff in assisting us with the production of this document, and we would like to address your request for management plans of specified areas around Pearl Harbor and for contact information for inquiries on these locations with Hawaiian cultural assets.

Commander Navy Region Hawaii does not have individual management plans for the areas specified in your letter; however, the 2002 Pearl Harbor Naval Complex Integrated Cultural Resources Management Plan contains information on the Navy's policy for protection and preservation of these areas, as well as other fishpond sites around the harbor, see enclosure (1). This document may be obtained from the State Historic Preservation Division library.

In regard to the management of natural resources in relation to extant fishponds, the November 2008 Draft Integrated Natural Resources Management Plan contains the following recommended action in Table 7.3, Wetlands Recommendations: "Item No. 6, Protect Fishpond Walls: The Navy will monitor the growth of mangrove in and immediately around the Loko Pa'aiau, Loko Laulaunui, Loko Pamoku, and Loko Oki'okiolepe (within Pearl Harbor). If necessary, control and manage the vegetation in order to preserve and protect the fishpond walls."

Inquiries about the fishponds by the general public should be directed to Ms. Grace Hewlen, Commander Navy Region Hawaii Environmental Public Affairs Officer. Should you have any further questions regarding the Naval Station Pearl Harbor Integrated Natural Resources

EVS1 / EV / EV2 / EV2 / EV3 / CC

11015
Ser EV2/ 471
18 JUN 2009

Management Plan, please contact Cory Campora of our Natural Resources Branch at 808.472.1408 or by email at cory.campora@navy.mil.

Sincerely,

KAREN SUMIDA
Business Line Manager
Environmental

Enclosure: Map with Fishpond Names and Locations

S:\DiskA\EV\183\22CC\Cory Letters Jun 09\OCCL Response Letter
15Jun09 mc

H18 – FORMAL SECTION 7 CONSULTATION ON ENDANGERED WATERBIRD AIR STRIKE HAZARD INTERACTION AT HICKAM AIR FORCE BASE, OAHU (USFWS 2009)

United States Department of the Interior

FISH AND WILDLIFE SERVICE
Pacific Islands Fish and Wildlife Office
300 Ala Moana Boulevard, Room 3-122, Box 50088
Honolulu, Hawaii 96850

In Reply Refer To:
2008-F-0186

AUG 26 2009

Mr. Gary O'Donnell
Chief, Environmental Planning Element
75 H Street
Hickam Air Force Base, Hawaii 96853

Subject: Formal Section 7 Consultation on Endangered Waterbird Air Strike Hazard Interaction at Hickam Air Force Base, Oahu

Dear Mr. O'Donnell:

This Biological Opinion responds to your request for formal consultation regarding activities and operations at Hickam Air Force Base and adverse effects to four species of endangered Hawaiian waterbirds; Hawaiian stilt (*Himantopus mexicanus knudseni*), Hawaiian coot (*Fulica alai*), Hawaiian moorhen (*Gallinule chloropus sandvicensis*), and Hawaiian duck (*Anas wyviliana*). At issue is the proposed take of active endangered Hawaiian stilt nests that have been documented in recent history within the Bird and Wildlife Air Strike Hazard (BASH) zone; potential air strike interactions between waterbirds and flight operations; construction activities in support of the aircraft missions; and the continued hazing of listed waterbirds conducted by the United States Department of Agriculture, Animal Plant Health Inspection Service, Wildlife Services (Wildlife Services). This response represents the U.S. Fish and Wildlife Service's (Service) Biological Opinion regarding the effects from the proposed project to the Hawaiian stilt, Hawaiian coot, Hawaiian moorhen, and Hawaiian duck pursuant to the Endangered Species Act of 1973 (16 U.S.C. 1531), as amended (Act). This consultation is based on your Biological Assessment, information gained during site visits, telephone conversations, electronic mail (email), (see Consultation History and References) and other information available to us. A full administrative record is available at Pacific Islands Fish and Wildlife Office (PIFWO).

CONSULTATION HISTORY

December 18, 2006. Hickam Air Force Base submitted a Biological Assessment to the Service in which it made a determination that the proposed project "may affect, but is not likely to adversely affect" listed Hawaiian waterbirds.

March 8, 2007. Hickam Air Force Base revised the Biological Assessment to provide further information requested by Peter Cohen (Service biologist).

July 9, 2007. The Service did not concur with Hickam Air Force Base's not likely to adversely affect determination, and in an email recommended initiation of formal consultation based on Hickam Air Force Base request to "take" endangered waterbirds.

July 17, 2007. Aaron Hebshi (Air Force), Darrin Phelps (Wildlife Services), Holly Herod and Aaron Nadig (Service biologists) attended a site visit at Hickam Air Force Base Flight line to discuss the development of a consultation package.

July 19, 2007. Aaron Nadig (Service) provided guidance to Aaron Hebshi (Air Force) via email describing the information necessary to assemble a complete package for formal consultation.

April 18, 2008. The Hickam Air Force Base consultation package was received by PIFWO.

May 16, 2008. A letter was sent to Mr. Gary O'Donnell acknowledging initiation of formal consultation for ongoing activities related to air operations at Hickam Air Force Base.

July 25, 2008. The project scope was changed to include actions for restoration of Oxbow wetlands at Bellows Air Force Station, modification of work at Ahua Reef, and hazing activities for BASH. The Air Force reviewed the changes and commitments with Kadena Air Force Base which maintains management authority for Bellows Air Force Station. A meeting was scheduled by Aaron Hebshi (Air Force) to meet with Flight Safety 15th Air Wing to approve actions near Hickam Air Force Base and was postponed until January 2009.

January 21, 2009. Due to a BASH program Flight Safety 15th Air Wing quarterly meeting, the project description was revised to maintain flight safety. Aaron Hebshi (Air Force) sent the final project description with revisions to Aaron Nadig (Service).

BIOLOGICAL OPINION

Description of the Proposed Action

Site Description
Hickam Air Force Base occupies approximately 2,520 acres and is located on the south shore of Oahu on a coastal plain between Pearl Harbor and the Honolulu International Airport (Figure 1). Much of the land is fill material that was used to construct a base of operations before and during World War II. Hickam Air Force Base is the Headquarters for the Pacific Air Forces and the 15th Air Wing. Although Hickam Air Force Base shares the airfield with Honolulu International Airport, many of the ramp areas and taxiways on Hickam Air Force Base are used exclusively by the Air Force and Hawaii Air National Guard.

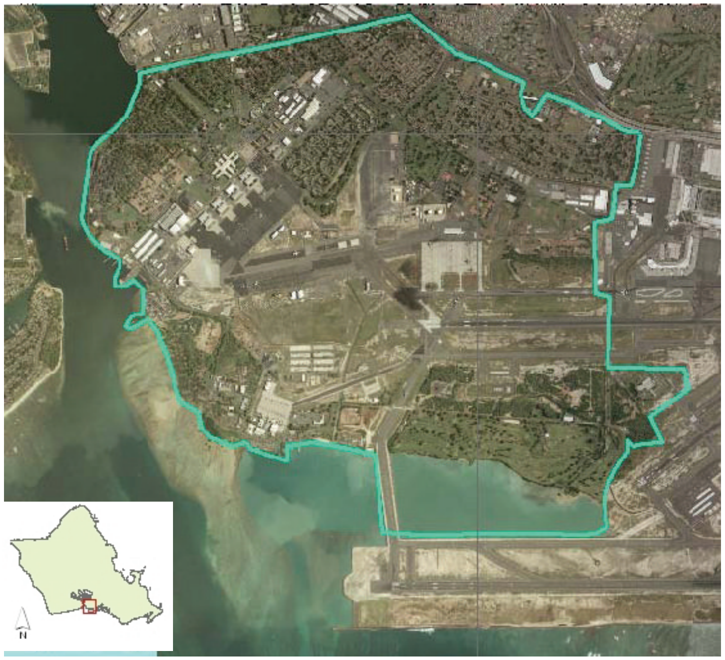


Figure 1. Location of Hickam Air Force Base.

Hickam Air Force Base maintains a system of open drainage canals (3.5 miles) to convey water from the runways and ramp areas. Figure 2 shows the drainage canal system in the vicinity of the airfield. A catchment pond, located south of the airfield (Figure 3), is used for irrigation of a nearby golf course. Currently, a temporary leak in the pond's lining keeps water from accumulating and limits the pond's attractiveness to waterbirds; however, surface water has been observed pooled around the catchment area. The pond will need to be repaired in the near future to limit the extent of pooling and improve the drainage in the area.

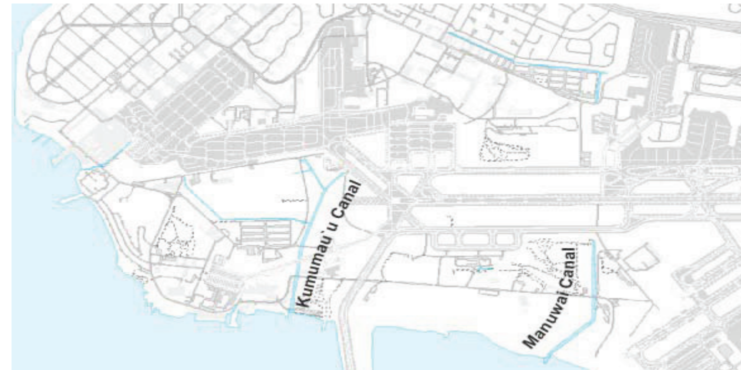


Figure 2. Drainage canals associated with Hickam Air Force Base.

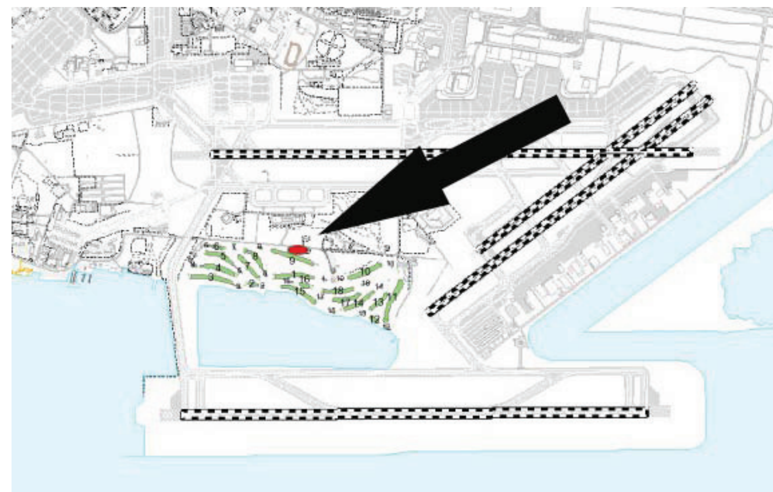


Figure 3. Permanent catchment pond associated with Hickam Air Force Base.

A four-acre wetland (Ahua Reef) and an adjacent expanse of mud and reef flat habitat exist at Hickam Air Force Base (Figure 4) although the wetland is fairly degraded by invasive red mangrove (*Rhizophora mangle*) and pickleweed (*Batis maritima*). The majority of the Hickam Air Force Base is classified as "improved grounds" used for facilities, infrastructure, or landscaping.

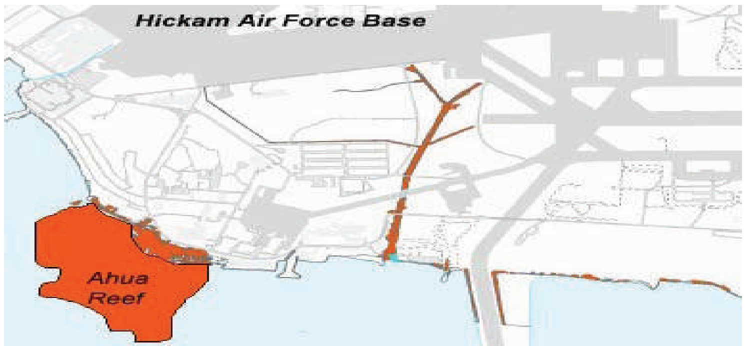


Figure 4. Ahua Reef wetland within Hickam Air Force Base.

Four endangered Hawaiian waterbird conservation areas are within five miles of Hickam Air Force Base (Figure 5). Pouhala Marsh, located 4.3 miles to the northwest of Hickam Air Force Base at Pearl Harbor, is a 70-acre waterbird sanctuary managed by the State of Hawaii Department of Land and Natural Resources, Division of Forestry and Wildlife (DOFAW). The Service manages the Pearl Harbor National Wildlife Refuge (NWR) which is composed of two separate units for Hawaiian waterbirds; the 37-acre Honouliuli wetland and the 25-acre Waiawa wetland. Data from the bi-annual State waterbird counts from Pouhala Marsh and Pearl Harbor NWR show significant populations of endangered Hawaiian waterbirds at these wetlands. Also, a private landowner, Haseko, Inc., maintains a 22-acre, Army Corps of Engineers Wetland Preservation Area in Ewa, about 4.9 miles west of Hickam Air Force Base (Figure 5). Because of the close proximity of the wetlands to Hickam Air Force Base, Hawaiian waterbirds can easily disperse to Hickam Air Force Base in order to forage and nest. Wetland habitat, managed by DOFAW, also exists at Keehi Lagoon in the vicinity of the Honolulu International Airport Reef Runway (east), but bi-annual State waterbird counts from this location are generally low.

Figure 5. Hawaiian waterbird conservation areas in proximity to Hickam Air Force Base.

Summary of Proposed Action

Proposed operations include maintenance of drainage canal systems, ongoing and increasing aircraft operations, construction activities, which may involve the creation of dewatering ponds, and efforts to control bird hazards to aircraft. The action encompasses ongoing operations that the Air Force currently conducts and will continue to conduct into the foreseeable future. The action area pursuant to section 7 regulations consists of "all areas to be affected directly or indirectly by the Federal action." The action area associated with the proposed action is delineated by the outer perimeter of Hickam Air Force Base installation (see Figure 1) and includes conservation work that will be conducted at Bellows Air Force Station (Figure 6) within the Oxbow wetland of Waimanalo stream.

Figure 6. Bellows Air Force Station.

Proposed Aircraft Operations

Hickam Air Force Base houses the 15th Airlift Wing of the Pacific Air Forces, which currently operates eight C-17 aircraft, 20 F-15 aircraft, and four KC-135 aircraft. Hickam Air Force Base also serves as a stopover hub for military aircraft traveling throughout the Pacific. The current level of air traffic present on the airfield is summarized in Tables 1 and 2; numbers exclude transient (Department of Defense) aircraft using Hickam Air Force Base as a stopover. The level of air traffic is routine and an integral component of Hickam Air Force Base operations, and will continue into the foreseeable future.

Table 1. Current and proposed military aircraft sorties (one sortie is defined as a single aircraft conducting a take-off, flight, and landing) at Hickam Air Force Base.

Aircraft	**Sorties: Current (2007)**	**Sorties: Proposed**	**Percent Increase**
F-22	N/A	4320	50%*
KC-135	495	743	50%
8 C-17s, 1 C-20, 2 C-37s, 1 C-40	2974	~2974	0%

*from current F-15 operations, which will be eliminated when the F-22 beddown occurs.

Table 2. Baseline Operations at Hickam Air Force Base and Honolulu International Airport. Each take-off or landing is considered an operation.

Fiscal Year	**Military**	**Civilian**	**Total Operations**
2003	16,088	289,577	305,665
2004	17,101	303,174	320,275
2005	14,819	315,727	330,546

Data from SAIC (2007), E2m (2008), and 15th AW Wing Aviation Resource Management.

Facility Construction, Renovation, and Demolition

Two beddown activities are currently proposed for Hickam Air Force Base. The Air force is proposing the reassignment of four KC-135 aircraft from Grand Forks Air Force Base, North Dakota, to the KC-135R inventory in Hawaii; additional infrastructure improvements; increase in staffing levels by 154 additional personnel; and construction of a 6,600-square-foot KC-135 Flight Simulator Training Facility. The Hawaii Air National Guard has proposed replacing the existing 20 F-15 aircraft with 20 F-22A aircraft beginning in fiscal year 2011. Demolition and renovation of several buildings and structures, and the construction of additional facilities in support of the beddown are proposed. All construction, renovation, and demolition activities, including the staging of equipment and materials, will occur on previously developed land.

Dewatering Ponds Associated with Construction

Dewatering ponds are occasionally created at new construction sites to collect shunted ground water from excavation activities. In 2006, for instance, construction of new facilities in support of the C-17 beddown required the use of dewatering ponds, which attracted Hawaiian stilts and Hawaiian ducks (or mallard-hybrids). The four dewatering ponds, currently filled, ranged in size between 0.5 and 2 acres. Construction activities in the area of the Hawaii Air National Guard, such as those in support of the F-22 beddown, will create similar dewatering ponds, and are expected to be in use for construction activities over the next five to 10 years (Figure 7) (SAIC 2007). Individual dewatering ponds from the various construction activities may persist for up to four years. Although these dewatering ponds are not permanent structures, such ponds will likely be created for the construction of each new facility. When construction projects are completed, the ponds are filled with coral rubble and soil.

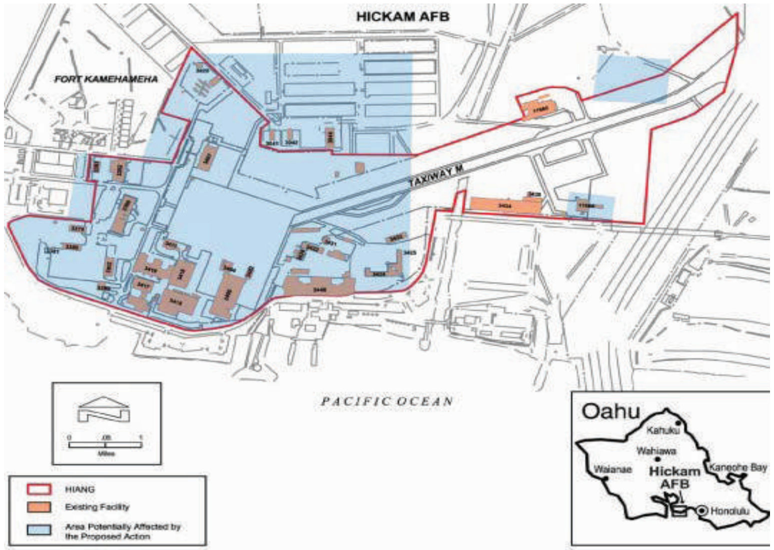


Figure 7. Hickam Air Force project area for F-22A beddown.

Bird and Wildlife Airstrike Hazard Program
To minimize the risk of aircraft collisions with birds or other wildlife, Wildlife Services implements an integrated wildlife control operation within the BASH zone (Figure 8) at Hickam Air Force Base, based on the findings of Linnell's (1995) thesis work. Methods include both lethal and non-lethal techniques. Lethal methods include shooting introduced bird species such as zebra doves (*Geopelia striata*), mynahs (*Acridotheres tristis*), spotted doves (*Streptopelia chinensis*), cattle egrets (*Bubulcus ibis*), and mannikins (*Lonchura* sp.) in high probability bird-strike zones along the runways and taxiways. Non-lethal control includes trapping and relocation, hazing using pyrotechnics, flushing using vehicles or personnel on foot. Only non-lethal control is used for Federally protected and endangered birds such as Pacific golden-plover (*Pluvialis dominca*), Hawaiian stilt, Hawaiian coot, Hawaiian duck, and Hawaiian moorhen. Wildlife Services is authorized to haze endangered birds from airfields in the Hawaiian Islands as an agent of the Service, pursuant to the Service's October 2006, Agent Designation Letter. This agreement, as amended, addresses increases in airports within Hawaii and has been in place since 1991. In addition, each airport maintains a Migratory Bird permit for hazing activities within the designated BASH zone.

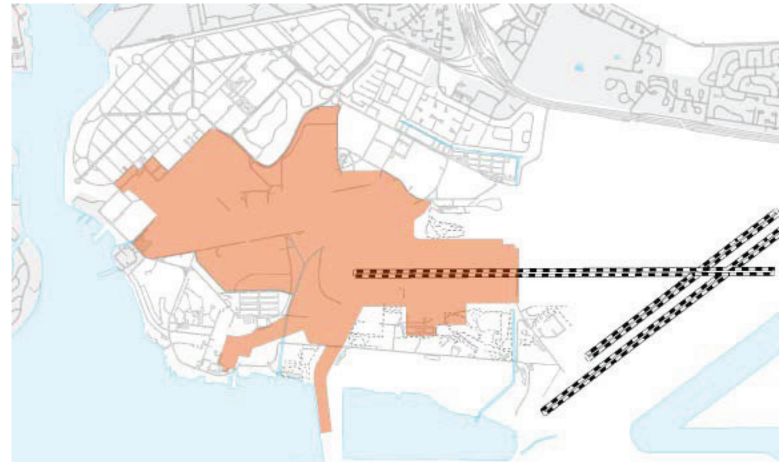


Figure 8. Hickam Air Force Base BASH zone.

Conservation Measures
The following are conservation measures proposed by Hickam Air Force Base to avoid and minimize effects to the endangered Hawaiian waterbirds and are considered part of the project description.

1) Minimize nuisance attractants within the BASH zone to prevent attraction and minimize potential interactions between Hawaiian waterbirds and aircraft:

   a) Develop and implement alternatives to dewatering ponds. Hickam Air Force Base has 3.5 miles of drainage ditches associated with the Airport. When feasible, drainage directly into ditches should be investigated as an alternative to establishing dewatering ponds.

   b) When the project site mandates use of dewatering ponds, ponds shall be constructed with side slopes that will have a 1.5 horizontal to 1.0 vertical slope (approximately 45 degree slope) which will minimize the potential for creating shallow water habitat for Hawaiian waterbirds. The Hickam Air Force Base will monitor the ponds and immediately repair any edge areas that are not at a 45 degree slope (due to rainstorms, wave action, etc.) to ensure habitat is not created within dewatering ponds. The Hickam Air Force Base shall ensure that water level is continuously maintained at a depth greater than three feet in all dewatering ponds. Ponds shall be covered by a method selected by the Hickam Air Force Base and approved by the Service, to reduce the attractiveness of these features to endangered Hawaiian waterbirds. Acceptable methods include the installation and maintenance of systems of bird balls, netting, or tarps to prevent bird access to the ponds.

c) To minimize the risk of attracting nesting Hawaiian waterbirds, the Hickam Air Force Base will evaluate the BASH program on a quarterly basis to determine where avian attraction or hotspots occur. This will allow Hickam Air Force Base to evaluate habitat modifications for locations that may be attracting waterbirds into the BASH zone.

d) If heavy rain events occur during the Hawaiian stilt breeding season (Mid-February through August), Hickam Air Force Base will require Wildlife Services to contact the Flight Safety Office to coordinate any BASH zone staffing increases necessary to prevent Hawaiian stilts from nesting on or around the airfield during these wet periods.

e) Hickam Air Force Base will reduce the attractiveness of the drainage canals within the BASH zone. Although the canals draining the runway areas cannot be filled, as that would lead to an increase in standing water in and around the airfield, the Hickam Air Force Base will remove woody vegetation, which can provide cover to the Hawaiian waterbirds, around canals to keep canals open and clear.

f) Hickam Air Force Base will repair the water catchment at the golf course to eliminate surface pooling water thus reducing its attractiveness to waterbirds.

2) The Air Force will restore wetland areas at Hickam Air Force Base and Bellows Air Force Station to provide habitat outside the BASH zone for endangered Hawaiian waterbirds. The four-acre wetland (Ahua Reef) at Hickam Air Force Base currently is used by Hawaiian stilts for foraging, but a large portion of potential foraging habitat in this wetland is overgrown with mangroves and pickleweed. Likewise, the Oxbow wetland of Waimanalo stream on Bellows Air Force Station (Figure 9) has been overgrown with red mangroves. Air Force will develop a management plan and implement actions to control invasive vegetation and control predators at these two locations beginning in Fiscal Year 2010.

a) Ahua Reef wetland shall be managed for the following:
- open water (1-6 inch depth) and mudflat (saturated and dry);
- interspersed with less than 25 percent cover of pest plants including pickleweed, and red mangrove;
- minimize predation of adult waterbirds by feral mammalian predators [e.g., cats (*Felis catus*), dogs (*Canis familiaris*)];
- Air Force shall enforce their policy to restrict domestic pets from Ahua Reef wetland area for the protection of listed waterbirds.

b) Bellows Air Force Station Oxbow wetland restoration will include the following:
- mudflat (dry and saturated) and open water (from less than 1 to18 inches depth);
- interspersed 30 to 60 percent cover of tall (3 to 8 feet) emergent vegetation (e.g., cattail), grasses (sprangletop, knot-grass, millet), and sedges (California bulrush, flatsedge, and *Fimbristylis* sp.) that provide seed and green browse and a mosaic of concealment cover, open water, and thermal cover;

- less than 25 percent cover of pest plants including marsh fleabane, pickleweed, water hyssop, California bulrush and California grass;
- interspersed vegetation with sufficient edge providing visual barriers to maximize territories available for breeding;
- minimize predation [e.g., mongoose (*Herpestes javanicus*), feral cats, feral dogs, rats (*Rattus* sp.), American bullfrogs (*Rana catesbeiana*), and cattle egrets];
- Recreation and training in the Oxbow wetland area will be restricted to minimize human disturbance.

c) Live trapping for feral cats will be conducted year round at Ahua Reef, and mongoose and feral cat trapping will be conducted year round at Bellows Air Force Station Oxbow wetland for the protection of listed waterbirds. Live traps for small mammals and frogs will be checked every 48 hours when trapping activity occurs. Bait stations (utilizing approved rodenticide) will be utilized during the breeding season at Bellows Air Force Station Oxbow wetland to reduce rat predation on listed species.

d) Bellows Air Force Station Oxbow wetland will be surveyed on a regular basis for early detection of American bullfrogs. If bullfrogs are discovered, methods should be implemented for immediate eradication.

e) Hawaiian ducks are declining primarily due to hybridization with mallard ducks (Engilis and Pratt 1993). Mallard and Hawaiian duck hybrid populations on Oahu are increasing based on DOFAW bi-annual waterbird survey data (Figure 10). Because feral ducks could displace listed ducks and have the potential to perpetuate hybridization, a program of survey and control will be coordinated with PIFWO prior to implementation. Methodology will be based on criteria outlined in the Hawaiian duck-hybrid Identification Key (Eadie et. al. 2009, Fowler et. al. 2008) to address incursions of these hybrid duck at Bellows Air Station Oxbow wetland. Specimens of hybrid ducks shall be retained and disposition of carcasses shall be coordinated with PIFWO.

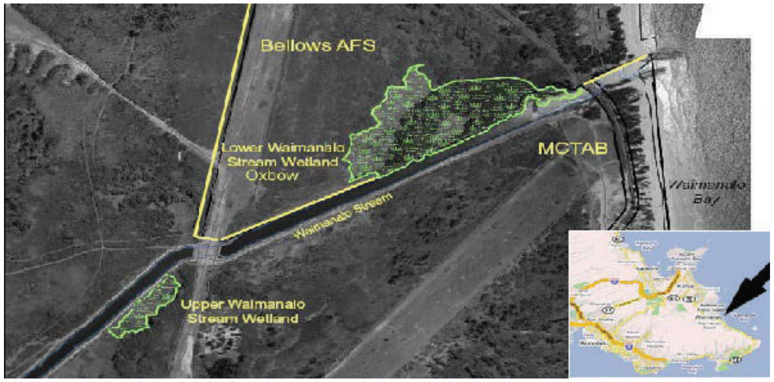
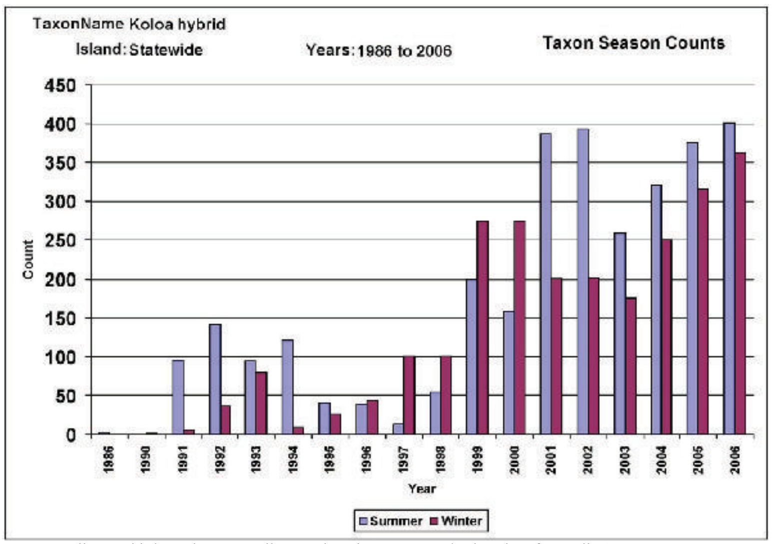


Figure 9. Oxbow Wetland of Waimanalo Stream on Bellows Air Force Station.

Figure 10. State waterbird surveys 1986 – 2006, summer and winter counts of hybrid Hawaiian duck and mallard.



Data: Hawaii Waterbird Database-Hawaii Natural Heritage Program/University of Hawaii 2007.

STATUS OF THE SPECIES

Hawaiian stilt or Ae o (*Himantopus mexicanus knudseni*)

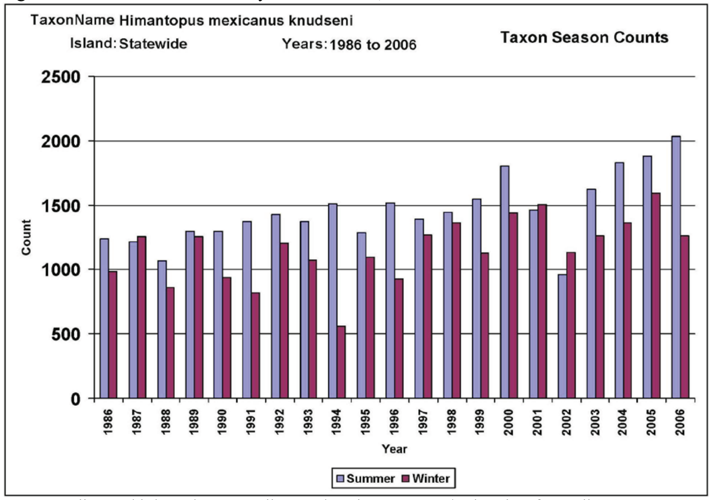
Legal Status
The Hawaiian stilt was listed as an endangered species on October 13, 1970 (Service 1970) pursuant to the Endangered Species Preservation Act of 1966. The original recovery plan was approved in 1978, and revised in 1985. The first draft of the second revision was released in May 1999, followed by the second draft of the second revision in May 2005. A species review has not yet been initiated pursuant to Section 4 (c)(2) of the Act which requires five year review after listing. Critical habitat has not been designated for the Hawaiian stilt (Service 2005).

Description
The Hawaiian stilt is a slender wading bird, black above (except for the forehead), white below, and with distinctive long, pink legs. Sexes are distinguished by the color of the back feathers (brownish in the female, black in the male) as well as by voice (females having a lower voice). Downy chicks are well camouflaged and are tan with black speckling. Immature birds have brownish-back and white patches on their cheeks (Pratt *et al.* 1987). A comprehensive summary of the current knowledge of stilts in North America has recently been published by The Birds of North America (Robinson *et al.* 1999).

Range and Distribution
Hawaiian stilts were historically known from all of the major Hawaiian Islands, except Lanai and Kahoolawe (Paton and Scott 1985). The first stilts on Lanai were documented in 1989, at the Lanai City wastewater treatment ponds (Hawaii Division of Forestry and Wildlife 1976 to 2003). Stilts are now found on all of the main Hawaiian Islands except Kahoolawe.

Population Densities
By the early 1940s, statewide population numbers were estimated to be between 200 to 1,000 Hawaiian stilts (Munro 1960, Schwartz and Schwartz 1949). However, these population estimates did not account for the Hawaiian stilts present on Niihau and are therefore considered underestimates. Though Hawaiian stilt census data show high year-to-year variability in the number of stilts observed (Engilis and Pratt 1993), long-term census data indicate that statewide populations have been relatively stable or slightly increasing (Reed and Oring 1993). Currently, the population of Hawaiian stilts is considered to be stable to increasing (Service 2005) and is estimated to be between 1,200 to 1,600 birds (Griffin *et al.* 1989; Engilis and Pratt 1993, Hawaii Waterbird Database-Hawaii Natural Heritage Program 2007) (Figure 11). Hawaiian stilts readily disperse between islands and constitute a homogenous metapopulation within Hawaii (Reed *et al.* 1994; Reed *et al.* 1998).

Figure 11. State waterbird surveys 1986 – 2006, summer and winter counts Hawaiian stilt.



Data: Hawaii Waterbird Database-Hawaii Natural Heritage Program/University of Hawaii 2007.

Habitat Types
Hawaiian stilts use a variety of aquatic habitats but are limited by water depth and vegetation cover. Hawaiian stilts are known to use ephemeral lakes, anchaline ponds, prawn farm ponds, marshlands and tidal flats. Stilts need early successional marshlands or other aquatic habitat with water depth less than 9 inches, perennial vegetation that is limited and low growing for foraging areas. Native low-growing wetland plants associated with stilt nesting areas include water hyssop (*Bacopa monnieri*); sea purslane (*Sesuvium portulacastrum*); and the sedges, makaloa (*Cyperus laevigatus*) and kaluha (*Bolboschoenus maritimus*) (Robinson *et al.* 1999). They may also use taro (*Colocasia esculenta*) ponds where the full-grown vegetation forms a protective canopy.

Breeding
Hawaiian stilts have higher nesting densities on freshly exposed mudflats, interspersed with low growing vegetation (Service 1983). Nesting has also been documented on low relief islands (natural and man-made) in fresh or brackish ponds, man-made floating nest structures, floating wooden platforms, and cleared level areas near foraging habitats (Shallenberger 1977; Morin 1994; Navy pers. comm. 2008). The nest itself is a simple scrape on the ground. They have also been observed using grass stems and rocks for nesting material (Coleman 1981). Hawaiian stilts defend an area of 66 to 99 feet around the nest and are semi-colonial. The nesting season normally extends from mid-February through August (Robinson *et al.* 1999). Peak nesting varies among years and re-nesting can occur after a loss of a clutch (Robinson *et al.* 1999). Stilts

usually lay three to four eggs that are incubated for approximately 24 days (Coleman 1981; Chang 1990). Chicks are precocial, leaving the nest within 24 hours of hatching. Adults with three-day old chicks have been observed to move three-tenths of a mile from the nest site (Reed and Oring 1993). Young may remain with both parents for several months after hatching (Coleman 1981).

Diet
Stilts are opportunistic feeders. They eat a wide variety of invertebrates and other aquatic organisms available in shallow water and mudflats. Specific organisms taken include water boatmen (Corixidae), beetles (Coleoptera), possibly brine fly (*Ephydra riparia*) larvae, polychaete worms, small crabs, Mozambique tilapia (*Tilapia mossambica*), western mosquito fish (*Gambusia affinis*), and tadpoles (*Bufo* spp.) (Robinson *et al.* 1999; Shallenberger 1977).

Hawaiian coot or Alae keokeo (*Fulica alai*)

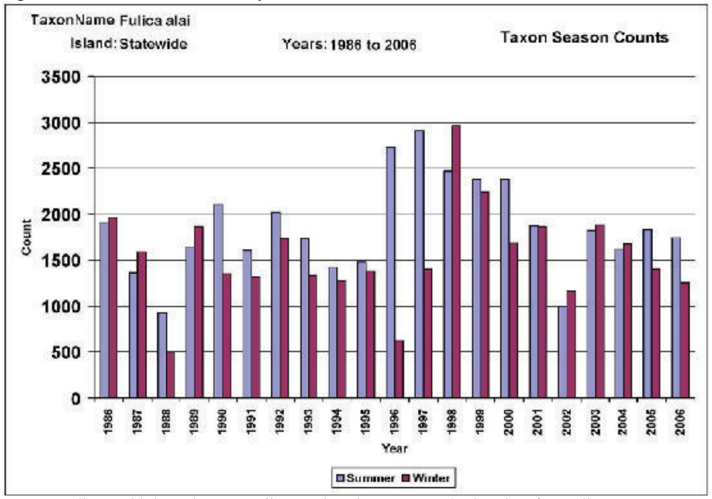
Legal Status
The Hawaiian coot was listed as an endangered species on October 13, 1970 (Service 1970) pursuant to the Endangered Species Preservation Act of 1966. The original recovery plan was approved in 1978, and revised in 1985. The first draft of the second revision was released in May 1999, followed by the second draft of the second revision in May 2005. A species review has not yet been initiated pursuant to Section 4 (c)(2) of the Act which requires five year review after listing. Critical habitat has not been designated for the Hawaiian coot (Service 2005).

Description
The Hawaiian coot adult males and females have a black head, a slate gray body with white undertail feathers, and a prominent white frontal shield and bill; feet are lobed rather than webbed and are greenish-gray.

Range and Distribution
Hawaiian coots occur in coastal plain wetlands usually below 1,320 feet elevation on all the main Hawaiian Islands except for Kahoolawe; however, breeding is restricted to relatively few sites. About 80 percent of the population occurs on Kauai (Hanalei, Huleia, Opaekaa), Oahu (coastal wetlands and reservoirs such as Lake Wilson and Nuuanu Reservoir, Kahuku Point and along the windward shore), and Maui (Kanaha and Kealia Ponds, Nuu Pond) (Service 2005). The remaining 20 percent of the population occurs in coastal ponds and playa wetlands, such as Paialoa Pond on Molokai, the Lanai City wastewater treatment pond, Aimakapa, Opaeula, Waiakea, and Loko Waka ponds on the island of Hawaii (Service 2005).

Population Densities
Island-wide population, based on bi-annual waterbird counts conducted by DOFAW, suggests that the population is stable and is estimated at between 2,000 and 3,000 individuals (Figure 12).

Figure 12. State waterbird surveys 1986 – 2006, summer and winter counts Hawaiian coot.



Data: Hawaii Waterbird Database-Hawaii Natural Heritage Program/University of Hawaii 2007.

Habitat Types
Life history and breeding biology are poorly known. The species is somewhat gregarious and uses freshwater and brackish wetlands including agricultural areas (e.g., taro fields) and aquaculture ponds. Hawaiian coot generally occur in low elevation, wetland habitats with suitable emergent plant growth interspersed with open water, especially freshwater wetlands, but also freshwater reservoirs, cane field reservoirs, sewage treatment ponds, taro loi, brackish wetlands, and limited use of saltwater habitats. However, on Kauai, some birds occur in plunge pools above 4,900 feet elevation and on the island of Hawaii, stock ponds up to 6,600 feet elevation. The species typically forages in water less than 12 inches deep, but will dive in water up to 48 inches deep. Compared to Hawaiian moorhen, Hawaiian coots prefer to forage in more open water. Logs, rafts of vegetation, narrow dikes, mud bars, and artificial islands are utilized for resting. Ephemeral wetlands support large numbers of coots during the non-breeding season. Some important habitats are located on NWR and in State waterbird sanctuaries and these sites receive management attention. However, other important habitats are not protected. These unprotected habitats include wetlands facing development or those used for agriculture or aquaculture. Examples include: playa lakes on Niihau, Opaekaa marsh, Lumahai wetlands on Kauai, Amorient prawn farms, Laie wetlands, Uko, Punahoolapa, and Waihee marshes, Waialua lotus fields, and Waipio Peninsula ponds on Oahu, Paialoa and Ooia playa fishponds on Molokai, and Opaeula, and Waiakea-Loko Waka ponds on the island of Hawaii.

Breeding
Nesting habitat includes freshwater and brackish ponds, irrigation ditches, and taro fields. Floating nests are constructed of aquatic vegetation and found in open water or anchored to emergent vegetation. Open water nests are usually composed of mats of bulrush (*Schoenoplectus* spp.), water hyssop (*Bacopa monniere*) and Hilo grass (*Paspalum conjugatum*). Nests in emergent vegetation are typically platforms constructed from buoyant stems of species such as bulrush (*Schoenoplectus* spp.). Nesting occurs year round. Nest initiation is tied to rainfall as higher water levels are critical to nest success. Clutch size range from three to ten eggs, and precocial young hatch after a 25 day incubation period.

Diet
Hawaiian coots are generalists and feed on land, grazing on grass adjacent to wetlands, or in the water. They have been observed grazing from the surface of the water, or foraging by diving to obtain food resources. Food items include seeds and leaves, snails, crustaceans, insects, tadpoles, and small fish. The species will travel long distances, including between islands, when local food sources are depleted.

Hawaiian moorhen or Alae Ula (*Gallinula chloropus sandvicensis*)

Legal Status
The Hawaiian moorhen is an endemic subspecies of the North American mainland Common moorhen. The Hawaiian moorhen was listed as an endangered species in 1967 pursuant to the Endangered Species Preservation Act of 1966. The original recovery plan was approved in 1978, and revised in 1985. The first draft of the second revision was released in May 1999, followed by the second draft of the second revision in May 2005. A species review has not yet been initiated pursuant to Section 4 (c)(2) of the Act which requires five year review after listing. Critical habitat has not been designated for the Hawaiian moorhen (Service 2005).

Description
The Hawaiian moorhen is a dark, gray bird with a black head and neck and white feathers on their flanks and undertail coverts. They have a very distinctive red frontal shield, and their bill tip is yellow with a red base. Their legs and feet are greenish and without lobes. The Hawaiian moorhen usually measure about 13 inches in length. Both sexes are similar and have chicken-like cackles and croaks. The Hawaiian moorhen is very similar to the common moorhen on the mainland in appearance. A comprehensive summary of the current knowledge of moorhen in North America has recently been published by The Birds of North America (Robinson *et al.* 1999). In Hawaiian legend, these birds were thought to have brought fire from the gods to the Hawaiian people.

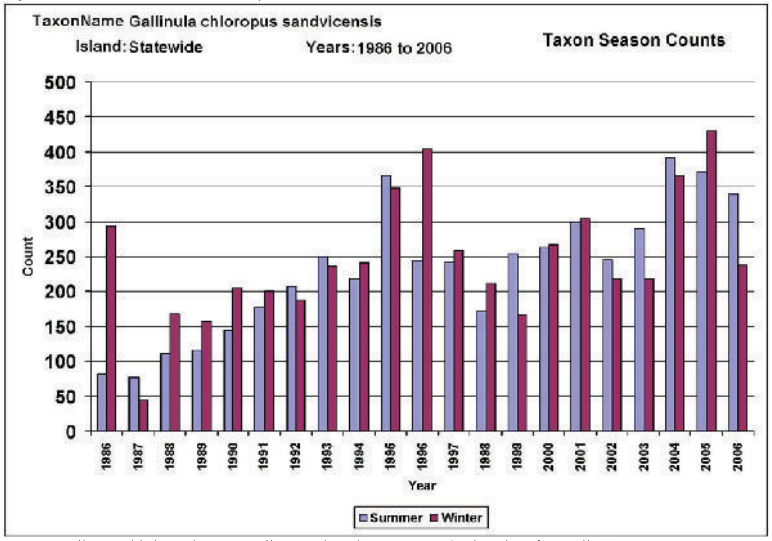
Range and Distribution
Hawaiian moorhen generally occur in wetland habitats below 410 feet elevation on the islands of Kauai and Oahu, although there have been reports from Keanae Peninsula on Maui and from the island of Hawaii. On Kauai, the largest populations occur in the Hanalei and Wailua river valleys. Hawaiian moorhen also occur in the irrigation canals on the Mana Plains of western Kauai and in taro fields. On Oahu, the species is widely distributed with most birds found between Haleiwa and Waimanalo; small numbers occur at Pearl Harbor and the leeward coast at

Lualualei Valley. Historically, Hawaiian moorhen occurred on all the main Hawaiian Islands except for Lanai and Kahoolawe.

Population Densities

No historical population estimates are available for the endemic Hawaiian moorhen. Because they are such secretive birds, it is difficult to conduct population surveys for this species. It is believed that they were common on the main Hawaiian Islands, except Lanai and Kahoolawe, in the 1800's but radically declined by the mid-1900. Surveys from the 1950's through the 1960's estimated only 57 individuals. Currently Hawaiian moorhen inhabit the islands of Kauai and Oahu (Service 2005). The State attempted a re-introduction of six banded moorhen (three females and three males) on May 18, 1983, to the island of Molokai at Kakahaia NWR. One of the banded birds was found dead January 2, 1985, and a local resident mistook the other five for chickens they were consumed (Dibben-Young 2009). Island-wide population, based on bi-annual waterbird counts conducted by DOFAW, suggests that the population is increasing, but count numbers are variable. Between 1993 and 2003, the average annual number of Hawaiian moorhen observed has been just under 300 individuals (Figure 13). However, these survey numbers are thought to be underestimates because of the moorhen's cryptic behavior. Standard survey methods in these counts include visual and aural detection. Recent research conducted by DesRochers between 2005 and 2007, has shown that passive surveys of cryptic waterbirds underestimate numbers of individuals present in the wetlands. Alternatively, broadcasting vocalizations of cryptic waterbirds to elicit responses increases detection. On average, DesRochers research has shown, broadcasting calls increased moorhen detection by 30 percent.

Figure 13. State waterbird surveys 1986 to 2006, summer and winter counts Hawaiian moorhen.



Data: Hawaii Waterbird Database-Hawaii Natural Heritage Program/University of Hawaii 2007.

Habitat Types

Hawaiian moorhen are the most secretive of the native waterbirds, preferring to forage, nest and rest in dense, late succession wetland vegetation. Most birds feeding along the waters edge or in open water will quickly seek cover when disturbed. The preferred habitat for moorhens includes: interspersed dense stands of robust late succession vegetation near open water (approximately 50 percent water to 50 percent vegetation) floating or barely emergent mats of vegetation and water depth less than 3 feet (Service 2005).

Breeding

These birds nest year-round but appear to have two active seasons from November through February and May through August (Service 2005). It is believed that the timing of nesting is related to water levels and late succession wetland vegetation. The Hawaiian moorhen usually lay an average of 5 to 6 eggs, although clutches have been up to 13 eggs, and incubation is about 25 days (Service 2005). Nesting phenology is apparently tied to water levels and the presence of appropriately dense vegetation. Platform nests are constructed in dense vegetation over water or near the waters edge. The particular species of emergent plant used for nest construction is not as important as stem density and vegetation height (Service 2005).

Diet
Hawaiian moorhen are opportunistic feeders and their diet likely varies with habitat, but includes algae, grass seeds, insects, snails, introduced fishes, crustaceans, mollusks, emergent grasses, and wetland plants (Service 2005).

Hawaiian duck or kaloa maoli (*Anas wyvilliana*)

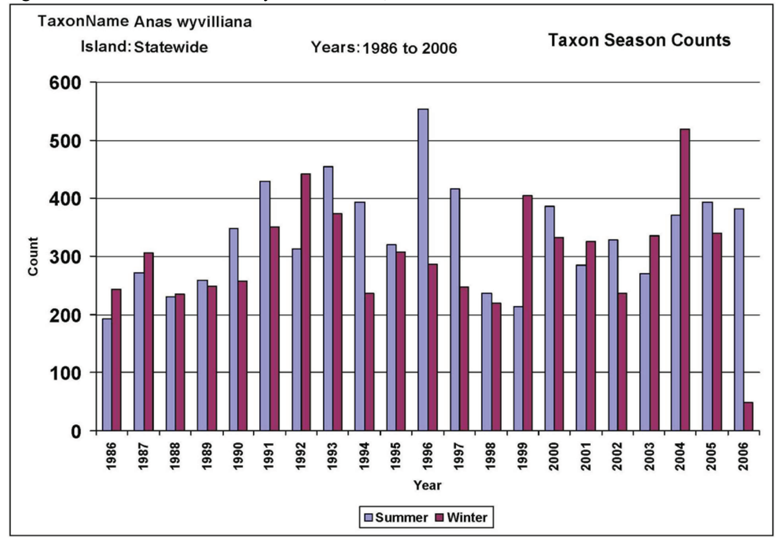
Legal Status
The Hawaiian duck was listed as an endangered species in 1967 (Service 1967) pursuant to the Endangered Species Preservation Act of 1966. The original recovery plan was approved in 1978, and revised in 1985. The first draft of the second revision was released on May 1999, followed by the second draft of the second revision in May 2005. A species review has not yet been initiated pursuant to Section 4 (c)(2) of the Act which requires five year review after listing. Critical habitat has not been designated for the Hawaiian duck (Service 2005).

Description
The Hawaiian duck is one of two extant native duck species (Family: Anatidae) found in Hawaii and is closely related to the well-known, but non-native mallard. Both sexes are mottled brown overall similar in appearance to a female mallard. Adult males have darker heads, with distinctive brown chevrons on the breast, flank and back feathers, and olive bills (Englis et. al 2002). Adult females are similar but are smaller than males on average and slightly lighter in color, with plainer, buff colored chin and back feathers (Englis et. al 2002).

Range and Distribution
Historically, Hawaiian ducks occurred on all the main Hawaiian Islands except for Lanai and Kahoolawe. Currently, Hawaiian ducks are generally found in wetland habitats from sea level to 9,900 feet elevation on all the main Hawaiian Islands except for Kahoolawe; populations on all islands except for Kauai originated from re-introduced birds. On Kauai, populations are found in Hanalei NWR and montane streams. On Oahu, populations are found in Kawainui, Hamakua, and Heeia marshes, James Campbell NWR, and in wetland habitats in or near Punahoolapa, Haleiwa, Pearl Harbor, and Lualualei Valley. On Maui, Hawaiian ducks are found in Kahului, Kanaha and Kealia ponds. On the island of Hawaii populations occur in the Kohala Mountains, in Pololu, Waimanu and Waipio valleys, and Mauna Kea.

Population Densities
The Hawaiian duck population is estimated to be approximately 2,000 individuals with 80 percent of individuals occurring on Kauai (Engilis et. al 2002). State bi-annual waterbird survey data count numbers range from 300 to 500 individuals (Figure 14). Because of the remoteness and inaccessibility of some habitats, the State waterbird counts are likely an underestimate. Historically, Hawaiian duck were fairly common in natural and agricultural wetland habitats. By 1949, only about 530 individuals remained, with 30 on Oahu and the remainder on Kauai (Service 2005).

Figure 14. State waterbird surveys 1986 – 2006, summer and winter counts Hawaiian duck.



Data: Hawaii Waterbird Database-Hawaii Natural Heritage Program/University of Hawaii 2007.

Habitat Types
Hawaiian ducks occur in a wide variety of natural and artificial wetland habitats including freshwater marshes, flooded grasslands, coastal ponds, streams, montane pools, forest swamplands, taro, lotus, shrimp, and fish ponds, irrigation ditches, reservoirs, and mouths of larger streams (Service 2005). Some important habitats are located on NWR or on State lands and receive management attention. However, other important habitats are not protected. These mostly include wetlands facing development or those used for agriculture or aquaculture. Examples include: playa lakes on Niihau, Opaekaa marsh, Lumahai wetlands on Kauai, Amorient prawn farms, Laie wetlands, Uko, Punahoolapa, and Waihee marshes, Waialua lotus fields, and Waipio Peninsula ponds on Oahu, Paialoa and Ooia playa fishponds on Molokai, and Opaeula, and Waiakea-Loko Waka ponds on the island of Hawaii.

Breeding
Hawaiian ducks nesting biology is poorly understood. Although some pairs nest in lowland habitats on Kauai, Hawaiian ducks have also been observed nesting in the upper Alakai swamp (Service 2005). Nesting occurs year round, but most activity occurs between January and May (Engilis et. al 2002). Nests are usually on the ground near water, but few nests are found in areas frequented by humans or areas supporting populations of mammalian predators. Generally eight to ten eggs are laid, and the precocial chicks hatch after an unknown incubation period, but likely less than 30 days.

Diet
Hawaiian ducks forage in a wide variety of freshwater habitats, including artificial wetlands. Movements between feeding and breeding habitats and between Kauai and Niihau occur. The species typically forages in shallow water (less than five inches deep). Like mallards, Hawaiian ducks are opportunistic and their diet includes snails, dragonfly larvae, earthworms, grass seeds, green algae, and seeds/leaf parts of wetland plants. Hawaiian ducks are usually found alone or in pairs and are wary, especially when nesting or molting, although during the winter they may gather in larger numbers to exploit abundant food resources (Service 2005).

Threats and Recovery Needs for all Hawaiian Waterbirds
The primary causes of the decline of the Hawaiian waterbirds are the loss of wetland habitat, predation by introduced animals, hunting in the late 1800's and early 1900's, disease, and environmental contaminants. A significant amount of Hawaii's wetlands have been lost due to human activities. Modification of wetlands includes filling and draining for agriculture, houses, hotels and golf courses. The Service estimates 22,475 acres of wetlands existed within the coastal plains of Hawaii circa 1780 (Service 1990). In 1990, the Service estimated only 15,474 acres remained a decrease of 31 percent (Service 2005). This loss of suitable wetland habitat is compounded by the alteration of wetland plant communities due to invasion by non-native plants. Species such as California grass, pickleweed, water hyacinth, Indian fleabane and red mangrove all present a serious threat by out-competing more desirable species and eliminating open water habitats. Unmanaged vegetation has reduced open water, shallow water, bare ground, and exposed mudflat habitat. All of these habitats are under serious threat without management to control these aggressive plant species (Service 2005).

Other major contributors to the decline of endangered Hawaiian waterbirds are introduced predators. Small Indian mongoose, feral cats, and feral dogs are all presently found within wetlands and pose a serious threat to Hawaiian waterbird reproductive success. All three of these predatory species are known to take eggs, young birds, and even adults. Both cats and dogs are of particular concern because of the close proximity of Hawaii wetlands to urban areas. Other species, such as the cattle egret, American bullfrog, and rats have been observed congregating around nesting waterbirds just prior to chicks hatching or in areas where young chicks have suddenly disappeared from nests (Woodside 1997). Oahu NWR staff have documented predation of waterbird chicks by cattle egret and black-crowned night heron. An American bullfrog was documented preying upon a Hawaiian moorhen chick at Hanalei NWR (Viernes 1995). More recently the key predators study of 2003 to 2004, on James Campbell NWR provided the first multiple observations of Hawaiian stilt chick predation by American bullfrogs, which accounted for 45 percent chick losses over the study period (Eijzenga 2005). Predation by introduced mammals and other native and non-native species is currently the most important factor limiting recovery for the Hawaiian waterbirds (Service 2005, Robinson *et al.* 1999). Recovery of the Hawaiian waterbirds focuses on the following objectives: (1) increase population numbers to a statewide baseline level; (2) establish multiple, viable breeding populations throughout each species' historic range; and (3) establish a network of wetlands on the main islands that are protected and managed for waterbirds (Service 2005).

Threats and Recovery Needs Specific to Hawaiian Duck
Currently the most important threat to the Hawaiian duck population is hybridization with non-native mallards. This is especially problematic on Oahu where most of the individuals are hybrids. In addition, feral pigs (*Sus scrofa*) and goats (*Capra hircus*) significantly reduce the suitability of nesting habitat for Hawaiian ducks along montane streams (Service 2005).

ENVIROMENTAL BASELINE

Status of the Species in the Action Area
Hawaiian stilts, are regular visitors to Hickam Air Force Base, frequently foraging in several watercourses and on the reef flat (Ahua Reef) extending off of the wetland area. However, this habitat does not provide for nesting or loafing opportunities making it marginal habitat for endangered waterbird life cycle needs. Occasional sightings of Hawaiian coots, Hawaiian moorhen, and Hawaiian ducks have been documented at Hickam Air Force Base.

Existing data for endangered Hawaiian waterbirds on Hickam Air Force Base is derived from the State bi-annual waterbird surveys conducted by DOFAW and by Hickam Air Force Base Natural Resources personnel. These data were collected systematically, with each survey being conducted by at least one person familiar with the site and one person experienced in waterbird identification. DOFAW waterbird surveys conducted between 1987 and 2004 encompassed only the reef flats off the Hickam Air Force Base wetland area (Ahua Reef and Fort Kamehameha Flat). Surveys were timed to coincide with low tide. Only the Hawaiian stilt was observed during these surveys averaging zero to four stilts per survey (Tables 3 and 4). Hickam Air Force Base Natural Resources personnel conducted waterbird surveys from 2006 to 2008, and included a broader area of coastline and wetlands. In July 2006, zero endangered waterbirds were observed; in January 2007, two adult stilts were observed at Ahua Reef; and in January 2008, two adult stilts were observed at the mouth of the Manuwai Canal.

The wetland area located at Bellows Air Force Station is not currently used by Hawaiian waterbirds. Unfortunately, the wetland is overgrown with non-native red mangrove and does not currently provide any function for Hawaiian waterbirds.

Between 2002 and 2006, Wildlife Services personnel documented all endangered species hazing events within the Hickam Air Force Base BASH zone. This information also includes data from nesting events and bird aircraft interactions and removal of pre-fledgling chicks from the Hickam Air Force runway (Table 5 and Figure 15). Hazing events can fluctuate from year to year as depicted in Table 5. In 2002 the number of hazing events for the Hawaiian stilt was 28 while in 2006, Wildlife Services documented 340 interactions with Hawaiian stilts. It is not known if these numbers represent many individuals or only a few individuals hazed repetitively. We do know that there is some level of repetitive hazing as it is highly unlikely that 340 individual Hawaiian stilts have passed through the Hickam Air Force Base.

Breeding by Hawaiian stilts though rare, has been documented near Hickam Air Force Base/Honolulu International Airport in 2002 and 2006, as both eggs and chicks have been removed by Wildlife Services for aircraft safety concerns. Wildlife Services attempts to discourage nesting activities prior to eggs being laid to minimize Hawaiian waterbird mortality.

When comparing State bi-annual waterbird data with BASH data collected by Wildlife Services, it may appear to be inconsistent. However, point in time surveys are only done for a short period of time versus the recorded incidents of hazing which are conducted out throughout the entire year. It is likely that the number of birds within the action area is low because the birds are highly transitory and only utilizing area in and around Hickam for foraging, with the exception of the Hawaiian stilts that have opportunistically attempted nesting during wet years.

Table 3. State waterbird surveys 1987 – 2003, summer counts Fort Kamehameha Flats Hawaiian waterbird count summary report.

Island: Oahu
Wetland:
Fort Kam Flats

Season: Summer

Year	Anas wyvilliana-Adult	Anas wyvilliana-Chick	Anas wyvilliana-Total	Fulica alai-Adult	Fulica alai-SubAdult	Fulica alai-Unknown	Fulica alai-Total	Gallinula chloropus sandvicensis-Adult	Gallinula chloropus sandvicensis-SubAdult	Gallinula chloropus sandvicensis-Unknown	Gallinula chloropus sandvicensis-Total	Himantopus mexicanus knudseni-Adult	Himantopus mexicanus knudseni-SubAdult	Himantopus mexicanus knudseni-Unknown	Himantopus mexicanus knudseni-Total
2003	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2002	0	0	0	0	0	0	0	0	0	0	0	1	0	0	1
2001	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2000	0	0	0	0	0	0	0	0	0	0	0	3	0	0	3
1999	0	0	0	0	0	0	0	0	0	0	0	2	0	0	2
1998	0	0	0	0	0	0	0	0	0	0	0	4	0	0	4
1997	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1996	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1995	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1994	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1993	0	0	0	0	0	0	0	0	0	0	0	4	0	0	4
1992	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1991	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1990	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1989	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1988	0	0	0	0	0	0	0	0	0	0	0	1	0	0	1
1987	0	0	0	0	0	0	0	0	0	0	0	1	0	0	1

Data: Hawaii Waterbird Database-Hawaii Natural Heritage Program/University of Hawaii 2007.

Table 4. State waterbird surveys 1987 – 2004, winter counts Fort Kamehameha Flats Hawaiian waterbird count summary report.

Island: Oahu
Wetland:
Fort Kam Flats

Season: Winter

Year	Anas wyvilliana-Adult	Anas wyvilliana-Chick	Anas wyvilliana-Total	Fulica alai-Adult	Fulica alai-SubAdult	Fulica alai-Unknown	Fulica alai-Total	Gallinula chloropus sandvicensis-Adult	Gallinula chloropus sandvicensis-SubAdult	Gallinula chloropus sandvicensis-Unknown	Gallinula chloropus sandvicensis-Total	Himantopus mexicanus knudseni-Adult	Himantopus mexicanus knudseni-SubAdult	Himantopus mexicanus knudseni-Unknown	Himantopus mexicanus knudseni-Total
2004	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2003	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2002	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2001	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2000	0	0	0	0	0	0	0	0	0	0	0	3	0	0	3
1999	0	0	0	0	0	0	0	0	0	0	0	3	0	0	3
1997	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1996	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1993	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1992	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1991	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1990	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1989	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1988	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1987	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Data: Hawaii Waterbird Database-Hawaii Natural Heritage Program/University of Hawaii 2007.

Table 5. Endangered waterbird actions within the BASH 2002-2006, at Honolulu International Airport and Hickam Air Force Base.

Species	Year	Incidents	Disposition
Hawaiian stilt	2002	28	hazed
Hawaiian stilt	2002	1	nest removal-2 eggs
Hawaiian stilt	2003	19	hazed
Hawaiian stilt	2004	36	hazed
Hawaiian stilt	2005	44	hazed
Hawaiian duck	2005	27	hazed
Hawaiian duck	2005	3	aircraft strike
Hawaiian stilt	2006	340	hazed
Hawaiian duck	2006	60	hazed
Hawaiian coot	2006	65	hazed
Hawaiian stilt	2006	2	chick removal

Data: Wildlife Services Letter designee annual reports 2003-2007.

Figure 15. Hawaiian stilt chicks removed from Hickam Air Force Base and Honolulu International Airport Runway 2006.

Photo: Wildlife Services

EFFECTS OF THE ACTION

Potential risks to listed waterbirds from the ongoing and increasing operations at Hickam Air Force Base include: (1) aircraft operations; (2) BASH program at Hickam Air Force Base; (3) short term and permanent water catchments and drainage canals associated with construction and renovation of airport facilities; and (4) management actions related to Bellows Air Force Station Oxbow wetland.

The issue of aircraft flight safety and collision with birds has been well documented and airports are responsible for reducing this risk through various management methods. Between 1998 and 2004, 164 aircraft have been destroyed and 194 people have lost their lives as a result of bird and other wildlife strikes with civil and military aircraft (Richardson et. al. 2000, Thorpe 2003, Wright 2008). Hickam Air Force Base's ongoing operations and forecasted expansion of air operations (SAIC 2007, E2m 2008) will have the potential for waterbird-aircraft collisions. It is anticipated that although there will be an increase in military operations that avoidance and minimization measures will stabilize or decrease potential for interactions. Despite preventative measures on the part of the Hickam Air Force Base and Wildlife Services, there remains the possibility for take of endangered Hawaiian waterbirds due to direct collision with an aircraft. For example, three ducks (one Hawaiian duck and two mallard/Hawaiian duck hybrids) were attracted to a Hickam Air Force Base ditch filled with standing water and were struck in 2005, in a single incident by a commercial aircraft (see Table 5). Mr. Willie Glover from the entomology

department of Hickam Air Force Base, documented a Hawaiian coot with a broken wing, brought to him by personnel who had recovered the bird from the flight line in early 2000 (INRMP 2003). Increased vigilance through interdepartmental and interagency communication of changing conditions (weather and habitat) within the BASH zone, and management to reduce water attractants within the BASH will minimize these lethal interactions with Hawaiian waterbirds.

One method employed to help reduce the potential for bird/aircraft collision is direct hazing of avifauna on the Hickam Air Force Base/Honolulu International Airport by Wildlife Services. Hazing includes endangered Hawaiian waterbirds and is performed in the BASH zone at Hickam Air Force Base. The hazing activities occur seven days a week during Hickam Air Force Base operational hours. Hazing activities include using pyrotechnics, flushing using vehicles or personnel on foot within the BASH zone, results in startle response flushing of foraging waterbirds from the airport area which could result in injury through collision with aircraft, fences, or structures. In addition, Wildlife Services personnel haze waterbirds to preclude nesting activities in the BASH zone. Again, this is necessary for the safe operations of the airport and hazing a pair of birds while attempting to nest reduces the risk of having to destroy an active nest with eggs or chicks. Harassment of waterbirds prior to nesting may also move the pair offsite to establish a nest in a more suitable location. In the last five years, according to data collected by Wildlife Services (see Table 5), one Hawaiian stilt nest was destroyed and two chicks were removed in 2006. These events result in the mortality of eggs and/or young.

The greatest number of hazing incidents recorded over the last five years reported by Wildlife Services was 340 Hawaiian stilts at Hickam Air Force Base/Honolulu International Airport (see Table 5). In 2006, 65 hazing events was recorded for Hawaiian coots along with 60 events for Hawaiian duck (because of Hawaiian duck hybrid identification issues; all birds are documented as Hawaiian ducks) (see Table 5). Since many of these birds are not banded or band identification is not collected, we do not know how many individual birds these numbers actually represent. For example, it is highly unlikely that 340 individual Hawaiian stilts have passed through the Hickam Air Force Base/Honolulu International Airport in one year. It is likely that the number of birds within the action area is low because the birds are highly transitory and only utilizing area in and around Hickam for foraging. In addition, it is anticipated that very few of the hazing incidents may result in injury, and that the hazing overall is an appropriate avoidance and minimization tool to avoid bird-aircraft collisions.

Water attractants within the BASH zone increase the potential for waterbird-aircraft collision resulting in injury and mortality of Hawaiian waterbirds. In March 2006, a pair of Hawaiian stilt nested adjacent to the runway where dewatering ponds and a leaky pipe from a construction project provided a nuisance attractant. Wildlife Services contacted the Service requesting permission to remove the nest from the area in an attempt to reduce the potential for an aircraft strike. In this case, it was determined the nest could remain in place, but the chicks failed to fledge (Darrin Phelps pers. comm.). In 2002, Hawaiian stilts nested within the BASH zone and Service personnel (Law Enforcement) were called to remove the nest due to safety concerns. Facility construction, renovation, and demolition will require short term dewatering ponds (up to 2 years) be constructed. Construction of these ponds will be straight sided and water levels will be maintained so that there will be no shallow water. These dewatering ponds will be covered (bird balls, nets, tarps, etc.) to reduce attractiveness to the ponds. The permanent airport facility drainage canals are required and also provide waterbird habitat within the BASH zone. To reduce the attractiveness of the canals to waterbirds, Hickam Air Force Base will remove woody vegetation and keep the canals open and clear. In addition, Hickam Air Force Base will repair the water catchment at the golf course to eliminate surface pooling water thus reducing its attractiveness to waterbirds. Eliminating or reducing the attractiveness of these temporary and permanent water sources will help to reduce the number of Hawaiian waterbirds utilizing Hickam Air Force Base thus reducing the harm and harassment to Hawaiian waterbirds.

The loss of wetland habitat has been identified as the primary cause for the decline of the Hawaiian waterbirds (Service 2005). The Air Force's proposed action includes increasing managed wetland habitat for Ahua Reef wetland and Bellows Air Force Station for the benefit of Hawaiian waterbirds. Restoration of Ahua Reef wetland will increase available foraging and loafing habitat. Restoration of the Bellows Air Force Station Oxbow wetland will provide additional foraging, loafing, and nesting habitat. The restored habitat will provide for increased reproduction and numbers of Hawaiian waterbirds. Since Oxbow wetland is currently unsuitable for waterbird use, the improvements to the site (habitat restoration and predator control) will provide additional habitat thus increasing wetland acreage suitable for waterbird nesting.

Predator control is necessary for Hawaiian waterbirds to successfully reproduce. Unfortunately, predator control traps attract the curious Hawaiian moorhen and birds have been captured in the predator traps. The use of predator control traps at Bellows Air Force Station Oxbow wetland may result in take of Hawaiian moorhen once a population becomes established. The trapability of moorhen was demonstrated by a study conducted in 2005 through 2007, by David DesRochers (Tufts University Massachusetts) and Oahu NWR Complex staff (DesRochers et al. 2006). Within a two-year time period, 90 Hawaiian moorhen were banded with 162 captures with no injuries. A moorhen was incidentally captured on James Campbell NWR, Kii Unit on April 2, 2002, which resulted in a broken wing from catching on a hanging bait jar. On July 1, 1994, an adult Hawaiian moorhen was found dead in one of the traps at Hanalei NWR followed an incident on November 27, 1994 where one adult and three juvenile moorhens were captured in one trap where one of the juveniles died. Therefore, due to their curious nature and hence attraction to predator control traps, it is anticipated that Hawaiian moorhen will be captured in live traps which could result in injury or mortality.

The Hawaiian duck is declining primarily due to hybridization with mallard ducks (Engilis and Pratt 1993). Mallard and Hawaiian duck hybrid populations on Oahu are increasing based on data from State bi-annual waterbird surveys (see Figure 10). Because feral ducks have the potential to perpetuate hybridization and could displace listed species, the Air Force will assess a program for hybrid duck surveys and eradication. Any future duck control plan will be coordinated with the Service prior to implementation. The mallard/hybrid duck control plan has long-term beneficial effect of helping to minimize the potential for hybridization of Hawaiian ducks and mallards at the Bellows Air Force Station Oxbow wetland.

Avian botulism outbreaks are common in Hawaii and can be a significant localized cause of waterbird mortality (Pratt and Brisbin 2002). The first documented outbreak in Hawaii occurred on Oahu at Kaelepulu pond, which is also known as Enchanted Lake, in Kailua in 1952 (Brock

and Breese 1953). Since then, avian botulism outbreaks have been documented at Hanalei NWR on Kauai (Pratt and Brisbin 2002), Aimakapa pond at Kaloko-Honokahau National Historical Park on Hawaii (Morin 1998), Ohiapilo pond on Molokai, and at Kealia NWR on Maui (Service 2005). Avian botulism is caused by a toxin produced by a widespread bacterium. Normally dormant, these spores release toxins only when certain conditions occur, including warm temperatures and stagnant waters. Birds usually acquire the disease by eating invertebrates containing the toxin. Typical signs in birds include weakness, lethargy, and inability to hold up the head or to fly (Work 2008, pers. comm.). There is a possibility that the proposed project may increase the risk for an outbreak of avian botulism. Botulism can occur in any area with standing fresh or brackish water frequented by waterbirds. The Air Force will maintain surveillance for outbreaks; respond to such outbreaks by removal of carcasses, and post-outbreak waterbird population monitoring.

Cumulative Effects

Cumulative effects are those impacts of future State and private actions that are reasonably certain to occur within the area of action subject to consultation. Cumulative effects include the impacts of future State, tribal, local, or private actions that are reasonably certain to occur in the action area considered in this Biological Opinion. The project areas are under Federal jurisdiction. We are unaware of any future State activities effects within the action area since it is all under Federal jurisdiction.

Conclusion

After reviewing the current status of each species, the environmental baseline for the species within the action area, and the effects, ongoing aircraft missions, construction impacts and management activities, including the cumulative effects, it is our Biological Opinion that implementation of the proposed action is not likely to jeopardize the survival and recovery of the Hawaiian stilt, Hawaiian coot, Hawaiian moorhen, and Hawaiian duck. No critical habitat has been designated for these species; therefore, none will be affected.

The proposed action is not likely to jeopardize Hawaiian stilt, Hawaiian coot, Hawaiian moorhen and Hawaiian duck because as discussed in the above environmental baseline, the number of birds within the action area is low. Although they will be impacted by the effects as previously discussed, the loss of birds will have a minimal impact on the status of the species as a whole. In addition, restoration of Bellows Air Force Station Oxbow wetland will provide additional foraging, loafing, and nesting habitat. The restored habitat will provide for increased reproduction and numbers of Hawaiian waterbirds.

Incidental Take Statement

Section 9 of the Act and Federal regulation pursuant to section 4(d) of the Act prohibit the take of endangered and threatened species, respectively, without special exemption. Take is defined as to harass, harm, pursue, hunt, shoot, wound, kill, trap, capture or collect, or to attempt to engage in any such conduct. Harm is further defined (50 CFR 17.3) by the Service to include significant habitat modification or degradation that results in death or injury to listed species by significantly impairing essential behavioral patterns, including breeding, feeding, or sheltering. Harass is defined by the Service (50 CFR 17.3) as intentional or negligent actions that create the likelihood of injury to listed species to such an extent as to significantly disrupt normal behavior

patterns which include, but are not limited to, breeding, feeding, or sheltering. Incidental take is defined as take that is incidental to, and not the purpose of, the carrying out of an otherwise lawful activity. Under the terms of section 7(b)(4) and section 7(o)(2), taking that is incidental to and not intended as part of the agency action is not considered to be prohibited taking under the Act provided that such taking is in compliance with the terms and conditions of this Incidental Take Statement.
The measures described below are non-discretionary, and must be undertaken by the Air Force so that they become binding conditions in order for the exemption in section 7(o)(2) to apply. The Air Force has a continuing duty to regulate the activity covered by this incidental take statement. If the Air Force (1) fails to assume and implement the terms and conditions or (2) fails to require any contractors to adhere to the terms and conditions of the incidental take statement through enforceable terms that are added to any permit or contract, then the protective coverage of section 7(o)(2) may lapse. In order to monitor the impact of incidental take, the Air Force must report the progress of the action and its impact on the species to the Service as specified in the incidental take statement [50 CFR § 402.14(i)(3)].

