FINAL

INTEGRATED NATURAL RESOURCES MANAGEMENT PLAN

PACIFIC MISSILE RANGE FACILITY

ISLANDS OF KAUA'I, O'AHU, AND KA'ULA, STATE OF HAWAI'I

COMMANDER, NAVY REGION HAWAII
NOVEMBER 2010

Integrated Natural Resources Management Plan
For
Pacific Missile Range Facility
Hawai'i

Prepared By: Natural Resources Branch
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Pacific Missile Range Facility
Integrated Natural Resources Management Plan
November 2010 (2010-2014)

Signature Page (Division of Forestry and Wildlife, State of Hawaii Department of Land and Natural Resources)

This Pacific Missile Range Facility (PMRF) Integrated Natural Resources Management Plan (INRMP) supersedes all previous PMRF INRMPs.

The Sikes Act Improvement Act 1997 requires that the proposed INRMP be prepared in cooperation and partnership with the U.S. Fish & Wildlife Service and the State fish and wildlife agency and that the management of fish and wildlife in the proposed INRMP reflects mutual agreement of Sikes Act partners. Department of Defense policy requires that NOAA Fisheries Service is also a partner and cooperating agency with INRMPs covering marine resources.

The U.S. Fish and Wildlife Service, Hawaii Division of Forestry and Wildlife, and NOAA Fisheries Service, by signature or an enclosed letter of agreement from their agency representative, grant their concurrence and acceptance of this document.

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Enclosure (4)

Pacific Missile Range Facility
Integrated Natural Resources Management Plan
November 2010 (2010 – 2014)

Signature Page (Pacific Islands Fish and Wildlife Office, U.S. Fish & Wildlife Service)

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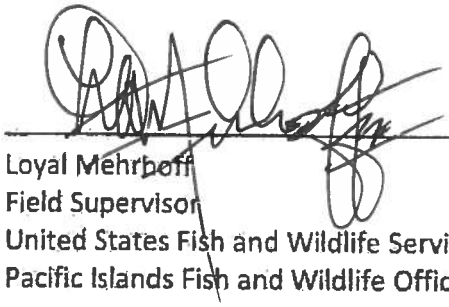
Approving Official:



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Enclosure (4)

Integrated Natural Resources Management Plan

Pacific Missile Range Facility

Islands of Kauaʻi, Oʻahu, and Kaʻula, State of Hawaiʻi

Prepared for:
Commander, Navy Region Hawaii

Prepared by:
Helber Hastert & Fee Planners, Inc.

November 2010

" *What happens in our environment and to our natural resources is a matter of national security. What happens in our environment cannot be dealt with at some later date; it must be addressed now, and we must keep it on our minds constantly."*

Admiral Gary Roughead, Chief of Naval Operations
May 28, 2009

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ACRONYMS AND ABBREVIATIONS

°	degree(s)
‘	minute(s)
ac	acre(s)
ADC	Agricultural Development Corporation
AFB	Air Force Base
AFS	Air Force Station
AICUZ	Air Installation Compatible Use Zone
ALF	Auxiliary Landing Field
APHIS	Animal and Plant Health Inspection Service
API	Agricultural Preservation Initiative
APZ	Accident Potential Zone
AT/FP	Anti-Terrorism/Force Protection
BAM	baseline assessment memorandum
BARSTUR	Barking Sands Tactical Underwater Range
BASH	bird aircraft strike hazard
BL	Badlands
BOS	Base Operations Support
BS	Beaches
BSF	Barking Sands Facility
BSURE	Barking Sands Underwater Range Expansion
BY	budget year
C	Celsius
C	Candidate
CEQ	Council on Environmental Quality
CERCLA	Comprehensive Environmental Compensation and Liability Act
CFR	Code of Federal Regulations
Cl^-	chlorides
cm	centimeter(s)
CNO	Chief of Naval Operations
CNRH	Commander, Navy Region Hawaii
CWA	Clean Water Act
CY	calendar year
CZ	clear zone
CZM	Coastal Zone Management
CZMA	Coastal Zone Management Act
DAR	Division of Aquatic Resources
DBEDT	Department of Business, Economic Development, and Tourism
DL	Dune Land
DLNR	Department of Land and Natural Resources
DOA	Department of Agriculture
DOFAW	Division of Forestry and Wildlife
DOD	Department of Defense
DOE	Department of Energy

DON	Department of the Navy
E	endangered (under ESA)
EMI	electromagnetic interference
EMR	electromagnetic radiation
EO	Executive Order
ERL	Environmental Readiness Level
ESA	Endangered Species Act
ESQD	explosives safety quantity distance
F	Fahrenheit
FEIS	Final Environmental Impact Statement
FIFRA	Federal Insecticide, Fungicide, and Rodenticide Act
Fleet	Commander Pacific Fleet
FR	Federal Register
ft	foot (feet)
ft^2	square feet
FY	fiscal year
GHA	ground hazard areas
GIS	Geographic Information System
g/m^2	grams per square meter
GPS	global positioning system
ha	hectare(s)
HERO	Hazards of Electromagnetic Radiation to Ordnance
HERF	Hazards of Electromagnetic Radiation to Fuel
HERP	Hazards of Electromagnetic Radiation to Personnel
HRCMP	Hawaii Range Complex Management Plan
ICRMP	Integrated Cultural Resources Management Plan
in	inch(es)
INRMP	Integrated Natural Resources Management Plan
IPMP	Integrated Pest Management Plan
IRP	Installation Restoration Program
JfB	Jaucus loamy fine sand, 0 to 80 percent slopes
KI	Ka‘ula Island
KISC	Kaua‘i Invasive Species Committee
KIUC	Kaua‘i Island Utilities Cooperative
km	kilometer(s)
km^2	square kilometers
KoA	Kekaha silty clay, 0 to 2 percent slopes
KoB	Kekaha clay, 0 to 6 percent slopes
KOYE	Kekaha extremely stony silty clay loam, 0 to 35 percent slopes
KPNWR	Kīlauea Point National Wildlife Refuge
KSKE	Kōke‘e silty clayey loam, 0 to 35 percent slopes
KTF	Kauai Test Facility
LTK	long-thorn kiawe
LUC	Land Use Commission (SOH)
MBTA	Migratory Bird Treaty Act of 1918

m	meter(s)
m^2	square meters
mg/l	milligrams per liter
MHI	main Hawaiian Islands
mi	mile(s)
mi^2	square miles
MMPA	Marine Mammal Protection Act of 1972
MOA	Memorandum of Agreement
M.S.	Master of Science
MWR	Morale, Welfare, and Recreation
NASA	National Aeronautics and Space Administration
NAVFAC HI	Naval Facilities Engineering Command, Hawaii
NAVFAC PAC	Naval Facilities Engineering Command, Pacific
Navy	Department of the Navy
NcD	Niu silty clay loam, 12 to 20 percent slopes
NcE2	Niu silty clay loam 20 to 35 percent slopes
NEPA	National Environmental Policy Act
NHPA	National Historic Preservation Act
nm	nautical mile(s)
NOAA	National Oceanic and Atmospheric Administration
NOAA Fisheries	NOAA National Marine Fisheries Service
NWHI	Northwest Hawaiian Islands
OEIS	Overseas Environmental Impact Statement
O&MN	Operations and Maintenance, Navy
OPNAVINST	Office of the Chief of Naval Operations Instruction
ORV	off-road vehicle
OSD	Office of Secretary of Defense
PASCAT	Pacific Scatter Station
Ph.D.	Doctor of Philosophy
POM	Program Objective Memorandum
PPBES	Planning, Programming, and Budgeting and Executive System
PdA	Pakala clay loa, 0 to 2 percent slopes
PL	Public Law
PMRF	Pacific Missile Range Facility
PR	Program Review
PRY	Program Year
PwD	Puʻu ʻŌpae silty clay loam, 15 to 25 percent slopes
PY	Prior Year
QRP	Qualified Recyling Program
RDT&E	Research, Development, Test & Evaluation
RPM	Remedial Project Manager
rRO	Rock outcrop
rRR	Rough broken land
rTP	tropohumults-Dystrandepts Association
SAIA	Sikes Act Improvement Act of 1997

SARA	Superfund Amendments and Reauthorization Act of 1986
SCAMP	Spacecraft Antenna on Medium Pedestal
seq.	sequitur
SHPO	State Historic Preservation Officer
SOH	State of Hawai‘i
SOP	standard operating procedure
SOS	Save Our Shearwaters
STARS	Strategic Target System
T	threatened (under ESA)
U.S.	United States
USACE	U.S. Army Corps of Engineers
USAF	U.S. Air Force
USB	Unified S-Band
U.S.C.	U.S. Code
USCG	U.S. Coast Guard
USDA	U.S. Department of Agriculture
USEPA	U.S. Environmental Protection Agency
USFWS	U.S. Fish and Wildlife Service
USGS	U.S. Geological Survey
UXO	Unexploded Ordnance
WJF	Waiawa extremely rocky clay, 30 to 80 percent slopes
WS	Wildlife Services (USDA)

EXECUTIVE SUMMARY

1. Introduction

This Integrated Natural Resources Management Plan (INRMP) has been developed for the United States (U.S.) Department of the Navy (Navy or DON), Commander, Navy Region Hawaii (CNRH) for its Pacific Missile Range Facility (PMRF) to meet statutory requirements of the Sikes Act Improvement Act (SAIA) of 1997 (16 U.S. Code [U.S.C.] 670(a) *et sequitor* Public Law 105-85). This INRMP is one of two CNRH INRMPs. The other INRMP is for Naval Station Pearl Harbor, which includes Navy lands on O'ahu. PMRF consists of several distinct land areas within Kaua'i and O'ahu Counties, State of Hawai'i (SOH) (Figure ES-1 and Table ES-1).

The primary purpose of this INRMP, which serves to update the 2001 PMRF INRMP, is to provide 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) it serves as an information repository for natural resource information, assets, and constraints; (2) it provides guidance on how PMRF is to comply with federal laws, rules, regulations, executive orders, and DoD and Navy directives relating to natural resources; and (3) it 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, as well as the management strategies for its implementation. The plan requires a 5-year update and annual review. Natural Resources Management uses an ecosystem management approach, with special consideration to protected species and rare habitats. An adaptive management strategy is described, whereby ongoing natural resources surveys are used to guide, and potentially change, the management actions required. The CNRH Natural Resource Program Manager, PMRF Environmental Coordinator, and natural resources staffs at Naval Facilities Engineering Commands Hawaii and Pacific (NAVFAC HI and NAVFAC PAC) and Commander Pacific Fleet (COMPACFLT) are responsible for implementing the INRMP. The INRMP is developed, updated, and reviewed in cooperation with the SAIA partners US Fish and Wildlife Service (USFWS), National Oceanic and Atmospheric Administration (NOAA) National Marine Fisheries (Fisheries) and SOH Department of Land and Natural Resources (DLNR).

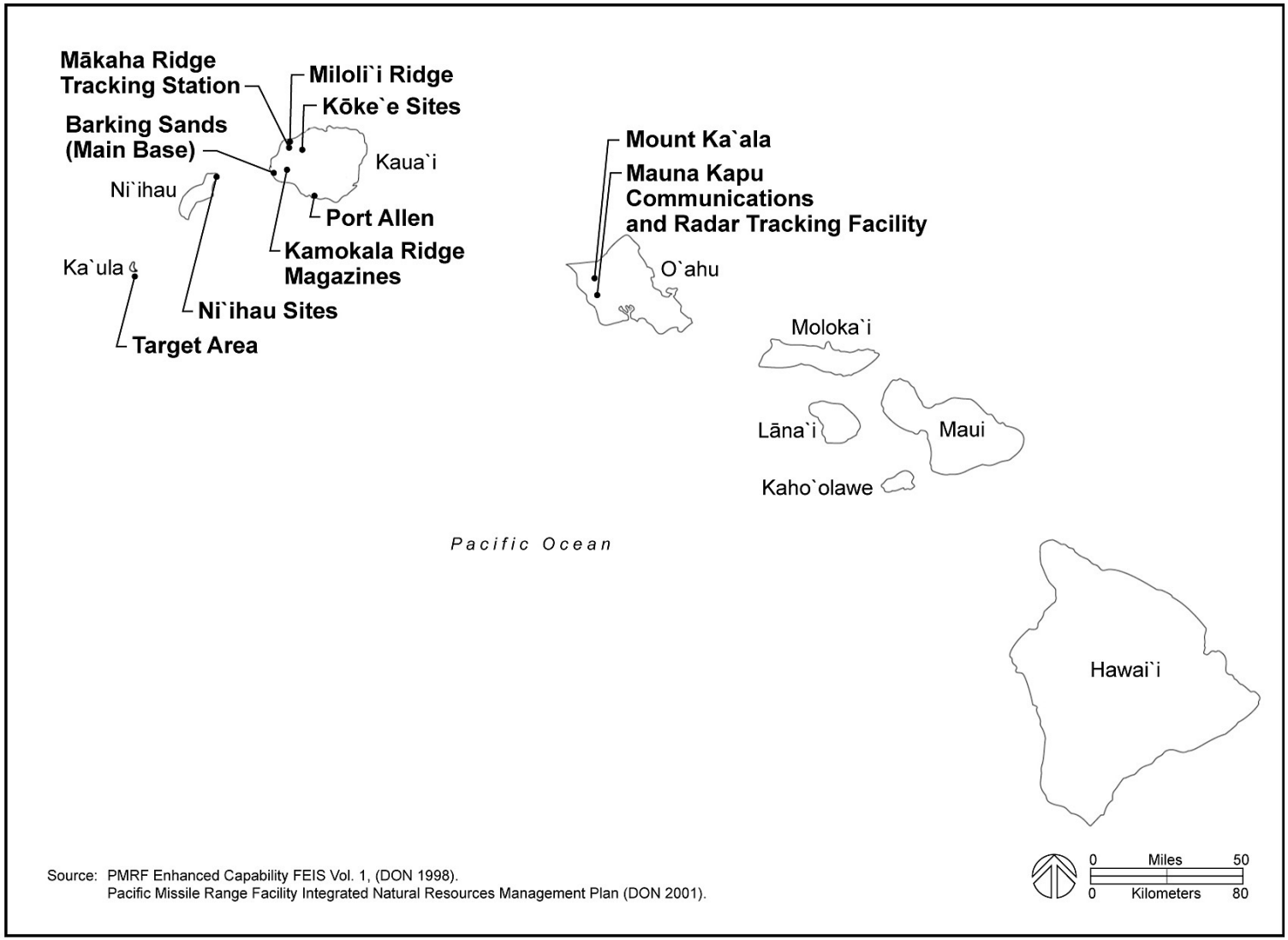

Figure ES-1: PMRF Facilities, State of Hawai‘i

Table ES-1: Lands and Waters Owned, Leased or Otherwise Used by PMRF

Site	Approximate Land Area in ac (ha)	Land Ownership	Tax Map Key Number	Land Use and Types of Operations	Resources Requiring Management Present
Barking Sands, Kauaʻi (Main Base)	1,991 (806)	Navy-owned	1-2-2:13	Range operations, missile assembly and launch, radar tracking, communications, aviation and aviation support, torpedo shop, personnel support	Yes
	70 (28)	Leased from SOH		Same as above	Yes
	2,109 (854)	Restrictive Easement granted to Navy by landowner SOH		Ground hazard area during launches; arcs ranging from 6,000 to 10,000 feet (ft) (1,829 to 3,048 meters [m])	No
Mākaha Ridge Tracking Station, Kauaʻi	245 (89)	Leased from SOH	1-2-1:06	Secondary operations area: (1) radar tracking; (2) telemetry receiving/recording; (3) frequency monitoring; and (4) target control	Yes
Kōkeʻe Sites, Kauaʻi	16 (6.6)	Leased from SOH	1-4-1:13		Yes
Site A	3.8 (1.5)	--	--	Support buildings: (1) tracking; (2) command; (3) training; (4) administration; and (5) logistics	--
Site B	1.2 (0.5)	--	--	Power plant and fuel storage facility	--
Site C	0.4 (0.2)	--	--	Bore sight equipment, microwave antenna, and radar support buildings	--
Site D	5.3 (2.2)	--	--	Transmitter building and antenna support facilities	--
Site E	5.3 (2.2)	--	--	NASA's Kōkeʻe Geophysical Observatory with large antenna arrays	--
-- = same as above					

Table ES-1: Lands and Waters Owned, Leased, or Otherwise Used by PMRF (Continued)

Site	Approximate Land Area in ac (ha)	Land Ownership	Tax Map Key Number	Land Use and Types of Operations	Resources Requiring Management Present
Kamokala Ridge Magazines, Kauaʻi	89 (36)	Leased from SOH	1-2-2:01, 27, and 29	Magazines for ordnance storage	Yes
Niʻihau Sites, Niʻihau	1,170 (473)	Leased from Niʻihau Ranch	1-1-1:01	Communications/electronics training activities, Perch Site and Optical Tracking Station; and Pāniau Radar Site.	Yes (see Appendix K)
Kaʻula Island	108 (43)	Navy-owned	1-1-1:01	10 ac (4 ha) target range for aircraft using inert ordnance	Yes
Mauna Kapu Communications and Radar Tracking Facility, Oʻahu	2.0 (1.0)	1.9 ac (0.8 ha) leased from the James Campbell Company; 0.1 ac (0.08 ha) under use agreement with U.S. government	9-2-5:13	Communications and radar tracking facility and frequency monitoring station building on a 0.4 ac (0.2 ha) site; 1.5 ac (0.6 ha) in utility easements	Yes
Miloliʻi Ridge, Kauaʻi	--	Leased from SOH		Three 10 square foot (0.9 square meters) reflector sites	No; small sites, no resources.
Port Allen, Kauaʻi	1.0 (0.4)	Leased from SOH		Warehousing, surface craft support	No; building space only
Mount Kaʻala, Oʻahu	1.8 (0.7)	Leased from James Campbell Company		Communications Center	No; building space only

2. Protected Species and Habitats

Chapters 3 through 8 detail the locations, military activities, resources and current management actions and policies for the different sites: Barking Sands, Makaha Ridge, Koke`e Sites, Kamokala Magazine, Ka`ula Islet, and Mauna Kapu Facility (Figure ES-1 and Table ES-1). Each site has unique natural resources and operational activities; therefore, management goals and objectives are detailed separately for each site.