Amount or Extent of Take
The Service anticipates that take will occur in the form of harm, harassment, and death as a result of Air Force activities described in this Biological Opinion.

<u>Hawaiian stilt</u>
The Service anticipates that one (1) Hawaiian stilt will be harmed, injured or killed due to potential waterbird-aircraft collision at Hickam Air Force Base every five years. The Service anticipates that two (2) Hawaiian stilt nest will be taken resulting in the mortality of up to seven eggs within a five year period. The Service anticipates a maximum of 340 harassment incidents of Hawaiian stilts may result from BASH zone hazing activities annually at Hickam Air Force Base.

<u>Hawaiian coot</u>
The Service anticipates that one (1) Hawaiian coot will be harmed due to potential waterbird-aircraft collision at Hickam Air Force Base every five years. The Service anticipates a maximum of 65 harassment incidents of Hawaiian coot may result from BASH zone hazing activities annually at Hickam Air Force Base.

<u>Hawaiian moorhen</u>
The Service anticipates take of not more than two (2) Hawaiian moorhen in the form of harassment due to capture in predator control traps at Bellows Air Force Station Oxbow wetland annually. Take in the form of injury or death of two (2) Hawaiian moorhen may occur every five years while conducting predator control for the duration of this management action at Bellows Air Force Station Oxbow wetland.

<u>Hawaiian duck</u>
The Service anticipates that one (1) Hawaiian duck will be harmed due to potential waterbird-aircraft collision at Hickam Air Force Base in a five year period. The Service anticipates a maximum of 60 harassment incidents of Hawaiian duck (or Hawaiian duck hybrid if identification is not feasible) may result from BASH hazing activities annually. The Service

anticipates take of not more than two (2) Hawaiian duck that may result in the injury or death through implementing a feral mallard duck removal program once the Bellows Air Force Station Oxbow wetland is restored. This level of take is for the life of the project.

The Service will not refer the incidental take of any migratory bird for prosecution under the Migratory Bird Treaty Act of 1918, as amended (16 U.S.C. §703-712), if such take is in compliance with the terms and conditions specified herein.

Effect of Take
In this Biological Opinion, the Service determined that this level of anticipated take is not likely to result in jeopardy of the Hawaiian stilt, Hawaiian coot, Hawaiian moorhen, and Hawaiian duck.

Reasonable and Prudent Measures
The reasonable and prudent measures given below, with their implementing terms and conditions, are designed to minimize the impacts of incidental take that might otherwise result from the proposed actions. If, during the course of the action, the level of incidental take is exceeded, such incidental take represents new information requiring reinitiation of consultation and review the reasonable and prudent measures provided. In addition, the Air Force must cease the activities that caused the taking; must immediately provide an explanation of the causes of the taking; and must review with the Service the need for possible modification of the reasonable and prudent measures. The Air Force project incorporates many of the measures to minimize and avoid take of listed species. The Service believes the following Reasonable and Prudent Measures are necessary and appropriate to minimize incidental take of Hawaiian stilt, Hawaiian coot, Hawaiian moorhen, and Hawaiian duck. The measures described below are non-discretionary and must be implemented.

1. Hawaiian waterbird injury and mortality from aircraft interactions will be minimized.
2. Harassment of Hawaiian waterbirds and nest and egg removal of Hawaiian stilt will be minimized.

Terms and Conditions
In order to be exempt from the prohibitions of section 9 of the Act, the Air Force must comply with the following terms and conditions, which implement the reasonable and prudent measures described above and outline required reporting or monitoring requirements. These terms and conditions are non-discretionary.

1. The following terms and conditions implement reasonable and prudent measure number one:

   1.1. The Air Force will fund a scientific research study to evaluate the effects of hazing activities within the BASH zone. The study will focus on Hawaiian waterbird movement in and around the BASH zone and it should determine the number of individuals actually represented by the harassment incidents and how these hazing incidents affect the long-term survivorship of these individuals. The study will be coordinated and implemented jointly with Air Force and PIFWO.

2. The following terms and conditions implement all reasonable and prudent measures:

    2.1. Annual reporting, in the form of a written report, of actual numbers of individuals taken will be submitted to PIFWO by the end of the Federal fiscal year (September 30).
    2.2. Air Force will complete Bellows Air Force Station Oxbow wetland restoration management plan coordinated with our office and finalized on or before completion of restoration efforts in 2010 to 2011. The management plan will include details on vegetation modification, predator control, waterbird monitoring, and an avian botulism surveillance response plan.
    2.3. Our office will be notified before restoration begins and upon completion of restoration activities at Bellows Air Force Station Oxbow and Ahua Reef wetlands. Notification will be via electronic mail.
    2.4. A written report will be provided to the Service to document the effectiveness of the waterbird monitoring. The written reports should be a summary documentation and will be submitted via mail to the Service.
    2.5. The depository designated to receive specimens of Hawaiian waterbirds that are collected is the B.P. Bishop Museum, 1525 Bernice Street, Honolulu, Hawaii, 96817 [phone: (808) 547-3511]. If the B.P. Bishop Museum does not wish to accession the specimens, the Service's Division of Law Enforcement in Honolulu, Hawaii [phone: (808) 861-8525; fax: (808) 861-8515] should be contacted for instructions on disposition.

Conservation Recommendations
Section 7(a)(1) of the Endangered Species Act directs Federal agencies to utilize their authorities to further the purposes of the Act by carrying out conservation programs for the benefit of endangered and threatened species. Conservation recommendations are discretionary agency activities to minimize or avoid adverse effects of a proposed action on listed species or critical habitat, to help implement recovery plans, or to develop information. In order for the Service to be kept informed of actions minimizing or avoiding adverse effects or benefiting listed species or their habitats, the Service requests notification of the implementation of any conservation recommendations.

1. We recommend that Air Force monitor migratory waterbird and shorebird use at Bellows Air Force Station Oxbow wetlands once restored to determine the effectiveness of the predator control program.

2. We recommend that if Hawaiian moorhen are captured in live traps; attempts should be made to band individual birds. Air Force biologist responsible for Bellows Air Force Station Oxbow wetland will be contacted immediately, and if available, will band the birds and coordinate with PIFWO. Birds should be banded with color bands and U.S. Geological Service's aluminum bands. Banding information will yield important life history information that will aid in recovery of the species.

3. We recommend that Air Force develop a routine monitoring of predator control program as part of the management plan. Goals should be to detect and remove initial animals

within restored Bellows Air Station Oxbow wetland addressed in this Biological Opinion and document rate of detection of newly immigrated animals into trapping area.

Reinitiation Statement
This concludes formal consultation on the proposed project described in this biological opinion. As required in 50 CFR § 402.16, reinitiation of consultation is required where discretionary Federal agency involvement or control over the action has been retained (or is authorized by law), and if: (1) the amount or extent of incidental take is exceeded; (2) new information reveals effects of the agency action that may affect listed species or critical habitat in a manner or to an extent not considered in this opinion; (3) the agency action is subsequently modified in a manner that causes an effect to the listed species or critical habitat not considered in this opinion; or (4) a new species is listed or critical habitat is designated that may be affected by the action. In instances where the amount or extent of incidental take is exceeded, any operation causing such take must cease pending reinitiation. Should there be a failure to carry out any or all of the described measures, or if the measures are not effective or are modified in any way without Service coordination, reinitiation of consultation will be required. If you have any questions regarding this Biological Opinion, please contact Fish and Wildlife Biologist Aaron Nadig (808) 792-9400.

Sincerely,

Loyal Mehrhoff
Field Supervisor

REFERENCES

Bird/Wildlife Aircraft Strike Hazard (BASH) Plan. 2005. 15th Airlift Wing, Hickam AFB, Hawaii.

Brock, V. E. and P. L. Breese. 1953. Duck botulism at Kaelepulu Pond, Kailua, Oahu. Elepaio 13: 80–81.

Burger, J. and M. Gochfeld. 1981. Discrimination of the threat of direct versus tangential approach to the nest by incubating herring and great black-backed gulls. J. Comp. Physiol. Phychol. 95(5): 676-684.

Conomy, J.T. J.A. Dubovsky, J.A. Collazo, and W.J. Fleming. 1998. Do black ducks and wood ducks habituate to aircraft disturbance. J. Wildl. Manage. 62(3): 1135-1142.

Chang, P. R. 1990. Strategies for managing endangered waterbirds on Hawaiian National Wildlife Refuges. M.S. Thesis, Univ. of Massachusetts, Dept. of Forestry and Wildl. Mngmt., Amherst, MA. 87 pp.

Coleman, R. A. 1981. The reproductive biology of the Hawaiian subspecies of the black-necked stilts, Himantopus mexicanus knudseni. Ph.D. diss., Pennsylvania State Univ. 106 pp.

DesRochers, David W., Hugo K.W. Gee, and J. Michael Reed. 2008. Response of Hawaiian Moorhens to broadcast of conspecific calls and a comparison with other survey methods. Journal of Field Ornithology.

DesRochers, David 2006. The first accurate census of the endangered Hawaiian Moorhen *(Gallinula chloropus sandvicensis*, unpublished.

DesRochers, David W., Michael D. Silbernagle, Aaron Nadig, J. Michael Reed. 2006. Improving population estimates of Hawaiian Moorhen *(Gallinula chloropus sandvicensis)* with call response surveys and banding data, unpublished.

Dibben-Young, A. 2009. Thirty Years of Banding the Hawaiian Coot and Hawaiian Gallinule. Elepaio in press.

Draft Integrated Natural Resources Management Plan (INRMP). 2003. 15th Air Base Wing, Hickam AFB, Hawaii.

E2M (environmental-engineering Management). 2008. Supplemental Environmental Assessment addressing the beddown of additional KC-135 aircraft at Hickam AFB, Hawaii. On file with 15CES Hickam AFB.

EA (EA Engineering, Science, and Technology). 1995. Preliminary Assessment/Site Investigation of Hickam AFB: Field Notes. On file at EA, Honolulu, Hawaii.

Eadie, John M., and Andrew Engilis Jr. 2009. Two Tiered Identification Key of Endangered Hawaiian ducks (*Anas wyvilliana*), introduced North American mallards (*A. platyrhynchos*) and their hybrids, unpublished.

Eijzenga, Jaap. 2005. Draft Key Predators study of 2003 to 2004 on James Campbell National Wildlife Refuge, unpublished.

Engilis A Jr, Uyehara KJ, Giffin JG. 2002. Hawaiian duck (Anas wyvilliana). In: Poole A, Gill F (eds) The Birds of North America, No. 694. The Birds of North America, Inc., Philadelphia.

Engilis, A., Jr. and T. K. Pratt. 1993. Status and population trends of Hawaii's native waterbirds, 1977-1987. Wilson Bull. 105(1):142-158.

Fowler, Ada C., John M. Eadie, and Andrew Engilis Jr. 20 December 2008. Identification of endangered Hawaiian ducks (*Anas wyvilliana*) introduced North American mallards (*A. platyrhynchos*) and their hybrids using multilocus genotypes. Conservation Genetics, Springer Science+ Business Media B.V. 2008, published online.

Glover, Willie. Hickam Air Force Base Entomology. Recovered Hawaiian coot from flight-line at Hickam Air Force Base. Phone: (808) 448-9264.

Griffin, C. R., R. J. Shallenberger, and S. I. Fefer. 1989. Hawaii's endangered waterbirds: a resource management challenge. Pp. 1165-1175 in Freshwater Wetlands and Wildlife. Department of Energy symposium no. 61 (R.R. Schwartz and Gibbons, eds.). U.S. Department of Energy, Oakridge, TN.

Hawaii Division of Forestry and Wildlife. 1976-2007. Biannual Hawaiian waterbird survey data. Summarized by Hawaii Natural Heritage Program and Pacific Islands Fish and Wildlife Office, Honolulu, Hawaii.

Hawaii Biodiversity and Mapping Program. 2007. Formerly Hawaii Natural Heritage Program. Hawaii Natural Heritage Program database, unpublished, Center for Conservation Research and Training (CCRT), Pacific BioSciences Research Center (PBRC), University of Hawaii.

Linnell, M.A. 1995. Assessment of factors contributing to bird-aircraft collisions at a tropical airport and methods of prevention. Masters of Science Thesis, Utah State Univ., Logan, Utah.

Morin, M. P. 1998. Endangered waterbird and wetland status. Kaloko-Honokohau National Historical Park. Hawaii Island. Cooperative National Park Resources Studies Unit. University of Hawaii at Manoa, Technical Report 119.

Morin, M. P. 1994. Hawaiian fishponds and endangered waterbirds on the Kona coast. Trans. Western Sect. Wildl. Soc. 30:66-71.

Munro, G. D. 1960. Birds of Hawaii. Rutland, Vermont & Tokyo: Charles E. Tuttle Co. 192 pp.

Ono, Mark. USDA-APHIS-Wildlife Services, Honolulu Office. Mark.ono@aphis.usda.gov

Paton, P. W. and M. J. Scott. 1985. Waterbirds of Hawaii Island. 'Elepaio 45:69-75.

Phelps, Darrin. USDA-APHIS-Wildlife Services, Honolulu Office. Darrin.Phelps@aphis.usda.gov.

Pratt, H. D. and I.L. Brisbin Jr. 2002. Hawaiian Coot (*Fulica alai*). *In* the Birds of North America, No. 697 (A. Poole, eds.). The Birds of North America, Inc., Philadelphia, PA.

Pratt, H. D., P. L. Bruner, and D. G. Berrett. 1987. A field guide to the Birds of Hawaii and the Tropical Pacific. Princeton: Princeton University Press. 409 pp.

Rauzon, M.J. and D.C. Drigot. 2002. Red mangrove eradication and pickleweed control in a Hawaiian wetland, waterbird responses, and lessons learned. In Eradication of Island Invasives: Practical Actions and Results Achieved. C.R. Veitch (ed). International Union for the Conservation of Nature, Auckland, New Zealand. p 94-102.

Reed, J. M., and L. W. Oring. 1993. Long-term population trends of the endangered Ae'o (Hawaiian stilt, Himantopus mexicanus knudseni). Trans. Western Sec. Wild. Soc. 29:54-60.

Reed, J. M., L. W. Oring, and M. Silbernagle. 1994. Metapopulation dynamics and conservation of the endangered Hawaiian stilt (Himantopus mexicanus knudseni). Trans. Western Sec. Wildl. Soc. 30:7-14.

Reed, J. M., M. Silbernagle, A. Engilis, Jr., K. Evans, and L. Oring. 1998. Movements of Hawaiian stilts (Himantopus mexicanus knudseni) as revealed by banding evidence. Auk 115:791-797.

Richardson, W. J., and T. West. 2000. Serious bird-strike accidents to military aircraft: updated list and summary. Pages 67–98 in Proceedings of International Bird Strike Committee meeting, Amsterdam, the Netherlands.

Robinson, J. A., J. M. Reed, J. P. Skorupa, and L. W. Oring. 1999. Black-necked stilt (Himantopus mexicanus). In The Birds of North America, No. 449 (A. Poole and F. Gill, eds.). The Birds of North America, Inc., Philadelphia, PA. 32 pp.

SAIC. 2007. Replacement of F-15 aircraft with F-22A aircraft, Hickam Air Force Base, Hawaii, Environmental Assessment. On file with 15CES Hickam AFB.

Smith, David. Department of Land and Natural Resources, Division of Forestry and Wildlife. kawika.smith@earthlink.net.

Schwartz, C. W. and E. R. Schwartz. 1949. The game birds in Hawaii. Div. Fish & Game and Board Comm. Agric. & For., Honolulu, Hawaii. 168 pp.

Shallenberger, R. J. 1977. An ornithological survey of Hawaiian wetlands. U.S. Army Corps of Engineers Contract DACW 84-77-C-0036, Honolulu, Hawaii. Ahuimanu Productions. 406 pp.

Swedberg, Gary. 1967. The Koloa - A Preliminary Report on the life history and status of the Hawaiian duck (*Anas wyviliana*). Wildlife Branch Division of Fish and Game, Department of Land and Natural Resources, Honolulu, Hawaii. 56pp.

Thorpe, J. 2003. Fatalities and destroyed aircraft due to bird strikes, 1912–2002. Pages 85–113, in Proceedings of the International Bird Strike Committee meeting, Warsaw, Poland.

U.S. Fish and Wildlife Service. 2005. Draft Revised Recovery Plan for the Hawaiian Waterbirds, Second draft of Second Revision. U.S. Fish and Wildlife Service.

U.S. Fish and Wildlife Service. 1999. Draft Revised Recovery Plan for the Hawaiian Waterbirds, 2nd Rev. U.S. Fish and Wildlife Service, Portland, OR. 107 pp.

U.S. Fish and Wildlife Service. 1983. Master Plan - Hawaiian Wetland National Wildlife Refuge complex (Draft). 2 volumes.

U.S. Fish and Wildlife Service. 1970. Conservation of Endangered Species and other Fish or Wildlife: United States List of Endangered Native Fish and Wildlife. Federal Register 35(199)16047-16048.

Viernes, K.J.F. 1995. Bullfrog predation of an endangered Common Moorhen chick at Hanalei National Wildlife Refuge, Kauai. Elepaio 55:37.

Work, Thierry. 2008. Personal communication regarding avian botulism. U.S. Geological Service, Biological Resources Division, National Wildlife Research Center, Honolulu, Hawaii.

Wright, S. E. 2008. Some significant wildlife strikes to civil aircraft in the United States, January 1990–June 2008. FAA Wildlife Strike Database, U.S. Department of Agriculture, Wildlife Services, Sandusky, Ohio, USA.

APPENDIX I
INSTRUCTIONS, PROTOCOL, GUIDANCE, AND AGREEMENTS FOR THE PROTECTION OF NATURAL RESOURCES

I1 – COMNAVREG HAWAII INSTRUCTION 5510.20C "REGULATIONS GOVERNING THE ENTRY AND OPERATION OF PRIVATELY OWNED LOCAL CRAFT IN THE PEARL HARBOR NAVAL DEFENSIVE SEA AREA" (FEBRUARY 2008)

This page is intentionally left blank.

DEPARTMENT OF THE NAVY
COMMANDER
NAVY REGION HAWAII
850 TICONDEROGA ST STE 110
PEARL HARBOR HI 96860-5101

COMNAVREGHIINST 5510.23C CH-4
N34
14 Feb 08

COMNAVREG HAWAII INSTRUCTION 5510.23C CHANGE TRANSMITTAL 4

Subj: REGULATIONS GOVERNING THE ENTRY AND OPERATION OF PRIVATELY OWNED LOCAL CRAFT IN THE PEARL HARBOR NAVAL DEFENSIVE SEA AREA

Encl: (1) Revised enclosure (7)

1. Purpose. To transmit new enclosure (7) which revises procedures for designated areas of recreational fishing in Pearl Harbor areas.

2. Action. Remove enclosure (7) of the basic instruction and insert enclosure (1)

DONALD D. HODGE
Chief of Staff

Distribution:
Electronic only, via COMNAVREG HI Directive Website
https://cnrh.cnicportal.cnic.navy.mil/HI/N00/N00WS/ADMINWS/directives/CNRH%20Instructions/Forms/Instructions.aspx

RECREATIONAL FISHING

1. Recreational fishing from the shores of Pearl Harbor will be permitted only in designated areas.

a. This instruction shall not be misconstrued to permit any violation of Federal or State Laws or regulations; neither does it permit fishing in non-government owned fisheries.

b. The provisions herein are applicable to the taking of all forms of marine life, including crustaceans (crabs) from the waters of Pearl Harbor.

c. In 1998, the State of Hawaii Department of Health issued an advisory not to eat any fish or shell fish from Pearl Harbor waters therefore, fishing from Pearl Harbor is on a catch and release basis only.

2. Designated Fishing Areas. Current Entry Regulation (COMNAVREGHIINST 5510.23) must be complied with when passing through any Access Control Point (ACP).

During periods of higher Force Protection Condition (FPCON) B thru D, recreational fishing will be secured in accordance with DoD Instruction 2000.16.

a. The following are designated fishing areas within the waters of Naval Station Pearl Harbor (Refer to the attached map of enclosure (7) for illustrations).

(1) Area 1 (Blue). Quarters K Pier. This is restricted to the residents of Quarters K and their authorized guests.

(2) Area 2 (Green). East Loch, north of Ford Island Bridge from Aiea Bay extending to Waiau Bank. There is no access restriction to this area.

(3) Area 3 (Green). Middle Loch, the area bordering Pearl City Peninsula extending to the northwest corner of inactive Ships. There is no access restriction to this area.

(4) Area 4 (Gold). Two locations at Ford Island. First location is from the golf course shoreline to the north shoal adjacent to Foxtrot 13 pier. Second location is at the

northwest bordering Kaima'ema'e Point and extending to the Seaplane landing. These areas are designated for all persons possessing proper DoD ID cards.

(5) Area 5 (Blue). Hospital Point Housing including Charlie Landing. This is restricted to the residents of Hospital Point Housing and their authorized guests.

(6) Area 6 (Red). Shoreline along Hickam Air Force Base from the US Navy Degaussing Station extending to Hickam Harbor. Fishing in these areas are enforced under the Hickam Air Force Base Fishing Rules and Restrictions; however, personnel engaged in fishing must clear the water during Navy vessel operations and/or as directed by the Navy harbor patrols.

b. Fishing from ships in Pearl Harbor. Commanding Officers of ships moored at berths outside the Naval Shipyard may authorize crewmembers to fish from their own ship's decks. With the exception of Quarters K, no fishing from piers will be authorized within Naval Station Pearl Harbor.

3. Fishing Rules & Restrictions

a. Fishing from privately owned leisure craft, including kayaks within Pearl Harbor is prohibited.

b. Launching of any type of boat from any shoreline is prohibited.

c. Entering the water from any shoreline or from an authorized fishing area is prohibited.

d. Use of rod and reel is the only fishing method authorized.

e. Parents must accompany family members under the age of 10 years old.

f. Guests will be accompanied by personnel maintaining a valid DoD ID card. Such guests must be accompanied by their host at all times while on Navy property.

g. Recreational fishing from the shores of privately managed property (Iroquois Point Club and Resort) bordering the waters of Pearl Harbor is subject to control by the State Fish and Game authorities.

h. Use the most direct route to gain access to fishing locations without entering the property of individual residences, driveways, or seeded areas.

i. The use of spear fishing equipment is prohibited.

j. Setting or operating nets or fish traps is prohibited.

k. Standing in the water, on rocks in the water or on any object that is not the shoreline is prohibited.

4. Hickam Air Force Base Fishing Rules & Restrictions (quoted from 15th Air Wing Instruction 31-101)

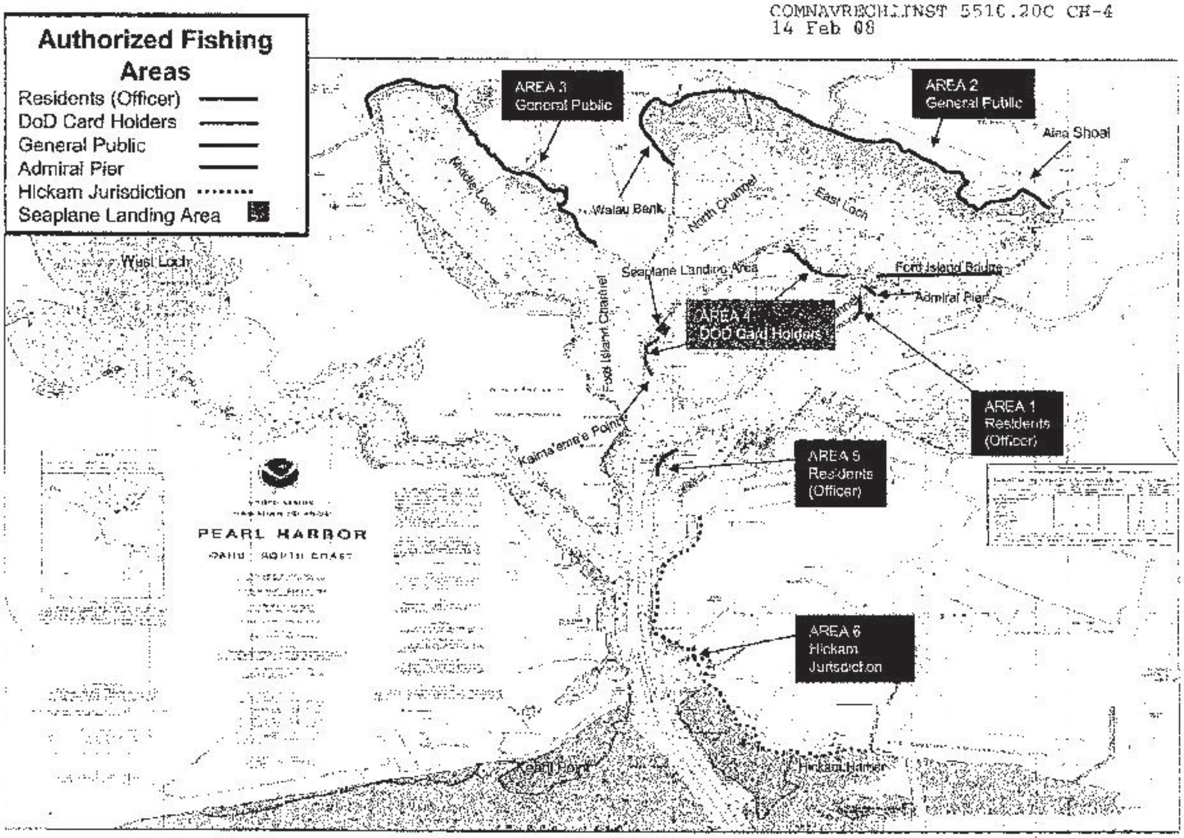
a. (10.3.2.16) The fishing pass for non-base connected civilians is no longer valid. Active duty military/dependents, DOD/installation civilian employees/dependents, and retired military are authorized to fish 24 hours a day/7 days a week. Additionally, people properly sponsored by these listed personnel are also authorized to fish as long as the sponsor is present.

b. (10.3.2.16.1) Use of rod and reel with artificial lures or live bait, drop hooks, trotlines, and the collection of seaweed are authorized. The use of set nets or seines is strictly prohibited. Subsurface fishing is authorized, provided it does not interfere or endanger persons involved in other recreational activities. Possession or use of explosives, poisons, drugs, chemicals, electrical devices, or any unlawful fishing items is prohibited. Persons engaged in fishing will not interfere with or interrupt the activities of others engaging in recreational activities/military functions, i.e., picnicking, swimming, sunbathing, and surfing. Fishing in any areas not specified in this supplement is prohibited. Vehicles will be parked in authorized parking areas. Overnight camping is not permitted in fishing areas on Hickam AFB. Violators are subject to Security Forces apprehension/detention.

c. (10.3.2.16.2) Shore fishing will be permitted near the Foster Point boat dock (next to the Hawaii Air National Guard parking area) and from the Air Force side of the Alpha Docks

along the parking lot to 30 feet from the Sewage Treatment Plant area. Shore fishing is also permitted at the area adjacent to Fort Kam housing area (except if otherwise posted). Fishing along the Channel Display area and north is not authorized.

d. (10.3.2.16.3) Offshore fishing is permitted within the 500-yard buffer zone that surrounds the installation.


Authorized Fishing Areas
Residents (Officer)
DoD Card Holders
General Public
Admiral Pier
Hickam Jurisdiction
Seaplane Landing Area
AREA 3 General Public
AREA 2 General Public
Aiea Shoal
Middle Loch
Waiau Bank
North Channel
East Loch
West Loch
Seaplane Landing Area
Ford Island Bridge
Admiral Pier
Ford Island Channel
AREA 4 DOD Card Holders
AREA 1 Residents (Officer)
Kaina'ema'e Point
AREA 5 Residents (Officer)
PEARL HARBOR
AREA 6 Hickam Jurisdiction
Hickam Harbor

I2 – INJURED BIRD RESPONSE PROTOCOL FOR JBPHH (2011)

INJURED BIRD RESPONSE PROTOCOL FOR JBPHH

Injured birds requiring response include seabirds, endangered waterfowl (stilts, moorhens, Hawaiian ducks, and coots), and owls. Dead birds do not require response but may be reported for West Nile virus surveillance by dialing 211 or 877-275-6569 or 808- ASK 2000.

For injured birds sighted in and around Pearl Harbor:

Contact Port Operations Control Tower…………………………………….**474-6262**
NAVSTA Command Duty Officer…………………………………………..**864-2460**

For injured birds sighted in other areas of JBPHH contact the local security for that area:

NAVMAG (West Loch and Lualualei)………………………...**668-7114** or **471-5141**
NCTAMS Pac (NRTF Lualualei and NCTAMS Wahiawa)…**653-0000** or **653-0234**
For Kalaeloa, contact the NAVSTA Security Police……………………….**471-7114**

NAVSTA CDO or Local Security will notify Environmental:

NAVFAC HI Natural Resources Manager…………………………..**471-1171 x 244**
Terence Tengan (NAVMAG)…..**471-1111 x 320**
Michelle Delaney (NCTAMS)……………………………………………..**474-7883**

Environmental will contact the State of Hawaii and USFWS and pursue veterinary care for the bird if necessary:

State of Hawaii Dept. of Fish and Wildlife…………………………….**808-973-9778**
USFWS……………………………………………………………….**808-792-9400**
Sea Birds – Deliver to Sea Life Park…………………………………. **866-365-7446**
Injured owls – Coordinate with Hilton Hawaiian Village
Wildlife Department……………………………….**949-4321 x 74037**

If the bird injury is a law enforcement issue, then Environmental will contact State of Hawaii DOCARE

DOCARE……………………………………………………………………**587-0077**

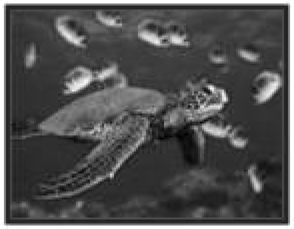
General Instructions:

- Gather and relay as much information about the bird as possible (e.g. tagged, nature of injury, location, etc.)
- Collect the bird as gently as possible and contain with a cardboard box or small animal carrier
- Try to minimize stress on the bird as it awaits/undergoes transportation

I3 – REPORTING PROCESS FOR SIGHTINGS OF PEARL HARBOR'S MARINE ANIMALS (2011)

Reporting Process for Sightings of Pearl Harbor's Marine Animals

Step 1
SIGHTING



TURTLES

SEALS

Step 2
STOP!

~ OBSERVE FROM AFAR ~ DO NOT APPROACH ~ DO NOT TOUCH ~
"Please Help to Protect Them"

Step 3
WHAT TO DO?

If you see or find a floating turtle, call POC below.

Hawaiian Monk Seals are a **HIGHLY ENDANGERED SPECIES** that occasionally come out of the water to rest. If sighted, call POC below.

Step 4
WHY?

<u>This is a SERIOUS ISSUE</u>: **Protected by the Federal Endangered Species Act & Marine Mammal Protection Act**

Step 5
ASSESS

Turtles:

1. Location?
2. Is it DEAD or INJURED?
3. Anyone maintaining visibility? *Obtain caller information.*

Seals:

1. Location?
2. Date and time of sighting?
3. Is it SLEEPING, HOOKED, or SWIMMING?
4. Is it on shore?

Step 6
CALL NAVY POC to contact NOAA

Navy POCs: 1) NAVFAC HI Natural Resources Manager
Normal Business Hours: 220-8371
2) Port Ops Tower 24hrs: 474-6262
NOAA contact normal business hours:
Turtles 983-5730, Seals 256-9840; After hours pager 288-5685

I4 – SNAKE SIGHTING RESPONSE PROTOCOL FOR NAVSTA PH (JUNE 2008)

This page is intentionally left blank.

SNAKE SIGHTING RESPONSE PROTOCOL FOR NAVSTA PH

For injured snakes sighted in and around Pearl Harbor:

NAVSTA Security Police…………………………………………………….**471-7114**

For snakes sighted in other areas of NAVSTA PH contact the local security for that area:

NAVMAG (West Loch and Lualualei)………………………...**668-7114** or **471-5141**
NCTAMS Pac (NRTF Lualualei and NCTAMS Wahiawa)…**653-0000** or **653-0234**
For Kalaeloa, contact the NAVSTA Security Police………………………**471-7114**

The area security officers will provide the first response to the snake sighting. The first response shall consist of:

- Informing NAVSTA dispatch (471-7114) of the situation
- Notifying the Hawaii Department of Agriculture (586-7378)
- Containing (kill or capture) the snake if it is visibly present
- Gathering information on the sighting (description, location, time, etc.)
- Acting as the point of contact for other responders arriving on the scene

NAVSTA Security will notify Environmental of the snake sighting:

Jennifer Sakai…………………………………………………………..**471-1171 x 345**
Terence Tengan (NAVMAG)…..**471-1111 x 320**
Dennis Chang (NCTAMS)……..……………………………………………...**474-7883**

Environmental will notify the NAVFAC Pacific Natural Resources Branch:

NAVFAC Pacific……………………………………………………………….**472-1406**

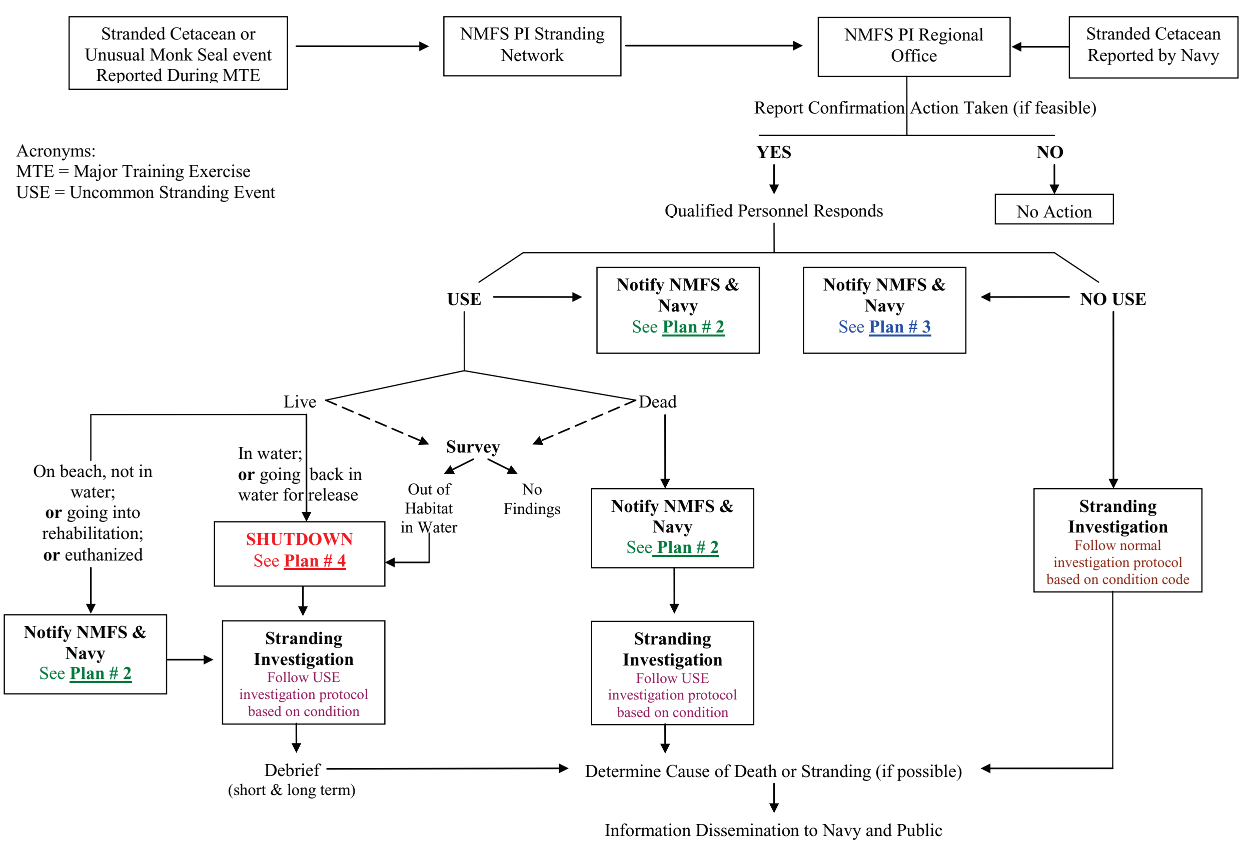
General Information:

- Security police shall be trained in snake response and snake handling equipment and techniques
- Brown tree snake awareness snake reporting procedures should be including in military and DOD civilian newcomer briefs
- Brown tree snake information posters should be displayed in buildings and common areas
- For more information contact Jennifer Sakai, NAVFAC Environmental, at 471-1171 ext 345 or John Muraoka, NAVFAC Environmental, at 473-4137 ext 239.

I5 – HAWAII RANGE COMPLEX MARINE MAMMAL STRANDING RESPONSE PLAN (2008)

This page is intentionally left blank.

HRC: STRANDING RESPONSE DURING MTE DECISION DIAGRAM



#1 HRC: MTE PRIOR NOTIFICATION COMMUNICATION TREE

NMFS PIRO PRD
David Schofield: 808-721-5343
David.Schofield@noaa.gov; if no answer

Lisa Van Atta: 808-266-0735
Alecia.Vanatta@noaa.gov

NAVY
COMPACFLT Environmental
Julie Rivers: 808-474-6391 (O)
808-479-9713 (C)
julie.rivers@navy.mil; if no answer
Ken MacDowell: 808-474-8410 (O)
808-383-2603 (C);
ken.macdowell@navy.mil; if no answer
Neil Sheehan: 808-474-7836 (O), 808-354-2837 (C), neil.sheehan@navy.mil

NMFS HQ PR
Teri Rowles: 301-675-8395 (C),
301-713-2322 ext 178 (O),
Teri.Rowles@noaa.gov; if no answer
Janet Whaley: 301-675-1827 (C),
301-713-2322 ext 170 (O),
Janet.Whaley@noaa.gov; if no answer
Trevor Spradlin: 240-429-9161 (C),
301-713-2322 ext 103 (O),
Trevor.Spradlin@noaa.gov; if no answer
Jaclyn Taylor: 301-713-2322 ext 118(O)
Jaclyn.Taylor@noaa.gov

HQ NAVY
Tom Fetherston: 703-604-5432 (O),
401-862-5790 (C)
thomas.n.fetherston@navy.mil
if no answer
Frank Stone: 703-282-6919 (C),
703-604-1424 (O);
frank.stone@navy.mil;

NMFS HQ PR
Jolie Harrison: 301-713-2289 ext 166 (O)
Jolie.Harrison@noaa.gov
Craig Johnson: 301-713-1401 ext 174 (O)
Craig.Johnson@noaa.gov

Legend
Primary Action
Information Exchange

Criteria for Prior Notification of MTE Operations;

1. Navy will notify NMFS Pacific Islands Regional Office **72 hours prior** to the start of the following MTE:
   a. Rim of the Pacific (RIMPAC)
   b. Undersea Warfare Exercise (USWEX)
   c. Multi Strike Group Exercise
2. Navy will provide NMFS the general geographic location of the MTE and the type of MTE that will occur.
3. NMFS PIR should be notified by both phone and email. The Navy should ensure that they have first reached NMFS via phone. A follow-up email should be sent to the entire NMFS PIR contact list.
4. NMFS will notify the geographically appropriate Regional Stranding Network members who respond to reports of stranded marine mammals in the areas where the upcoming MTE will occur.

#2 HRC: UNCOMMON STRANDING EVENT (USE) DURING MTE COMMUNICATION TREE

Regional Stranding Network

NMFS PIRO PRD
David Schofield: 808-721-5343;
if no answer
Nicole Davis: 808-292-2372;
if no answer
Lisa Van Atta: 808-266-0735

#1

NMFS HQ PR
Teri Rowles: 301-675-8395 (C),
301-713-2322 ext 178 (O); if no answer
Janet Whaley: 301-675-1827 (C),
301-713-2322 ext 170 (O); if no answer
Trevor Spradlin: 240-429-9161 (C),
301-713-2322 ext 103 (O); if no answer
Jaclyn Taylor: 301-713-2322 ext 118(O)

NMFS HQ PR
Jolie Harrison:
301-713-2289 ext 166 (O)
Craig Johnson:
301-713-1401 ext 174 (O)

#3

#2

NMFS PIRO Public Affairs
Wende Goo: 808-721-4098

NMFS HQ Public Affairs

NAVY
COMPACFLT Environmental
Julie Rivers: 808-474-6391 (O)
808-479-9713 (C)
julie.rivers@navy.mil; if no answer
Ken MacDowell: 808-474-8410 (O)
808-383-2603 (C);
ken.macdowell@navy.mil; if no answer
Neil Sheehan: 808-474-7836 (O), 808-354-2837 (C), neil.sheehan@navy.mil
Navy Region Hawaii
Patty Coleman: 808-473-4137 x 224 (O),
808-220-8371 (C); if no answer
John Muraoka: 808-473-4137 x 239 (O)
3rd Fleet Watch Officer
619-545-9534

NMFS HQ PR ADMIN
Jim Lecky: 240-676-4646 (C),
301-713-2332 ext 127 (O); if no answer
Helen Golde: 240-429-0344 (C),
301-713-2332 ext 108 (O); if no answer
David Cottingham: 240-688-7289 (C),
301-713-2322 ext 101 (O); if no answer
Michael Payne: 301-980-0616 (C),
301-713-2289 ext 110 (O);

NMFS HQ F Suite
Jim Balsiger:
Sam Rauch:
(301) 713-2239 (O)
John Oliver:
(301) 713-2239 x110 (O)

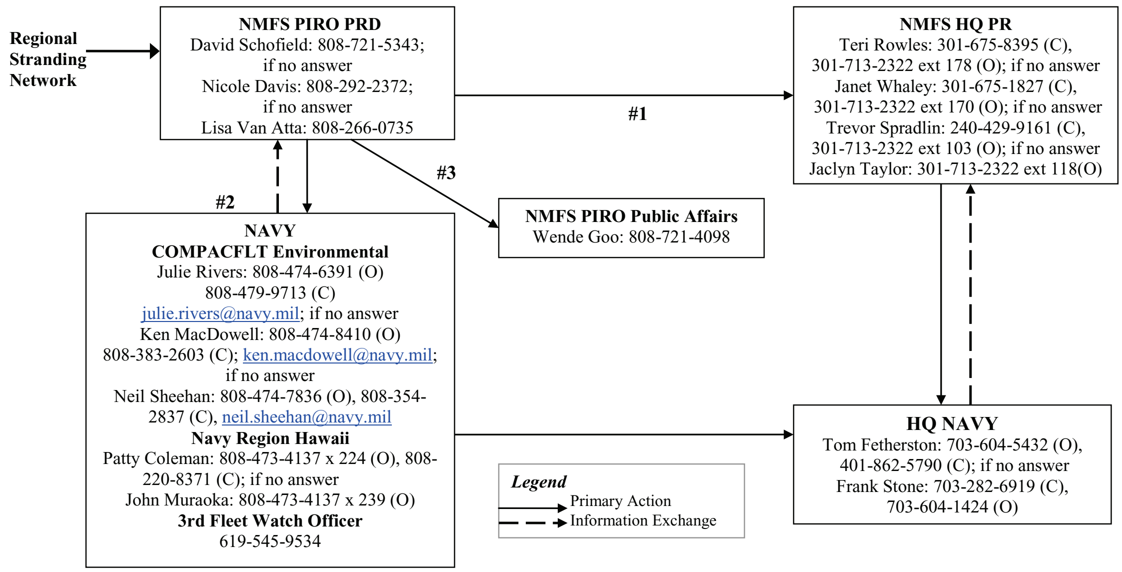
HQ NAVY
Tom Fetherston: 703-604-5432 (O),
401-862-5790 (C)
thomas.n.fetherston@navy.mil
if no answer
Frank Stone: 703-282-6919 (C),
703-604-1424 (O);
Frank.stone@navy.mil;

Legend
Primary Action
Information Exchange

Criteria for Notification of Stranded Cetaceans During MTE:

- The NMFS PIR stranding network will respond to reports of stranded marine mammals in areas where there is geographic coverage by the stranding network, when feasible.
- When a stranded marine mammal triggers a USE, NMFS staff (or other qualified individual) will initiate a Phase 1 Investigation appropriate to condition code and feasibility. NMFS will provide Navy with the following: species, time and location of the stranding event, # of stranded animals and condition of the animal (live v. dead).
- All marine mammals that are responded to will receive an examination appropriate to the condition code of the animal and the feasibility of the logistics.
- Uncommon stranding event (USE)=a) two or more individuals of <u>any</u> cetacean species (i.e., could be two different species, but not including mother/calf pairs, unless of species of concern listed in next bullet) found dead or live on shore within a two day period and occurring on same shore lines or facing shorelines of different islands; b) A single individual or mother/calf pair of any of the following marine mammals of concern: beaked whale of any species, kogia sp., risso's dolphin, melon-headed whale, pilot whales, humpback whales, sperm whales, blue whales, fin whales, sei whales, or monk seal and c) A group of 2 or more cetaceans of any species exhibiting indicators of distress.

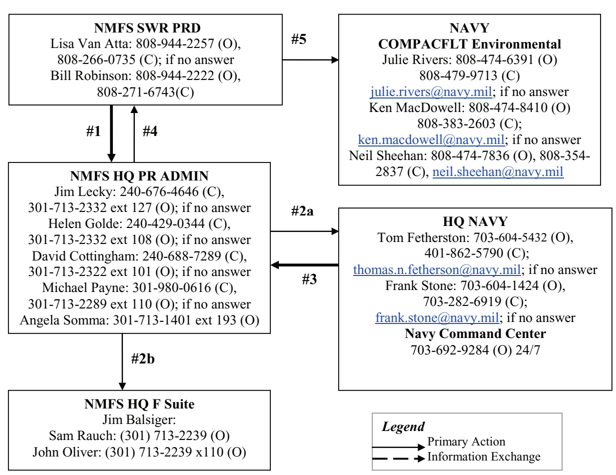
#3 HRC: NON-UNCOMMON STRANDING EVENT (USE) DURING MTE COMMUNICATION TREE



Criteria for Notification of Non-Uncommon Stranding Event (USE) During MTE:

- The NMFS regional stranding network will respond to reports of stranded marine mammals in areas where there is geographic coverage by the stranding network, when feasible.
- All marine mammals that are responded to will receive examination appropriate to the condition code of the animal and the feasibility of the logistics.
- If applicable, NMFS will provide the Navy with a weekly summary of all non-USE marine mammal strandings that occur during a MTE.

#4 HRC: EVENT SHUTDOWN and RESTART COMMUNICATION TREE



Criteria for shutdown (within 14 nm of live animals in the water)(cessation of operations using sonar and explosive detonation):

1. If live animals involved in the USE **are in the water** (i.e., could be exposed to MFAS), NMFS will advise the Navy of the need to implement shutdown procedures.
2. If live animals are on the beach and are being put back in the water for release, NMFS will advise the Navy of the need to implement shutdown procedures.
3. If attempts are being made to herd animals back to the ocean and animals are not willing to leave OR animals are seen repeatedly heading for open ocean but turning around, then NMFS and Navy will coordinate to determine if the proximity of MFAS operations or explosive detonations, farther than 14 nm from the animals, is likely decreasing the likelihood that the animals return to the ocean.

Criteria for Restart

- If at any time, the subject(s) of the USE die or are euthanized, NMFS will immediately advise the Navy that the shutdown around that animal(s)' location is no longer needed.
- Shutdown procedures will remain in effect until NMFS determines that, and advises the Navy that, all live animals involved in the USE have left the area (either of their own volition or herded). During the restart discussion, NMFS will coordinate internally, with the Navy, and with other federal and state agencies with the intent of securing arrangements to track the movement of the animals (via aircraft, vessel, tags, etc.) following the dispersal of the USE, and will evaluate whether a re-start area might increase the likelihood of the animals re-stranding. If so, then NMFS and Navy will further coordinate to determine the measures necessary to minimize that likelihood.

#5 HRC: GENERAL NOTIFICATION OF STRANDED (EXCEPT SHIP STRIKE) CETACEANS FROM NAVY TO NMFS

If, at any time or place (i.e., all of the Hawaiian Islands and EEZ and not just during the activities covered under NMFS' regulations), Navy personnel find a *stranded* cetacean either on the shore, near shore, or floating at sea, NMFS requests that the Navy contact NMFS immediately (or as soon as clearance procedures allow).

NMFS PIRO PRD
David Schofield: 808-721-5343; if no answer
Nicole Davis: 808-292-2372; if no answer
Lisa Van Atta: 808-226-0735

NMFS HQ PR
Teri Rowles: 301-675-8395 (C),
301-713-2322 ext 178 (O); if no answer
Janet Whaley: 301-675-1827 (C),
301-713-2322 ext 170 (O); if no answer
Trevor Spradlin: 240-429-9161 (C),
301-713-2322 ext 103 (O); if no answer
Jaclyn Taylor: 301-713-2322 ext 118(O)

NAVY
COMPACFLT Environmental
Julie Rivers: 808-474-6391 (O)
808-479-9713 (C)
julie.rivers@navy.mil; if no answer
Ken MacDowell: 808-474-8410 (O)
808-383-2603 (C);
ken.macdowell@navy.mil; if no answer
Neil Sheehan: 808-474-7836
Navy Region Hawaii
Patty Colemon: 808-473-4137 x 224 (O),
-220-8371 (C); patrician.colemon@navy.mil
if no answer
John Muraoka: 808-473-4137 x 239 (O)
3rd Fleet Watch Officer
619-545-9534

#1b

#1a

HQ NAVY
Tom Fetherston: 703-604-5432 (O),
401-862-5790 (C), if no answer
Frank Stone: 703-282-6919 (C),
703-604-1424 (O)

Criteria for General Notification of Stranded Cetaceans:

- NMFS requests the Navy immediately provide NMFS with species or description of cetacean (s), the condition of the cetacean (including carcass condition if the cetacean is dead – see glossary for condition codes), location (lat/long), time of first discovery, observed behaviors (if alive), description of any attached fishing gear or other human-related markings, and photos or video (if available).

#6 HRC: GENERAL NOTIFICATION OF CETACEAN SHIP STRIKE FROM NAVY TO NMFS

If, at any time or place (i.e., all of the Hawaiian Islands and EEZ and not just during the activities covered under NMFS' regulations), the Navy is involved in a vessel strike of a cetacean, NMFS requests that the Navy contact NMFS immediately (or as soon as clearance procedures allow).

NMFS PIRO PRD, HIHWNMS and HI DLNR
David Schofield (PIRO): 808-721-5343
Ed Lyman (HIHWNMS): 808-264-8023
Jeff Walters (DLNR): 808-282-0155
Lisa Van Atta (PIRO): 808-266-0735

NMFS HQ PR
Teri Rowles: 301-675-8395 (C),
301-713-2322 ext 178 (O); if no answer
Janet Whaley: 301-675-1827 (C),
301-713-2322 ext 170 (O); if no answer
Trevor Spradlin: 240-429-9161 (C),
301-713-2322 ext 103 (O); if no answer
Jaclyn Taylor: 301-713-2322 ext 118(O)

NAVY
COMPACFLT Environmental
Julie Rivers: 808-474-6391 (O)
808-479-9713 (C)
julie.rivers@navy.mil; if no answer
Ken MacDowell: 808-474-8410 (O)
808-383-2603 (C);
ken.macdowell@navy.mil; if no answer
Neil Sheehan: 808-474-7836
Navy Region Hawaii
Patty Coleman: 808-473-4137 x 224 (O),
808-220-8371 (C); if no answer
John Muraoka: 808-473-4137 x 239 (O)
3rd Fleet Watch Officer
619-545-9534

NMFS HQ PR
Jolie Harrison: 301-713-2289 ext 166 (O)
Craig Johnson: 301-713-1401 ext 174 (O)

HQ NAVY
Tom Fetherston: 703-604-5432 (O), 401-862-5790 (C)
if no answer
Frank Stone: 703-282-6919 (C), 703-604-1424 (O);

Criteria for General Notification of a Cetacean Ship Strike:

- NMFS requests that the Navy immediately report to NMFS the following:
  - species identification (if known)
  - estimated length of the animal
  - status of the animal (dead, injured, or unknown)
  - the presence or absence of blood in the water
  - location of the vessel strike (geographic area plus latitude/longitude)
  - date and time of vessel strike
  - sea state and sighting conditions
- As soon as feasible, provide NMFS with the following:
  - vessel class/type, including vessel length and gross weight
  - vessel operational status - (transiting or participating in training activities)
  - vessel speed and heading at the time of the ship strike
  - # and position of watch standers and observers
  - and any photos or video taken of the animal

I6 – HAWAII RANGE COMPLEX NOAA FISHERIES LETTER OF AUTHORIZATION UNDER THE MMPA JANUARY 2009-JANUARY 2010 (2009)

This page is intentionally left blank.

DEPARTMENT OF COMMERCE

NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION

NATIONAL MARINE FISHERIES SERVICE

Letter of Authorization

The Commander, U.S. Pacific Fleet, 250 Makalapa Drive, Pearl Harbor, HI 96860-7000, and persons operating under his authority (i.e., Navy), are authorized to take marine mammals incidental to Navy exercises conducted in the Hawaii Range Complex (HRC) in accordance with 50 CFR Part 216, Subpart P--Taking Marine Mammals Incidental to U.S. Navy Training in the Hawaii Range Complex (HRC) subject to the provisions of the Marine Mammal Protection Act (16 U.S.C. 1361 *et seq.*; MMPA) and the following conditions:

1. This Authorization is valid for the period January 8, 2009, through January 8, 2010.

2. This Authorization is valid only for the unintentional taking of the species of marine mammals and methods of take identified in 50 CFR § 216.172(c) and Condition (5) of this Authorization incidental to the activities specified in 50 CFR § 216.170(c) and Condition (4)(a) of this Authorization and occurring within the Hawaii Operational Area, which extends from 16 to 43° N. lat. and from 150 to 179° degrees W. long.

3. This Authorization is valid only if the Holder of the Authorization or any person(s) operating under his authority implements the mitigation, monitoring, and reporting required pursuant to 50 CFR §§ 216.174 & 216.175 and implements the Terms and Conditions of this Authorization.

4. (a) This Authorization is valid for the activities and designated amounts of use listed below:

(1) The use of the following mid-frequency active sonar (MFAS) and high frequency active sonar (HFAS) sources for U.S. Navy anti-submarine warfare (ASW) training, maintenance, and research, development, testing and evaluation (RDT&E) in the amounts indicated below (+/- 10 percent):

(i) AN/SQS-53 (hull-mounted sonar) – 1284 hours
(ii) AN/SQS-56 (hull-mounted sonar) – 383 hours
(iii) AN/AQS-22 (helicopter dipping sonar) – 1010 dips
(iv) SSQ-62 (sonobuoys) – 2423 sonobuoys
(v) MK-48 (torpedoes) – 313 torpedoes
(vi) AN/BQQ-10 (submarine mounted sonar) – 200 hours

(2) The detonation of the underwater explosives indicated in (2)(i) conducted as part of the training exercises indicated in (2)(ii):

(i) Underwater Explosives:

(A) 5" Naval Gunfire (9.5 lbs)
(B) 76 mm rounds (1.6 lbs)
(C) Maverick (78.5 lbs)
(D) Harpoon (448 lbs)
(E) MK-82 (238 lbs)
(F) MK-83 (574 lbs)
(G) MK-84 (945 lbs)
(H) MK-48 (851 lbs)
(I) Demolition Charges (20 lbs)
(J) EER/IEER (5 lbs)

(ii) Training Events:

(A) Mine Neutralization – 68 exercises
(B) Air-to-Surface MISSILEX – 50 exercises
(C) Surface-to-Surface MISSILEX – 12 exercises
(D) BOMBEX – 38 exercises
(E) SINKEX – 6 exercises
(F) Surface-to-Surface GUNEX – 91 exercises
(G) Naval Surface Fire Support – 28 exercises

(b) If the number of sonar hours, dips, and sonobuoys, and exercises indicated in Condition 4(a)(1) are exceeded by more than 10 percent, subsequent LOAs issued under the HRC final rule will ensure that the total over five years does not exceed the amount indicated in 50 CFR 216.170(c).

(c) The sonar hours conducted as described in Condition (4)(a)(1) will be seasonally and spatially distributed such that no additional exposures of humpback whales to MFAS/HFAS would occur beyond those used to estimate take in the years with a RIMPAC.

5. This authorization is valid only for the incidental take of the following marine mammal species, and only by the indicated method and amount of take:

(a) Level B Harassment (+/-10 percent of the number of takes indicated below):

(i) Mysticetes:

(A) Humpback whale (Megaptera novaeangliae) - 1347
(B) Minke whale (Balaenoptera acutorostrata) – 64
(C) Sei whale (Balaenoptera borealis) – 1
(D) Fin whale (Balaenoptera physalus) – 20
(E) Bryde's whale (Balaenoptera edeni) – 64

(ii) Odontocetes:

(A) Sperm whales (Physeter macrocephalus) – 727

(B) Pygmy sperm whales (Kogia breviceps) – 865
(C) Dwarf sperm whale (Kogia sima) – 2122
(D) Cuvier's beaked whale (Ziphius cavirostris) – 1150
(E) Blainville's beaked whale (Mesoplodon densirostris) – 357
(F) Longman's beaked whale (Indopacetus pacificus) – 105
(G) Rough-toothed dolphin (Steno bredanensis) – 1077
(H) Bottlenose dolphin (Tursiops truncatus) – 734
(I) Pan-tropical dolphins (Stenella attenuata) – 2199
(J) Spinner dolphins (Stenella longirostris) – 421
(K) Striped dolphins (Stenella coeruleoalba) - 3209
(L) Risso's dolphin (Grampus griseus) – 497
(M) Melon-headed whale (Peponocephala electra) – 597
(N) Fraser's dolphin (Lagenodelphis hosei) – 1247
(O) Pygmy killer whale (Feresa attenuata) – 196
(P) False killer whale (Pseudorca crassidens) – 46
(Q) Killer whale (Orcinus orca) – 46
(R) Short-finned pilot whale (Globicephala macrorynchus) –1798

(ii) Pinnipeds: Hawaiian monk seal (Monachus schauinslandi) – 110

(b) Level A Harassment and/or mortality of 10 individuals of each of the species listed below over the course of the 5-year regulations: Bottlenose dolphin (Tursiops truncatus), Pygmy and Dwarf sperm whales (Kogia breviceps and sima), Melon-headed whale (Peponocephala electra), Pantropical spotted dolphin (Stenella attenuata), Pygmy killer whale (Feresa attenuata), Short-finned pilot whale (Globicephala macrorynchus), Striped dolphin (Stenella coeruleoalba), and Cuvier's beaked whale (Ziphius cavirostris), Blainville's beaked whale, (Mesoplodon densirostris), Longman's beaked whale (Indopacetus pacificus).

(c) If any of the take in Condition (5)(b) occurs, it will be deducted from the take to be authorized in subsequent LOAs under 50 CFR Subpart P so as to ensure that the total taking over 5 years does not exceed the amounts indicated in Condition 5(b) and 50 CFR § 216.172(c).

6. Mitigation - The Holder of this Authorization, and any individuals operating under his authority, must implement the following mitigation measures when conducting activities identified in 50 CFR § 216.170(c) and Condition 4(a) of this Authorization:

(1) Mitigation Measures for ASW training:

(i) All lookouts onboard platforms involved in ASW training events shall review the NMFS-approved Marine Species Awareness Training (MSAT) material prior to use of mid-frequency active sonar.

(ii) All Commanding Officers, Executive Officers, and officers standing watch on the Bridge shall have reviewed the MSAT material prior to a training event employing the use of mid-frequency active sonar.

(iii) Navy lookouts shall undertake extensive training in order to qualify as a watchstander in accordance with the Lookout Training Handbook (NAVEDTRA, 12968-D).

(iv) Lookout training shall include on-the-job instruction under the supervision of a qualified, experienced watchstander. Following successful completion of this supervised training period, Lookouts shall complete the Personal Qualification Standard program, certifying that they have demonstrated the necessary skills (such as detection and reporting of partially submerged objects).

(v) Lookouts shall be trained in the most effective means to ensure quick and effective communication within the command structure in order to facilitate implementation of mitigation measures if marine species are spotted.

(vi) On the bridge of surface ships, there shall be at least three people on watch whose duties include observing the water surface around the vessel.

(vii) All surface ships participating in ASW exercises shall, in addition to the three personnel on watch noted previously, have at all times during the exercise at least two additional personnel on watch as lookouts.

(viii) Personnel on lookout and officers on watch on the bridge shall have at least one set of binoculars available for each person to aid in the detection of marine mammals.

(ix) On surface vessels equipped with mid-frequency active sonar, pedestal mounted "Big Eye" (20x110) binoculars shall be present and in good working order.

(x) Personnel on lookout shall employ visual search procedures employing a scanning methodology in accordance with the Lookout Training Handbook (NAVEDTRA 12968-D).

(xi) After sunset and prior to sunrise, lookouts shall employ Night Lookouts Techniques in accordance with the Lookout Training Handbook.

(xii) Personnel on lookout shall be responsible for reporting all objects or anomalies sighted in the water (regardless of the distance from the vessel) to the Officer of the Deck.

(xiii) CPF shall distribute the final mitigation measures contained in this Authorization and NMFS' Biological Opinion to the Fleet.

(xiv) Commanding Officers shall make use of marine species detection cues and information to limit interaction with marine species to the maximum extent possible consistent with safety of the ship.

(xv) All personnel engaged in passive acoustic sonar operation (including aircraft, surface ships, or submarines) shall monitor for marine mammal vocalizations and report the detection of any marine mammal to the appropriate watch station for dissemination and appropriate action.

(xvi) During mid-frequency active sonar training activities, personnel shall utilize all available sensor and optical systems (such as Night Vision Goggles) to aid in the detection of marine mammals.

(xvii) Navy aircraft participating in exercises at sea shall conduct and maintain, when operationally feasible and safe, surveillance for marine mammals as long as it does not violate safety constraints or interfere with the accomplishment of primary operational duties.

(xviii) Aircraft with deployed sonobuoys shall use only the passive capability of sonobuoys when marine mammals are detected within 200 yards (182 m) of the sonobuoy.

(xix) Marine mammal detections shall be reported immediately to assigned Aircraft Control Unit for further dissemination to ships in the vicinity of the marine species as appropriate where it is reasonable to conclude that the course of the ship will likely result in a closing of the distance to the detected marine mammal.

(xx) Safety Zones - When marine mammals are detected by any means (aircraft, shipboard lookout, or acoustically) the Navy shall ensure that MFAS transmission levels are limited to at least 6 dB below normal operating levels if any detected marine mammals are within 1000 yards (914 m) of the sonar dome (the bow).

(A) Ships and submarines shall continue to limit maximum MFAS transmission levels by this 6-dB factor until the marine mammal has been seen to leave the area, has not been detected for 30 minutes, or the vessel has transited more than 2,000 yards (1828 m) beyond the location of the last detection.

(B) The Navy shall ensure that MFAS transmissions will be limited to at least 10 dB below the equipment's normal operating level if any detected animals are within 500 yards (457 m) of the sonar dome. Ships and submarines shall continue to limit maximum ping levels by this 10-dB factor until the marine mammal has been seen to leave the area, has not been detected for 30 minutes, or the vessel has transited more than 2000 yards (1828 m) beyond the location of the last detection.

(C) The Navy shall ensure that MFAS transmissions are ceased if any detected marine mammals are within 200 yards of the sonar dome. MFAS transmissions will not resume until the marine mammal has been seen to leave the area, has not been detected for 30 minutes, or the vessel has transited more than 2,000 yards beyond the location of the last detection.

(D) Special conditions applicable for dolphins and porpoises only: If, after conducting an initial maneuver to avoid close quarters with dolphins or porpoises, the Officer of the Deck concludes that dolphins or porpoises are deliberately closing to ride the vessel's bow wave, no further mitigation actions are necessary while the dolphins or porpoises continue to exhibit bow wave riding behavior.

(E) If the need for power-down should arise as detailed in "Safety Zones" above, Navy shall follow the requirements as though they were operating at 235 dB – the normal operating level (i.e., the first power-down will be to 229 dB, regardless of at what level above 235 dB sonar was being operated).

(xxi) Prior to start up or restart of active sonar, operators shall check that the Safety Zone radius around the sound source is clear of marine mammals.

(xxii) Sonar levels (generally) - Navy shall operate sonar at the lowest practicable level, not to exceed 235 dB, except as required to meet tactical training objectives.

(xxiii) Helicopters shall observe/survey the vicinity of an ASW Exercise for 10 minutes before the first deployment of active (dipping) sonar in the water.

(xxiv) Helicopters shall not dip their sonar within 200 yards (183 m) of a marine mammal and shall cease pinging if a marine mammal closes within 200 yards (183 m) after pinging has begun.

(xxv) Submarine sonar operators shall review detection indicators of close-aboard marine mammals prior to the commencement of ASW training activities involving active mid-frequency sonar.

(xxvi) Night vision goggles shall be available to all ships and air crews, for use as appropriate.

(xxvii) Humpback Whale Cautionary Area – this area is defined as the area extending 5km (2.7 nm) from a line drawn from Kaunakakai on the island of Molokai to Kaena Point on the Island of Lanai; and an area extending 5 km (2.7 nm) from a line drawn from Kaunolu on the Island of Lanai to the most Northeastern point on the Island of Kahoolawe; and within a line drawn from Kanapou Bay on the Island of Kahoolawe to Kanahena Point on the Island of Maui and a line drawn from Cape Halawa on the Island of Molokai to Lipo Point on the Island of Maui, excluding the existing submarine operating area. Following are the required measures related to this area:

(A) Should national security needs require MFAS training and testing in the cautionary area between 15 December and 15 April, it must be personally authorized by the Commander, U.S. Pacific Fleet based on his determination that training and testing in that specific area is required for national security purposes. This authorization shall be documented by the CPF in advance of transiting and training in the cautionary area, and the determination shall be based on the unique characteristics of the area from a military readiness perspective, taking into account the importance of the area for humpback whales and the need to minimize adverse impacts on humpback whales from MFAS

whenever practicable. Further, Commander, U.S. Pacific Fleet will provide specific direction on required mitigation measures prior to operational units transiting to and training in the cautionary area.

(B) The Navy shall provide advance notification to NMFS of any such activities (listed in xxvii(A), above).

(C) The Navy shall include in its periodic reports for compliance with the MMPA whether or not activities occurred in the Humpback Whale Cautionary Area above and any observed effects on humpback whales due to the conduct of these activities.

(xxviii) The Navy shall abide by the letter of the final "Stranding Response Plan for Major Navy Training Exercises in the HRC" (attachment A) to include the following measures:

(A) Shutdown Procedures– When an Uncommon Stranding Event (USE – as defined in 50 C.F.R. § 216.171(b) and Attachment A) occurs during a Major Training Exercise (MTE, including RIMPAC, USWEX, or Multi-Strike Group Exercise) in the HRC, the Navy shall implement the procedures described below.

(1) The Navy shall implement a Shutdown (as defined in 50 C.F.R. § 216.171(b) and Attachment A) when advised by a NMFS Office of Protected Resources Headquarters Senior Official designated in the HRC Stranding Communication Protocol that a USE involving live animals has been identified and that at least one live animal is located in the water. NMFS and Navy will maintain a dialogue, as needed, regarding the identification of the USE and the potential need to implement shutdown procedures.

(2) Any shutdown in a given area shall remain in effect in that area until NMFS advises the Navy that the subject(s) of the USE at that area die or are euthanized, or that all live animals involved in the USE at that area have left the area (either of their own volition or herded).

(3) If the Navy finds an injured or dead animal floating at sea during an MTE, the Navy shall notify NMFS immediately or as soon as operational security considerations allow. The Navy shall provide NMFS with species or description of the animal(s), the condition of the animal(s) including carcass condition if the animal(s) is/are dead), location, time of first discovery, observed behavior (if alive), and photo or video (if available). Based on the information provided, NMFS will determine if, and advise the Navy whether a modified shutdown is appropriate on a case-by-case basis.

(4) In the event, following a USE, that: a) qualified individuals are attempting to herd animals back out to the open ocean and animals are not willing to leave, or b) animals are seen repeatedly heading for the open ocean but turning back to shore, NMFS and the Navy shall coordinate (including an investigation of

other potential anthropogenic stressors in the area) to determine if the proximity of MFAS training activities or explosive detonations, though farther than 14 nm from the distressed animal(s), is likely contributing to the animals' refusal to return to the open water. If so, NMFS and the Navy will further coordinate to determine what measures are necessary to improve the probability that the animals will return to open water and implement those measures as appropriate.

(B) Within 72 hours of the notification of the USE the Navy will inform NMFS where and when they were conducting training (within 80 nm and 72 hours of the event) and whether or not they were operating sonar or detonating explosives. Within 7 days of the completion of any exercises that were being conducted within 80 nm or 72 hours prior to the event, the Navy will further provide information to NMFS (per the HRC Stranding Communication Protocol), as available, regarding the number and types of acoustic/explosive sources, direction and speed of units using MFAS, and marine mammal sightings information associated with those training activities. Information not initially available regarding the 80 nm, 72 hours, period prior to the event will be provided as soon as it becomes available. The Navy will provide NMFS investigative teams with additional relevant unclassified information as requested (or classified information to qualified NMFS staff), if available.

(C) Memorandum of Agreement (MOA) – The Navy and NMFS shall develop a MOA, or other mechanism consistent with federal fiscal law requirements (and all other applicable laws), that will establish a framework whereby the Navy can (and provide the Navy examples of how they can best) assist NMFS with stranding investigations in certain circumstances. This document shall be finalized in 2009 (unless NMFS notifies the Navy that a delay is needed).

(xxviii) While in transit, Naval vessels shall be alert at all times, use extreme caution, and proceed at a "safe speed" so that the vessel can take proper and effective action to avoid a collision with any marine animal and can be stopped within a distance appropriate to the prevailing circumstances and conditions.

(xxix) When marine mammals have been sighted in the area, Navy vessels shall increase vigilance and take reasonable and practicable actions to avoid collisions and activities that might result in close interaction of naval assets and marine mammals. Actions may include changing speed and/or direction and are dictated by environmental and other conditions (e.g., safety, weather).

(2) Mitigation for IEER

(i) Crews shall conduct aerial visual reconnaissance of the drop area prior to laying their intended sonobuoy pattern. This search should be conducted below 500 yards (457 m) at a slow speed, if operationally feasible and weather conditions permit. In dual aircraft training activities, crews are allowed to conduct coordinated area clearances.

(ii) Crews shall conduct a minimum of 30 minutes of visual and acoustic monitoring of the search area prior to commanding the first post detonation. This 30-minute observation period may include pattern deployment time.

(iii) For any part of the briefed pattern where a post (source/receiver sonobuoy pair) will be deployed within 1,000 yards (914 m) of observed marine mammal activity, the Navy shall deploy the receiver ONLY and monitor while conducting a visual search. When marine mammals are no longer detected within 1,000 yards (914 m) of the intended post position, co-locate the explosive source sonobuoy (AN/SSQ-110A) (source) with the receiver.

(iv) When able, crews will conduct continuous visual and aural monitoring of marine mammal activity. This is to include monitoring of own-aircraft sensors from first sensor placement to checking off station and out of communication range of these sensors.

(v) Aural Detection: If the presence of marine mammals is detected aurally, then that shall cue the aircrew to increase the diligence of their visual surveillance. Subsequently, if no marine mammals are visually detected, then the crew may continue multi-static active search.

(vi) Visual Detection:

(A) If marine mammals are visually detected within 1,000 yards (914 m) of the explosive source sonobuoy (AN/SSQ-110A) intended for use, then that payload shall not be detonated. Aircrews may utilize this post once the marine mammals have not been re-sighted for 30 minutes, or are observed to have moved outside the 1,000 yards (914 m) safety buffer.

(B) Aircrews may shift their multi-static active search to another post, where marine mammals are outside the 1,000 yards (914 m) safety buffer.

(vii) Aircrews shall make every attempt to manually detonate the unexploded charges at each post in the pattern prior to departing the operations area by using the "Payload 1 Release" command followed by the "Payload 2 Release" command. Aircrews shall refrain from using the "Scuttle" command when two payloads remain at a given post. Aircrews will ensure that a 1,000 yard (914 m) safety buffer, visually clear of marine mammals, is maintained around each post as is done during active search operations.

(viii) Aircrews shall only leave posts with unexploded charges in the event of a sonobuoy malfunction, an aircraft system malfunction, or when an aircraft must immediately depart the area due to issues such as fuel constraints, inclement weather, and in-flight emergencies. In these cases, the sonobuoy will self-scuttle using the secondary or tertiary method.

(ix) The Navy shall ensure all payloads are accounted for. Explosive source sonobuoys (AN/SSQ-110A) that cannot be scuttled shall be reported as unexploded ordnance via voice communications while airborne, then upon landing via naval message.

(x) Marine mammal monitoring shall continue until out of own-aircraft sensor range.

(3) Mitigation for Demolitions (DEMOs) and Mine Countermeasure (MCM) Training (Up to 20 lb).

(i) Exclusion Zones – Explosive charges shall not be detonated if a marine mammal is detected within 700 yards (640 m) of the detonation site.

(ii) Pre-Exercise Surveys - For MCM training activities, the Navy shall conduct a pre-exercise survey within 30 minutes prior to the commencement of the scheduled explosive event. The survey may be conducted from the surface, by divers, and/or from the air. If a marine mammal is detected within the survey area, the exercise shall be suspended until the animal voluntarily leaves the area.

(iii) Post-Exercise Surveys - Surveys within the same radius shall also be conducted within 30 minutes after the completion of the explosive event.

(iv) Reporting - Any evidence of a marine mammal that may have been injured or killed by the action shall be reported immediately to NMFS.

(v) Mine Laying Training – Though mine laying training operations involve aerial drops of inert training shapes on floating targets, measures 1, 2, and 3 for Demolitions and Mine countermeasures (above) will apply to mine laying training. To the maximum extent feasible, the Navy shall retrieve inert mine shapes dropped during Mine Laying Training.

(4) Mitigation for SINKEX, GUNEX, MISSILEX, and BOMBEX.

(i) All weapons firing shall be conducted during the period 1 hour after official sunrise to 30 minutes before official sunset.

(ii) Extensive range clearance operations shall be conducted in the hours prior to commencement of the exercise.

(iii) An exclusion zone with a radius of 1.0 nm (1.85 km) shall be established around each target. An additional buffer of 0.5 nm (0.93 km) shall be added to account for errors, target drift, and animal movements. Additionally, a safety zone, which extends out an additional 0.5 nm (0.93 km), shall be surveyed. Together, the zones extend out 2 nm (3.7 km) from the target.

(iv) A series of surveillance over-flights shall be conducted within the exclusion and the safety zones, prior to and during the exercise, when feasible. Survey protocol would be as follows:

(A) Overflights within the exclusion zone shall be conducted in a manner that optimizes the surface area of the water observed. This may be accomplished through the use of the Navy's Search and Rescue (SAR) Tactical Aid (TACAID).

(B) All visual surveillance activities shall be conducted by Navy personnel trained in visual surveillance. At least one member of the mitigation team shall have completed the Navy's marine mammal training program for lookouts.

(C) In addition to the overflights, the exclusion zone shall be monitored by passive acoustic means, when assets are available. This passive acoustic monitoring shall be maintained throughout the exercise. Potential assets include sonobuoys, which can be utilized to detect any vocalizing marine mammals in the vicinity of the exercise. The sonobuoys shall be re-seeded as necessary throughout the exercise. Additionally, passive sonar onboard submarines may be utilized to detect any vocalizing marine mammals in the area. The Officer Conducting the Exercise (OCE) shall be informed of any aural detection of marine mammals and would include this information in the determination of when it is safe to commence the exercise.

(D) On each day of the exercise, aerial surveillance of the exclusion and safety zones shall commence two hours prior to the first firing.

(E) The results of all visual, aerial, and acoustic searches shall be reported immediately to the OCE. No weapons launches or firing would commence until the OCE declares the safety and exclusion zones free of marine mammals.

(F) If a marine mammal observed within the exclusion zone is diving, firing shall be delayed until the animal is re-sighted outside the exclusion zone, or 30 minutes has elapsed.

(G) During breaks in the exercise of 30 minutes or more, the exclusion zone shall again be surveyed for any marine mammals. If marine mammals are sighted within the exclusion zone, the OCE would be notified, and the procedure described above would be followed.

(H) Upon sinking of the vessel, a final surveillance of the exclusion zone shall be monitored for two hours, or until sunset, to verify that no marine mammals were harmed.

(vi) Aerial surveillance would be conducted using helicopters or other aircraft based on necessity and availability. These aircraft shall be capable of (and shall, to the extent practicable) flying at the slow safe speeds necessary to enable viewing of marine mammals with unobstructed, or minimally obstructed, downward and outward visibility. The Navy may cancel the exclusion and safety zone surveys in the event that a mechanical problem, emergency search and rescue, or other similar and unexpected event preempts the use of one of the aircraft onsite for the exercise.

(vii) Where practicable, the Navy shall conduct the exercise in sea states that are ideal for marine mammal sighting, i.e., Beaufort Sea State 3 or less. In the event of a Beaufort Sea State of 4 or above, the Navy shall utilize additional aircraft (conducting tight search patterns), if available, to increase survey efforts within the zones.

(viii) The exercise shall not be conducted unless the exclusion zone can be adequately monitored visually.

(ix) In the unlikely event that any marine mammals are observed to be harmed in the area, a detailed description of the animal shall be documented, the location noted, and if possible, photos taken. This information would be provided to NMFS.

7. Monitoring and Reporting – When conducting operations identified in 50 CFR § 216.170(c) and Condtion 4(a), the Holder of the Authorization and any person(s) operating under his authority must implement the following monitoring and reporting measures. All reports should be submitted to the Director, Office of Protected Resources, National Marine Fisheries Service, 1315 East-West Highway, Silver Spring MD 20910 and a copy provided to the Assistant Regional Administrator for Protected Resources, Pacific Islands Regional Office, National Marine Fisheries Service, 1601 Kapiolani Boulevard, Suite 1110, Honolulu, HI 96814.

(a) The Navy must notify NMFS immediately (or as soon as clearance procedures allow) if the specified activity identified in Condition (4)(a) is thought to have resulted in the mortality or injury of any marine mammals, or in any take of marine mammals not identified in 50 C.F.R. § 216.172(c) and Condition 5.

(b) The Navy shall implement the final HRC Monitoring Plan (attachment B).

(c) The Navy shall complete (to include input and review by NMFS) the Integrated Comprehensive Monitoring Program (ICMP) Plan and submit it to NMFS by December 31, 2009. This planning and adaptive management tool shall include:

(1) A method for prioritizing monitoring projects that clearly describes the characteristics of a proposal that factor into its priority.

(2) An agreed-upon (with NMFS) method for annually reviewing, with NMFS, monitoring results, Navy R&D, and current science to use for potential modification of mitigation or monitoring methods.

(3) A detailed description of the Monitoring Workshop to be convened in 2011 and how and when Navy/NMFS will subsequently utilize the findings of the Monitoring Workshop to potentially modify subsequent monitoring and mitigation.

(4) An adaptive management plan

(5) A method for standardizing data collection across Range Complexes

(d) General Notification of Injured or Dead Marine Mammals - Navy personnel shall ensure that NMFS (regional stranding coordinator) is notified immediately (or as soon as clearance procedures allow) if an injured or dead marine mammal is found during or shortly

after, and in the vicinity of, any Navy training exercise utilizing MFAS, HFAS, or underwater explosive detonations. The Navy shall provide NMFS with species or description of the animal(s), the condition of the animal(s) (including carcass condition if the animal is dead), location, time of first discovery, observed behaviors (if alive), and photo or video (if available). The Navy shall consult the final HRC Stranding Response Plan (attachment A) to obtain more specific reporting requirements for specific circumstances.

(e) Annual HRC Monitoring Plan Report - The Navy shall submit a report on October 1, 2009 describing the implementation and results (through August 1, 2009) of the HRC Monitoring Plan, described above. Data collection methods will be standardized across range complexes to allow for comparison in different geographic locations. Although additional information will be gathered, the marine mammal observers (MMOs) collecting marine mammal data pursuant to the HRC Monitoring Plan shall, at a minimum, provide the same marine mammal observation data required in condition (7)(F). The HRC Monitoring Plan Report may be provided to NMFS within a larger report that includes the required Monitoring Plan Reports from multiple Range Complexes.

(f) Annual HRC Exercise Report - The Navy shall submit an Annual HRC Exercise Report on October 1, 2009 (covering data gathered through August 1, 2009)). This report shall contain the information identified below.

(1) MFAS/HFAS Major Training Exercises - This section shall contain the following information for Major Training Exercises (MTEs, which include RIMPAC, USWEX, and Multi Strike Group) conducted in the HRC:

(i) Exercise Information (for each MTE):

(A) Exercise designator
(B) Date that exercise began and ended
(C) Location
(D) Number and types of active sources used in the exercise
(E) Number and types of passive acoustic sources used in exercise
(F) Number and types of vessels, aircraft, etc., participating in exercise
(G) Total hours of observation by watchstanders
(H) Total hours of all active sonar source operation
(I) Total hours of each active sonar source (along with explanation of how hours are calculated for sources typically quantified in alternate way (buoys, torpedoes, etc.)).
(J) Wave height (high, low, and average during exercise)

(ii) Individual marine mammal sighting info (for each sighting in each MTE):

(A) Location of sighting
(B) Species (if not possible – indication of whale/dolphin/pinniped)
(C) Number of individuals
(D) Calves observed (y/n)

(E) Initial Detection Sensor
(F) Indication of specific type of platform observation made from (including, for example, what type of surface vessel, i.e., FFG, DDG, or CG)
(G) Length of time observers maintained visual contact with marine mammal
(H) Wave height (in feet)
(I) Visibility
(J) Sonar source in use (y/n).
(K) Indication of whether animal is <200yd, 200-500yd, 500-1000yd, 1000-2000yd, or >2000yd from sonar source in (J) above.
(L) Mitigation Implementation – Whether operation of sonar sensor was delayed, or sonar was powered or shut down, and how long the delay was.
(M) If source in use (J) is hullmounted, true bearing of animal from ship, true direction of ship's travel, and estimation of animal's motion relative to ship (opening, closing, parallel).
(N) Observed behavior – Watchstanders shall report, in plain language and without trying to categorize in any way, the observed behavior of the animals (such as animal closing to bow ride, paralleling course/speed, floating on surface and not swimming, etc.).

(iii) An evaluation (based on data gathered during all of the MTEs) of the effectiveness of mitigation measures designed to avoid exposing to mid-frequency sonar. This evaluation shall identify the specific observations that support any conclusions the Navy reaches about the effectiveness of the mitigation.

(2) ASW Summary - This section shall include the following information as summarized from both MTEs and non-major training exercises (i.e., unit-level exercises, such as TRACKEXs):

(i) Total annual hours of each type of sonar source (along with explanation of how hours are calculated for sources typically quantified in alternate way (buoys, torpedoes, etc.)).

(ii) Total hours (from December 15, 2008 through April 15, 2009) of hull-mounted active sonar operation occurring in the dense humpback areas generally shown on the Mobley map (73 FR 35510, 35520) plus a 5-km buffer, but not including the Pacific Missile Range Facility. The Navy shall work with NMFS to develop the exact boundaries of this area.

(iii) Total estimated annual hours of hull-mounted active sonar operation conducted in Humpback Whale Cautionary area between December 15, 2008 and April 15, 2009.

(vi) Cumulative Impact Report - To the extent practicable, the Navy, in coordination with NMFS, shall develop and implement a method of annually reporting non-major (i.e., other than RIMPAC, USWEX, or Multi-Strike Group Exercises) training

exercises utilizing hull-mounted sonar. The report shall present an annual (and seasonal, where practicable) depiction of non-major training exercises geographically across the HRC. The Navy shall either include (in the HRC annual report) the Cumulative Impact Report, as described above, or provide a brief annual progress update on the status of development of the Cumulative Report.

(3) SINKEXs - This section shall include the following information for each SINKEX completed that year:

(i) Exercise information (gathered for each SINKEX):

(A) Location
(B) Date and time exercise began and ended
(C) Total hours of observation by watchstanders before, during, and after exercise
(D) Total number and types of rounds expended / explosives detonated
(E) Number and types of passive acoustic sources used in exercise
(F) Total hours of passive acoustic search time
(G) Number and types of vessels, aircraft, etc., participating in exercise
(H) Wave height in feet (high, low and average during exercise)
(I) Narrative description of sensors and platforms utilized for marine mammal detection and timeline illustrating how marine mammal detection was conducted

(ii) Individual marine mammal observation (by Navy lookouts) information (gathered for each marine mammal sighting)

(A) Location of sighting
(B) Species (if not possible, indicate whale, dolphin or pinniped)
(C) Number of individuals
(D) Whether calves were observed
(E) Initial detection sensor
(F) Length of time observers maintained visual contact with marine mammal
(G) Wave height
(H) Visibility
(I) Whether sighting was before, during, or after detonations/exercise, and how many minutes before or after
(J) Distance of marine mammal from actual detonations (or target spot if not yet detonated) – use four categories to define distance: 1) the modeled injury threshold radius for the largest explosive used in that exercise type in that OPAREA (91 m for SINKEX in HRC); 2) the required exclusion zone (1 nm for SINKEX in HRC); (3) the required observation distance (if different than the exclusion zone (2 nm for SINKEX in HRC); and, (4) greater than the required observed distance. For example, in this case, the observer would indicate if < 91 m, from 91 m – 1 nm, from 1 nm – 2 nm, and > 2 nm.
(K) Observed behavior – Watchstanders will report, in plain language and without trying to categorize in any way, the observed behavior of the animal(s) (such as animal

closing to bow ride, paralleling course/speed, floating on surface and not swimming etc.), including speed and direction.

(L) Resulting mitigation implementation – Indicate whether explosive detonations were delayed, ceased, modified, or not modified due to marine mammal presence and for how long.

(M) If observation occurs while explosives are detonating in the water, indicate munition type in use at time of marine mammal detection.

(4) IEER Summary - This section shall include an annual summary of the following IEER information:

(i) Total number of IEER events conducted in the HRC
(ii) Total expended/detonated rounds (buoys)
(iii) Total number of self-scuttled IEER rounds

(5) Explosives Summary - To the extent practicable, the Navy will provide the information described below for all of their explosive exercises. Until the Navy is able to report in full the information below, they will provide an annual update on the Navy's explosive tracking methods, including improvements from the previous year.

(i) Total annual number of each type of explosive exercises identified in 50 C.F.R. § 216.170 and in Condition 4(a)(2) that are conducted in the HRC

(ii) Total annual expended/detonated rounds (missiles, bombs, etc.) for each explosive type

(g) Sonar Exercise Notification - The Navy shall submit to the NMFS Office of Protected Resources (list of email addresses and phone numbers attached) either an electronic (preferably) or verbal report within fifteen calendar days after the completion of any major exercise (RIMPAC, USWEX, or Multi Strike Group) indicating:

(1) Location of the exercise
(2) Beginning and end dates of the exercise
(3) Type of exercise (e.g., RIMPAC, USWEX, or Multi Strike Group)

(h) HRC 5-yr Comprehensive Report - The Navy shall submit to NMFS a draft report that analyzes and summarizes all of the multi-year marine mammal information gathered during ASW and explosive exercises for which annual reports are required (Annual HRC Exercise Reports and HRC Monitoring Plan Reports). This report will be submitted at the end of the fourth year of the rule (November 2012), covering activities that have occurred through June 1, 2012.

(i) Comprehensive National ASW Report - By June 2014, the Navy shall submit a draft Comprehensive National Report that analyzes, compares, and summarizes the active sonar data gathered (through January 1, 2014) from the watchstanders in accordance with the Monitoring Plans for the HRC, the Atlantic Fleet Active Sonar Training, the Southern California (SOCAL)

Range Complex, the Marianas Range Complex, the Northwest Training Range, the Gulf of Alaska, and the East Coast Undersea Warfare Training Range.

(j) The Navy shall respond to NMFS comments and requests for additional information or clarification on the HRC Comprehensive Report, the draft National ASW report, the Annual HRC Exercise Report, or the Annual HRC Monitoring Plan Report (or the multi-Range Complex Annual Monitoring Plan Report, if that is how the Navy chooses to submit the information) if submitted within 3 months of receipt. These reports will be considered final after the Navy has addressed NMFS' comments or provided the requested information, or three months after the submittal of the draft if NMFS does not comment by then.

(k) In 2011, the Navy shall convene a Monitoring Workshop in which the Monitoring Workshop participants will be asked to review the Navy's Monitoring Plans and monitoring results and make individual recommendations (to the Navy and NMFS) of ways of improving the Monitoring Plans. The recommendations shall be reviewed by the Navy, in consultation with NMFS, and modifications to the Monitoring Plan shall be made, as appropriate.

8. This Authorization may be modified, suspended or withdrawn (pursuant to 50 CFR § 216.106(e)(1 or 2) if the Holder or any person operating under his authority fails to abide by the conditions prescribed herein or if the authorized taking is having more than a negligible impact on the species or stock of affected marine mammals.

9. A copy of this Authorization (including Attachment A) and the attached Subpart P of the regulations, or a document containing the equivalent requirements specified in this Authorization and 50 CFR Subpart P, must be in the possession of the on-site Commanding Officer in order to take marine mammals under the authority of this Letter of Authorization while conducting the specified activity(ies).

10. The Holder of this Authorization and any person operating under his authority is required to comply with the Terms and Conditions of the Incidental Take Statement corresponding to NMFS' Biological Opinion as they pertain to listed marine mammals.

James H. Lecky, Director
Office of Protected Resources
National Marine Fisheries Service

JAN 8 2009
Date

I7 – CNO POLICY LETTER PREVENTING FERAL CAT AND DOG POPULATIONS ON NAVY PROPERTY (2002)

DEPARTMENT OF THE NAVY
OFFICE OF THE CHIEF OF NAVAL OPERATIONS
2000 NAVY PENTAGON
WASHINGTON, D.C. 20350-2000

IN REPLY REFER TO
5090
Ser N456M/1U595820
10 JAN 2002

From: Chief of Naval Operations

Subj: POLICY LETTER PREVENTING FERAL CAT AND DOG POPULATIONS ON NAVY PROPERTY

Ref: (a) SECNAVINST 6401-1A, of 16 Aug 94, Veterinary health services
(b) AFPMB TIM #37, Guidelines for Reducing Feral/Stray Cat populations on Military Installations in the united states
(c) OPNAVINST 6250.4b, dtd 27 Aug 1998, pest Management programs
(d) Executive order 13112 of 3 Feb 1999, Invasive Species

1.This letter clarifies the application of reference (a) regarding the prevention of free roaming (also called wild, feral or stray) tat and dog populations on Navy installations. The objective is to prevent injury or disease to Navy personnel, and eliminate adverse impacts on native wildlife. It requires Navy commands to institute pro-active pet management procedures in order to prevent establishment of free roaming cat and dog populations. Free roaming cats and dogs pose a potential public health threat to personnel on Navy installations, and they pose a threat to wildlife including endangered species and migratory birds.

2.Existing policy at paragraph 4-2c(4) of reference (a) states Dogs, cats, and other privately-owned or stray animals will not be permitted to run at large on military reservations. consistent with this policy, Navy commands must ensure the humane capture and removal of free roaming cats and dogs. Consistent with this requirement, Trap/Neuter/Release (TNR) programs will no longer be established on Navy land. All existing TNR programs on Navy land must be terminated no later than 1 January 2003.

3.Responsible pet ownership is a key factor in eliminating free roaming cat and dog populations. In consultation with supporting Army Veterinary Office, installations shall implement appropriate pet management measures to preclude establishment

of feral cat/dog populations, including, but not limited to the following:

Require installation residents to keep and feed pet animals indoors or under close supervision when outdoors (such as on leash and collar or other physical control device - cage, fenced yard etc.).

Encourage neutering or spaying of cats and dogs before they reach reproductive age (exceptions to this policy can be made on a case by case basis as determined by the Installation Commander).

Require routine vaccinations of vats and dogs for rabies and other diseases as required by federal, state and local laws and ordnances. A current vaccination record is required at time of registration of pets.

Require microchipping registration (or other system of pet identification approved by supporting veterinary office) of all pet cats and dogs brought onto installations. Installation residents must register cats and dogs and have pets wear registration or identification tags at all times.

Prohibit the feeding of feral animals on the installation.

Provide educational materials to pet owners regarding installation regulations and general pet management.

Enforce prohibition of abandonment of animals on installations.

Comply with all humane and animal control regulations at the federal, state and local level (and their equivalents in host nation countries).

Navy installations in Europe that do not have a supporting veterinary office contact 100th Medical Detachment (VA HQ) (011) 49-622-177-2968; for all other locations that do not have a supporting veterinary office the POC is the VETCOM HQ, Commander (210) 221-6522.

Subj: POLICY LETTER PREVENTING FERAL CAT AND DOG POPULATIONS ON NAVY PROPERTY

4. Effective prevention, management and elimination of feral cat and dog populations requires close coordination and cooperation between natural resources, pest management, security, veterinary, and housing personnel to develop and implement an effective and humane program. Reference (b) provides information for preventing free roaming cat populations on military installations General pest management guidelines are detailed in reference (c). Every effort should be made to work with other federal, state and local agencies to support reference (a) and reference (d) by eliminating free roaming cat and dog populations on Navy land. Navy commands. should work with local animal control agencies to determine the best approach for the ultimate disposition of the captured animals. Every effort should be made, if practical, to find homes for adoptable feral cats and dogs.

5. My point of contact on this issue is Mr. Joe Cook, CNO N456M, at (703) 602-5335, or DSN 332-5335.

William G. Mattheis
WILLIAM G. MATTHEIS
Deputy Director, Environmental
Protection, Safety and Occupational
Health Division

Distribution:
CINCLANTFLT (N465)
CINCPACFLT (N465)
COMNAVRESFOR (01E, N46)
CNR (91)
CNET (44)
COMNAVSECGRU (N443)
COMNAVTELCOM (N451)
BUMED (NEGC-EPWR)
COMNAVAIRSYSCOM (AIR.OY)
COMSPAWARSYSCOM (07-1)
COMNAVSUPSYSCCM (4A2, 421)
COMNAYSEASYSCOM (SEA 00T)
COMNAVFACENGCOM (ENV, 09)
CINCUSNAVEUR (N4, N76)
COMSC (NOCEP)
COMNAVMETOCCOM (N13)

Subj: POLICY LETTER PREVENTING FERAL CAT AND DOG POPULTIONS ON NAVY PROPERTY

Distribution:
CHBUMED (NEHC-EPWR)
DIRSSP (SP20161)
ONI (411)

Copy to:
OASN (I&E)
OAGC (I&E)
CNC, N44, N46, 09BF
CMC, LFL
COMNAVREG MIDLANT
COMNAVREG SE
NTC GREAT LAKES
COMNAVRESFOR
COMNAVREG SW
COMNAVREG PEARL HARBOR
COMNAVMARIANAS
COMNAVREG NW
CNFJ
CNFK
PACNAVFACENGCOM PEARL HARBOR HI (CODE 23)
LANTNAVFACENGCOM NORFOLK VA (CODE 2032)
SOUTHWESTNAVFACENGCOM SAN DIEGO CA (CODE 03EN)
SOUTHNAVFACENGCON CHARLESTON SC (CODE 064)
ENOFLOACT NE PHILADELPHIA PA (CODE 18)
ENGFLDACT WEST SAN BRUNO CA (CODE 053)
ENGFLDACT CHES WASHINGTON DC (CODE 20E)
ENGFLDACT NW POULSBO WA (CODE 05EC4)
CO PWC GREAT LAKES
CO PWC GUAM
CO PWC JACKSONVILLE
CO PWC NORFOLK
CO PWC PEARL HARBOR
CO PWC PENSACOLA
CO PWC SAN DIEGO
CO PWC SAN FRANSICO BAY
CO PWC WASHINGTON DC
CO PWC YOKOSUKA
CO CEC PORT HUENEME
CO CEC GULFPORT
QESO
MESO
DODVSA/OTSG (Chief Animal Medicine)

I8 – MEMORANDUM OF UNDERSTANDING AMONG U.S. DEPARTMENT OF DEFENSE, U.S. FISH AND WILDLIFE SERVICE, AND THE INTERNATIONAL ASSOCIATION OF FISH AND WILDLIFE AGENCIES FOR A COOPERATIVE INTEGRATED NATURAL RESOURCES MANAGEMENT PROGRAM ON MILITARY INSTALLATIONS (2006)

This page is intentionally left blank.

MEMORANDUM OF UNDERSTANDING
AMONG
THE U.S. DEPARTMENT OF DEFENSE
AND
THE U.S. FISH AND WILDLIFE SERVICE
AND
THE INTERNATIONAL ASSOCIATION OF FISH AND WILDLIFE AGENCIES
FOR A
COOPERATIVE INTEGRATED NATURAL RESOURCE MANAGEMENT PROGRAM
ON MILITARY INSTALLATIONS

A. PURPOSE

The purpose of this Memorandum of Understanding (MOU) is to establish a cooperative relationship between the U.S. Department of Defense (DoD), the U.S. Department of the Interior, Fish and Wildlife Service (FWS), and the State fish and wildlife agencies as represented by the International Association of Fish and Wildlife Agencies (IAFWA) in preparing, reviewing, and implementing integrated natural resource management plans (INRMPs) on military installations.

B. BACKGROUND

In recognition that military lands have significant natural resources, Congress enacted the Sikes Act in 1960 to address wildlife conservation and public access on military installations. The 1997 amendments to the Sikes Act require the DoD to develop and implement an INRMP for each military installation with significant natural resources. The INRMP must be prepared in cooperation with the FWS and the State fish and wildlife agency (States) and reflect the mutual agreement of the parties concerning conservation, protection, and management of fish and wildlife resources on military lands.

INRMPs provide for the management of natural resources, including fish, wildlife, and plants. They incorporate, to the maximum extent practicable, ecosystem management principles and provide the landscape necessary for the sustainment of military land uses. INRMPs allow for multipurpose uses of resources, including public access necessary and appropriate for those uses, provided such access does not conflict with military land use requirements. Effective partnering among the DoD, the FWS, and the States, initiated early in the planning process at national, regional, and the military installation levels, is essential to the development and implementation of comprehensive INRMPs. When such partnering involves the participation of all parties and synchronization of INRMPs with existing FWS and State natural resource management plans, the mutual agreement of all parties is achieved more easily. Consistent with the use of military installations to ensure the readiness of the Armed Forces, the purpose of INRMPs is to provide for the conservation and rehabilitation of natural resources on military lands. Thus, a clear understanding of land use objectives for military lands should enable DoD, the FWS, and the States to share a common understanding of land management requirements while preparing and reviewing INRMPs.

This MOU addresses the responsibilities of the Parties to facilitate optimum management of natural resources on military installations. It replaces a DoD-FWS MOU on "Ecosystem-based Management of Fish, Wildlife and Plant Resources on Military Lands" which expired May 17, 2004.

C. AUTHORITIES

This MOU is established under the authority of the Sikes Act, as amended, 16 U.S.C. 670a-670f, which requires the Secretary of Defense to carry out a program to provide for the conservation and rehabilitation of natural resources on military installations in cooperation with the FWS and the State fish and wildlife agencies. The DoD's primary mission is national defense. DoD manages approximately 30 million acres of land and waters under the Sikes Act to conserve and protect biological resources while supporting sustained military land use.

The FWS manages approximately 96 million acres of the National Wildlife Refuge System, and administers numerous fish and wildlife conservation and management statutes and authorities, including: the Fish and Wildlife Coordination Act, the Migratory Bird Treaty Act of 1918, the Endangered Species Act, the Marine Mammal Protection Act, the Bald and Golden Eagle Protection Act, the Anadromous Fish Conservation Act, the Nonindigenous Aquatic Nuisance Prevention and Control Act of 1990, the Federal Noxious Weed Act, the Alien Species Prevention Enforcement Act of 1992, the North American Wetland Conservation Act, and the Coastal Barrier Resources Act.

The States in general possess broad trustee and police powers over fish and wildlife within their borders, including – absent a clear expression of Congress' intent to the contrary – fish and wildlife on Federal lands within their borders. Where Congress has given Federal agencies certain conservation responsibilities, such as for migratory birds or species listed as threatened or endangered under the Endangered Species Act, the States, in most cases, have cooperative management jurisdiction.

The Sikes Act (16 U.S.C. 670c-1) allows the Secretary of a military department to enter into cooperative agreements with States, local governments, nongovernmental organizations, and individuals to provide for the maintenance and improvement of natural resources, or to benefit natural and cultural resources research, on DoD installations.

The Sikes Act (16 U.S.C. 670f(b)) also encourages the Secretary of Defense, to the greatest extent practicable, to enter into agreements to use the services, personnel, equipment, and facilities, with or without reimbursement, of the Secretary of the Interior in carrying out the provisions of this section.

The Economy Act (31 U.S.C. 1535 and 1536) allows a Federal agency to enter into an agreement with another Federal agency for services, when those services can be rendered in a more convenient and cost effective manner by another Federal agency.

The Intergovernmental Cooperation Act of 1968 (P.L. 90-577 (82 Stat. 1098)) allows the "improvement of the administration of grants-in-aid to the States, to permit provision of reimbursable technical services to State and local government.

D. RESPONSIBILITIES

The Parties to this agreement hereby enter into a cooperative program of INRMP development and implementation with mutually agreed-upon fish and wildlife conservation objectives to satisfy the goals of the Sikes Act.

1. **The DoD, the FWS and IAFWA (the Parties) mutually agree, in accordance with all applicable Federal, State and local laws and regulations:**

   a. To meet at least annually to discuss implementation of this MOU. The DoD will coordinate the annual meeting and any other meetings related to this MOU. Proposed amendments to the MOU should be presented in writing to the parties at least 15 days prior to the annual meeting. The terms of this MOU and any proposed amendments may be reviewed at the annual meeting. The meeting may also review mutual Sikes Act accomplishments, research and technology needs, and other emerging issues.

   b. To establish a Sikes Act Tripartite Working Group consisting of representatives from the Parties. This Working Group will meet at least quarterly to discuss and develop projects and documents to assist in the preparation and implementation of INRMPs and to discuss Sikes Act issues of national importance.

   c. The Sikes Act Tripartite Working Group will encourage the establishment of INRMP Development and Implementation Teams to facilitate early communication during preparation, review, revision or implementation of an INRMP and to ensure that such INRMPs are comprehensive and implemented as mutually agreed.

   d. Supplemental Sikes Act MOUs or other agreements may be developed at the regional and/or State level.

   e. To recognize the current DoD and FWS Sikes Act Guidelines on http://www.fws.gov and http://www.denix.osd.mil as the guidance for communication and cooperation of the Parties represented by this MOU.

   f. That none of the Parties to the MOU is relinquishing any authority, responsibility, or duty as required by law, regulation, policy, or directive.

g. To engage in sound management practices for natural resource protection and management pursuant to this MOU with due regard for military readiness, the welfare of the public, native fish and wildlife, threatened and endangered species, and the environment.

h. Consistent with DoD's primary military mission and to the extent reasonably practicable, to promote the sustainable multipurpose use of natural resources on military installations, to include hunting, fishing, trapping, and nonconsumptive uses such as wildlife viewing, boating, and camping.

i. To designate the individuals listed below as the national representative from each signatory to participate in the activities pursuant to this MOU. Representatives may also be designated at the regional and local levels to participate in similar Sikes Act planning or coordination activities.

    i. DoD: Conservation Team Leader, ODUSD (I&E) EM, 1225 Clark Street Suite 1500, Arlington, VA 22202-4336

    ii. FWS: National Sikes Act Coordinator, U.S. Fish and Wildlife Service, 4401 North Fairfax Drive, Room 400, Arlington, VA 22203.

    iii. IAFWA: Executive Vice-President, IAFWA, 444 North Capitol Street, NW, Suite 544, Washington, DC 20001.

2. DoD agrees to:

a. Communicate the establishment of this MOU to all DoD Components.

b. Take the lead in the development of policies related to INRMP development and implementation and seek the cooperation of the FWS and the State fish and wildlife agencies during development, review, and implementation.

c. Ensure distribution of the DoD and revised FWS Sikes Act Guidelines to all appropriate DoD offices at every level of command.

d. Encourage military installations to invite appropriate FWS and State fish and wildlife agency offices to participate in developing and updating the INRMPs. All such invitations should be extended well in advance of the needed date for the product or work in order to facilitate meaningful participation by all three Parties.

e. Encourage military installations to take advantage of FWS and State fish and wildlife agency natural resources expertise through the use of Economy Act transfers and cooperative agreements. Priority should be given to projects that:

    i. Sustain the military mission;

    ii. Consider the strategic planning priorities of the FWS and the State fish and wildlife agency; and

    iii. Effectively apply the principles of ecosystem management.

f. Encourage military installation to identify INRMP project requirements and give priority to those that:

    i. Ensure conservation of natural resources while sustaining military mission activities;

    ii. Achieve compliance with Federal, State, and local laws; and

    iii. Provide adequate staffing for the development and implementation of the INRMP.

g. Discuss with the FWS and the State fish and wildlife agencies all issues of mutual interest related to the protection, conservation, and management of fish and wildlife resources on DoD installations, and obtain the mutual agreement of the FWS and the States regarding all INRMP provisions related to activities within their legal jurisdiction.

h. Subject to mission, safety and security requirements, provide public access to military installations to facilitate the sustainable multipurpose use of its natural resources.

i. Identify DoD natural resource research needs, and develop research proposals with input from FWS and/or the IAFWA.

j. Encourage the Military Services to establish natural resources management liaisons to facilitate:

    i. Coordination and mutual agreement of INRMPs;

    ii. Development and implementation of cooperative regional and local natural resource conservation partnerships and conservation initiatives with FWS and State fish and wildlife agency offices; and

    iii. Natural resources conservation technology transfer and training initiatives between the Military Services, Federal land management agencies, and State fish and wildlife agencies.

3. FWS agrees to:

a. Communicate the establishment of this MOU to each FWS Regional Office and appropriate field stations in close proximity to military installations.

b. Distribute the DoD and revised FWS Sikes Act Guidelines to each FWS Regional Office and appropriate field station in close proximity to military installations.

c. Designate regional and field station FWS liaisons to develop partnerships and assist the DoD in implementing joint management of ecosystem-based natural resource management programs.

d. Identify FWS personnel needs for the development, review, updating, and implementation of INRMPs and expedite the fulfillment of those needs, as appropriate, based on funding and FWS priorities.

e. Provide technical assistance to the DoD in managing Federal trust resources such as endangered species, migratory birds, interjurisdictional fisheries, invasive species, contaminants, wetlands, coastal resources, law enforcement, or other natural resource issues within the scope of FWS responsibilities, funding constraints and expertise.

f. Work with the DoD to coordinate military natural resource research efforts and the creation of a consolidated source of information, with a particular emphasis on research on listed species and species at-risk.

g. Disseminate upcoming proposed listing and critical habitat designations to DoD Headquarters offices and potentially affected installations as part of outreach efforts before the Federal Register publication of such proposed designations.

h. Provide law enforcement support to protect fish, wildlife and plant resources on military installations within the jurisdiction of the FWS.

4. IAFWA agrees to:

a. Communicate the establishment of this MOU to each State fish and wildlife agency director and appropriate field offices.

b. Distribute the DoD and revised FWS Sikes Act Guidelines to each State fish and wildlife agency director and appropriate field offices.

c. Facilitate and coordinate with the States to encourage them to:

i. Participate in the development, review, updating and implementation of INRMPs upon request of military installations.

ii. Designate State liaisons to assist in developing partnerships and to assist the DoD in implementing natural resource conservation and management programs.

iii. Identify State wildlife management areas in close proximity to military installations and, where appropriate, participate in the joint management of ecosystem-based natural resource management projects.

iv. Provide technical assistance to the DoD in managing natural resource issues such as endangered species, migratory birds, interjurisdictional fisheries, invasive species, contaminants, wetlands, coastal resources, law enforcement, outdoor recreation, or other natural resource issues within the scope of State responsibility and expertise.

v. Identify State personnel needs for the development, review and implementation of INRMPs and expedite the fulfillment of these needs as appropriate based on available funding and State priorities.

vi. Coordinate current and proposed State natural resource research efforts with those that may relate to DoD installations.

vii. Coordinate with DoD installations in development of comprehensive state wildlife conservation plans.

E. STATEMENT OF NO FINANCIAL OBLIGATION

This MOU does not impose any financial obligation on the part of any signatory.

F. ESTABLISHMENT OF COOPERATIVE AGREEMENTS

The Parties are encouraged to enter into cooperative agreements to coordinate and implement natural resource management on military installations. If fiscal resources are to be transferred in support of this MOU, the Parties must develop a separately funded cooperative agreement. Such cooperative agreements may be entered into under the authorities of the Sikes Act (16 U.S.C. 670a-670f, as amended) and the Economy Act (31 U.S.C. 1535 and 1536). Each funded cooperative agreement shall include a work plan and a financial plan that identify goals, objectives, and a budget and payment schedule. A cooperative agreement to accomplish a study or research also will include a study design and methodology in the work plan. It is understood and agreed that any monies allocated via these cooperative agreements shall be expended in accordance with its terms and in the manner prescribed by the fiscal regulations and/or administrative policies of the party making the funds available.

G. AMENDMENTS

This MOU may be amended at any time by mutual agreement of the parties in writing.

H. TERMINATION

Any party to this agreement may remove itself from this MOU upon sixty (60) days written notice to the other parties.

I. EFFECTIVE DATE AND DURATION

This MOU will be in effect upon date of final signature and will continue for five years from date of final signature. The parties will meet 6 months prior to the expiration of this MOU to discuss potential modifications and renewal terms.

1/31/06 — Alex A. Beehler

Date — Assistant Deputy Under Secretary of Defense
(Environment, Safety and Occupational Health)
U.S. Department of Defense

1/31/06 — H. Dale Hall

Date — Director
Fish and Wildlife Service
U.S. Department of Interior

1/31/06

Date — Executive Vice-President
International Association of Fish and Wildlife Agencies

I9 - NCTAMSPAC WAHIAWA PIG HUNTING MEMO (2007)

This page is intentionally left blank.

DEPARTMENT OF THE NAVY
COMMANDER
NAVY REGION HAWAII
850 TICONDEROGA ST STE 110
PEARL HARBOR HI 96860-5101

5090
Ser N00L/032
25 Jul 07

From: Commander, Navy Region Hawaii
To: Commanding Officer, Naval Computer and Telecommunications Area Master Station, Pacific

Subj: PERMISSION TO CAPTURE AND REMOVE FERAL/WILD PIGS FROM NAVAL COMPUTER AND TELECOMMUNICATIONS AREA MASTER STATION, PACIFIC

Ref: (a) Your ltr 1710 Ser N1/239 of 6 Jun 07

1. Proposal set forth in reference (a) is approved subject to the following:

a. Human safety is given priority while the capture and removal of feral/wild pigs is being undertaken.

b. Number, sex, estimated age, and general health of each animal be reported to Region Environmental (N45) and NAVFAC PAC. Data provided will be used in future natural resource management plans and other planning documents.

2. Point of contact: Region Environmental (N45) email randy.miyashiro@navy.mil and NAVFAC PAC email vanessa.pepi@navy.mil.

TAYLOR W. SKARDON
Chief of Staff

Copy to:
NAVFAC PAC

DEPARTMENT OF THE NAVY
NAVAL COMPUTER AND TELECOMMUNICATIONS
AREA MASTER STATION, PACIFIC
500 CENTER STREET
WAHIAWA, HAWAII 96786-3050

1710
Ser N1/ 239
6 Jun 07

From: Commanding Officer, Naval Computer and Telecommunications Area Master Station, Pacific
To: Commander, Navy Region Hawaii

Subj: PERMISSION TO CAPTURE AND REMOVE FERAL/WILD PIGS FROM NAVAL COMPUTER AND TELECOMMUNICATIONS AREA MASTER STATION, PACIFIC

Encl: (1) Project proposal
(2) Ariel photographs of proposal site

1. Feral pigs are becoming a serious safety and environmental problem at Naval Computer and Telecommunications Area Master Station, Pacific (NCTAMS PAC). The enclosed depredation plan will hopefully alleviate this problem and create a safer environment for Sailors, employees and residents of NCTAMS PAC.

2. Forwarded, recommending approval.

J. M. DONOVAN

PROJECT: FERAL/WILD PIGS DEPREDATION
LOCATION: NCTAMS PAC HI.
START DATE: UPON APPROVAL
STOP DATE: APPROX. 3 MONTHS. TO BE RE-EVALUATED AFTER STOP DATE.

STAFF/PERSONNEL INFO:

CSC(SW/AW) GENARO DEUZ
NCTAMS COMPLEX MANAGER
WK# 808-622-1864
CL# 808-221-6141
CLEARANCE: SECRET

MANOLO M EDROSA (USN, RET.)
NETWORK ENGINEER, PACOM
CL# 808-265-7173
CLEARANCE: TOP SECRET SCI

MA1(SW) FRANSISCO A. GACUYA
NCTAMS SECURITY, 2ND SHIFT WATCH COMMANDER
WK# 808-653-5234
CL# 808-772-1629

HUNTING PERMITS ARE ALL UP TO DATE. TRAPS ARE IN ACCORDANCE WITH RULES AND REGULATIONS OF THE STATE OF HAWAII, DIVISION OF FORESTRY AND WILDLIFE

TYPES OF EQUIPMENT USED:

6' X 8' CAGE TRAPS (UP TO 3, DEPENDING ON NUMBER OF PIGS FROM PHOTOS TAKEN)
CANINE NOOSE

TYPES OF DETERRING METHODS USED:

SENSOR CHIMES (NOISE MAKERS)
HOUSEHOLD PRODUCTS (I.E. DETERGENTS, BLEACH)
HUMAN SCENTS

TARGET LOCATIONS:

SEE ATTACHMENTS
PROJECTED SITES ARE DETERMINED BY SURVEYING OF LAND AREA.
MAIN OBJECTIVE IS TO DIVERT AND RELOCATE AWAY FROM ANY RESIDENTIAL HOUSING AND BUSINESS AREA.

Enclosure (1)

PROCEDURES:

- SURVEY LAND AND LOCATE EXISTING TRACKS AND TRAILS
- ESTABLISH PROPER TECHNIQUES TO BE USED
- STATION DIGITAL CAMERAS AT EACH LOCATION TO DETERMINE TIME OF ARRIVALS
- DIVERT THEIR FREQUENT AREA ROUTES AWAY FROM RESIDENTIAL AND BUSINESS AREA BY LURING THEM WITH CORN FEED, BREAD, FRUITES ETC. (PROVIDED)
- PREPPING OF AREA IS NEEDED TO ALLOW EQUIPMENT TO OPERATE EFFICIENTLY
- CAGE TRAPS (TO BE MONITORED AND CHECKED MINIMUM OF 1X PER DAY)

TRANSPORTING:

PROCEDURES OF TRANSPORTING PIGS WILL BE DETERMINED BY SIZE AND TYPE OF EQUIPMENT USED. FOR TRAPS, ON A CASE BY CASE BASIS, ALL PIGS CAUGHT WILL BE RESTRAINED AND SUBDUED BY CANINE NOOSE, THEN TIED FOR TRANSPORT. BECAUSE THEIR LEVEL OF STRENGTH, MALE PIGS THAT ARE 100+ POUNDS WITH TUSK PROTRUDING JAWLINE AND FEMALE PIGS 150+ POUNDS, IF NECESSARY, WILL NEED TO BE KILLED ON THE SPOT FOR SAFETY REASONS BEFORE TRANSPORTING. EQUIPMENT TO BE USED IS SHARP OBJECT ATTACHED TO A 6 FOOT POLE.

SAFETY ISSUE PROPASAL:

MINIMUM PERSONAL EQUIPMENT REQUESTING ARE HUNTING KNIVES AS LAST RESORT OF DEFENSE

INITIAL TRANSPORTING OF ANY WEAPONS ONTO AND ON FACILITY WILL BE LOCKED IN VEHICLE AND/OR BED OF TRUCK

TRANSPORTING OF ANY WEAPONS TO AND FROM LOCATION SITES WILL BE REPORTED TO SECURITY

TIMES OF OPERATION:

ALL ACTIVITIES WILL BE CONDUCTED AFTER WORKING HOURS AND/OR WEEKENDS. AT NO TIME, FOR SAFETY REASONS, ANY ACTIVITY WILL BE CONDUCTED DURING NIGHT OR EARLY MORNING HOURS WHERE VISIBILITY IS EXTREMELY LOW.

REPORTS:

A RECORD OF REPORT WILL BE MAINTAINED
- LOCATION
- TIME/DATE
- DESCRIPTION OF ANIMAL, ETC.

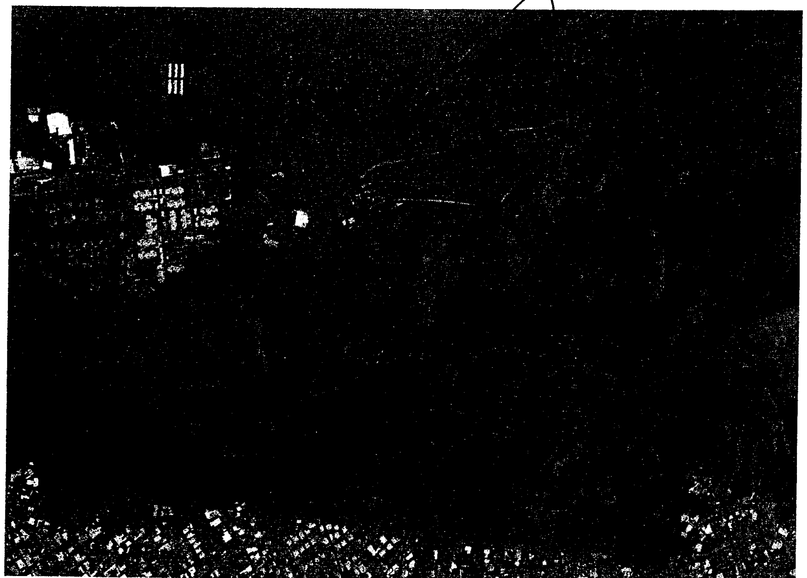
CHECK IN/OUT WITH SECURITY. ALL ANIMALS WILL BE REPORTED TO SECURITY PRIOR TO DEPARTING BASE

PRIMARY POINT OF CONTACT:

CSC(SW/AW) GENARO DEUZ
WK# 808-622-1864
CL# 808-221-6141

Google Maps Address **Wahiawa, HI**

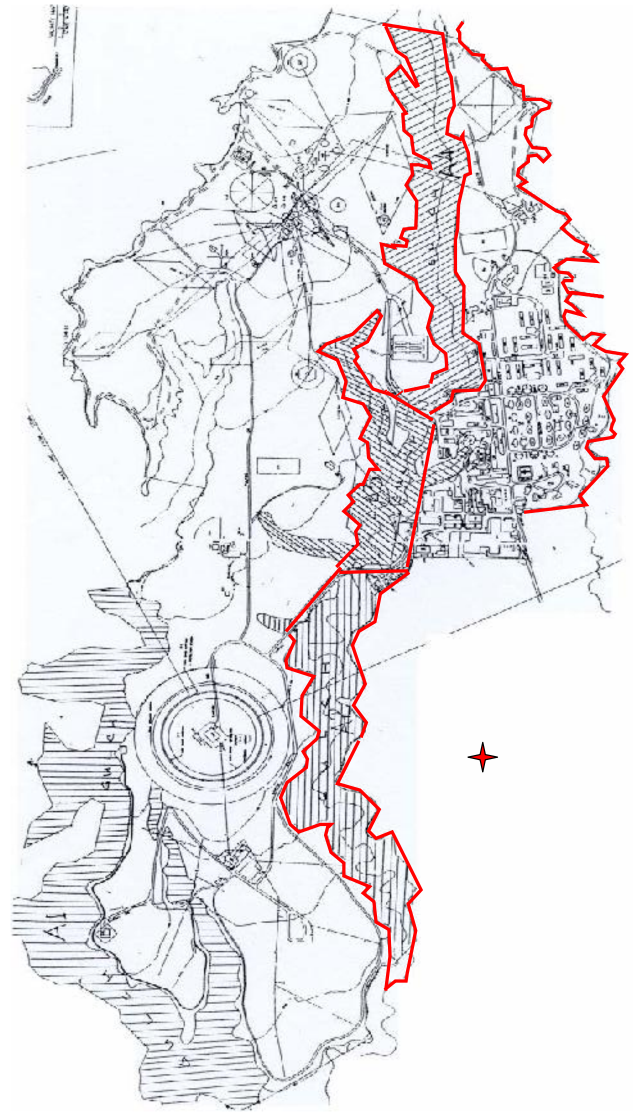
SITE A



SITE B

EITHER/OR AT EACH SITE POINTS. WILL DETERMINE AFTER SURVEYING LAND.

LOCATIONS MAY BE RE-LOCATED. SECURITY WILL BE NOTIFIED



I10 – PROTECTING HAWAI‘I’S ENVIRONMENT – A TEAM EFFORT (NO DATE)

Why is environmental stewardship important?

- Provides a safer place to live and work.
- Preserves Hawaii's ecosystems that serve as habitats for a wide variety of protected plants and animals, including:
  - Native forests
  - Wetlands
  - Coastlines
  - Coral reefs

Endangered Abutilon menziesii

Hawaiian stilts, one of four endangered wading birds native to Hawaii.

- Protects our cultural and historical resources, including Pearl Harbor—a National Historic Treasure

Endangered Green Sea Turtle

- Complies with environmental regulations, which were created to protect the environment for current and future generations as well as our own health and safety

Working Together to Protect Hawaii's Environment

Navy Region Hawaii's Environmental Department works together with regulatory agencies, natural resource managers and local communities to ensure that environmental protection is incorporated into our daily operations. You are now an important member of that team! Together, our proactive efforts will help ensure that present and future generations will be able to enjoy Hawaii's environmental treasures.

Call These Numbers to Get ACTION:

- **If you are at:**
  Location: Pearl Harbor Naval Complex
  Name: Alan Sugihara
  Phone: 473-4137 Ext. 234
  Email: Alan.Sugihara@navy.mil

  Location: Naval Magazine (NAVMAG) Pearl Harbor, and Lualualei Branch
  Name: Terence Tengan
  Phone: 471-1111 Ext. 168
  Email: Terence.Tengan@navy.mil

  Location: Naval Computer and Telecommunications Area Master Station, Pacific (NCTAMSPAC)
  Name: Stan Kato
  Phone: 653-9859
  Email: stanley.kato@navy.mil

- **To report an oil spill in the waters of Pearl Harbor**
  Naval Station Port Operations - 474-6262
- **To report an oil or chemical spill ashore**
  Region's Dispatch Center – 911
- **To learn more about recycling**
  Region's Recycling Center – 474-9207

The Navy In Hawaii

Protecting Hawaii's Environment – A Team Effort

"Protection of the environment is an integral part of accomplishing our mission. . . It is everyone's responsibility to help protect Hawaii's environment."

–Rear Adm. Michael C. Vitale
Commander, Navy Region Hawaii
(Environmental Protection Policy Statement)

Introduction

Welcome aboard Navy Region Hawaii, where we are committed to taking care of our environment! You are the Navy's first-line of defense to help protect Hawaii's land, sea, and air environments.

In this brochure, you'll learn about:

- Managing Hazardous Material/Waste
- Pollution Prevention
- Reporting Spills

Hazardous Material /Waste

Hazardous materials are used for many purposes in different jobs and we need your help to ensure that they're properly taken care of.

What is hazardous waste (HW)? It is any waste material that meets one or more of the U.S. Environmental Protection Agency's criteria for:

- Flammability → it burns!
- Corrosivity → it destroys by rusting or chemical reaction!
- Reactivity → it explodes!
- Toxicity → it poisons!

Products such as paints, cleaners, oils, batteries and pesticides frequently contain potentially hazardous ingredients and require special handling and disposal. The Region's environmental workers are trained and ready to help you if you aren't sure what to do.

Dumpster Know How – Did you know that certain items besides hazardous waste don't belong in trash dumpsters? Items can include:

- Green waste – leaves, grass, and branches
- Tires
- Mattresses
- Fluorescent tubes
- Liquids

If you're not sure whether it's O.K. to dispose of a particular item in the dumpster, contact the Region's Environmental Department.

TIP: Don't Dump--RECYCLE

Items such as aluminum cans, clean glass bottles, newspaper, office white paper, corrugated cardboard, scrap metals, and copier/printer cartridges should be recycled instead of being added to our landfill. For more information contact the **Region's Recycling Center.**

Pollution Prevention

Pollutants can be carried by water flowing over streets and yards that eventually enter the storm drain system. We need your help to spot and report environmentally unfriendly conditions, including:

- Abandoned vehicle or equipment batteries
- Improperly managed hazardous materials in the work area, e.g., paints, solvents, oils, etc.

The Clean Water Act governs pollution in the ocean or streams. With a few exceptions, <u>no pollutants</u> are allowed to be discharged into the ocean or streams without a permit. Any other discharge must be reported to the Region's Environmental Department.

Reporting Spills

If any oil is spilled into Pearl Harbor, which creates a sheen, no matter how small, or that enters into a storm drain/drainage ditch that leads into the harbor, you must immediately report it to **Naval Station Port Operations.**

Any hazardous substance spill on land that you can't safely contain or clean up should be treated as an emergency. You must report the chemical spill to the **Region's Dispatch Center.**

I11 – NIULI‘I PONDS MANAGEMENT PLAN (2008)

This page is intentionally left blank.

Purpose of plan

The purpose of creating a wildlife management plan for the U.S. Navy Wildlife Refuge at Niuli‘i Ponds is to establish a framework of priorities and specific actions to be carried out in support of the management goals and objectives of the land manager. This management plan was written for the United States Navy under the direction and advisory of Vanessa Pepi and is in agreement with the following U.S. Navy wildlife mission statement:

“The U.S. Navy complies with the Endangered Species Act, the Marine Mammal Protection Act, and other laws to protect threatened and endangered species and their habitat” (United States Navy 2007).

The state of Hawaii is noted for its unique and fragile ecosystems. The isolation of the Hawaiian island chain has led to the evolution through adaptive radiation of many endemic species that are highly susceptible to displacement by nonnative invasive species. According to the United States Department of Agriculture Wildlife Services, “Many unique Pacific Island plants and animals are threatened with extinction. Hawaii has the highest number of endangered species in the nation,” (Pitzler 2006). High levels of endemism and loss of native biodiversity within Hawaiian ecosystems has raised protective and conservative environmental efforts. Wildlife Services also stresses that it is important to “protect endangered water birds

at State sanctuaries and wetland sites on military lands from introduced predators such as the small Indian mongoose,” (Pitzler 2006).

Area description

The wildlife refuge is located on a Naval Reservation in a large coastal valley on Oahu's southwestern shore. Niuli'i Pond Complex is located on a 1,700 acre Naval Radio Transmitting Facility (NRTF) on the western side of the valley. Adjacent to the NRTF is a Naval Magazine (NAVMAG), which occupies over 8,000 acres of the eastern side of the valley. Surrounding the area is agriculture and conservation land. Rainfall averages about 20 inches per year, with a higher rate of potential evaporation. Freshwater comes from the NAVMAG due to salinization of wells at lower elevations (ATSDR, 1998). The site lies on fairly level terrain at an elevation of 39-43 meters above sea level. The NRTF is located on a foundation of limestone, covered by alluvial and coastal sediments (Pike, 2000). The soil in the area is made up of Lualualei stony clay and Pulehu clay loam (NRCS).

The Niuli'i Pond Complex is approximately 9.6 acres on an 88.4 acre wildlife refuge and was established as early as 1943. It began to be used as an oxidation and settling basin for the wastewater from the NAVMAG community in 1957. The complex consists of two distinct ponds, separated by a small roadway, within a fenced area. The south pond (Pond 1) is substantially larger than the north pond (Pond 2). Pond 1 has a large pipe that transports wastewater from the NAVMAG via gravity into the pond for secondary treatment. Freshwater began to be fed into Pond 1 from the Naval Reservation water supply in 2005. Rudimentary piping has been recently installed to transfer water from Pond 1 to Pond 2.

Goals and objectives

The overarching purpose of the U.S. Navy wildlife refuge at Niuli'i ponds is to encourage an increase in endangered Hawaiian bird populations, specifically the populations of Hawaiian moorhens, Hawaiian coots, and Hawaiian stilts. The land managers desire one of the ponds within the refuge to serve as a suitable habitat for Hawaiian moorhens and Hawaiian coots and the other pond to be modified to suit the ecological needs of the Hawaiian stilt. There are four specific management measures that the land manager would like to implement in the attempt to raise the bird populations: establishing a continuous water supply, planting native vegetation, banding all endangered birds, and constructing of an educational sign for the refuge entrance.

This management plan seeks to further the goals and objectives of the land manager through modifications to the current physical environment of the refuge as well as modifications to the management techniques. The plan considers the interactions between the refuge organisms and their physical environment as an integrated system, to be managed as a cohesive ecosystem. The management plan has been formed based on technical, physical and economic feasibility for the land managers.

Figure 1. Niuli'i Pond Complex

Methods

Species identification is an important aspect of any plan dealing with the management of flora and fauna. This management plan called for a complete identification of all current bird species and plant species. Separate identification methods were utilized for the identification of birds and plants.

Bird species were identified by observation from five established viewing sites. Birds were observed from each location for fifteen minute time periods. Two people were designated as observers and were equipped with binoculars. One person, equipped with multiple field guides, served as data recorder. The data recorder tallied the bird sightings from each location and verified the species identification by referencing the field guide descriptions.

Plant species found on the site were systematically identified using plot transects. Pond 1 was divided into four equally spaced horizontal transects and three equally spaced vertical transects. The plant types on these transects were identified and promptly recorded. . The same method of plant identification was employed for Pond 2, using three horizontal transects and one vertical transect. A pictorial representation of the pond transects and the plant species found along them is provided in Appendix 1.

Samples were taken of any plant species that were not immediately identifiable. These samples were further analyzed and researched off-site.

Current Vegetation

The current vegetation within the fenced wildlife refuge is mainly composed of non-native species of plants. The native species are highlighted, and additionally there were 12 unidentified plant species at the sight. These unidentified plant species are small populations, and do not seem to pose any immediate threat or obstacle to the goals for this site. The dominant species at the site are (in order of frequency) California grass, Koa Haole and Kiawe. These species are considered to be aggressive invasive, as identified by use of Hawaii Wetland Field Guide (Erickson and Puttock, 2006). The California grass is the dominant species on the floor of the ponds and encroaches up the banks, while the two woody invasives are prominent along the perimeter of the pond. It was noted that the Koa Haole and Kiawe within the area were of manageable size at the time of the survey, however with mature trees bordering the exterior it is possible that these trees are the current seed source for the infestation within the fenced area.

Table 1. Current Vegetation

Scientific	Common	Hawaiian
Chloris barbata	Swollen Fingergrass	Mau‘u lei
Ludwiga octavalvis	Primrose Willow	Kamole
Bacopa monnieri	Water Hyssop	‘Ae ‘ae
Urochloa mutica	California grass, para grass	
Prosopis palida	Mesquite	Kiawe
Leucaena leucocephoala	Koa Haole	
	Tomato	
	Thistle	
Typha Sp.	Cattail	
Sida fallax		Ilima

Current Wildlife Resources

The wildlife species present on the refuge can be divided into three categories: bird species, insect species, and predator species. The bird species were specifically identified, but the insect and predator species were only identified by their common names. The following table lists the current wildlife at the site, with the species of interest highlighted. The species are listed in order of increasing frequency.

Table 2. Current Wildlife

	Scientific	Common	Hawaiian
Bird Species			
	Bubulcus ibis	Cattle Egret	
	Paroaria coronata	Red-crested Cardinal	
	Zosterops japonicus	Japanese White-eye	
	Estrilda melpoda	Orange-cheeked Waxbill	
	Streptopelia chinensis	Spotted Dove	
	Fulica alai	Hawaiian Coot	\`Alae ke\`oke\`o
	Geopelia striata	Zebra Dove	
	Carpodacus mexicanus	House Finch	
	Lonchura punctulata	Nutmeg Mannikin	
	Estrilda astrild	Common Waxbill	
	Gallinula chloropus sandvicensis	Hawaiian Moorhen	\`Alae \`ula
	Passer domesticus	House Sparrow	
Insect Species			
		Dragonfly	
		Ladybug	
		Honeybee	
		Bumblebee	
		Spiders	
		Grasshoppers	
		Butterflies	
Predator Species			
		Mongoose	
		Cat	

Current Predator Control

A chain-link fence was constructed in the early 1990's in order to keep cattle, pigs, and dogs out of the site. Within the boundary, an unpaved service road follows the fence line, allowing vehicle access to the whole area. There are currently multiple holes underneath the fence created by burrowing predators such as mongoose. Animal traps line the fence, spaced approximately 10 meters apart. This predator control started in 1994 to keep out predators such as cats, mongoose, and rats. A pest control agent checks the traps every other day.

Figure 2. Predator control trap containing mongoose

Bird Species of Interest

Hawaiian Coot / `Alae ke`oke`o / (*Fulica alai*)

Hawaiian Coot adults are dark slate gray with a white bill and a large frontal shield. The frontal shield is usually white but can vary from bluish white to yellow to dark blood red. They have white under tail feathers that are seen when swimming or during their courtship displays. Male and female coots look alike. Hawaiian Coots are endemic to Hawaii and are smaller than their mainland relatives, measuring 15 inches in length (US Fish and Wildlife Service 2008).

Chicks have black down, except on the head, neck and throat, where the down is reddish-orange. They are able to run and swim soon after hatching but maintain contact with parents by frequent calling. Their calls include a variety of short, harsh croaks.

Coots are found in fresh and brackish-water marshes and ponds. They rarely fly, but are capable of sustained flight close to the water. When nesting, the Hawaiian coot builds floating nests in aquatic vegetation. Typically in which four to ten eggs are laid. Adults defend their nests vigorously. The diet of the Hawaiian Coot consists of seeds and leaves of aquatic plants, insects, tadpoles, and small fish (US Fish and Wildlife Service 2008).

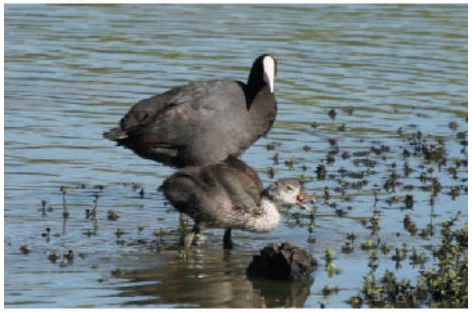


Figure 3. Hawaiian Coot

Hawaiian Moorhen /`Alae `ula / (*Gallinula chloropus sanvicensis*)

The Hawaiian Moorhen adults are dark gray bird with a black head and neck, and white feathers on their flanks and under tail feathers. They have a very distinctive red frontal shield, and their bill tip is yellow with a red base. Their legs and feet are greenish and without lobes. They usually measure about 13 inches in length. Both sexes are similar in appearance and have chicken-like cackles and croaks.

The Hawaiian Moorhen can be found in freshwater marshes, taro patches, irrigation ditches, reservoirs, and wet pastures. They favor dense emergent vegetation near to open water, floating or barely emergent mats of vegetation, and water depths of less than one meter.

Moorhens nest year-round but the active season is usually from March through August. It is believed that the timing of nesting is related to water levels and vegetation growth. The Hawaiian Moorhen typically lays an average of 5 to 6 eggs per clutch with an incubation period of about 22 days. The diet of the Hawaiian Moorhen is primarily comprised of small mollusks, insects, water plants, and grasses (US Fish and Wildlife Service 2008).

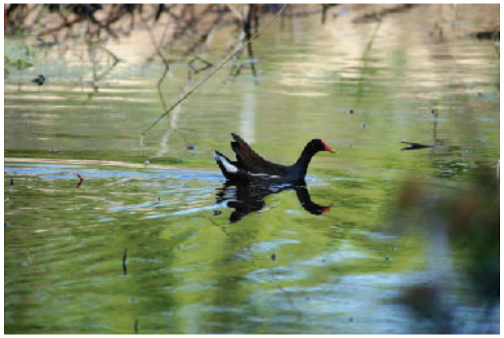


Figure 4. Hawaiian Moorhen

Hawaiian Stilt / Ae`o / *(Himantopus mexicanus knudseni*)

Hawaiian stilts are slender wading birds. They can be identified by their black back, white forehead, black neck and white chin. Females have a tinge of brown on their backs. Stilts have long pink legs and a long black bill. The Hawaiian subspecies differs from the North American stilt by having more black on its face and neck, and a longer bill, tarsus, and tail. Stilts can grow up to 16 inches in length.

Stilts use a variety of aquatic habitats. They like to walk around in open mudflats, pickle weed mats, and open pasturelands where visibility is good and predator populations are low. Nest sites are typically separated from feeding sites and stilts move between these areas daily. Nesting sites are adjacent to or on low islands within bodies of fresh, brackish, or salt water. Feeding habitats are shallow bodies of water providing them with a wide variety of invertebrates and other aquatic organisms such as worms, crabs, or small fish (US Fish and Wildlife Service 2008).

Figure 5. Hawaiian Stilt

Management Recommendations- Vegetation

1. Short term

Short-term management for the vegetation is integral in establishing a habitat for native birds. The first step for managing the site will be to eliminate the dominating California grass that covers the floor of the ponds. A general herbicide such as Round-up would be sufficient for controlling the invasive grass, as long as the herbicide is approved for the site. However, this will also remove the native species of wetland plant ‘ae ‘ae (*Bacopa monnieri*). The species that dominate the perimeter of the ponds (Koa Haole and the Kiawe) should be removed by hand, as currently practiced.

In order for the removal of invasive species to be at all effective, the ponds must be promptly refilled with water. If the pond is not refilled with water from the Naval Reservation water supply or an alternate water source, then the invasive species will quickly return to dominate the pond ground surface. The continual flow of water is necessary to the control measures against the invasive grasses and other aggressive vegetation.

2. Long Term

Long-term management of the vegetation will involve both the control of nonnative invasive species and establishing native plant species that will assist in the creation of a native wetland habitat that will encourage native wildlife. Hand-weeding will be necessary to manage the vegetation after an initial large-scale invasive plant removal. Large-scale removal using herbicide and potentially weed-whackers could be necessary on an annual basis.

Another long-term management strategy that would significantly reduce the amount of hand-weeding necessary would be the removal of the larger Kiawe and Koa Haole outside of the fenced area. These trees that are surrounding the fence perimeter are a constant seed source for the highly invasive trees that litter the fenced-in area.

Native plant introduction will be reliant on a constant source of water. Listed below are native wetland plant species that could be used to increase the native plant population on site, as well as establishing native wetland bird habitat.

Pond 1, which is focused on encouraging moorhens and coots, would benefit from having native species established. The suitable native species for Pond 1 are listed in *Table 3* in green. These wetland plants are tolerant to flooding, and could be planted close to the edge of the waterline. *Bacopa monnieri*, which is already present at the site, could be propagated and planted into other areas of both Pond 1 and Pond 2 to encourage native wetland birds. Hawaiian stilts are known to inhabit mudflats and pickleweed mats. *Bacopa monnieri*, which is a pickleweed (‘ae‘ae), could be planted in Pond 2 in an effort to increase Hawaiian stilt populations. The suitable native species for Pond 2 are listed in *Table 3* in blue. These are native wetland species and their success will be highly dependent on water availability.

Table 3.

Scientific	Common	Hawaiian
Bacopa monnieri	water hyssop	‘ae‘ae
Sesuvium portulacastrum	sea purslane	‘akulikuli
Bolboschoenus maritimus	bulrush	kaluha
Cyperus laevigatus	smooth flatsedge	makaloa
Schoenoplectus lacustris	great bulrush	‘aka‘akai

Management Recommendations- Wildlife

All wildlife management practices for the Lualualei Naval Base are dependent upon the acquisition of a reliable and adequate supply of water for the two ponds. The Hawaiian Coot, Moorhen, and Stilt are only attracted to the site when there is water present. Since these birds are wetland species, a consistent water supply is crucial to their habitat. These birds have particular habits and prefer different depths of water in which to feed, reproduce, and nest.

1. Short Term

Short-term wildlife management recommendations for the ponds at Lualualei are to:

- Obtain a stable and consistent source of water
- Reduce the amount of predators entering into the area
- Provide habitat for Hawaiian coots, moorhens, and stilts

The source of water for the ponds is currently the Naval Reservation water supply, but this source has proved inconsistent due to faulty technology and varying water availability. The timer for the water gauge first needs to be repaired in order to ensure water distribution whether the land manager is present or not. The timer should be programmed in a way that guarantees a daily water flow of at least ten minutes. This management recommendation must be followed before any further wildlife management may be attempted.

It will also be necessary to establish a method of transferring water from Pond 1 to Pond 2. In the past there was a covert that allowed for water from the first pond into the second pond, however the source of water for the second pond was extinguished when the covert collapsed. Currently, there is an ineffective piping system to transfer water from Pond 1 to Pond 2 that consists of a small network of PVC pipes. The piping has proven to be inefficient in water transfer and a new system will be necessary to pump water into Pond 2.

Once the water source has been established, the predator species must be effectively controlled. In order to successfully reduce the amount of predators entering the area, there are two short-term options that may be considered. First, the holes that are currently underneath the fence must be filed. Without filling the holes, any adjustments to fencing type or height would prove to be useless. The second priority for reducing predators would be to outfit the perimeter fence with a "cap" or "hat." The current fence is approximately six feet tall, which is not tall enough to prevent cats from jumping over the fence. A cap/hat is an overhanging structure that is attached to the top of the fence. Such hats have been used and have proven to be effective at keeping cats out of fenced areas (Karori Wildlife Sanctuary 2008).

When considering the option of providing habitat for the select species of native Hawaiian wetland birds, it is necessary to consider the water levels of the ponds. Each of the three birds of interest has specific habitat preferences, requiring different water levels. One of the management objectives of the land manager is to divide the two ponds into sections that cater to the needs of each species of wetland bird. The various sections of habitat would be determined by water depth.

Pond 1 would be suitable for both the Hawaiian Coot and the Hawaiian Moorhen. The coot would prefer the deeper, central water of the pond and the perimeter of the pond with emergent vegetation would serve as a habitat for the moorhen. Pond 2 would make the ideal location to create a shallow mud basin, with surrounding vegetation. This habitat would provide for the wading of the Hawaiian Stilt.

2. Long Term

Long-term wildlife management recommendations for the ponds at Lualualei are:

- Install improved predator fencing
- Manage water levels in order to stimulate breeding and nesting
- Set in place a program for marking/banding any unmarked/unbanded birds

To further reduce the amount of predators that enter into the site, it is important that a new and improved fence be installed. This fence would effectively combat the predator situation. In order to stop any animals that may be burrowing under the fence the new fence would have to have an underground skirt. An underground skirt is simply a portion of the fence that is located beneath the ground and is in the shape of an "L." When confronted with a predator control fence, burrowing predators do not attempt to dig under the fence from a distance, but they dig at the point where the fence makes contacts the ground. The underground skirt works by prohibiting any burrowing animal from tunneling beneath the fence (Karori Wildlife Sanctuary 2008).

The second aspect of a new predator control fence would be the hat or cap. This overhang would successfully prevent any climbing animal such as feral cats from being able to scale the fence.

In addition to cats and mongoose, there is also the issue of mice and rats. Mice and rats can easily pass through the holes in the common chain-link fence, and prey on young chicks and eggs. The most effective way to prohibit a mouse or rat from bypassing the fence it to have the lower portion of the fence equipped with wire mesh and a tin wall. The wire mesh acts as a barrier through which even the smallest mouse or rat cannot pass, and the tin wall prohibits the progress of any animal that may be inclined to attempt to climb over the wire mesh layer.

With the introduction of a virtually impassible predator control fence, the number of predators entering into the site would be significantly reduced. This would also reduce the need for predator control traps, thus reducing the expense of personnel checking the traps and disposing of any captured animals.