The following paragraphs provide a summary of the protected species found at Barking Sands, Mākaha Ridge Tracking Station, Kōkeʻe Sites, Kamokala Ridge Magazines, Kaʻula Island, and Mauna Kapu Facility. Table ES-6 provides the INRMP 10-Year Fiscal Plan for these facilities.

Barking Sands

Table ES-2 provides a listing of the federally-listed ESA species and candidate species at Barking Sands.

Table ES-2: Federally-Listed ESA and Candidate Species at Barking Sands

Latin Binomial	Common Name	Regulatory Status
Anas wyvilliana	Hawaiian Duck (Koloa)	E
Gallinula chloropus sandvicensis	Hawaiian Common Moorhen	E
Fulica alai	Hawaiian Coot	E
Himantopus mexicanus knudseni	Hawaiian Stilt	E
Branta sandviciensis	Hawaiian Goose (Nēnē)	E
Puffinus auricularis newelli	Newell's Shearwater	T
Phoebastria albatrus	Short-Tailed Albatross	E
Pterodroma sandwichensis	Hawaiian Petrel	E
Oceanodroma castro	Band-rumped Storm-Petrel	C
Lasiurus cinereus	Hawaiian Hoary Bat	E
Monachus schauinslandi	Hawaiian monk seal	E
Megaptera novaeangliae	Humpback Whale	E
Pseudorca crassidens	False Killer Whale	C
Chelonia mydas	Green Turtle	T
Eretmochelys imbricata	Hawksbill Turtle	E
Panicum niihauense	lau'ehu	Unoccupied CH

E – endangered; T – threatened; C – candidate; CH – critical habitat

Protected Animals

Bird Species. There are seven federally-listed endangered bird species that have been observed at Barking Sands: (1) Hawaiian duck or koloa (*Anas wyvilliana*); (2) Hawaiian moorhen or alae ula (*Gallinula chloropus sandwichensis*); (3) Hawaiian coot or alae keʻokeʻo (*Fulica alai*); (4) Hawaiian stilt or ae o (*Himantopus mexicanus knudseni*); (5) Hawaiian goose or

nēnē (*Branta sandvicensis*); (6) Newell's shearwater (*Puffinus auricularis newelli*) or ʻaʻo and (7) short-tailed albatross (*Phoebastria albatrus*) (NAVFAC 2006f). All federally-listed species under ESA are also SOH-listed species.

The Hawaiian petrel (*Pterodroma sandwichensis*) or ʻuaʻu hasn't been seen on Barking Sands, but may also fly over during the breeding season. A federal candidate seabird species, the band-rumped storm-petrel (*Oceanodroma castro*) or ʻakeʻake also travels over Barking Sands during breeding season.

Migratory bird species protected under the Migratory Bird Treaty Act of 1918 (MBTA) are present at Barking Sands (Section 3.3.4.1). At Barking Sands, there are two nesting colonies of wedge-tailed shearwaters *(Puffinus pacificus*), an MBTA-protected bird. There is also an on-going relocation program for Laysan albatross (*Phoebastria immutabilis*), another MBTA-protected native seabird which attempts to nest adjacent to the runway and poses a Bird Aircraft Strike Hazard (BASH) concern.

Mammal Species. There is one ESA-listed terrestrial mammal species, the Hawaiian hoary bat or *ʻope ʻape ʻa (Lasiurus cinereus semotus*), and two ESA-listed and SOH-listed marine mammal species at Barking Sands: (1) the endangered Hawaiian monk seal or *ilio*-holo-i-ka-uaua *(Monachus schauinslandi*); and (2) the endangered humpback whale or *koholā* (*Megaptera novaeangliae*). In addition, the false killer whale (*Pseudorca crassidens*), a candidate species, has been sighted off of the west coast of Kauaʻi near Barking Sands.

Other marine mammals protected under the Marine Mammal Protection Act but not listed under the ESA have been observed in the waters off of Barking Sands; they include spinner dolphins (*Stenella longirostris*) and bottlenose dolphins (*Tursiops truncates gilli*).

Reptile Species. There are two marine turtle species that are known to occur in waters off Kauaʻi. The federally-listed threatened green turtle, or honu (*Chelonia mydas*), is common in the Hawaiian Islands and is known to forage, bask and nest at Barking Sands. The federally-listed endangered hawksbill turtle, or honu'ea (*Eretmochelys imbricata*), is considered rare compared to the green turtle and has not been observed on land at Barking Sands.

Protected Plants

Currently, there are no known threatened or endangered plant species occurring at the Barking Sands facility (NAVFAC 2006a). However, there is unoccupied critical habitat for lau'ehu (*Panicum niihauense*) within the installation. In addition, A`ali`i Nama Scrub habitat and nohili dunes represent some of the last extant dryland coastal habitats on Kauai and contain several rare plant species, including *Nama sandwicencis* and *Chamaesyce celastroides*

Mākaha Ridge Tracking Station

Table ES-3 provides a listing of the federally-listed ESA species at Mākaha Ridge Tracking Station.

Table ES-3: Federally-Listed ESA species at Mākaha Ridge Tracking Station

Latin Binomial	Common Name	Regulatory Status
Lasiurus cinereus	Hawaiian Hoary Bat	E
Branta sandviciensis	Hawaiian Goose (Nēnē)	E
Puffinus auricularis newelli	Newell's Shearwater	T
Pterodroma phaeopygia sandwichensis	Hawaiian Dark-Rumped Petrel	E
Wilkesia hobdyi	Dwarf Iliau	E
Spermolepis hawaiiensis	No common name	E

E – endangered; T – threatened;

Protected Animals

Bird Species: A small group of federally-listed endangered Hawaiian geese (nēnē) are observed regularly at the Mākaha Ridge Tracking Station. There are also three MBTA-protected bird species may occur at the station: (1) cattle egret; (2) Pacific golden plover; and (3) white-tailed tropicbird or koa e kea (*Phaethon lepturus*).

Mammal Species. The federally-listed endangered Hawaiian hoary bat is known to frequent the general area of Mākaha Ridge and may forage or roost on the property or surrounding forested areas (Bruner 2000).

Protected Plants

The dwarf ili‘au *(Wilkesia hobdyi),* a federally-listed endangered species, occurs on the cliffs of the installation overlooking Mākaha Valley within the station boundary. *Spermolepis hawaiiensis*, a federally-listed endangered plant species, can be found in two large colonies on north facing, precipitous slopes within the station boundary (Wood 2006).

Kōkeʻe Sites

Table ES-4 provides a listing of the federally-listed ESA and candidate species at Kōkeʻe Sites.

Table ES-4: Federally-Listed ESA and Candidate Species at the Kōkeʻe Sites

Latin Binomial	Common Name	Regulatory Status
Branta sandviciensis	Hawaiian Goose (Nēnē)	E
Puffinus auricularis newelli	Newell's Shearwater	T (May fly over)
Pterodroma sandwichensis	Hawaiian Petrel	E (May fly over)
Oceanodroma castro	Band-rumped Storm-Petrel	C (May fly over)
Lasiurus cinereus	Hawaiian Hoary Bat	E (May occur)
Drosophila musaphilia	Hawaiian picture-wing fly	E (Critical Habitat designated near property)
Drosophila sharpi	Hawaiian picture-wing fly	E (Critical Habitat designated near property; presence unknown)

E – endangered; T – threatened; C - candidate

Protected Animals

Bird Species. Hawaiian geese were observed flying over the installation in 2006 (NAVFAC PAC 2006f). Newell's shearwaters, Hawaiian petrels and band-rumped storm-petrels, may fly over these sites. Protected by MBTA, the Pacific golden-plover can also occur at the sites (NAVFAC PAC 2006f).

Mammal Species. Federally-listed Hawaiian hoary bats have been observed at the Kōkeʻe Sites (Bruner 2000).

Insect Species. The USFWS has designated critical habitat for the endangered Hawaiian picture-wing fly in vicinity of the Kōkeʻe Sites. *Drosophila musaphilia*, a Hawaiian picture-wing fly, is historically known in four sites on the island of Kauaʻi. The host plant is native koa occurring within mesic, montaine, ohia and koa forest (Federal Register [FR] Volume 72, No. 228, 67428 to 67522, November 28, 2007). On 13 April 2010, 75 FR 18960 19165, USFWS determined endangered status for *D. sharpi* on Kauai. Similar to the *D. musaphilia* designated critical habitat, part of its designated critical habitat is adjacent to the Kōkeʻe Sites.

Protected Plants

There are no known threatened and endangered or otherwise protected plant species or critical habitat at the Kōkeʻe Sites (NAVFAC PAC 2006c). However, the native montane forest at Koke`e remains relatively intact in some sites, surrounding the facilities and landscaped areas. Site B, particularly, hosts rare Cyanea plants and a diverse rain forest community.

Kamokala Ridge Magazines

Protected Animals

There are no federally-listed threatened and endangered animal species and/or critical habitat at the magazines. There are three MBTA protected bird species found there: (1) the white-tailed tropic bird; (2) the Pacific golden plover and; (3) cattle egret (NAVFAC PAC 2006f).

Protected Plants

Currently, there are no federally-listed threatened and endangered or otherwise protected plant species or critical habitat at the magazines (NAVFAC PAC 2006d).

Ka‘ula Island

Table ES-5provides a listing of the federally-listed ESA and candidate species at Ka‘ula Island.

Table ES-5: Federally-Listed ESA Species at Ka‘ula Island

Latin Binomial	Common Name	Regulatory Status
Monachus schauinslandi	Hawaiian monk seal	E
Megaptera novaeangliae	Humpback Whale	E
Eretmochelys imbricata	Hawksbill Sea Turtle	E
Chelonia mydas	Green Sea Turtle	T

E – endangered; T – threatened

Protected Animals

Bird Species. There are 21 MBTA-protected bird species that have been observed on the island (Table 7-2).

Mammal Species. Humpback whales frequent the nearshore waters during the peak winter season. Recent surveys have reported three to 15 Hawaiian monk seals at Kaula Island (NOAA Fisheries 2009; NAVFAC PAC 2009).

Protected Plants

There are no federally-listed threatened and endangered plant species or critical habitat for plant species on the island.

Mauna Kapu Communications and Radar Tracking Facility

Protected Animals. There are no federally-listed threatened and endangered or protected plant species or critical habitat at the Mauna Kapu site.

Protected Plants. There are no federally-listed threatened and endangered or protected animals species or critical habitat at the Mauna Kapu site.

3. Recommended Natural Resources Projects

Table ES-6 provides the INRMP Ten Year Fiscal Plan which includes recommended projects for Barking Sands, Mākaha Ridge Tracking Station, Kōkeʻe Sites, Kamokala Ridge Magazines, Kaʻula Island, and the Mauna Kapu Facility. The plan includes the estimated costs for each project, funding priority and class (see Chapter 9) and implementation schedule.

Table ES-6: INRMP Ten-Year Fiscal Plan

Item No.	Recommendation	Management Action	Funding Class	Y1 (2011)	Y2 (2012)	Y3 (2013)	Y4 (2014)	Y5 (2015)	Y6 (2016)	Y7 (2017)	Y8 (2018)	Y9 (2019)	Y10 (2020)	Total	Comments
A. Barking Sands															
1	Bird Aircraft Strike Hazard.	Project-Specific	P2/NOC	Costs are included in the day-to-day functions of the PMRF Air Operations Department, no additional funding is required.											
2	Base-wide Predator Control.	Project-Specific (protected species)	P2/C2	$21,788	$22,660	$23,566	$24,509	$25,489	$26,508	$27,569	$28,672	$29,818	$31,011	$261,589	Increase in predator control funds includes supplies and increased USDA-WS manpower hours.
3	Sea Turtle Management.	Project-Specific (protected species)	P2/NOC	Costs are included in the day-to-day functions of the PMRF Environmental Department, no additional funding is required.											
4	Nocturnal Seabird Fallout Monitoring and Management.	Project-Specific (protected species)	P1/C1	$50,000	$52,000	$54,000	$56,200	$58,500	$60,900	$63,300	$65,800	$68,400	$71,200	$600,300	Fallout monitoring, offbase mitigation
5	Use of Green Lights and Light Shielding to Protect Seabirds.	Project-Specific (protected species)	P1 /C1 and P2/C2	$15,000	$15,000	$0	$0	$0	$0	$0	$0	$0	$0	$30,000	
6	Protection of Wildlife from Potential EMR Impacts.	Project-Specific (protected species)	P2/NOC	Costs are included in the day-to-day functions of the PMRF Environmental Department, no additional funding is required.											
7	Enhance and Improve Beach Cottages Shearwater Colony.	Project-Specific (protected species)	P2/C2	$3,000	$3,100	$3,200	$3,400	$3,500	$3,600	$3,800	$3,900	$4,100	$4,300	$35,900	Includes labor and supplies.

TABLE ES-6: INRMP TEN-YEAR FISCAL PLAN (CONTINUED)

Item No.	Recommendation	Management Action	Funding Class	Y1 (2011)	Y2 (2012)	Y3 (2013)	Y4 (2014)	Y5 (2015)	Y6 (2016)	Y7 (2017)	Y8 (2018)	Y9 (2019)	Y10 (2020)	Total	Comments
8	Waterbird Species.	Project-Specific (Protected Species)	P2/NOC	Costs are included in the day-to-day functions of the PMRF Environmental Department, no additional funding is required.											
9	Hawaiian Hoary Bat.	Project-Specific (protected species)	P1/C1	$5,000	$5,200	$5,400	$5,600	$5,800	$6,100	$6,300	$6,600	$6,800	$7,100	$59,900	
10	Hawaiian Monk Seals.	Project-Specific (protected species)	P2/NOC	Costs are included in the day-to-day functions of the PMRF Environmental Department, no additional funding is required.											
11	Humpback Whales and Other Cetaceans.	Project-Specific (protected species)	P2/NOC	Costs are included in the day-to-day functions of the PMRF Environmental Department, no additional funding is required.											
12	Marine Debris Cleanup.	Project-Specific (protected species)	P2/NOC	Costs are included in the day-to-day functions of the PMRF Environmental Department, no additional funding is required.											
13	Invasive Species Prevention and Control.	Project-Specific (Invasive Species)	P2/NOC	Costs are included in the day-to-day functions of the PMRF Environmental Department, no additional funding is required.											
14	Develop a Biosecurity Program for PMRF.	Project-Specific (invasive species)	P2/C2	$0	$50,000	$5,000	$5,000	$5,000	$5,000	$5,000	$5,000	$5,000	$5,000	$90,000	
15	Critical Habitat and Dune Vegetation Restoration Project.	Project-Specific (protected species and invasive species)	P2/C2	$50,000	$52,000	$54,000	$56,000	$58,000	$61,000	$63,000	$66,000	$68,000	$71,000	$599,000	Includes labor, materials, and supplies, ltk contract removal
16	Plant Nursery Development.	Project-Specific	P3/C3	$0	$0	$0	$0	$65,000	$0	$0	$0	$0	$0	$65,000	

TABLE ES-6: INRMP TEN-YEAR FISCAL PLAN (CONTINUED)

Item No.	Recommendation	Management Action	Funding Class	Y1 (2011)	Y2 (2012)	Y3 (2013)	Y4 (2014)	Y5 (2015)	Y6 (2016)	Y7 (2017)	Y8 (2018)	Y9 (2019)	Y10 (2020)	Total	Comments
17	Wetlands Maintenance.	Project-Specific (wetlands)	P2/NOC	Costs are included in the day-to-day functions of the PMRF Environmental Department, no additional funding is required.											
18	Oxidation Pond Improvements.	Project-Specific (wetlands)	P3/C3	$0	$0	$8000	$0	$0	$3,000	$0	$0	$0	$3,000	$14,000	Includes costs for materials, supplies, and labor to make improvements to waterbird habitat.
19	Beach and Dune Access Restrictions.	Project-Specific	P2/NOC	Costs are included in the day-to-day functions of the PMRF Environmental Department, no additional funding is required.											
20	Kawaiele Wetlands Waterbird Sanctuary.	Project-Specific (wetlands)	P3/NOC	Costs are included in the day-to-day functions of the PMRF Environmental Department, no additional funding is required.											
21	INRMP Annual and 5-year Updates.	Natural Resources Studies	P2/C2	$10,000	$10,000	$11,000	$80,000	$12,000	$12,000	$13,000	$13,000	$90,000	$14,000	$265,000	
22	Fauna Surveys Update/Initiate.	Natural Resources Studies	P2/C2	$0	$0	$0	$15,000	$0	$0	$0	$0	$$18,000	$0	$33,000	Includes materials and labor.
23	Botanical Surveys and Mapping.	Natural Resources Studies	P2/C2	$0	$0	$0	$40,000	$0	$0	$0	$0	$45,000	$0	$85,000	Includes federally-listed species dwar iliau and *Spermolepis hawaiiensis* at Mākaha Ridge Tracking Station and akoko at Kōke'e Sites.
24	Marine Resources and Fisheries Survey Update.	Natural Resources Studies	P3/C3	$0	$0	$0	$40,000	$0	$0	$0	$0	$45,000	$0	$95,000	

TABLE ES-6: INRMP TEN-YEAR FISCAL PLAN (CONTINUED)

Item No.	Recommendation	Management Action	Funding Class	Y1 (2011)	Y2 (2012)	Y3 (2013)	Y4 (2014)	Y5 (2015)	Y6 (2016)	Y7 (2017)	Y8 (2018)	Y9 (2019)	Y10 (2020)	Total	Comments
25	Fishing Survey.	Natural Resources Studies	P3/C3	Funded through Fish and Wildlife fees.											
26	Integrate Natural Resources Survey Data in GIS Database.	GIS	P2/C2	$0	$0	$0	$8,000	$0	$0	$0	$0	$9,000	$0	$17,000	
27	Kiawe and Pine Forest Products.	Forestry	P3/C3	$0	$0	$6,000	$0	$0	$0	$0	$0	$0	$0	$6,000	
28	Natural Resources Information Center.	Community Outreach	P3/C3	$6,000	$500	$500	$500	$500	$6,000	$500	$500	$500	$500	$16,000	Includes costs for updating the Natural Resources Information Center within the Pass and Identification center, and labor for renewing educational materials.
29	Natural Resources Signs.	Community Outreach	P3/C3	$5,000	$0	$0	$0	$5,000	$0	$0	$0	$5,000	0	$15,000	Materials and supplies.
30	Native Medicinal Plant Garden Development/ Maintenance.	Community Outreach	P3/C3	$800	$800	$900	$900	$1,000	$1,000	$1,100	$1,100	$1,100	$1,100	$9,600	Materials and supplies
31	Educational Outreach Partnership.	Community Outreach	P3/NOC	Costs are included in the day-to-day functions of the PMRF Environmental Department, no additional funding is required.											
32	SOS Support and Shearwater Banding.	Community Outreach	P3/NOC	Costs are included in the day-to-day functions of the PMRF Environmental Department, no additional funding is required.											
33	Fishing, Surfing, Windsurfing, and Beach Activities.	Outdoor Recreation	P3/NOC	Costs are included in the day-to-day functions of the PMRF Environmental Department, no additional funding is required.											

TABLE ES-6: INRMP TEN-YEAR FISCAL PLAN (CONTINUED)

Item No.	Recommendation	Management Action	Funding Class	Y1 (2011)	Y2 (2012)	Y3 (2013)	Y4 (2014)	Y5 (2015)	Y6 (2016)	Y7 (2017)	Y8 (2018)	Y9 (2019)	Y10 (2020)	Total	Comments
34	Dissemination of Pertinent Natural Resources Information to Recreation Pass Program Applicants.	Outdoor Recreation	P3/NOC	Costs are included in the day-to-day functions of the PMRF Environmental Department, no additional funding is required. Fish and Wildlife Fees may be used to augment NOCs.											
35	Base Planning.	Land Management	P2/NOC	Costs are included in the day-to-day functions of the PMRF Environmental Department, no additional funding is required.											
36	Landscape Design.	Land Management	P2/NOC	Costs are included in the day-to-day functions of the PMRF Environmental Department, no additional funding is required.											
37	Protection of Natural Resources in Undeveloped Areas.	Land Management	P2/NOC	Costs are included in the day-to-day functions of the PMRF Environmental Department, no additional funding is required.											
38	Drainage Pumps and Ditch Maintenance.	Flood Plains; Leases and Encroachment Management	P2/NOC	Costs are included in the day-to-day functions of the PMRF Environmental Department, no additional funding is required.											
39	Wildland Fire Control.	Wildland Fire	P2/NOC	Costs are included in the day-to-day functions of the PMRF Environmental Department, no additional funding is required.											
40	Law Enforcement.	Law Enforcement	P2/NOC	Costs are included in the day-to-day functions of the PMRF Environmental Department, no additional funding is required.											
B. Mākaha Ridge Tracking Station															
1 a.	Hawaiian Geese Monitoring.	Project-Specific (protected species)	P2/C2	$3,000	$3,100	$3,200	$3,400	$3,500	$3,600	$3,800	$3,900	$4,100	$4,300	$35,900	
1b.	Hawaiian Hoary Bat Surveys.	Project-Specific (protected species)	P2/C2	Costs included in item 9 of Section A											

TABLE ES-6: INRMP TEN-YEAR FISCAL PLAN (CONTINUED)

Item No.	Recommendation	Management Action	Funding Class	Y1 (2011)	Y2 (2012)	Y3 (2013)	Y4 (2014)	Y5 (2015)	Y6 (2016)	Y7 (2017)	Y8 (2018)	Y9 (2019)	Y10 (2020)	Total	Comments
1c.	Dwarf iliau and *Spermolepis hawaiiensis* Monitoring and Management.	Project-Specific (protected species)	P2/C2	$3,500	$3,500	$3,500	$3,500	$3,500	$3,500	$3,500	$3,500	$3,500	$3,500	$35,000	
2	Nocturnal seabird fallout monitoring and management	Project-Specific (protected species)	P1/C1	Costs included in item 4 of Section A											
3	Use of Green Lights and Light Shielding to Protect Seabirds	Project-Specific (protected species)	P1/C1 and P2/C2	Costs included in item 5 of Section A											
4	Protection of Wildlife from Potential EMR Impacts	Project-Specific (protected species)	P2/NOC	Costs are included in the day-to-day functions of the PMRF Environmental Department, no additional funding is required.											
5	Native Plant Restoration.	Project-Specific (invasive species)	P3/C0	$0	$40,000	$30,000	$10,000	$10,000	$11,000	$11,000	$12,000	$12,000	$13,000	$149,000	
6	Feral Goat Control.	Project-Specific (invasive species)	P2/C0	$300,000	$8,000	$8,300	$8,700	$9,000	$9,400	$9,700	$10,000	$11,000	$11,000	$385,100	Cost includes fencing, goat removal, and annual structure maintenance
7	Predator Control.	Project-Specific (protected species)	P2/C2	$0	$5,000	$5,200	$5,400	$5,600	$5,800	$6,100	$6,300	$6,600	$6,800	$52,800	Includes costs for labor and materials to remove feral cats to protect nesting nēnē

TABLE ES-6: INRMP TEN-YEAR FISCAL PLAN (CONTINUED)

Item No.	Recommendation	Management Action	Funding Class	Y1 (2011)	Y2 (2012)	Y3 (2013)	Y4 (2014)	Y5 (2015)	Y6 (2016)	Y7 (2017)	Y8 (2018)	Y9 (2019)	Y10 (2020)	Total	Comments
8	Trial Goat Hunting.	Project-Specific (invasive species); Outdoor Recreation	P3/C3	Funded through Fish and Wildlife Fees											
9	Fauna Surveys Update/Initiate.	Natural Resources Studies	P2/C2	Costs are included in Item 22 of Section A.											
10	Botanical Surveys and Mapping	Natural Resources Studies	P2/C2	Costs are included in Item 23 of Section A.											
11	Integrate Natural Resources Survey Data in GIS Database.	GIS	P2/C2	Costs are included in Item 26 of Section A.											
12	Base Planning.	Land Management	P2/NOC	Costs are included in the day-to-day functions of the PMRF Environmental Department, no additional funding is required.											
13	Landscape Design.	Land Management	P2/NOC	Costs are included in the day-to-day functions of the PMRF Environmental Department, no additional funding is required.											
14	Protection of Natural Resources in Undeveloped Areas.	Land Management	P2/NOC	Costs are included in the day-to-day functions of the PMRF Environmental Department, no additional funding is required.											
15	Soil Erosion Control.	Land Management	P3/C0	$0	$60,000	$12,000	$3,000	$3,100	$3,200	$3,400	$3,500	$3,600	$3,800	$95,600	
16	Wildland Fire Control.	Wildland Fire	P2/NOC	Costs are included in the day-to-day functions of the PMRF Environmental Department, no additional funding is required.											
17	Law Enforcement.	Law Enforcement	P2/NOC	Costs are included in the day-to-day functions of the PMRF Environmental Department, no additional funding is required.											
C. Kōkeʻe Sites															
1	Nocturnal seabird fallout monitoring and management	Project-Specific (protected species)	P1/C1	Costs included in item 4 of Section A											

TABLE ES-6: INRMP TEN-YEAR FISCAL PLAN (CONTINUED)

Item No.	Recommendation	Management Action	Funding Class	Y1 (2011)	Y2 (2012)	Y3 (2013)	Y4 (2014)	Y5 (2015)	Y6 (2016)	Y7 (2017)	Y8 (2018)	Y9 (2019)	Y10 (2020)	Total	Comments
2	Use of Green Lights and Light Shielding to Protect Seabirds	Project-Specific (protected species)	P1/C1 and P2/C2	Costs included in item 5 of Section A											
3	Protection of Wildlife from Potential EMR Impacts.	Project-Specific (protected species)	P2/NOC	Costs are included in the day-to-day functions of the PMRF Environmental Department, no additional funding is required.											
4	Hawaiian Hoary Bats.	Project-Specific (protected species)	P2/C2	Costs are included in Item 9 of Section A											
5	Hawaiian Picture-Wing Fly.	Project-Specific (protected species)	P1/C1	$13,000	$14,000	$14,000	$15,000	$15,000	$16,000	$16,000	$17,000	$18,000	$19,000	$157,000	
6	Native Plant Habitat Improvement.	Project-Specific (invasive species)	P2/C2	$12,000	$12,000	$13,000	$13,000	$14,000	$15,000	$15,000	$16,000	$16,000	$17,000	$143,000	
7	Melastome Eradication.	Project-Specific (Invasive Species)	P2/C2	Costs are included in Item 6 of Section C											
8	Fauna Surveys Update/Initiate.	Natural Resources Studies	P2/C2	Costs are included in Item 22 of Section A.											
9	Botanical Surveys and Mapping.	Natural Resources Studies	P2/C2	Costs are included in Item 23 of Section A.											
10	Integrate Natural Resources Survey Data in GIS Database.	GIS	P2/C2	Costs are included in Item 26 of Section A											
11	Base Planning.	Land Management	P2/NOC	Costs are included in the day-to-day functions of the PMRF Environmental Department, no additional funding is required.											

TABLE ES-6: INRMP TEN-YEAR FISCAL PLAN (CONTINUED)

Item No.	Recommendation	Management Action	Funding Class	Y1 (2011)	Y2 (2012)	Y3 (2013)	Y4 (2014)	Y5 (2015)	Y6 (2016)	Y7 (2017)	Y8 (2018)	Y9 (2019)	Y10 (2020)	Total	Comments
12	Landscape Design.	Land Management	P2/NOC	Costs are included in the day-to-day functions of the PMRF Environmental Department, no additional funding is required.											
13	Protection of Natural Resources in Undeveloped Areas.	Land Management	P2/NOC	Costs are included in the day-to-day functions of the PMRF Environmental Department, no additional funding is required.											
14	Wildland Fire Control .	Wildland Fire	P2/NOC	Costs are included in the day-to-day functions of the PMRF Environmental Department, no additional funding is required.											
15	Law Enforcement.	Law Enforcement	P2/NOC	Costs are included in the day-to-day functions of the PMRF Environmental Department, no additional funding is required.											
D. Kamokala Ridge Magazines															
1	Native Plant Habitat Improvement.	Project-Specific (invasive species)	P3/C3	$4,000	$4,200	$4,300	$4,500	$4,700	$4,900	$5,100	$5,300	$5,500	$5,700	$48,200	
2	Fauna Surveys Update/Initiate.	Natural Resources Studies	P2/C2	Costs are included in Item 22 of Section A.											
3	Botanical Surveys and Mapping.	Natural Resources Studies	P2/C2	Costs are included in Item 23 of Section A.											
4	Integrate Natural Resources Survey Data in GIS Database.	GIS	P2/C2	Costs are included in Item 26 of Section A											
5	Base Planning.	Land Management	P2/NOC	Costs are included in the day-to-day functions of the PMRF Environmental Department, no additional funding is required.											
6	Landscape Design.	Land Management	P2/NOC	Costs are included in the day-to-day functions of the PMRF Environmental Department, no additional funding is required.											
7	Protection of Natural Resources in Undeveloped Areas.	Land Management	P2/NOC	Costs are included in the day-to-day functions of the PMRF Environmental Department, no additional funding is required.											
8	Wildland Fire Control.	Wildland Fire	P2/NOC	Costs are included in the day-to-day functions of the PMRF Environmental Department, no additional funding is required.											
9	Law Enforcement.	Law Enforcement	P2/NOC	Costs are included in the day-to-day functions of the PMRF Environmental Department, no additional funding is required.											

TABLE ES-6: INRMP TEN-YEAR FISCAL PLAN (CONTINUED)

Item No.	Recommendation	Management Action	Funding Class	Y1 (2011)	Y2 (2012)	Y3 (2013)	Y4 (2014)	Y5 (2015)	Y6 (2016)	Y7 (2017)	Y8 (2018)	Y9 (2019)	Y10 (2020)	Total	Comments
E. Ka'ula Island															
1	Hawaiian Monk Seal Protection	Project-Specific (protected species)	P2/NOC	Costs are included in the day-to-day functions of the PMRF Environmental Department, no additional funding is required.											
2	MBTA Compliance.	Project-Specific (protected species)	P2/NOC	Costs are included in the day-to-day functions of the PMRF Environmental Department, no additional funding is required.											
3	Fauna Surveys Update/Initiate.	Natural Resources Studies	P2/C2	Funding is provided by COMPACFLT in support of military training operations											
4	Botanical Surveys and Mapping.	Natural Resources Studies	P3/C3	Costs are included in Item 23 of Section A.											
5	Integrate Natural Resources Survey Data in GIS Database.	GIS	P2/C2	Costs are included in Item 26 of Section A											
F. Mauna Kapu Facility															
1	Fauna Surveys Initiate.	Natural Resources Studies	P2/C2	Costs are included in Item 22 of Section A.											
2	Botanical Surveys and Mapping.	Natural Resources Studies	P2/C2	Costs are included in Item 23 of Section A.											
3	Integrate Natural Resources Survey Data in GIS Database.	GIS	P2/NOC	Costs are included in Item 26 of Section A											
4	Base Planning.	Land Management	P2/NOC	Costs are included in the day-to-day functions of the PMRF Environmental Department, no additional funding is required.											
5	Landscape Design.	Land Management	P2/NOC	Costs are included in the day-to-day functions of the PMRF Environmental Department, no additional funding is required.											

TABLE ES-6: INRMP TEN-YEAR FISCAL PLAN (CONTINUED)

Item No.	Recommendation	Management Action	Funding Class	Y1 (2011)	Y2 (2012)	Y3 (2013)	Y4 (2014)	Y5 (2015)	Y6 (2016)	Y7 (2017)	Y8 (2018)	Y9 (2019)	Y10 (2020)	Total	Comments
6	Protection of Natural Resources in Undeveloped Areas.	Land Management	P2/NOC	Costs are included in the day-to-day functions of the PMRF Environmental Department, no additional funding is required.											
7	Wildland Fire Control.	Wildland Fire	P2/NOC	Costs are included in the day-to-day functions of the PMRF Environmental Department, no additional funding is required.											
8	Law Enforcement.	Law Enforcement	P2/NOC	Costs are included in the day-to-day functions of the PMRF Environmental Department, no additional funding is required.											

Y – Year; P – Priority; C – Class; NOC – Normal Operating Costs; SOS – Save Our Shearwaters; GIS – Geographic Information System; EMR – Electromagnetic Radiation; MBTA – Migratory Bird Treaty Act; USDA-WS – U.S. Department of Agriculture- Wildlife Services

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CHAPTER ONE: OVERVIEW

This Integrated Natural Resources Management Plan (INRMP) has been developed for the United States (U.S.) Department of the Navy (Navy or DON), Commander, Navy Region Hawaii (CNRH) for its Pacific Missile Range Facility (PMRF) to meet the statutory requirements of the Sikes Act Improvement Act (SAIA) of 1997 (16 U.S. Code [U.S.C] 670(a) *et sequitor* [seq.] Public Law [PL] 105-85). This INRMP is one of two INRMPs prepared for CNRH. The other INRMP covers Naval Station Pearl Harbor, which includes most of the Navy's O'ahu facilities.

Chapter 1 provides an overview of the purpose, applicable laws and process of the INRMP. Chapter 2 presents a general installation description. Chapters 3, 4, 5, 6, 7, and 8 provide summaries of the current conditions and use and natural resources program elements at the various PMRF installations including Barking Sands (Main Base), Mākaha Ridge Tracking Station, Kōke'e Sites, Kamokala Ridge Magazines, Ka'ula Island, and Mauna Kapu Communications and Radar Tracking Facility, respectively. Chapter 9 provides the INRMP implementation plan. Chapter 10 provides a summary of the references and resources used to prepare the INRMP. Chapter 11 provides a listing of the preparers and contributors to the plan.

1.1 PURPOSE

The primary purpose of this INRMP is to integrate the shore facility requirements of PMRF, in support of its military mission, with the management and conservation of natural resources. The INRMP establishes PMRF's approach and guidelines, relative to natural resources, to accomplish this end. The plan summarizes the baseline information and ensures compliance with regulatory and planning processes, such as those required by the National Environmental Policy Act (NEPA), Endangered Species Act (ESA), Clean Water Act (CWA), and Department of Defense (DOD) and Navy policies and legal requirements regarding natural resource planning.