Along with the reduction of predator species, there would be an increased survival rate of eggs and hatchlings within the area. The native bird populations at the ponds would be protected, and birds such as the Hawaiian stilt, which has a tendency not to nest if there could be predators in the area, would be more likely to create nests onsite.

Water levels also play an important role in the breeding and nesting cycles of Hawaiian wetland birds. The Hawaiian Coot, for example, builds floating nests, thus if the water level is too low the nests will not float and it is not likely that the birds will be inclined to nest at that time. In contrast, the Hawaiian Moorhen does not build floating nests, but prefers to nest in dense vegetation close to the water. The Hawaiian moorhen typically nests between March and August since these months are notably drier than the winter months in Hawaii. In the wetter months, typically September through February it would be beneficial to increase water levels within the ponds, to suit the nesting conditions preferred by the Hawaiian coot. In the drier summer months of March through August, the water levels of the ponds should be reduced to coincide with and match the desired nesting conditions for the Hawaiian moorhen. Regulating the water level of the ponds would simulate the annual flooding and drying of Hawaii's natural wetlands. If these water management practices are put into effect, there should be an increase in the number of eggs laid, chicks hatched, and wetland bird populations.

With the addition of habitat and bird populations it is assumable that unmarked native birds will be attracted to the site. In order for these birds to be protected and populations measured

accurately, a marking/banding program would be beneficial. In the United States, it is illegal for an unauthorized individual to capture and band a bird. Federal regulations require that a federal or state agency capture and band waterfowl. In Hawaii, there are various institutions that can be used to develop a banding program. The USGS: Biological Resource Division (USGS-BRD) Hawaii division, known as the Pacific Islands Ecosystem Research Center, has been involved in banding native Hawaiian birds. To better establish a banding program at Niuli'I Ponds, contact with USGS should be made. Information concerning banding programs or permitting may be obtained from the following sources:

Pacific Island Ecosystems Research Center
677 Ala Moana Blvd. Suite 615, Honolulu, HI 96813
Telephone: 808-587-7452
Fax: 808-587-7451

Loyal Mehrhoff, Center Director
Telephone: 808-587-7455
677 Ala Moana Blvd. Suite 615, Honolulu, HI 96813
Loyal_Mehrhoff@usgs.gov

John Alexander (President & NABC Rep)
Klamath Bird Observatory
PO Box 758
Ashland, OR 97520-0758
jda@klamathbird.org

Michael Boyles (1st Vice President)
National Park Service
601 Nevada Highway
Boulder City, NV 89005-2426
michael_i_boyles@nps.gov

Educational Outreach

A sign needs to be created to inform people of the nature of the refuge, as well as the endangered species that inhabit the site and their requirements. The wording should include the name Niuli'i Reservoir, the types of endangered species found in the pond complex and the phrase "No Hunting-Wildlife Refuge". The sign should also warn against the introduction of specific invasive species, such as tilapia.

Works Cited

ATSDR. 1998. Agency for Toxic Substances and Disease Registry. Public health assessment, Naval Radio Transmitter Facility Lualualei, Oahu, Hawaii. December 29, 1998.

Cronk, Julie K. and Fennessy, M. Siobhan. *Wetland Plants: Biology and Ecology*. Lewis Publishers: Boca Raton, FL, 2000.

Erickson, T.E. & Puttock, T.A. *Hawaii Wetland Fielf Guide*. EPA: Honolulu, 2006.

Karori Wildlife Sanctuary. "The Sanctuary fence." Karori Wildlife sanctuary Trust 2000-2006 Ohio State Department of Natural Resources."Wildlife Management Plan". www.dnr.state.oh.us. January 2008.

Miller, B., & Carroll, N., 2006. "Developing a Wildlife Habitat Management Plan" Accessed from http://www.ces.purdue.edu/extmedia/4H/4-H-991-W.pdf, March, 2008.

NRCS. "Hawaii Soils" Accessed from http://www.ctahr.hawaii.edu/soilsurvey/soils.htm, March, 2008.

Pike, J., 2000. "Naval Magazine, Lualualei" Accessed from http://www.globalsecurity.org/military/facility/lualualei.htm, March, 2008.

Pitlzer, M.E., "Wildlife Services- Hawaii" Animal and Plant Health Inspection Service, United States Department of Agriculture. 2006

Stemmermann, Lani. *A Guide to Pacific Wetland Plants*. Army Corps of Engineers: Honolulu. 1981.

Texas A&M University, Department of Wildlife and Fisheries Sciences. "Management Outline". http://apc/tamu/edu

US Fish and Wildlife Service: Pacific Islands. "Threatend and Endangeres Animals in The Hawaiian and Pacific Islands." USFWS: April 22, 2008 http://www.fws.gov/pacificislands/wesa/hawanimalsindex.html

U.S. General Services Administration. http://www.gsa.gov/gsa/cm_attachments/GSA_BASIC/. January 2008.

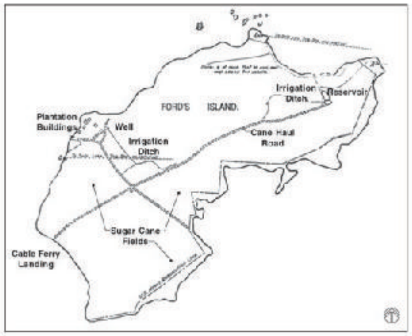
U.S. Navy, Pacific Fleet. "Threatened and Endangered Species Protection." Training Range Complex Environmental Impact Statement/ Overseas Environmental Impact Statement. September 2007.

Weller, Milton W. *Freshwater Marshes: Ecology & Wildlife Management*. University of Minnesota Press. 1994.

I12 – NAVSTA PH FORD ISLAND SELF-GUIDED HISTORY TOUR BROCHURE (NO DATE)

Why *Ford* Island? The island's namesake, Dr. Seth Porter Ford, was a prominent O'ahu doctor. He arrived from Connecticut in 1852 and became the primary physician for King Kamehameha IV. He died in 1866, and his son, Seth, Jr., owned the island until 1890.

What was the island used for before the U.S. military arrived? Around the turn of the twentieth century, when sugarcane was "king" of agriculture in Hawaii, Oahu Sugar



Company leased most of Ford Island for growing sugarcane (see 1914 plan above). Centuries earlier, Hawaiians brought many varieties of sugarcane (*ko*) for sweetening food and medicine, producing medical tonics, and thatching their houses (*hale*).

When did the U.S. military arrive on Ford Island? The United States purchased its first Ford Island parcel in 1902 and owned the entire island by 1916. Constructed by the Army and named after early twentieth-century Army officers, Batteries Henry Adair (pictured below in 1922) and Charles T. Boyd

were the first military installations on Ford Island. They were strategically located to protect Pearl Harbor during World War I. Gun emplacements were deactivated following the war. In 1936, a Navy officer's house was built over Battery Adair. Battery Boyd is still a prominent structure on Ford Island.

Is the Army still present on Ford Island? Army population peaked in the early 1930s, but the island became too crowded for the Army and Navy to share. By 1940, the Army had relocated to Wheeler and Hickam fields on O'ahu. The Army Reserve's 548th [ship] Transportation Detachment recently moved from the Army's original location on the southwest side of Ford Island to Bishop Point at Hickam Air Force Base. The former runway down the center of the island is still called Luke Field after World War I Army ace pilot Frank Luke.

* * *

Planes and aviation facilities were also targets of the attack (see image, right). Hangars on Ford Island were heavily damaged, and 33 planes (nearly half of the planes on the island)—including long-range patrol seaplanes—were put out of commission, some with engines nothing but "puddles of molten aluminum." Strafing marks, shrapnel scars, and patched bomb craters **(5G)** are still visible in concrete aprons and taxiways.

6. World War II

Even before the United States entered World War II, NAS Ford Island was a key defensive component in the central Pacific area. Shortly after December 7, concrete revetments were built to protect planes from attack, and bomb shelters **(6A)** and decontamination chambers were constructed to protect personnel. The control tower began operations in May 1942, and an aircraft pool provided reserve supply for carriers, air groups, and squadrons in the Pacific Fleet. Five additional seaplane ramps **(6B)** were built to accommodate the greatly increased flow of aircraft into and out of the station. A retired U.S. Navy commander who was an aircraft mechanic on Ford Island during the war remembered repairing damaged aircraft and preparing newly arriving aircraft on ships: "Most of them arrived with their wings off so more could be packed on ships. Also, they were new designs I had never seen before so I had a lot to learn. We were working every waking hour."

The Commander Air Force Pacific Seventh Fleet moved his headquarters to Ford Island to direct operations of the carrier fleet, and Ford Island was further transformed to support these efforts. In 1943, three carrier wharfs were completed on the northwest side of the island **(6C)**. By 1944, ammunition magazines were in place between the Bachelor Officers' Quarters (now the Navy Lodge) and the wharves; a former torpedo magazine still remains **(6D)**.

In honor of the role that aircraft carriers played in the Pacific during the war, Ford Island streets are named after the carriers Lexington, Saratoga, Ranger, Yorktown, Enterprise, Wasp, and Hornet (see image above, taken from Ford Island, of the *Hornet* entering Pearl Harbor on May 26, 1942, after the Battle of Coral Sea).

December 2006

U.S. Naval Station Pearl Harbor

FORD ISLAND

Self-Guided History Tour

Welcome

Welcome to Ford Island! It may be small in size, but it is big in history. The unforgettable day of December 7, 1941, is memorialized by sunken ships, strafing marks, and historical markers. Other less well known facets of Ford Island history are also preserved in the historic structures, the landscape, and views on and from Ford Island.

This self-guided tour is the first phase of the Ford Island Interpretive Trail, which was conceived to present Ford Island history where events actually occurred. When completed, interpretive panels at rest stops along the trail will detail historical themes with thought-provoking text, historic images, and maps and drawings.

This brochure interprets many of the historical themes of the trail: aviation; housing; ferries; community center; December 7, 1941, attack; and World War II activities. The map in this pamphlet links these themes to significant sites on the island, which may be visited in any order.

Rules and Regulations

1. The self-guided tour is intended for individuals with military passes that permit access to Ford Island.
2. Tours should be taken only during daylight hours.
3. Photography shall be limited to the Ex USS *Missouri* and USS *Utah* Memorials only. No photographs may be taken of operational buildings/units. This policy is strictly enforced.
4. In respect of residents' privacy, do not enter housing areas.
5. Read and follow instructions on all posted regulatory signs.

Ford Island Facts

Area: The island increased in size from around 360 acres in the late 1800s to over 450 acres today. In the 1930s, dredged material from deepening the harbor was used to create fill land (see image below of fill land near Luke Field housing).

Dimensions: Just over 1 mile long and 0.6 miles wide.

Elevation: Maximum 20 to 30 feet above sea level at the former runway.

Distance from O'ahu: Almost a mile at the Admiral Clarey Bridge.

Vegetation: In pre-contact times, *pili* grass was harvested on Ford Island. Algaroba (also known as mesquite or *kiawe*) trees covered the island by the late 1800s. Examples are visible near the shoreline. In the early 1900s, the island was a sugarcane plantation. Today's mature trees were planted at the same time that housing was constructed on Ford Island.

Frequently Asked Questions

Did anyone live on Ford Island before military housing was built? Hawaiians probably used the island for only short periods of time, since there was no fresh water. In the early 1800s, Spaniard Don Francisco de Paula y Marin, a court interpreter for Kamehameha I, raised animals for his ship provisioning business on the island, which as a result became known as Rabbit Island and Little Goat Island. The family of Irene I'i Brown, whose father served kings Kamehameha I, II, III, and IV, had a country house and cottages on the island, obtaining water from an artesian well drilled in 1889.

What is the island's significance to Hawaiians? Hawaiians probably used the island when fishing, growing seasonal crops, and collecting pili grass for house (*hale*) thatching. They called Ford Island *Moku-'ume'ume*, "Island of the Game," in recognition of fertility rites practiced there.

Pearl Harbor, or *Ka-awa-lau-o-pu'uloa* (the many harbored sea of *Pu'uloa*), was rich in seafoods. As early as 1650, Hawaiians had deepened the harbor entrance and set up walled fish traps, many of which remained into the twentieth century. The harbor was associated with the *mo'o* (lizard or eel beings) and shark gods *Ka'ahupahau* and her brother *Kahi'uka*. Shark gods are still believed to aid fishermen, protect the life of the seas, and drive off man-eating sharks.

Self-Guided Tour Themes and Sites

1. Aviation

The former control tower **(1A)** stands as a symbol of the island's rich aviation history. For nearly 45 years, Ford Island was an important aviation center for the United States.

The Army built the island's first aviation facilities in 1918 (see image, left, of Luke Field in 1930). Army seaplanes provided reconnaisance and aerial fire direction for batteries around Pearl Harbor—including Batteries Adair and Boyd on Ford Island—and Honolulu during World War I. The grass landing field from this era was the predecessor of the more recent runway **(1B)**. Army hangars from the 1920s provide another glimpse of the past **(1C)**.

In 1923, Navy aviators moved to their first hangar and seaplane ramp **(1D)** and established the U.S. Naval Air Station (NAS) Ford Island. Facilities, such as seaplane ramps **(1E)**, an engine and aircraft overhaul shop **(1F)**, and storerooms **(1G)**, were essential for the station to fulfill important missions during World War II and the Korean War. In 1962, when the runway could no longer support jets and larger aircraft, the station was decommissioned **(1H)**.

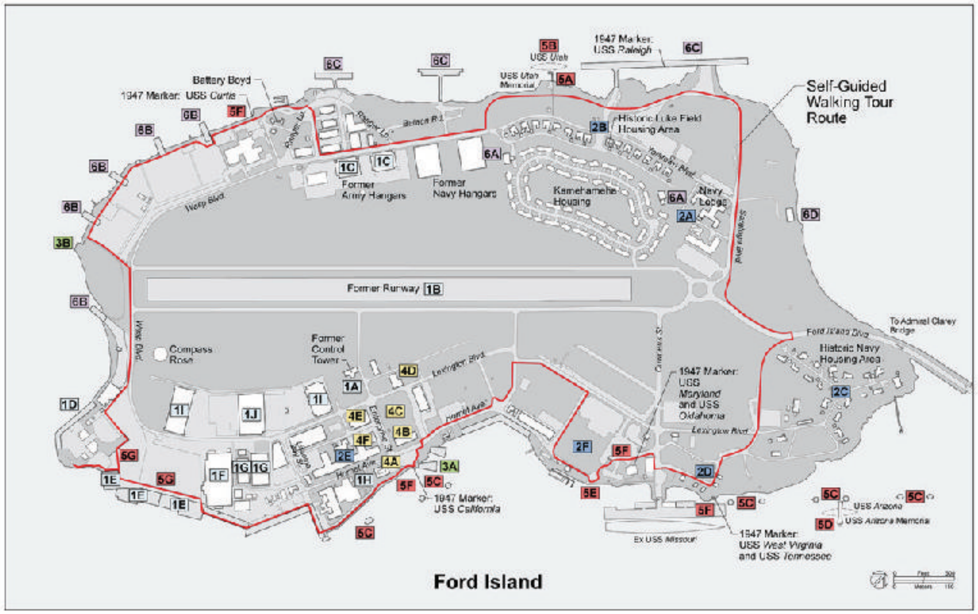
Ford Island's aviation history even includes chapters on civilian aviation. Pan American World Airways Clippers used Ford Island's seaplane facilities in the late 1930s. On March 20, 1937, Amelia Earhart crashed on Luke Field as she took off for the second leg of her attempted round-the-world flight.

Former Navy hangars **(1I)**, assembly shop **(1J)**, and control tower will be adapted for the Pacific Aviation Museum, a visitor attraction that will interpret aviation during World War II, in Korea and Vietnam, and during the Cold War.

2. Housing

Did you know that the Navy Lodge **(2A)** was Navy Bachelor Officers' Quarters (BOQ) and Mess Hall for almost 45 years? Shortly after completion in 1941, the BOQ became a temporary medical facility to treat those injured in the Japanese surprise attack. The building was designed by noted Honolulu architect C. W. Dickey.

Military families have called Ford Island home for more than 80 years. Luke Field housing **(2B)** (see image, above), next to the Navy Lodge, was the first housing constructed on the island.



Completed by 1922, this former married Army officers' housing is now occupied by Navy officers' families. The Navy began constructing their own married officers' housing in 1923 **(2C)**. Known as Nob Hill, Navy officers and their families still live in this neighborhood. Married Chief Petty Officers' (CPO) housing **(2D)** was constructed about the same time as the Nob Hill residences.

The Enlisted Men's Barracks **(2E)**, not far from the former control tower, was built as the Bachelor Enlisted Quarters (BEQ) and Galley in 1936 (see image, left). By December 7, 1941, Ford Island also accommodated a multi-story Navy BOQ at Nob Hill and CPO four-plex units, where monkeypod trees still create a parklike atmosphere **(2F)**.

Can you imagine what it would have been like to live on Ford Island during the attack of Pearl Harbor? An island resident at the time remembered, "Our closeness to the major targets of the Japanese attacking force could be measured in yards. It was no wonder that our eardrums seemed about to burst with each explosion." Many residents evacuated to Battery Adair for safety.

3. Ferries

Chances are that you came to Ford Island over the Admiral Bernard "Chick" Clarey Bridge. But before the bridge opened on April 15, 1998, you would have taken a ferry to one of these two former landings **(3A)**, conveniently located near the community center. During World War II, more than 40,000 people who lived and worked on Ford Island depended on the ferries for transportation and supplies.

An earlier chapter of ferry service was written when the island was a sugarcane plantation. A cable ferry traveled from the south end of the island **(3B)** transporting harvested sugarcane to nearby Waipi'o Peninsula for processing.

4. Community Center

To support the growing population of workers and full-time residents, a community center was established surrounding the Bachelor Enlisted Quarters and Galley. Even the Japanese surprise attack did not halt the building boom that started in 1939. As you walk through Ford Island's "downtown," you will see the former dispensary **(4A)** and site of the theater **(4B)**, buildings which were designed by same the architect who designed the Navy Lodge. Nearby are the softball field **(4C)** and the former bowling alley **(4D)** and laundry **(4E)**. For protection during wartime, bomb shelters with gun emplacements were constructed in 1942 **(4F)**. You can see that the community center was only a short ferry ride from Main Base.

Map Key to Tour Sites

I.D.	Name
1A	Operations Building and Control Tower
1B	Runway (Luke Field)
1C	Army Hangar
1D	Seaplane Runway
1E	Seaplane Runway
1F	Airplane Overhaul Shop
1G	Aircraft Storeroom
1H	NAS Ford Island Commissioning Plaque and Plaza
1I	Navy Hangar
1J	Aviation Assembly Shop
2A	Bachelor Officers' Quarters (BOQ) and Mess Hall
2B	Luke Field Housing
2C	Nob Hill Housing
2D	Chief Petty Officers' (CPO) Housing
2E	Bachelor Enlisted Quarters (BEQ) and Galley
2F	Location of CPO Four-Plex Units
3A	Ferry Landings
3B	Cable Ferry Landing
4A	Dispensary
4B	Theater
4C	Softball Field
4D	Bowling Alley
4E	Laundry
4F	Bomb Shelter
5A	USS *Utah* Memorial
5B	USS *Utah*
5C	Mooring Dolphins
5D	USS *Arizona* Memorial
5E	Location of Fueling Pier
5F	Historical Marker
5G	Strafing Marks, Shrapnel Scars, Patched Bomb Craters
6A	Bomb Shelter
6B	Seaplane Ramp
6C	Carrier Wharf
6D	Torpedo Magazine

5. December 7, 1941, Attack

Though you may have read volumes about the Japanese surprise attack, your self-guided tour will take you to places where events of the day actually unfolded.

Just offshore from its memorial **(5A)** are the remains of the USS *Utah* **(5B)**. On December 7, the USS *Tangier* was moored aft and USS *Raleigh* and USS *Detroit* forward of the USS *Utah*. Just after 8:00 a.m., two torpedoes hit the *Utah's* port side. By 8:05, the *Utah* had capsized.

On the south side of the island, you can still see five pairs of mooring dolphins along Battleship Row **(5C)**. The USS *Arizona* Memorial **(5D)**, straddling the remains of the USS *Arizona*, is clearly visible. On December 7, the USS *Vestal* was moored on the starboard side of the USS *Arizona*; the USS *Nevada* was moored forward; and the USS *Tennessee* and USS *West Virginia*, and the USS *Maryland* and USS *Oklahoma*, were paired aft. The oil tanker USS *Neosho* was docked at a fueling pier nearby **(5E)**. At 7:55 a.m., its tanks had just been emptied. By 8:05, the USS *California* was oozing oil, the USS *Oklahoma* was starting to list, and the USS *Arizona* was minutes away from exploding (see image, below). Less than two hours after the attack began, twenty-one ships of the U.S. Pacific Fleet were sunk or damaged.

The *Neosho* was the only ship at Battleship Row to escape damage or loss of life. Along your tour route, descriptions of the attack on battleships are recorded on historical markers installed in 1947 near where the ships were moored on December 7 **(5F)**.

I13 – OVERLAY REFUGE AGREEMENT (DON 1980)

STATUS OF REAL ESTATE TRANSACTION
PACDOCKS 11011/1 (11-66)

ITEM	ACTION	DATE	BY
Legal Description			
Recording N/A			
Microfilm	To NavFac	11/4/74	J.E.N.
Summary Map on working copies 5/14/73 J.E.N. need (partly on)			
Inventory	Entered	4/20/73	LAB
Grantor-Grantee Index	(Blind - 9-6-130A) 9-1-196A	5/14/73	J.E.N.
District Land Register	(Blind - 9-7- 9-1-196A	5/14/73	J.E.N.
Amendment			
Termination Indefinite			

COMMENTS Use Agreement for Wildlife Refuges - 36.65 acres at NAD West Loch (Salt Evaporator area) - DLR 9-1-196-A and 24.5 acres at Pearl City (Waiawa) Peninsula - DLR 9-6-130A (SEE ALSO RE-1084)
AMENDMENT NO. I to USE AGREEMENT
CHANGES DESCRIPTION FOR WAIAWA SITE, ADDS P.C. PENIN. SITE

AMENDMENT NO. 1
TO
USE AGREEMENT NF(R)-10935
BETWEEN
DEPARTMENT OF THE NAVY
AND
U. S. DEPARTMENT OF THE INTERIOR,
FISH AND WILDLIFE SERVICE
FOR LAND AT
U. S. NAVAL BASE, PEARL HARBOR
U. S. NAVAL MAGAZINE, LUALUALEI, WEST LOCH BRANCH

1. THIS AMENDMENT, made and entered into this 12th day of MAY, 1980, by and between the Department of the Navy (hereinafter called the "Navy") and the Department of the Interior, Fish and Wildlife Service, formerly known as the Bureau of Sport Fisheries and Wildlife (hereinafter called the "Wildlife Service"):

WITNESSETH:

WHEREAS, by Use Agreement NF(R)-10935, made and entered into as of the 17th day of October 1972, the Navy did provide for the exclusive use by the Wildlife Service certain lands under the control of the Navy for the operation, preservation and maintenance of wildlife refuges for rare and endangered species as part of the National Wildlife Refuge System; and

WHEREAS, the U.S. Naval Ammunition Depot, Oahu, has been redesignated the U.S. Naval Magazine, Lualualei; and

WHEREAS, the Navy has made available and the Wildlife Service has agreed to accept for the uses and purposes aforesaid, certain additional lands at the Waiawa and Pearl City Peninsulas, Island of Oahu; and

Encl (1)

WHEREAS, it is desired that lands obtained by Civil Action be delineated separately and differentiated from those formerly under the waters of Pearl Harbor in Presidential Executive Order No. 8143; and

WHEREAS, the Wildlife Service has requested and the Navy is willing to grant a right-of-way for use of an additional portion of the aforesaid Waiawa Peninsula for purposes of installing a water pump and a waterline to provide an adequate supply of fresh water to the bird habitats.

NOW, THEREFORE, the said Use Agreement is amended in the following respect and to the following extent:

a. Article 1 is revised as follows:

"1. The Wildlife Service shall have exclusive right to use the lands described and shown on Exhibits 'B,' 'C,' 'D' and 'E,' attached hereto and made a part hereof, together with the necessary rights of ingress and egress. Additionally, the Wildlife Service shall have the right to use a 10-foot wide right-of-way, as shown on Exhibit 'F,' attached hereto and made a part hereof, for purposes of installing a water pump and a 4-inch waterline to provide fresh water to the bird habitats on Waiawa Peninsula."

b. The attachment Exhibit "A" is deleted and in lieu thereof is replaced by the following exhibits, attached hereto and made a part hereof:

(1) Exhibit "C," narrative description of two parcels of land encompassing the former "Bird Habitat-Pearl City Peninsula," adding 2.7 acres of reclaimed land thereto and retitled "Bird Habitat-Waiawa Peninsula";

(2) Exhibit "D," narrative description of an additional 13.43 acres of reclaimed land at the Pearl City Peninsula and titled "Bird Habitat-Pearl City Peninsula";

(3) Exhibit "E," Real Estate Drawing No. RE-1148, on which the changes above are delineated; and

(4) Exhibit "F," portion of Real Estate Summary Map Y&D Drawing No. 998648, on which the water pump location and 10-foot right-of-way alignment are depicted.

2. Except as herein amended, all other conditions of Use Agreement NF(R)-10935 remain in full force and effect.

DEPARTMENT OF THE NAVY

By ________
By direction of the Commander, Naval Facilities Engineering Command, acting under the direction of the Secretary of the Navy

Date: 12 MAY 1980

DEPARTMENT OF THE INTERIOR
FISH AND WILDLIFE SERVICE

By ________

Date: 12-1-78

BIRD HABITAT - WAIAWA PENINSULA

(FORMERLY CALLED BIRD HABITAT - PEARL CITY PENINSULA)

PARCEL 1-A

Land Situated at Waiawa, Ewa, Oahu, Hawaii

Being portions of Royal Patent 4475, Land Commission Award 7713, Apana 46 to V. Kamamalu, and Royal Patent 198, Land Commission Award 1696, Apana 3 to Namomoku, acquired by the United States of America in Civil Action No. 464 filed in the U. S. District Court for the District of Hawaii, and the Declaration of Taking filed therein on October 21, 1941, said pleading being recorded in the Bureau of Conveyances of the State of Hawaii in Liber 1986 at page 7.

Beginning at the southwest corner of this parcel of land, being also a point herenow accepted as being at former high water mark between said Civil 464 and Presidential Executive Order No. 8143 dated May 26, 1939, the coordinates of said point referred to Government Survey Triangulation Station "Ewa Church" being 2,287.14 feet South and 832.44 feet West and running by azimuths measured clockwise from true South:

Following along the former high water mark of Pearl Harbor Middle Loch (now reclaimed lands of said Presidential Executive Order No. 8143) for the next thirteen (13) courses, the direct azimuths and distances between points on the original high water mark being:

1.	154° 00' 00"	57.39 feet;
2.	160° 10' 00"	120.00 feet;
3.	168° 20' 00"	160.00 feet;
4.	186° 45' 00"	30.00 feet;

EXHIBIT "C"

5.	168° 10' 00"	100.00	feet;
6.	159° 30' 00"	115.00	feet;
7.	165° 40' 00"	100.00	feet;
8.	161° 55' 00"	78.00	feet;
9.	95° 40' 00"	190.00	feet;
10.	78° 40' 00"	95.00	feet;
11.	117° 25' 00"	35.00	feet;
12.	165° 00' 00"	30.00	feet;
13.	200° 00' 00"	93.43	feet; thence
14.	250° 30' 00"	751.77	feet along remainder of R.P. 4475, L.C. Aw. 7713, Ap. 46 to V. Kamamalu (along remainder of U.S. Civil 464) along south edge of existing dirt road;
15.	318° 00' 00"	480.00	feet along same, portion being along remainder of R.P. 198, L.C. Aw. 1696, Ap. 3 to Namomoku (along remainder of U.S. Civil 464);
16.	353° 00' 00"	240.00	feet along remainder of R.P. 4475, L.C. Aw. 7713, Ap. 46 to V. Kamamalu (along remainder of U.S. Civil 464) along top of bank to the 1/2-inch pipe;
17.	38° 18' 36"	147.13	feet along same along top of bank to a 1/2-inch pipe (previous point of beginning for Bird Habitat-Pearl City Peninsula);
18.	47° 19' 00"	133.00	feet along same along top of bank;
19.	50° 27' 00"	488.35	feet along same to the point of beginning and containing an area of 13.759 acres, more or less.

PARCEL 1-B

Being a portion of Reclaimed Land (Fill) in Pearl Harbor set aside by Presidential Executive Order No. 8143 dated May 26, 1939, said reclaimed land abutting on the above described Parcel 1-A, and being an extension of Waiawa Peninsula situated at Waiawa, Ewa, Oahu, Hawaii.

Beginning at the southeast corner of this parcel of land, at a point herenow accepted as being at the former high water mark at shoreline between Pearl Harbor Middle Loch and the westerly boundary of Royal Patent 4475, Land Commission Award 7713, Apana 46 to V. Kamamalu (being also the westerly boundary of U.S. Civil 464), the coordinates of said point of beginning referred to Government Survey Triangulation Station "Ewa Church" being 2,287.14 feet South and 832.44 feet West and running by azimuths measured clockwise from true South:

1. 50° 27' 00" 632.00 feet, more or less, along remainder of Reclaimed Land (Fill) in Presidential Executive Order No. 8143 to present high water mark at shoreline of Pearl Harbor Middle Loch;

thence following the sinuosities of the present high water mark at shoreline of Pearl Harbor Middle Loch along remainder of Presidential Executive Order No. 8143 for the next three (3) courses, the direct azimuths and distances between points on said present high water mark being approximately:

2. 144° 00' 00" 430.00 feet;

3. 181° 20' 00" 465.00 feet;

4. 201° 52' 08" 460.69 feet; thence

5. 250° 30' 00" 68.00 feet, more or less, along remainder of Reclaimed Land (Fill) in Presidential Executive Order No. 8143, to former high water mark between said Presidential Executive Order No. 8143 and U.S. Civil 464;

thence following along the former high water mark of Pearl Harbor Middle Loch, being also along the westerly boundary of U.S. Civil 464, for the next thirteen (13) courses, the direct azimuths and distances between points on the original high water mark being:

6. 20° 00' 00" 93.43 feet;

7. 345° 00' 00" 30.00 feet;

8. 297° 25' 00" 35.00 feet;

9. 258° 40' 00" 95.00 feet;

10. 275° 40' 00" 190.00 feet;

11. 341° 55' 00" 78.00 feet;

12. 345° 40' 00" 100.00 feet;

13. 339° 30' 00" 115.00 feet;

14. 348° 10' 00" 100.00 feet;

15. 6° 45' 00" 30.00 feet;

16. 348° 20' 00" 160.00 feet;

17. 340° 10' 00" 120.00 feet;

18. 334° 00' 00" 57.39 feet to the point of beginning and containing an area of 13.43 acres, more or less.

BIRD HABITAT - PEARL CITY PENINSULA

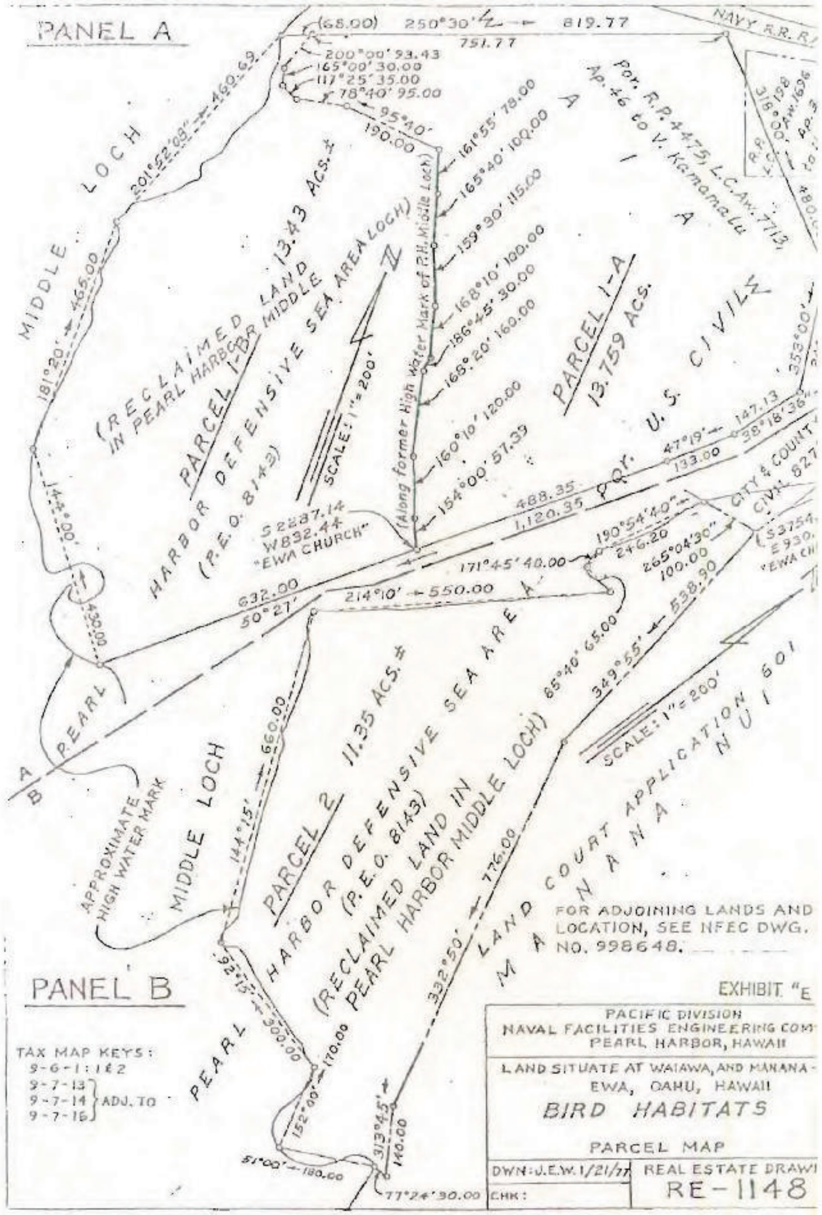
PARCEL 2

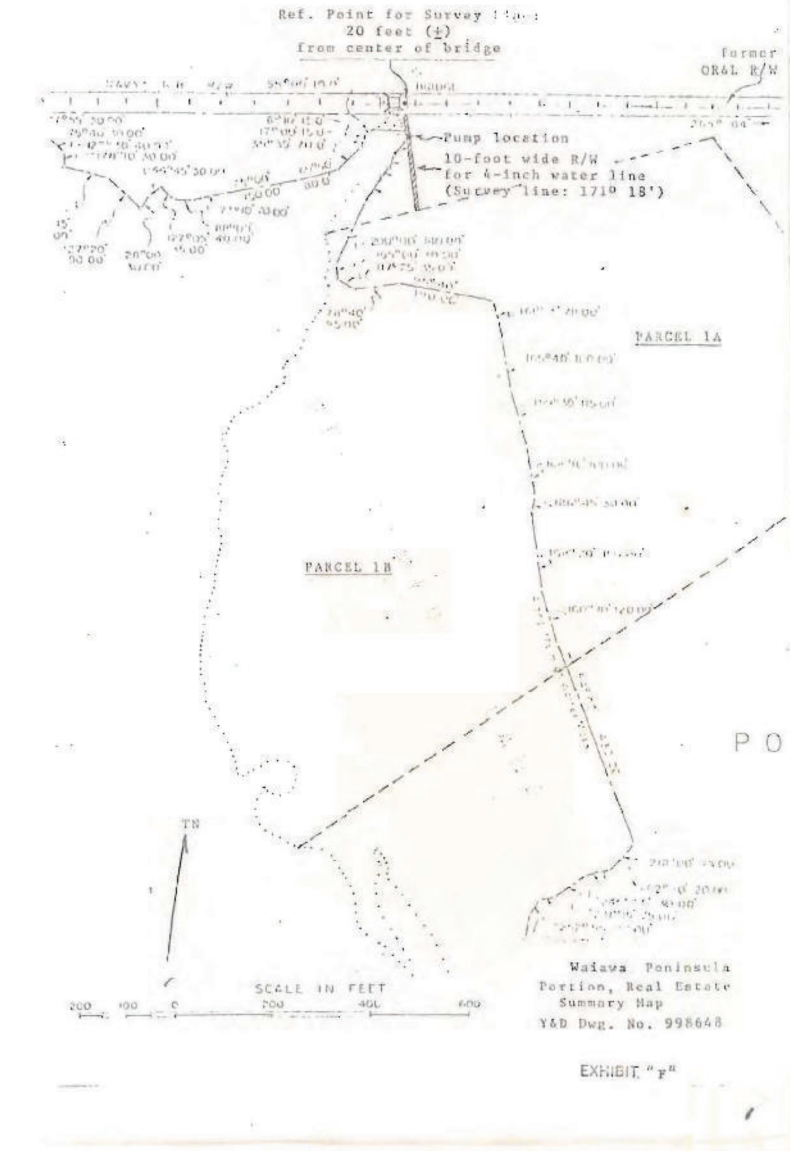
Being a portion of Reclaimed Land (Fill) in Pearl Harbor set aside by Presidential Executive Order No. 8143 dated May 26, 1939, said reclaimed land being an extension of Pearl City Peninsula situated at Manana-nui, Ewa, Oahu, Hawaii.

Beginning at the northeast corner of this parcel of land, being also the southeast corner of Parcel 3 of City and County of Honolulu's Civil Action No. 8279 (Final Order of Condemnation recorded in the Bureau of Conveyances of the State of Hawaii in Liber 4170 at page 268), and being, further, the westernmost corner of Lot 138, as shown on Map 6 of Land Court Application 601, the coordinates of said point of beginning referred to Government Survey Triangulation Station "Ewa Church" being 3,754.60 feet South and 930.45 feet East and running by azimuths measured clockwise from true South:

1.	349° 55' 00"	538.90 feet along said Land Court Application 601;
2.	332° 50' 00"	776.00 feet along same;
3.	313° 45' 00"	140.00 feet along same to the southwest corner of Lot 320 (Map 6) of said Land Court Application 601;
4.	77° 24' 00"	30.00 feet, more or less, along remainder of Reclaimed Land (Fill) in Presidential Executive Order No. 8143 to present high water mark at shoreline of Pearl Harbor Middle Loch;
		thence along sinuosities of said present high water mark at shoreline of Pearl Harbor Middle Loch for the next eight (8) courses, the direct azimuths and distances between points on said shoreline being approximately:
5.	51° 00' 00"	180.00 feet;
6.	152° 00' 00"	170.00 feet;
7.	92° 15' 00"	300.00 feet;
8.	144° 15' 00"	660.00 feet;
9.	214° 10' 00"	550.00 feet;
10.	85° 40' 00"	65.00 feet;
11.	171° 45' 00"	40.00 feet;
12.	190° 54' 40"	246.20 feet to the southern boundary of Parcel 3 of City and County of Honolulu's Civil Action 8279;
13.	265° 04' 30"	100.00 feet, more or less, along said City and County of Honolulu's Parcel 3 of Civil Action 8279 to the point of beginning and containing an area of 11.35 acres, more or less.

EXHIBIT "D"


PANEL A
PANEL B
MIDDLE LOCH
PARCEL 1-B (RECLAIMED LAND IN PEARL HARBOR MIDDLE LOCH) HARBOR DEFENSIVE SEA AREA 13.43 ACS.±
(P.E.O. 8143)
PARCEL 1-A 13.759 ACS.
POR. U.S. CIVIL
Por. R.P. 4475, L.C.Aw. 7713, Ap. 46 to V. Kamamalu
(Along former High Water Mark of P.H. Middle Loch)
SCALE: 1"=200'
NAVY R.R. R/W
CITY & COUNTY
"EWA CHURCH"
PARCEL 2 11.35 ACS.±
HARBOR DEFENSIVE SEA AREA
(P.E.O. 8143)
(RECLAIMED LAND IN PEARL HARBOR MIDDLE LOCH)
LAND COURT APPLICATION 601
MANANA NUI
APPROXIMATE HIGH WATER MARK
PEARL
FOR ADJOINING LANDS AND LOCATION, SEE NFEC DWG. NO. 998648.
TAX MAP KEYS:
9-6-1:1&2
9-7-13
9-7-14 ADJ. TO
9-7-16
EXHIBIT "E
PACIFIC DIVISION
NAVAL FACILITIES ENGINEERING COM
PEARL HARBOR, HAWAII
LAND SITUATE AT WAIAWA, AND MANANA - EWA, OAHU, HAWAII
BIRD HABITATS
PARCEL MAP
DWN: J.E.W. 1/21/77
REAL ESTATE DRAWI
RE-1148
CHK:


Ref. Point for Survey line:
20 feet (±)
from center of bridge
Former
OR&L R/W
Pump location
10-foot wide R/W
for 4-inch water line
(Survey line: 171° 18')
PARCEL 1A
PARCEL 1B
PO
TN
SCALE IN FEET
200 100 0 200 400 600
Waiawa Peninsula
Portion, Real Estate
Summary Map
Y&D Dwg. No. 998648
EXHIBIT "F"

NF(R)-10935

USE AGREEMENT
BETWEEN
DEPARTMENT OF THE NAVY
AND
U. S. BUREAU OF SPORT FISHERIES AND WILDLIFE
FOR LAND AT
U. S. NAVAL BASE, PEARL HARBOR
U. S. NAVAL AMMUNITION DEPOT, OAHU

THIS AGREEMENT between the Department of the Navy (hereinafter called the "Navy") and the U. S. Bureau of Sport Fisheries and Wildlife (hereinafter called the "Bureau") provides for the use by the Bureau of certain lands under the control of the Navy for the operation, preservation and maintenance of wildlife refuges for rare and endangered species on the following terms and conditions:

1. The Bureau shall have exclusive right to use the lands as shown and described on Exhibits "A" and "B," attached hereto and made a part hereof, together with the necessary rights of ingress and egress.

2. The said lands shall be used exclusively for the operation, preservation and maintenance of wildlife refuges as part of the National Wildlife Refuge System according to management plans previously approved by the Navy.

3. The improvements placed upon the lands by or on behalf of the Bureau shall remain the property of the Bureau and shall be carried on its inventory.

4. All work performed under this Agreement shall be at no expense to the Navy.

5. The Bureau shall reimburse the Navy in accordance with applicable statutes and regulations for the cost of utilities and services furnished, if any.

ORIGINAL

NAVD PR 1-00003AA, PWC PR 1-00020AD

6. No construction on the property shall be undertaken without the prior approval of the Commander, Pacific Division, Naval Facilities Engineering Command.

7. The Navy reserves the right to enter on the lands hereinabove described at any time for the purposes of inspecting the same to determine compliance by the Bureau with the terms and conditions of this Agreement.

8. This Agreement shall be effective as of 17 OCT 1972 and shall remain in effect until terminated by mutual consent of both parties or by the Navy in accordance with other provisions of this Agreement.

9. This Agreement may be terminated by the Navy at any time:

(a) during a national emergency declared by the President or Congress; and

(b) in the event that for any reason the premises cease to be used for the specified purposes.

10. If required by the Navy, the Bureau shall remove its improvements and restore the property of the Navy when the use is terminated.

DEPARTMENT OF THE NAVY

By H. A. Locke
By direction of the Commander, Naval Facilities Engineering Command, acting under the direction of the Secretary of the Navy

3 OCT 1972
Date

DEPARTMENT OF THE INTERIOR
BUREAU OF SPORT FISHERIES AND WILDLIFE

By John D. Findlay

OCT 17 1972
Date

BIRD HABITAT - PEARL CITY PENINSULA

PROPERTY BOUNDARY DESCRIPTION

Beginning at a 1/2 inch diameter iron pipe on the Southeasterly corner of this tract of land, which point is also designated as point "A", having coordinates calculated as 1,886.01 south, 358.12 west in reference to Ewa Church origin and as shown on a Department of the Navy Pearl City Peninsula Sanitary Landfill Area Development Plan, NAVFAC Drawing No. 1258992, dated March 1, 1970, thence running by azimuths measured clockwise from true south:

1.	47° 19' 00"	133.00 feet	along top of bank to point A-1
2.	50° 27' 00"	1,020.00 feet	to point B
3.	140° 00' 00"	180.00 feet	to point C
4.	150° 00' 00"	160.00 feet	to point D
5.	181° 00' 00"	380.00 feet	to point E
6.	186° 30' 00"	530.00 feet	to point F
7.	250° 30' 00"	800.00 feet	along south edge of existing dirt road to point G
8.	318° 00' 00"	480.00 feet	to point H
9.	353° 00' 00"	240.00 feet	along top of bank to a 1/2 inch pipe point P-O
10.	38° 18' 36"	147.13 feet	along top of bank to point of beginning and containing an area of 24.5 ACRES more or less.

BIRD HABITAT _ PEARL CITY PENINSULA

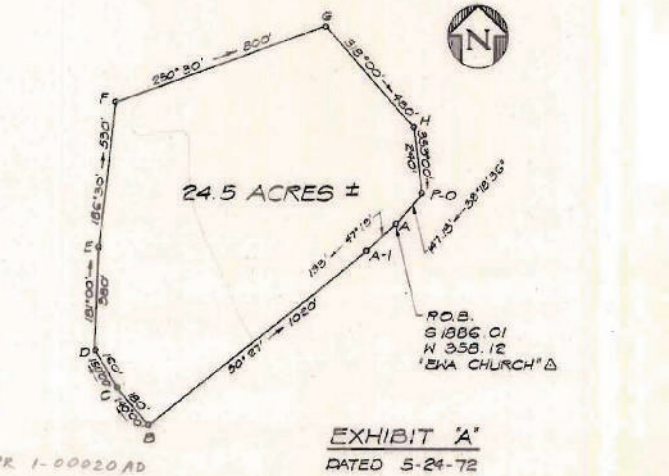


EXHIBIT 'A'

DATED 5-24-72

PWC PR 1-00020AD

BIRD HABITAT - SALT PONDS, WEST LOCH

PROPERTY BOUNDARY DESCRIPTION

Beginning at a point on the west boundary of Lot 303 as shown on the 14th Naval District Public Works Department Map Showing Navy Land Under Lease to Ewa Plantation Company, Ltd., P.W. Drawing No. OA-N1-2016, dated November 28, 1949, which point is also situated on the Southwesterly corner of Lot 51 (vacant), herein designated as Point "A", having coordinates calculated as 7,272.54 south, 17,214.92 east in reference to "Kapuai New" origin, thence running by azimuths measured clockwise from true south:

1. along the east side of O.R.&L. Right of Way on a curve to the left having a radius of 1930.00 feet, the chord azimuth and distance being:

	171° 44' 15"	858.19 feet	to point B
2.	248° 02' 00"	30.00 feet	to point C
3.	289° 08' 30"	2,089.50 feet	to point D
4.	32° 06' 00"	100.00 feet	to point E
5.	72° 34' 00"	57.70 feet	to point F
6.	342° 34' 00"	179.30 feet	to point G
7.	37° 25' 00"	572.90 feet	to point H
8.	92° 21' 00"	441.40 feet	to point I
9.	155° 52' 00"	164.70 feet	to point J
10.	120° 48' 00"	113.60 feet	to point K
11.	45° 37' 00"	194.80 feet	to point L
12.	122° 19' 00"	864.61 feet	to point of beginning and containing an area of 36.65 ACRES more or less.

BIRD HABITAT _ SALT PONDS, WEST LOCH

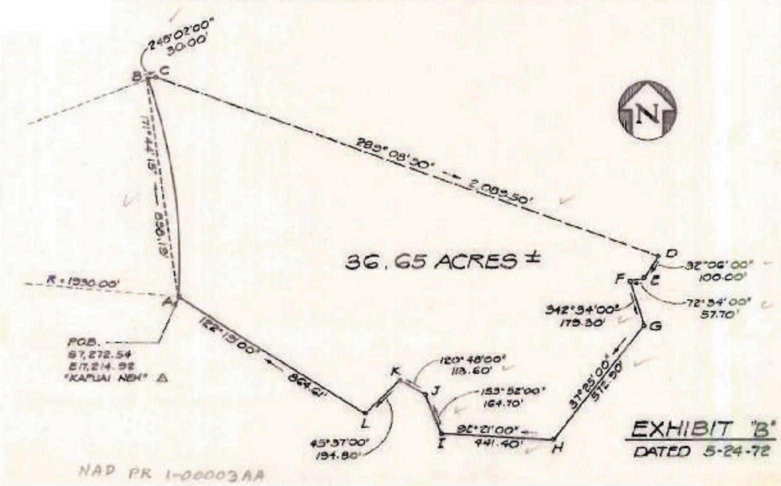
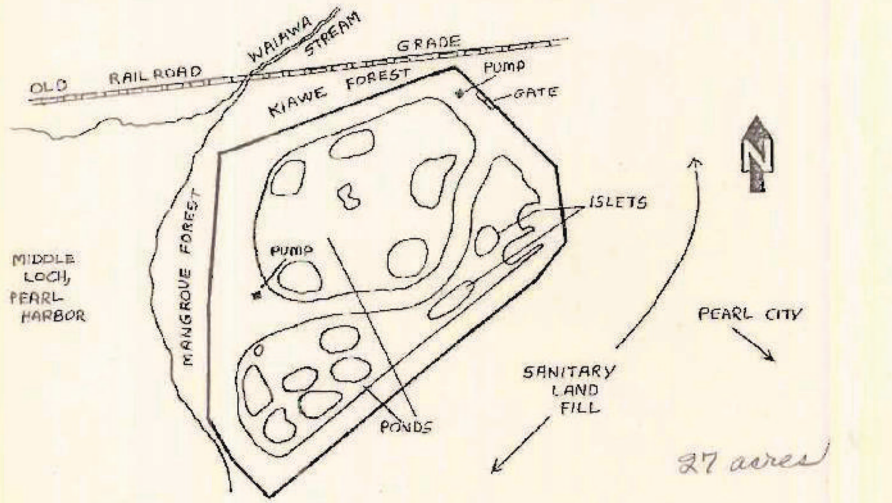


EXHIBIT "B"

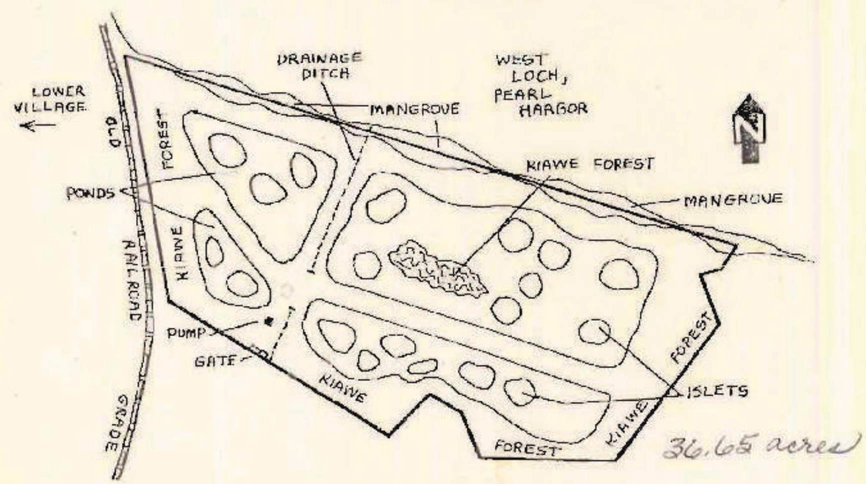
DATED 5-24-72

NAD PR 1-00003AA

WAIAWA UNIT - PEARL HARBOR NATIONAL WILDLIFE REFUGE, OAHU



HONOULIULI UNIT - PEARL HARBOR NATIONAL WILDLIFE REFUGE, OAHU



I14 – MEMORANDUM OF UNDERSTANDING BETWEEN NAVAL STATION PEARL HARBOR AND U.S. ARMY GARRISON, HAWAII NATURAL RESOURCE MANAGEMENT AT LUALUALEI NAVAL RESERVATION (CNRH 2008)

DEPARTMENT OF THE ARMY
US ARMY INSTALLATION MANAGEMENT COMMAND, PACIFIC REGION
HEADQUARTERS, UNITED STATES ARMY GARRISON, HAWAII
851 WRIGHT AVENUE, WHEELER ARMY AIRFIELD
SCHOFIELD BARRACKS, HAWAII 96857-5000

FILE COPY

REPLY TO ATTENTION OF:

IMPC-HI-ZA

05 DEC 2008

MEMORANDUM FOR Commander, Navy Region Hawaii, 850 Ticonderoga Street, Suite 110, Naval Station Pearl Harbor, HI 96860-5101

SUBJECT: Memorandum of Understanding between the Naval Station Pearl Harbor and the US Army Garrison, Hawaii for Natural Resource Management at Lualualei Naval Reservation.

1. Pursuant to the US Fish and Wildlife Service Biological Opinions for training on Army lands, the Army is required to manage a number of endangered species off Army property to minimize the threat of military training on these species. This work includes management of species on Navy owned lands at the Lualualei Naval Reservation. Management actions within Lualualei will consist of monitoring two endangered plant species on approximately two acres of land. The Army Natural Resource staff will also control invasive species in the area.

2. In concert with Mr. John Muraoka of your Regional Engineer Office, my Natural Resource staff has developed the enclosed Memorandum of Understanding (MOU) to implement the above mentioned management actions on Lualualei. I have signed the MOU and am forwarding for Naval Station Pearl Harbor Commanding Officer signature.

3. My point of contact for this action is Ms. Michelle Mansker, Directorate of Public Works, Environmental Division, 656-3090.

Encl

MATTHEW T. MARGOTTA
COL, IN
Commanding

DEPARTMENT OF THE ARMY
US ARMY INSTALLATION MANAGEMENT COMMAND, PACIFIC REGION
HEADQUARTERS, UNITED STATES ARMY GARRISON, HAWAII
851 WRIGHT AVE, BLDG 106, WHEELER ARMY AIRFIELD
SCHOFIELD BARRACKS, HI 96857-5000

REPLY TO ATTENTION OF

MEMORANDUM OF UNDERSTANDING (MOU)
BETWEEN
COMMANDER, US ARMY GARRISON, HAWAII (USAG-HI)
AND
NAVAL STATION PEARL HARBOR, HAWAII

SUBJECT: Memorandum of Understanding for the Army's Makua Implementation Plan natural resource management actions at Lualualei Naval Reservation, Oahu, Hawaii.

1. **Reference.** AR 420-10.

2. **Purpose.** The purpose of this Agreement is to enable the Army to provide for stabilization of endangered species on lands owned /managed by the Navy granting to the Army and its contractors access to Navy lands shown in exhibit 1 to perform those actions listed below in section 3. This will enable the Army to fulfill its Section 7 Endangered Species Act species stabilization requirements.

3. **Background.** The 1999 US Fish and Wildlife Service Biological Opinion for Makua Military Reservation required the Army to prepare and implement an Implementation Plan (IP) to provide natural resource management actions for 29 target taxa found at or adjacent to MMR. In order to stabilize the populations of the target taxa, management efforts need to take place on lands both within and outside of MMR due to the rarity and limited distribution of many of the species. The Navy manages and owns lands in the Nanakuli/Halona region(Lualualei Naval Reservation) of the Island of Oahu which are required for stabilization actions of the target taxa (maps with tax map keys [TMK's] at Exhibit 1).

4. **Scope.** To enable the Army to provide for stabilization of endangered species on lands owned /managed by the Navy granting to the Army and its contractors access to Navy lands shown in exhibit 1 to perform those actions listed below in section 3. This will enable the Army to fulfill its Section 7 Endangered Species Act species stabilization requirements. The USFWS has stated that the non-Army landowners are not responsible for continuing stabilization actions (e.g. removal of non-native plants) should the Army training at MMR change such that stabilization of target taxa is no longer required to be undertaken by the Army (USFWS letter at Exhibit 2).

5. **Roles and Responsibilities.**

a. The Army:

(1) is solely responsible to fund and undertake stabilization actions as outlined in the "Implementation Plan for Makua Military Reservation, Island of Oahu", dated May

2003. These actions may include but are not limited to the following: establishing and maintaining fuel breaks, conducting various forms of threat management (ungulate, small mammal, and invertebrate control; weed control; erosion control; and other types of threat control as assessed), collecting propagules of endangered plant species, and monitoring population units. The Army will provide an annual report to the Navy discussing exactly what actions were performed on Navy lands, and exactly where these actions were accomplished.

(2) will not introduce, reintroduce, or augment populations of threatened and endangered plant species on Navy land.

(3) assumes liability for damages caused directly or indirectly by stabilization actions if such damages are cognizable and payable under appropriate federal statutes and regulations.

(4) will prepare all necessary legal and environmental documents required to conduct the stabilization actions.

(5) will honor any lease or land agreements that the Navy has with any lessees of the involved Navy lands.

b. The Navy:

(1) will, within operational limitations, allow the Army and its contractors as deemed necessary by the Army to conduct stabilization actions on Navy lands as noted in this agreement.

(2) is not responsible to maintain or continue any stabilization actions initiated or implemented by the Army

6. **Effective Date.** This agreement becomes effective upon the date of the last signature and it will remain in effect until revised, superseded or terminated.

RICHARD KITCHENS	MATTHEW T. MARGOTTA
CAPTAIN, US NAVY	COL, IN
Commanding	Commanding
	5 DEC 2008
(Date)	(Date)

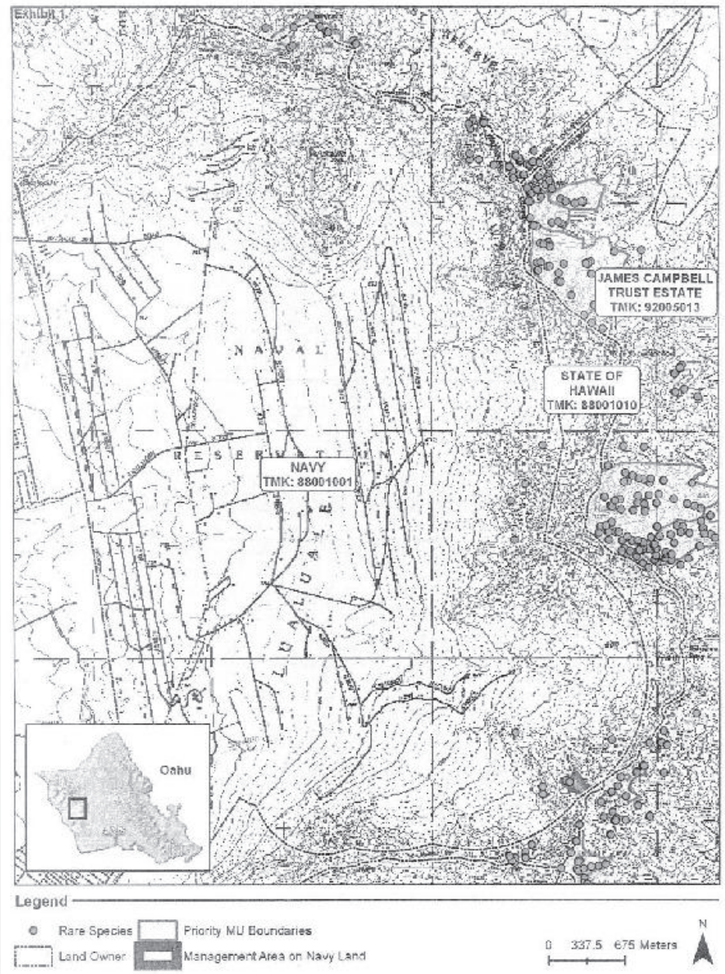


Exhibit 1

United States Department of the Interior

FISH AND WILDLIFE SERVICE
[illegible]

[illegible]

[illegible]

[illegible]
Department of the Army
Headquarters, U.S. Army Garrison, Hawaii
Schofield Barracks, Hawaii 96857-5000

[illegible]

[illegible]

[illegible] However, the Service would encourage that Army landowners to [illegible] the conservation activities initiated by the Army.

We appreciate your commitment to the protection of endangered and threatened species. If you have any questions, please contact me or Fish and Wildlife Biologist Elizabeth Sharpe at (808) 541-3441.

Sincerely,

Paul Henson
Field Supervisor
Ecological Services

116

Exhibit 2

I15 – MOWING ENDANGERED PLANTS AT NRTF LUALUALEI (2011)

MOWING ENDANGERED PLANTS AT NRTF LUALUALEI

Prior to scheduled mowings, NAVFAC HI Biologist will survey the *Marsilea villosa* and *Cyperus trachysanthos* populations, and will determine if the populations need to be mowed.

Aaron Hebshi **471-1171 x244**

If mowing is required, NAVFAC HI Biologist will notify the Environmental Coordinator:

Michelle Delaney **653-9850**

NAVFAC Environmental Coordinator will then notify RTF LLL Contract Management

Michael Lachowski **668-3066**

RTF LLL Contract Management will then notify Contractor Grounds keeping to remove barriers and mow.

When mowing is finished, RTF LLL Contract Management will replace barriers then notify NAVFAC Environmental Coordinator.

General Management actions required for *Cyperus trachysanthos*:

- Install warning signs and barriers to delineate plant habitat occurrence(s)
- Brief the maintenance personnel on the location of listed plants and prohibited activities
- Suspend mowing when there is mud in the depression where the plants have been observed
- Monitor the plants for seed fall (at least 50 percent)
- Resume mowing when the mud hole is not present and after at least 50 percent of the seeds have fallen.
- Set mower blade height to 8" to keep blade from mowing the base of the *Cyperus* plants on uneven terrain

Cyperus trachysanthos

General Management actions required for *Marsilea villosa*:

- Install warning signs and barriers to delineate plant habitat occurrence(s)
- Brief the maintenance personnel on the location of listed plants and prohibited activities.
- Set mower blade height to 3" that allows the mower to cut the invasive grasses, while leaving the *Marsilea villosa* uncut.
- Mowing shall occur during the late summer when the plants have completely dried and are dormant for the season. As well as in the spring or early summer when the plant is emergent.

Marsilea vilosa

I16 – PEARL HARBOR ESTUARY PROGRAM MEMORANDUM OF UNDERSTANDING (1993)

MEMORANDUM OF UNDERSTANDING
RELATING TO THE PEARL HARBOR ESTUARY PROGRAM

between the
SOUTH OAHU SOIL AND WATER CONSERVATION DISTRICT
WEST OAHU SOIL AND WATER CONSERVATION DISTRICT
USDI GEOLOGICAL SURVEY
USDI FISH AND WILDLIFE SERVICE
UNITED STATES DEPARTMENT OF THE NAVY
UNITED STATES DEPARTMENT OF THE AIRFORCE
UNITED STATES DEPARTMENT OF THE ARMY
US ARMY CORPS OF ENGINEERS, HONOLULU ENGINEER DISTRICT
USDA SOIL CONSERVATION SERVICE
HAWAII STATE DEPARTMENT OF HEALTH
HAWAII STATE DEPARTMENT OF LAND AND NATURAL RESOURCES
UofH COLLEGE OF TROPICAL AGRICULTURE AND HUMAN RESOURCES
UofH WATER RESOURCES RESEARCH CENTER
HAWAII STATE DOT, DIVISION OF HIGHWAYS
C&C OF HONOLULU, DEPARTMENT OF PUBLIC WORKS
C&C OF HONOLULU BOARD OF WATER SUPPLY
and the
HAWAII ASSOCIATION OF CONSERVATION DISTRICTS

I. PURPOSE

The purpose of this Memorandum of Understanding (MOU) is to define the roles and responsibilities of each of the member agencies of the Pearl Harbor Estuary Program Interagency Committee (Committee). The mission of the Committee is to develop nonpoint source pollution prevention projects, seek funding for these projects, and guide project implementation and evaluation.

II. BACKGROUND

Both the State of Hawaii's final "Nonpoint Source Pollution Management Plan" and "Hawaii's Assessment of Nonpoint Source Pollution Water Quality Problems" identify Pearl Harbor as a high priority watershed for addressing the nonpoint source pollution problems. Pearl Harbor is also identified on the Clean Water Act Section 304(1) "long list" which identifies waters impacted by both point and nonpoint source pollution, and the Clean Water Act Section 303(d) list of Water Quality-Limited Segments (WQLS). The "Report on Water Quality" (Clean Water Act Section 305(b) report) also lists Pearl Harbor as one of the State's 14 WQLS. The Assessment Report identifies nitrogen, phosphorus, fecal coliform and turbidity as the nonpoint source pollutants present in Pearl Harbor at levels which exceed State water quality standards. These pollutants are generated from the various urban, agricultural, military and conservation areas within the Pearl Harbor watershed.

The South Oahu Soil and Water Conservation District has stated that soil erosion adversely affects all residents of Oahu, directly and indirectly. Those individuals or organizations engaged in agricultural activities are directly affected as soil productivity declines due to topsoil loss. Others are indirectly affected by deterioration of aesthetic and recreational quality of Oahu's water and land resources, including the loss of vegetation, forests, and wildlife habitat.

The majority of drinking water for Honolulu comes from the underlying Pearl Harbor groundwater aquifer. There is concern that the water quality of this aquifer can be compromised by nonpoint source contaminants percolating down from the ground surface.

The goals of the Committee are: (1) to reduce the nonpoint source pollution entering Pearl Harbor from the Pearl Harbor watershed drainage area with an emphasis on reducing sediment loading at the source; and (2) to restore Pearl Harbor to a healthy biological estuarine ecosystem.

III. THE SOUTH OAHU SWCD AGREES TO:

A. Sponsor and provide leadership by sharing the chairmanship of the Committee.

B. Take the lead role in developing the Pearl Harbor Estuary Program goals and objectives, identifying land use practices that create water quality problems, developing nonpoint source pollution prevention projects, and guiding project implementation and evaluation.

C. Provide technical assistance within its capabilities in the implementation of program actions.

D. Represent the residents of the watershed in proposing and reviewing actions of the Committee.

IV. THE WEST OAHU SWCD AGREES TO:

Carry out the items A, B, C, and D under paragraph III.

V. THE USDI GEOLOGICAL SURVEY AGREES TO:

A. Appoint a member of its organization who will support the Districts in carrying out the mission of the Committee.

B. Assist the Districts in developing the Pearl Harbor Estuary Program goals and objectives, including the identification of land use practices that create water quality problems. Where appropriate, assist the Districts' development of nonpoint source pollution prevention projects, including the implementation and evaluation processes.

C. Assist in the monitoring of the waters affected by the watershed by providing and interpreting data from USGS ongoing programs and monitoring programs sponsored by the Committee.

VI. THE USDI FISH AND WILDLIFE SERVICE AGREES TO:

A. Appoint a member of its organization who will support the Districts in carrying out the mission of the Committee.

B. Assist the Districts in developing the Pearl Harbor Estuary Program goals and objectives, including the identification of land use practices that create water quality problems. Where appropriate, assist the Districts' development of nonpoint source pollution prevention projects, including the implementation and evaluation processes.

C. Assist in the evaluation of water quality by the monitoring of the fish and wildlife and their habitats in the Pearl Harbor estuary and watershed using data from its ongoing programs.

D. Seek Service funds for projects recommended by the Committee, when mutually consistent with Fish and Wildlife Service goals.

VII. THE UNITED STATES DEPARTMENT OF THE NAVY AGREES TO:

A. Appoint a member of its organization who will support the Districts in carrying out the mission of the Committee.

B. Assist the Districts in developing the Pearl Harbor Estuary Program goals and objectives, including the identification of land use practices that create water quality problems. Where appropriate, assist the Districts' development of nonpoint source pollution prevention projects, including the implementation and evaluation processes.

C. Seek Navy funds for projects recommended by the Committee, when mutually consistent with Navy goals.

D. Provide available water quality and land use data and information on its properties as may be needed by the Committee for project implementation and evaluation.

VIII. THE UNITED STATES DEPARTMENT OF THE AIR FORCE AGREES TO:

A. Appoint a member of its organization who will support the Districts in carrying out the mission of the Committee.

B. Assist the Districts in developing the Pearl Harbor Estuary Program goals and objectives, including the identification of land use practices that create water quality problems. Where appropriate, assist the Districts' development of nonpoint source pollution prevention projects, including the implementation and evaluation processes.

C. Seek Air Force funds for projects recommended by the Committee when mutually consistent with Air Force goals.

D. Provide available water quality and land use data and information on its properties as may be needed by the Committee for project implementation and evaluation.

IX. THE UNITED STATES DEPARTMENT OF THE ARMY AGREES TO:

A. Appoint a member of its organization who will support the Districts in carrying out the mission of the Committee.

B. Assist the Districts in developing the Pearl Harbor Estuary Program goals and objectives, including the identification of land use practices that create water quality problems. Where appropriate, assist the Districts' development of nonpoint source pollution prevention projects, including the implementation and evaluation processes.

C. Seek Army funds for projects recommended by the Committee when mutually consistent with Army goals.

D. Provide available water quality and land use data and information on its properties as may be needed by the Committee for project implementation and evaluation.

X. THE US ARMY CORPS OF ENGINEERS, HONOLULU DISTRICT AGREES TO:

A. Appoint a member of its organization who will support the Districts in carrying out the mission of the Committee.

B. Assist the Districts in developing the Pearl Harbor Estuary Program goals and objectives, including the identification of land use practices that create water quality problems. Where appropriate, assist the Districts' development of nonpoint source pollution prevention projects, including the implementation and evaluation processes.

C. Provide technical assistance, when available, in the design and installation of project works sponsored by the Committee.

D. Provide data and information available to the Corps of Engineers to the Committee for project implementation and evaluation.

F. Provide a meeting room, when available, for Committee meetings.

XI. THE USDA SOIL CONSERVATION SERVICE AGREES TO:

A. Appoint a member of its organization who will support the Districts in carrying out the mission of the Committee.

B. Assist the Districts in developing the Pearl Harbor Estuary Program goals and objectives, including the identification of land use practices that create water quality problems. Where appropriate, assist the Districts' development of nonpoint source pollution prevention projects, including the implementation and evaluation processes.

C. Provide technical assistance, when available, in the design and installation of project works sponsored by the Committee.

D. Provide technical assistance in planning and implementing information and education projects developed by the Committee.

E. Provide technical assistance in soil and water conservation on project measures developed by the Committee.

F. Seek Service funds for projects recommended by the Committee, when mutually consistent with SCS goals.

XII. THE HAWAII STATE DEPARTMENT OF HEALTH AGREES TO:

A. Appoint a member of its organization who will support the Districts in carrying out the mission of the Committee.

B. Assist the Districts in developing the Pearl Harbor Estuary Program goals and objectives, including the identification of land use practices that create water quality problems. Where appropriate, assist the Districts' development of nonpoint source pollution prevention projects, including the implementation and evaluation processes.

C. Seek U.S. Environmental Protection Agency funds for projects recommended by the Committee when this is consistent with Hawaii State Department of Health goals.

D. Provide data and information available from the Hawaii State Department of Health to the Committee.

XIII. THE HAWAII STATE DEPARTMENT OF LAND AND NATURAL RESOURCES AGREES TO:

A. Appoint a member of its organization who will support the Districts in carrying out the mission of the Committee.

B. Assist the Districts in developing the Pearl Harbor Estuary Program goals and objectives, including the identification of land use practices that create water quality problems. Where appropriate, assist the Districts' development of nonpoint source pollution prevention projects, including the implementation and evaluation processes.

C. Provide water quality and land use data and information available from its various divisions for use by the Committee.

XIV. THE UNIVERSITY OF HAWAII CTAHR AGREES TO:

A. Appoint a member of its organization who will support the Districts in carrying out the mission of the Committee.

B. Assist the Districts in developing the Pearl Harbor Estuary Program goals and objectives, including the identification of land use practices that create water quality problems. Where appropriate, assist the Districts' development of nonpoint source pollution prevention projects, including the implementation and evaluation processes.

C. Provide technical assistance, when available, in planning and implementing information and education projects developed by the Committee.

XV. THE UofH WATER RESOURCES RESEARCH CENTER AGREES TO:

A. Appoint a member of its organization who will support the Districts in carrying out the mission of the Committee.

B. Assist the Districts in developing the Pearl Harbor Estuary Program goals and objectives, including the identification of land use practices that create water quality problems. Where appropriate, assist the Districts' development of nonpoint source pollution prevention projects, including the implementation and evaluation processes.

C. Provide technical assistance, when available, in the design and installation of project measures, including monitoring of the waters in the watershed.

XVI. THE HAWAII DOT, DIVISION OF HIGHWAYS AGREES TO:

A. Appoint a member of its organization who will support the Districts in carrying out the mission of the Committee.

B. Assist the Districts in developing the Pearl Harbor Estuary Program goals and objectives, including the identification of land use practices that create water quality problems. Where appropriate, assist the Districts' development of nonpoint source pollution prevention projects, including the implementation and evaluation processes.