This INRMP is intended to be a technical document to be used in the preparation of PMRF approvals, management actions, orders, instructions, guidelines, standard operating procedures (SOPs), and other planning documents. It provides technical guidance for the integration of natural resource issues into planning and decision-making processes. Field personnel are expected to operate under guidelines, plans, orders, or other approvals that have been developed using this INRMP; have environmental compliance review; and, where applicable, regulatory approvals. This INRMP does not dictate land use decisions but, rather, provides information relevant to supporting sound land use decisions and natural resource management.

1.2 SCOPE

Navy installations, including PMRF, having custody of land and water assets suitable for conservation and management of natural resources, are required to prepare and implement an INRMP and update it every five years. The INRMP and its updates are to include all elements of natural resource management applicable to the installation. The INRMP and its updates must address compliance with federal mandates protecting specific natural resources. This INRMP outlines conservation efforts at PMRF and establishes procedures to ensure compliance with applicable environmental laws and regulations for fiscal years 2011 through 2015. The INRMP considers resources at both installation and regional levels.

1.3 RESPONSIBILITIES

Environmental stewardship is the responsibility for managing and caring for natural resources to ensure that these resources are sustainably managed for current and future generations. Stewardship of the environment can include recycling, conservation, regeneration, and restoration. In addition, it is an ethic whereby natural resources managers and personnel participate in the careful and responsible management of air, land, water, and biodiversity to ensure healthy ecosystems for present and future generations. It is an ethic that embodies cooperative planning and management of environmental resources with agencies, community organizations, and others to actively engage in the prevention of loss of habitat and to facilitate habitat recovery in the interest in long-term stability.

Responsibility for the preparation and implementation of the INRMP rests primarily with the installation commanding officer. Naval Facilities Engineering Command (NAVFAC), Hawaii (NAVFAC HI) and NAVFAC Pacific (NAVFAC PAC) Natural Resources staffs work together with PMRF and Navy activities in an on-going effort to sustainably manage the natural resources at PMRF. In addition, the Navy works with U.S. Fish and Wildlife Service (USFWS), National Oceanographic and Atmospheric Administration (NOAA) National Marine Fisheries Services (NOAA Fisheries), the U.S. Department of Agriculture (USDA), and State of Hawai'i (SOH) Department of Land and Natural Resources (DLNR) personnel to adaptively manage these resources and to comply with the pertinent laws, regulations, and guidance presented in Section 1.5.

The PMRF Environmental Coordinator and the Hawai'i Range Complex Sustainment Environmental Coordinator assure coordination among facilities planners, resource managers, federal, SOH, and county officials. The PMRF Environmental Coordinator is the point of contact to provide relevant information on issues with potential to affect protected bird species, such as aircraft flight frequencies, sound levels, direct habitat loss due to clearance and construction, proximity to neighboring habitats, and sensitivity of bird species to disturbance. The PMRF Environmental Coordinator oversees natural resources surveys and updates. In addition, he ensures that appropriate mitigation measures are developed to assure protection of federally-listed threatened and endangered, or otherwise protected species and their habitats.

The PMRF Environmental Coordinator and the Hawai'i Range Complex Sustainment Environmental Coordinator work with NAVFAC HI and NAVFAC PAC Natural Resources staff, the CNRH Natural and Cultural Resource Program Manager, and appropriate SOH and federal agencies when mitigation planning is required to reduce the severity or intensity of impacts from a proposed action. Mitigation planning can include: (1) avoiding the impact altogether by not taking certain actions or parts of action or by moving the project location; (2) minimizing impacts by limiting the degree or magnitude of the action and its implementation; (3) rectifying the impact by repairing, rehabilitating, or restoring the affected environment; (4) reducing or eliminating the impact over time by monitoring, maintaining, and/or replacing equipment or structures so that future environmental degradation due to equipment or structural failure does not occur during the life of an action; and (5) compensating for the impact by replacing or providing substitute resources or environments.

1.4 MILITARY MISSION

1.4.1 Achieving No Net Loss to the Military Mission

INRMPs are principally intended to help the Installation Commander and natural resource managers manage natural resources more effectively to ensure that installation lands remain available and in good condition to support the military mission (i.e., provide for "no net loss in the capability of the military installation lands to support the military mission of the installation"). Through implementing effective planning and conservation measures, the INRMP also provides a guide for meeting natural resources and conservation compliance requirements.

Appropriate management objectives to protect mission capabilities of installation lands (from which annual projects are developed) should be clearly articulated in the planning process and should be high in INRMP resourcing priorities. The effectiveness of the INRMP in providing for "no net loss" is evaluated annually. Mission requirements and priorities identified in the INRMP are, where applicable, integrated in other environmental programs and policies. It is not the intent that natural resources are to be consumed by mission requirements, but rather sustained to support mission requirements. In order to achieve this, environmental programs and policies must have the goal of controlling environmental encroachment and preserving an unencumbered environment for the purpose of the mission.

1.4.2 Defining Impact to the Military Mission

Impacts to the military mission of PMRF can be defined by a loss of or reduction in ability to use land areas and facilities required to meet the operational requirements of the installation. This could include loss in training areas, base support, airfield operations, infrastructure, and/or delays in the mission due to lack of permits or violations of pertinent laws, regulations, and/or requirements.

Natural resources are managed at PMRF to support the military mission and to provide sustainable environments for training, education, and operations. Ecosystem management recognizes that people are an integral component of ecological systems, and it supports multiple-use of natural resources and sustainable development. Within the safety and operational constraints and with the needs of PMRF, the installation works to provide outdoor recreational opportunities. These outdoor recreational opportunities are consistent with demand from installation personnel, residents, military retirees in nearby communities, and the general public.

1.5 AUTHORITY

The SAIA is the basis for the preparation of the INRMP. In addition, other legal requirements governing all federal actions are followed, including laws for protected species and habitat, wetlands, water quality, and environmental contamination. The following subsections provide a summary of these legal requirements as they pertain to this INRMP.

1.5.1 SAIA and Related Guidance

Prior to the passage of SAIA, implementation of natural resources management plans on military lands was largely discretionary. While a requirement existed to prepare natural resources plans on applicable installations, there was no legal requirement to implement those plans. The only required natural resources management activities were those associated with ESA, CWA, other statutory requirements, and DOD directives. The SAIA added a requirement for natural resource plan implementation. The SAIA requires "the Secretary of each military department to prepare and implement an integrated natural resources management plan for each military installation in the United States under the jurisdiction of the Secretary."

The SAIA requires that the Secretary of Defense carry out a program for the conservation and rehabilitation of natural resources on military installations. To facilitate the program, the Secretary of each military department is required to prepare and implement an INRMP and its updates for each installation. Furthermore, the SAIA requires that, consistent with the use of the military installations to ensure the preparedness of the Armed Forces, each INRMP shall, where appropriate and applicable, provide for:

- Fish and wildlife management, land management, forest management, and fish and wildlife-oriented outdoor recreation;
- Fish and wildlife habitat enhancement or modifications;
- Integration of, and consistency among, the various activities conducted under the INRMP and its updates;
- Establishment of specific natural resource management objectives and time frames for proposed action;
- Sustained use by the public of natural resources to the extent such use is consistent with the needs of fish and wildlife management;
- Public access to the military installation that is necessary or appropriate for sustained use by the public of natural resources to the extent that the use is consistent with the needs of fish and wildlife resources, subject to requirements necessary to ensure safety and military security;
- Enforcement of natural resource laws and regulations;
- No net loss in the capability of military installation lands to support the military mission of the installation; and
- Such other activities as the Secretary of the military department considers appropriate.

Development, implementation and revisions of this INRMP fulfills the statutory requirements under the SAIA, which is viewed as an umbrella law with regard to management of natural resources on military lands. Thus, this INRMP helps ensure PMRF's compliance with applicable federal and SOH laws as well as DOD and Navy guidelines, instructions, and directives that require military installations to manage and protect sensitive biological and other natural resources. A summary of the SAIA and related guidance is presented in Appendix D.

1.5.2 National Environmental Policy Act

The SAIA of 1997 requires compliance with NEPA (16 U.S.C. 4701 et seq. [PL 91-190]), as implemented by regulations of the Council on Environmental Quality (CEQ). NEPA is a basic national charter for protection of the environment. It establishes policy, sets goals, and provides a

means for carrying out environmental policy. Navy policy requires that INRMP planning and implementation comply with NEPA requirements. The INRMP Guidance for Navy Installations (DON 2005c) states that annual updates and revisions be covered under the original INRMP NEPA process unless there has been a major change in installation mission or program scope.

1.5.3 Endangered Species Act

Under the ESA (16 U.S.C. Part 1531-1544 [PL 93-205] Section 1.5.5), all federal agencies are required to carry out programs to protect and conserve federally-listed threatened and endangered species in consultation with USFWS and/or NOAA, which each have responsibilities in administering the act.

Office of the Chief of Naval Operations instruction (OPNAVINST) 5090.1C (DON 2007) reiterates Section 7 of the ESA by requiring Navy to review its proposed and ongoing activities and identify those that may affect federally-listed species or designated critical habitats and those that may jeopardize the continued existence of proposed species or destroy or adversely modify proposed critical habitat. Further, where Navy determines that such an action may affect a listed species or a designated critical habitat, formal consultation with USFWS and/or NOAA Fisheries is required. Where Navy determines that the action may jeopardize the continued existence of a proposed species or destroy or adversely modify proposed critical habitat, the Navy must confer with USFWS and/or NOAA Fisheries. The required processes are detailed in 50 Code of Federal Regulations (CFR) Part 402.

The INRMP is programmatic in nature and is a planning document. As such, an action's potential to affect listed and proposed species and designated and proposed critical habitat will be assessed on a project-specific basis. All required consultation with UFWS and/or NOAA Fisheries must be completed prior to undertaking an action affecting such species and/or habitats.

As a matter of policy, actions to protect species listed as threatened or endangered under the ESA are given top priority in the INRMP. Appendix D presents a summary of ESA as well as other applicable protected species and habitat laws, regulations, and requirements. As defined by the ESA, endangered species are species in danger of extinction throughout all or a significant portion of their range. Threatened species are those which are likely to become endangered within the foreseeable future throughout all or a significant portion of their range. ESA defines "critical habitat" as the specific areas within the geographical area occupied by the species at the time it is listed on which are found those physical or biological features essential to the conservation of the species and which may require special management considerations or protection. Critical habitat may also include areas unoccupied by the species where the Secretary of the Interior has determined that such areas are essential for the conservation of the species.

Candidate species are those species that are actively being considered for listing as endangered or threatened under ESA, as well as those species that USFWS and/or NOAA has initiated an ESA status review announced in the Federal Register (FR). Neither "candidate species" nor "species of concern" carries any procedural or substantive protections under the ESA (50 CFR §424.02 and 69 FR 19975).

All Navy installations with federally-listed threatened or endangered species, proposed federally-listed threatened or endangered species, candidate species, or unoccupied habitat (as defined in Section 3 of the ESA) for a listed species where critical habitat may be designated, must structure

the INRMP to avoid the designation of critical habitat. The plan may obviate the need for designating critical habitat if it specifically addresses both the benefit provided to the listed species and the provisions made for the long-term conservation of the species and habitat. The species benefit must be clearly identified in the document and should be referenced as a specific topic in the INRMP table of contents.

At the national level, the Navy and its federal SAIA partners are currently developing policies to ensure threatened and endangered species receive special management or protection through the implementation of INRMPs. As required by the new policy, the INRMP addresses maintenance and improvement of habitat and provides for the long-term conservation of threatened and endangered species.

1.5.4 Cultural Resources

The Navy is aware that there may be circumstances under which the protection and enhancement of natural resources could affect cultural resources. Appendix D summarizes applicable cultural resources laws, regulations, and requirements. When natural resource projects resulting from this INRMP have been precisely defined, they will be evaluated for potential effects on cultural resources. Section 106 consultation will be initiated with the State Historic Preservation Officer (SHPO), if appropriate, in accordance with the National Historic Preservation Act (NHPA), 16 U.S.C. 470 (f), as amended, and its implementing regulations, 36 CFR part 800. In addition, other potentially applicable federal cultural resource statutes include the Archaeological Resources Protection Act of 1979 (16 U.S.C. 470aa-470ll) and Native American Graves Protection and Repatriation Act (25 U.S.C. 3001 et seq.).

1.5.5 Wetlands and Water Quality

Wetlands and water quality are important issues addressed in this INRMP. The U.S. Army Corps of Engineers (USACE) and U.S. Environmental Protection Agency (USEPA) define wetlands as "those areas that are inundated or saturated by surface or groundwater at a frequency and duration sufficient to support, and that under natural circumstances do support, a prevalence of vegetation typically adapted for life in saturated soil conditions. Wetlands generally include swamps, marshes, bogs, and similar areas." The USACE Wetland Delineation Manual (1987) defines wetlands as areas having all three of the following characteristics present:

1. Vegetation: at least periodically, the land supports hydrophytes (i.e., water-loving plants);

2. Soil: the substrate is predominantly undrained, hydric soil; and

3. Water: the substrate is non-soil and is saturated with water or covered by shallow water at some time during the growing season of each year.

The USFWS defines wetlands more broadly and, unlike the USACE wetland delineation procedure, requires only one or more of the three wetland parameters (vegetation, soil, and water) to be present. OPNAVINST 5090.1C requires "no overall net loss" of wetlands (DON 2007). All Navy facilities and operational actions must avoid, to the maximum degree feasible, wetland destruction and degradation. Appendix D provides a summary of the applicable wetlands and water quality laws, regulations, and requirements.

1.5.6 Environmental Contamination

The Comprehensive Environmental Compensation and Liability Act (CERCLA) of 1980 (42 U.S.C. §9601 et seq.), assigns USEPA the responsibility for regulating the uncontrolled release of hazardous substances nationwide. The Superfund Amendments and Reauthorization Act of 1986 (SARA) amended CERCLA so that it applies to all federal facilities. CERCLA requires that existing areas of contamination must be identified and remediated to levels protective of human health and the environment.

The Navy recognizes that the release of hazardous substances, pollutants, and contaminants into the environment may result in adverse impacts to natural resources addressed in this INRMP. The Navy Installation Restoration Program (IRP) is responsible for identifying CERCLA releases, considering risks and assessing impacts to human health and the environment (including impacts to endangered species, migratory bird species, and biotic communities), as well as developing and selecting response action(s) when it is likely that a release could result or has resulted in an unacceptable risk to human health or the environment. When appropriate, the regional or installation natural resource management staff will assist the IRP Remedial Project Manager (RPM) in identifying potential impacts to natural resources caused by the release of these contaminants.

Regional or installation natural resources staff will also participate, as appropriate, in the IRP decision-making process by communicating natural resource issues on the installation to the RPM, attending Restoration Advisory Board meetings, reviewing and commenting on IRP documents (e.g., Remedial Investigation, Ecological Risk Assessment), and ensuring that response actions are undertaken in accordance with all applicable or appropriate and relevant environmental laws to avoid and minimize impacts to natural resources on the installation.

Other applicable statutes include the Oil Pollution Act of 1990, 33 U.S.C. §2701 *et seq*.; and Federal Insecticide, Fungicide, and Rodenticide Act of 1972 (FIFRA), 7 U.S.C. 136 *et seq*. Appendix D provides a summary of the applicable environmental contamination laws, regulations, and requirements.

1.5.7 Coastal Zone Management

The Coastal Zone Management Act of 1972 (CZMA, 16 U.S.C. 1451-1464 [PL 92-583]) requires that all federal facilities ensure that their activities are consistent to the maximum extent practicable with the enforceable policies of an approved state Coastal Zone Management (CZM) plan. The CZMA requires the Navy to consult with the SOH CZM Program when the proposed action has the potential for reasonably foreseeable direct or indirect effects on any coastal use or resource of the SOH's coastal zone. Copies of the agency review draft INRMP were sent to the SOH CZM Program for review. In the future, 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.

1.5.8 Other DOD Directives, Statutes, and Executive Orders

Appendix D provides an overview of other pertinent DOD directives statutes, and executive orders.

1.6 ENCROACHMENT

The prevention of environmental encroachment is detailed in the INRMP (Section 3.4.11). The Fiscal Year (FY) 03 Defense Authorization Act involves a provision, codified as Title 10 U.S.C. 2684a. The Act provides the Navy with a new tool to help control environmental encroachment through executing agreements with public and private partners to acquire real estate interests near installations to help preclude environmental restrictions on military training and testing operations.

1.7 INRMP DEVELOPMENT

Installation objectives are established, prioritized, and revisited on a regular basis. This includes consideration of natural resources management to meet both installation (mission) and regional objectives. If there are any conflicts, they can be resolved through periodic regional workshops and stakeholder discussions.

1.7.1 Review and Revision Process

The initial 2001 PMRF INRMP was adopted after preparation of a NEPA Environmental Assessment that resulted in a Finding of No Significant Impact. There have been no major changes to installation mission or scope from the 2001 INRMP and, therefore, a supplemental NEPA document is not indicated.

The SAIA requires that INRMPs be continually monitored, reviewed annually, updated if necessary, and re-approved at least every five years. The first INRMP for PMRF was completed in 2001 (DON 2001) and updated the 1988 Natural Resources Management Plan for PMRF (DON 1988). This document builds upon and updates the information from those two management plans. This plan includes natural resources surveys conducted by NAVFAC PAC in 2006 and the Navy's conservation mapping conducted in 2005. The surveys and maps are included in Appendices A through C. The INRMP is intended for use by installation personnel in managing natural resources at PMRF. It is a tool to guide and prioritize short (immediate to two years) and middle range (three to five years) actions and projects, as well as longer term (six to 10 years) resource conservation planning. The planning horizon for the INRMP is 10 years. During this period, changes could occur in the activity's mission, operational and security requirements, or the condition of the natural resources. For these reasons, the INRMP has been updated to insure it reflects current requirements and management priorities.

Navy installations are required to develop the following metrics for the Assistant Secretary of the Navy using the web-based "Metrics-Builder" tool on the Natural Resources Data Call Station for the assessment of: (1) INRMP implementation; (2) partnerships/cooperation and effectiveness; (3) team adequacy; (4) INRMP impact on the installation mission; (5) status of federally-listed species and critical habitat; (6) ecosystem integrity; and (7) fish and wildlife management and public use. The Navy Conservation Metrics will be developed during the annual INRMP reviews.

1.7.2 Beneficial Partnerships and Collaborative Resource Planning

Executive Order (EO) 13352 (26 August 2004) "Facilitation of Cooperative Conservation" mandates cooperation and involvement of federal agencies with all other levels of government, non-government organizations, local interest groups, and individuals in the public involving environmental programs and planning activities. Several natural resources initiatives at PMRF involved cooperative conservation initiatives (e.g., bird-aircraft strike hazard [BASH] protection, predator control, threatened and endangered species monitoring, alien plant removal, Migratory Bird Treaty Act of 1918 [MBTA] bird protection and habitat restoration). Cooperating agencies have included the SOH DLNR, USFWS, USDA, and Kauai Invasive Species Committee (KISC). Appendix F presents correspondence between the Navy and natural resources agencies.

1.7.3 Commitment of USFWS, NOAA, and DLNR

Preparation of this INRMP, as required by SAIA, has been accomplished in cooperation with SAIA partners including USFWS, NOAA Fisheries, and SOH DLNR. This cooperation ensured that this INRMP reflected the mutual agreement of these parties concerning conservation, protection, and management of fish and wildlife resources on PMRF. Also as required by SAIA, this INRMP reflects comments received by the Navy following public review draft of this document (Appendix J).

1.7.4 Working Group

The SAIA requires that the Navy prepare INRMPs in cooperation with appropriate federal and SOH fish and wildlife agencies. The PMRF INRMP Working Group is composed of USFWS, NOAA Fisheries, SOH DLNR, and SOH Department of Business, Economic Development, and Tourism (DBEDT) CZM Program, and County of Kaua'i representatives (Table 1-1). Cooperation for this INRMP began early: a kickoff meeting and discussion was held June 2006 with representatives of the Working Group members in attendance. Natural resources management planners maintained open lines of communication with identified Working Group members throughout the planning process. Working Group members were asked to evaluate and comment on the agency review draft INRMP documents. All comments and suggestions from Working Group members were evaluated and addressed in the final INRMP (Appendix I).

This INRMP was developed in accordance with the SAIA as well as the Deputy Under Secretary of Defense (Installations and Environment) Memorandum, 10 October 2002, "Implementation of Sikes Act Improvement Act" and the OPNAVINST 5090.1C Environmental and Natural Resources Program (DON 2007). In accordance with SAIA, management options reflect the mutual agreement of USFWS, NOAA, SOH DLNR, and other interested agencies in the conservation, protection, and management of natural resources. All such management options have the potential to conflict with PMRF's daily operations should the military mission or security requirements change in the future. Re-evaluation of and adjustments to these management actions may be necessary should such mission changes occur. Appendix G provides memorandum of understanding for the implementation of INRMPs and correspondence with Working Group Members.

1.7.5 Stakeholders

Stakeholders in the public and private sectors were identified early in the process of updating the INRMP and were interviewed in preparation of the INRMP document. Table 1-2 provides a listing of Stakeholders consulted as part of the INRMP update process. Stakeholders were asked to evaluate and comment on public review draft INRMP documents (Appendix I).

1.7.6 Public Participation

Through public notices in the Garden Island Newspaper on April 10, 11, and 12, 2009, the general public was encouraged to provide comments on the public review draft. However, no comments were received.

1.8 GOALS AND OBJECTIVES

Goals for the INRMP represent the long-range (10-15 years) intentions of CNRH with respect to natural resources under its responsibility. The primary goal of the INRMP is to support and sustain the military mission of PMRF while managing, protecting, and enhancing biological diversity and ecosystem integrity of military lands and waters and all associated threatened and endangered species and their habitats. Furthermore, it is a goal of the INRMP to provide multiple-use programs for the management, conservation, and protection of renewable natural resources including wildlife, soil, water, and natural areas in conformance with applicable federal and SOH natural resource laws, regulations, and policies.

1.9 COOPERATIVE MANAGEMENT

The operations and natural resources management communities at PMRF share a common goal: a sustainable landscape that can accommodate continued operations with minimal restrictions placed upon it. This shared value is attainable only through cooperation and collaboration between CNRH and each activity. Open communication and information sharing is crucial to their respective missions. The PMRF environmental coordinator is the primary point of contact for all PMRF natural resources issues.

Because ecosystems do not follow political or social boundaries, a coordinated approach at PMRF includes: (1) early and regular coordination with Working Group members; (2) incorporation of ecosystem management goals into strategic, financial, and program planning and design budgets for PMRF; and (3) the prevention of duplication of effort and minimization of inefficiencies.

Ecosystem management depends upon participation by diverse Working Group members and Stakeholders and their ability to develop a shared vision of what constitutes a desirable future condition for the region of concern. At PMRF, this means considering the mission as well as the relationship of the installation to surrounding communities and regional environmental efforts.

Table 1-1: INRMP Update Working Group Members

Point of Contact	Phone Number	Address	Email address
U.S. Fish and Wildlife Service (USFWS), Pacific Islands			
Ms. Patrice Ashfield, Deputy Project Leader	808.792.9400	300 Ala Moana Blvd. Room 3-122 Honolulu, HI 96813	patrice_ashfield@fws.gov
Ms. Megan Laut, Fish and Wildlife Biologist	808.792.9400	Same as above	megan_laut@fws.gov
Ms. Paula Levin	808.792.9400	Same as above	paula_levin@fws.gov
National Oceanic and Atmospheric Administration (NOAA) Fisheries			
Mr. Alan Everson, Habitat Division	808.944.2212	1601 Kapiolani Boulevard, Suite 1110 Honolulu, HI 96814	alan.everson@noaa.gov
Mr. Lance Smith, ESA Coordinator	808.944.2258	Same as above	lance.smith@noaa.gov
Ms. Jayne Le Fors, NEPA Specialist	808.944.2277	Same as above	jayne.lefors@noaa.gov
State of Hawai'i (SOH) Department of Land and Natural Resources (DLNR)			
Mr. Paul Conry, Administrator, Division of Fish and Wildlife (DOFAW)	808.587.0166	1151 Punchbowl Street, Room 325 Honolulu, HI 96813	paul.j.conry@hawaii.gov
Mr. Stephen L. Thompson, Administrator, Division of State Parks	808.587.0303,	3060 Eiwa Street, Room 306, Lihue, Hawai'i 96766	stephen.l.thompson@hawaii.gov
Mr. Alvin Kyono, Kauai Branch Manager, DOFAW	808.274-3436	3060 Eiwa Street, Room 306, Lihue, Hawai'i 96766	alvin.m.kyono@hawaii.gov
Donald Heacock, Kaua'i District Aquatic Biologist, Division of Aquatic Resources (DAR)	808.645.0532	3060 Eiwa Street, Room 306, Lihue, Hawai'i 96766	donald.e.heacock@hawaii.gov
SOH Coastal Zone Management (CZM) Program, Department of Business, Economic Development, and Tourism (DBEDT)			
Mr. John Nakagawa, Planner	808.587.2878	P.O. Box 2359 Honolulu, HI 96804	jnakagawa@dbedt.hawaii.gov

Table 1-2: INRMP Update Stakeholders

Point of Contact	Phone Number	Address	Email address
PMRF			
Charles Smith, PMRF Environmental Coordinator		P.O. Box 128, Kekaha, HI 96752	charles.smith@navy.mil
Mr. John Burger, Hawai'i Range Complex Sustainment Environmental Coordinator	808.335.4632	Same as above	john.burger1@navy.mil
Mr. Craig Ulrich, Director Morale, Welfare, Recreation	808.335.4672	Same as above	craig.ulrich@navy.mil
Mr. Tom Clements, Public Affairs Officer	808.335.4740	Same as above	thomas.h.clements@navy.mil
Commander Navy Region Hawaii (CNRH)			
Ms. Rebecca Hommon, Environmental Attorney	808.473.4731	850 Ticonderoga Street, Suite 110, Pearl Harbor, Hawai'i 96860	rebecca.hommon@navy.mil
Mr. David Sullivan, Regional Environmental Coordinator	808.473.4141	850 Ticonderoga Street, Suite 110, Pearl Harbor, Hawai'i 96860	david.m.sullivan1@navy.mil
Naval Facilities Engineering Command, Hawaii (NAVFAC HI)			
Dr. Aaron Hebshi, Natural Resources Program Manager, NAVFAC Code HIEV1	808.471.1171 ext. 244	400 Marshall Road, Pearl Harbor, HI 96860	aaron.hebshi@navy.mil
Commander Pacific Fleet (COMPACFLT or Fleet)			
Mr. Larry Foster, Fleet Environmental Officer	808.471.4235	250 Makalapa Drive, Pearl Harbor, Hawai'i 96860	larry.foster@navy.mil
Ms. Julie Rivers, Marine and Natural Resources Program Manager	808.474.6391	Same as above	julie.rivers@navy.mil
Naval Facilities Engineering Command, Pacific (NAVFAC PAC)			
Ms. Vanessa Pepi, Supervisory Fish and Wildlife Biologist	808.472.1406	258 Makalapa Drive, Suite 100, Pearl Harbor, HI 96860-3134	vanessa.pepi@navy.mil
Mr. Stephan Lee, Entomologist	808.472.1384	Same as above	stephan.g.lee@navy.mil

Table 1-2: INRMP Update Stakeholders (Continued)

Point of Contact	Phone Number	Address	Email address
Dr. Angela Anders, Wildlife Biologist	808.472.1087	Same as above	angela.anders@navy.mil
Mr. Stephen Smith, Marine Ecologist	808.472.1405	Same as above	stephen.h.smith@navy.mil
Mr. Don Rochon, Public Affairs Officer	808.472.1008	Same as above	don.rochon@navy.mil
U.S. Department of Agriculture (USDA) Animal Plant Health Inspection Service (APHIS) Wildlife Service (WS)			
Mr. Scott Williamson, Supervisory Wildlife Biologist, Kauai District	808.241-3941	3901 Mokulele Loop, Box 20 Lihue, HI 96766	
Mr. Tim Ohashi, Staff Wildlife Biologist	808.985.8505	P.O. Box 786, Volcano, HI 96785	tim.j.ohashi@aphis.usda.gov
Kaua'i Invasive Species Committee (KISC)			
Ms. Keren Gundersen	808.246.0684	P.O. Box 1998 Lihue, HI 96766	keren.kisc@hawaiiantel.net

1.10 ADAPTIVE MANAGEMENT

Ecosystems are constantly changing. Understanding of ecosystems and natural communities is constantly evolving through science and adaptive management. The Navy is committed to the collection, maintenance, and use of scientific data required for making sound natural resources and land use management decisions. NAVFAC PAC Natural Resources staff continues to update botanical, bird, and wildlife surveys in order to understand how these communities are changing over time and to better manage these resources in a sustainable manner.

Management practices must accommodate changes in both the ecosystem and the understanding of these systems. This INRMP will be reviewed annually and updated again in five years. The CNRH Natural and Cultural Resources Program, PMRF Environmental Coordinator, and NAVFAC PAC Natural Resources staff continue to adapt environmental management efforts when new information is available or significant changes to the ecosystem occur.

1.11 ECOSYSTEM MANAGEMENT

Management of installation natural resources will support sustainable military use through the application of an integrated approach to ecosystem management. Ecosystem management is an interdisciplinary planning and management process that focuses on identifying, restoring, and maintaining natural communities in support of the military mission and other sustainable activities. The principles of ecosystem management have been incorporated in DOD Conservation Instruction 4715.3.

The ecosystem approach to natural resources management has the overarching goal of protecting the properties and functions of natural ecosystems. Ecosystem management for PMRF includes inventory and monitoring; protection and damage prevention; soil, water, and vegetation management; wildlife population management; research; enforcement; and awareness.

The ecosystem management approach depends on specific and measurable objectives and criteria with which to evaluate activities in the ecosystem. This INRMP includes specific measurable goals and objectives, and task schedules for PMRF (Chapter 9).

1.12 TRAINING OF NATURAL RESOURCES PERSONNEL

OPNAVINST 5090.1C Appendix P provides a summary of the Formal Navy Environmental, Natural and Cultural Resources Training Course and Billet-Specific Course (DON 2007). Navy natural resources personnel receive training based on the billet or job that they fulfill. Required training for the CNRH Natural and Cultural Resources Program Manager, PMRF Environmental Coordinator, and NAVFAC PAC Natural Resources staff includes courses on environmental protection, basic and advance environmental law, environmental negotiation, NEPA application, , health and environmental risk communications, natural resource management, DOD MBTA training, DOD water and air quality management, environmental laws and regulations, and air installation compatible use zones (AICUZ).

In addition, the CNRH Natural and Cultural Resources Program Manager also receives training for the Navy's environmental restoration program, uniform federal policy for quality assurance, environmental background analysis, ecological and human health risk assessment, environmental geographical information system (GIS)/geostatistics, optimizing remedy selection and site closeout process, munitions response site management, historic preservation law and Section 106 Compliance, cultural resources management laws and regulations, and health and environmental risk communication. Due to the relatively remote location of PMRF and lack of other natural and cultural resource personnel, the PMRF Environmental Coordinator has additional responsibilities that require training for hazardous waste facility operators, pollution prevention operations and management laws and regulations, spill management, and environmental quality sampling.

1.13 MANAGEMENT STRATEGY

The Navy uses the following three criteria to determine if a plan provides adequate special management or protection:

1.13.1 Criteria 1. Conservation Benefit

The plan provides a conservation benefit to the species. The cumulative benefits of the management activities identified in a management plan, for the length of the plan, must maintain or provide for an increase in a species' population, or the enhancement or restoration of its habitat within the area covered by the plan (i.e., those areas deemed essential to the conservation of the species). A conservation benefit may result from reducing fragmentation of habitat, maintaining or increasing populations, insuring against catastrophic events, enhancing and restoring habitats, buffering protected areas, or testing and implementing new conservation strategies.

1.13.2 Criteria 2. Implementation of the Plan

The plan provides assurances that the management plan will be implemented. Persons charged with plan implementation are capable of accomplishing the objectives of the management plan and have adequate funding for the management plan. They have the authority to implement the plan and have obtained all the necessary authorizations or approvals. An implementation schedule (including completion dates) for the conservation effort is provided in the plan.

1.13.3 Criteria 3. Management Effectiveness

The plan provides assurances that the conservation effort will be effective. The following criteria will be considered when determining the effectiveness of the conservation effort. The plan includes (1) biological goals (broad guiding principles for the program) and objectives (measurable targets for achieving the goals); (2) quantifiable, scientifically valid parameters that will demonstrate achievement of objectives, and standards for these parameters by which progress will be measured, are identified; (3) provisions for monitoring and, where appropriate, adaptive management; (4) provisions for reporting progress on implementation (based on compliance with the implementation schedule) and effectiveness (based on evaluation of quantifiable parameters) of the conservation effort are provided (this goal will be accomplished at the annual INRMP review and update, in coordination with the appropriate state fish and wildlife agency and USFWS); and (5) a duration sufficient to implement the plan and achieve the benefits of its goals and objectives. The INRMPs are five-year plans but may be extended further than five years if installation mission or natural resources do not change, or changes are minimal. This is a time period long enough to seek funding for projects, implement those projects, and monitor and report progress. At the end of the five-year period the INRMP will be reviewed and updated or rewritten if necessary to continue protection and enhancement for threatened and endangered species and habitats.

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CHAPTER TWO: GENERAL INSTALLATION DESCRIPTION

2.1 DESCRIPTION OF PMRF FACILITIES

CNRH oversees the Navy's largest and most strategic island base in the Pacific. Navy Region Hawai'i extends over 23,000 acres (ac) (9,308 hectares [ha]) of land and water in SOH, including PMRF. At 3,700 ac (1,497 ha), PMRF is the largest instrumented multi-environment test range in the world and includes land, sea, and air zones. The main base is located at Barking Sands which has training and Research, Development, Test & Evaluation (RDT&E) activities areas for tracking and surveillance radars, data processing, communications network, and an airfield. In addition to the main base at Barking Sands, there are support facilities located on Kaua'i at Mākaha Ridge, (secondary range), Kōke'e (tracking radars, telemetry, communications, command and control), Kamokala Ridge (explosive storage), Miloli'i Ridge (reflectors); at Ni'ihau Island (radar, optics, and electronic warfare); at Ka'ula Island (aircraft gunnery and inert ordnance target practice); and Mauna Kapu, O'ahu (communications and radar) (DON 2008).

PMRF supports training, tactics development, and evaluations of air, surface, and subsurface weapons systems for the Navy and other DOD agencies, foreign military forces, and private industry. It also maintains facilities and provides services to support naval operations (Feet underwater, surface, and air training exercises) and other activities and units designated by the Chief of Naval Operations (CNO).

2.1.1 Areas Included in the INRMP

This INRMP includes those PMRF lands with natural resource value that are owned, leased, or otherwise controlled by the Navy. These areas are summarized in Table 2-1 and shown on Figure 2-1, and include the following installations:

1. Barking Sands, Kaua'i (Main Base);
2. Mākaha Ridge Tracking Station, Kaua'i;
3. Sites A through E at Kōke'e ("Kōke'e Sites"), Kaua'i;
4. Kamokala Ridge Magazines, Kaua'i;
5. Ka'ula Island; and
6. Mauna Kapu Communications and Radar Tracking Facility ("Mauna Kapu Facility"), O'ahu.