C. Provide available water quality and land use data and information on its properties as may be needed by the Committee for project implementation and evaluation.

D. Assist the Committee in the installation of project measures, including monitoring devices, on its properties.

XVII. THE C&C OF HONOLULU PUBLIC WORKS DEPARTMENT AGREES TO:

A. Appoint a member of its organization who will support the Districts in carrying out the mission of the Committee.

B. Assist the Districts in developing the Pearl Harbor Estuary Program goals and objectives, including the identification of land use practices that create water quality problems. Where appropriate, assist the Districts' development of nonpoint source pollution prevention projects, including the implementation and evaluation processes.

C. Provide available water quality and land use data and information on its properties as may be needed by the Committee for project implementation and evaluation.

D. Assist the Committee in the installation of project measures within the jurisdiction of the C&C of Honolulu.

XVIII. THE C&C OF HONOLULU BOARD OF WATER SUPPLY AGREES TO:

A. Appoint a member of its organization who will support the Districts in carrying out the mission of the Committee.

B. Assist the Districts in developing the Pearl Harbor Estuary Program goals and objectives, including the identification of land use practices that create water quality problems. Where appropriate, assist the Districts' development of nonpoint source pollution prevention projects, including the implementation and evaluation processes.

C. Provide available water supply data on its system as may be needed by the Committee for project implementation and evaluation.

XIX. THE HAWAII ASSOCIATION OF CONSERVATION DISTRICTS AGREES TO:

A. Appoint a member of its organization who will support the Districts in carrying out the mission of the Committee.

B. Assist the Districts in developing the Pearl Harbor Estuary Program goals and objectives, including the identification of land use practices that create water quality problems. Where appropriate, assist the Districts' development of nonpoint source pollution prevention projects, including the implementation and evaluation processes.

C. Assist in the evaluation of the effectiveness of the project after the program is completed.

XIII. OTHER PROVISIONS

This MOU does not alter the statutory authorities and responsibilities of any of the signing agencies or groups. Its intent is to form a basis by which the aforementioned goals and objectives can be carried out by the agencies and groups in a cooperative manner.

This is not a fund-obligating document. The Committee will seek any needed funds through grant programs such as those administered by the Environmental Protection Agency. Agency participants may contribute funds through their respective programs or contribute in-kind services.

This MOU complies with the nondiscrimination provisions of Title VI of the Civil Rights Act of 1964 and other nondiscrimination statutes, namely Section 504, Title IX, and the Age Discrimination Act of 1975, and other nondiscrimination policies.

This MOU can be modified or terminated at any time by mutual consent of the agencies thereto or participation can be terminated by any agency alone by giving 60 days' notice in writing to the others.

SOUTH OAHU SOIL AND WATER CONSERVATION DISTRICT

BY: James L. [signature]

TITLE: AGRONOMIST, DIRECTOR SWCD SOUTH OAHU

DATE: 02 DEC 92

WEST OAHU SOIL AND WATER CONSERVATION DISTRICT

BY: Peter W. Gibson

TITLE: DIRECTOR WEST OAHU SWCD

DATE: 12/1/92

USDI GEOLOGICAL SURVEY

BY: William Meyer

TITLE: District Chief

DATE: 1/21/93

USDI FISH AND WILDLIFE SERVICE

BY: Robert P. Smith

TITLE: Field Supervisor, Pacific Islands Office

DATE: April 29, 1993

UNITED STATES DEPARTMENT OF THE NAVY

BY: William A. Retz
W. A. RETZ, RADM, U. S. NAVY

TITLE: Commander, Naval Base, Pearl Harbor

DATE: 02 February 1993

UNITED STATES DEPARTMENT OF THE AIR FORCE

BY: _______________

TITLE: Commander

DATE: 27 Jan 93

UNITED STATES DEPARTMENT OF THE ARMY

JOHNNIE H. CORNS
Lieutenant General, USA
Commanding General, U.S. Army, Pacific

DATE: 31 January 1993

U.S. ARMY CORPS OF ENGINEERS, HONOLULU ENGINEER DISTRICT

BY: [signature]

TITLE: DISTRICT ENGINEER

DATE: 17 FEB 93

USDA SOIL CONSERVATION SERVICE

BY: Warren M Lee

TITLE: State Conservationist

DATE: 1/8/93

HAWAII STATE DEPARTMENT OF HEALTH

BY: ____________________

TITLE: Deputy Director

DATE: February 17, 1993

HAWAII STATE DEPARTMENT OF LAND AND NATURAL RESOURCES

BY: John P. Keppeler

TITLE: Acting Chairperson

DATE: February 3, 1993

UofH COLLEGE OF TROPICAL AGRICULTURE AND HUMAN RESOURCES

BY: N. P. Kefford

TITLE: Dean

DATE: January 11, 1993.

UofH WATER RESOURCES RESEARCH CENTER

BY: Roger S. Fujioka

TITLE: DIRECTOR

DATE: MAY 11, 1993

HAWAII DEPARTMENT OF TRANSPORTATION, HIGHWAYS DIVISION

BY: R. Harano

TITLE: Chief, H'Ways Div.

DATE: 1/22/93

C&C OF HONOLULU, PUBLIC WORKS DEPARTMENT

BY: C. Michael Street

TITLE: Director and Chief Engineer

DATE: 12/15/92

ATTEST: Alex Ho

ALEX HO
Environmental Engineer

DATE: 12/4/92

Approved as to Form
and Legality

Deputy Corporation Counsel

C&C OF HONOLULU, BOARD OF WATER SUPPLY

BY: Kazu Hayashida
KAZU HAYASHIDA

TITLE: Manager and Chief Engineer

DATE: 1/5/93

HAWAII ASSOCIATION OF CONSERVATION DISTRICTS

BY: Marcus D. Parker

TITLE: President

DATE: Jan 15, 1993

I17 – MEMORANDUM OF UNDERSTANDING BETWEEN COMMANDER, U.S. ARMY GARRISON, HAWAII AND JOINT BASE PEARL HARBOR HICKAM – SUBJECT: MEMORANDUM OF UNDERSTANDING FOR THE ARMY'S MAKUA IMPLEMENTATION PLAN NATURAL RESOURCES MANAGEMENT AT LUALUALEI NAVAL RESERVATION, O'AHU, HAWAI'I

DEPARTMENT OF THE ARMY
US ARMY INSTALLATION MANAGEMENT COMMAND, PACIFIC REGION
HEADQUARTERS, UNITED STATES ARMY GARRISON, HAWAII
851 WRIGHT AVE, BLDG 106, WHEELER ARMY AIRFIELD
SCHOFIELD BARRACKS, HI 96857-5000

REPLY TO
ATTENTION OF

MEMORANDUM OF UNDERSTANDING (MOU) BETWEEN COMMANDER, US ARMY GARRISON, HAWAII (USAG-HI) AND JOINT BASE PEARL HARBOR HICKAM

SUBJECT: Memorandum of Understanding for the Army's Makua Implementation Plan natural resource management actions at Lualualei Naval Reservation, Oahu, Hawaii.

1. **Reference.** AR 420-10.

2. **Purpose.** The purpose of this Agreement is to enable the Army to provide for stabilization of endangered species on lands owned /managed by the Navy granting to the Army and its contractors access to Navy lands shown in exhibit 1 to perform those actions listed below in section 3. This will enable the Army to fulfill its Section 7 Endangered Species Act species stabilization requirements.

3. **Background.** The 1999 US Fish and Wildlife Service Biological Opinion for Makua Military Reservation required the Army to prepare and implement an Implementation Plan (IP) to provide natural resource management actions for 29 (target taxa) found at or adjacent to MMR. In order to stabilize the populations of the target taxa, management efforts need to take place on lands both within and outside of MMR due to the rarity and limited distribution of many of the species. The Navy manages and owns lands in the Nanakuli/Halona region(Lualualei Naval Reservation) of the Island of Oahu which are required for stabilization actions of the target taxa (maps with tax map keys [TMK's] at Exhibit 1).

4. **Scope.** To enable the Army to provide for stabilization of endangered species on lands owned /managed by the Navy granting to the Army and its contractors access to Navy lands shown in exhibit 1 to perform those actions listed below in section 3. This will enable the Army to fulfill its Section 7 Endangered Species Act species stabilization requirements. The USFWS has stated that the non-Army landowners are not responsible for continuing stabilization actions (e.g. removal of non-native plants) should the Army training at MMR change such that stabilization of target taxa is no longer required to be undertaken by the Army (USFWS letter at Exhibit 2).

5. **Roles and Responsibilities.**

a. The Army:

(1) is solely responsible to fund and undertake stabilization actions as outlined in the "Implementation Plan for Makua Military Reservation, Island of Oahu", dated May

2003. These actions may include but are not limited to the following: establishing and maintaining fuel breaks, conducting various forms of threat management (ungulate, small mammal, and invertebrate control; weed control; erosion control; and other types of threat control as assessed), collecting propagules of endangered plant species, and monitoring population units. The Army will provide an annual report to the Navy discussing exactly what actions were performed on Navy lands, and exactly where these actions were accomplished.

(2) will not introduce, reintroduce, or augment populations of threatened and endangered plant species on Navy land.

(3) assumes liability for damages caused directly or indirectly by stabilization actions if such damages are cognizable and payable under appropriate federal statutes and regulations.

(4) will prepare all necessary legal and environmental documents required to conduct the stabilization actions.

(5) will honor any lease or land agreements that the Navy has with any lessees of the involved Navy lands.

b. The Navy:

(1) will, within operational limitations, allow the Army and its contractors as deemed necessary by the Army to conduct stabilization actions on Navy lands as noted in this agreement.

(2) is not responsible to maintain or continue any stabilization actions initiated or implemented by the Army

6. Effective Date. This agreement becomes effective upon the date of the last signature and it will remain in effect until revised, superseded or terminated.

DOUGLAS S. MULBURY
COL, IN
Commanding

9 JUN 11
(Date)

JEFFREY W. JAMES
CAPTAIN, US NAVY
Commanding

8/5/11
(Date)

SUBJECT: Memorandum of Understanding for the Army's Makua Implementation Plan natural resource management actions at Lualualei Naval Reservation, Oahu, Hawaii.

Willette Baldomero

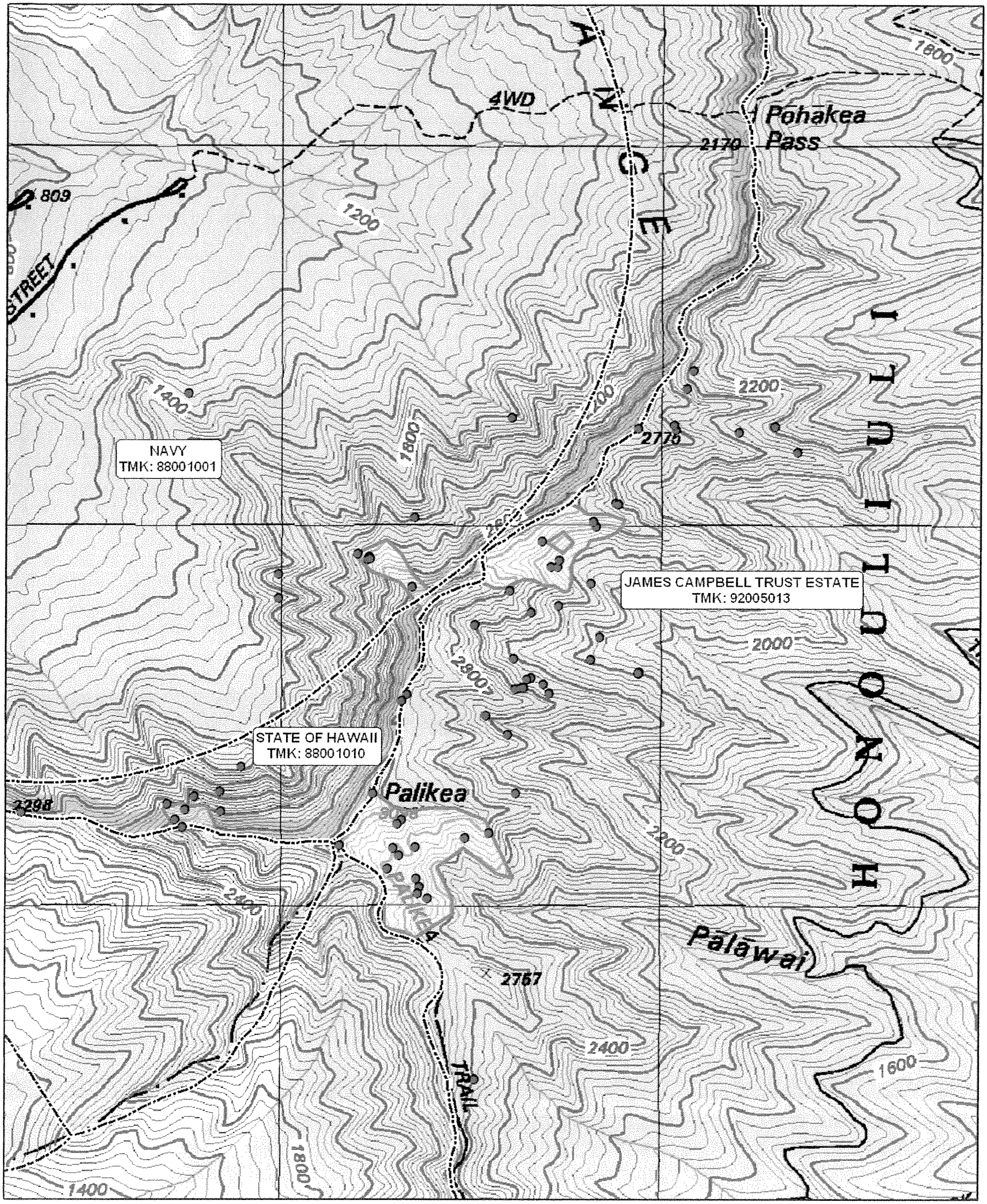
for LYLE TOM
COMPTROLLER
Commander, Navy Region Hawaii

8/11/2011
(Date)

William E. Grandrath

WILLIAM E. GRANDRATH
EXECUTIVE DIRECTOR
Commander, Navy Region Hawaii

12 AUG 2011
(Date)



Legend

Rare Species Priority MU Boundaries Land Owner

0 150 300 Meters

N

EXHIBIT 1

United States Department of the Interior

FISH AND WILDLIFE SERVICE
Pacific Islands Ecoregion
300 Ala Moana Boulevard, Room 3-122
Box 50088
Honolulu, Hawaii 96850

JUL 18 2000

In Reply Refer to: EAS

William R. Puttmann, Jr
Colonel, U.S. Army
Department of the Army
Headquarters, U.S. Army Garrison, Hawaii
Schofield Barracks, Hawaii 96857-5000

Re: Responsibility for Maintaining Conservation Actions

Dear Colonel Puttmann

The U.S. Fish and Wildlife Service (Service) has received your letter requesting confirmation of Army and non-Army landowner responsibilities for maintaining stabilization actions for federally protected species should Army training change such that those actions are not required for certain species. As I indicated during a meeting with your environmental staff on April 20, 2000, the Army and non-Army landowners would not be responsible for maintaining stabilization actions (e.g., construction of ungulate fences, rat-proof barriers for tree snails, and removal of non-native plants), as described in your project description, should Army training change such that those actions are not required. However, the Service would encourage non-Army landowners to continue the conservation actions initiated by the Army

We appreciate your commitment to the protection of endangered and threatened species. If you have any questions, please contact me or Fish and Wildlife Biologist Elizabeth Sharpe at (808) 541-3441

Sincerely,

Paul Henson

Paul Henson
Field Supervisor
Ecological Services

EXHIBIT 2

This page is intentionally left blank.

APPENDIX J
COMMENTS/RESPONSE TO COMMENTS ON INRMP UPDATE

J1 – USFWS COMMENTS ON AGENCY REVIEW DRAFT OF NAVSTA PH INRMP

Reviewer	Section/Page	Line	Comment	Action
USFWS-PL.1	General		Your planning effort in consolidating the INRMPs (CINRMP) on Navy lands in Oahu is a much appreciated, thoughtful approach to conserving Federal trust resources. We offer general and specific recommendations regarding implementation of the actions in the INRMP that could enhance biological responses to the conservation actions. We look forward to reviewing the final plan.	Comment noted.
USFWS-PL.2	General		The draft CINRMP is a programmatic document intended to identify management objectives for natural resources on several Oahu Navy installations over a five-year planning horizon. While INRMPS should be revised every five years, it is understood that funding deficits and policy concerns regarding consolidation of the formerly individual Oahu Navy INRMPs into a single document delayed this revision for approximately 2.5 years. We support this consolidation as it should simplify and enhance the efficiency of project implementation and facilitate progress reports on actions to manage and conserve natural resources on Navy land and facilities on Oahu.	Comment noted.
USFWS-PL.3	General		It is reasonable to expect that tangible results in resource conservation have occurred over this planning timeframe. Therefore, equally as important as the 5-year revision of the final CINRMP, is the opportunity for us to review any interim monitoring reports or documentation of observations and results of conservation actions, so that if adaptive management is needed to reach conservation goals, we would be able to provide the Navy with the appropriate technical assistance. We recommend a FWS staff biologist meet with your staff biologists and tour sites where Navy INRMP conservation actions have been accomplished. This coordination will help identify opportunities for us to assist you with implementation of conservation actions and provide technical assistance that could help strengthen effectiveness of the plan.	Recommendation has been forwarded to NAVFAC HI.

Reviewer	Section/Page	Line	Comment	Action
USFWS-PL.4	General – Endangered Species		The draft CINRMP lists actions taken and actions to be taken in the future. However, there is no provision of a schedule for implementation of future actions, details on planned project monitoring activities, schedule for reporting monitoring results or project progress, or review of evidence of positive or negative results of management actions and how these actions may be adapted to improve future management. We recommend that the plan be modified to include this information.	Table 7-13 provides the INRMP ten-year fiscal plan with funding (when known). In addition, NAVFAC PAC utilizes a metrics builder tool to conduct annual INRMP reviews, generates a conservation program metric, provides an assessment of the health of the conservation program, keeps the INRMP current, cultivates the relationship with the SOH and USFWS, and assesses the influence of the conservation programs on the installation mission. The focus areas of the metrics builder include an assessment of the INRMP implementation, assessment of partnerships/cooperation and their effectiveness, assessment of team adequacy, assessment of the INRMP impact on the installation mission, assessment of the status of federally-listed species and critical habitat, assessment of ecosystem integrity, and fish and wildlife management and public use.
USFWS-PL.5	General – Endangered Species		USFWS-PL	General – Endangered Species

U.S. Fish and Wildlife Service (USFWS) comments on the Agency Review Draft for NAVSTA PH INRMP

Reviewer	Section/Page	Line	Comment	Action
USFWS-PL.6	General – Endangered Species		The Service designated critical habitat for one endangered bird species in 2001, the Oahu elepaio (*Chasiempis sandwichensis*), and for 99 endangered plant species in 2003. Some of these listed species occur on Navy land in Lualualei Valley, Oahu. Currently, the Service is preparing a draft proposal to list 20 additional plant species and 3 Hawaiian damselflies as endangered and to designate critical habitat for these species. These proposed critical habitat areas that occur in Lualualei provide occupied and unoccupied habitat for multiple plant species (*Cyanea calycina, Korthalsella degeneri, Melicope christophersenii, M. makahae, Platydesma cornuta var. decurrens,* and *Pteralyxia macrocarpa*) and the blackline and crimson Hawaiian damselflies (Megalagrion nigrohamatum nigrolineatum and *Megalagrion leptodemas*, respectively). These proposed critical habitat units entirely overlap areas previously designated as critical habitat in 2001 and 2003.	Comment noted. Section 4.3.1 Threatened and Endangered Species and Species of Concern provides a discussion of these animal and plant species and critical habitat.
USFWS-PL.7	General – Endangered Species		The draft CINRMP describes conservation actions proposed for implementation within this entire area (i.e., within the combined existing and proposed critical habitat areas) but descriptions of specific actions to better manage and control feral goat populations are absent. Feral goats were identified as the greatest threat to the rare plants found in the upper elevations of Lualualei (Hawaii Natural Heritage Program 2004). Only 1 acre (ac) [0.4 hectare (ha)] of the Halona Valley Special Management Area (SMA), and 0.5 ac (0.2 ha) of the Puu Hapapa SMA are fenced and subjected to some weed control actions. No fencing or other management actions are ascribed to the Puu Kailio SMA and Puu Kaua SMA. While the fencing and weed control efforts in the Halona Valley and Puu Hapapa SMAs are commendable, these 1.5 ac (0.6 ha) are inadequate for maintenance of viable populations of the 12 endangered species found in these areas. We recommend increased management of feral goats and nonnative plants in these SMAs and are available to work with you regarding development and enhancement of conservation planning efforts for endangered species at these sites.	As indicated in Section 4.3.4.2 Mammal Species/1. NAVMAG Lualualei, there were several goat populations within the installation, primarily on open ridges; however, they were significantly reduced in 2001 by the USDA-WS. Section 7.3.5 Vegetation, Table 7-5, and Table 7-11/ Section E Vegetation, item #6 identifies the Navy's plans to control alien plants.

U.S. Fish and Wildlife Service (USFWS) comments on the Agency Review Draft for NAVSTA PH INRMP

Reviewer	Section/Page	Line	Comment	Action
USFWS-PL.8	General –Migratory Birds and Hawaiian Waterbirds		Extensive bird surveys were completed around Pearl Harbor in 1998 and 1999 (Bruner 2000) for the purpose of examining habitats suitable for foraging waterbirds and shorebirds. It is not clear in the plan if other sites containing streams, wetlands, or shorelines were surveyed, nor does the plan contain conservation actions that propose to restore habitat for migratory birds. We recommend a more comprehensive survey of the sites on all Oahu Navy land for migratory bird habitat suitability or species presence. The Service could provide technical assistance to survey, identify conservation actions, evaluate restoration potential, and develop restoration plans for migratory birds.	The following text was added to Table 7-2: Threatened and Endangered Species, Critical Habitat, and Species of Concern Recommendations, item #4 (Update/initiate flora and fauna mapping): "Bird surveys will include discussion and recommendations for habitat restoration opportunities."

U.S. Fish and Wildlife Service (USFWS) comments on the Agency Review Draft for NAVSTA PH INRMP

Reviewer	Section/Page	Line	Comment	Action
USFWS-PL.9	General –Migratory Birds and Hawaiian Waterbirds		We also recommend a review of the January 10, 2001, Executive Order 13186 on "Responsibilities of Federal Agencies to Protect Migratory Birds" (EO) directing executive departments and agencies to take certain actions to further implement Federal agency obligations to conserve species protected by the Migratory Bird Treaty Act (MBTA). The Service has developed a Memorandum of Understanding (MOU) with the Department of Defense (DoD), signed on July 31, 2006, to insure compliance with the EO, More information on the EO can be found at http://www.fws.gov/policy/720fw2.html, and more information on the MOU can be found at http://www.fws.gov/migratorybirds/EO/DoDMOUfinalSignature.pdf. Specifically, the EO directs agencies to ensure: A) "...environmental analysis of Federal actions required by the NEPA, or other established environmental review process, evaluate the effects of actions and agency plans on migratory birds, with emphasis on species of concern. Species of concern (as defined in the EO) refers to those species listed in a) the periodic report Birds of Conservation Concern, published by the USFWS Division of Migratory Bird Management and (b) priority migratory bird species as documented by established plans (such as Bird Conservation Regions in the North American Bird Conservation Initiative or Partners In Flight physiographic areas), and (c) those species listed in 50 C.F.R. 17.11 (ESA listed species)." B) "...in conjunction with the adoption, amendment, or revision of agency management plans and guidance, ensure [that] agency plans and actions promote programs and recommendations of comprehensive migratory bird planning efforts such as Partners In Flight, U.S. National Shorebird Plan, North American Waterfowl Management Plan, North American Colonial Waterbird Plan, and other planning efforts, as well as guidance from other sources including the Food and Agricultural Organization's International Plan of Action for Reducing Incidental Catch of Seabirds in Longline Fisheries."	Appendix F1, Legal Requirements, Table 5: Summary of Applicable Protected Species and Habitat Laws, Regulations, and Requirements, pages 10 and 11 summarize Migratory Bird Treaty Act of 1918 (MBTA), 16 U.S.C. 703-712 (PL 65-186) including Executive Order 13186 and the MOU with DOD. The NAVSTA PH INRMP was prepared in recognition of the MBTA and applicable EO, MOU, and guidance.
USFWS-PL.10	General –Migratory Birds and Hawaiian Waterbirds		We recommend that we work together during the implementation phase of the final CINRMP to incorporate migratory bird conservation actions recommended in these plans on Oahu Navy land.	Comment noted.

U.S. Fish and Wildlife Service (USFWS) comments on the Agency Review Draft for NAVSTA PH INRMP

Reviewer	Section/Page	Line	Comment	Action
USFWS-PL.11	Introduction, p. ES-6, Protected Species, Protected Animals,	lines 13-17.	The Hawaiian Common Moorhen (*Gallinula chloropus sandvicensis*) is a subspecies of the Common moorhen, the Hawaiian stilt (*Himantopus mexicanus knudseni*) is a subspecies of the Black-necked stilt, and the Hawaiian Short-eared owl (*Asio flammeus sandwichensis*) is a subspecies of the short-eared owl. It is important to accurately document the species observed or their habitats, even if unoccupied, to clarify that you are discussing conservation of native or resident populations. We recommend a careful review of the document for consistency when referring to species names, as many variations of use occur, as well as noting their appropriate protected status (e.g. federally listed as threatened or endangered or State listed). It is important to differentiate upon the first reference to species to acknowledge that the plan also addresses State Conservation goals, as species protected status may vary between islands. While many species might be both federally and State protected, they are not necessarily "listed" under the ESA. We recommend a thorough reconciliation of species names and protected status. Bird species should be cited as described in accordance with American Ornithologists' Union. 1998. Check-list of North American Birds, 7th ed. American Ornithologists' Union, Washington, D.C. This resource can also be found at the following link: www.AOU.org/checklist/index.php3	The text was checked against the bird surveys to ensure that the correct species and regulatory status is cited. Revisions were made accordingly.
USFWS-PL.12	Introduction, p. ES-7	line 3, Protected Plants	This section refers to "federally-listed, candidate, and species of concern." The only time a species is considered "listed" is when it is listed as endangered or threatened under the ESA. We recommend you refer to those species that are not federally listed endangered or threatened, as candidates or species of concern as applicable.	The text was revised per comment and throughout the document.
USFWS-PL.13	Introduction, p. ES-7	line 22, Protected Plants	The listed endangered Chamaesyce at Kalaeloa is *Chamaesyce skottsbergii var. kalaeloana* (not var. skottsbergii). Please revise the species name throughout the document.	The text was revised per comment and throughout the document.

Reviewer	Section/Page	Line	Comment	Action
USFWS-PL.14	Section 3.3.1.1, p. 3-71	line 27	The Hawaiian duck (*Anas Wyvilliana*) description states that it has been replaced by hybrid Hawaiian duck-mallard and no longer exists in Pearl Harbor. It is true as documented by State waterbird bi-annual survey efforts that the hybridized duck numbers do dominate the Island of Oahu. However, as recently as 2005, a Hawaiian duck has been documented on Oahu, through genetic testing, as result of an airstrike incident with a commercial airliner at Honolulu International airport. Hawaiian ducks are present on Oahu and it is inappropriate to conclude that they do not exist at this time. We recommend revising this sentence to make a more accurate statement.	The last two sentences of the paragraph have been revised as follows: "Biologists believe that the Hawaiian duck has largely been replaced with a hybrid between the Hawaiian duck and mallard. State waterbird bi-annual survey efforts indicate that the hybridized duck numbers do dominate the Island of O'ahu. However, as recently as 2005, a Hawaiian duck has been documented on O'ahu, through genetic testing, as result of an airstrike incident with a commercial airliner at Honolulu International airport. Hawaiian ducks are present on O'ahu (USFWS 2009)."
USFWS-PL.15	Table 3-9, p.3-94,	Photo 3-44	Information about the White-faced Ibis (*Plegadis Chihi*) is merged with information on the Cattle egret (*Bulbulcus ibis*). We recommend reviewing the table for similar corrections.	The first sentence of the last row, page 3-94, third column was revised to reflect "cattle egret" vice "white-faced ibis." The table was reviewed and revisions were made (minor spelling corrections) as appropriate.
USFWS-PL.16	Section 4.4.1.2, p. 4-44. Plant and Animal Survey Updates		Surveys included in the Appendices appear to be up to date and thorough. We recommend the final IRMP implementation section to discuss the survey results and management decisions made as a result of these surveys.	Section 4.4.1.2 was revised to reflect the survey results and recommendations for botanical resources. A new section was created (Section 4.4.1.3) to reflect the results and recommendations from the animals surveys.

Reviewer	Section/Page	Line	Comment	Action
USFWS-PL.17	Section 4.4.1.3 p. 4-44. Conservation Mapping		The Navy is to be commended for expanding its existing conservation mapping at Lualualei for the purpose of expanding its database on potential listed species at the sub-installation. We recommend the final INRMP include discussion of survey results, illustrative figures, and management decisions made as a result of additional information obtained about the species.	The following text was added to Section 4.4.1.4 (formerly Section 4.4.1.3): "Sections 4.4.1.2-4.4.1.3 and Section 4.4.1.5 present a summary of the results of the conservation mapping surveys and any management recommendations. Critical habitat for the Oahu elepaio and plant species are illustrated in Figure 4-2. Figure 4-5 illustrates the locations of protected animal species and Figures 4-6 through 4-7 illustrate the locations of plant species mapped as part of these surveys. Figures 4-8 and 4-9 illustrate the locations of broad vegetation types determined from botanical surveys of NAVMAG PH Lualualei Branch and NRTF Lualualei, respectively."
USFWS-PL.18	Section 4.4.1.4, p.4-44. Oahu 'Elepaio (*Chasiempis sandwichensis ibidis*) Survey		The Navy completed surveys for this ESA listed bird, including its range and population for the purpose of proactively managing the species. We recommend providing discussion of survey results and management decisions or recovery goals explored or established.	Section 4.4.1.5 (formerly Section 4.4.14) was revised to reflect the survey results and recommendations from the elepaio survey.
USFWS-PL.19	Section 4.4.1.5, p. 4-44 line 14, Predator Control at Niuli'i Ponds		We commend the Navy for continuing to fund U.S. Department of Agriculture - Wildlife Services to provide predator control at this site. We recommend providing information about the level of activity over the 8-year period (2001-2009) for predator control at this site and future commitment levels (2009-2013).	The following text was added to the end of Section 4.4.1.5: "The work involves a trapping operation within the confines of the ponds' enclosure (Appendix D3 [Figure 23]). The traps are checked every 48 hours and all animals caught are recorded (Appendix D3 [Table 1]). Table 1 of Appendix D3 covers the period of 2004-2005. Other data were not available."

Reviewer	Section/Page	Line	Comment	Action
USFWS-PL.20	Section 4.4.2.2 p. 4-45 line 4, Comply with the Cooperative Agreement		The CDINRMP references complying with a cooperative agreement between the Service and the Navy for the maintenance of wetland habitat at Niuli'i Ponds Wildlife Refuge. We recommend providing more detail on the management activities conducted at this site and how endangered waterbird species have benefited related to the referenced cooperative agreement.	Section 4.4.2.2 was revised to reflect the management actions in place at Niulii Ponds. Section 4.4.1.3 provides a description of the waterbirds that use the ponds and the changes in their numbers over the survey period which are apparently related to the water levels in the pond.
USFWS-PL.21	Section 4.4.8 p.4-46 line 27, Wildland Fire		Wildland fire is an acknowledged threat to Navy lands at Lualualei, but there are no wildland fire plans except for maintenance of developed areas. Lualualei and other Navy lands covered by the CDINRMP may be located in dry leeward areas of Oahu where wildland fires could be interdependent with the activities and land uses that may affect federally listed species and critical habitat. We recommend you coordinate with interagency members of the Oahu Wildland Fire Council to ensure fuelbreaks, water sources, fire prevention measures, and fire suppression staffing are adequate to ensure the activities on these lands minimize potential for wildland fire impacts to listed species. This coordination should be included in the implementation table.	Section 4.4.8 was revised to reflect that the Federal Fire Department at Lualualei currently coordinates with the Oahu Wildland Fire Council to ensure that fuel breaks, water sources, fire prevention measures, and fire suppression staffing are adequate are adequate to ensure the activities at the Lualualei INRMP study area minimize potential for wildland fire impacts to listed species. Section 7.3.8, Table 7-8 Wildland Fire Recommendations (item 1) was revised to reflect this continued effort.

Reviewer	Section/Page	Line	Comment	Action
USFWS-PL.22	Appendix, Section G-1, Table 1, pp. 1-25. Implementation Status of 2001 INRMP Recommendations	21.	Brief descriptions of management actions and implementation of the CDINRMP proposed actions are included. However, it is not clear how successful implementation has been to date. We recommend adding a column in the implementation table to provide a brief discussion of the implementation of past projects, with references to more detailed documentation of monitoring reports, successes and lessons learned, and how prior implementation contributes to guiding future goals and objectives for natural resource management. We also recommend adding a column to comment on the status of threatened and endangered species on Navy lands and how their baseline numbers have responded to Navy adaptive management strategies since implementing the 2001 INRMP.	Table 1 of Appendix G1 provides the known implementation status as provided by the former CNRH Natural Resources Manager. NAVFAC PAC utilizes a metrics builder tool to conduct annual INRMP reviews, generates a conservation program metric, provides an assessment of the health of the conservation program, keeps the INRMP current, cultivates the relationship with the SOH and USFWS, and assesses the influence of the conservation programs on the installation mission. The focus areas of the metrics builder include an assessment of the INRMP implementation, assessment of partnerships/cooperation and their effectiveness, assessment of team adequacy, assessment of the INRMP impact on the installation mission, assessment of the status of federally-listed species and critical habitat, assessment of ecosystem integrity, and fish and wildlife management and public use.

J2 – USDA-WS COMMENTS ON AGENCY REVIEW DRAFT OF NAVSTA PH INRMP

U.S. Department of Agriculture – Wildlife Service (USDA-WS) comments on the Agency Review Draft for NAVSTA PH INRMP

Reviewer	Section/Page	Line	Comment	Action
USDA-WS.1	General		USDA Wildlife Services is proud to provide federal leadership in managing wildlife damages at facilities in Hawaii under the jurisdiction of the Department of the Navy in the form of operational and technical assistance. We have reviewed the Draft Copy of the Naval Station Pearl Harbor Hawaii INRMP and have no further comments to offer. Thank you for the opportunity to review this important natural resource management document.	Comment noted.

J3 – SOH DLNR DAR COMMENTS ON AGENCY REVIEW DRAFT OF NAVSTA PH INRMP

Reviewer	Section/Page	Line	Comment	Action
SOH DLNR DAR – DP.1	General		The Department of Land and Natural Resources, Division of Aquatic Resources (DAR) has reviewed the Agency Review Draft, Integrated Natural Resource Management Plan Update for Naval Station Pearl Harbor and appreciates the Navy's proactive approach in protecting the aquatic resources of Hawaii.	Comment noted.
SOH DLNR DAR – DP.2			A major pathway for Aquatic Invasive Species (AIS) introductions is inactive vessels, barges or platforms coming into Hawaii. In general these vessels are not subject to the same AIS protocols as active Navy vessels. These vessels are classified as high risk because they sit for long periods, sometimes decades, with little or no maintenance, allowing huge biofouling communities to establish themselves. If these ships are allowed to come to Hawaii without addressing AIS pathways, the negative impacts to Hawaii's aquatic environment could be tremendous. A number of studies have shown that these pathways are responsible for a large number of AIS introductions into Hawaii's waters. DAR has been working successfully with the Navy Inactive Ship Program for a number of years. They have been providing a list of incoming vessels with ample lead time to address any risk that incoming vessels may pose. They have addressed previous concerns expressed by having vessel's hulls cleaned and in one case a high risk vessel was refueled out of Hawaii's waters to reduce the risk. The Navy has strict ballast water protocols and requires decontamination of all vehicles, equipment and personal gear; however, AIS hull fouling is often overlooked. Studies have shown that hull fouling is the primary vector for marine AIS transfer in Hawaii. Management strategies should be in place to increase awareness of and address hull fouling issues. The submerged surfaces of vessels, buoys, tender boats, and ancillary gear should be inspected prior to movement in or out of Pearl Harbor especially when there have been long periods of inactivity. Special areas of concern should be sea chests, intake pipes, and propulsion systems. DAR recommends adding these conditions to the plan: Continued cooperation with DAR by providing early notification of decommissioned vessels, barges, platforms or other objects	The following text was added as Section 3.4.6.6 Control of Aquatic Invasive Species: "The Navy continues to cooperate with DAR by providing early notification of decommissioned vessels, barges, platforms or other objects stationary for long periods of time that are scheduled to arrive in Hawaii as well as implementation of management activities to reduce risk of aquatic invasive species (AIS) transfer. The Navy ensures that the cleaning of vessels hulls, ancillary gear and other surfaces in the water as well as ballast water flushing is budgeted for inactive vessels coming to Hawai'i. The Navy continues to partner with DAR in addressing AIS issues in Pearl Harbor by providing notification of AIS matters and jointly working on prevention, early detection monitoring, and eradication projects. DAR has the capacity to address such matters with specialized survey equipment including a remote operated vehicle, specialized removal equipment, well-trained divers, and the nation's only rapid-response team for AIS. The Navy continues to raise awareness among active duty personnel, dependents, and civilian employees of the potential harm AIS can cause to Hawai'i's sensitive ecosystems. Furthermore, the Navy continues to employ preventative steps to minimize risk of introducing AIS." In addition, the following text was added to item 1 (Reduce and prevent the release of AIS) of Table 7-6 Coast Marine Recommendations: "The Navy will continue to ensure that the cleaning of vessels hulls, ancillary gear and other surfaces in the water as well as ballast water flushing is budgeted for inactive vessels coming to Hawai'i. The Navy will continues to partner with DAR in addressing AIS issues in Pearl Harbor by providing notification of AIS matters and jointly working on prevention, early detection monitoring, and eradication projects. The Navy will continue to raise awareness among active duty personnel, dependents, and civilian employees of the potential harm AIS can cause to Hawai'i's sensitive ecosystems. Furthermore, the Navy will

Reviewer	Section/Page	Line	Comment	Action
			stationary for long periods of time that are scheduled to arrive in Hawaii as well as implementation of management activities to reduce risk of AIS transfer. Ensure that the cleaning of vessels hulls, ancillary gear and other surfaces in the water as well as ballast water flushing is budgeted for inactive vessels coming to Hawaii. Partner with DAR in addressing AIS issues in Pearl Harbor. Provide notification of AIS matters and jointly work on prevention, early detection monitoring, and eradication projects. DAR has the capacity to address such matters with specialized survey equipment including a remote operated vehicle, specialized removal equipment, well-trained divers, and the nation's only rapid-response team for AIS. Increase awareness and preventative steps implemented to minimize risk of introducing AIS. Prevention of new introductions into Hawaii's waters is vital in our joint efforts to protect Hawaii's fragile and valuable ecosystems, and every effort should be taken to minimize the possibility of AIS introductions into the state's waters. DAR appreciates the progress made thus far and looks forward to continued cooperation with the U.S. Navy on addressing this extremely important issue. Please contact Jason Leonard, the DAR Hull Fouling/Ballast Water Coordinator at 808-587-2275 if you have any questions.	continues to employ preventative steps to minimize risk of introducing AIS."

J4 – SOH DLNR OCCL COMMENTS ON AGENCY REVIEW DRAFT OF NAVSTA PH INRMP

State of Hawaii (SOH) Department of Land and Natural Resources (DLNR) Office of Conservation and Coastal Lands (OCCL) comments on the Agency Review Draft for NAVSTA PH INRMP

Reviewer	Section/Page	Line	Comment	Action
SOH DLNR OCCL – SL.1			The Office of Conservation and Coastal Lands (OCCL) is in receipt of the subject draft copy. We have included Conservation District Subzone Maps of areas that lie within the Conservation District that are part of the subject area. We request copies of management plans for these areas to be forwarded to us.	NAVFAC PAC prepared a letter dated 18 June 2009 in response to OCCL's comments. As indicated in the letter, the Navy does not have individual management plans for the areas specified in OCCL's letter. As indicated in the letter, the 2002 Pearl Harbor Naval Complex ICRMP contains information on the Navy's policy for protection and preservation of areas with cultural resource value. Similarly, the INRMP contains information on the Navy's programs for the protection of areas of natural resource value including areas that lie within the Conservation District.
SOH DLNR OCCL – SL.2			Of particular interest to the OCCL are management plans for the Hawaiian cultural assets noted as Loko Laulaunui, Loko Paaiau, Loko Pamoku, an Loko Okiokiolepe in the Pearl Harbor Area as our Office has received community inquiry regarding restoration and rehabilitation of these wetland historical features. In addition, the OCCL requests a contact position of the Department of the Navy that we may refer the General Public to regarding inquiries that lie within the State Land Use Conservation District that falls under the Navy's stewardship. Should you have any questions regarding this matter, please contact Tiger Mills of our Office at (808) 587-0382.	See response to comment #1.

J5 – SOH DLNR DSP COMMENTS ON AGENCY REVIEW DRAFT OF NAVSTA PH INRMP

State of Hawaii Department of Land and Natural Resources Division of State Parks comments on the Agency Review Draft for NAVSTA PH INRMP

Reviewer	Section/Page	Line	Comment	Action
SOH DLNR-DSP.1			Division of State Parks: We reviewed the Draft Copy of the Naval Station Pearl Harbor Hawai'i Integrated Natural Resources Management Plan Facility and have no comments to offer. Thank you for the opportunity to review and comment on the proposed projects of the Navy.	Comment noted.

J6 – SOH DBEDT CZM COMMENTS ON AGENCY REVIEW DRAFT OF NAVSTA PH INRMP

State of Hawaii (SOH) Department of Business and Economic Development and Tourism (DBEDT) Coastal Zone Management (CZM) Program comments on the Agency Review Draft for NAVSTA PH INRMP

Reviewer	Section/Page	Line	Comment	Action
Hawaii Coastal Zone Management -JN.1	Chapter One, Section 1.5.2.1 Coastal Zone Management Consultations		The Hawaii CZM Program is in agreement with the information presented in this section. We do not have any other comments on the "Agency Review Draft".	Comment noted.

J7 – SOH DOH CWB COMMENTS ON AGENCY REVIEW DRAFT OF NAVSTA PH INRMP

State of Hawaii (SOH) Department of Health (DOH) Clean Water Branch (CWB) comments on the Agency Review Draft for NAVSTA PH INRMP

Reviewer	Section/Page	Line	Comment	Action
DOH CWB-RM.1	General		The Department of Health (DOH), Clean Water Branch (CWB), has reviewed the subject document and offers these comments on your project. Please note you may be responsible for fulfilling additional requirements related to our program in compliance with Hawaii Administrative Rules (HAR), Chapters 11-54 and 11-55. We recommend that you also read our standard comments on our website at: http://www.hawaii.gov/health/environmental/env-planning/landuse/CWB-standardcomment.pdf.	Comment noted. The INRMP is programmatic in nature and is a planning document. For this reason, compliance with various DOH/CWB is achieved on a project basis and specific compliance requirements are not addressed in the INRMP.
DOH CWB-RM.2	General		Any project and its potential impacts to State waters must meet the following criteria: Antidegradation policy (HAR, Section 11-54-1.1), which requires that the existing uses and the level of water quality necessary to protect the existing uses of the receiving State water be maintained and protected. Designated uses (HAR, Section 11-54-3), as determined by the classification of the receiving State waters. Water quality criteria (HAR, Sections 11-54-4 through 11-54-8).	Comment noted. See response to comment #1.

State of Hawaii (SOH) Department of Health (DOH) Clean Water Branch (CWB) comments on the Agency Review Draft for NAVSTA PH INRMP

Reviewer	Section/Page	Line	Comment	Action
DOH CWB-RM.3	General		You are required to obtain a National Pollutant Discharge Elimination System (NPDES) permit for discharges of wastewater, including storm water runoff, into State surface waters (HAR, Chapter 11-55). For the following types of discharges into Class A or Class 2 State waters, you may apply for NPDES general permit coverage by submitting a Notice of Intent (NOI) form: a. Storm water associated with industrial activities. b. Storm water associated with construction activities, including clearing, grading, and excavation, that result in the disturbance of equal to or greater than one (1) acre of total land area. The total land area includes a contiguous area where multiple separate and distinct construction activities may be taking place at different times on different schedules under a larger common plan of development or sale. An NPDES permit is required before the start of the construction activities. c. Treated effluent from leaking underground storage tank remedial activities. d. Once through cooling water less than one (1) million gallons per day. e. Hydrotesting waters or waters used to test the integrity of a tank or pipeline. f. Construction activity dewatering. g. Treated process wastewater associated with petroleum bulk stations and terminals. h. Treated process wastewater associated with well drilling activities. i. Occasional or unintentional discharges from recycled water systems. j. Discharges of storm water from small municipal separate storm sewer systems. k. Discharges of circulation water from decorative ponds or tanks. You must submit a separate NOI form for each type of discharge at least 30 calendar days prior to the start of the discharge activity, except when applying for coverage for discharges of storm water associated with construction activity. For this type of discharge, the NOI must be submitted 30 calendar days before to the start of construction activities. The NOI forms may be picked up at our office or downloaded from our website at http://www.hawaii.gov/health/environmental/water/cleanwater/forms/genl-index.html.	Comment noted. See response to comment #1.
DOH CWB-RM.4	General		For types of wastewater not listed in Item 2 above or wastewater discharging into Class 1 or Class AA waters, you may need an NPDES individual permit. Class 1 waters include, but is not limited to, all State waters in natural reserves, preserves, sanctuaries, and refuges established by the Department of Land and Natural Resources under chapter 195, Hawaii Revised Statutes (HRS), or similar reserves for the protection of aquatic life established under chapter 195, HRS. An application for an NPDES individual permit must be submitted at least 180 calendar days before the commencement of the discharge. The NPDES application forms may be picked up at our office or downloaded from our website at http://www.hawaii.gov/health/environmental/water/cleanwater/forms/indiv-index.html.	Comment noted. See response to comment #1.

State of Hawaii (SOH) Department of Health (DOH) Clean Water Branch (CWB) comments on the Agency Review Draft for NAVSTA PH INRMP

Reviewer	Section/Page	Line	Comment	Action
DOH CWB-RM.5	General		You must also submit a copy of the NOI or NPDES permit application to the State Department of Land and Natural Resources, State Historic Preservation Division (SHPD), or demonstrate to the satisfaction of the CWB that SHPD has or is in the process of evaluating your project. Please submit a copy of your request for review by SHPD or SHPD's determination letter for the project along with your NOI or NPDES permit application, as applicable.	Comment noted. See response to comment #1.
DOH CWB-RM.6	General		Please comply with the U.S. Environmental Protection Agency (EPA) 2008 NPDES Vessel General Permit (VGP). A Section 401 Water Quality Certification (WQC), CWB File No. WQC 0000742, was issued on December 19, 2008 to include Hawaii State Water Quality Standards in the VGP. Information on the VGP can be obtained on the EPA website at: http://cfpub.epa.gov/npdes/home.cfm?program_id=350#authorization.	Comment noted. See response to comment #1.
DOH CWB-RM.7	General		Please consult with the Honolulu Engineer District (HED) of the U.S. Army Corps of Engineers (COE) regarding Department of Army permitting requirements for any work within Pearl Harbor. Pursuant to Federal Water Pollution Control Act [commonly known as the "Clean Water Act" (CWA)], Paragraph 401(a)(1), a Section 401 WQC is required for "[a]ny applicant for Federal license or permit to conduct any activity including, but not limited to, the construction or operation of facilities, which may result in any discharge into the navigable waters..." (emphasis added). The term "discharge" is defined in CWA, Subsections 502(16), 502(12), and 502(6); Title 40, Code of Federal Regulations, Section 122.2; and Hawaii Administrative Rules (HAR), Chapter 11-54.	Comment noted. See response to comment #1.

State of Hawaii (SOH) Department of Health (DOH) Clean Water Branch (CWB) comments on the Agency Review Draft for NAVSTA PH INRMP

Reviewer	Section/Page	Line	Comment	Action
DOH CWB-RM.8	General		Please note that Pearl Harbor is identified as High Priority, Category 3 and 5, waters in the Clean Water Act, Section 303(d) list of impaired water bodies in Chapter IV of the 2006 State of Hawaii Water Quality Monitoring and Assessment Report. Pearl Harbor is presently identified as not attaining the applicable water quality criteria for total nitrogen, nitrate+nitrite nitrogen, total phosphorus, turbidity, chlorophyll a, nutrients, suspended solids, PCBs, and advisory for fish consumption. Accordingly, a Total Daily Maximum Load (TMDL) development analysis is currently in progress for the Pearl Harbor Watershed. Any NPDES permit(s) and/or Section 401 WQC(s) for discharges into these water bodies will incorporate the requirement for the development and implementation of a facility/project-specific Waste Load Allocation (WLA) implementation and monitoring plan when a Total Maximum Daily Load (TMDL) which specifies WLAs applicable to the project is approved by the EPA. The facility/project-specific WLA implementation and monitoring plan shall be incorporated and implemented as part of the project's Storm Water Pollution Control Plan or Site-Specific Best Management Practices (BMPs) Plan, as appropriate. The facility/project-specific WLA implementation and monitoring plan shall include Data Quality Objectives (DQO) and Quality Assurance (QA) and Quality Control (QC) methods. The purpose and goal of DQO process can be found at http://www.hanford.gov/dqo. Information on the DOH WLA Implementation and TMDLs are available on the DOH Environmental Planning Office website at http://hawaii.gov/health/environmental/env-planning/wqm/wqm.html (see TMDL Technical Reports and Implementation Plans for approved TMDLs are available here for download in pdf format).	Comment noted. See response to comment #1.
DOH CWB-RM.9	General		Please note that all discharges related to the project construction or operation activities, whether or not NPDES permit coverage and/or Section 401 WQC are required, must comply with the Water Quality Standards. Noncompliance with water quality requirements contained in HAR, Chapter 11-54, and/or permitting requirements, specified in HAR, Chapter 11-55, may be subject to penalties of $25,000 per day per violation	Comment noted. See response to comment #1.
DOH CWB-RM.10	General		If you have any questions, please visit our website at: http://www.hawaii.gov/health/environmental/water/cleanwater/index.html, or contact the Engineering Section, CWB, at 586-4309.	Comment noted. See response to comment #1.

J8 – CCH DPP COMMENTS ON AGENCY REVIEW DRAFT OF NAVSTA PH INRMP

City and County of Honolulu (CCH) Department of Planning and Permitting (DPP) comments on the Agency Review Draft for NAVSTA PH INRMP

Reviewer	Section/Page	Line	Comment	Action
CCH-DPP.1	General		We have reviewed the subject Agency Review Draft of the Integrated Natural Resources Management Plan Update. We have no comments to offer at this time.	Comment noted.

J9 – OISC COMMENTS ON AGENCY REVIEW DRAFT OF NAVSTA PH INRMP

Oahu Invasive Species Committee comments on the Agency Review Draft for NAVSTA PH INRMP

Reviewer	Section/Page	Line	Comment	Action
OISC-RN.1			The Oahu Invasive Species Committee is a voluntary partnership of public agencies and private organizations united to prevent, eradicate and contain those species that threaten that the environment, economy and quality of life on Oahu. We thank you for this opportunity to comment on the Integrated Natural Resources Management Plan (INRMP). OISC is very pleased to see the control and prevention of invasive species as part of the INRMP and applauds requiring the decontamination of vehicles equipment, personal gear, shoes, and clothing before entering training areas. This is one of the best ways to prevent invasive species from spreading. We do however have some suggestions to ensure that invasive species work done by OISC and other organizations outside of Navy lands complements the work outlined in the INRMP. We have also made some suggestion that will provide extra safeguards against the introduction of new, potentially damaging species. OISC's comments are attached and referenced with the number of the action in the implementation plan in Chapter 7.	Comment noted.
OISC-RN.2	Table 7-4, Item 2 Provide natural resources staff focused annual training		Include the Hawaii Department of Agriculture's pest hotline (643-PEST) in natural resources staff training and other outreach. This number can be used to report snakes, Red Imported Fire Ant, coqui frog, invasive plants and other suspicious creatures. Coqui frog identification should also be included in training.	The following text was added to the end of item 2 of Table 7-4: "Training and outreach materials will include Hawaii Department of Agriculture's pest hotline (643-PEST). This number can be used to report snakes, Red Imported Fire Ant, coqui frog, invasive plants and other suspicious creatures. In addition, training will include Coqui frog identification materials."
OISC-RN.3	Table 7-5, Item 1, Landscape Design		When choosing plants for landscape design, landscapers should consult the Weed Risk Assessment (www.hear.org/wra) to ensure the species area not potentially invasive. The WRA analyzes a species' biology and history in Hawaii to determine if it poses a high risk of becoming invasive. Species not listed on the website can be assessed for potential high risk by contacting hpwra@yahoo.com.	The following text was added to the end of item 1 of Table 7-5: "When choosing plants for landscape design, landscapers will consult the Weed Risk Assessment (WRA) (www.hear.org/wra) to ensure the species area not potentially invasive. The WRA analyzes a species' biology and history in Hawaii to determine if it poses a high risk of becoming invasive. Species not listed on the website can be assessed for potential high risk by contacting hpwra@yahoo.com."

Oahu Invasive Species Committee comments on the Agency Review Draft for NAVSTA PH INRMP

Reviewer	Section/Page	Line	Comment	Action
OISC-RN.4	Table 7-5, Item 2, Protect mature and significant trees		Species of trees that are invasive should not be protected. In cases where the tree provides an important function (shade, for example) replacement with a non-invasive tree should be considered.	The following text was added to the end of item 2 of Table 7-5: "Species of trees that are invasive would not be protected. In cases where the tree provides an important function (shade, for example) replacement with a non-invasive tree will be considered."
OISC-RN.5	Table 7-5, Item 3, Continued standard provisions in construction/landscape contracts		Contract landscapers should also be instructed to plant non-invasive species when choosing plants for ornamental purposes. Species can be checked for potential high risk at www.wra.org or hpwra@yahoo.com	The following text was added to the end of item 3 of Table 7-5: "Contract landscapers will also be instructed to plant non-invasive species when choosing plants for ornamental purposes. Species can be checked for potential high risk at www.wra.org or hpwra@yahoo.com."
OISC-RN.6	Table 7-5, Item 4, Update botanical surveys		Botanical surveys should also include early detection for species of concern that may be new to Leeward Oahu or species that may be new to the island. Findings should be shared with the Oahu Invasive Species Committee so that OISC can conduct delimiting surveys on lands bordering Navy property if necessary.	The following text was added to the end item 4 of Table 7-2: "Botanical surveys will also include early detection for species of concern that may be new to Leeward Oahu or species that may be new to the island. Findings will be shared with the Oahu Invasive Species Committee (OISC) so that OISC can conduct delimiting surveys on lands bordering Navy property if necessary."
OISC-RN.7	Table 7-5, Item 6, Control alien plants		The Oahu Invasive Species Committee's goal is island-wide eradication for some species, preventing spread to the Leeward side for others. In order to fully understand the status of certain invasive plants, information on Navy invasive species control activities is necessary. The Navy should share its target list with OISC and, in the event that OISC and the Navy share a target, the Navy should regularly inform OISC on the status of that target and if action by OISC outside of Navy lands may be required.	Comment noted. The Navy does not have a target list.

Oahu Invasive Species Committee comments on the Agency Review Draft for NAVSTA PH INRMP

Reviewer	Section/Page	Line	Comment	Action
OISC-RN.8	Table 7-7, item 1, Invasive species prevention and control		Navy natural resource managers should also control potentially invasive species being introduced to Navy lands and the rest of Oahu through retail outlets such as the Navy Exchange. In May 2008, Bishop Museum botanists discovered seeds of 30 different ornamental grass species for sale at the Navy Exchange. Twenty-seven of these had never been collected on Oahu and 17 had never been collected in the state. Twenty-two are considered weeds elsewhere in the world and one was an OISC target species – pampas grass (Cortaderia sellona). Pampas grass is not established on Oahu and we have worked hard to take it out of cultivation. Assistance with removing this display and preventing others like it from being erected will help prevent invasive, fire-adapted invasive species from establishing on Oahu.	Comment noted. NAVFAC PAC has submitted a request to NAVFAC Hawaii to meet and discuss this issue with Navy Exchange representatives.

APPENDIX K
COMMENTS/RESPONSE TO COMMENTS ON PUBLIC REVIEW DRAFT OF NAVSTA PH INRMP

K1 – USFWS COMMENTS ON PUBLIC REVIEW DRAFT OF NAVSTA PH INRMP

Comment No.	Reviewer	Section/Page	Line	Comment	Action
1	USFWS.1	General	—	Given the consolidation of all Oahu Navy Lands into this INRMP, it appears that extensive opportunities to accomplish species recovery exist on appropriate Navy lands that may contain potentially adequate habitat and are unlikely to be used for training, other military exercises or construction. We recommend that the Navy augment, outplant, or otherwise expand or encourage re-colonization of federally listed threatened or endangered species on DOD properties. The Navy acknowledged that current DOD policy may preclude such efforts, and that short of actions that would increase species populations, sustaining extant populations could be accomplished via removal of invasive species and predators. The INRMP identifies several opportunities to accomplish conservation actions of that nature but does not refer to any intention or plans to focus any work in these areas. We recommend that appropriate areas, which we could assist in identifying, be more seriously considered for conservation actions due to their proximity to State conservation land, their relatively long term protected nature, and minimal development pressure or risk of impacts from military activities. We also recommend that Navy consider cooperative agreements with the State to implement conservation work on adjacent, non-military land, either as part of the INRMP or in a seperate partnership.	The Navy has updated Chapter 9 implementation plan to include projects to protect listed species, particularly at Lualualei which are in close proximity to State conservation lands. Projects include control of invasive vegetation with areas of dryland forest and protected plant and snail species, goat and pig control through fence construction and/or aerial and ground hunting; seed collection of listed plant species for future propogation potential; invasive predator (rat, chameleon, rosy wolf snail) control in areas of listed/rare snails. Moreover, the Navy is partnering with the Army and Waianae Mountain Watershed Partnership to jointly stabilize populations of listed species.

Comment No.	Reviewer	Section/Page	Line	Comment	Action
2	USFWS.2	General	—	Several feral goat populations in the Lualualei Valley installation were reported as eradicated by the U.S. Department of Agriculture-Wildlife Services in 2001, however, in a survey conducted in 2004, goats were observed to be one of the main threats to the survival of the rare plants at Lualualei. Pigs may also be abundant because hunting is restricted. We understand that the Navy is working on reinstating hunting, which could result in conservation benefits for native species, but we recommend that specific actions to accomplish this conservation action be included in the implementation plan. In the interim, we recommend additional monitoring to identify if feral ungulates are continuing to be a problem in conserving native plant habitat.	Chapter 9 Implementation plan includes projects for feral ungulate control and hunting including Lualualei.
3	USFWS.3	General	—	<u>Recommended surveys to support species conservation and recovery.</u> The Navy has conducted extensive plant and animal surveys within Naval Munitions Command East Asia Division Detachment Pearl Harbor, Naval Station Pearl Harbor Lualualei Annex (referred to in INRMP as NAVMAG PH Lualualei) and within the Naval Radio Transmitter Facility (NRTF Lualualei) to help develop a prioritized list of species for monitoring and implementation of recovery actions. In addition, the Navy evaluates and encourages the use of native plants in landscaping and habitat restoration whenever possible and prohibits troops in areas marked by signs or fences indicating the presence of rare and protected species. We recommend annual reporting of surveys and management activities that result from the data collected are provided to the Service.	Chapter 9 includes updates to the INRMP which would include annual reporting of surveys and management activities.

Comment No.	Reviewer	Section/Page	Line	Comment	Action
4	USFWS.4	General	--	Threats to the endangered forest bird, Oahu elepaio (*Chasiempis sandwichensis ibidis*), listed plants, and the snails of the genus *Achatinella* and *Amastra* are inadequately addressed in the INRMP. We recommend improved rat control near Oahu elepaio territories, and near known *Achatinella*, and the only *Amastra cylindrica* population in the world. Additionally, a snail enclosure, similar to those managed by the Army for *Achatinella* should be erected for *A. cylindrica*. We recommend that the Navy include a new survey for *A. cylindrica* in the INRMP because the most recent survey in 2005 noted recent rat predation, and only juvenile *A. cylindrica* individuals were found.	Chapter 9 Implementation plan includes projects to monitor and manage protected animal and plant species at Lualualei including predator control. However, Oahu Elepaio have not been observed at LLL in recent years. A snail enclosure is not practical for the Amastra site which is on an extreme slope. Updated survey results are presented in the Appendix.
5	USFWS.5	General	—	The endangered Hawaiian hoary bat (*Lasiurus cinereus semotus*) is known to occur on Oahu, however, it is not mentioned in the INRMP. We recommend the Navy evaluate habitat for the potential presence of bats and where necessary consult with the Service to ensure that any potential impacts to bats are adequately avoided or minimized. For overall conservation of Hawaiian hoary bats related to the INRMP the Navy should conduct acoustic monitoring throughout the lands identified within the INRMP to identify locations of prominent bat use.	Chapter 9 Implementation Plan includes projects to monitor for the presence of Hawaiian hoary bats using acoustic monitoring techniques.

Comment No.	Reviewer	Section/Page	Line	Comment	Action
6	USFWS.6	General	—	There are four candidate Hawaiian damselflies (*Megalagrion leptodemas, Megalagrion nigrohamatum nigrolineatum, Megalagrion oceanicum, and Megalagrion Xanthomelas*) reported from the Island of Oahu. We recommend the INRMP include an action to conduct stream bioassessments on Navy lands to identify if suitable habitat could be conserved in areas where minimal military training or other activities are expected to occur. The stream bio-assessments should include native species documentation and identify important native stream habitats, similar to those the Navy conducted in 2007 on Waiawa stream. Additionally, the bioassessments should include surveillance and mapping of aquatic nuisance or invasive species presence throughout the landscape that may impact native stream fauna.	Chapter 9 Implementation Plan includes projects to conduct stream bioassessments at Lualualei.

Comment No.	Reviewer	Section/Page	Line	Comment	Action
7	USFWS.7	General	—	Species Recovery and Conservation Actions on Oahu Navy Lands. Twenty-two listed plants (see Appendix I) and four candidate species occur on NAVMAG PH Lualualei, while three listed plants (*Abutilon menziesii, Cyperus trachysanthos,* and *Marsilea villosa*) occur on NRTF Lualualei. There are two fenced exclosures in the NAVMAG PH Lualualei. The Navy fenced 1-acre (4-hectares) of the 280-acre (113 hectares) Halona Special Management Area (SMA) to protect the listed plant *Abutilon sandwicense* and its immediately surrounding native forest from feral ungulates. A smaller fenced exclosure (0.5 ac; 0.2 ha) constructed further north in the 30-ac (12-ha) Puu Hapapa Special Management Area protects the following listed species: Oahu tree snails (*Achatinella* spp.), Oahu elepaio, the plant *Abutilon sandwicense*, and surrounding native forest. The Navy maintains the integrity of these fences to prevent ingress by non-native ungulates, and controls non-native plants within the exclosures. In the NRTF Lualualei, the Navy regularly mows the areas surrounding the transmission towers, which benefits *Cyperus trachysanthos* and *Marsilea villosa* by keeping the non-native grasses from taking over the habitat. The Navy installed signage and fences around the three populations of *Abutilon menziesii* at NRTF Lualualei to protect them from inadvertent impacts from landscaping and development. Recommendations regarding how to improve the conservation benefits of these measures are provided in the specific comments below. Fire is a threat to the lowland dry and dry cliff ecosystems in the Waianae Mountains, including the dry cliff ecosystem in NAVMAG PH Lualualei and NRTF Lualualei. Wildland fires have not impacted Lualualei Valley in recent years, but the disturbed dry habitat is prone to brush fires, as evidenced by many recent fires occurring in similar habitat in adjacent valleys. The Navy's wildfire management activities include maintenance (mowing, pruning, and watering) of vegetation within the developed portions of the installations, and a commitment to respond "to any fires that may occur." The Service's March 2008 comments noted that wildland fires could be interdependent with the activities and land uses that may affect federally listed species and critical habitat. We recommended the Navy coordinate with interagency members of the Oahu Wildland Fire Council (OWFC) to ensure fire breaks, water sources, fire prevention measures and fire suppression staffing are adequate to ensure the activities on these lands minimize potential for wildland fire impacts to listed species. While the INRMP notes that this coordination has occurred, there is no reference to an implementation plan.	

Response: Chapter 9 Implementation Plan includes a project to prepare wildland fire management plan and to continue to coordinate with the OWFC.

Comment No.	Reviewer	Section/Page	Line	Comment	Action
8	USFWS.8	General	—	Examples of conservation actions we recommend the Navy consider incorporating into the implementation plan of the INRMP to provide additional benefits to trust resources include, but are not limited to actions that will: (1) reduce fragmentation of habitat, (2) establish, maintain or increase rare plant populations, (3) eradicate ungulates, (4) install fencing around sensitive areas, (5) control the spread of non-native species, (6) enhance and restore habitats, (7) monitor and report habitat conditions and rare plant population status, (8) develop a coordinated wildland fire management plan. We encourage the Navy to work collaboratively with the Service to develop appropriate special management considerations or protections for the above species.	Chapter 9 Implementation plan includes several projects that directly address the comment. Moreover, ongoing regulatory agency coordination will allow for collaboration with regards to management of rare and listed species.
9	USFWS.9	3.4.5.1/3-129	12	Page 3-129, Sec. 3.4.5.1 line 12: We suggest changing "ulei huehue" to "ulei and huehue". They are two separate plants: ulei (*Osteomeles anthyllidifolia*) and huehue (*Cocculus orbiculatus*).	The text was revised per comment.
10	USFWS.10	4.1/4-4	Figure 4-2	Page 4-4, Fig. 4-2. Constraints, Lualualei Study Area: The map of combined critical habitat for various plant species is missing designated critical habitat for *Marsilea villosa* in NRTF Lualualei. In 2003, we designated two separate polygons of critical habitat for *Marsilea villosa* within NRTF Lualualei. Please revise the map.	The figure was revised per comment.
11	USFWS.11	4.3/4-22	Table 4-3	Page 4-22, Table 4-3, Federally Listed Plant Species, Federal Candidate Plant Species, and Federal Plant Species of Concern at NAVMAG PH Lualualei (Continued). Please revise the name for *Alectryon macrococcus* var. *micrococcus* to *Alectryon macrococcus* var. *macrococcus*.	The text was revised per comment.
12	USFWS.12	4.3/4-27		Page 4-27, Table 4-3, Federally Listed Plant Species, Federal Candidate Plant Species, and Federal Plant Species of Concern at NAVMAG PH Lualualei (Continued). We suggest adding to the *Marsilea villosa* table the presence of critical habitat in NRTF Lualualei (Figure 4-2).	The text was revised per comment.

Comment No.	Reviewer	Section/Page	Line	Comment	Action
13	USFWS.13	4.3.1.2/4-36		Page 4-36, Sec. 4.3.1.2. We recommend providing additional details on the management protocol of applying insecticide on *Abutilon menziesii*. Consistent with our informal consultation, we also recommend that you specify that mowing of *Cyperus trachysanthos* will be suspended when there is mud in the depression where the plants have been observed. Regular monitoring of seed fall must occur to determine that at least 50 percent of the seeds have fallen from the plants. In addition, mowing may resume when the mud hole is not present and after at least 50 percent of the seeds have fallen.	Section 4.4.1.2 provides a description of the current management actions for these plants. Chapter 9 Implementation Plan provides recommendations for management and monitoring of these plants. The SOP for mowing at LLL RTF is attached as an appendix.
14	USFWS.14	4.3.1.3/4-36 to 4-37		Page 4-36 through 4-37, Sec. 4.3.1.3. Only two of the four Special Management Areas (SMAs) are fenced and subjected to some weed and rodent control actions. However, no fencing or other management actions are ascribed to the Puu Kaua SMA and Puu Kailio SMA. We recommend that management actions continue to occur within Puu Hapapa SMA and Halona Valley SMA for the protection of endangered species. In addition, we recommend that management actions be developed and implemented at the remaining SMAs, Puu Kaua and Puu Kailio, for the protection of threatened and endangered species.	Chapter 9 Implementation Plan provides recommendations for management actions for the protected plant species at Lualualei including fencing for all four of the SMAs.

Comment No.	Reviewer	Section/Page	Line	Comment	Action
15	USFWS.15	4.4.1.2/4-47		Page 4-47, Sec. 4.4.1.2. To achieve success in protecting threatened and endangered species, this INRMP should include rare plant management plans for all federally-listed threatened and endangered, as well as candidate species (see Appendix 1).	Chapter 9 Implementation Plan provides recommendations for management and monitoring of protected and rare plants. These include direct weeding of invasive vegetation around listed plants as well as monitoring to identify new/changing threats.
16	USFWS.16	4.4.1.2/4-47	29-32	Page 4-47, Sec. 4.4.1.2, lines 29 through 32. Please revise the name for *Alectryon micrococcus* var. micrococcus to Alectryon macrococcus var. macrococcus.	The text was revised per comment.
17	USFWS.17	4.4.1.2, 4-47	33 - 35	Page 4-47, Sec. 4.4.1.2, lines 33 through 35. We recommend that long term seed storage and seed collection of *Flueggea neowawraea* be performed by a permitted botanist. We suggest that you add *Flueggea neowawraea* to your endangered species collecting permit, if not already included.	Chapter 9 Implementation plan provides a recommendation for seed storage/propagation. Our partnership with the Army includes Army personnel regularly visiting the Flueggea trees to collect seeds, if present, and cuttings.

Comment No.	Reviewer	Section/Page	Line	Comment	Action
18	USFWS.18	4.4.1.2, 4-47	36 - 40	Page 4-47, Sec. 4.4.1.2, lines 36 through 40: This population of *Alectryon macrococcus var. macrococcus* is very important as there are less than 148 individuals in the wild on Oahu. Every individual plant is vital to the restoration of genetic diversity within small plant populations. We recommend that long-term seed storage and seed collection of *Alectryon macrococcus var. macrococcus* be performed by a permitted botanist. We suggest that you add *Alectryon macrococcus var. macrococcus* to your endangered species collecting permit, if not already included.	Chapter 9 Implementation plan provides a recommendation for seed storage/propagation.
19	USFWS.19	4.4.1.2, 4-48		Page 4-48, Sec. 4.4.1.2, Plant Survey Updates - *Flueggea neowawraea*. The Navy describes the importance of preserving the genetic variability of the trees at Lualualei, and describes the Army's implementation of a genetic diversity preservation plan, the importance of the trees at Lualualei, and the need for vegetation management of the alien trees. However, the INRMP does not state that the Navy will implement any of these activities. We recommend the Navy include implementation of these recommended actions in the INRMP.	Chapter 9 Implementation Plan provides recommendations for management and monitoring of protected and rare plants including invasive vegetation management around Flueggea trees.
20	USFWS.20	4.4.1.2, 4-49	14	Page 4-49, Section 4.4.1.2, line 14, *Abutilon menziesii*. The Navy states that a thick layer of tall grasses likely preclude the population at Lualualei from recruiting. We recommend that the Navy control the nearby grasses.	Chapter 9 Implementation Plan provides recommendations for management and monitoring of protected and rare plants including invasive vegetation management around Abutilon menziesii.