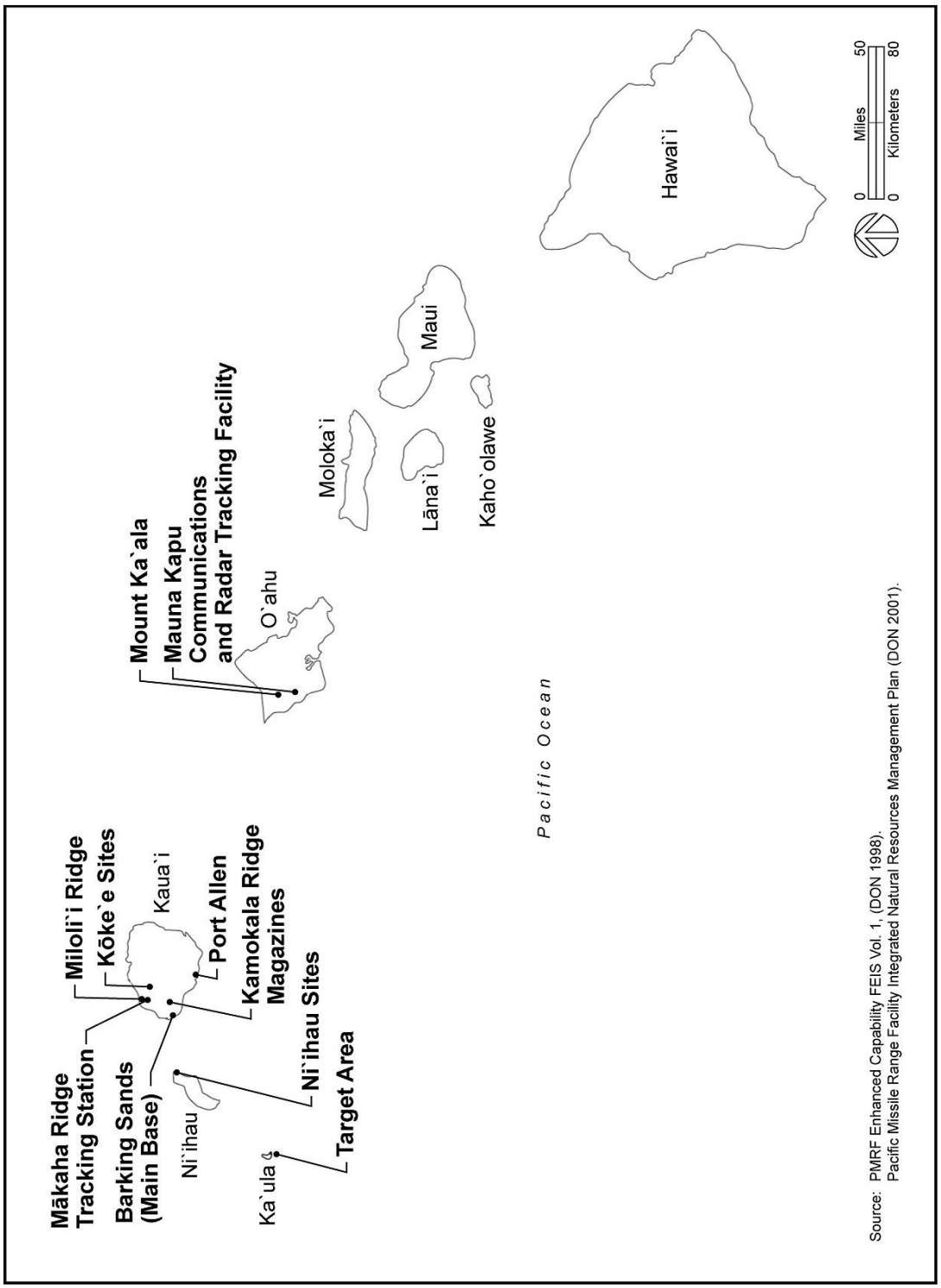


Figure 2-1: PMRF Facilities, State of Hawai‘i

Table 2-1: Lands and Waters Owned, Leased or Otherwise used by PMRF

Site	Approximate Land Area in ac (ha)	Land Ownership	Tax Map Key Number	Land Use and Types of Operations	Resources Requiring Management Present
Barking Sands, Kauaʻi (Main Base)	1,991 (806)	Navy-owned	1-2-2:13	Range operations, missile assembly and launch, radar tracking, communications, aviation and aviation support, torpedo shop, personnel support	Yes
	70 (28)	SOH lease		Same as above	Yes
	2,109 (854)	Restrictive Easement on SOH land		Ground hazard area during launches; arcs ranging from 6,000 to 10,000 feet (ft) (1,829 to 3,048 meters [m])	No
Mākaha Ridge Tracking Station, Kauaʻi	245 (89)	SOH lease	1-2-1:06	Secondary operations area: (1) radar tracking; (2) telemetry receiving/recording; (3) frequency monitoring; and (4) target control	Yes
Kōkeʻe Sites, Kauaʻi	16 (6.6)	SOH lease	1-4-1:13		Yes
Site A	3.8 (1.5)	--	--	Support buildings: (1) tracking; (2) command; (3) training; (4) administration; and (5) logistics	--
Site B	1.2 (0.5)	--	--	Power plant and fuel storage facility	--
Site C	0.4 (0.2)	--	--	Bore sight equipment, microwave antenna, and radar support buildings	--
Site D	5.3 (2.2)	--	--	Transmitter building and antenna support facilities	--
Site E	5.3 (2.2)	--	--	National Aeronautics and Space Administration's (NASA's) Kōkeʻe Geophysical Observatory with large	--

TABLE 2-1: LANDS AND WATERS OWNED, LEASED OR OTHERWISE USED BY PMRF (CONTINUED)

Site	Approximate Land Area in ac (ha)	Land Ownership	Tax Map Key Number	Land Use and Types of Operations	Resources Requiring Management Present
				antenna arrays	
Kamokala Ridge Magazines, Kauaʻi	89 (36)	SOH lease	1-2-2:01, 27, and 29	Magazines for ordnance storage	Yes
Niʻihau Sites, Niʻihau	1,170 (473)	Niʻihau Ranch lease	1-1-1:01	Communications/electronics training activities, Perch Site and Optical Tracking Station; and Pāniau Radar Site.	No. The Navy does not hold any rights or obligations to manage natural resources on this property.
Kaʻula Island	108 (43)	Navy-owned	1-1-1:01	10-ac (4 ha) target range for aircraft using inert ordnance	Yes
Mauna Kapu Facility, Oʻahu	2.0 (1.0)	1.9 ac (0.8 ha) leased from the James Campbell Company; 0.1 ac (0.08 ha) under use agreement with U.S. government	9-2-5:13	Communications and radar tracking facility and frequency monitoring station building on a 0.4 ac (0.2 ha) site; 1.5 ac (0.6 ha) in utility easements	Yes
Miloliʻi Ridge, Kauaʻi		SOH lease		Three 10 square ft (ft^2) (0.9 square m [m^2]) reflector sites	No; small sites, no resources
Port Allen, Kauai	1.0 (0.4)	SOH lease		Warehousing, surface craft support	No; building space only
Mount Kaʻala, Oʻahu	1.8 (0.7)	James Campbell Company lease		Communications Center	No; building space only

-- = same as above

2.1.2 Areas Not Included in the INRMP

Land Areas: Communications/Electronics Training Activities Site, Perch Site and Optical Tracking Station; and Pāniʻau Radar Site (hereinafter, the "Niʻihau Sites") on Niʻihau (Table 2-1 and Figure 2-1) are not included in the INRMP. Navy does not hold any rights or obligations to manage natural resources on this property.

Very small PMRF sites at Port Allen and Miloliʻi Ridge on Kauaʻi and at Mount Ka'ala, Oʻahu (Table 2-1 and Figure 2-1) are not included in the INRMP. Port Allen and Mount Kaʻala consist of leased building space only. Miloliʻi Ridge is a small, undeveloped site with no significant resources within its boundaries. PMRF also utilizes support facilities, operated by others, on the islands of Hawaiʻi and Maui, such as an Air Force telescope on the summit of Haleakala; however, these facilities are not managed or operated by the Navy and, therefore are not included in the INRMP.

Offshore Areas. The installation on the seaward boundary typically ends at the high water mark. Offshore areas are typically considered territorial waters. Although the Navy does provide some fisheries and marine resources information in the INRMP for offshore areas at Barking Sands, the natural resources of these offshore areas are not managed by the Navy.

There are 1,100 square nautical miles (nm) (3,773 square kilometers [km^2]) of underwater ranges that are associated with PMRF (Figure 2-2). The underwater ranges are within open ocean areas and extend into territorial waters. The Navy does not have exclusive use of these areas. The natural resources of the underwater ranges are discussed in the *Hawaii Range Complex Environmental Impact Statement* (DON 2008a) and the *Marine Resources Assessment for the Hawaiian Islands Operating Area* (DON 2005c).

2.2 GENERAL PHYSICAL ENVIRONMENT

2.2.1 Physical Geography

2.2.1.1 Hawaiian Islands

The Hawaiian Islands form an archipelago of 19 islands and atolls, numerous small islets, and undersea seamounts trending northwest by southeast in the North Pacific Ocean between latitudes 19 degrees (°) North and 29° North. The archipelago extends 1,500 mile (mi) (2,400 kilometer [km]) from the Island of Hawaiʻi in the south to the northernmost Kure Atoll (Juvik *et al*. 1998).

2.2.1.2 Kauaʻi

The island of Kauaʻi is located at 22° 13 minutes (') North latitude and 159° 22' West longitude. The land area of the island encompasses 552.3 square miles (mi^2) (1,430.5 km^2). Kauaʻi is nearly circular, with a maximum length of 33 mi (53 km), a width of 25 mi (40 km), and a perimeter of 94 mi (151 km) (Mac Donald *et al.* 1960).

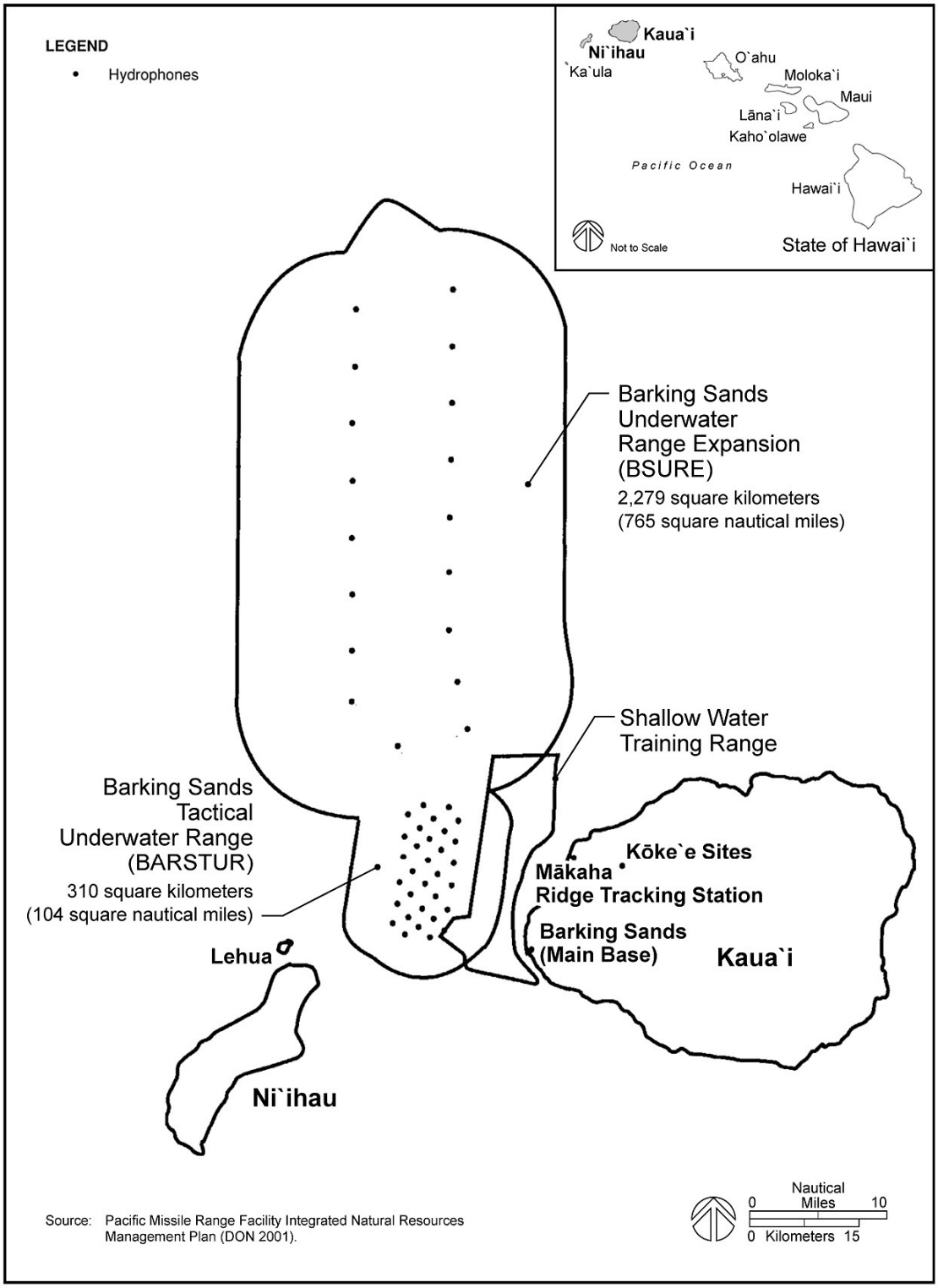


Figure 2-2: Underwater Ranges

2.2.2 Topography

The island of Kauaʻi is a deeply eroded volcanic shield that is partly veneered with much later volcanics. It has a maximum elevation of 5,243 ft (1,598 m) at Kawaikini (Juvik *et al*. 1998).

2.2.3 Climate

The climate on Kauaʻi is mild and semi-tropical. The island is known for the variety of microclimates that exist throughout including temperate regions, dry sand dune complexes, and lush river valleys. The complex climate of Kauaʻi is created in part by the island's high mountains. Mountains such as the centrally located Mount Waiʻaleʻale (5,148 ft [1,569 m]), trap moisture from the prevailing trade winds, creating vast amounts of rainfall and surface runoff that have carved deep canyons into the island (Yale 2007).

The mean annual temperature on the drier, lowland Mānā Plain ranges from 70° to 78° Fahrenheit (F) (21° to 26° Celsius [C]). Kauaʻi and the entire Hawaiian Island chain are located at the edge of the tropical zone within the belt of the prevailing year-round northeasterly tradewinds. Annual rainfall levels on Kauaʻi range from 486 inches (in) (1,234 centimeters [cm]) at the top of Mount Waiʻaleʻale, one of the wettest spots on Earth, to approximately 20 in (52 cm) on the western side of the island in the vicinity of PMRF Barking Sands. Rainfall is highest from October to April during the wet season, which contributes to 75 percent of the yearly average total rainfall for the island. Relative humidity is constant, with a daily average of 60 percent throughout the year. These general climatic conditions apply to all PMRF-leased and -owned lands on Kauaʻi (DON 2001).

2.2.4 Geology

2.2.4.1 Hawaiian Archipelago

The Hawaiian Islands are the exposed peaks of large volcanic mountain ranges, most of which lie beneath the sea, that constitute the Hawaiian Ridge. They were produced by a series of volcanic eruptions during the Pliocene Epoch. These volcanic eruptions are a result of a plume of hot rock anchored 100 mi (161 km) beneath the Pacific (Tectonic) Plate and the movement of the plate across that "hot spot." The hot spot has continuously fed magma (molten rock) through the crust to fuel countless volcanic eruptions over the past 40 million years as the Pacific Plate has continued to move west-northwestward at a rate of 3.5 in (9 cm) a year. The plate has rafted approximately 129 volcanoes in all including the 19 volcanoes making up the major islands of Hawaiʻi (Juvik *et al*. 1998).

2.2.4.2 Kauaʻi

Kauaʻi is the most northern and oldest of the eight Main Hawaiian Islands (MHI). It is estimated that Kauaʻi was formed 5.1 million years ago and has a roughly circular shape. Currently, there are two models for the island's morphology: (1) a single shield model; and (2) a two-shield model (Yale 2007). Most geologists agree that, generally, the formation of the island of Kauaʻi is the result of a massive shield volcano, part of a chain of similar volcanoes that migrated southeastward, becoming, over geologic time, the present configuration of the Hawaiian archipelago (Macdonald *et al*. 1960).

In most geological aspects, Kauaʻi is the most complex of the MHI. It is the oldest of the MHI, has subsided more than any other, and its original volcanic shield underwent large scale structural displacement and erosion before much of it was covered with extrusions of new volcanism. The post-erosional volcanics are the most voluminous of this class of rocks in the island chain. Kauaʻi would be a much smaller land mass had not the Koloa volcanic series filled deep valleys and covered the irregular topography of the eroded primary volcanic dome in the eastern half of the island (Mink and Lau 1992).

The main mass of Kauaʻi was built about three to five million years ago, although there were very small eruptions on the island as late as 400,000 years ago. The Waimea Canyon volcanic series comprises all of the rocks of the major volcanic shield that constitutes most of the island of Kauaʻi. Mac Donald *et al*. (1960) located the caldera of the original volcano in the interior of the island and identified a smaller eruptive center in the southeast, on Haupu Ridge. The Waimea Canyon volcanic series consists almost entirely of olivine basalt with much less abundant basalt poor in olivine, and picrite-basalt rich in olivine. It is composed of four formations or members: (1) the Napali formation; (2) the Olokele formation; (3) the Makaweli formation; and (4) the Haupa formation (Macdonald *et al*. 1960).