Comment No.	Reviewer	Section/Page	Line	Comment	Action
21	USFWS.21	4.4.1.2, 4-49	19-23	Page 4-49, Sec. 4.4.1.2, lines 19-23: We suggest adding to the sentence "An ESA consultation with USFWS conducted in 2004 allows the Navy to mow, if necessary, *Cyperus trachysanthos* populations, a federally endangered sedge, in NRTF Lualualei. Mowing is allowed after the plants have dropped at least 50 percent of their seeds." and "when the mud hole where the plants have been observed is not present." The conservation recommendations in the noted informal consultation requested follow up to ensure concerns about the action of mowing C. *trachysanthos*, and compliance with the conditions of the consultation were addressed. After six years of mowing, we are interested in an assessment of the overall effect to the C. *trachysanthos* population. We understand that these populations are monitored regularly by Navy biologists and we recommend that a qualified biologist continue to monitor these populations. The Service is willing to provide technical assistance to the individual responsible for monitoring C. *trachysanthos*. In addition, we are most interested in the decision process that drives the necessary action to mow C. *trachysanthos*, and the specific monitoring details that are required before and after the mowing occurs. To ensure that these populations of C. *trachysanthos* are not being adversely affected by mowing, we request that you provide us with a detailed description of the monitoring plan for C. *trachysanthos*. More specifically, we are interested in the type of information being collected and the frequency of the monitoring schedule. Additionally, we would like to receive a report on the current number of individuals per populations, overall plant vigor for each population, and overall reproductive status of the species.	The text was added per comment. Chapter 9 Implementation Plan provides recommendations for the monitoring and management of the plant species. An SOP for mowing at RTF LLL and protection of Marsilea and Cyperus is attached as an appendix.
22	USFWS.22	4.4.1.2, 4-49	28	Page 4-49, Sec. 4.4.1.2, line 28, *Marsilea villosa*. We recommend that Navy manage the fourth population of this species in the sparse kiawe forest.	Chapter 9 Implementation Plan provides recommendations for the monitoring and management of the

Comment No.	Reviewer	Section/Page	Line	Comment	Action
					plant species
23	USFWS.23	4.4.1.3-1, 4-50		Page 4-50, Sec. 4.4.1.3-1, Birds Species: We recommend more effective trapping for rats be conducted in the vicinity of elepaio territories.	Chapter 9 Implementation Plan provides recommendations for the monitoring and management of the protected species including trapping of rats. However, rat trapping and baiting has been put on hold due to the lack of current nesting of Elepaio at LLL. If nesting Elepaio are resighted in LLL, rat trapping will resume.
24	USFWS.24	4.4.1.3-, 4-51		Page 4-51, Sec. 4.4.1.3.3, Snails: Reports from the surveys for and management of *A. cathonica* should be provided to the Service.	The survey reports are part of the appendices of the INRMP.
25	USFWS.25	4.4.1.3, 4-52	1	Page 4-52, Sec. 4.4.1.3, line 1: We suggest changing "extinct" to "extinct".	The text was moved to Section 4.3.1.1 and was revised to reflect "extinct".
26	USFWS.26	4.4.1.3, 4-52	3	Page 4-52, Sec. 4.4.1.3, line 3: Please revise *Pisonia umbellifera* to *Pisonia umbellifera*.	The text was moved to Section 4.3.1.1 and was revised per comment.
27	USFWS.27	4.4.1.3, 4-52	12-13	Page 4-52, Sec. 4.4.1.3, lines 12-13: It has recently been found that the most serious threats to the survival of Oahu tree snails are predation by the introduced carnivorous snail (*Euglandina rosea*) and predation by rats (*Rattus* spp.). In addition, loss of habitat due to the spread of nonnative vegetation into higher elevation forests continues to threaten the survival of Oahu tree snails. We recommend revising the paragraph to reflect this information.	The text was moved to Section 4.3.1.1 and was revised per comment.

Comment No.	Reviewer	Section/Page	Line	Comment	Action
28	USFWS.28	4.4.1.6, 4-53		Page 4-53, Sec. 4.4.1.6, Predator Control at Nuuli Ponds: We recommend that the Navy consult with the Service on potential incidental take of endangered Hawaiian moorhen (*Gallinula chloropus sandvicensis*) associated with predator control activities.	Table 9-3 (Item 16) was revised to state that Sec 7 consultation will be conducted with regards to predator control at Nuuli Ponds.
29	USFWS.29	4.4.1.7, 4-53	27-30	Page 4-53, Sec. 4.4.1.7, lines 27-30: We recommend providing more details on the management strategy for *Marsilea villosa*.	Section 4.4.1.2 provides a summary of the current management strategy for this species.
30	USFWS.30	Ch. 7		<u>Chapter 7: Implementation Plan</u>: We recommend editing the tables found in the Implementation Plan. There appear to be several errors in the action item numbers that are supposed to correspond to references included in the tables.	Chapter 9 Implementation was revised per comment.
31	USFWS.31	Appendix 12		Appendix 12: Injured Bird Response Protocol for NAVSTA PH: We recommend that Hawaiian ducks (*Anas wyvilliana*) be added to the list of endangered waterfowl. In addition, we suggest that the State of Hawaii's Department of Fish and Wildlife (DOFAW) be the main contact for injured endangered waterfowl. NAVSTA PH should contact the DOFAW Office in Makiki at 808-973-9778. However, we would like our office to remain as an additional contact at 808/792-9400.	Appendix 12 was revised per comment.
32	USFWS.32	Appendix 13		Appendix 13: Reporting Process for Sightings of Pearl Harbor's Marine Animals: We recommend coordinating with the National Oceanic and Atmospheric Administration (NOAA) on sea turtle and monk seal sightings and injury response.	Appendix 13 was revised per comment.

K2 – NOAA FISHERIES COMMENTS PUBLIC REVIEW DRAFT OF NAVSTA PH INRMP

Comment No.	Reviewer	Section/Page	Line	Comment	Action
1	NOAA.1	p. 6-4	33-34	On this page you refer to White Sands cottages; should this be White Plains? If not please look forward in document for consistencies White Sands and White Plains seem to be used interchangeably.	The text was revised to reflect White Plains vice White Sands.
2	NOAA.2	6.3.11, 6-13	8	Again using White Sands beach? Also Hawaiian monk seals regularly use both Nimitz beach and White Plains beach for hauling-out. Science center staff characterizes this area as a high use area for monk seals on Oahu. I don't think occasionally properly describes the use of these beaches. (comment may apply to 6-16 line 13 as well)	The text was revised to reflect White Plains vice White Sands. The text was revised to reflect regular use of Nimitz and White Plains beaches.
3	NOAA.3	6-18	17-18	I'm not sure that all of the conservation activities described early fit into the management plan for Kalaeloa. Do the same fishing restrictions, beach restrictions, and security restrictions apply? Who implements them?	Security and MWR personnel enforce where fishing can occur at White Plains and Nimitz beaches. In addition, a project proposing the hiring of a conservation officer to help enforce fishing regulations is included in Chapter 9 Implementation Plan.

Comment No.	Reviewer	Section/Page	Line	Comment	Action
4	NOAA.4	General – relating to Hawaiian Monk Seals		While the threats are generally discussed along with the Navy efforts; the details of how these programs are implemented are not spelled out in the sense of quantity and quality. The draft INRMP does spell out how the plans are funded and the priorities for funding, but the implementation of the plans over the years. Specifically the team would like to know from the document that a plan is not only in place but that the details of that plan are well understood, that the plans are well monitored (quantitatively), that the plan includes a process for review of the protocol as well as provisions that will accommodates for changes in protocol as the management needs are discovered and that all of these things are documented. In deciding if the plan is a benefit to the species, we must make sure that our decision is defensible and that management plans across all areas included under that INRMP are a benefit to the species. Any member of the public that picks up the plan should be able to see in writing the how the plan will be implemented and that the management effectiveness should be reflected in the plan as well. Our team asked the following: Could the INRMP more accurately outline how programs are run including details such as how often monitoring occurs, how often monitoring is reported, how monitoring protocols are established, how is monitoring information used for future management decisions (how often is that determined)? (We are aware the Hawaiian monk seal monitoring and efforts are accounted for in the HRC monitoring protocol as well as reported via Mimi from PMRF but what about all the habitat based assessments including water quality, marine debris, ect...The Marine Corps actually has some pretty detailed appendices that start to get at these questions by saying which reports convey the info, the comments received and how they responded to the comments, how and when goals were met).	
Recommendation: The Monitoring SOP provides immediate recording of monk seals observed in or around Pearl Harbor. NAVFAC HI maintains a sightings database. The SOP provides the monk seal number at NOAA for immediate reporting to NOAA. Monk Seals at Kalaeloa are monitored by DLNR volunteers and reported to NOAA. Monk seal protective taping is installed by DLNR volunteers as well.					

APPENDIX L
MANAGEMENT PLANS

L1 – JBPHH HAWAIIAN MONK SEAL CONSERVATION MANAGEMENT PLAN

Joint Base Pearl Harbor-Hickam
Hawaiian Monk Seal Conservation
Management Plan

3 June 2012

INTRODUCTION

This management plan functions as the implementation document for Hawaiian Monk Seal (HMS) management practices described in sections 3.4.1.1 (page 3-120), 6.4.1.1 (page 6-20), and 7-10.2.2 (page 7-107) of the September 2011 draft version of the Joint Base Pearl Harbor-Hickam Integrated Natural Resources Management Plan (JBPHH INRMP).

Joint Base Pearl Harbor-Hickam HMS conservation areas include all near-shore marine and terrestrial locations on JBPHH property or under JBPHH stewardship where HMS may occur. This management plan focuses on coastal, terrestrial areas where HMS is known to periodically occur or could possibly occur in the future. Currently these areas include the shorefront around the entrance to Pearl Harbor (See Figure 1 – Iroquois Point and Hickam) and Kalaeloa (see Figure 2. – Nimitz Beach, White Plains Beach, and BRAC parcels).

Location and scope of management actions may be expanded based on future changes in HMS distribution or frequency of occurrence. Additionally, Navy managed conservation areas may change based on changes in land ownership (i.e. the transfer of Navy properties to non-Navy entities such as the other Federal agencies, the State of Hawaii, or private entities). Any changes or additions to the HMS Conservation Plan will be coordinated through the Protected Resources Division of the NOAA Pacific Islands Regional Office.

MANAGEMENT ACTIONS

<u>Feral Animal Control</u>

Description

The Navy has contracted USDA APHIS Wildlife Services to conduct feral cat and dog control, and to some extent mongoose control, at Nimitz Beach, White Plains Beach, coastal Kalaeloa BRAC parcels, Iroquois Point, and the Fort Kamehameha/Ahua Reef/Harbor areas of Hickam Field (see Figures 1 and 2). The Wildlife Services' Work Plan for this contract is approved by Navy renewed on annual basis. The work plan is also provided to the NOAA Protected Resources Division and USFWS Pacific Islands Office for review. The goal of this action is to have HMS conservation areas free of feral cats and dogs, and reduction in numbers of mongoose.

Wildlife Services generates monthly reports of the number of traps set in each conservation area, location of traps, and numbers and types of feral animals caught. Reports will also include any other management activities carried out by Wildlife Services within the Conservation Areas. Reports are provided to the Navy and are available to Federal and State Regulatory Agencies for review. A summary of work accomplished under the contract is provided as part of the JBPHH INMRP annual review.

Figure 1.

Hawaiian Monk Seal Conservation Areas Pearl Harbor-Hickam Oahu, Hawaii

Monk Seal Conservation Area

JBPHH Installation Area

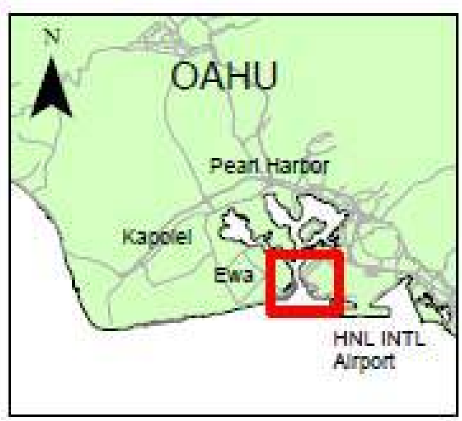


Figure 2.

Hawaiian Monk Seal Conservation Areas Kalaeloa, Oahu, Hawaii

Monk Seal Conservation Area

JBPHH Installation Area

Points of contact

Points of contact within Wildlife Services and Navy points of contact for HMS Conservation areas are provided to Federal and State Regulatory Agencies. These include: 1) USDA APHIS WS Technician, 2) JBPHH Natural Resources Manager, 3) JBPHH Environmental Storefront Manager for Kalaeloa, 4) MWR Manager for Kalaeloa, 4) JBPHH Environmental Storefront Manager for Iroquois Point, 5) Manager for the Waterfront at Puuloa, 6) JBPHH Environmental Storefront Manager for Hickam, and 7) JBPHH Police.

Metrics

Metrics for this action include: 1) Monthly – feral animal trapping and management reports; 2) Annual - Wildlife Services Work Plan; 3) Annual – Feral Animal Control Summary.

<u>Harassment Prevention and Enforcement</u>

Description

The Navy will assist Federal and State law enforcement personnel with protecting HMS and enforcing laws regarding human interaction with HMS. City and County of Honolulu Lifeguards are on site from 0800 -1700 at White Plains Beach and (Hickam Beach Name?). All other HMS conservation areas are patrolled by JBPHH Police on an unscheduled basis (approximately once a week). Annual training on laws governing HMS conservation for JBPHH Police and MWR personnel is coordinated through the NOAA Protected Resources Division.

The following phone tree is established in the event of an illegal action regarding a monk seal:

C&C Lifeguard/MWR Patron/Housing Resident/ JBPHH personnel/or other person witnessing illegal action calls 24-hour JBPHH Police Dispatch:
474-2222

↓

JBPHH Police Dispatch notifies JBPHH Game Warden or other JBPHH Officer on duty at the time of the incident

↓

Game Warden or on-duty Officer notifies the following before responding to the incident:

NOAA Fisheries Office of Law Enforcement - 1-800-853-1964

DOCARE Officer - 643-3567

USFWS Conservation Law Enforcement - 792-9549

Point of Contact

Points of contact within the Navy for enforcement of laws regarding the protection of HMS are provided to Federal and State Regulatory Agencies. These include: 1) JBPHH Police Department, 2) JBPHH Game Warden, 3) MWR Manager Kalaeloa, 4) Waterfront at Puuloa Manager, and 4) MWR Manager Hickam.

Metrics

Metrics for this action include: 1) Annual – Summary report of all reported incidences, record of training, and updates to the phone tree.

<u>Community Outreach</u>

Description

Creation of HMS education materials and planning of outreach events within the HMS Conservation Areas. Outreach will be done in coordination with NOAA staff/biologists in the Pacific Islands Regional Office Protected Resources Division and the Pacific Islands Fisheries Science Center to ensure that outreach activities and materials supplement their HMS Education and Outreach and Volunteer Programs and support their HMS conservation objectives.

Navy biologists will work with NOAA to create a list of materials required. Materials may include banners, posters, tables, chairs, brochures, and other education items such toys, magnets, books, etc. Navy will fund design of materials, purchase equipment and supplies, and host and provide labor for outreach events. At least two outreach events will be hosted annually.

Estimated budget is $10,000 for FY12 and approximately $15,000 for subsequent Fiscal Years.

Points of Contact

Points of contact within the Navy for HMS outreach will be provided to NOAA and include: 1) JBPHH Natural Resources Manager, 2) Navy Region Hawaii Regional Environmental Coordinator, 3) NAVFAC Pacific Marine Resources Specialists, and 4) JBPHH Public Affairs Officer.

Metrics

Metrics for this action include: 1) Annual – Summary report of funds spent on HMS outreach materials and labor and a description of outreach events.

HMS Monitoring

Description

All Navy HMS conservation areas, except for Hickam, are monitored daily for hauled out monk seals by NOAA volunteers who are part of the Oahu Monk Seal Response Team. When a monk seal is sighted on land, volunteers set up signage and a protection zone to protect seals from disturbance. NOAA volunteers also collect data on the monk seals, monitor pupping events, and report any seals that appear to be in distress.

Wildlife Services technicians will visit HMS conservation areas, particularly at night, to perform feral animal control, and will notify NOAA/Oahu seal sighting hotline if they observe HMS that appear to have recently hauled out and not yet been observed by NOAA volunteers (as evidenced by a lack of signs and protective zone). JBPHH Police will also notify NOAA if they see a newly hauled out seal that has not yet been found by volunteers.

Monk seal occurrences within the Hickam conservation area are rare, therefore the area is not regularly monitored for HMS. If an HMS is found in the Hickam conservation area, it will be reported to NOAA.

Points of Contact

Points of contact within Wildlife Services and Navy points of contact for HMS monitoring within conservation areas are provided to Federal and State Regulatory Agencies. These include: 1) USDA APHIS WS Technician, 2) JBPHH Natural Resources Manager, and 3) JBPHH Game Warden.

Metrics

Metrics for this action include: Annual - raw HMS occurrence data (provided to Navy by NOAA); Annual - summary of HMS occurrences on all Navy properties and managed areas (provided to NOAA by Navy).

APPENDIX M
COMMENTS/RESPONSE TO COMMENTS ON FINAL INRMP

M1 – USFWS COMMENTS ON THE FINAL JBPHH INRMP

United States Department of the Interior

FISH AND WILDLIFE SERVICE
Pacific Islands Fish and Wildlife Office
300 Ala Moana Boulevard, Room 3-122, Box 50088
Honolulu, Hawaii 96850

In Reply Refer To:
2012-TA-0254

APR 3 0 2012

Ms. Karen Sumida
Business Line Manager
Environmental
Naval Facilities Engineering Command, Pacific
258 Makalapa Drive, Suite 100
Pearl Harbor, Hawaii 96860-3134

Subject: 2011 Navy Joint Base Pearl Harbor-Hickam Integrated Natural Resources Management Plan

Dear Ms. Sumida:

Thank you for your transmittal, October 27, 2011, of the *final Integrated Natural Resources Management Plan* (INRMP) *-Joint Base Pearl Harbor-Hickam* dated September 2011 concerning conservation, protection and management of natural resources pursuant to the Sikes Act Improvement Act (16 U.S.C. 670a *et seq.*), as amended, and the Endangered Species Act of 1973 [16 U.S.C. 1531 *et seq.*; 87 Stat. 884], as amended (ESA). To this end, INRMP dated September 2011 has detailed a wide variety of natural resources and conservation goals for U.S. Navy installations on Oahu. Pursuant to the Sikes Act the INRMP must be revised every five years and this revision of the INRMP was prepared for the years 2011 through 2015. This letter transmits our comments regarding the latest version of the INRMP for Navy lands at Navy Radio Transmitter Facility (NRTF) Lualualei (NAVMAG PH), and Kalaeloa Barbers Point.

The Navy's 2001 INRMPs are the only finalized plans, the most recent INRMPs with signed tri-party memorandums of agreement pursuant to paragraph (a)(2) of the Sikes Act, for Navy lands at Lualualei and Kalaeloa Barbers Point. The Service recommended modifications to the revision drafts INRMPs via electronic mail in February and March of 2009 (Service file number 2009-TA-0093) and in February of 2010 (Service file number 2010-TA-0142) to benefit listed species and natural resources. In our review of the Navy's 2011 INRMP our analysis is to determine whether it provides a conservation benefit to the species on Navy lands. However, because neither the State of Hawaii nor the Service have signed this version of the INRMP in accordance with the tri-party memorandum of agreement, the 2011 INRMP is effectively in draft status until all partners have concurred with the revisions and updates. Since completion of the 2001 final INRMPs for Oahu Navy installations, the Navy has made significant progress in identifying management actions, recognizing the need for monitoring plans, and initial determinations of funding required for natural resource management. Although the Service supports the Navy's initial natural resource management measures included in the 2011 INRMP, we find that it does not provide an adequate conservation benefit to the species found at Lualualei and Kalaeloa Barbers Point. The reasons for this finding are summarized below, grouped by issues of concern, relating specifically to the inadequacies of the 2011 INRMP.

NAVMAG PH Lualualei and NRTF Lualualei

Issue: Control of Feral Goats
In the 2011 INRMP, goats are identified as a threat to the watershed. These animals have been observed on Lualualei Ridge, Puu Kaua above Halona Valley and at Puu Hapapa (U.S. Navy 2011, pp. 4-10, 4-47). According to the 2011 INRMP, goats were eradicated from the Lualualei area in 2001 and were not expected to reestablish in the southern part of the range; however, three years later, in 2004, goats were observed during a survey in the upper reaches of Lualualei Valley (U.S. Navy 2011, Appendix 9 NAVFAC PAC 2006D, p. 1). According to the 2011 INRMP, the Navy conducted monthly ground hunts with supplemental air operations at unspecified time periods up until 2006. The 2011 INRMP does not provide any information regarding the status of implementation of goat control actions since 2006, or information regarding surveys for, or sightings of, goats or other feral ungulates beyond the statement that [the Navy] "continues to monitor and control" (U.S. Navy 2011, p. 4-57). Based on this information we are unable to agree that goats are currently "controlled" within and unable to access Navy lands. Although goats are unlikely to access the 1.5 acres (0.61 hectares) of fenced exclosures currently maintained by the Navy to protect individuals of five endangered plants (*Abutilon sandwicense*, *Bonamia menziesii*, *Flueggea neowawraea*, *Lipochaeta lobaba* var. *leptophylla*, and *Nototrichium humile*) they are likely to access unfenced areas within the Special Management Areas (SMAs) and other unfenced Navy lands at Lualualei, some of which are proposed plant critical habitat. Therefore, in our opinion, the Navy's 2011 INRMP does not adequately address the threat posed by feral ungulates to the species and their habitat.

We recognize that the 2011 INRMP contains recommended management actions to control feral ungulates on Navy lands at Lualualei (U.S. Navy 2011, Table 9-3. Recommended Management Actions for Lualualei, p. 9-12). We fully support recommendation number 19 to "monitor, control, and exclude feral ungulates within SMAs, develop and implement a fencing strategy, and work with the Waianae Mountains Watershed Partnership to eradicate goats" (U.S. Navy 2011, p. 9-16). According to Table 9-9 (U.S. Navy 2011, p. 9-46) funding for this recommended management action is provided separately from normal operating costs, but actual funding is dependent on Navy budgets. According to this same table, significant funding for goat monitoring and control, and fence construction within SMAs will be provided beginning in fiscal year 2014 and these actions will be funded every other year until fiscal year 2020. However, the 2011 INRMP does not provide information on the location of the proposed "larger fence," (enabling us to assess the amount of area and the species it will protect), or the time line for contracting, constructing, or monitoring the fenced area. The roles of those participating in the informal partnership remain undefined, and although there is a possibility of funding recommendation number 19, the uncertainty of its implementation is high.

Ungulate barrier fences will provide a benefit to listed species and their habitat, but the timeline for that benefit is currently uncertain and unknown. We recommend you coordinate with the Service and other partners to develop plans for strategic placement of ungulate exclosure fences on Navy lands. In addition, we recommend the 2011 INRMP include a plan and budget to monitor newly fenced areas annually.

Issue: Control of Threats from Rats, Slugs, Snails and Insects
The 2011 INRMP addresses Oahu elepaio (*Chasiempis sandwichensis ibidis*) monitoring and management and impacts to plant fruits and seeds by rats in management recommendation number 5 (U.S. Navy 2011, Table 9-3, Recommended Management Actions for Lualualei, p. 9-13). In our Proposed Rule, we did not propose new critical habitat or revise the critical habitat (designated in 2001) on Navy lands for Oahu elepaio. Management recommendation number 5 includes an aerial rodenticide application project that will reduce and control rat populations in the application area to benefit the native plants by alleviating the threat of rat predation. As described in the 2011 INRMP, fencing will be completed first, to exclude feral ungulates from the area of proposed rodenticide application. Your letter indicates that construction of large-scale fenced exclosures began in 2010. Although the 2011 INRMP includes information about the two exclosures in the Puu Hapapa and Halona SMA, which together total 1.5 acres (0.61 hectares), it does not include an update on the status of the large-scale fenced exclosures. The status and management plans for large-scale fenced exclosures should be incorporated into the 2011 INRMP. We support the Navy's current participation in the environmental compliance process for rodent and mongoose control, which will enable the Navy to implement aerial rodenticide application. In addition to aerial rodenticide application, we recommend the Navy consider additional rat control methods such as bait stations and snap traps to conserve listed plants and Oahu elepaio. Areas with rare or listed plants and Oahu elepaio that are subject to rat predation would benefit from these targeted rat control actions.

Non-native snails and slugs consume listed plants and this impact is not addressed in the 2011 INRMP. Management and control of the non-native rosy wolfsnail (*Euglandina rosea*) that preys upon native Hawaiian tree snails (*Achatinella* sp.) is the only non-native snail abatement action included in the recommended management actions (U.S. Navy 2011, Table 9-3. Recommended Management Actions for Lualualei, pp. 9-14, 9-16) in the 2011 INRMP. Three endangered *Flueggea neowawraea* were reported from Navy lands in Lualualei as recently as 2004. In 2010, two of the three trees were dead, and all three trees showed signs of black-twig borer (*Xylosandrus compactus*) infestations (U.S. Navy 2011, Table 4-3. Federally-listed Plant Species, Federal Candidate Plant Species, and Federal Plant Species of Concern at NAVMAG PH Lualualei Branch, p. 4-32). The Service recommends the Navy work cooperatively with other stakeholders to provide funding to investigate methods to control this non-native insect. As described in management recommendation number 24 (U.S. Navy 2011, Table 9-3. Recommended Management Actions for Lualualei, p. 9-17), research on methods to control the black-twig borer can be supported through a cooperative agreement with the University of Hawaii, although it is unclear if the Navy intends to support all or any of this research. According to the 2011 INRMP, black-stem [twig] borer research will receive Navy funding in 2018 (U.S. Navy 2011, Table ES-6. INRMP Ten-Year Fiscal Plan, p. ES-19). In your letter, management recommendation number 25 (U.S. Navy 2011, Table 9-3. Recommended Management Actions for Lualualei, p. 9-17.) describes a peafowl (*Pavo cristatus*) seed predation study to determine the effect of peafowl in Lualualei. According to the Navy, peafowl are becoming more abundant in Lualualei and are documented to consume fruits of native tree species such as *Antidesma* sp. (hame).

Issue: Wildland Fire

According to the 2011 INRMP (p. 4-61) Navy lands in Lualualei Valley have not been recently impacted by wildland fires. While the INRMP recognizes Lualualei Valley is "dangerously prone" to brush fires it acknowledges that currently there is not a clear leadership structure or operational plan to respond to a wildfire in Lualualei (U.S. Navy 2011, p. 4-61). In 2004, a wildfire occurred at Kauaopuu on Navy lands in Lualualei where there is an occurrence of the endangered plant *Chamaesyce kuwaleana*; however, it is unclear from the information in the 2011 INRMP if the plants were impacted (U.S. Navy 2011, p. 4-30). According to the 2011 INRMP, the "threat from fire is sharply on the rise for this species" (U.S. Navy 2011, p. 4-52) and "the ongoing spread of Guinea grass (*Panicum maximum*) and molasses grass (*Melinus minutiflora*) contributes to the threat of fire." The Service supports recommended management action number 43 (September 2011 INRMP, Table 9-3. Recommended Management Actions for Lualualei, p. 9-20) which includes the development of a wildland fire management plan for Navy lands in Lualualei Valley. The Service is available to assist the Navy with the development of this plan. Funding for development of this plan is not scheduled until 2014. Until an adequate fire management plan is developed and implemented, listed species and their habitat are at significant risk of destruction or degradation from wildland fire (U.S. Navy 2011, Table 9-9. Ten-Year Fiscal Plan, p. 9-47). It is essential that the Navy develop and implement a wildland fire management plan to ensure fire prevention and fire suppression measures are adequate to protect *Chamaesyce kuwaleana* and other listed species on Navy lands in Lualualei from wildland fires.

Issue: Rare Plant Monitoring

The Service fully supports the Navy in its plan to use the best available expertise to develop and implement a program to monitor all rare plants on Navy lands at Lualualei, and to manage these species using adaptive management (U.S. Navy 2011, Table 9-3. Recommended Management Actions for Lualualei, p. 9-14). The Service is available to work with the Navy and others to develop a rare plant species monitoring plan for Navy lands in Lualualei. The Service also encourages the Navy to develop a means of collating monitoring data and providing it to cooperators, in an annual summary or report.

In your letter you refer to a project description regarding three endangered plants, *Chamaesyce kuwaleana*, *Lipochaeta lobata* var. *leptophylla*, and *Melanthera tenuifolia*. The reference to the "project description" is unclear as there is neither a recommended management action in Table 9-3 (September 2011 INRMP, Table 9-3. Recommended Management Actions for Lualualei) nor a project itemized for funding in Table 9-9 (U.S. Navy 2011, Table 9-9. INRMP Ten-Year Fiscal Plan) regarding these three endangered plants. The 2011 INRMP cites the 2004 Hawaii Natural Heritage Program Flora and Fauna Survey of NAVMAG PH Lualualei, (U.S. Navy 2011, p. 4-52) that recommended these three rare plants merit the highest priority in a rare plant management program. We recommend the 2011 INRMP include a plan and budget to monitor all rare plants on Navy lands at Lualualei annually. We support adaptive management of these species based on the annual monitoring data. Implementation of a rare plant species program would provide a benefit to listed species and their habitat at Lualualei by enabling managers to provide management needed to prevent the immediate extirpation of the individual plants, provide for future expansion of the populations of these species on Navy lands, and improve the potential for recovery of these species.

Issue: Non-native Plant Control

The 2011 INRMP provides only cursory reference to non-native plant control in Lualualei and indicates that natural resource staff continue to control invasive plants in "protected areas" (U.S. Navy 2011, p. 4-57) and in higher elevation management areas (U.S. Navy 2011, p. 4-60) to support growth and survival of native plants. It is unclear if "protected areas" and higher elevation management areas are one and the same or if these areas are SMAs. It is also unclear if non-native plants are controlled only in the 1.5 acres (0.61 hectares) of fenced exclosures, or are controlled both within and outside the fenced exclosures in the SMAs. According to recommended management action number 18, the Navy will continue to evaluate and prioritize invasive plants, with priority on biocontrol of prickly pear cactus (*Opuntia ficus-indica*) and control of newly emerging weeds (U.S. Navy 2011, Table 9-3. Recommended Management Actions for Lualualei, p. 9-16). In addition, recommended management action number 23 indicates that non-native plants will be controlled by chemical (e.g., herbicides) and manual means focused on native forest stands in the SMAs and in the immediate vicinity of listed plants throughout the "forested area" of NAVMAG PH Lualualei (U.S. Navy 2011, Table 9-3. Recommended Management Actions for Lualualei, p. 9-17). According to the 2011 INRMP, non-native plant control on all five Navy installations on Oahu is provided as one itemized project for funding (U.S. Navy 2011, Table 9-9. INRMP Ten-Year Fiscal Plan, pp. 9-41, 9-46). The amount of annual funding that will be provided for non-native plant control on NAVMAG PH Lualualei Branch and NRTF Lualualei is not specified. The Service fully supports non-native plant control in priority natural resource areas and encourages the Navy to develop and implement a plan to identify areas of highest priority on NAVMAG PH Lualualei and NRTF Lualualei for weed control. The Service is available to work with the Navy and others to develop this plan. A non-native plant control program will benefit listed species and their habitats at Lualualei by reducing the threat from species competition, and reducing the threat from wildland fire from combustable non-native plant species (e.g., *Cenchrus ciliaris* (buffle grass), *Prosopis pallida* (kiawe), and *Leucaena leucocephala* (koa haole)). This management will prevent the immediate extirpation of individual listed plants, provide for future expansion of the plant populations, and improve the potential for the recovery of these species.

Issue: *Marsilea villosa* Management

According to the 2011 INRMP, *Marsilea villosa* is found in seven occurrences on Navy lands at Lualualei: six at NRTF Lualualei and one at NAVMAG PH Lualualei (U.S. Navy 2011, Table 4-3. Federally-listed Plant Species, Federal Candidate Plant Species, and Federal Plant Species of Concern at NAVMAG PH Lualualei Branch, p. 4-34). However, location information is only given for five of the seven occurrences (U.S. Navy 2011, Figure 4-6. Federally-listed Plant Species Mapped at the Lualualei Study Area, p. 25 and Table 4-3. Federally-listed Plant Species, Federal Candidate Plant Species, and Federal Plant Species of Concern at NAVMAG PH Lualualei Branch, p. 4-34) and it is unclear if current management actions for this species are undertaken at all occurrences. According to the 2011 INRMP, all occurrences are monitored throughout the year, although the specific information collected throughout the year is not available nor described in the 2011 INRMP. The Navy's current management strategy for this plant is the placement of signs and removable posts in areas where this species occurs to protect the plants from accidental mowing, construction impacts, vehicle traffic, and trampling (U.S. Navy 2011, p. 4-57). Three occurrences are found in the NRTF Lualualei antenna fields which are mowed regularly (to reduce fire threat to the antennas); however, mowing restrictions are in place when individuals of this ephemeral plant are evident following winter rains. According to recommended management action number 13, the Navy will use hand tools to remove or control non-native *Cenchrus ciliaris* and *Prosopis pallida* around *M. villosa* and two other listed plant species (U.S. Navy 2011, Table 9-3. Recommended Management Actions for Lualualei, p. 9-15). Monitoring of the individual plants following hand removal of weeds is included in this recommendation. The status of these individual plants should be monitored annually, although it is unclear if management actions have been modified or changed based on the results of past monitoring efforts. The INRMP is unclear regarding leased lands on Lualualei. According to the 2011 INRMP, unauthorized ground clearing and accidental intrusion into the area by off-road vehicles could threaten the occurrence of *M. villosa* on NAVMAG PH Lualualei, although the lessee has been instructed not to disturb the site (U.S. Navy 2011, p. 4-57). The 2011 INRMP states that most of the land on NRTF Lualualei is suitable for animal grazing although currently there are no leases on these lands (U.S. Navy 2011, p. 4-62). The Service supports the Navy's efforts to prevent the immediate extirpation of individuals of *M. villosa* on their lands and is willing to work with the Navy to develop a management plan for this unique water fern that will benefit this species by providing for future expansion of the populations on Navy lands and improving the potential for recovery of this species.

<u>Issue: Projects to Improve Species Recovery (Plant Propagation and Outplanting)</u>
Recommended management action number 11 in the 2011 INRMP includes development of a plant propagation plan for Navy lands at Lualualei. However, *in situ* propagation and *ex situ* propagation and outplanting of listed plants to augment existing populations and reintroduce plant species to historical locations are practices not currently allowed or implemented on Navy lands (U.S. Navy 2011, Table 9-3. Recommended Management Actions for Lualualei, p. 9-14). These valuable conservation actions will require approval by the Secretary of the Navy. It is unclear if this approval has been requested. The Navy also indicates that all outplanted listed plants on Navy lands must be designated as "experimental" populations so that the affected installation will not be "further encumbered" (U.S. Navy 2011, Table 9-3. Recommended Management Actions for Lualualei, p. 9-14).

We recommend that approval from the Secretary of the Navy be requested and, if granted, that the INRMP include a plan and annual budget for propagation and outplanting of listed plants. The Service welcomes the Navy's interest in developing rare plant propagation and outplanting plan and is available to work with the Navy and others to develop a plan for NAVMAG PH Lualualei and NRTF Lualualei. Development and implementation of this plan will benefit listed species by providing for future expansion of the populations of these species on Navy lands and improving the potential for recovery of these species. The Service would also like to work with the Navy to provide clarification regarding designation of outplantings as experimental populations.

<u>Issue: Projects to Improve Species Recovery (Limited Fenced Areas)</u>
Special Management Areas are areas identified by the Navy that contain threatened and endangered plant and animal species, and concentrations of native forest or shrubland (U.S. Navy 2011, pp. 4-43–44; Appendix C1-Lualualei Botanical Projects Report (NAVFAC PAC 2006E), p. 1). The feral ungulate barrier fencing constructed in 1994, at the Halona and Puu Hapapa exclosures, encompass only 1.5 acres (0.61 hectares) (less than 0.5 percent) of the combined total area of 310 acres (125.5 hectares) of these two SMAs. These two small exclosures prevent the immediate extirpation of several individuals of three endangered plant species which were reported within these fenced areas as recently as 2006 (*Abutilon sandwicense*, *Flueggea neowawraea*, and *Nototrichium humile*). However, the two exclosures do not provide adequate area for *in situ* propagation or off-site propagation and outplanting

(neither of these action are currently implemented on Navy lands) (U.S. Navy 2011, Appendix C1-Lualualei Botanical Projects Report (NAVFAC PAC 2006E), pp. 1–3). In addition, these small fenced areas do not protect other threatened and endangered plant species from ungulate browsing and habitat degradation and destruction on Navy lands nor do they provide for future expansion of the populations of other plant species for which critical habitat is proposed on their lands. Therefore, we recommend reassessing the size of the exclosures provide adequate area for in situ propagation or off-site propagation and outplanting.

Issue: Management of Lualualei NRTF, Niulii Ponds Site

Navy management actions at the Niulii Ponds wetland area include: 1) predator trapping by U.S. Department of Agriculture; 2) waterbird surveys; and 3) management of the water level in the pond. Niulii Pond is an 8-acre (3.2-hectare) site that has supported the federally endangered Hawaiian stilt *(Himantopus mexicanus knudseni)*, Hawaiian moorhen *(Gallinula chloropus sandvicensis)*, Hawaiian coot *(Fulica alai)* and Hawaiian duck *(Anas wyvilliana)*, as well as populations of migratory waterfowl and shorebirds protected under the Migratory Bird Treaty Act. All endangered Hawaiian waterbirds have successfully nested at this location. Niulii pond is referenced as a supporting wetland for the recovery of endangered Hawaiian waterbirds in the *2011 Recovery Plan for Hawaiian Waterbirds, Second Revision.* It is our understanding the Navy is having difficulty with the water delivery system for the ponds. Loss of this pond will negatively impact endangered Hawaiian waterbirds at this site. We recommend the Navy develop a plan for the waterbird species that use Niulii pond and a timeline for completion and implementation of the plan. The plan should include improving water and vegetation management, and continued predator control and waterbird monitoring of the site.

Kalaeloa Barbers Point

Issue: *Chamaesyce skottsbergii* var. *skottsbergii* Management

Chamaesyce skottsbergii var. *skottsbergii* (Ewa plains akoko) at Kalaeloa Barbers Point is incorrectly identified as *C. kuwaleana*, which is an endangered plant found at NAVMAG PH Lualualei (U.S. Navy 2011, Table 6-2. Federally-Listed ESA Species and Species of Concern at Kalaeloa, p. 6-14). *Chamaesyce skottsbergii* var. *skottsbergii* is found on the Navy's Lot 58-D (Northern Trap and Skeet Range (NTSR)) and is included in the proposed critical habitat unit Oahu—Lowland Dry—Unit 11. As of 2008, the total number of *C. skottsbergii* var. *skottsbergii* plants within the NTSR was estimated, by the Navy, to be approximately 1,500 plants, with over 70 percent of those plants being outplanted individuals (U.S. Navy 2011, p. 6-15). The current total number of individuals of this species is estimated to be 300 to 400 wild individuals with 1,100 to 1,200 outplanted individuals on Navy, and other Federal and private lands (Guinther and Withrow 2008, pp. 6, 9–10, Whistler 2008, pp. 7–9). The 2011 INRMP includes the following recommended management actions for *C. skottsbergii* var. *skottsbergii*: avoidance of training in, and restricting access to, areas occupied by this endangered plant until the transfer of Lot 58-D is completed, fencing and signage to notify personnel of the presence of rare and protected species, and support for volunteer efforts to remove weeds around the plants (U.S. Navy 2011, Table 9-5. Recommended Management Actions for Kalaeloa, p. 9-26). Annual funding for restricting access to Lot 58-D and supporting volunteer weed efforts at Kalaeloa Barbers Point is projected to be $2,000 from 2012 to 2018, when it will increase to $3,000 annually. Annual funding for fencing and signage at Kalaeloa Barbers Point is included in the costs for Lualualei recommended management action 12 (Fencing and signage used to mark presence of rare and/or protected species) and is projected to be $2,500 from 2012 to 2020 (U.S.

Navy 2011. Table 9-9. INRMP Ten-Year Fiscal Plan, p. 9-50). We are aware the Navy is planning to transfer ownership of Lot 58-D (NTSR) to the Hawaii Community Development Authority, although this transfer has not yet occurred. The Service is currently assisting the Navy with a draft conservation plan for *C. skottsbergii* var. *skottsbergii* to ensure this population is adequately addressed and should be properly transferred to another entity. This would include implementation of the conservation plan for C. *skottsbergii* var. *skottsbergii* and the establishment of a conservation easement into perpetuity.

The Service supports the Navy's efforts to prevent the immediate extirpation of individuals of *Chamaesyce skottsbergii* var. *skottsbergii* on Navy lands through implementation of the recommended management actions listed above. However, because of the limited distribution of the species and the unknown disposition of the lands supporting the last population of wild *C. skottsbergii* var. *skottsbergii*, we maintain the 2011 INRMP does not provide an adequate conservation benefit to the species.

The Service will continue to work with the Navy to develop management plans and programs for listed species and their habitats on Navy lands. We will continue to work together to finalize the INRMP process. The following summarize our recommendations written above.

- We recommend you coordinate with the Service and other partners to develop plans for strategic placement of ungulate exclosure fences on Navy lands. In addition, we recommend the 2011 INRMP include a plan and budget to monitor newly fenced areas annually.
- In addition to aerial rodenticide application, we recommend the Navy consider additional rat control methods such as bait stations and snap traps to conserve listed plants and Oahu elepaio.
- The Service recommends the Navy work cooperatively with other stakeholders to provide funding to investigate methods to control this non-native insect that are impacting listed species.
- The Navy develop and implement a wildland fire management plan to ensure fire prevention and fire suppression measures are adequate to protect *Chamaesyce kuwaleana* and other listed species on Navy lands in Lualualei from wildland fires.
- We recommend the 2011 INRMP include a plan and budget to monitor all rare plants on Navy lands at Lualualei annually.
- The Service fully supports non-native plant control in priority natural resource areas and encourages the Navy to develop and implement a plan to identify areas of highest priority on NAVMAG PH Lualualei and NRTF Lualualei for weed control.
- Develop a management plan for *M. villosa* that will benefit this species by providing for future expansion of the populations on Navy lands and improving the potential for recovery of this species.
- We recommend that approval from the Secretary of the Navy be requested and, if granted, that the INRMP include a plan and annual budget for propagation and outplanting of listed plants.
- We recommend reassessing the size of the existing exclosures so that they can be increased to provide adequate area for in situ propagation or off-site propagation and outplanting.
- We recommend the Navy develop a plan for the endangered Hawaiian waterbird species that use Niulii pond and a timeline for completion and implementation of the plan.

- Include implementation of the conservation plan for C. skottsbergii var. skottsbergii and the establishment of a conservation easement into perpetuity.

In summary, the Service will provide technical assistance and guidance as needed to assist the Navy with effectively implementing the conservation actions described above and to develop an INRMP that addresses concerns outlined herein. We hope that these recommendations will assist the Navy in finalizing the INRMP pursuant to the Sikes Act.

We appreciate your efforts to conserve natural resources. If you have questions, please contact me by phone (808/792-9400) or by email (Loyal_Mehrhoff@fws.gov).

Sincerely,

Loyal Mehrhoff
Field Supervisor

cc: Mr. Paul Conry, Hawaii State, Division of Forestry and Wildlife
Mr. Gerry Davis, National Marine Fisheries Service, Pacific Islands Regional Office
Mr. J.P. Quinn, Energy and Environmental Readiness Division Department of the Navy

United States Department of the Interior

FISH AND WILDLIFE SERVICE

Pacific Islands Fish and Wildlife Office
300 Ala Moana Boulevard, Room 3-122, Box 50088
Honolulu, Hawaii 96850

JUL 12 2012

In Reply Refer To:
2012-TA-0355

Captain John Coronado
CEC, United States Navy
Regional Engineer
Navy Region Hawaii
850 Ticonderoga Street, STE 110
Joint Base Pearl Harbor-Hickam, Hawaii 96860-5101

Subject: Final Draft of the 2011 Joint Base Pearl Harbor-Hickam Integrated Natural Resources Management Plan Update (2011-2015)

Dear Captain Coronado:

In accordance with the Sikes Act (16 USAC 670a et seq.), the United States (U.S.) Navy Joint Base Pearl Harbor-Hickam prepared an Integrated Natural Resources Management Plan (INRMP) in 2001. Since then, we reviewed and provided comments on draft INRMPs in 2009, 2010 and most recently, a draft to the 2011 Joint Base Pearl Harbor-Hickam INRMP in 2012. In addition, pursuant to our recommendations, on June 8, 2012, you provided an Addendum to the 2011 Joint Base Pearl Harbor-Hickam INRMP. In the Addendum, additional information was provided including primary strategies to meet management goals at Lualualei and additional details regarding progress made on planned projects for endangered plants found on U.S. Navy lands at Lualualei. These additional objectives and amended actions include: (1) a survey documenting numbers and locations of endangered plant species; (2) identification of an additional population of *Marsilea villosa* in the Radio Transmitting Facility; (3) development of a *M. villosa* management plan based on recommendation strategies outlined in a dissertation, partly funded by the U.S. Navy; (4) expansion of funding for a fencing plan and fence construction for ungulate control with specified timeline; (5) completion of aerial surveys for feral goats, with plans for their removal beginning in 2013; (6) non-native plant removal within exclosures at Halona and Mikiula management areas; (7) allocation of funding for research on black twig borer control methods; (8) commitment to prioritize the production of a wildfire management plan; (9) commitment to address outplanting needs for threatened and endangered species to augment and stabilize populations within U.S. Navy property at Lualualei; and (10) allocated funding for development and implementation of a *Chamaesyce skottsbergii* var. *skottsbergii* management plan on U.S. Navy lands at Kalaeloa.

In summary, the U.S. Navy has made progress in identifying needed management actions, recognizing the need for monitoring plans, increasing initial determinations of funding required for natural resource management, and recognizing the need for propagation and outplanting of endangered and threatened plant species on U.S. Navy lands.

Based on our review and analysis: the final 2011 INRMP and 2012 Addendum (1) provide a conservation benefit to listed species if plans are implemented; (2) provide assurances that conservation management strategies will be implemented if funded at proposed levels; and (3) that conservation management strategies will be effective, in particular implementing fencing and outplanting threatened and endangered plant species to augment and stabilize populations within U.S. Navy property at Lualualei . The Service has determined that the Navy's final 2011 INRMP for Joint Base Pearl Harbor-Hickam and the 2012 Addendum provide conservation benefits to listed species that occur within the Naval Magazine Pearl Harbor Lualualei and Navy Radio Transmitter Facility Lualualei. The Service has also determined the 2011 INRMP and the 2012 addendum does not provide a conservation benefit to *Chamaesyce skottsbergii* var. *skottsbergii* on U.S. Navy lands at Kalaeloa. These determinations will be factored into pending critical habitat determinations. Future revisions or additions to critical habitat will also consider the contributions of this INRMP, implementation of this INRMP, and any additions to the INRMP (e.g. for Oahu elepaio (*Chasiempis sandwichensis ibidis*))

With regard to protection of species listed under the Endangered Species Act of 1973 [16 U.S.C. 1531 *et seq.*; 87 Stat. 884], as amended (ESA), the Service and U.S. Navy agree that the INRMP is programmatic in nature and is a planning document. For this reason, we anticipate that consultation under section 7 of the ESA will be undertaken on a project-specific basis prior to implementation of any actions.

Based on our review and coordination, this letter serves to communicate the Service and U.S. Navy are in mutual agreement with regard to the plan's content, consistent with paragraph (a)(2) of the Sikes Act.

We appreciate the U.S. Navy's effort to conserve and protect fish and wildlife resources on lands under their jurisdiction. You propose to monitor threatened and endangered species, restore native ecosystems and commit to maintaining communication with the Service through development and implementation of ongoing conservation and management plans. We look forward to working with you to implement the INRMP, which will assist achieving the concurrent goals of protecting natural resources while accomplishing the important mission of the U.S. Navy.

If you have questions, please contact Aaron Nadig, Fish and Wildlife Biologist, (phone: 808-792-9400, fax: 808-792-9581).

Sincerely,

for Loyal Mehrhoff
Field Supervisor

cc: Mr. Paul Conry, Hawaii State, Division of Forestry and Wildlife
Mr. Gerry Davis, National Marine Fisheries Service, Pacific Islands Regional Office

M2 – NOAA COMMENTS ON THE FINAL JBPHH INRMP

Review of Final Integrated Natural Resource Management Plan:
Joint Base Pearl Harbor-Hickam (Sep2011)

Comments by R. Schroeder, NOAA-PIRO-HCD (30Nov2011):

The Habitat Conservation Division (HCD) of the NOAA Fisheries Pacific Islands Regional Office (PIRO) has reviewed the Final Integrated Natural Resource Management Plan: Joint Base Pearl Harbor-Hickam. Overall, the current JBPPH-INRMP (basically an update of an earlier approved version) is a long, comprehensive, and detailed document (incl. appendices), that does an adequate job of balancing environmental protection/ marine resource/habitat conservation with supporting and maintaining military readiness. Our review focuses on potential impacts on Essential Fish Habitat (EFH) pursuant to the Magnuson-Stevens Conservation and Management Act. The Plan addresses all major environmental aspects and covers those objectives/projects of most concern to our mandate, including habitat enhancement/restoration, soil stabilization/ erosion control, marine debris, invasive species, pollution mitigation, BMPs for land management, etc. The Plan would benefit by expanding the discussion on specific management measures to be implemented, particularly in regard to EFH (e.g., fishery-dependent creel-surveys to better understand the nature and possible impacts from this activity; post-release survival?, etc.).

HCD has the following comments/recommendations for the INRMP:

Page#	Section	Parag.	Comment
ES-16	45.		"… study of effects of fishing on the harbor" – where is this project described in the Plan?
1-1/16	Chap. 1		Good listing/summary of the applicable legal mandates for Navy to consider and comply with in the Plan
1-14/15		1.10/1.11	Ecosystem approach to management and adaptive mgmt.- where are these described in terms of detailed implementation plans, specific goals/objectives, for Pearl Harbor? (cites Chap.7- but this is for Hickam only?)
			What ecosystem-based/adaptive management steps will the Navy take to reduce and/or mitigate impacts to EFH from development or maintenance projects in Pearl Harbor?
1-10	Tab. 1-1	NOAA	Change 'Mr. Alan Everson' to 'Dr. Robert Schroeder' Habitat Division Tel (808) 944-2158 robert.schroeder@noaa.gov
3-65	3.3		'Coastal Management in Pearl Harbor (see Appdx B5 for report)' – Not found (B5 is a marine mammal sightings log)
3-66	Tab. 3-6		Good to see inclusion of consideration for petitioned coral species
3-105	3.3.4.5	Corals/ fishes	'Smith et al. (2006) study … conducted in small areas… site-specific info.' – could implement a stratified (by depth, habitat type) random design survey to assess the overall conditions of marine resources/habitat in the harbor/NDSA
3-106	Coral spp.	1st	Notes no stony corals recorded on early 1970s surveys. May be an artifact of not surveying more/different types of habitats, compared to later surveys (?) Invasive gorilla seaweed – what implementation activities are proposed in the INRMP to address this problem in Pearl

			Harbor?
3-118	3.4.1		This section focuses nearly exclusively on ecosystem monitoring/ management related to protected species. Such monitoring/ mgmt. should also adequately address all affected living marine resources.
3-122	Food limitation	1st	'… PHNC serves as a de facto marine reserve... provide a source for regional fishery enhancement' – Where is there evidence for this (cite studies). Most the habitat of PH is generally poor for reef fishes (except the marine debris that serves as habitat structure to aggregate fishes from elsewhere). 'Contributes to a healthy food base for MHI seals'.- statement needs support.
3-126	Contaminants	2nd	'Pearl Harbor receives runoff and pollutants from 22% of Oahu's urban/agricultural land area.' - Following periodic episodes of heavy rains, Pearl Harbor is commonly observed to be very muddy. While this sediment run-off is largely from outside Navy jurisdiction, its impact on the health of the harbor is considerable (compared to pre-occupation baseline). Such observations put in doubt some of the statements made in this Plan about the healthy conditions of the harbor.
3-128	3.4.1.4	Biosecurity	'No policy mandating hull cleaning for alien species'. – Seems like resolving this shortcoming would be a logical objective that this INRMP should address.
3-132	3.4.2.3	Marine Resource Mgmt. & Monitoring	This should be a major section in this Plan (not just a half page). Pertinent results from Smith et al. (2006), Appdx B3, implications, and management needs/measures/plans should be summarized here. Section on EFH should be expanded to explain the requirements and how the Navy implements its mandate in this regard.
3-134	3.4.6	4th	'… those within NOAA Fisheries … who think that Pearl Harbor should be opened.. for… fishing…' – be carful of loosely throwing out generic allegations without sufficient context!
3-135	Fishing	3rd	'… unauthorized, illegal fishing/methods… occurs regularly and openly in many areas' – improving the effectiveness of enforcement should be a major objective and project (detailing implementation procedures) in this INRMP
3-135	Fishing	4th	'consumptive fishing… concern about contaminated fish and shellfish' – Plan should detail what actions/plans are being taken to reduce the toxicity in the harbor. One value of the 'purported' increasing health of Pearl Harbor and its function as a de facto marine reserve is that it exports fish to areas outside the NDSA. What is the Navy's liability if these contaminated fish are taken in adjacent state waters, open to the public, producing negative human health impacts?
8-27	Ballast water exchange	5th	'water released in port during refueling may… contain exotic organisms… not addressed in policy…' - remedying this shortcoming should be a major objective and project in this INRMP
8-28	V. Coral description/ management	4th	'Pearl Harbor supports higher fish densities and larger average fish sizes than other sites in MHI (Smith et al. 2006) - Cited report only considers transects off Lanai as representative for all of MHI. Many remote shores of MHI

8-29		2nd	also serve as de facto reserves, with abundant large fish. Comparison w/ MHI should be more representative of all the islands. Should also report on findings of similar UVC surveys (e.g., by CRED, HCRI, W. Hawaii project, etc.). (See Williams et al. 2008 Environ. Conserv.) Can't conclusively consider the harbor to be 'improving in environmental conditions' simply because more fish are attracted to more (cumulative) junk (metal debris = habitat) on the harbor floor.
8-31	Factors influencing corals	3rd	'big wave events = most signif. factor affecting coral' – Hurricanes Iwa (1982) and Iniki (1992) crushed many corals along the S. shore of Oahu to beds of loose rubble that prevented subsequent recruitment for many years (ref Grigg).
8-32			'Objectives to conserve natural resources: 3. Maintain baseline information on fishery resources' – need periodic fishery-independent creel surveys.

(Comments on Final INRMP-JBPP_30Nov11_RES.doc)

M3 – SOH DLNR DAR COMMENTS ON THE FINAL JBPHH INRMP

NEIL ABERCROMBIE
GOVERNOR OF HAWAII

WILLIAM J. AILA, JR.
CHAIRPERSON
BOARD OF LAND AND NATURAL RESOURCES
COMMISSION ON WATER RESOURCE MANAGEMENT

GUY KAULUKUKUI
FIRST DEPUTY

WILLIAM M. TAM
DEPUTY DIRECTOR - WATER

AQUATIC RESOURCES
BOATING AND OCEAN RECREATION
BUREAU OF CONVEYANCES
COMMISSION ON WATER RESOURCE MANAGEMENT
CONSERVATION AND COASTAL LANDS
CONSERVATION AND RESOURCES ENFORCEMENT
ENGINEERING
FORESTRY AND WILDLIFE
HISTORIC PRESERVATION
KAHOOLAWE ISLAND RESERVE COMMISSION
LAND
STATE PARKS

STATE OF HAWAII
DEPARTMENT OF LAND AND NATURAL RESOURCES
DIVISION OF AQUATIC RESOURCES
1151 PUNCHBOWL STREET, ROOM 330
HONOLULU, HAWAII 96813

Suspense Date: 11/30/11

Date: 11/15/11

MEMORANDUM

TO: Robert Nishimoto, Program Manager AV
Environmental and Resources Protection
THROUGH: Alton Miyasaka, Aquatic Biologist AM
FROM: Jo-Anne Kushima, Aquatic Biologist JK
SUBJECT: Review and comments on Final Joint Base Pearl Harbor-Hickam (JBPHH) Integrated Natural Resources Management Plan (INRMP), September 2011

Comment		Date Request	Receipt	Referral
Requested by:	Cory Campora (EV2CC) Department of the Navy	10/26/11	10/31/11	11/07/11

Summary of Proposed Project

Title: Final Joint Base Pearl Harbor-Hickam Integrated Natural Resources Management Plan, September 2011

Project by: Department of the Navy

Location: Pearl Harbor Naval Complex, Naval Magazine Pearl Harbor Lualualei and West Loch Branches, Naval Computer and Telecommunications Area Master Station Pacific Wahiawa, Naval Radio Transmitter Facility Lualualei, Navy-retained Lands at Kalaeloa, Hickam Air Force Base, Oahu, State of Hawaii

Brief Description: The Integrated Natural Resources Management Plan (INRMP) was developed for the United States Department of the Navy, Commander, Navy Region Hawaii for its Joint Base Pearl Harbor-Hickam (JBPHH), Oahu.

The primary purpose of this INRMP was to update the 2001 INRMPs for Pearl Harbor Naval Complex, Naval Magazine Pearl Harbor, and Naval Computer and Telecommunications Area Master Station Pacific Wahiawa and to update the 1997 Natural Resources Management Plan for Navy-retained land at the former Naval Air Station Barbers Point (now known as Kalaeloa) within the context of the operational mission of the facilities. Hickam Air Force Base came under Navy control as of October 1, 2010 as a result of the Joint-Basing process. Natural resource management at Hickam was covered in an Air Force INRMP that covered all previously held Air Force properties in Hawaii. The sections in that INRMP that pertain to those properties that are now under Navy jurisdiction have been extracted and are inserted in Chapter 7 of this INRMP.

The current plan provides a framework where natural resources are managed in accordance with the SAIA mandate to provide "no net loss in the capability of military installation lands to support the military mission of the installation." This INRMP serves three main functions:
1) serves as an information repository for natural resource information, assets and constraints;
2) provides guidance on how JBPHH is to comply with federal laws, rules, regulations, executive orders, and Department of Defense and Navy directives relating to natural resources; and
3) identifies management goals, required actions and resources necessary to protect and manage the installation's natural resources to provide the flexibility required to maintain "no net loss capability."

Chapters 1 and 2 describe the purpose and scope of the INRMP and the management strategies for implementation. The plan takes an ecosystem management approach, with special consideration given to protected species and rare habitats. It also describes the adaptive management strategy that ongoing natural resources surveys will be used to guide, and potentially change required management actions. The plan will be reviewed annually and updated every 5-years.

Implementing the INRMP is the responsibility of the JBPHH Installation Environmental Program Manager, and natural resources staff at Naval Facilities Engineering Commands Hawaii and Pacific and Commander Pacific Fleet. Updating and reviewing the INRMP will be done in cooperation with the SAIA partners: U.S. Fish and Wildlife Service, National Oceanic and Atmospheric Administration, National Marine Fisheries and the State of Hawaii, Department of Land and Natural Resources.

Comments: Table 1-1: INRMP Update Working Group Members, identifies Dan Polhemus as the contact for the Division of Aquatic Resources, Department of Land and Natural Resources (DLNR), State of Hawaii. Dan Polhemus is no longer employed by DLNR. The contact person for the Division of Aquatic Resources should be Robert Nishimoto, Program Manager for Environment and Resource Protection.

On page 391 under the section describing invertebrates, the report identifies the long spined BLACK sea urchin as *Echinothirix calamaris*. The identification of the long spined black sea urchin needs to be clarified because the long primary spines of the adult *E. calamaris* are typically banded, usually black (dark colored) and white (light colored).

The two commonly observed long spined black urchins in Hawaii are; 1) *Echinothrix diadema* which when viewed at certain angles in full sunlight, the primary spines appear an iridescent royal blue and 2) *Diadema paucispinum* whose primary spines are totally black even when viewed in the sunlight. The long primary spines of *D. paucispinum* are very thin and longer that the primary long spines of the two *Echinothrix* urchins.

The report needs to clarify WHICH long spined BLACK sea urchin it is referring to? Is it really *E. calamaris*? Or is it one of the two long spined black sea urchins; either *Echinothrix diadema* or *Diadema paucispinum*?

The State of Hawaii, Division of Aquatic Resources has been working closely with the Navy to address Invasive Species and Biosecurity issues. The cooperative program between the Navy and DAR involves notification of decommissioned vessels, barges, platforms or other objects that remain stationary for long periods of time and that are scheduled to arrive in Hawaii as well as implementation of management activities for reducing the risk of aquatic invasive species (AIS) transfer is ongoing. The Navy has budgeted for cleaning vessel hulls, ancillary gear and other surfaces in the water as well as ballast water flushing for inactive vessels coming to Hawaii.

AIS and biosecurity issues remain a high priority with DAR and even with significant budgetary cutbacks, resources are allocated for cooperative work with the Navy to continue. A Ballast Water & Hull Fouling Coordinator has been hired and will be on duty December 2011. Until then, the Aquatic Invasive Species Program Leader is the point of contact for AIS and bio-security issues. Phone: (808) 256-3095.

Based on the information provided, the Final Report does not appear to raise any concerns that relate to the protection, conservation, sustainability and management of natural aquatic resources on the DOD installations described in the report.

DEPARTMENT OF THE NAVY
COMMANDER
NAVY REGION HAWAII
850 TICONDEROGA ST STE 110
JBPHH, HAWAII 96860-5101

5750
Ser N45/ 1432
October 26, 2011

Mr. Francis G. Oishi
Division of Aquatic Resources
1151 Punchbowl Street, Room 330
Honolulu, HI 96813

DAR 4095
AMV
JK
FYI

Dear Mr. Oishi:

SUBJECT: FINAL JOINT BASE PEARL HARBOR-HICKAM INTEGRATED NATURAL RESOURCES MANAGEMENT PLAN, SEPTEMBER 2011

We are forwarding a copy of the final Joint Base Pearl Harbor-Hickam (JBPHH) Integrated Natural Resources Management Plan (INRMP), September 2011 for your review and use. This document serves as a consolidated update of the 2001 Pearl Harbor INRMP, 2001 Naval Magazine (NAVMAG) INRMP, 2001 Naval Computer and Telecommunications Area Master Station (NCTAMS) INRMP, and the 1997 Naval Air Station (NAS) Barber's Point INRMP. The JBPHH INMRP also includes information on the former Hickam Air Force Base. Finalization of the JBPHH INRMP meets the statutory requirements of the Sikes Act Improvement Amendments (SAIA) of 1997 and provides CNRH with the necessary resource information to support sound land use decisions and natural resources management on Oahu Navy lands.

Federal, State, and City and County resource agencies were afforded opportunities to review the preliminary draft (2008) and the public review draft (2009). Comments and Navy responses to comments are provided in Appendices J and K respectively. We ask that you provide a letter of concurrence with the Final JBPHH INRMP no later than 30 November 2011. A negative reply is requested if you do not concur with the document.

All questions pertaining to this project should be directed to my point of contact, Mr. Cory Campora (EV2CC) at (808) 471-1170, ext 244 or by e-mail at cory.campora@navy.mil

Sincerely,

D. R. Bustamante
Captain, CEC, U.S. Navy
Regional Engineer, Acting
By direction of the
Commander

Enclosure: 1. CD containing Integrated Natural Resource management Plan.

M4 – SOH DLNR OCCL COMMENTS ON THE FINAL JBPHH INRMP

NEIL ABERCROMBIE
GOVERNOR OF HAWAII

WILLIAM J. AILA, JR.
CHAIRPERSON
BOARD OF LAND AND NATURAL RESOURCES
COMMISSION ON WATER RESOURCE MANAGEMENT

GUY H. KAULUKUKUI
FIRST DEPUTY

WILLIAM M. TAM
DEPUTY DIRECTOR - WATER

AQUATIC RESOURCES
BOATING AND OCEAN RECREATION
BUREAU OF CONVEYANCES
COMMISSION ON WATER RESOURCE MANAGEMENT
CONSERVATION AND COASTAL LANDS
CONSERVATION AND RESOURCES ENFORCEMENT
ENGINEERING
FORESTRY AND WILDLIFE
HISTORIC PRESERVATION
KAHOOLAWE ISLAND RESERVE COMMISSION
LAND
STATE PARKS

STATE OF HAWAII
DEPARTMENT OF LAND AND NATURAL RESOURCES

OFFICE OF CONSERVATION AND COASTAL LANDS
POST OFFICE BOX 621
HONOLULU, HAWAII 96809

REF: OCCL: AJR

COR: OA-12-107

NOV - 9 2011

Cory Campora (EV2CC)
Department of the Navy
Naval Facilities Engineering Command, Pacific
258 Makalapa Dr., Ste. 100
Pearl Harbor, HI 96860-3134

SUBJECT: *Comments for Final Joint Base Pearl Harbor-Hickam Integrated Natural Resources Management Plan, September 2011*
Pearl Harbor, Honolulu County, Hawaii

Dear Mr. Campora,

The Department of Land and Natural Resources (DLNR), Office of Conservation and Coastal Lands (OCCL) is in receipt of your letter requesting comments on the Final Joint Base Pearl Harbor-Hickam Integrated Natural Resources Management Plan (JBPHH INRMP).

A review of the management plan reveals that there are lands within the area covered by the INRMP that are within the Conservation District Resource and Protective Subzones. **Exhibit A** is a map which outlines the Conservation District Lands located in the vicinity of the West Loch; **Exhibit B** map reveals only one small area of Conservation District lands in the vicinity of the East Loch. We look forward to working with your office on any necessary permits for land uses within the Conservation District.

The Office of Conservation and Coastal Lands (OCCL) would like to reiterate comments made during the draft INRMP on *February 9, 2009* concerning management plans, community outreach and best management practices (BMP).

1. There are four historic fishponds that are part of the *Pearl Harbor Wetlands*, we support the Navy's development of a community outreach program to monitor the Loko Pa'aiau, Loko Laulaunui, Loko Pamoku, and Loko 'Oki'okiolepe extant fishponds;

2. The OCCL supports the plan to integrate comprehensive mangrove removal in an effort to provide protection for fishpond walls at Pearl Harbor and nearby areas;

3. The OCCL supports specific management programs at the refuge which include the maintenance of manmade ponds and wetlands, predator control, and the reduction of human disturbances to restore wetland habitat while retaining wetland function. If necessary, the program should promote the control and management of vegetation in order to preserve and protect the fishpond walls; and

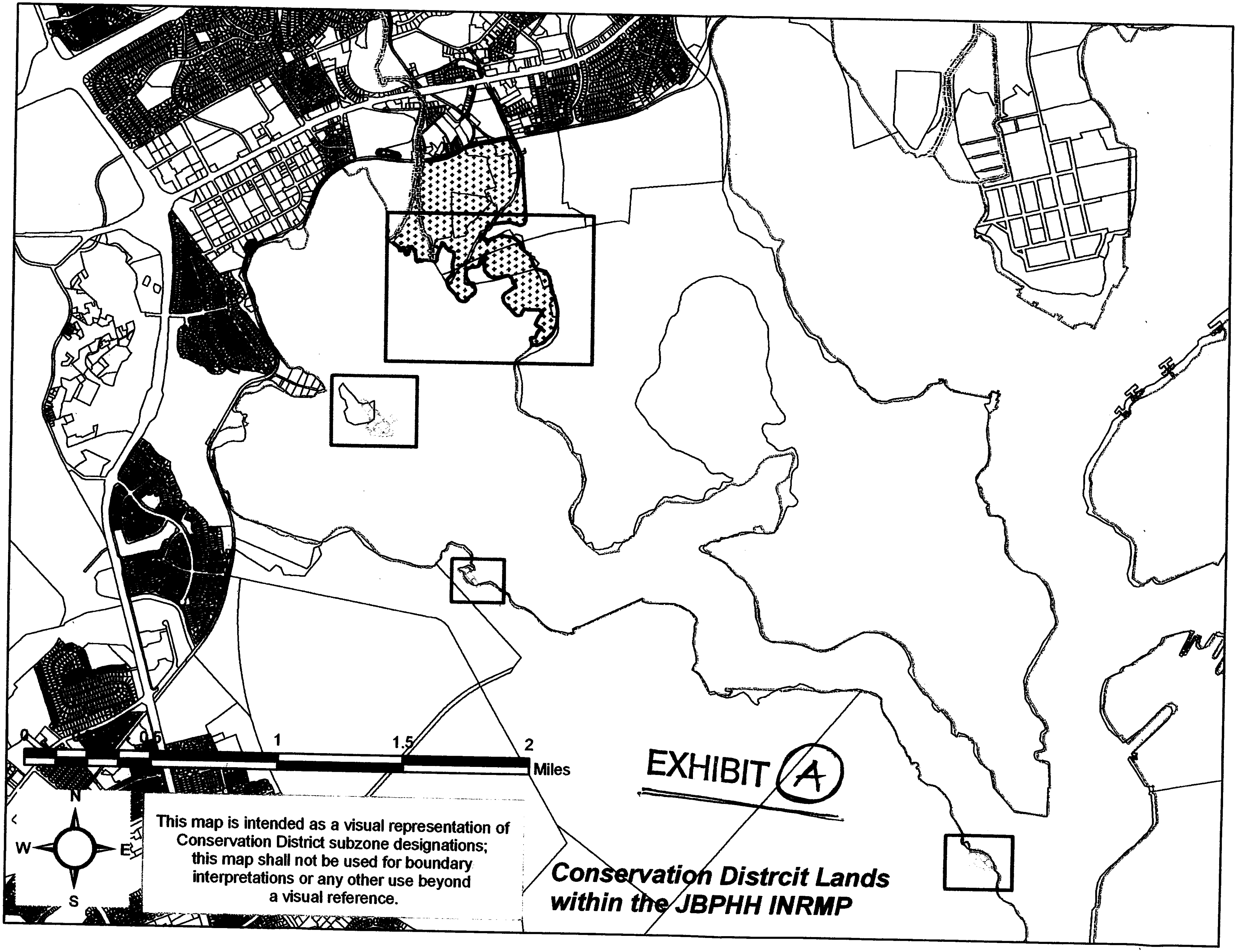
4. Promoting adequate setbacks for near shore, riparian, stream and wetland resources to limit the amount of potential impacts by the public that will allow for natural vegetation to flourish is an important natural resource management tool

Should you have any further questions about these comments or require additional information, please contact Alex J. Roy of the Office of Conservation and Coastal Lands at 808-587-0316

Sincerely,

Samuel J. Lemmo, Administrator
Office of Conservation of Coastal Lands

CC: Chairperson
C&C DPP
ODLO
DOFAW
DAR


0
0.5
1
1.5
2
Miles
EXHIBIT A
N
W
E
S
This map is intended as a visual representation of Conservation District subzone designations; this map shall not be used for boundary interpretations or any other use beyond a visual reference.
Conservation Distrcit Lands within the JBPHH INRMP

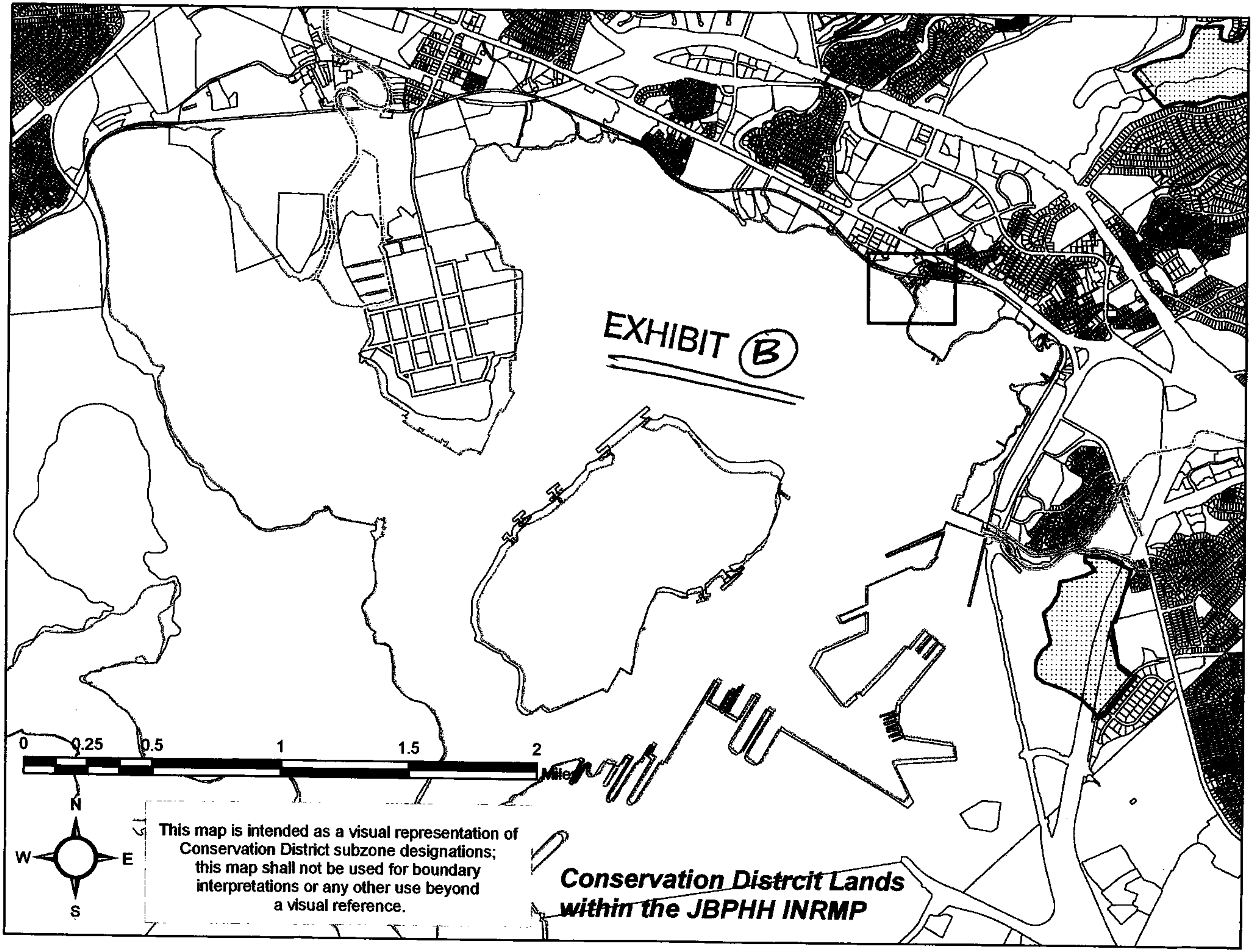


EXHIBIT B
0
0.25
0.5
1
1.5
2
Miles
N
W
E
S
This map is intended as a visual representation of
Conservation District subzone designations;
this map shall not be used for boundary
interpretations or any other use beyond
a visual reference.
Conservation Distrcit Lands
within the JBPHH INRMP

M5 – SOH DBEDT CZM COMMENTS ON THE FINAL JBPHH INRMP

NEIL ABERCROMBIE
GOVERNOR
RICHARD C. LIM
DIRECTOR
MARY ALICE EVANS
DEPUTY DIRECTOR
JESSE K. SOUKI
DIRECTOR
OFFICE OF PLANNING

DEPARTMENT OF BUSINESS, ECONOMIC DEVELOPMENT & TOURISM

OFFICE OF PLANNING

235 South Beretania Street, 6th Floor, Honolulu, Hawaii 96813
Mailing Address: P.O. Box 2359, Honolulu, Hawaii 96804

Telephone: (808) 587-2846
Fax: (808) 587-2824

Ref. No. P-13448

November 2, 2011

D. R. Bustamante
Captain, CEC, U.S. Navy
Regional Engineer, Acting
Navy Region Hawaii
850 Ticonderoga Street, Suite 110
JBPHH, Hawaii 96860-5101

Attention: Mr. Cory Campora (EV2CC)

Dear Captain Bustamante:

Subject: Hawaii Coastal Zone Management (CZM) Program Review of the Final Joint Base Pearl Harbor-Hickam (JBPHH) Integrated Natural Resources Management Plan (INRMP), September 2011

This responds to your request for Hawaii CZM Program review and concurrence with the Final JBPHH INRMP. According to the INRMP (p. 1-2), it is "intended to be a technical document to be used in the preparation of JBPHH approvals, management actions, orders, instructions, guidelines, standard operating procedures, and other planning documents." "It provides technical guidance for the integration of natural resource issues into planning and decision-making processes." Because the INRMP is a technical document and does not in itself cause or have any coastal effects, the INRMP does not require CZM federal consistency review and concurrence. However, we do agree with the INRMP statement (p. 1-8): "As specific natural resource projects are proposed and screened for applicability they will be submitted to the SOH CZM Program for consistency review, if required." Implementation of individual INRMP actions which have a reasonably foreseeable effect on any coastal use or resource are required to be submitted for Hawaii CZM Program federal consistency review, pursuant to 15 CFR 930, Subpart C.

We appreciate the opportunity for the CZM Program to participate as a member of the INRMP Working Group. If you have any questions, please call John Nakagawa of our CZM Program at 587-2878.

Sincerely,

Jesse K. Souki
Director

M6 – CCH DPP COMMENTS ON THE FINAL JBPHH INRMP

DEPARTMENT OF PLANNING AND PERMITTING
CITY AND COUNTY OF HONOLULU
650 SOUTH KING STREET, 7TH FLOOR • HONOLULU, HAWAII 96813
TELEPHONE: (808) 768-8000 • FAX: (808) 768-6041
DEPT. WEB SITE: www.honoluludpp.org • CITY WEB SITE: www.honolulu.gov

PETER B. CARLISLE
MAYOR

DAVID K. TANOUE
DIRECTOR

JIRO A. SUMADA
DEPUTY DIRECTOR

2011/ELOG-2459 (rns)

November 30, 2011

D. R. Bustamante
Captain, CEC, U. S. Navy
Regional Engineer, Acting
850 Ticonderoga Street, Suite 110
JBPHH, Hawaii 96860-5101

Dear Captain Bustamante:

Subject: Concurrence with the Final Joint Base Pearl Harbor-Hickam Integrated Natural Resources Management Plan, September 2011

We have reviewed the **Final Joint Base Pearl Harbor-Hickam Integrated Natural Resources Management Plan** (September 2011) as requested in your letter referenced 5750 Ser N45/ 1428 and dated October 26, 2011.

The **Integrated Natural Resources Management Plan** (INRMP) is generally consistent with the City's long-range policy plans, including the **O'ahu General Plan**, and the development plans for the areas covered by the INRMP (the Primary Urban Center, Central O'ahu, 'Ewa, and Wai'anae).

We note that our July 7, 2010 letter with attached comments on the Draft INRMP was not incorporated in Appendix J. We have included a copy of that letter for your information. We would be interested in the Navy's responses to the areas where City policies may differ slightly from those in the INRMP.

Specifically, those included:

- The extent of access to the East Loch proposed in the **Primary Urban Center Development Plan** may be more than is allowed under the INRMP;
- The extent of access to the West Loch and Middle Loch proposed in the **Central O'ahu Sustainable Communities Plan** (CO SCP) is more than is allowed under the INRMP; and

- The storage of dredged material on the Waipi'o Peninsula may adversely impact the area's potential for agricultural use which is the desired long-term use called for by the CO SCP.

Thank you for the opportunity to provide comments on the INRMP. We appreciate the effort to consult us and to work with us to protect the natural resources of our island.

Very truly yours,

fr David K. Tanoue, Director
Department of Planning and Permitting

DKT:js

895292

Attachment: Department of Planning and Permitting July 7, 2010 letter to
Naval Facilities Engineering Command, Pacific

DEPARTMENT OF PLANNING AND PERMITTING
CITY AND COUNTY OF HONOLULU
650 SOUTH KING STREET, 7TH FLOOR • HONOLULU, HAWAII 96813
TELEPHONE: (808) 768-8000 • FAX: (808) 768-6041
DEPT. WEB SITE: www.honoluludpp.org • CITY WEB SITE: www.honolulu.gov

MUFI HANNEMANN
MAYOR

DAVID K. TANOUE
DIRECTOR

ROBERT M. SUMITOMO
DEPUTY DIRECTOR

2010/ELOG-112(HS)

July 7, 2010

Mr. Cory Campora
Department of the Navy
Naval Facilities Engineering Command, Pacific
258 Makalapa Drive, Suite 100
Pearl Harbor, Hawai'i 96860-3134

Dear Mr. Campora:

Subject: Comments on the Public Review Draft of the Naval Station Pearl Harbor Hawai'i Integrated Natural Resources Management Plan

Thank you for the opportunity to provide these late comments on the Public Review Draft of the Naval Station Pearl Harbor Hawai'i Integrated Natural Resources Management Plan (INRMP).

In general, the INRMP is consistent with the City's Long-Range Policy Plans, and the General Plan. These plans are available on our website, http://www.honoluludpp.org/.

A final comment suggests that the discussion of the impact of sea level rise, raised in the INRMP discussion of potential negative impacts on Monk Seal Habitat, might be extended to include an assessment of impacts on other natural resources management objectives.

If you have any question about these comments, please feel free to contact Hal Senter of my staff at 768-8055 or by e-mail at hsenter@honolulu.gov.

Very truly yours,

for David K. Tanoue, Director
Department of Planning and Permitting

DKT:lh
762789

COMMENTS ON THE PUBLIC REVIEW DRAFT
INTEGRATED NATURAL RESOURCE MANAGEMENT PLAN (INRMP)
NAVAL STATION PEARL HARBOR (January 12, 2010)

COMMENTS

1. The City Council adopted the **Primary Urban Center Development Plan** (PUC DP) in 2004. It provides a vision for the PUC's development, and policies and guidelines regarding desirable uses for Pearl Harbor from the Pearl City Peninsula to Holakahiki Point. The existing Plan is available on-line at: http://honoluludpp.org/Planning/DevSust_PrimaryUrbanCenter.asp .

   Pertinent policies and guidelines from the PUC DP include:
   - **Vision Element**: Honolulu's Natural, Cultural, and Scenic Resources are Protected and Enhanced (Section 2.1)
     - Protect and preserve shorelines and natural resources that lie within the urban area.
     - Assure and continually enhance physical access to the shoreline.
     - Provide "promenades, bikeways, and opportunities for entertainment" along the Pearl Harbor waterfront.
   - **Policy**: Protecting and Enhancing Natural, Cultural, and Scenic Resources (Sec. 3.1.2)
     - Preserve historic and cultural sites
     - Preserve and protect natural resource and constraint areas
     - Preserve panoramic views of natural landmarks and the urban skyline
     - Improve access to shoreline areas
     - Provide "continuous lateral access ... around the East Loch of Pearl Harbor, where urban activity is most intense
   - **Guideline**: "Provide continuous lateral shoreline access for pedestrians extending . . . from Neal S. Blaisdell Park through Aiea Bay State Recreation Area." (Sec. 3.1.3.4)
     - "Along the Pearl Harbor shoreline in Aiea and Pearl City, acquire privately owned properties and the Navy-owned McGrew Point *makai* of the Pearl Harbor bikeway for recreational use, and/or encourage complementary redevelopment with incentives for higher zoning in return for view corridors, extra open space, public amenities, and public access to the shoreline."
   - **Vision Element:** Honolulu is the Pacific's Leading City and Travel Destination (Sec. 2.4)
     - "Residents and visitors also enjoy the broad waterfront of Pearl Harbor's East Loch."
     - "The historic OR&L bikeway and promenade links extensive parks, including Aiea Bay State Recreation Area, the new park at McGrew Point, and an expanded Neal Blaisdell Park."

- **Policy**: The Pacific's Leading City (Sec. 3.4)
  - Create public open space along the Pearl Harbor waterfront and strengthen the physical and visual connections between the urban center and the water
  - Improve mauka-makai pedestrian and bicycle circulation across Kamehameha Highway
  - Support continuation of military uses
  - Integrate civilian and military residential communities through use of connecting roadways, bikeways, walkways, landscape features
- **Policy**: Water Allocation and System Development (Sec. 4.1)
  - Integrate resource management of all potable and nonpotable water sources including groundwater, stream water, storm water, and wastewater effluent.
  - Protect and maintain watersheds to ensure an adequate supply of high quality water with sufficient infiltration recharge into groundwater aquifers.
- **Policy**: Stormwater Systems (Sec. 4.6)
  - Require methods of retaining of detaining stormwater for gradual release into the ground as the preferred strategy for the management of stormwater. Where feasible, utilize open spaces including parking lots, landscaped areas, and volume and runoff rates.
  - Preserve stream and estuarine habitats.

  Comment: The management objectives and actions recommendations of the INRMP appear to be compatible with the PUC DP vision, policies and guidelines although the extent of access to the East Loch proposed in the PUC DP may be more than would be allowed under the INRMP.

2. The City Council adopted the **Central O'ahu Sustainable Communities Plan** (CO SCP) in 2002. It provides a vision for Central Oahu's development and policies and guidelines regarding desirable uses for Pearl Harbor along the shoreline in Central O'ahu from the Pearl City Peninsula to West Loch Shoreline Park. The CO SCP is currently under review for updates and revisions, and a public review draft of a proposed revised CO SCP is scheduled to be released in the near future. The existing Plan is available on-line at: http://honoluludpp.org/Planning/DevSust_CentralOahu.asp .

   Pertinent vision elements, policies and guidelines from the CO SCP include:
   - **Vision Element**: Creation of An Open Space Network (Sec. 2.1)
     - Protect prime agricultural lands . . . on the Waipio Peninsula for diversified agriculture . . .
     - Develop a Shoreline Park and Preservation area along the entire shoreline in Pearl Harbor's West Loch and Middle Loch to restore the shoreline in Waipahū to public use, provide active and passive recreation facilities, and help create the Pearl Harbor Historic Trail ... running from Rainbow Marina near Aloha Stadium to the Wai'anae Coast.

- **Policy**: Open Space Preservation and Development. (Sec. 3.1)
  - Provide long range protection for diversified agriculture . . . on lands outside the Urban Community Boundary . . .
  - Protect scenic views and provide recreation
- **Guideline**: Shoreline Areas (Sec. 3.1.4.3)
  - Provide public access to the Pearl Harbor shoreline at intervals of approximately one mile, except where access is restricted by the military for security reasons.
  - Maintain and enhance nearshore wetlands and mangroves, where necessary, as wildlife habitats.
- **Guideline**: Parks (Sec. 3.1.4.5, also 3.2.3.1)
  - Establish a major new shoreline park at Waipio Peninsula, giving access from Waipahū to the Pearl Harbor shoreline on the West Loch and Middle Loch.
- **Policy**: Military Areas: Pearl Harbor Naval Base (Waipio Peninsula) (Sec. 3.12.1.2)
  - Continue use of the Waipio Peninsula lands for diversified agriculture or aquaculture activities
  - Allow expansion of limited public access to the shoreline waters of West Loch beyond the West Loch Shoreline Park
  - Retain and enhance wetland areas along the Pearl Harbor shoreline.

  Comment: As shown on Figure 2-1 (p. 2-8), the INRMP identifies only areas in the East Loch and the Middle Loch as open to public catch-and-release fishing, and describes recreational opportunities at West Loch as either non-existent or severely limited due to access restrictions. The INRMP recognizes the Pearl Harbor Historic Trail (describing it as the Pearl Harbor Bike Path) and notes that a portion runs on Navy property from the Arizona Memorial Center to the Waipio Point Access Road.

- **Vision Element**: Conservation of Natural Resources (Sec. 2.1)
- **Policy**: Conserve natural resources by retention of natural drainageways, protection of valuable plant and wildlife habitats, and supporting efforts to minimize degradation of protection provided to the environment by the Conservation District. (Sec. 2.1)
- **Policy**: Identify and protect endangered species habitats and other important ecological zones from threats such as fire, weeds, feral animals, and human activity. (Sec. 2.2.8)
- **Policy**: Design the regional drainage and wastewater treatment system to minimize non-point source pollution of the ocean and Pearl Harbor. (Sec. 2.2.8)
- **Policy**: Protect valuable habitats for endangered waterbirds located on the shoreline of Pearl Harbor at Pouhala Marsh and Pearl Harbor Ponds. (Sec. 2.2.8)
- **Policy**: Maintain and enhance nearshore wetlands and mangroves where necessary as wildlife habitats. (Sec. 3.1.4.3)
- **Policy**: Retain, protect, and incorporate wetland and other wildlife habitat areas as passive recreation resources [in sports and recreation complexes]. (Sec. 3.2.3.2)

- o **Policy**: Protect and enhance wetlands along the West Loch and Middle Loch shorelines. (Sec. 3.12.3.2)
  Comment: The IRMP's management programs and actions, based on extensive analysis of potential impacts on wildlife habitat, are consistent with the EDP policies and guidelines.

- o **Vision Element**: Protection of Agricultural Lands
- o **Policy**: Protect agricultural lands to create an opportunity for long-term retention and development of diversified agriculture on small farms, corporate lands, and agricultural parks. (Sec. 2.2.1)
- o **Policy**: Provide long-range protection for diversified agriculture . . . (Sec. 3.1.1)
- o **Policy**: Permit facilities necessary to support intensive cultivation of arable agricultural lands. (Sec. 3.1.4.4)
- o **Policy**: Continue agricultural uses on the Waipio Peninsula within the Explosive Safety Quantity Distance (ESQD) zone for the Pearl Harbor Naval Munitions Command. (Sec. 3.12.3.2)
  Comment: The Navy has been using the lower portions of the Waipi'o Peninsula to store dredged material which may adversely impact the area's potential for agricultural use.

Comment: The management objectives and actions recommendations of the INRMP appear to be compatible with the CO SCP policies and guidelines, with the possible exception of the storage of dredged material on the Waipi'o Peninsula.

3. The City Council adopted the **Ewa Development Plan** (EDP) in 1997. It provides a vision for Ewa's development and policies and guidelines regarding desirable uses for Pearl Harbor along the shoreline in Ewa from West Loch Shoreline Park to Iroquois Point. It also includes policies and guidelines for Kalaeloa. The EDP is currently under review for updates and revisions, and a proposed revised EDP is scheduled to be transmitted to the Planning Commission and City Council in the near future. The existing Plan is available on-line at: http://honoluludpp.org/Planning/DevSust_Ewa.asp .

   Pertinent policies and guidelines from the EDP include:
   - o **Vision Element**: Creation Of An Open Space Network (Sec. 2.1)
     - o Protect prime agricultural lands . . . within the West Loch Naval Magazine Blast Zone for diversified agriculture.
     - o Provide easy access to the ocean with a shoreline walkway from Ko Olina to Ewa Beach.
     - o Provide access to beaches and swimming and surfing spots all along the entire Ewa coastline by road or a network of pedestrian paths and bikeways.
     - o Preserve open space in parks, golf courses and agricultural areas which will also help to protect significant vistas.
     - o Retain wildlife habitats at Kalaeloa, Ocean Pointe, and West Loch.

- **Policy**: Kalaeloa - Create a continuous pedestrian route along the entire 'Ewa Coast by reserving the entire shoreline of Kalaeloa for public access and recreation, and linking to adjacent pathways in Ocean Pointe/Hoakalei and Campbell Industrial Park. (Sec. 3.1 and 3.2)
  Comment: The INRMP calls for continued public recreational use of Nimitz Beach and White Sands Beach at Kalaeloa. This is congruent with Ewa DP policies.
- **Policy**: West Loch - Expand limited public access to the shoreline waters of West Loch beyond the West Loch Shoreline Park. (Sec 3.7.5)
  Comment: While promoting shoreline pedestrian access, the Ewa DP also recognizes that restrictions may be necessary to support the Navy's mission.
- **Policy**: Wetland areas – Retain and enhance wetland areas along the Pearl Harbor shoreline. (Sec 3.7.5)
  Comment: The INRMP's management programs and actions, based on extensive analysis of potential impacts on wildlife habitat, are consistent with the EDP policies and guidelines.
- **Policy**: West Loch – Support agricultural operations in the ESQD area (Sec 2.2.2)
  Comment: As there are no federal or Hawaii listed threatened and/or endangered plant species at NAVMAG-PH West Loch, the area within the ESQD remains suitable for outleasing for agricultural operations. (Section 3.3.5.6) Currently, 1,025 acres are leased till March 31, 2023. (Section 3.4.14 – p 135) The Navy's continuation of agricultural leasing in the NAVMAG PH West Loch ESQD area is supported by the relevant Ewa DP policies and guidelines.

4. The City Council adopted the **Wai'anae Sustainable Communities Plan** (WSCP) in 2000. It provides policies and guidelines regarding desirable uses for the open space and agricultural areas at Wai'anae, including those in the Lualualei INRMP study area. The WSCP is currently under review for updates and revision, and proposed revised WSCP is scheduled to be transmitted to the Planning Commission and City Council in the near future. The existing Plan is available on-line at: http://honoluludpp.org/Planning/DevSust_Waianae.asp .

- **Vision Element**: Preservation of the rural landscape and the country lifestyle of the Wai'anae People.
- **Vision**: Preservation of the rural community (Sec. 2.3)
- **Vision**: Ahupua'a/ecosystem-based planning (Sec 2.5)
- **Vision**: Environmentally appropriate development (Sec 2.6)
  - potable water imported now; need to develop nonpotable water sources
  - special natural and cultural resources needing protection
- **Vision**: Confine growth within rural community boundary (Sec 2.7.2)
- **Vision**: Develop an alternative to Farrington Highway (Sec 2.7.9)
- **Vision**: Protect and restore natural streams and stream corridors (Sec 2.7.5)
  - Enforce No Dumping rule

- Require siltation basins and other means to control urban and agricultural stormwater runoff
- Restore natural vegetation within stream floodplain areas

- **Policy**: Sec. 3.2: Preserve open space by limiting urban development to the Rural Community area
- **Policy**: Sec. 3.4: Preserve mountain forest land
  - Restore endemic and indigenous forest plants and animals
  - Protect habitat for rare species
- **Policy**: Sec. 3.5: Preserve streams and stream corridors
  - Establish stream conservation corridors, including
    - Ulehawa Stream
    - Māʻiliʻili Stream
  - Restrict uses within stream corridors
  - Establish Minimum in-stream flow standards
- **Policy**: Sec. 3.6: Preserve Historic and Cultural Sites
  - Preserve cultural landscapes in the upper reached of the valley
  - Preserve other cultural sites in other areas wherever possible
- **Policy**: Sec. 3.7: Preservation of Agricultural Lands
  - Establish a boundary for important agricultural lands
  - Limit land use to agricultural and related compatible activities
  - Restrict incompatible non-agricultural land uses
  - Use zoning and taxation to help support agricultural uses
- **Policy**: Sec. 3.12: Military Land Use
  - Preserve military lands as agricultural/open space
  - Recognize continued use of lands for military purposes
  - Continue cooperative programs with military for preservation of cultural/natural resources on military lands
- **Policy**: Sec. 4.1: Transportation Systems
  - Establish an emergency road as alternate to Farrington Highway
  - Construct a reliever road parallel to Farrington Highway
- **Policy**: Sec. 4.2: Potable Water System
  - Determine safe yield of aquifers as related to stream flow
  - Promote efficient use of available water supplies
  - Establish program for affordable water for agriculture
- **Policy**: Sec. 4.5: Drainage Systems
  - Prepare comprehensive study of local flooding and drainage problems
  - Avoid degradation of coastline an near shore water quality
  - Integrate drainage improvements with open space network
  - Pursue program of sediment control to protect water quality

5. The Public Review Draft on pages 3-75 to 3-77 mentions the potential negative impact of sea level rise on Monk Seal habitat near Iroquois Point. No other mention is made of the impact that sea level rise would have on other species.

Comment: The impact of sea level rise on the surrounding Pearl Harbor environment deserves broader discussion including possible methods of adaptation and mitigation. For assumptions to use regarding potential sea rise, we suggest that you might use the scenarios that the Army Corps of Engineers is using in its assessment of the Ala Wai Watershed Project.

762789

APPENDIX N
ADDENDUM TO THE INRMP DATED JUNE 2012

DEPARTMENT OF THE NAVY
COMMANDER
NAVY REGION HAWAII
850 TICONDEROGA ST STE 110
JBPHH, HAWAII 96860-5101

5750
Ser N45/0583
June 7, 2012

CERTIFIED MAIL NO. 7010 2780 0003 1014 0334

Dr. Loyal Mehrhoff
Field Supervisor
Pacific Islands Fish & Wildlife Office
300 Ala Moana Boulevard
Box 50098
Honolulu, HI 96850

Dear Dr. Mehrhoff:

SUBJECT: ADDENDUM TO 2011 JOINT BASE PEARL HARBOR-HICKAM INTEGRATED NATURAL RESOURCES MANAGEMENT PLAN

We would like to thank you and your staff for taking the time to discuss the subject matter with representatives of Commander, Navy Installations Command, Naval Facilities Engineering Command (NAVFAC) Headquarters, NAVFAC Pacific and NAVFAC HI. The enclosed Addendum provides additional information for Navy-owned parcels at Navy Munitions Command East Asia Division Detachment Joint Base Pearl Harbor-Hickam Lualualei Annex (formerly known as NAVMAG PH Lualualei Branch), Naval Radio Transmitter Facility (NRTF) Lualualei, and Kalaeloa at the former Naval Air Station Barbers Point.

This information will be incorporated in the Joint Base Pearl Harbor-Hickam Integrated Natural Resources Management Plan. We will continue to work with your office and seek your concurrence on this important document.

We appreciate your accommodation and consideration concerning the Navy's request to exclude NAVMAG PH Lualualei Branch, NRTP Lualualei, and Kalaeloa from plant critical habitat designation. We look forward to your feedback.

Should you have any questions, please contact Dr. Cory Campora, (808) 471-1171, extension 244 or email cory.campora@navy.mil.

Sincerely,

J. Coronado

J. CORONADO
Captain, CEC, U.S. Navy
Regional Engineer
By direction of the
Commander

5750
Ser N45/0583
June 7, 2012

Enclosure: 1. Addendum to the September 2011 Final Integrated Natural Resource Management Plan-Joint Base Pearl Harbor-Hickam.

Copy to: NAVFAC Hawaii (ARE, OPHE2)
NAVFAC Pacific (EV22)

Addendum to the

Integrated Natural Resource Management Plan

Joint Base Pearl Harbor-Hickam

Navy Munitions Command East Asia Division Detachment Joint Base Pearl Harbor-Hickam Lualualei Annex,
Naval Radio Transmitter Facility Lualualei, and
Kalaeloa (Former Naval Air Station Barber’s Point)
O‘ahu, State of Hawai‘i

Commander Navy Region Hawaii
June 2012

Table of Contents

List of Figures

List of Tables

1.0 Introduction and Overview

This Addendum has been prepared in accordance with and is officially incorporated as part of the JBPHH INRMP (September 2011) to address the proposed critical habitat designations for 42 plant species including *Abutilon sandwicense, Alectryon macrococcus, Bonamia menziesii, Cenchrus agrimonioides, Chamaesyce herbstii, C. kuwaleana, Cyanea acuminata, C. calycina, C. grimesiana* ssp. *obatae, Cyperus trachysanthos, Diellia falcata, D. unisora, Flueggea neowawraea, Gouania meyenii, Hesperomannia arbuscula, Kadua parvula, Labordia cyrtandrae, Lepidium arbuscula, Lipochaeta lobata* var. *leptophylla, Lobelia niihauensis, L. oahuensis, Marsilea villosa, Melicope christophersenii, M. pallida, M. saint-johnii, Neraudia angulata, Nototrichium humile, Phyllostegia hirsuta, Plantago princeps* var. *princeps, Platydesma cornuta* var. *decurrens, Pleomele forbesii, Pteralyxia macrocarpa, Sanicula mariversa, Schiedea hookeri, S. kaalae, S. trinervis, Silene perlmanii, Spermolepis hawaiiensis, Stenogyne kanehoana, Tetramolopium lepidotum* ssp. *lepidotum, Urera kaalae,* and *Viola chamissoniana* ssp. *Chamissoniana.*

The critical habitat designations would occur on Navy-owned parcels at Navy Munitions Command East Asia Division Detachment Joint Base Pearl Harbor-Hickam Lualualei Annex (formerly known as Naval Magazine Pearl Harbor Lualualei) and Naval Radio Transmitter Facility (NRTF) Lualualei (Figure 1). The critical habitat proposed for Kalaeloa (Former Naval Air Station Barber’s Point) occurs only on parcels to be released under the Base Realignment and Closure (BRAC) program (Figure 2).

Current and Proposed Plant Critical Habitat, Lualualei, Oahu, Hawaii

- JBPHH Lualualei Annex
- Current Lualualei Plant Critical Habitat
- 2011 Proposed Lualualei Plant Critical Habitat
- New Area

(Current plant critical habitat = 972 acres)

(Lualualei proposed plant critical habitat = 393 acres)

(News areas of plant critical habitat = 4 acres)

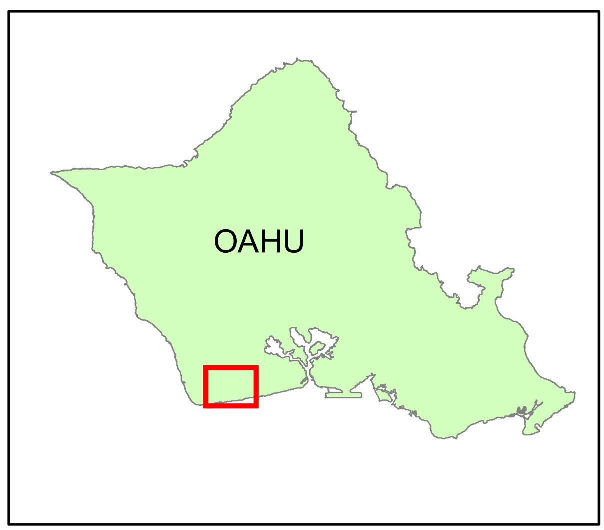
Figure 2.

Kalaeloa (Former NAS Barber's Point) Navy Retained Lands and Proposed Critical Habitat

0 0.25 0.5 1 Kilometers

Navy Retained Lands

Proposed CH



2.0 Navy Munitions Command East Asia Division Detachment Joint Base Pearl Harbor-Hickam Lualualei Annex and Naval Radio Transmitter Facility Lualualei

2.1 Additional Information and Progress of Projects Included in the INRMP

The primary strategies to meet management goals at Lualualei are to install ungulate fencing and remove invasive species. This section provides additional details of the programmed projects for endangered plants that are listed in the 2011 Draft INRMP, and summarizes progress made on the programmed projects. See Table 1 for a list of applicable projects excerpted from Table 9.9 in the INRMP.

Table 1 Excerpt from INRMP Table 9.9: JBPHH Ten-Year Fiscal Plan for Projects at Lualualei

Objectives and Projects	Y1 (2012)	Y2 (2013)	Y3 (2014)	Y4 (2015)	Y5 (2016)	Y6 (2017)	Y7 (2018)	Y8 (2019)	Y9 (2020)	Y10 (2021)	Total
11. Monitoring and management of NAVMAG PH Lualualei Branch listed/candidate/species of concern plant species	$45,000	$47,000	$49,000	$51,000	$54,000	$56,000	$59,000	$61,000	$64,000	$67,000	$533,000
13. *Abutilon menziesii*, *Marsilea villosa*, *Cyperus trachysanthos* monitoring and management	$7,500	$3,500	$3,500	$3,500	$3,500	$3,500	$4,000	$4,000	$4,000	$4,000	$41,000
19. Monitor, control and exclude feral ungulates within SMAs	$12,000	$13,000	$400,000	$20,000	$400,000	$25,000	$400,000	$30,000	$400,000	$50,000	$1,750,000
23. Native habitat management through invasive vegetation removal at SMAs in NAVMAG Lualualei	$80,000	$84,000	$87,000	$91,000	$95,000	$100,000	$104,000	$109,000	$114,000	$119,000	$983,000
24. Black-stem borer research	$0	$0	$0	$0	$0	$0	$30,000	$30,000	$0	$0	$60,000
43. Continue FFD and/or HFD response to any wildland fires	$0	$0	$65,000	$0	$0	$5,000	$0	$0	$5,000	$0	$75,000

<u>Objective 11 - Monitoring and management of NAVMAG PH Lualualei Branch listed/candidate/species of concern plant species</u>

As planned in the INRMP, the Navy funded $46,400 in FY12 for in-house surveys of known sites within the Magazine area where threatened and endangered and candidate threatened and endangered plant species are documented to occur. This survey effort is currently ongoing and is expected to conclude by the end of September 2012. Surveys are expected to provide updated status of these plants and identify plants that require specialized management. The results of these efforts will be used to create a management plan for endangered plant species at Lualualei. The preparation of the management plan is currently unfunded; however, if additional funds are available at the end of this fiscal year, this management plan is our top priority. If FY12 funds are not available at the end of the year, we will be program the management plan as an FY13 project.

<u>Objective 13 - *Abutilon menziesii*, *Marsilea villosa*, *Cyperus trachysanthos* monitoring and management</u>

As planned in the INRMP, in 2012 the Navy conducted comprehensive in-house surveys of the Lualualei Radio Transmitting Facility (LLL RTF) and additional populations of *Marsilea villosa* were identified within NRTF Lualualei. In 2008, the Navy funded University of Hawai‘i to conduct research at NRTF Lualualei to investigate the soil and associated plant community in relation to the *M. villosa* population. The Navy expects to receive a copy of the dissertation and management recommendations strategies for *M. villosa* later this year. The results of these efforts will be used to inform the management plan described in section 2.1 above.

<u>Objective 19 - Monitor, control and exclude feral ungulates within SMAs</u>

The original scope described in the INRMP included ungulate surveys and removal with a budgeted amount of $12,000. We were able to commit an additional $140,000 to expand the scope of work to include a fencing plan. This plan will identify and prioritize areas of Lualualei to be fenced and provide cost estimates for fence installation, ungulate removal, and fence maintenance. The contract for an Ungulate Fencing Plan is in the process of being awarded and will be awarded by the end of July. The draft plan is anticipated in May 2013, with the final plan in July 2013. The results of the Ungulate Fencing Plan will be used to update the cost estimates and phasing for construction of the fencing at Lualualei.

Funds for fence construction are already programmed, starting in 2014. The fence will be constructed in phases. Additional funds for construction of future phases, maintenance and monitoring are programmed for subsequent years. Also included in the cost is ungulate removal following fence construction.

Aerial goat surveys were completed in February through a cooperative partnership between the Navy and other members of the Waianae Mountain Watershed Partnership, including the Army, State of Hawai‘i, private landowners, and other private stakeholder entities. Funds were part of a larger cooperative agreement with the University of Hawai‘i HPI-CESU. Surveys were completed in February. Goat removal is anticipated to begin in FY13.

<u>Objective 23 - Native habitat management through invasive vegetation removal at SMAs in NAVMAG Lualualei</u>

As planned in the INRMP, the Navy funded $80,000 in FY12 for surveys and removal of invasive vegetation. The work is being done under multiple ongoing projects. One project is a survey specific to locally-restricted invasive plant species, including *Phytolacca dioica*, *Tetraclinus articulata*, and other species that are naturalizing within Lualualei. Work is currently ongoing and being performed by the Oahu Invasive Species Committee. The project funds were part of a larger cooperative agreement with the University of Hawai‘I HPI-CESU. Surveys were initiated in April and are expected to conclude by the end of September 2012.

Another project is to remove invasive vegetation and propagate native plants in-situ in the Halona and Mikilua fenced exclosures. Work was initiated in November of 2011 and is expected to conclude by the end of September 2012.

<u>Objective 24 - Black-stem borer research</u>

The goal of this research is to find the methods of reducing damage to *Flueggea neowawraea*. This project is currently programmed for FY18 and FY19.

<u>Objective 43 - Continue FFD and/or HFD response to any wildland fires</u>

The wildland fire prevention management and response plan is currently programmed for FY14; however, we are planning to reprioritize projects in an attempt to push this project up to FY13.

2.2 Additional Projects

In addition to the projects identified in the 2011 Draft INRMP, the projects and actions listed below are priorities for programming as emergent projects or FY15 projects.

1) Develop management plans for endangered plant species at Lualualei. If additional funds are available at the end of this fiscal year, this management plan is our top priority. If FY12 funds are not available at the end of the year, we will be programing the management plan as an FY13 project.

2) Construct fencing around the *M. villosa* population located outside the installation perimeter in the northwestern section of NAVMAG PH Lualualei Branch to protect the plant from potential impacts caused by off-road vehicles and feral ungulates. We will be requesting additional funds as an emergent project this fiscal year. If the funding can be secured, the fencing can be completed within six months of receipt of funds.

3) Aerial application of rodenticides within fenced areas, following construction of the ungulate fence. This project is dependent upon completion of the Programmatic EIS for Hand and Aerial Broadcast of Rodenticide for Conservation Use in the State of Hawaiʻi. The Navy is a cooperating agency for this EIS and will continue to support this effort. Funding would be programmed in FY15 at the earliest.

4) Develop survey data in conjunction with the Service and other stakeholders to collect data that can be used to document population status and effects of management actions. We anticipate having draft forms for the Service and stakeholders review by the end of the fiscal year.

5) Request permission through the chain of command to outplant threatened and endangered species to augment and stabilize populations within Navy property at Lualualei. The request package will be sent up for review by the end of the fiscal year. If approved, the Navy will program additional funds to integrate outplanting into the INRMP. The Navy will work with the Service on the species priority and preferred locations for outplanting. The Navy would explore the possibility of working with the Army in the outplanting efforts.

3.0 Kalaeloa (Former Naval Air Station Barber's Point)

3.1 Additional Information and Progress of Projects Included in the INRMP

This section provides additional details of the programmed project for endangered plants that are listed in the 2011 Draft INRMP, and summarizes progress made on the programmed project. Table 2 is excerpted from Table 9.9 in the INRMP.

Table 2 Excerpt from INRMP Table 9.9: JBPHH Ten-Year Fiscal Plan for Projects at Barbers Point

Objectives and Projects	Y1 (2012)	Y2 (2013)	Y3 (2014)	Y4 (2015)	Y5 (2016)	Y6 (2017)	Y7 (2018)	Y8 (2019)	Y9 (2020)	Y10 (2021)	Total
7. Kalaeloa ‘akoko management	$2,000	$2,000	$2,000	$2,000	$2,000	$2,000	$3,000	$3,000	$3,000	$3,000	$24,000

<u>Objective 7 – Kalaeloa ‘akoko management</u>

The INRMP programmed funds for ‘akoko management on an annual basis; however, in 2012 the funds were reallocated to other natural resource management projects in anticipation of pending BRAC actions. As part of the BRAC process, surveys for ‘akoko were completed March 2012. A conservation plan is being developed to ensure conservation of ‘akoko following land transfer under the BRAC program. When completed, the INRMP may incorporate applicable conservation measures.

3.2 Additional Projects

Additional projects may be proposed following the completion of the ‘akoko conservation plan.

APPENDIX L
MANAGEMENT PLANS

L1 – JBPHH HAWAIIAN MONK SEAL CONSERVATION MANAGEMENT PLAN

Joint Base Pearl Harbor-Hickam

Hawaiian Monk Seal Conservation

Management Plan

3 June 2012

INTRODUCTION

This management plan functions as the implementation document for Hawaiian Monk Seal (HMS) management practices described in sections 3.4.1.1 (page 3-120), 6.4.1.1 (page 6-20), and 7-10.2.2 (page 7-107) of the September 2011 draft version of the Joint Base Pearl Harbor-Hickam Integrated Natural Resources Management Plan (JBPHH INRMP).

Joint Base Pearl Harbor-Hickam HMS conservation areas include all near-shore marine and terrestrial locations on JBPHH property or under JBPHH stewardship where HMS may occur. This management plan focuses on coastal, terrestrial areas where HMS is known to periodically occur or could possibly occur in the future. Currently these areas include the shorefront around the entrance to Pearl Harbor (See Figure 1 – Iroquois Point and Hickam) and Kalaeloa (see Figure 2. – Nimitz Beach, White Plains Beach, and BRAC parcels).

Location and scope of management actions may be expanded based on future changes in HMS distribution or frequency of occurrence. Additionally, Navy managed conservation areas may change based on changes in land ownership (i.e. the transfer of Navy properties to non-Navy entities such as the other Federal agencies, the State of Hawaii, or private entities). Any changes or additions to the HMS Conservation Plan will be coordinated through the Protected Resources Division of the NOAA Pacific Islands Regional Office.

MANAGEMENT ACTIONS

Feral Animal Control

Description

The Navy has contracted USDA APHIS Wildlife Services to conduct feral cat and dog control, and to some extent mongoose control, at Nimitz Beach, White Plains Beach, coastal Kalaeloa BRAC parcels, Iroquois Point, and the Fort Kamehameha/Ahua Reef/Harbor areas of Hickam Field (see Figures 1 and 2). The Wildlife Services' Work Plan for this contract is approved by Navy renewed on annual basis. The work plan is also provided to the NOAA Protected Resources Division and USFWS Pacific Islands Office for review. The goal of this action is to have HMS conservation areas free of feral cats and dogs, and reduction in numbers of mongoose.

Wildlife Services generates monthly reports of the number of traps set in each conservation area, location of traps, and numbers and types of feral animals caught. Reports will also include any other management activities carried out by Wildlife Services within the Conservation Areas. Reports are provided to the Navy and are available to Federal and State Regulatory Agencies for review. A summary of work accomplished under the contract is provided as part of the JBPHH INMRP annual review.

Figure 1.

Hawaiian Monk Seal Conservation Areas Pearl Harbor-Hickam Oahu, Hawaii

Monk Seal Conservation Area
JBPHH Installation Area

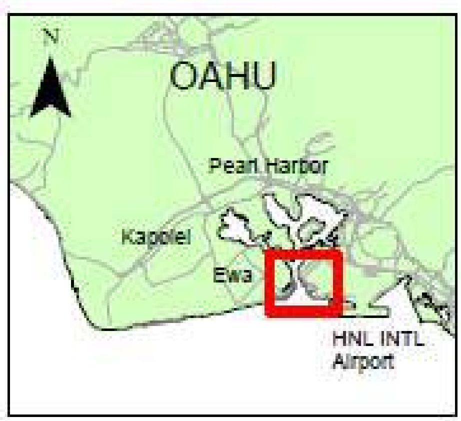


Figure 2.

Hawaiian Monk Seal Conservation Areas Kalaeloa, Oahu, Hawaii

Monk Seal Conservation Area
JBPHH Installation Area

Points of contact

Points of contact within Wildlife Services and Navy points of contact for HMS Conservation areas are provided to Federal and State Regulatory Agencies. These include: 1) USDA APHIS WS Technician, 2) JBPHH Natural Resources Manager, 3) JBPHH Environmental Storefront Manager for Kalaeloa, 4) MWR Manager for Kalaeloa, 4) JBPHH Environmental Storefront Manager for Iroquois Point, 5) Manager for the Waterfront at Puuloa, 6) JBPHH Environmental Storefront Manager for Hickam, and 7) JBPHH Police.

Metrics

Metrics for this action include: 1) Monthly – feral animal trapping and management reports; 2) Annual - Wildlife Services Work Plan; 3) Annual – Feral Animal Control Summary.

<u>Harassment Prevention and Enforcement</u>

Description

The Navy will assist Federal and State law enforcement personnel with protecting HMS and enforcing laws regarding human interaction with HMS. City and County of Honolulu Lifeguards are on site from 0800 -1700 at White Plains Beach and (Hickam Beach Name?). All other HMS conservation areas are patrolled by JBPHH Police on an unscheduled basis (approximately once a week). Annual training on laws governing HMS conservation for JBPHH Police and MWR personnel is coordinated through the NOAA Protected Resources Division.

The following phone tree is established in the event of an illegal action regarding a monk seal:

C&C Lifeguard/MWR Patron/Housing Resident/ JBPHH personnel/or other person witnessing illegal action calls 24-hour JBPHH Police Dispatch:
474-2222

↓

JBPHH Police Dispatch notifies JBPHH Game Warden or other JBPHH Officer on duty at the time of the incident

↓

Game Warden or on-duty Officer notifies the following before responding to the incident:

NOAA Fisheries Office of Law Enforcement - 1-800-853-1964

DOCARE Officer - 643-3567

USFWS Conservation Law Enforcement - 792-9549

Point of Contact

Points of contact within the Navy for enforcement of laws regarding the protection of HMS are provided to Federal and State Regulatory Agencies. These include: 1) JBPHH Police Department, 2) JBPHH Game Warden, 3) MWR Manager Kalaeloa, 4) Waterfront at Puuloa Manager, and 4) MWR Manager Hickam.

Metrics

Metrics for this action include: 1) Annual – Summary report of all reported incidences, record of training, and updates to the phone tree.

Community Outreach

Description

Creation of HMS education materials and planning of outreach events within the HMS Conservation Areas. Outreach will be done in coordination with NOAA staff/biologists in the Pacific Islands Regional Office Protected Resources Division and the Pacific Islands Fisheries Science Center to ensure that outreach activities and materials supplement their HMS Education and Outreach and Volunteer Programs and support their HMS conservation objectives.

Navy biologists will work with NOAA to create a list of materials required. Materials may include banners, posters, tables, chairs, brochures, and other education items such toys, magnets, books, etc. Navy will fund design of materials, purchase equipment and supplies, and host and provide labor for outreach events. At least two outreach events will be hosted annually.

Estimated budget is $10,000 for FY12 and approximately $15,000 for subsequent Fiscal Years.

Points of Contact

Points of contact within the Navy for HMS outreach will be provided to NOAA and include: 1) JBPHH Natural Resources Manager, 2) Navy Region Hawaii Regional Environmental Coordinator, 3) NAVFAC Pacific Marine Resources Specialists, and 4) JBPHH Public Affairs Officer.

Metrics

Metrics for this action include: 1) Annual – Summary report of funds spent on HMS outreach materials and labor and a description of outreach events.

HMS Monitoring

Description

All Navy HMS conservation areas, except for Hickam, are monitored daily for hauled out monk seals by NOAA volunteers who are part of the Oahu Monk Seal Response Team. When a monk seal is sighted on land, volunteers set up signage and a protection zone to protect seals from disturbance. NOAA volunteers also collect data on the monk seals, monitor pupping events, and report any seals that appear to be in distress.

Wildlife Services technicians will visit HMS conservation areas, particularly at night, to perform feral animal control, and will notify NOAA/Oahu seal sighting hotline if they observe HMS that appear to have recently hauled out and not yet been observed by NOAA volunteers (as evidenced by a lack of signs and protective zone). JBPHH Police will also notify NOAA if they see a newly hauled out seal that has not yet been found by volunteers.

Monk seal occurrences within the Hickam conservation area are rare, therefore the area is not regularly monitored for HMS. If an HMS is found in the Hickam conservation area, it will be reported to NOAA.

Points of Contact

Points of contact within Wildlife Services and Navy points of contact for HMS monitoring within conservation areas are provided to Federal and State Regulatory Agencies. These include: 1) USDA APHIS WS Technician, 2) JBPHH Natural Resources Manager, and 3) JBPHH Game Warden.

Metrics

Metrics for this action include: Annual - raw HMS occurrence data (provided to Navy by NOAA); Annual - summary of HMS occurrences on all Navy properties and managed areas (provided to NOAA by Navy).

APPENDIX M
COMMENTS/RESPONSE TO COMMENTS ON FINAL INRMP

M1 – USFWS COMMENTS ON THE FINAL JBPHH INRMP

United States Department of the Interior

FISH AND WILDLIFE SERVICE

Pacific Islands Fish and Wildlife Office
300 Ala Moana Boulevard, Room 3-122, Box 50088
Honolulu, Hawaii 96850

In Reply Refer To:
2012-TA-0254

APR 30 2012

Ms. Karen Sumida
Business Line Manager
Environmental
Naval Facilities Engineering Command, Pacific
258 Makalapa Drive, Suite 100
Pearl Harbor, Hawaii 96860-3134

Subject: 2011 Navy Joint Base Pearl Harbor-Hickam Integrated Natural Resources Management Plan

Dear Ms. Sumida:

Thank you for your transmittal, October 27, 2011, of the *final Integrated Natural Resources Management Plan* (INRMP) *-Joint Base Pearl Harbor-Hickam* dated September 2011 concerning conservation, protection and management of natural resources pursuant to the Sikes Act Improvement Act (16 U.S.C. 670a *et seq.*), as amended, and the Endangered Species Act of 1973 [16 U.S.C. 1531 *et seq.*; 87 Stat. 884], as amended (ESA). To this end, INRMP dated September 2011 has detailed a wide variety of natural resources and conservation goals for U.S. Navy installations on Oahu. Pursuant to the Sikes Act the INRMP must be revised every five years and this revision of the INRMP was prepared for the years 2011 through 2015. This letter transmits our comments regarding the latest version of the INRMP for Navy lands at Navy Radio Transmitter Facility (NRTF) Lualualei (NAVMAG PH), and Kalaeloa Barbers Point.

The Navy's 2001 INRMPs are the only finalized plans, the most recent INRMPs with signed tri-party memorandums of agreement pursuant to paragraph (a)(2) of the Sikes Act, for Navy lands at Lualualei and Kalaeloa Barbers Point. The Service recommended modifications to the revision drafts INRMPs via electronic mail in February and March of 2009 (Service file number 2009-TA-0093) and in February of 2010 (Service file number 2010-TA-0142) to benefit listed species and natural resources. In our review of the Navy's 2011 INRMP our analysis is to determine whether it provides a conservation benefit to the species on Navy lands. However, because neither the State of Hawaii nor the Service have signed this version of the INRMP in accordance with the tri-party memorandum of agreement, the 2011 INRMP is effectively in draft status until all partners have concurred with the revisions and updates. Since completion of the 2001 final INRMPs for Oahu Navy installations, the Navy has made significant progress in identifying management actions, recognizing the need for monitoring plans, and initial determinations of funding required for natural resource management. Although the Service supports the Navy's initial natural resource management measures included in the 2011 INRMP, we find that it does not provide an adequate conservation benefit to the species found at Lualualei and Kalaeloa Barbers Point. The reasons for this finding are summarized below, grouped by issues of concern, relating specifically to the inadequacies of the 2011 INRMP.

NAVMAG PH Lualualei and NRTF Lualualei

Issue: Control of Feral Goats
In the 2011 INRMP, goats are identified as a threat to the watershed. These animals have been observed on Lualualei Ridge, Puu Kaua above Halona Valley and at Puu Hapapa (U.S. Navy 2011, pp. 4-10, 4-47). According to the 2011 INRMP, goats were eradicated from the Lualualei area in 2001 and were not expected to reestablish in the southern part of the range; however, three years later, in 2004, goats were observed during a survey in the upper reaches of Lualualei Valley (U.S. Navy 2011, Appendix 9 NAVFAC PAC 2006D, p. 1). According to the 2011 INRMP, the Navy conducted monthly ground hunts with supplemental air operations at unspecified time periods up until 2006. The 2011 INRMP does not provide any information regarding the status of implementation of goat control actions since 2006, or information regarding surveys for, or sightings of, goats or other feral ungulates beyond the statement that [the Navy] "continues to monitor and control" (U.S. Navy 2011, p. 4-57). Based on this information we are unable to agree that goats are currently "controlled" within and unable to access Navy lands. Although goats are unlikely to access the 1.5 acres (0.61 hectares) of fenced exclosures currently maintained by the Navy to protect individuals of five endangered plants (*Abutilon sandwicense*, *Bonamia menziesii*, *Flueggea neowawraea*, *Lipochaeta lobaba* var. *leptophylla*, and *Nototrichium humile*) they are likely to access unfenced areas within the Special Management Areas (SMAs) and other unfenced Navy lands at Lualualei, some of which are proposed plant critical habitat. Therefore, in our opinion, the Navy's 2011 INRMP does not adequately address the threat posed by feral ungulates to the species and their habitat.

We recognize that the 2011 INRMP contains recommended management actions to control feral ungulates on Navy lands at Lualualei (U.S. Navy 2011, Table 9-3. Recommended Management Actions for Lualualei, p. 9-12). We fully support recommendation number 19 to "monitor, control, and exclude feral ungulates within SMAs, develop and implement a fencing strategy, and work with the Waianae Mountains Watershed Partnership to eradicate goats" (U.S. Navy 2011, p. 9-16). According to Table 9-9 (U.S. Navy 2011, p. 9-46) funding for this recommended management action is provided separately from normal operating costs, but actual funding is dependent on Navy budgets. According to this same table, significant funding for goat monitoring and control, and fence construction within SMAs will be provided beginning in fiscal year 2014 and these actions will be funded every other year until fiscal year 2020. However, the 2011 INRMP does not provide information on the location of the proposed "larger fence," (enabling us to assess the amount of area and the species it will protect), or the time line for contracting, constructing, or monitoring the fenced area. The roles of those participating in the informal partnership remain undefined, and although there is a possibility of funding recommendation number 19, the uncertainty of its implementation is high.

Ungulate barrier fences will provide a benefit to listed species and their habitat, but the timeline for that benefit is currently uncertain and unknown. We recommend you coordinate with the Service and other partners to develop plans for strategic placement of ungulate exclosure fences on Navy lands. In addition, we recommend the 2011 INRMP include a plan and budget to monitor newly fenced areas annually.

Issue: Control of Threats from Rats, Slugs, Snails and Insects

The 2011 INRMP addresses Oahu elepaio (*Chasiempis sandwichensis ibidis*) monitoring and management and impacts to plant fruits and seeds by rats in management recommendation number 5 (U.S. Navy 2011, Table 9-3, Recommended Management Actions for Lualualei, p. 9-13). In our Proposed Rule, we did not propose new critical habitat or revise the critical habitat (designated in 2001) on Navy lands for Oahu elepaio. Management recommendation number 5 includes an aerial rodenticide application project that will reduce and control rat populations in the application area to benefit the native plants by alleviating the threat of rat predation. As described in the 2011 INRMP, fencing will be completed first, to exclude feral ungulates from the area of proposed rodenticide application. Your letter indicates that construction of large-scale fenced exclosures began in 2010. Although the 2011 INRMP includes information about the two exclosures in the Puu Hapapa and Halona SMA, which together total 1.5 acres (0.61 hectares), it does not include an update on the status of the large-scale fenced exclosures. The status and management plans for large-scale fenced exclosures should be incorporated into the 2011 INRMP. We support the Navy's current participation in the environmental compliance process for rodent and mongoose control, which will enable the Navy to implement aerial rodenticide application. In addition to aerial rodenticide application, we recommend the Navy consider additional rat control methods such as bait stations and snap traps to conserve listed plants and Oahu elepaio. Areas with rare or listed plants and Oahu elepaio that are subject to rat predation would benefit from these targeted rat control actions.

Non-native snails and slugs consume listed plants and this impact is not addressed in the 2011 INRMP. Management and control of the non-native rosy wolfsnail (*Euglandina rosea*) that preys upon native Hawaiian tree snails (*Achatinella* sp.) is the only non-native snail abatement action included in the recommended management actions (U.S. Navy 2011, Table 9-3. Recommended Management Actions for Lualualei, pp. 9-14, 9-16) in the 2011 INRMP. Three endangered *Flueggea neowawraea* were reported from Navy lands in Lualualei as recently as 2004. In 2010, two of the three trees were dead, and all three trees showed signs of black-twig borer (*Xylosandrus compactus*) infestations (U.S. Navy 2011, Table 4-3. Federally-listed Plant Species, Federal Candidate Plant Species, and Federal Plant Species of Concern at NAVMAG PH Lualualei Branch, p. 4-32). The Service recommends the Navy work cooperatively with other stakeholders to provide funding to investigate methods to control this non-native insect. As described in management recommendation number 24 (U.S. Navy 2011, Table 9-3. Recommended Management Actions for Lualualei, p. 9-17), research on methods to control the black-twig borer can be supported through a cooperative agreement with the University of Hawaii, although it is unclear if the Navy intends to support all or any of this research. According to the 2011 INRMP, black-stem [twig] borer research will receive Navy funding in 2018 (U.S. Navy 2011, Table ES-6. INRMP Ten-Year Fiscal Plan, p. ES-19). In your letter, management recommendation number 25 (U.S. Navy 2011, Table 9-3. Recommended Management Actions for Lualualei, p. 9-17.) describes a peafowl (*Pavo cristatus*) seed predation study to determine the effect of peafowl in Lualualei. According to the Navy, peafowl are becoming more abundant in Lualualei and are documented to consume fruits of native tree species such as *Antidesma* sp. (hame).

Issue: Wildland Fire

According to the 2011 INRMP (p. 4-61) Navy lands in Lualualei Valley have not been recently impacted by wildland fires. While the INRMP recognizes Lualualei Valley is "dangerously prone" to brush fires it acknowledges that currently there is not a clear leadership structure or operational plan to respond to a wildfire in Lualualei (U.S. Navy 2011, p. 4-61). In 2004, a wildfire occurred at Kauaopuu on Navy lands in Lualualei where there is an occurrence of the endangered plant *Chamaesyce kuwaleana*; however, it is unclear from the information in the 2011 INRMP if the plants were impacted (U.S. Navy 2011, p. 4-30). According to the 2011 INRMP, the "threat from fire is sharply on the rise for this species" (U.S. Navy 2011, p. 4-52) and "the ongoing spread of Guinea grass (*Panicum maximum*) and molasses grass (*Melinus minutiflora*) contributes to the threat of fire." The Service supports recommended management action number 43 (September 2011 INRMP, Table 9-3. Recommended Management Actions for Lualualei, p. 9-20) which includes the development of a wildland fire management plan for Navy lands in Lualualei Valley. The Service is available to assist the Navy with the development of this plan. Funding for development of this plan is not scheduled until 2014. Until an adequate fire management plan is developed and implemented, listed species and their habitat are at significant risk of destruction or degradation from wildland fire (U.S. Navy 2011, Table 9-9. Ten-Year Fiscal Plan, p. 9-47). It is essential that the Navy develop and implement a wildland fire management plan to ensure fire prevention and fire suppression measures are adequate to protect *Chamaesyce kuwaleana* and other listed species on Navy lands in Lualualei from wildland fires.

Issue: Rare Plant Monitoring

The Service fully supports the Navy in its plan to use the best available expertise to develop and implement a program to monitor all rare plants on Navy lands at Lualualei, and to manage these species using adaptive management (U.S. Navy 2011, Table 9-3. Recommended Management Actions for Lualualei, p. 9-14). The Service is available to work with the Navy and others to develop a rare plant species monitoring plan for Navy lands in Lualualei. The Service also encourages the Navy to develop a means of collating monitoring data and providing it to cooperators, in an annual summary or report.

In your letter you refer to a project description regarding three endangered plants, *Chamaesyce kuwaleana*, *Lipochaeta lobata* var. *leptophylla*, and *Melanthera tenuifolia*. The reference to the "project description" is unclear as there is neither a recommended management action in Table 9-3 (September 2011 INRMP, Table 9-3. Recommended Management Actions for Lualualei) nor a project itemized for funding in Table 9-9 (U.S. Navy 2011, Table 9-9. INRMP Ten-Year Fiscal Plan) regarding these three endangered plants. The 2011 INRMP cites the 2004 Hawaii Natural Heritage Program Flora and Fauna Survey of NAVMAG PH Lualualei, (U.S. Navy 2011, p. 4-52) that recommended these three rare plants merit the highest priority in a rare plant management program. We recommend the 2011 INRMP include a plan and budget to monitor all rare plants on Navy lands at Lualualei annually. We support adaptive management of these species based on the annual monitoring data. Implementation of a rare plant species program would provide a benefit to listed species and their habitat at Lualualei by enabling managers to provide management needed to prevent the immediate extirpation of the individual plants, provide for future expansion of the populations of these species on Navy lands, and improve the potential for recovery of these species.

Issue: Non-native Plant Control

The 2011 INRMP provides only cursory reference to non-native plant control in Lualualei and indicates that natural resource staff continue to control invasive plants in "protected areas" (U.S. Navy 2011, p. 4-57) and in higher elevation management areas (U.S. Navy 2011, p. 4-60) to support growth and survival of native plants. It is unclear if "protected areas" and higher elevation management areas are one and the same or if these areas are SMAs. It is also unclear if non-native plants are controlled only in the 1.5 acres (0.61 hectares) of fenced exclosures, or are controlled both within and outside the fenced exclosures in the SMAs. According to recommended management action number 18, the Navy will continue to evaluate and prioritize invasive plants, with priority on biocontrol of prickly pear cactus (*Opuntia ficus-indica*) and control of newly emerging weeds (U.S. Navy 2011, Table 9-3. Recommended Management Actions for Lualualei, p. 9-16). In addition, recommended management action number 23 indicates that non-native plants will be controlled by chemical (e.g., herbicides) and manual means focused on native forest stands in the SMAs and in the immediate vicinity of listed plants throughout the "forested area" of NAVMAG PH Lualualei (U.S. Navy 2011, Table 9-3. Recommended Management Actions for Lualualei, p. 9-17). According to the 2011 INRMP, non-native plant control on all five Navy installations on Oahu is provided as one itemized project for funding (U.S. Navy 2011, Table 9-9. INRMP Ten-Year Fiscal Plan, pp. 9-41, 9-46). The amount of annual funding that will be provided for non-native plant control on NAVMAG PH Lualualei Branch and NRTF Lualualei is not specified. The Service fully supports non-native plant control in priority natural resource areas and encourages the Navy to develop and implement a plan to identify areas of highest priority on NAVMAG PH Lualualei and NRTF Lualualei for weed control. The Service is available to work with the Navy and others to develop this plan. A non-native plant control program will benefit listed species and their habitats at Lualualei by reducing the threat from species competition, and reducing the threat from wildland fire from combustable non-native plant species (e.g., *Cenchrus ciliaris* (buffle grass), *Prosopis pallida* (kiawe), and *Leucaena leucocephala* (koa haole)). This management will prevent the immediate extirpation of individual listed plants, provide for future expansion of the plant populations, and improve the potential for the recovery of these species.

Issue: *Marsilea villosa* Management

According to the 2011 INRMP, *Marsilea villosa* is found in seven occurrences on Navy lands at Lualualei: six at NRTF Lualualei and one at NAVMAG PH Lualualei (U.S. Navy 2011, Table 4-3. Federally-listed Plant Species, Federal Candidate Plant Species, and Federal Plant Species of Concern at NAVMAG PH Lualualei Branch, p. 4-34). However, location information is only given for five of the seven occurrences (U.S. Navy 2011, Figure 4-6. Federally-listed Plant Species Mapped at the Lualualei Study Area, p. 25 and Table 4-3. Federally-listed Plant Species, Federal Candidate Plant Species, and Federal Plant Species of Concern at NAVMAG PH Lualualei Branch, p. 4-34) and it is unclear if current management actions for this species are undertaken at all occurrences. According to the 2011 INRMP, all occurrences are monitored throughout the year, although the specific information collected throughout the year is not available nor described in the 2011 INRMP. The Navy's current management strategy for this plant is the placement of signs and removable posts in areas where this species occurs to protect the plants from accidental mowing, construction impacts, vehicle traffic, and trampling (U.S. Navy 2011, p. 4-57). Three occurrences are found in the NRTF Lualualei antenna fields which are mowed regularly (to reduce fire threat to the antennas); however, mowing restrictions are in place when individuals of this ephemeral plant are evident following winter rains. According to recommended management action number 13, the Navy will use hand tools to remove or control non-native *Cenchrus ciliaris* and *Prosopis pallida* around *M. villosa* and two other listed plant species (U.S. Navy 2011, Table 9-3. Recommended Management Actions for Lualualei, p. 9-15). Monitoring of the individual plants following hand removal of weeds is included in this recommendation. The status of these individual plants should be monitored annually, although it is unclear if management actions have been modified or changed based on the results of past monitoring efforts. The INRMP is unclear regarding leased lands on Lualualei. According to the 2011 INRMP, unauthorized ground clearing and accidental intrusion into the area by off-road vehicles could threaten the occurrence of *M. villosa* on NAVMAG PH Lualualei, although the lessee has been instructed not to disturb the site (U.S. Navy 2011, p. 4-57). The 2011 INRMP states that most of the land on NRTF Lualualei is suitable for animal grazing although currently there are no leases on these lands (U.S. Navy 2011, p. 4-62). The Service supports the Navy's efforts to prevent the immediate extirpation of individuals of *M. villosa* on their lands and is willing to work with the Navy to develop a management plan for this unique water fern that will benefit this species by providing for future expansion of the populations on Navy lands and improving the potential for recovery of this species.

Issue: Projects to Improve Species Recovery (Plant Propagation and Outplanting)
Recommended management action number 11 in the 2011 INRMP includes development of a plant propagation plan for Navy lands at Lualualei. However, *in situ* propagation and *ex situ* propagation and outplanting of listed plants to augment existing populations and reintroduce plant species to historical locations are practices not currently allowed or implemented on Navy lands (U.S. Navy 2011, Table 9-3. Recommended Management Actions for Lualualei, p. 9-14). These valuable conservation actions will require approval by the Secretary of the Navy. It is unclear if this approval has been requested. The Navy also indicates that all outplanted listed plants on Navy lands must be designated as "experimental" populations so that the affected installation will not be "further encumbered" (U.S. Navy 2011, Table 9-3. Recommended Management Actions for Lualualei, p. 9-14).

We recommend that approval from the Secretary of the Navy be requested and, if granted, that the INRMP include a plan and annual budget for propagation and outplanting of listed plants. The Service welcomes the Navy's interest in developing rare plant propagation and outplanting plan and is available to work with the Navy and others to develop a plan for NAVMAG PH Lualualei and NRTF Lualualei. Development and implementation of this plan will benefit listed species by providing for future expansion of the populations of these species on Navy lands and improving the potential for recovery of these species. The Service would also like to work with the Navy to provide clarification regarding designation of outplantings as experimental populations.

Issue: Projects to Improve Species Recovery (Limited Fenced Areas)
Special Management Areas are areas identified by the Navy that contain threatened and endangered plant and animal species, and concentrations of native forest or shrubland (U.S. Navy 2011, pp. 4-43–44; Appendix C1-Lualualei Botanical Projects Report (NAVFAC PAC 2006E), p. 1). The feral ungulate barrier fencing constructed in 1994, at the Halona and Puu Hapapa exclosures, encompass only 1.5 acres (0.61 hectares) (less than 0.5 percent) of the combined total area of 310 acres (125.5 hectares) of these two SMAs. These two small exclosures prevent the immediate extirpation of several individuals of three endangered plant species which were reported within these fenced areas as recently as 2006 (*Abutilon sandwicense*, *Flueggea neowawraea*, and *Nototrichium humile*). However, the two exclosures do not provide adequate area for *in situ* propagation or off-site propagation and outplanting

(neither of these action are currently implemented on Navy lands) (U.S. Navy 2011, Appendix C1-Lualualei Botanical Projects Report (NAVFAC PAC 2006E), pp. 1–3). In addition, these small fenced areas do not protect other threatened and endangered plant species from ungulate browsing and habitat degradation and destruction on Navy lands nor do they provide for future expansion of the populations of other plant species for which critical habitat is proposed on their lands. Therefore, we recommend reassessing the size of the exclosures provide adequate area for in situ propagation or off-site propagation and outplanting.

Issue: Management of Lualualei NRTF, Niulii Ponds Site
Navy management actions at the Niulii Ponds wetland area include: 1) predator trapping by U.S. Department of Agriculture; 2) waterbird surveys; and 3) management of the water level in the pond. Niulii Pond is an 8-acre (3.2-hectare) site that has supported the federally endangered Hawaiian stilt *(Himantopus mexicanus knudseni)*, Hawaiian moorhen *(Gallinula chloropus sandvicensis)*, Hawaiian coot *(Fulica alai)* and Hawaiian duck *(Anas wyvilliana)*, as well as populations of migratory waterfowl and shorebirds protected under the Migratory Bird Treaty Act. All endangered Hawaiian waterbirds have successfully nested at this location. Niulii pond is referenced as a supporting wetland for the recovery of endangered Hawaiian waterbirds in the *2011 Recovery Plan for Hawaiian Waterbirds, Second Revision.* It is our understanding the Navy is having difficulty with the water delivery system for the ponds. Loss of this pond will negatively impact endangered Hawaiian waterbirds at this site. We recommend the Navy develop a plan for the waterbird species that use Niulii pond and a timeline for completion and implementation of the plan. The plan should include improving water and vegetation management, and continued predator control and waterbird monitoring of the site.

Kalaeloa Barbers Point

Issue: *Chamaesyce skottsbergii* var. *skottsbergii* Management
Chamaesyce skottsbergii var. *skottsbergii* (Ewa plains akoko) at Kalaeloa Barbers Point is incorrectly identified as *C. kuwaleana*, which is an endangered plant found at NAVMAG PH Lualualei (U.S. Navy 2011, Table 6-2. Federally-Listed ESA Species and Species of Concern at Kalaeloa, p. 6-14). *Chamaesyce skottsbergii* var. *skottsbergii* is found on the Navy's Lot 58-D (Northern Trap and Skeet Range (NTSR)) and is included in the proposed critical habitat unit Oahu—Lowland Dry—Unit 11. As of 2008, the total number of *C. skottsbergii* var. *skottsbergii* plants within the NTSR was estimated, by the Navy, to be approximately 1,500 plants, with over 70 percent of those plants being outplanted individuals (U.S. Navy 2011, p. 6-15). The current total number of individuals of this species is estimated to be 300 to 400 wild individuals with 1,100 to 1,200 outplanted individuals on Navy, and other Federal and private lands (Guinther and Withrow 2008, pp. 6, 9–10, Whistler 2008, pp. 7–9). The 2011 INRMP includes the following recommended management actions for *C. skottsbergii* var. *skottsbergii*: avoidance of training in, and restricting access to, areas occupied by this endangered plant until the transfer of Lot 58-D is completed, fencing and signage to notify personnel of the presence of rare and protected species, and support for volunteer efforts to remove weeds around the plants (U.S. Navy 2011, Table 9-5. Recommended Management Actions for Kalaeloa, p. 9-26). Annual funding for restricting access to Lot 58-D and supporting volunteer weed efforts at Kalaeloa Barbers Point is projected to be $2,000 from 2012 to 2018, when it will increase to $3,000 annually. Annual funding for fencing and signage at Kalaeloa Barbers Point is included in the costs for Lualualei recommended management action 12 (Fencing and signage used to mark presence of rare and/or protected species) and is projected to be $2,500 from 2012 to 2020 (U.S.

Navy 2011. Table 9-9. INRMP Ten-Year Fiscal Plan, p. 9-50). We are aware the Navy is planning to transfer ownership of Lot 58-D (NTSR) to the Hawaii Community Development Authority, although this transfer has not yet occurred. The Service is currently assisting the Navy with a draft conservation plan for *C. skottsbergii* var. *skottsbergii* to ensure this population is adequately addressed and should be properly transferred to another entity. This would include implementation of the conservation plan for C. *skottsbergii* var. *skottsbergii* and the establishment of a conservation easement into perpetuity.

The Service supports the Navy's efforts to prevent the immediate extirpation of individuals of *Chamaesyce skottsbergii* var. *skottsbergii* on Navy lands through implementation of the recommended management actions listed above. However, because of the limited distribution of the species and the unknown disposition of the lands supporting the last population of wild *C. skottsbergii* var. *skottsbergii*, we maintain the 2011 INRMP does not provide an adequate conservation benefit to the species.

The Service will continue to work with the Navy to develop management plans and programs for listed species and their habitats on Navy lands. We will continue to work together to finalize the INRMP process. The following summarize our recommendations written above.

- We recommend you coordinate with the Service and other partners to develop plans for strategic placement of ungulate exclosure fences on Navy lands. In addition, we recommend the 2011 INRMP include a plan and budget to monitor newly fenced areas annually.
- In addition to aerial rodenticide application, we recommend the Navy consider additional rat control methods such as bait stations and snap traps to conserve listed plants and Oahu elepaio.
- The Service recommends the Navy work cooperatively with other stakeholders to provide funding to investigate methods to control this non-native insect that are impacting listed species.
- The Navy develop and implement a wildland fire management plan to ensure fire prevention and fire suppression measures are adequate to protect *Chamaesyce kuwaleana* and other listed species on Navy lands in Lualualei from wildland fires.
- We recommend the 2011 INRMP include a plan and budget to monitor all rare plants on Navy lands at Lualualei annually.
- The Service fully supports non-native plant control in priority natural resource areas and encourages the Navy to develop and implement a plan to identify areas of highest priority on NAVMAG PH Lualualei and NRTF Lualualei for weed control.
- Develop a management plan for *M. villosa* that will benefit this species by providing for future expansion of the populations on Navy lands and improving the potential for recovery of this species.
- We recommend that approval from the Secretary of the Navy be requested and, if granted, that the INRMP include a plan and annual budget for propagation and outplanting of listed plants.
- We recommend reassessing the size of the existing exclosures so that they can be increased to provide adequate area for in situ propagation or off-site propagation and outplanting.
- We recommend the Navy develop a plan for the endangered Hawaiian waterbird species that use Niulii pond and a timeline for completion and implementation of the plan.

- Include implementation of the conservation plan for C. skottsbergii var. skottsbergii and the establishment of a conservation easement into perpetuity.

In summary, the Service will provide technical assistance and guidance as needed to assist the Navy with effectively implementing the conservation actions described above and to develop an INRMP that addresses concerns outlined herein. We hope that these recommendations will assist the Navy in finalizing the INRMP pursuant to the Sikes Act.