The innumerable lava flows that accumulated to form the volcanic dome are called the Napali formation, the oldest member of the Waimea Canyon volcanic series. The Napali formation constitutes the bulk of the mountain from the sea floor to 3,700 ft (1,128 m) above sea level in the Kōkeʻe area. It is estimated to be approximately 19,000 ft (5,791 m) thick (Macdonald *et al*. 1960). The rocks of the Napali formation are the most permeable (Mink and Lau 1992).

The rocks filling the main caldera are from the Olokele formation. This formation is composed mostly of tholeiitic basalts that are thick and ponded and have a few flows of post-shield, alkalic basalts as its youngest flow. The Olokele lavas are found in a very large area in the central part of the island. These lavas are thick and flat, suggesting that they may have ponded inside a closed topographic feature. There are also normal faults exposed in a few places on the margins. For these reasons, and because of its central location, the Olokele formation has been interpreted as filling a big caldera for the “single” shield volcano of the island. The top of the Olokele formation is at an altitude of 5,170 ft (1,576 m) at Kawaikini Peak (Yale 2007).

In the small caldera in the southeast of the island the rocks are from the Haupu formation. This formation is composed of thick ponded lavas found in a small, fault-bounded caldera in the southeast part of the island. These lavas are composed of tholeiitic basalts. This formation is an extension of the Waimea Canyon volcanic series. The Makaweli lavas fill a graben-like feature in the southern part of the island and are composed mostly of tholeiitic basalts (Yale 2007).

A second shield building stage began more than 1.5 million years after the primary shield building stage had ceased on Kauaʻi. During this gap in volcanism, the original shield volcano was deeply eroded. The rejuvenated volcanism, known as the Koloa Volcanic Series, resurfaced two thirds of the eastern side of the island. Locations on the north, east, and southern coasts of Kauaʻi contain lavas of the Koloa Series. Remnant volcanic vents trend generally north-south across the island and may be found at a few locations on both the north and south shores (Yale 2007).

2.2.5 Hydrology

Rainfall is the source of all fresh water on the island; a portion of it runs off directly to the sea in streams and overland flow (surface water), another part escapes into the atmosphere by evaporation and transpiration, and a part moves downward through the soil and rocks to the zone of saturation and becomes groundwater. The groundwater moves slowly through the rocks and eventually reaches the points of discharge at springs and seeps in stream valleys and along the shore (Macdonald *et al*. 1960). The discussion of the Kaua'i hydrology is divided into two sections: (1) a discussion of the surface water resources; and (2) the hydrogeology (groundwater resources).

2.2.5.1 Surface Water Resources

Rainfall for the entire island of Kaua'i averages 98 in/year (249 cm/year), higher than for any other island in the archipelago. High rainfall coupled with extensive occurrence of high-level aquifers results in an unusually large percentage of total rain draining into the sea as stream flow. In the eastern half of the island, perched aquifers in the Koloa formation sustain perennial stream flow in numerous small streams. Larger streams reaching inland to the mountains drain dike aquifers in the Waimea Canyon volcanic series as well as perched Koloa aquifers. In the interior, drainage from Alakai Swamp supports many headwater streams flowing into major rivers like Waimea, Olokele, Makaweli, Hanapepe, Wainiha, and Lumahai. In the hydrologic balance, the greatest fraction of rainfall not consumed in evapotranspiration reaches the sea as defined stream flow rather than groundwater underflow (Mink and Lau 1992).

Perennial streams flow to the sea in all parts of Kaua'i, except the sector west of Waimea Canyon (where Barking Sands is located). The major streams are large and have relatively uniform flow in comparison with those of the other islands of Hawai'i. All the large streams head in the rainy uplands, and in at least their upper reaches, they flow in deep, steep walled valleys. The low flow of the streams is maintained by direct run-off from persistent rainfall in the mountains and by the discharge of water from high-level springs and seeps. Water in the streams is extensively developed for agricultural irrigation (formerly sugar cane cultivation) and is transported long distances through complex ditch and tunnel systems to the irrigated fields (Macdonald *et al*. 1960).

Numerous small reservoirs, which are mostly parts of the ditch systems in the lowlands, provide short-term storage of irrigation water during its flow from points of diversion to the agricultural fields. Two relatively large reservoirs are the Alexander Reservoir, which is formed by a dam across Wahiawa Stream and which has a capacity of about 800 million gallons (3.0 billion liters); and the Koloa Reservoir near the town of Koloa, which holds 2,500 million gallons (9.4 billion liters) and which stores water diverted from streams, mostly from tributaries of the Waialua River (Macdonald *et al*. 1960).

2.2.5.2 Hydrogeology

Although they are surrounded by seawater, the Hawaiian Islands are underlain by large quantities of fresh groundwater which are the result of the large island landmasses causing orographic rainfall. The Hawaiian Islands obstruct oceanic winds, causing air to rise and moisture to precipitate (orographic rainfall) with as much as 276 to 394 in (7,000 to 10,000 cm)

of mean annual rainfall in the mountainous uplands of the larger islands. The permeable soils and rocks that comprise the uplands allow easy infiltration of the abundant rainfall to accumulate as fresh groundwater. These geologic conditions allow for subsurface movement of water and low-permeability geologic features impound large amounts of water in the thick groundwater reservoirs (Hunt *et al*. 1988). The hydrogeology, or distribution and movement of groundwater in soil and rocks, of Kaua'i is controlled by local and regional hydrologic conditions that influence the supply and distribution of water in the sedimentary deposits and volcanic rocks (basalts) that compose the island.

On Kaua'i, groundwater occurs in all of the rock formations, chiefly in high level aquifers starting a few miles inland. In the Koloa Series, perched groundwater is common, while in the Napali Formation groundwater is trapped between dikes or moves freely in flank lavas. Dikes have been mapped in the Waimea Canyon Volcanic Series throughout the island, but where their frequency is low, aquifers behave as flank aquifers (Mink and Lau 1992).

The following paragraphs provide a general description of four major aquifer types which occur on Kaua'i: (1) flank volcanic basal aquifers (primary geologic feature of hydrologic importance); (2) dike-impounded high-level aquifers (secondary geologic feature of hydrologic importance); (3) perched high-level aquifers; and (4) sedimentary basal aquifers.

1. Flank Volcanic Basal Aquifers

The principal geologic feature of hydrologic importance in flank volcanic basal aquifers is the presence of thousands of thin-bedded (10 ft [3.2 m] or less), gently sloping (3 to 10°), extrusive basaltic lava flows that comprise the bulk of the MHI, including Kaua'i. The structural features associated with these flows, such as an abundance of clinker sections, voids between flow surfaces, shrinkage joints, fractures, lava tubes, and gas vesicles make these rocks porous and highly permeable, thus ideal aquifers (Juvik *et al*. 1998). Hydraulic properties of the volcanic rock aquifers are determined by the distinctive textures and shape of individual lava flows. Individual lava flows commonly are highly permeable. The stratified nature of lava flows imparts a layered heterogeneity or diversity. Averaged over several lava-flow thicknesses, lateral hydraulic conductivity of dike-free lava flows is about 500 to 5,000 ft per day (152 to 1520 m per day), with smaller and larger values not uncommon. Systematic areal variations in lava-flow thickness or other properties may impart trends in the heterogeneity.

2. Dike-impounded High-Level Aquifers

The primary geologic feature of hydrologic importance for dike-impounded high-level aquifers is the presence of dikes (hardened volcanic intrusive features) which occur in volcanic rift zones. The dikes are dense, poorly permeable, and nearly vertical sheets of basaltic rock which have intruded into the highly permeable extrusive basaltic lava flows. Measuring a few feet in thickness, these dikes are very important hydrogeologically as they restrict the flow of groundwater. Where dikes make up 10 percent or more of the total rock volume and cut into the permeable basalt flows to form water storage compartments, they are called dike complexes. These are generally located at higher elevations and impound rain-fed, percolating water. High-level groundwater saturates dike complexes in the rift zones. Groundwater accumulates between dikes until it either escapes through fractures or reaches the surface, where it discharges as springs (Juvik *et al*. 1998).

3. Perched High-Level Aquifers

High-level groundwater also occurs as local zones of saturation in permeable rock underlain by less permeable formations, such as buried ash or soil layers, called perched water, such resources are generally of much smaller volume than high-level water impounded by dikes, but they may be adequate for local needs (Juvik *et al*. 1998).

4. Sedimentary Basal Aquifers

Groundwater also saturates sediments on coastal plains, particularly layers of limestone. This water is not usually fresh enough for drinking, but it may be acceptable for irrigation. Alluvium in stream valleys also carries small amounts of groundwater (Juvik *et al*. 1998).

2.3 ORGANIZATION OF CHAPTERS 3 THROUGH 8

The standard organization for chapters three through eight is in two parts: (1) General Biotic Environment; and (2) Current Management of Natural Resources.

2.3.1 Program Elements

INRMP objectives were developed through consultation with Navy resource managers, SAIA Working Group Members (USFWS, NOAA Fisheries, and the SOH DLNR) and Navy and non-Navy stakeholders. Table 2-2 provides a summary of the five natural resource management areas typically addressed in INRMPs, their corresponding goals, and their programmatic objectives. In addition, within the body of this INRMP each of the natural resources management areas is addressed through 18 program elements required by Navy INRMP Guidance (DON 2005c). They include:

1. Threatened and Endangered Species, Critical Habitat, and Species of Concern;
2. Wetlands;
3. Fish and Wildlife;
4. Forests;
5. Vegetation;
6. Coastal Marine;
7. Invasive Species;
8. Wildland Fire;
9. Land Management;
10. Floodplains;
11. Outdoor Recreation;
12. BASH;
13. Law Enforcement;

14. Agricultural Outleasing;
15. Other Leases;
16. Migratory Birds;
17. Research Needs;
18. Use of GIS; and
19. Community Outreach.

A 19th program element has been added due to the importance of the installation and its natural resources to the community: (19) Community Outreach. For each objective identified in Table 2-2, corresponding program element numbers (#) are identified.

Table 2-2: Natural Resource Management Areas, Goals, and Objectives

Resource Area	Definition	Goals
Land Management	Includes actions conducted to support the continuation of the military mission while complying with the suite of laws governing protection of natural resources.	Continued management, maintenance, and enhancement of land with natural resource value and protection of wetland and watershed resources.
Objectives and Associated Program Element #s: 1. Manage, maintain, and enhance land areas with natural resource value (#2, #3, #5, #8, #9, #10, #17, #18). 2. Preserve, protect, and enhance wetlands (#2, #10). 3. Preserve and improve native habitats and ecosystems (#1, #2, #3, #9). 4. Control, eradicate, and prevent the establishment of alien species (#4, #5, #7). 5. Manage, maintain, and enhance nesting habitat of protected bird species (#1, #3, #12, #16). 6. Protect coastal dunes ecosystem at Barking Sands (#1, #5, #6, #7, #9). 7. Protect coral reef ecosystem at Barking Sands (#1, #3, #6). 8. Protect native vegetation within the riparian habitat of certain streams or drainage ditches at Barking Sands (#1, #2, #3, #5, #9, #10, #15). 9. Monitor adjacent civilian development and encroachment that could threaten the Navy's mission or natural resources (#9, #13, #15). 10. Limit encroachment that threatens the Navy's ability to accomplish its mission, comply with Anti-Terrorism/Force Protection (AT/FP) requirements, and protect natural resources (#9, #13, #15). 11. Protect threatened and endangered species associated with PMRF lands and waters through management actions and cooperative, interagency projects (#1, #3, #5, #7, #9, #12, #13, #17, #18). 12. Bolster the existing education campaign to centralize and disseminate information about PMRF's natural resources information (#19). 13. Increase on-base and community-wide cooperation, participation, and awareness to supplement efforts to protect lands with natural resource value and habitat for threatened and endangered or otherwise protected species and essential habitat (#19). 14. Actively participate in future land use and facility development decisions by providing input and advice regarding natural resources constraints, potentially significant impacts, and suggested mitigation measures (#9).		

TABLE 2-2: NATURAL RESOURCE MANAGEMENT AREAS, GOALS, AND OBJECTIVES (CONTINUED)

Resource Area	Definition	Goals
Fish and Wildlife Management	Consists of actions necessary to protect fish, wildlife, plants, and their habitats, with particular emphasis on threatened and endangered species and associated habitats, migratory bird species, wetlands, coral reefs, and other federal trust resources.	Continued conservation, protection, and when feasible, enhancement of fish and wildlife resources, especially protected and sensitive species. Native plant and animal species take precedence over alien species. Pest species should be controlled to benefit not only humans but native species as well.
Objectives and Associated Program Element #s: 1. Protect, conserve, and manage terrestrial and aquatic flora and fauna as vital elements of the natural resources program (#1, #3, #5, #9). 2. Proactively manage/monitor known threatened and endangered or otherwise protected species as required by law (#1). 3. Maintain baseline information on aquatic resources and fisheries at Barking Sands in order to facilitate effective resource management (#3, #6). 4. Monitor and track changes in the quality of the marine environment over time (#6). 5. Protect threatened and endangered or otherwise protected marine species that may occur in waters adjacent to PMRF (#1, #6). 6. Strengthen efforts to prevent the introduction of new non-indigenous species to PMRF (#7).		
Forestry Management	Consists of actions to exercise best management practices to develop and maintain a biological balance in the forest community consistent with proven scientific practices to provide for wildlife habitat, watershed protection, and recreation opportunities.	While PMRF has no traditional lumber/forest resources for commercial sale, limited sources of raw-wood materials do exist at Barking Sands. Continued promotion of native plant and animal species and habitat and control and management of alien vegetation.
Objectives and Associated Program Element #s: 1. Promote reuse of raw-wood material collected from invasive species control projects (#4, #5, #7, #9).		
Agricultural Outlease	Consists of actions to provide agricultural outleases of suitable and available land.	Agricultural outlease is a natural resources management category that does not apply to PMRF lands. At present, PMRF has no agricultural outleases and none are anticipated (Program Element # 14).

TABLE 2-2: NATURAL RESOURCE MANAGEMENT AREAS, GOALS, AND OBJECTIVES (CONTINUED)

Resource Area	Definition	Goals
Outdoor Recreation	Outdoor recreation activities that are fish and wildlife-oriented are also included within the purview of the Environmental Coordinator. Other outdoor recreation activities that are facilities-oriented (e.g., recreation cabins, outdoor recreation fields, swimming facilities) are not actions normally included in INRMPs.	Provide military personnel, their dependents, and the public, in general, an opportunity to participate in outdoor recreation activities that capitalize on natural resources. These activities, however, should be controlled and monitored when they interfere with natural resource management objectives and goals.
Objectives and Associated Program Element #s: 1. Continue to provide public opportunities for natural resource-related outdoor recreation where it does not conflict with public health and safety, the military mission, or security (#11). 2. Ensure that the degree of access allowed for outdoor recreation is consistent with conservation of natural resources (#9, #11). 3. Continue to promote awareness of natural resources, the importance of resource stewardship, and a sense of pride in the natural environment of PMRF (#11, #19). 4. Continue to restore and enhance natural and cultural resource assets at PMRF for public benefit and enjoyment (#11).		

2.4 GIS MANAGEMENT, DATA INTEGRATION, ACCESS, AND REPORTING

As the installation's natural resources are surveyed and updated, the NAVFAC PAC Natural Resources staff has been classifying land uses and constraints by location. This compilation of physical information is captured, stored, updated, manipulated, displayed, and analyzed in a GIS database. The natural resources data will be integrated into the installation's GIS system and made available to planners and land managers to aid in decision-making. When combined with operational and infrastructure information, natural resource GIS provides installation commanders and public works officers the situational awareness information they need to make sound decisions. Integration of natural resources data into the GIS database ensures that the installation is not using conflicting resource management techniques or planning land uses that conflict with natural resources preservation or the installation's mission.

The PMRF Environmental Coordinator and NAVFAC PAC Natural Resources staff ensures that newly acquired or updated natural resources information is integrated into the installation GIS database on a regular basis. NAVFAC PAC has created GIS layers in geodatabase format for Barking Sands, Mākaha Ridge Tracking Station, Kōke'e Sites, and Kamokala Ridge Magazines for the following data: (1) fauna habitat; (2) fauna special species areas; (3) wildlife management areas; (4) flora special species areas; and (5) land vegetation cover. That information has been used to generate maps for this INRMP.

CHAPTER THREE: BARKING SANDS

3.1 CURRENT CONDITIONS AND USE

Photo 3-1: Barking Sands, Kaua'i

3.1.1 Installation Information

The principal operations area for PMRF is Main Base at Barking Sands on the west shore of Kaua'i (Figure 1-1). Barking Sands is a long, narrow site bordered by agricultural land, coastal undeveloped land, and parkland (photo 3-1). The area consists of approximately 2,060 ac (834 ha) extending from Kokole Point in the south to Polihale State Park in the north (approximately 7.6 mi [12.2 km] of shoreline). At its northern and southern boundaries, Barking Sands is just over 0.6 mi (1 km) wide. The installation narrows to 0.3 mi (0.5 km) in its central and narrowest portion. Barking Sands beach is named Ke-one-kani-o-Nohili, which means "the sounding sand of Nohili" in the Hawaiian language. This refers to the loud sounds made when the sands are walked upon (MacDonald *et al*. 1977).