We appreciate your efforts to conserve natural resources. If you have questions, please contact me by phone (808/792-9400) or by email (Loyal_Mehrhoff@fws.gov).

Sincerely,

Loyal Mehrhoff
Field Supervisor

cc: Mr. Paul Conry, Hawaii State, Division of Forestry and Wildlife
Mr. Gerry Davis, National Marine Fisheries Service, Pacific Islands Regional Office
Mr. J.P. Quinn, Energy and Environmental Readiness Division Department of the Navy

United States Department of the Interior

FISH AND WILDLIFE SERVICE
Pacific Islands Fish and Wildlife Office
300 Ala Moana Boulevard, Room 3-122, Box 50088
Honolulu, Hawaii 96850

JUL 1 2 2012

In Reply Refer To:
2012-TA-0355

Captain John Coronado
CEC, United States Navy
Regional Engineer
Navy Region Hawaii
850 Ticonderoga Street, STE 110
Joint Base Pearl Harbor-Hickam, Hawaii 96860-5101

Subject: Final Draft of the 2011 Joint Base Pearl Harbor-Hickam Integrated Natural Resources Management Plan Update (2011-2015)

Dear Captain Coronado:

In accordance with the Sikes Act (16 USAC 670a et seq.), the United States (U.S.) Navy Joint Base Pearl Harbor-Hickam prepared an Integrated Natural Resources Management Plan (INRMP) in 2001. Since then, we reviewed and provided comments on draft INRMPs in 2009, 2010 and most recently, a draft to the 2011 Joint Base Pearl Harbor-Hickam INRMP in 2012. In addition, pursuant to our recommendations, on June 8, 2012, you provided an Addendum to the 2011 Joint Base Pearl Harbor-Hickam INRMP. In the Addendum, additional information was provided including primary strategies to meet management goals at Lualualei and additional details regarding progress made on planned projects for endangered plants found on U.S. Navy lands at Lualualei. These additional objectives and amended actions include: (1) a survey documenting numbers and locations of endangered plant species; (2) identification of an additional population of *Marsilea villosa* in the Radio Transmitting Facility; (3) development of a *M. villosa* management plan based on recommendation strategies outlined in a dissertation, partly funded by the U.S. Navy; (4) expansion of funding for a fencing plan and fence construction for ungulate control with specified timeline; (5) completion of aerial surveys for feral goats, with plans for their removal beginning in 2013; (6) non-native plant removal within exclosures at Halona and Mikiula management areas; (7) allocation of funding for research on black twig borer control methods; (8) commitment to prioritize the production of a wildfire management plan; (9) commitment to address outplanting needs for threatened and endangered species to augment and stabilize populations within U.S. Navy property at Lualualei; and (10) allocated funding for development and implementation of a *Chamaesyce skottsbergii* var. *skottsbergii* management plan on U.S. Navy lands at Kalaeloa.

In summary, the U.S. Navy has made progress in identifying needed management actions, recognizing the need for monitoring plans, increasing initial determinations of funding required for natural resource management, and recognizing the need for propagation and outplanting of endangered and threatened plant species on U.S. Navy lands.

Based on our review and analysis: the final 2011 INRMP and 2012 Addendum (1) provide a conservation benefit to listed species if plans are implemented; (2) provide assurances that conservation management strategies will be implemented if funded at proposed levels; and (3) that conservation management strategies will be effective, in particular implementing fencing and outplanting threatened and endangered plant species to augment and stabilize populations within U.S. Navy property at Lualualei . The Service has determined that the Navy's final 2011 INRMP for Joint Base Pearl Harbor-Hickam and the 2012 Addendum provide conservation benefits to listed species that occur within the Naval Magazine Pearl Harbor Lualualei and Navy Radio Transmitter Facility Lualualei. The Service has also determined the 2011 INRMP and the 2012 addendum does not provide a conservation benefit to *Chamaesyce skottsbergii* var. *skottsbergii* on U.S. Navy lands at Kalaeloa. These determinations will be factored into pending critical habitat determinations. Future revisions or additions to critical habitat will also consider the contributions of this INRMP, implementation of this INRMP, and any additions to the INRMP (e.g. for Oahu elepaio (*Chasiempis sandwichensis ibidis*))

With regard to protection of species listed under the Endangered Species Act of 1973 [16 U.S.C. 1531 *et seq.*; 87 Stat. 884], as amended (ESA), the Service and U.S. Navy agree that the INRMP is programmatic in nature and is a planning document. For this reason, we anticipate that consultation under section 7 of the ESA will be undertaken on a project-specific basis prior to implementation of any actions.

Based on our review and coordination, this letter serves to communicate the Service and U.S. Navy are in mutual agreement with regard to the plan's content, consistent with paragraph (a)(2) of the Sikes Act.

We appreciate the U.S. Navy's effort to conserve and protect fish and wildlife resources on lands under their jurisdiction. You propose to monitor threatened and endangered species, restore native ecosystems and commit to maintaining communication with the Service through development and implementation of ongoing conservation and management plans. We look forward to working with you to implement the INRMP, which will assist achieving the concurrent goals of protecting natural resources while accomplishing the important mission of the U.S. Navy.

If you have questions, please contact Aaron Nadig, Fish and Wildlife Biologist, (phone: 808-792-9400, fax: 808-792-9581).

Sincerely,

Ibison Le

for Loyal Mehrhoff
Field Supervisor

cc: Mr. Paul Conry, Hawaii State, Division of Forestry and Wildlife
Mr. Gerry Davis, National Marine Fisheries Service, Pacific Islands Regional Office

M2 – NOAA COMMENTS ON THE FINAL JBPHH INRMP

Review of Final Integrated Natural Resource Management Plan:
Joint Base Pearl Harbor-Hickam (Sep2011)

Comments by R. Schroeder, NOAA-PIRO-HCD (30Nov2011):

The Habitat Conservation Division (HCD) of the NOAA Fisheries Pacific Islands Regional Office (PIRO) has reviewed the Final Integrated Natural Resource Management Plan: Joint Base Pearl Harbor-Hickam. Overall, the current JBPPH-INRMP (basically an update of an earlier approved version) is a long, comprehensive, and detailed document (incl. appendices), that does an adequate job of balancing environmental protection/ marine resource/habitat conservation with supporting and maintaining military readiness. Our review focuses on potential impacts on Essential Fish Habitat (EFH) pursuant to the Magnuson-Stevens Conservation and Management Act. The Plan addresses all major environmental aspects and covers those objectives/projects of most concern to our mandate, including habitat enhancement/restoration, soil stabilization/ erosion control, marine debris, invasive species, pollution mitigation, BMPs for land management, etc. The Plan would benefit by expanding the discussion on specific management measures to be implemented, particularly in regard to EFH (e.g., fishery-dependent creel-surveys to better understand the nature and possible impacts from this activity; post-release survival?, etc.).

HCD has the following comments/recommendations for the INRMP:

Page#	Section	Parag.	Comment
ES-16	45.		"… study of effects of fishing on the harbor" – where is this project described in the Plan?
1-1/16	Chap. 1		Good listing/summary of the applicable legal mandates for Navy to consider and comply with in the Plan
1-14/15		1.10/1.11	Ecosystem approach to management and adaptive mgmt.- where are these described in terms of detailed implementation plans, specific goals/objectives, for Pearl Harbor? (cites Chap.7- but this is for Hickam only?)
			What ecosystem-based/adaptive management steps will the Navy take to reduce and/or mitigate impacts to EFH from development or maintenance projects in Pearl Harbor?
1-10	Tab. 1-1	NOAA	Change 'Mr. Alan Everson' to 'Dr. Robert Schroeder' Habitat Division Tel (808) 944-2158 robert.schroeder@noaa.gov
3-65	3.3		'Coastal Management in Pearl Harbor (see Appdx B5 for report)' – Not found (B5 is a marine mammal sightings log)
3-66	Tab. 3-6		Good to see inclusion of consideration for petitioned coral species
3-105	3.3.4.5	Corals/ fishes	'Smith et al. (2006) study … conducted in small areas… site-specific info.' – could implement a stratified (by depth, habitat type) random design survey to assess the overall conditions of marine resources/habitat in the harbor/NDSA
3-106	Coral spp.	1st	Notes no stony corals recorded on early 1970s surveys. May be an artifact of not surveying more/different types of habitats, compared to later surveys (?) Invasive gorilla seaweed – what implementation activities are proposed in the INRMP to address this problem in Pearl

			Harbor?
3-118	3.4.1		This section focuses nearly exclusively on ecosystem monitoring/ management related to protected species. Such monitoring/ mgmt. should also adequately address all affected living marine resources.
3-122	Food limitation	1st	'… PHNC serves as a de facto marine reserve... provide a source for regional fishery enhancement' – Where is there evidence for this (cite studies). Most the habitat of PH is generally poor for reef fishes (except the marine debris that serves as habitat structure to aggregate fishes from elsewhere). 'Contributes to a healthy food base for MHI seals'.- statement needs support.
3-126	Contaminants	2nd	'Pearl Harbor receives runoff and pollutants from 22% of Oahu's urban/agricultural land area.' - Following periodic episodes of heavy rains, Pearl Harbor is commonly observed to be very muddy. While this sediment run-off is largely from outside Navy jurisdiction, its impact on the health of the harbor is considerable (compared to pre-occupation baseline). Such observations put in doubt some of the statements made in this Plan about the healthy conditions of the harbor.
3-128	3.4.1.4	Biosecurity	'No policy mandating hull cleaning for alien species'. – Seems like resolving this shortcoming would be a logical objective that this INRMP should address.
3-132	3.4.2.3	Marine Resource Mgmt. & Monitoring	This should be a major section in this Plan (not just a half page). Pertinent results from Smith et al. (2006), Appdx B3, implications, and management needs/measures/plans should be summarized here. Section on EFH should be expanded to explain the requirements and how the Navy implements its mandate in this regard.
3-134	3.4.6	4th	'… those within NOAA Fisheries … who think that Pearl Harbor should be opened.. for… fishing…' – be carful of loosely throwing out generic allegations without sufficient context!
3-135	Fishing	3rd	'… unauthorized, illegal fishing/methods… occurs regularly and openly in many areas' – improving the effectiveness of enforcement should be a major objective and project (detailing implementation procedures) in this INRMP
3-135	Fishing	4th	'consumptive fishing… concern about contaminated fish and shellfish' – Plan should detail what actions/plans are being taken to reduce the toxicity in the harbor. One value of the 'purported' increasing health of Pearl Harbor and its function as a de facto marine reserve is that it exports fish to areas outside the NDSA. What is the Navy's liability if these contaminated fish are taken in adjacent state waters, open to the public, producing negative human health impacts?
8-27	Ballast water exchange	5th	'water released in port during refueling may… contain exotic organisms… not addressed in policy…' - remedying this shortcoming should be a major objective and project in this INRMP
8-28	V. Coral description/ management	4th	'Pearl Harbor supports higher fish densities and larger average fish sizes than other sites in MHI (Smith et al. 2006) - Cited report only considers transects off Lanai as representative for all of MHI. Many remote shores of MHI

8-29		2nd	also serve as de facto reserves, with abundant large fish. Comparison w/ MHI should be more representative of all the islands. Should also report on findings of similar UVC surveys (e.g., by CRED, HCRI, W. Hawaii project, etc.). (See Williams et al. 2008 Environ. Conserv.) Can't conclusively consider the harbor to be 'improving in environmental conditions' simply because more fish are attracted to more (cumulative) junk (metal debris = habitat) on the harbor floor.
8-31	Factors influencing corals	3rd	'big wave events = most signif. factor affecting coral' – Hurricanes Iwa (1982) and Iniki (1992) crushed many corals along the S. shore of Oahu to beds of loose rubble that prevented subsequent recruitment for many years (ref Grigg).
8-32			'Objectives to conserve natural resources: 3. Maintain baseline information on fishery resources' – need periodic fishery-independent creel surveys.

(Comments on Final INRMP-JBPP_30Nov11_RES.doc)

M3 – SOH DLNR DAR COMMENTS ON THE FINAL JBPHH INRMP

NEIL ABERCROMBIE
GOVERNOR OF HAWAII

WILLIAM J. AILA, JR.
CHAIRPERSON
BOARD OF LAND AND NATURAL RESOURCES
COMMISSION ON WATER RESOURCE MANAGEMENT

GUY KAULUKUKUI
FIRST DEPUTY

WILLIAM M. TAM
DEPUTY DIRECTOR - WATER

AQUATIC RESOURCES
BOATING AND OCEAN RECREATION
BUREAU OF CONVEYANCES
COMMISSION ON WATER RESOURCE MANAGEMENT
CONSERVATION AND COASTAL LANDS
CONSERVATION AND RESOURCES ENFORCEMENT
ENGINEERING
FORESTRY AND WILDLIFE
HISTORIC PRESERVATION
KAHOOLAWE ISLAND RESERVE COMMISSION
LAND
STATE PARKS

STATE OF HAWAII
DEPARTMENT OF LAND AND NATURAL RESOURCES
DIVISION OF AQUATIC RESOURCES
1151 PUNCHBOWL STREET, ROOM 330
HONOLULU, HAWAII 96813

Suspense Date: 11/30/11

Date: 11/15/11

MEMORANDUM

TO:	Robert Nishimoto, Program Manager AV Environmental and Resources Protection
THROUGH:	Alton Miyasaka, Aquatic Biologist AM
FROM:	Jo-Anne Kushima, Aquatic Biologist JK
SUBJECT:	Review and comments on Final Joint Base Pearl Harbor-Hickam (JBPHH) Integrated Natural Resources Management Plan (INRMP), September 2011

Comment		Date Request	Receipt	Referral
Requested by:	Cory Campora (EV2CC) Department of the Navy	10/26/11	10/31/11	11/07/11

Summary of Proposed Project

Title: Final Joint Base Pearl Harbor-Hickam Integrated Natural Resources Management Plan, September 2011

Project by: Department of the Navy

Location: Pearl Harbor Naval Complex, Naval Magazine Pearl Harbor Lualualei and West Loch Branches, Naval Computer and Telecommunications Area Master Station Pacific Wahiawa, Naval Radio Transmitter Facility Lualualei, Navy-retained Lands at Kalaeloa, Hickam Air Force Base, Oahu, State of Hawaii

Brief Description: The Integrated Natural Resources Management Plan (INRMP) was developed for the United States Department of the Navy, Commander, Navy Region Hawaii for its Joint Base Pearl Harbor-Hickam (JBPHH), Oahu.

The primary purpose of this INRMP was to update the 2001 INRMPs for Pearl Harbor Naval Complex, Naval Magazine Pearl Harbor, and Naval Computer and Telecommunications Area Master Station Pacific Wahiawa and to update the 1997 Natural Resources Management Plan for Navy-retained land at the former Naval Air Station Barbers Point (now known as Kalaeloa) within the context of the operational mission of the facilities. Hickam Air Force Base came under Navy control as of October 1, 2010 as a result of the Joint-Basing process. Natural resource management at Hickam was covered in an Air Force INRMP that covered all previously held Air Force properties in Hawaii. The sections in that INRMP that pertain to those properties that are now under Navy jurisdiction have been extracted and are inserted in Chapter 7 of this INRMP.

The current plan provides a framework where natural resources are managed in accordance with the SAIA mandate to provide "no net loss in the capability of military installation lands to support the military mission of the installation." This INRMP serves three main functions:
1) serves as an information repository for natural resource information, assets and constraints;
2) provides guidance on how JBPHH is to comply with federal laws, rules, regulations, executive orders, and Department of Defense and Navy directives relating to natural resources; and
3) identifies management goals, required actions and resources necessary to protect and manage the installation's natural resources to provide the flexibility required to maintain "no net loss capability."

Chapters 1 and 2 describe the purpose and scope of the INRMP and the management strategies for implementation. The plan takes an ecosystem management approach, with special consideration given to protected species and rare habitats. It also describes the adaptive management strategy that ongoing natural resources surveys will be used to guide, and potentially change required management actions. The plan will be reviewed annually and updated every 5-years.

Implementing the INRMP is the responsibility of the JBPHH Installation Environmental Program Manager, and natural resources staff at Naval Facilities Engineering Commands Hawaii and Pacific and Commander Pacific Fleet. Updating and reviewing the INRMP will be done in cooperation with the SAIA partners: U.S. Fish and Wildlife Service, National Oceanic and Atmospheric Administration, National Marine Fisheries and the State of Hawaii, Department of Land and Natural Resources.

Comments: Table 1-1: INRMP Update Working Group Members, identifies Dan Polhemus as the contact for the Division of Aquatic Resources, Department of Land and Natural Resources (DLNR), State of Hawaii. Dan Polhemus is no longer employed by DLNR. The contact person for the Division of Aquatic Resources should be Robert Nishimoto, Program Manager for Environment and Resource Protection.

On page 391 under the section describing invertebrates, the report identifies the long spined BLACK sea urchin as *Echinothirix calamaris*. The identification of the long spined black sea urchin needs to be clarified because the long primary spines of the adult *E. calamaris* are typically banded, usually black (dark colored) and white (light colored).

The two commonly observed long spined black urchins in Hawaii are; 1) *Echinothrix diadema* which when viewed at certain angles in full sunlight, the primary spines appear an iridescent royal blue and 2) *Diadema paucispinum* whose primary spines are totally black even when viewed in the sunlight. The long primary spines of *D. paucispinum* are very thin and longer that the primary long spines of the two *Echinothrix* urchins.

The report needs to clarify WHICH long spined BLACK sea urchin it is referring to? Is it really *E. calamaris*? Or is it one of the two long spined black sea urchins; either *Echinothrix diadema* or *Diadema paucispinum*?

The State of Hawaii, Division of Aquatic Resources has been working closely with the Navy to address Invasive Species and Biosecurity issues. The cooperative program between the Navy and DAR involves notification of decommissioned vessels, barges, platforms or other objects that remain stationary for long periods of time and that are scheduled to arrive in Hawaii as well as implementation of management activities for reducing the risk of aquatic invasive species (AIS) transfer is ongoing. The Navy has budgeted for cleaning vessel hulls, ancillary gear and other surfaces in the water as well as ballast water flushing for inactive vessels coming to Hawaii.

AIS and biosecurity issues remain a high priority with DAR and even with significant budgetary cutbacks, resources are allocated for cooperative work with the Navy to continue. A Ballast Water & Hull Fouling Coordinator has been hired and will be on duty December 2011. Until then, the Aquatic Invasive Species Program Leader is the point of contact for AIS and bio-security issues. Phone: (808) 256-3095.

Based on the information provided, the Final Report does not appear to raise any concerns that relate to the protection, conservation, sustainability and management of natural aquatic resources on the DOD installations described in the report.

DEPARTMENT OF THE NAVY
COMMANDER
NAVY REGION HAWAII
850 TICONDEROGA ST STE 110
JBPHH, HAWAII 96860-5101

5750
Ser N45/ 1432
October 26, 2011

Mr. Francis G. Oishi
Division of Aquatic Resources
1151 Punchbowl Street, Room 330
Honolulu, HI 96813

DAR 4095
AM
JK
FYI

Dear Mr. Oishi:

SUBJECT: FINAL JOINT BASE PEARL HARBOR-HICKAM INTEGRATED NATURAL RESOURCES MANAGEMENT PLAN, SEPTEMBER 2011

We are forwarding a copy of the final Joint Base Pearl Harbor-Hickam (JBPHH) Integrated Natural Resources Management Plan (INRMP), September 2011 for your review and use. This document serves as a consolidated update of the 2001 Pearl Harbor INRMP, 2001 Naval Magazine (NAVMAG) INRMP, 2001 Naval Computer and Telecommunications Area Master Station (NCTAMS) INRMP, and the 1997 Naval Air Station (NAS) Barber's Point INRMP. The JBPHH INMRP also includes information on the former Hickam Air Force Base. Finalization of the JBPHH INRMP meets the statutory requirements of the Sikes Act Improvement Amendments (SAIA) of 1997 and provides CNRH with the necessary resource information to support sound land use decisions and natural resources management on Oahu Navy lands.

Federal, State, and City and County resource agencies were afforded opportunities to review the preliminary draft (2008) and the public review draft (2009). Comments and Navy responses to comments are provided in Appendices J and K respectively. We ask that you provide a letter of concurrence with the Final JBPHH INRMP no later than 30 November 2011. A negative reply is requested if you do not concur with the document.

All questions pertaining to this project should be directed to my point of contact, Mr. Cory Campora (EV2CC) at (808) 471-1170, ext 244 or by e-mail at cory.campora@navy.mil

Sincerely,

D. R. Bustamante
Captain, CEC, U.S. Navy
Regional Engineer, Acting
By direction of the
Commander

Enclosure: 1. CD containing Integrated Natural Resource management Plan.

NEIL ABERCROMBIE
GOVERNOR OF HAWAII

STATE OF HAWAII
DEPARTMENT OF LAND AND NATURAL RESOURCES

DIVISION OF FORESTRY AND WILDLIFE
1151 PUNCHBOWL ST., ROOM 325
HONOLULU, HAWAII 96813
TEL (808) 587-0166 FAX (808) 587-0160

2/19
XO
EV
EV2 (Cory Campora)

February 10, 2014

Department of the Navy
Commander
Navy Region Hawaii
850 Ticonderoga St. Ste 110
JBPHH, Hawaii 96860-5101

EV' KO 2/19/14

Subject: Final Joint Base Pearl Harbor-Hickam Integrated Natural Resource Management Plan (INRMP), September 2011

Dear Captain Williamson:

The Hawaii Division of Forestry and Wildlife has reviewed the Final Joint Base Pearl Harbor-Hickam INRMP, September 2011concerning conservation, protection and management of natural resources pursuant to the Sikes Act Improvement Act 1997. The Final INRMP was submitted to our office for review and signature in January of 2014. This letter transmits our concerns and comments regarding the Final INRMP.

We appreciate the opportunity to review the Final INRMP and commend the Navy's efforts to update the 2001 INRMP so as to provide the needed protections to State and Federally protected species and their habitats.

General Concerns and Comments

We have provided general comments related to natural resources and the INRMP below.

- Table ES-2 (pg ES- 43) lists the White Tern as a state endangered species. Note that the State of Hawaii lists the White Tern (*Gygis alba rothschildi*) as threatened and not as endangered on the island of Oahu.
- Stakeholder contacts as listed on pages 1-10 through 1-14 are no longer accurate with several state and federal staff no longer in their listed positions. We recommend using position titles and not names.
- P3-67: It should be noted that Hawaiian ducks are highly vulnerable to cat attacks/predation and to hybridization with introduced feral mallards. Under threats for Hawaiian Ducks mongoose should be added for the islands of Oahu, Maui, and the Big

Island. The estimated population size for Hawaiian Ducks is 2200+ birds per the USFWS Recovery Plan for Hawaiian Waterbirds (2011).

- Population numbers for all endangered waterbirds should reference the USFWS Recovery Plan for Hawaiian Waterbirds.
- White Terns: Over 690 adults were censused between 2001-2003
- We strongly recommend that all managed wetlands have an Avian Botulism Response Plan. Avian botulism is the number one known cause of mortality in Hawaii's endangered waterfowl. All installations should know what signs/symptoms are associated with Avian Botulism and how to properly deal with this paralytic disease.
- We strongly recommend that more up-to-date bird surveys and references be used as currently documents cited are out-dated and do not appear to represent current population numbers of native, non-native and predatory wildlife in the area.
- Kalaeloa: unidentified ducks have been observed by DOFAW staff along with Black Crowned Night Herons at Ordy Pond. It is highly recommended that surveys of the Pond be done to determine waterbird usage.
- Appendix A: Bird Surveys-we find these surveys to be outdated. Bruner's 2000 surveys for example most certainly do not reflect 2011 bird populations at the facilities. It should also be noted that survey methods used by Bruner are inadequate in determining Hawaiian Short-eared Owl presence. Given the Short-eared Owls listing as an endangered species by the State we strongly suggest that future bird surveys include appropriate methodology for surveying of Short-eared Owls.
- Appendix I-12 Injured Bird Protocols: All dead native wildlife should be reported to the Oahu District Biologist with 24 hours (808-973-9778). Native wildlife that have died of no apparent cause or that are suspected of having died of avian botulism should be sent to Dr. Thierry Work at the USGS National Wildlife Health Laboratory Honolulu Field Station (808-792-9521) for necropsy. A copy of the necropsy report should be forwarded to DOFAW. The current DOFAW phone number lists us as the Division of Fish and Wildlife note that it should read the Division of Forestry and Wildlife. All injured wildlife should be reported to DOFAW immediately. Only those rehabilitation facilities that have both State and Federal authorization should be listed as points of contact. As of now Sea Life Park and the Hilton Hawaiian Village do not have the proper authorization to conduct wildlife rehabilitation.
- We recommend that State wildlife staff tour the listed facilities to discuss management efforts and identify opportunities for collaboration/provision of technical support.
- We recommend that more comprehensive wildlife surveys of the sites be done to examine habitats suitable and in current use by wildlife.

If you have any questions on any of the above, please contact Dr. Marie Morin at 587-4187 or Norma Crep at 587-0163.

Yours sincerely,

Randy Kennedy

Randy Kennedy, Acting DOFAW Administrator

M4 – SOH DLNR OCCL COMMENTS ON THE FINAL JBPHH INRMP

NEIL ABERCROMBIE
GOVERNOR OF HAWAII

STATE OF HAWAII
DEPARTMENT OF LAND AND NATURAL RESOURCES
OFFICE OF CONSERVATION AND COASTAL LANDS
POST OFFICE BOX 621
HONOLULU, HAWAII 96809

WILLIAM J. AILA, JR.
CHAIRPERSON
BOARD OF LAND AND NATURAL RESOURCES
COMMISSION ON WATER RESOURCE MANAGEMENT

GUY H. KAULUKUKUI
FIRST DEPUTY

WILLIAM M. TAM
DEPUTY DIRECTOR - WATER

AQUATIC RESOURCES
BOATING AND OCEAN RECREATION
BUREAU OF CONVEYANCES
COMMISSION ON WATER RESOURCE MANAGEMENT
CONSERVATION AND COASTAL LANDS
CONSERVATION AND RESOURCES ENFORCEMENT
ENGINEERING
FORESTRY AND WILDLIFE
HISTORIC PRESERVATION
KAHOOLAWE ISLAND RESERVE COMMISSION
LAND
STATE PARKS

REF: OCCL: AJR COR: OA-12-107

NOV - 9 2011

Cory Campora (EV2CC)
Department of the Navy
Naval Facilities Engineering Command, Pacific
258 Makalapa Dr., Ste. 100
Pearl Harbor, HI 96860-3134

SUBJECT: *Comments for Final Joint Base Pearl Harbor-Hickam Integrated Natural Resources Management Plan, September 2011*
Pearl Harbor, Honolulu County, Hawaii

Dear Mr. Campora,

The Department of Land and Natural Resources (DLNR), Office of Conservation and Coastal Lands (OCCL) is in receipt of your letter requesting comments on the Final Joint Base Pearl Harbor-Hickam Integrated Natural Resources Management Plan (JBPHH INRMP).

A review of the management plan reveals that there are lands within the area covered by the INRMP that are within the Conservation District Resource and Protective Subzones. **Exhibit A** is a map which outlines the Conservation District Lands located in the vicinity of the West Loch; **Exhibit B** map reveals only one small area of Conservation District lands in the vicinity of the East Loch. We look forward to working with your office on any necessary permits for land uses within the Conservation District.

The Office of Conservation and Coastal Lands (OCCL) would like to reiterate comments made during the draft INRMP on *February 9, 2009* concerning management plans, community outreach and best management practices (BMP).

1. There are four historic fishponds that are part of the *Pearl Harbor Wetlands*, we support the Navy's development of a community outreach program to monitor the Loko Pa'aiau, Loko Laulaunui, Loko Pamoku, and Loko 'Oki'okiolepe extant fishponds;

2. The OCCL supports the plan to integrate comprehensive mangrove removal in an effort to provide protection for fishpond walls at Pearl Harbor and nearby areas;

3. The OCCL supports specific management programs at the refuge which include the maintenance of manmade ponds and wetlands, predator control, and the reduction of human disturbances to restore wetland habitat while retaining wetland function. If necessary, the program should promote the control and management of vegetation in order to preserve and protect the fishpond walls; and

4. Promoting adequate setbacks for near shore, riparian, stream and wetland resources to limit the amount of potential impacts by the public that will allow for natural vegetation to flourish is an important natural resource management tool

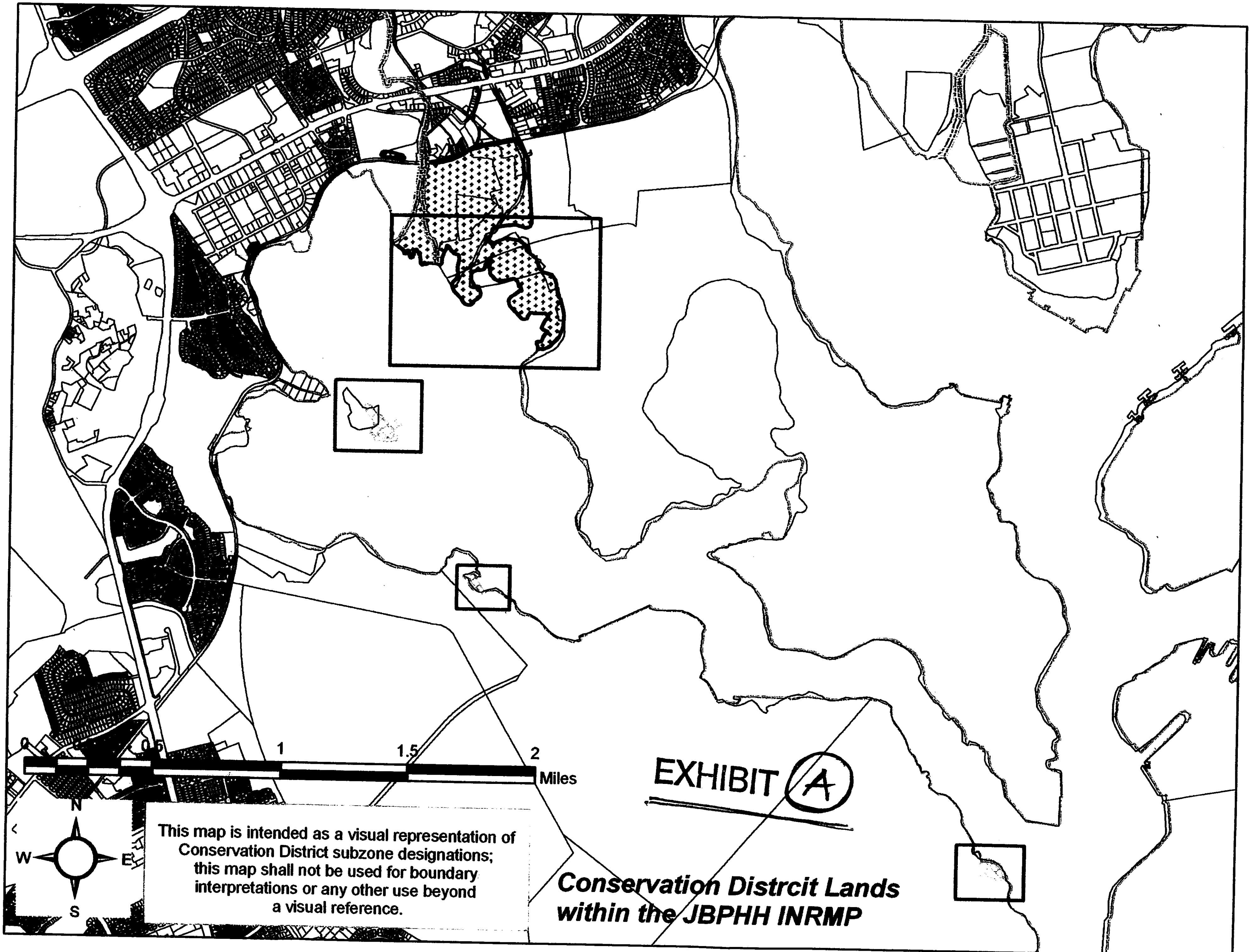
Should you have any further questions about these comments or require additional information, please contact Alex J. Roy of the Office of Conservation and Coastal Lands at 808-587-0316

Sincerely,

Michael Cain for

Samuel J. Lemmo, Administrator
Office of Conservation of Coastal Lands

CC: Chairperson
C&C DPP
ODLO
DOFAW
DAR



0
0.5
1
1.5
2
Miles
EXHIBIT A
N
W
E
S
This map is intended as a visual representation of Conservation District subzone designations; this map shall not be used for boundary interpretations or any other use beyond a visual reference.
Conservation Distrcit Lands within the JBPHH INRMP

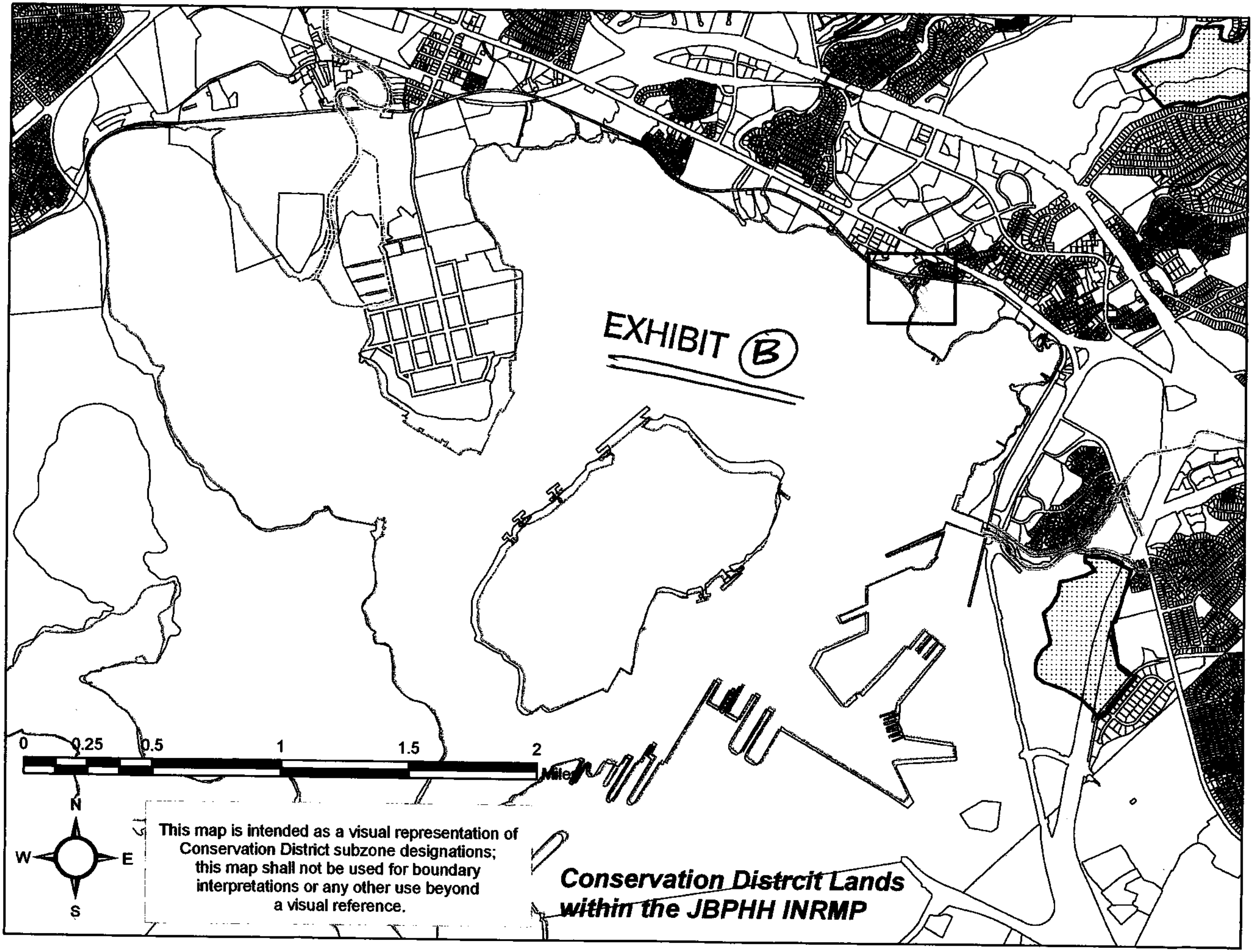


EXHIBIT B
0
0.25
0.5
1
1.5
2
Miles
N
W
E
S
This map is intended as a visual representation of
Conservation District subzone designations;
this map shall not be used for boundary
interpretations or any other use beyond
a visual reference.
Conservation Distrcit Lands
within the JBPHH INRMP

M5 – SOH DBEDT CZM COMMENTS ON THE FINAL JBPHH INRMP

NEIL ABERCROMBIE
GOVERNOR
RICHARD C. LIM
DIRECTOR
MARY ALICE EVANS
DEPUTY DIRECTOR
JESSE K. SOUKI
DIRECTOR
OFFICE OF PLANNING

DEPARTMENT OF BUSINESS, ECONOMIC DEVELOPMENT & TOURISM

OFFICE OF PLANNING

235 South Beretania Street, 6th Floor, Honolulu, Hawaii 96813
Mailing Address: P.O. Box 2359, Honolulu, Hawaii 96804

Telephone: (808) 587-2846
Fax: (808) 587-2824

Ref. No. P-13448

November 2, 2011

D. R. Bustamante
Captain, CEC, U.S. Navy
Regional Engineer, Acting
Navy Region Hawaii
850 Ticonderoga Street, Suite 110
JBPHH, Hawaii 96860-5101

Attention: Mr. Cory Campora (EV2CC)

Dear Captain Bustamante:

Subject: Hawaii Coastal Zone Management (CZM) Program Review of the Final Joint Base Pearl Harbor-Hickam (JBPHH) Integrated Natural Resources Management Plan (INRMP), September 2011

This responds to your request for Hawaii CZM Program review and concurrence with the Final JBPHH INRMP. According to the INRMP (p. 1-2), it is "intended to be a technical document to be used in the preparation of JBPHH approvals, management actions, orders, instructions, guidelines, standard operating procedures, and other planning documents." "It provides technical guidance for the integration of natural resource issues into planning and decision-making processes." Because the INRMP is a technical document and does not in itself cause or have any coastal effects, the INRMP does not require CZM federal consistency review and concurrence. However, we do agree with the INRMP statement (p. 1-8): "As specific natural resource projects are proposed and screened for applicability they will be submitted to the SOH CZM Program for consistency review, if required." Implementation of individual INRMP actions which have a reasonably foreseeable effect on any coastal use or resource are required to be submitted for Hawaii CZM Program federal consistency review, pursuant to 15 CFR 930, Subpart C.

We appreciate the opportunity for the CZM Program to participate as a member of the INRMP Working Group. If you have any questions, please call John Nakagawa of our CZM Program at 587-2878.

Sincerely,

Jesse K. Souki
Director

M6 – CCH DPP COMMENTS ON THE FINAL JBPHH INRMP

DEPARTMENT OF PLANNING AND PERMITTING
CITY AND COUNTY OF HONOLULU
650 SOUTH KING STREET, 7TH FLOOR • HONOLULU, HAWAII 96813
TELEPHONE: (808) 768-8000 • FAX: (808) 768-6041
DEPT. WEB SITE: www.honoluludpp.org • CITY WEB SITE: www.honolulu.gov

PETER B. CARLISLE
MAYOR

DAVID K. TANOUE
DIRECTOR

JIRO A. SUMADA
DEPUTY DIRECTOR

2011/ELOG-2459 (rns)

November 30, 2011

D. R. Bustamante
Captain, CEC, U. S. Navy
Regional Engineer, Acting
850 Ticonderoga Street, Suite 110
JBPHH, Hawaii 96860-5101

Dear Captain Bustamante:

Subject: Concurrence with the Final Joint Base Pearl Harbor-Hickam Integrated Natural Resources Management Plan, September 2011

We have reviewed the **Final Joint Base Pearl Harbor-Hickam Integrated Natural Resources Management Plan** (September 2011) as requested in your letter referenced 5750 Ser N45/ 1428 and dated October 26, 2011.

The **Integrated Natural Resources Management Plan** (INRMP) is generally consistent with the City's long-range policy plans, including the **O'ahu General Plan**, and the development plans for the areas covered by the INRMP (the Primary Urban Center, Central O'ahu, 'Ewa, and Wai'anae).

We note that our July 7, 2010 letter with attached comments on the Draft INRMP was not incorporated in Appendix J. We have included a copy of that letter for your information. We would be interested in the Navy's responses to the areas where City policies may differ slightly from those in the INRMP.

Specifically, those included:

- The extent of access to the East Loch proposed in the **Primary Urban Center Development Plan** may be more than is allowed under the INRMP;
- The extent of access to the West Loch and Middle Loch proposed in the **Central O'ahu Sustainable Communities Plan** (CO SCP) is more than is allowed under the INRMP; and

- The storage of dredged material on the Waipi'o Peninsula may adversely impact the area's potential for agricultural use which is the desired long-term use called for by the CO SCP.

Thank you for the opportunity to provide comments on the INRMP. We appreciate the effort to consult us and to work with us to protect the natural resources of our island.

Very truly yours,

for David K. Tanoue, Director
Department of Planning and Permitting

DKT:js

895292

Attachment: Department of Planning and Permitting July 7, 2010 letter to Naval Facilities Engineering Command, Pacific

DEPARTMENT OF PLANNING AND PERMITTING
CITY AND COUNTY OF HONOLULU
650 SOUTH KING STREET, 7TH FLOOR • HONOLULU, HAWAII 96813
TELEPHONE: (808) 768-8000 • FAX: (808) 768-6041
DEPT. WEB SITE: www.honoluludpp.org • CITY WEB SITE: www.honolulu.gov

MUFI HANNEMANN
MAYOR

DAVID K. TANOUE
DIRECTOR

ROBERT M. SUMITOMO
DEPUTY DIRECTOR

2010/ELOG-112(HS)

July 7, 2010

Mr. Cory Campora
Department of the Navy
Naval Facilities Engineering Command, Pacific
258 Makalapa Drive, Suite 100
Pearl Harbor, Hawai'i 96860-3134

Dear Mr. Campora:

Subject: Comments on the Public Review Draft of the Naval Station Pearl Harbor Hawai'i Integrated Natural Resources Management Plan

Thank you for the opportunity to provide these late comments on the Public Review Draft of the Naval Station Pearl Harbor Hawai'i Integrated Natural Resources Management Plan (INRMP).

In general, the INRMP is consistent with the City's Long-Range Policy Plans, and the General Plan. These plans are available on our website, http://www.honoluludpp.org/.

A final comment suggests that the discussion of the impact of sea level rise, raised in the INRMP discussion of potential negative impacts on Monk Seal Habitat, might be extended to include an assessment of impacts on other natural resources management objectives.

If you have any question about these comments, please feel free to contact Hal Senter of my staff at 768-8055 or by e-mail at hsenter@honolulu.gov.

Very truly yours,

for David K. Tanoue, Director
Department of Planning and Permitting

DKT:lh
762789

COMMENTS ON THE PUBLIC REVIEW DRAFT
INTEGRATED NATURAL RESOURCE MANAGEMENT PLAN (INRMP)
NAVAL STATION PEARL HARBOR (January 12, 2010)

COMMENTS

1. The City Council adopted the **Primary Urban Center Development Plan** (PUC DP) in 2004. It provides a vision for the PUC's development, and policies and guidelines regarding desirable uses for Pearl Harbor from the Pearl City Peninsula to Holakahiki Point. The existing Plan is available on-line at: http://honoluludpp.org/Planning/DevSust_PrimaryUrbanCenter.asp .

   Pertinent policies and guidelines from the PUC DP include:

   - **Vision Element**: Honolulu's Natural, Cultural, and Scenic Resources are Protected and Enhanced (Section 2.1)
     - Protect and preserve shorelines and natural resources that lie within the urban area.
     - Assure and continually enhance physical access to the shoreline.
     - Provide "promenades, bikeways, and opportunities for entertainment" along the Pearl Harbor waterfront.
   - **Policy**: Protecting and Enhancing Natural, Cultural, and Scenic Resources (Sec. 3.1.2)
     - Preserve historic and cultural sites
     - Preserve and protect natural resource and constraint areas
     - Preserve panoramic views of natural landmarks and the urban skyline
     - Improve access to shoreline areas
     - Provide "continuous lateral access ... around the East Loch of Pearl Harbor, where urban activity is most intense
   - **Guideline**: "Provide continuous lateral shoreline access for pedestrians extending . . . from Neal S. Blaisdell Park through Aiea Bay State Recreation Area." (Sec. 3.1.3.4)
     - "Along the Pearl Harbor shoreline in Aiea and Pearl City, acquire privately owned properties and the Navy-owned McGrew Point *makai* of the Pearl Harbor bikeway for recreational use, and/or encourage complementary redevelopment with incentives for higher zoning in return for view corridors, extra open space, public amenities, and public access to the shoreline."
   - **Vision Element:** Honolulu is the Pacific's Leading City and Travel Destination (Sec. 2.4)
     - "Residents and visitors also enjoy the broad waterfront of Pearl Harbor's East Loch."
     - "The historic OR&L bikeway and promenade links extensive parks, including Aiea Bay State Recreation Area, the new park at McGrew Point, and an expanded Neal Blaisdell Park."

- **Policy**: The Pacific's Leading City (Sec. 3.4)
  - Create public open space along the Pearl Harbor waterfront and strengthen the physical and visual connections between the urban center and the water
  - Improve mauka-makai pedestrian and bicycle circulation across Kamehameha Highway
  - Support continuation of military uses
  - Integrate civilian and military residential communities through use of connecting roadways, bikeways, walkways, landscape features
- **Policy**: Water Allocation and System Development (Sec. 4.1)
  - Integrate resource management of all potable and nonpotable water sources including groundwater, stream water, storm water, and wastewater effluent.
  - Protect and maintain watersheds to ensure an adequate supply of high quality water with sufficient infiltration recharge into groundwater aquifers.
- **Policy**: Stormwater Systems (Sec. 4.6)
  - Require methods of retaining of detaining stormwater for gradual release into the ground as the preferred strategy for the management of stormwater. Where feasible, utilize open spaces including parking lots, landscaped areas, and volume and runoff rates.
  - Preserve stream and estuarine habitats.

  Comment: The management objectives and actions recommendations of the INRMP appear to be compatible with the PUC DP vision, policies and guidelines although the extent of access to the East Loch proposed in the PUC DP may be more than would be allowed under the INRMP.

2. The City Council adopted the **Central O'ahu Sustainable Communities Plan** (CO SCP) in 2002. It provides a vision for Central Oahu's development and policies and guidelines regarding desirable uses for Pearl Harbor along the shoreline in Central O'ahu from the Pearl City Peninsula to West Loch Shoreline Park. The CO SCP is currently under review for updates and revisions, and a public review draft of a proposed revised CO SCP is scheduled to be released in the near future. The existing Plan is available on-line at: http://honoluludpp.org/Planning/DevSust_CentralOahu.asp .

   Pertinent vision elements, policies and guidelines from the CO SCP include:
   - **Vision Element**: Creation of An Open Space Network (Sec. 2.1)
     - Protect prime agricultural lands . . . on the Waipio Peninsula for diversified agriculture . . .
     - Develop a Shoreline Park and Preservation area along the entire shoreline in Pearl Harbor's West Loch and Middle Loch to restore the shoreline in Waipahū to public use, provide active and passive recreation facilities, and help create the Pearl Harbor Historic Trail ... running from Rainbow Marina near Aloha Stadium to the Wai'anae Coast.

- **Policy**: Open Space Preservation and Development. (Sec. 3.1)
  - Provide long range protection for diversified agriculture . . . on lands outside the Urban Community Boundary . . .
  - Protect scenic views and provide recreation
- **Guideline**: Shoreline Areas (Sec. 3.1.4.3)
  - Provide public access to the Pearl Harbor shoreline at intervals of approximately one mile, except where access is restricted by the military for security reasons.
  - Maintain and enhance nearshore wetlands and mangroves, where necessary, as wildlife habitats.
- **Guideline**: Parks (Sec. 3.1.4.5, also 3.2.3.1)
  - Establish a major new shoreline park at Waipio Peninsula, giving access from Waipahū to the Pearl Harbor shoreline on the West Loch and Middle Loch.
- **Policy**: Military Areas: Pearl Harbor Naval Base (Waipio Peninsula) (Sec. 3.12.1.2)
  - Continue use of the Waipio Peninsula lands for diversified agriculture or aquaculture activities
  - Allow expansion of limited public access to the shoreline waters of West Loch beyond the West Loch Shoreline Park
  - Retain and enhance wetland areas along the Pearl Harbor shoreline.

  Comment: As shown on Figure 2-1 (p. 2-8), the INRMP identifies only areas in the East Loch and the Middle Loch as open to public catch-and-release fishing, and describes recreational opportunities at West Loch as either non-existent or severely limited due to access restrictions. The INRMP recognizes the Pearl Harbor Historic Trail (describing it as the Pearl Harbor Bike Path) and notes that a portion runs on Navy property from the Arizona Memorial Center to the Waipio Point Access Road.

- **Vision Element**: Conservation of Natural Resources (Sec. 2.1)
- **Policy**: Conserve natural resources by retention of natural drainageways, protection of valuable plant and wildlife habitats, and supporting efforts to minimize degradation of protection provided to the environment by the Conservation District. (Sec. 2.1)
- **Policy**: Identify and protect endangered species habitats and other important ecological zones from threats such as fire, weeds, feral animals, and human activity. (Sec. 2.2.8)
- **Policy**: Design the regional drainage and wastewater treatment system to minimize non-point source pollution of the ocean and Pearl Harbor. (Sec. 2.2.8)
- **Policy**: Protect valuable habitats for endangered waterbirds located on the shoreline of Pearl Harbor at Pouhala Marsh and Pearl Harbor Ponds. (Sec. 2.2.8)
- **Policy**: Maintain and enhance nearshore wetlands and mangroves where necessary as wildlife habitats. (Sec. 3.1.4.3)
- **Policy**: Retain, protect, and incorporate wetland and other wildlife habitat areas as passive recreation resources [in sports and recreation complexes]. (Sec. 3.2.3.2)

- o **Policy**: Protect and enhance wetlands along the West Loch and Middle Loch shorelines. (Sec. 3.12.3.2)
  Comment: The IRMP's management programs and actions, based on extensive analysis of potential impacts on wildlife habitat, are consistent with the EDP policies and guidelines.

- o **Vision Element**: Protection of Agricultural Lands
- o **Policy**: Protect agricultural lands to create an opportunity for long-term retention and development of diversified agriculture on small farms, corporate lands, and agricultural parks. (Sec. 2.2.1)
- o **Policy**: Provide long-range protection for diversified agriculture . . . (Sec. 3.1.1)
- o **Policy**: Permit facilities necessary to support intensive cultivation of arable agricultural lands. (Sec. 3.1.4.4)
- o **Policy**: Continue agricultural uses on the Waipio Peninsula within the Explosive Safety Quantity Distance (ESQD) zone for the Pearl Harbor Naval Munitions Command. (Sec. 3.12.3.2)
  Comment: The Navy has been using the lower portions of the Waipi'o Peninsula to store dredged material which may adversely impact the area's potential for agricultural use.

Comment: The management objectives and actions recommendations of the INRMP appear to be compatible with the CO SCP policies and guidelines, with the possible exception of the storage of dredged material on the Waipi'o Peninsula.

3. The City Council adopted the **Ewa Development Plan** (EDP) in 1997. It provides a vision for Ewa's development and policies and guidelines regarding desirable uses for Pearl Harbor along the shoreline in Ewa from West Loch Shoreline Park to Iroquois Point. It also includes policies and guidelines for Kalaeloa. The EDP is currently under review for updates and revisions, and a proposed revised EDP is scheduled to be transmitted to the Planning Commission and City Council in the near future. The existing Plan is available on-line at: http://honoluludpp.org/Planning/DevSust_Ewa.asp .

   Pertinent policies and guidelines from the EDP include:
   - o **Vision Element**: Creation Of An Open Space Network (Sec. 2.1)
     - o Protect prime agricultural lands . . . within the West Loch Naval Magazine Blast Zone for diversified agriculture.
     - o Provide easy access to the ocean with a shoreline walkway from Ko Olina to Ewa Beach.
     - o Provide access to beaches and swimming and surfing spots all along the entire Ewa coastline by road or a network of pedestrian paths and bikeways.
     - o Preserve open space in parks, golf courses and agricultural areas which will also help to protect significant vistas.
     - o Retain wildlife habitats at Kalaeloa, Ocean Pointe, and West Loch.

- **Policy**: Kalaeloa - Create a continuous pedestrian route along the entire 'Ewa Coast by reserving the entire shoreline of Kalaeloa for public access and recreation, and linking to adjacent pathways in Ocean Pointe/Hoakalei and Campbell Industrial Park. (Sec. 3.1 and 3.2)
  Comment: The INRMP calls for continued public recreational use of Nimitz Beach and White Sands Beach at Kalaeloa. This is congruent with Ewa DP policies.
- **Policy**: West Loch - Expand limited public access to the shoreline waters of West Loch beyond the West Loch Shoreline Park. (Sec 3.7.5)
  Comment: While promoting shoreline pedestrian access, the Ewa DP also recognizes that restrictions may be necessary to support the Navy's mission.
- **Policy**: Wetland areas – Retain and enhance wetland areas along the Pearl Harbor shoreline. (Sec 3.7.5)
  Comment: The INRMP's management programs and actions, based on extensive analysis of potential impacts on wildlife habitat, are consistent with the EDP policies and guidelines.
- **Policy**: West Loch – Support agricultural operations in the ESQD area (Sec 2.2.2)
  Comment: As there are no federal or Hawaii listed threatened and/or endangered plant species at NAVMAG-PH West Loch, the area within the ESQD remains suitable for outleasing for agricultural operations. (Section 3.3.5.6) Currently, 1,025 acres are leased till March 31, 2023. (Section 3.4.14 – p 135) The Navy's continuation of agricultural leasing in the NAVMAG PH West Loch ESQD area is supported by the relevant Ewa DP policies and guidelines.

4. The City Council adopted the **Wai'anae Sustainable Communities Plan** (WSCP) in 2000. It provides policies and guidelines regarding desirable uses for the open space and agricultural areas at Wai'anae, including those in the Lualualei INRMP study area. The WSCP is currently under review for updates and revision, and proposed revised WSCP is scheduled to be transmitted to the Planning Commission and City Council in the near future. The existing Plan is available on-line at: http://honoluludpp.org/Planning/DevSust_Waianae.asp .

- **Vision Element**: Preservation of the rural landscape and the country lifestyle of the Wai'anae People.
- **Vision**: Preservation of the rural community (Sec. 2.3)
- **Vision**: Ahupua'a/ecosystem-based planning (Sec 2.5)
- **Vision**: Environmentally appropriate development (Sec 2.6)
  - potable water imported now; need to develop nonpotable water sources
  - special natural and cultural resources needing protection
- **Vision**: Confine growth within rural community boundary (Sec 2.7.2)
- **Vision**: Develop an alternative to Farrington Highway (Sec 2.7.9)
- **Vision**: Protect and restore natural streams and stream corridors (Sec 2.7.5)
  - Enforce No Dumping rule

- Require siltation basins and other means to control urban and agricultural stormwater runoff
  - Restore natural vegetation within stream floodplain areas
- **Policy**: Sec. 3.2: Preserve open space by limiting urban development to the Rural Community area
- **Policy**: Sec. 3.4: Preserve mountain forest land
  - Restore endemic and indigenous forest plants and animals
  - Protect habitat for rare species
- **Policy**: Sec. 3.5: Preserve streams and stream corridors
  - Establish stream conservation corridors, including
    - Ulehawa Stream
    - Māʻiliʻili Stream
  - Restrict uses within stream corridors
  - Establish Minimum in-stream flow standards
- **Policy**: Sec. 3.6: Preserve Historic and Cultural Sites
  - Preserve cultural landscapes in the upper reached of the valley
  - Preserve other cultural sites in other areas wherever possible
- **Policy**: Sec. 3.7: Preservation of Agricultural Lands
  - Establish a boundary for important agricultural lands
  - Limit land use to agricultural and related compatible activities
  - Restrict incompatible non-agricultural land uses
  - Use zoning and taxation to help support agricultural uses
- **Policy**: Sec. 3.12: Military Land Use
  - Preserve military lands as agricultural/open space
  - Recognize continued use of lands for military purposes
  - Continue cooperative programs with military for preservation of cultural/natural resources on military lands
- **Policy**: Sec. 4.1: Transportation Systems
  - Establish an emergency road as alternate to Farrington Highway
  - Construct a reliever road parallel to Farrington Highway
- **Policy**: Sec. 4.2: Potable Water System
  - Determine safe yield of aquifers as related to stream flow
  - Promote efficient use of available water supplies
  - Establish program for affordable water for agriculture
- **Policy**: Sec. 4.5: Drainage Systems
  - Prepare comprehensive study of local flooding and drainage problems
  - Avoid degradation of coastline an near shore water quality
  - Integrate drainage improvements with open space network
  - Pursue program of sediment control to protect water quality

5. The Public Review Draft on pages 3-75 to 3-77 mentions the potential negative impact of sea level rise on Monk Seal habitat near Iroquois Point. No other mention is made of the impact that sea level rise would have on other species.

   Comment: The impact of sea level rise on the surrounding Pearl Harbor environment deserves broader discussion including possible methods of adaptation and mitigation. For assumptions to use regarding potential sea rise, we suggest that you might use the scenarios that the Army Corps of Engineers is using in its assessment of the Ala Wai Watershed Project.

762789

APPENDIX N
ADDENDUM TO THE INRMP DATED JUNE 2012

DEPARTMENT OF THE NAVY
COMMANDER
NAVY REGION HAWAII
850 TICONDEROGA ST STE 110
JBPHH, HAWAII 96860-5101

5750
Ser N45/0583
June 7, 2012

CERTIFIED MAIL NO. 7010 2780 0003 1014 0334

Dr. Loyal Mehrhoff
Field Supervisor
Pacific Islands Fish & Wildlife Office
300 Ala Moana Boulevard
Box 50098
Honolulu, HI 96850

Dear Dr. Mehrhoff:

SUBJECT: ADDENDUM TO 2011 JOINT BASE PEARL HARBOR-HICKAM INTEGRATED NATURAL RESOURCES MANAGEMENT PLAN

We would like to thank you and your staff for taking the time to discuss the subject matter with representatives of Commander, Navy Installations Command, Naval Facilities Engineering Command (NAVFAC) Headquarters, NAVFAC Pacific and NAVFAC HI. The enclosed Addendum provides additional information for Navy-owned parcels at Navy Munitions Command East Asia Division Detachment Joint Base Pearl Harbor-Hickam Lualualei Annex (formerly known as NAVMAG PH Lualualei Branch), Naval Radio Transmitter Facility (NRTF) Lualualei, and Kalaeloa at the former Naval Air Station Barbers Point.

This information will be incorporated in the Joint Base Pearl Harbor-Hickam Integrated Natural Resources Management Plan. We will continue to work with your office and seek your concurrence on this important document.

We appreciate your accommodation and consideration concerning the Navy's request to exclude NAVMAG PH Lualualei Branch, NRTP Lualualei, and Kalaeloa from plant critical habitat designation. We look forward to your feedback.

Should you have any questions, please contact Dr. Cory Campora, (808) 471-1171, extension 244 or email cory.campora@navy.mil.

Sincerely,

J. Coronado

J. CORONADO
Captain, CEC, U.S. Navy
Regional Engineer
By direction of the
Commander

5750
Ser N45/0583
June 7, 2012

Enclosure: 1. Addendum to the September 2011 Final Integrated Natural Resource Management Plan-Joint Base Pearl Harbor-Hickam.

Copy to: NAVFAC Hawaii (ARE, OPHE2)
NAVFAC Pacific (EV22)

Addendum to the

Integrated Natural Resource Management Plan

Joint Base Pearl Harbor-Hickam

Navy Munitions Command East Asia Division Detachment Joint Base Pearl Harbor-Hickam Lualualei Annex,
Naval Radio Transmitter Facility Lualualei, and
Kalaeloa (Former Naval Air Station Barber's Point)
O‘ahu, State of Hawai‘i

Commander Navy Region Hawaii
June 2012

Table of Contents

List of Figures

List of Tables

1.0 Introduction and Overview

This Addendum has been prepared in accordance with and is officially incorporated as part of the JBPHH INRMP (September 2011) to address the proposed critical habitat designations for 42 plant species including *Abutilon sandwicense, Alectryon macrococcus, Bonamia menziesii, Cenchrus agrimonioides, Chamaesyce herbstii, C. kuwaleana, Cyanea acuminata, C. calycina, C. grimesiana* ssp. *obatae, Cyperus trachysanthos, Diellia falcata, D. unisora, Flueggea neowawraea, Gouania meyenii, Hesperomannia arbuscula, Kadua parvula, Labordia cyrtandrae, Lepidium arbuscula, Lipochaeta lobata* var. *leptophylla, Lobelia niihauensis, L. oahuensis, Marsilea villosa, Melicope christophersenii, M. pallida, M. saint-johnii, Neraudia angulata, Nototrichium humile, Phyllostegia hirsuta, Plantago princeps* var. *princeps, Platydesma cornuta* var. *decurrens, Pleomele forbesii, Pteralyxia macrocarpa, Sanicula mariversa, Schiedea hookeri, S. kaalae, S. trinervis, Silene perlmanii, Spermolepis hawaiiensis, Stenogyne kanehoana, Tetramolopium lepidotum* ssp. *lepidotum, Urera kaalae,* and *Viola chamissoniana* ssp. *Chamissoniana.*

The critical habitat designations would occur on Navy-owned parcels at Navy Munitions Command East Asia Division Detachment Joint Base Pearl Harbor-Hickam Lualualei Annex (formerly known as Naval Magazine Pearl Harbor Lualualei) and Naval Radio Transmitter Facility (NRTF) Lualualei (Figure 1). The critical habitat proposed for Kalaeloa (Former Naval Air Station Barber’s Point) occurs only on parcels to be released under the Base Realignment and Closure (BRAC) program (Figure 2).

Current and Proposed Plant Critical Habitat, Lualualei, Oahu, Hawaii

JBPHH Lualualei Annex

Current Lualualei Plant Critical Habitat

2011 Proposed Lualualei Plant Critical Habitat

New Area

(Current plant critical habitat = 972 acres)

(Lualualei proposed plant critical habitat = 393 acres)

(News areas of plant critical habitat = 4 acres)

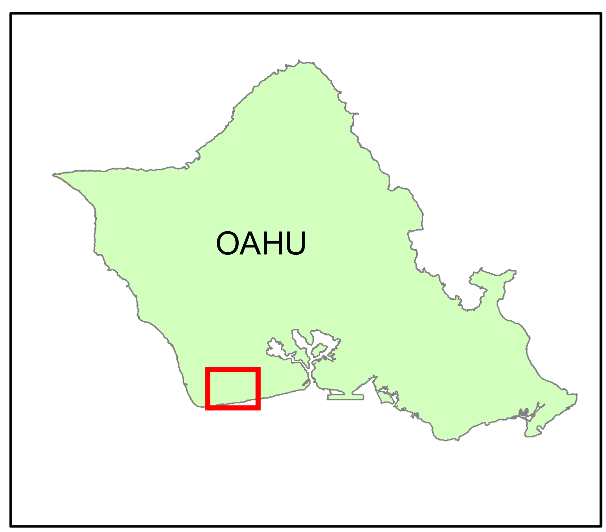
Figure 2.

Kalaeloa (Former NAS Barber's Point) Navy Retained Lands and Proposed Critical Habitat

0 0.25 0.5 1 Kilometers

Navy Retained Lands

Proposed CH



2.0 Navy Munitions Command East Asia Division Detachment Joint Base Pearl Harbor-Hickam Lualualei Annex and Naval Radio Transmitter Facility Lualualei

2.1 Additional Information and Progress of Projects Included in the INRMP

The primary strategies to meet management goals at Lualualei are to install ungulate fencing and remove invasive species. This section provides additional details of the programmed projects for endangered plants that are listed in the 2011 Draft INRMP, and summarizes progress made on the programmed projects. See Table 1 for a list of applicable projects excerpted from Table 9.9 in the INRMP.

Table 1 Excerpt from INRMP Table 9.9: JBPHH Ten-Year Fiscal Plan for Projects at Lualualei

Objectives and Projects	Y1 (2012)	Y2 (2013)	Y3 (2014)	Y4 (2015)	Y5 (2016)	Y6 (2017)	Y7 (2018)	Y8 (2019)	Y9 (2020)	Y10 (2021)	Total
11. Monitoring and management of NAVMAG PH Lualualei Branch listed/candidate/species of concern plant species	$45,000	$47,000	$49,000	$51,000	$54,000	$56,000	$59,000	$61,000	$64,000	$67,000	$533,000
13. *Abutilon menziesii*, *Marsilea villosa*, *Cyperus trachysanthos* monitoring and management	$7,500	$3,500	$3,500	$3,500	$3,500	$3,500	$4,000	$4,000	$4,000	$4,000	$41,000
19. Monitor, control and exclude feral ungulates within SMAs	$12,000	$13,000	$400,000	$20,000	$400,000	$25,000	$400,000	$30,000	$400,000	$50,000	$1,750,000
23. Native habitat management through invasive vegetation removal at SMAs in NAVMAG Lualualei	$80,000	$84,000	$87,000	$91,000	$95,000	$100,000	$104,000	$109,000	$114,000	$119,000	$983,000
24. Black-stem borer research	$0	$0	$0	$0	$0	$0	$30,000	$30,000	$0	$0	$60,000
43. Continue FFD and/or HFD response to any wildland fires	$0	$0	$65,000	$0	$0	$5,000	$0	$0	$5,000	$0	$75,000

<u>Objective 11 - Monitoring and management of NAVMAG PH Lualualei Branch listed/candidate/species of concern plant species</u>

As planned in the INRMP, the Navy funded $46,400 in FY12 for in-house surveys of known sites within the Magazine area where threatened and endangered and candidate threatened and endangered plant species are documented to occur. This survey effort is currently ongoing and is expected to conclude by the end of September 2012. Surveys are expected to provide updated status of these plants and identify plants that require specialized management. The results of these efforts will be used to create a management plan for endangered plant species at Lualualei. The preparation of the management plan is currently unfunded; however, if additional funds are available at the end of this fiscal year, this management plan is our top priority. If FY12 funds are not available at the end of the year, we will be program the management plan as an FY13 project.

Objective 13 - *Abutilon menziesii*, *Marsilea villosa*, *Cyperus trachysanthos* monitoring and management

As planned in the INRMP, in 2012 the Navy conducted comprehensive in-house surveys of the Lualualei Radio Transmitting Facility (LLL RTF) and additional populations of *Marsilea villosa* were identified within NRTF Lualualei. In 2008, the Navy funded University of Hawai‘i to conduct research at NRTF Lualualei to investigate the soil and associated plant community in relation to the *M. villosa* population. The Navy expects to receive a copy of the dissertation and management recommendations strategies for *M. villosa* later this year. The results of these efforts will be used to inform the management plan described in section 2.1 above.

Objective 19 - Monitor, control and exclude feral ungulates within SMAs

The original scope described in the INRMP included ungulate surveys and removal with a budgeted amount of $12,000. We were able to commit an additional $140,000 to expand the scope of work to include a fencing plan. This plan will identify and prioritize areas of Lualualei to be fenced and provide cost estimates for fence installation, ungulate removal, and fence maintenance. The contract for an Ungulate Fencing Plan is in the process of being awarded and will be awarded by the end of July. The draft plan is anticipated in May 2013, with the final plan in July 2013. The results of the Ungulate Fencing Plan will be used to update the cost estimates and phasing for construction of the fencing at Lualualei.

Funds for fence construction are already programmed, starting in 2014. The fence will be constructed in phases. Additional funds for construction of future phases, maintenance and monitoring are programmed for subsequent years. Also included in the cost is ungulate removal following fence construction.

Aerial goat surveys were completed in February through a cooperative partnership between the Navy and other members of the Waianae Mountain Watershed Partnership, including the Army, State of Hawai‘i, private landowners, and other private stakeholder entities. Funds were part of a larger cooperative agreement with the University of Hawai‘i HPI-CESU. Surveys were completed in February. Goat removal is anticipated to begin in FY13.

Objective 23 - Native habitat management through invasive vegetation removal at SMAs in NAVMAG Lualualei

As planned in the INRMP, the Navy funded $80,000 in FY12 for surveys and removal of invasive vegetation. The work is being done under multiple ongoing projects. One project is a survey specific to locally-restricted invasive plant species, including *Phytolacca dioica*, *Tetraclinus articulata*, and other species that are naturalizing within Lualualei. Work is currently ongoing and being performed by the Oahu Invasive Species Committee. The project funds were part of a larger cooperative agreement with the University of Hawai‘I HPI-CESU. Surveys were initiated in April and are expected to conclude by the end of September 2012.

Another project is to remove invasive vegetation and propagate native plants in-situ in the Halona and Mikilua fenced exclosures. Work was initiated in November of 2011 and is expected to conclude by the end of September 2012.

Objective 24 - Black-stem borer research

The goal of this research is to find the methods of reducing damage to *Flueggea neowawraea*. This project is currently programmed for FY18 and FY19.

Objective 43 - Continue FFD and/or HFD response to any wildland fires

The wildland fire prevention management and response plan is currently programmed for FY14; however, we are planning to reprioritize projects in an attempt to push this project up to FY13.

2.2 Additional Projects

In addition to the projects identified in the 2011 Draft INRMP, the projects and actions listed below are priorities for programming as emergent projects or FY15 projects.

1) Develop management plans for endangered plant species at Lualualei. If additional funds are available at the end of this fiscal year, this management plan is our top priority. If FY12 funds are not available at the end of the year, we will be programing the management plan as an FY13 project.

2) Construct fencing around the *M. villosa* population located outside the installation perimeter in the northwestern section of NAVMAG PH Lualualei Branch to protect the plant from potential impacts caused by off-road vehicles and feral ungulates. We will be requesting additional funds as an emergent project this fiscal year. If the funding can be secured, the fencing can be completed within six months of receipt of funds.

3) Aerial application of rodenticides within fenced areas, following construction of the ungulate fence. This project is dependent upon completion of the Programmatic EIS for Hand and Aerial Broadcast of Rodenticide for Conservation Use in the State of Hawai‘i. The Navy is a cooperating agency for this EIS and will continue to support this effort. Funding would be programmed in FY15 at the earliest.

4) Develop survey data in conjunction with the Service and other stakeholders to collect data that can be used to document population status and effects of management actions. We anticipate having draft forms for the Service and stakeholders review by the end of the fiscal year.

5) Request permission through the chain of command to outplant threatened and endangered species to augment and stabilize populations within Navy property at Lualualei. The request package will be sent up for review by the end of the fiscal year. If approved, the Navy will program additional funds to integrate outplanting into the INRMP. The Navy will work with the Service on the species priority and preferred locations for outplanting. The Navy would explore the possibility of working with the Army in the outplanting efforts.

3.0 Kalaeloa (Former Naval Air Station Barber's Point)

3.1 Additional Information and Progress of Projects Included in the INRMP

This section provides additional details of the programmed project for endangered plants that are listed in the 2011 Draft INRMP, and summarizes progress made on the programmed project. Table 2 is excerpted from Table 9.9 in the INRMP.

Table 2 Excerpt from INRMP Table 9.9: JBPHH Ten-Year Fiscal Plan for Projects at Barbers Point

Objectives and Projects	Y1 (2012)	Y2 (2013)	Y3 (2014)	Y4 (2015)	Y5 (2016)	Y6 (2017)	Y7 (2018)	Y8 (2019)	Y9 (2020)	Y10 (2021)	Total
7. Kalaeloa ‘akoko management	$2,000	$2,000	$2,000	$2,000	$2,000	$2,000	$3,000	$3,000	$3,000	$3,000	$24,000

<u>Objective 7 – Kalaeloa ‘akoko management</u>

The INRMP programmed funds for ‘akoko management on an annual basis; however, in 2012 the funds were reallocated to other natural resource management projects in anticipation of pending BRAC actions. As part of the BRAC process, surveys for ‘akoko were completed March 2012. A conservation plan is being developed to ensure conservation of ‘akoko following land transfer under the BRAC program. When completed, the INRMP may incorporate applicable conservation measures.

3.2 Additional Projects

Additional projects may be proposed following the completion of the ‘akoko conservation plan.