3.1.1.1 General Description

Barking Sands contains a multi-instrumented range capable of supporting surface, subsurface, air and space events and activities simultaneously. RDT&E activities areas at Barking Sands contain tracking and surveillance radars, data processing, and other communications networks. These activities are supported by an active airfield and associated facilities. At Kaua'i Test Facility (KTF), in the northern section of Barking Sands, Sandia National Laboratories operates the launch areas for the Department of Energy (DOE) and provides PMRF with rocket launch services for target systems and upper atmosphere measurements (DON 2008).

3.1.1.2 Land Use Constraints

Land use constraints at Barking Sands result from both the military mission and the sensitive habitats and species located on the installation. The military land use constraints are defined by the operations and the facilities that serve them, while the environmental land use constraints are defined by the presence of ESA-protected species and sensitive habitat, including critical habitat and wetlands (Figures 3-1, 3-5, 3-6, 3-8 and 3-9). Section 3.3 presents a description of the protected species and habitats located at Barking Sands. The following paragraphs describe the military land use constraints.

Barking Sands functions are purposely conducted in areas that are developed only to the degree necessary for mission accomplishment. The military operations and training missions at Barking Sands require that the Navy institute measures to reduce potential risks to public health and safety. These measures include the exchange or purchase of affected lands, acquisition of easements, or temporary closure of potentially hazardous areas during action operations and training events.

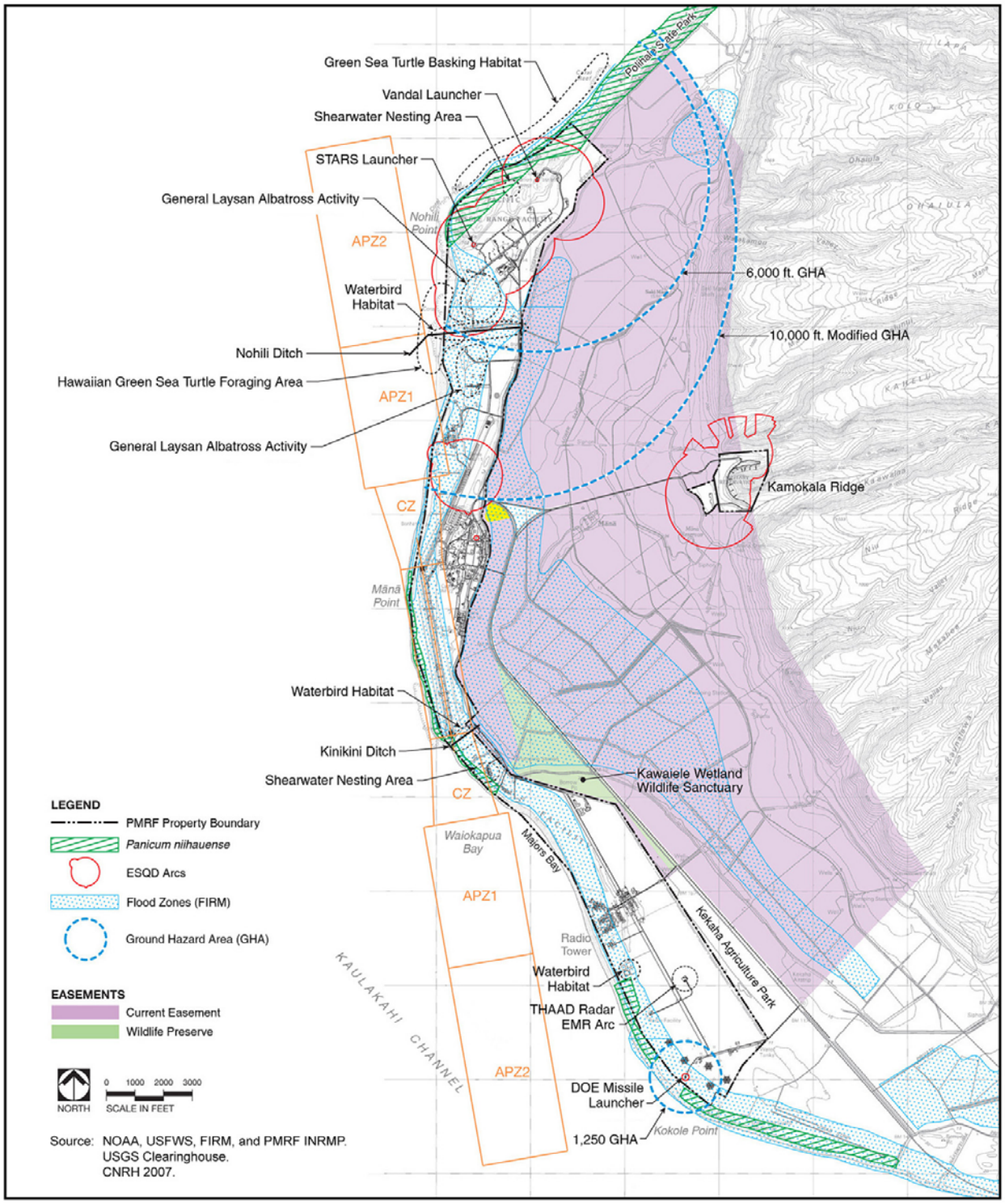


Figure 3-1: Constraints, Barking Sands, Kaua'i

There are five types of land use constraints related to operations/training at Barking Sands: (1) Ground Hazard Areas (GHAs); (2) Electromagnetic Zones; (3) Explosive Hazard Zones; (4) Aviation Safety Zones; and (5) Range Safety Zones. These zones are established to safeguard the public and station personnel from the effects of missile and aircraft operations. Other areas are kept clear of facilities and/or activity as needed to maintain "line of sight" clearances for optical calibration instruments, radar, and telemetry.

1. Ground Hazard Areas

As shown on Figure 3-1, the ground hazard area (GHA) is an arc with a radius of about 6,000 ft (1,829 m) for the U.S. Navy *Vandal* missile launches, or a modified arc with a radius of approximately 10,000 ft (3,048 m) for the launches associated with the Strategic Target Systems (STARS). The Navy is required by DOD policy to exclude the public and non-essential mission personnel from hazardous areas. On-base restrictions involve curtailing traffic and activities on the beaches north of the airfield and along the road connecting to the KTF. The off-base portion of the GHA is within the restrictive easement acquired from the SOH. The Navy works with DLNR's Division of State Parks to establish safety controls during missile launches and restricts entry to the southern portion of Polihale Beach Park, a popular site for tourists and island residents, beginning 20 minutes prior to launches. Advance notification of beach closure times is provided through a 24-hour hotline at Barking Sands so minimal impacts on subsistence fishing and other activities occur.

2. Electromagnetic Zones

Unobstructed lines of sight are required between microwave antennas and are required in the path of radars. These "look angles" constrain facility development and placement to ensure that structures do not cause electromagnetic interference (EMI). Electromagnetic radiation (EMR) zones are designated around transmitter sites and tracking radars to ensure that high-density electromagnetic power will not constitute a hazard to personnel (HERP), ordnance (HERO), or fuel (HERF). Radar and transmitter sites are situated for clear lines of sight and to eliminate hazards to personnel in areas immediately in front of each emitter.

3. Explosives Safety Quantity Distance

The DOD establishes explosives hazard zones based on various quantities and types of ammunition stored in magazines, being transported, and staged on ordnance handling pads. Explosives Safety Quantity Distance (ESQD) arcs establish ground areas of restricted non-ammunition-related facilities and activities.

As shown on Figure 3-1, the ESQD arcs extend across undeveloped agricultural lands and the ocean beyond Barking Sands boundaries. The restrictive land uses within the arcs are the subject of a Memorandum of Agreement (MOA) with the SOH. The SOH has no development plans that would lead to encroaching upon facilities or activities. If the SOH decided to develop these lands, the Navy would have the option to purchase the additional lands needed to keep the arcs on government property.

4. Aviation Safety Zones

An AICUZ is established to provide guidelines for preventing incompatible development in high noise exposure areas, minimize public exposure to safety hazards associated with airfield operations, and protect the station's operational capability from constraints due to encroachment by adjacent non-compatible land uses. The County of Kaua'i has zoned the surrounding off-base areas as agricultural, preservation, or public facility; land uses that are compatible with PMRF airfield operations.

OPNAVINST 11010.36B establishes clear zones (CZs) as the first priority for acquisition or restrictive easement, should encroachment threaten (DON 2002). There are 17 ac (7 ha) in the runway clear zone (CZ) owned by the SOH; 11 ac (3.7 ha) are leased to the Navy and 6.1 ac (2.5 ha) are used for agricultural purposes or are fallow (Figure 3-1). On base, certain facilities related to airfield operations and range operations could be affected by noise levels that demand noise shielding.

Accident Potential Zones (APZs) are designated for runways along the approach and departure flight tracks over land. Normally, there are two APZs (each 5,000 ft [1.5 km] long and 3,000 ft [0.9 km] wide) on both ends of a runway, designated as the accident approach zone (APZ) I and APZ II. At Barking Sands, one APZ extends from both north and south ends of the runway. Because the flight tracks beyond this area are over the ocean, an APZ II is not required (Figure 3-1).

The adjacent on-base Barking Sands recreation beach lies within the CZ. It is closed to recreation purposes during daylight hours and all other times when the airfield may be in operation. PMRF Airfield Operations controls access to this area.

5. Range Safety Zones

There are no active firing ranges at Barking Sands and, therefore, no range safety zones. An inactive pistol range is located northeast of the *Vandal* missile launch pad (North Zone).

3.1.1.3 Operations and Activities

The Nohili and Kinikini Ditches act as natural dividers, separating PMRF into three zones: north, central, and south (Figure 3-2).

1. North Zone

The North Zone includes DOE KTF. This area is devoted to missile assembly and launch operations and associated support activities, administration, and services. The North Zone includes a portion of the ESQD arcs and GHAs (Figure 3-1). Access to this area is controlled at all times. There are also temporary closures of on-base and adjoining SOH access roads and beaches during missile launches.

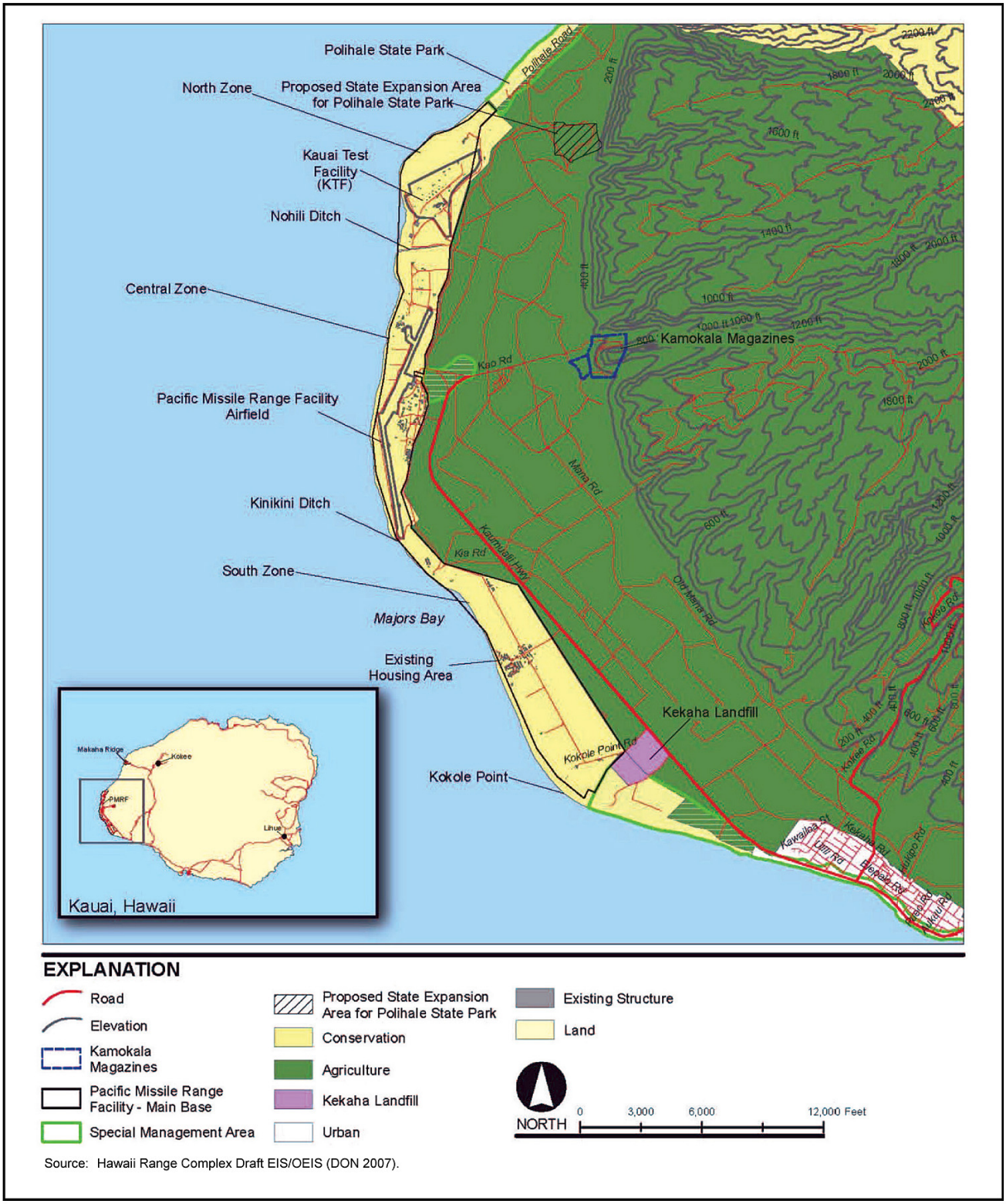


Figure 3-2: Operations Areas, Barking Sands, Kaua'i

2. Central Zone

The Central Zone contains the airfield and associated air operations, base administration, supply, base service, range operations, ordnance maintenance, and fuel supply. In addition, the airfield has CZs and APZs (Figure 3-1).

3. South Zone

The South Zone contains housing, personnel support, recreation facilities, communications, undeveloped lands, an antenna array, and rocket launcher facilities (KTF). ESQD arcs and GHAs exist for the rocket launcher pad (Figure 3-1). Bachelor and family housing along with community support facilities such as a Navy Exchange and Shoppette are located in the South Zone. Recreation facilities include a gymnasium, youth center, fitness center, soccer field, and movie theater. A consolidated open mess is also sited in the South Zone.

3.1.1.4 Abbreviated History and Pre-Military Land Use

Archaeological studies indicate that Native Hawaiians utilized the extensive coastal wetlands on the Mānā Plain for hunting and gathering and inhabited permanent dwellings located on the coastal back beach area (behind the dunes). The coastal dunes were used as temporary, seasonal fishing camps and ceremonial functions as well as burial grounds.

The following is a list of historical events leading to the present status of Barking Sands.

1922: Wetlands inland of Barking Sands were drained. Natural water flow was replaced by a system of pumps and side canals. Sugar cane fields were established in the area.

1923: The Governor of the Territory of Hawai‘i designated 142 ac (57 ha) south of the Nohili Dunes as Mānā Park.

1928: An additional 550 ac (222 ha) south of Mānā Park became the site of the Mānā Airport. The airport was seldom used and was later disestablished by the Governor.

1939-1944: The Governor set aside the former Mānā Airport land as the site for the Mānā Airport Military Reservation. Development began in 1940, and an additional 1,509 ac (610 ha) were acquired for base expansion. In 1941, the Governor withdrew control of the Mānā Park land from the County Board of Supervisors. Development of base defensive positions followed. The primary mission of the newly expanded Barking Sands Army Base during World War II was flight training. The base played a supporting role for U.S. Army Air Corps B-17s engaged in the Battle of Midway. Use of Barking Sands diminished with the end of World War II.

1947-1949: The U.S. Air Force (USAF) was established and the base was re-designated as Barking Sands Air Force Base (AFB). Within a year, the USAF declared the base excess and deactivated the facility.

1953: Following the Korean War, Barking Sands was reactivated, renamed Bonham AFB, and was used to stockpile ordnance, missile loaders, and vehicles. Soon thereafter, Bonham AFB was downgraded to an Air Force Station (AFS). The Hawai‘i Air National Guard conducted quarterly flight deployment activities until 1992.

1956: The Navy was given permission by the USAF to use Barking Sands for the Regulus missile program, which continued until 1965. The missiles were stored and maintained at Barking Sands.

1958: Barking Sands became one of four fixed Pacific Missile Range stations in Hawai‘i as part of a network including three bases in California and eight islands in the Pacific. These stations tracked ballistic missiles launched from California and detected the impact of missile reentry.

1961-1962: Sandia Laboratories (an Atomic Energy Commission/DOE contractor) established the KTF. Rocket launching facilities were established at the northern end of Barking Sands in the Nohili Dunes area. These facilities supported atmospheric nuclear testing in the Pacific and later became available for other research, development, and testing activities by other federal and international agencies and laboratories.

1961-1964: The Navy was recognized as the primary user of Barking Sands and requested a transfer of lands from USAF. Three years later the transfer was completed and Bonham AFS became the Navy's Auxiliary Landing Field (ALF) Bonham. During the transition, the Navy transferred 229 ac (92 ha) at the southern end of the base for the Army's Pacific Scatter Station (PASCAT), which operated until 1967. The land was then returned to the Navy.

1966-1976: ALF Bonham was renamed PMRF. The PMRF Hawai‘i and Area Headquarters moved from Kaneohe Bay, O‘ahu, to Barking Sands, Kaua‘i. Development of an enlarged underwater range began in 1976 and became fully operational shortly thereafter.

1993-1994: PMRF supported research and development launching associated with STARS. Today, larger and heavier rockets use Barking Sands' Launch Pad 42.

Previous cultural resource studies have identified historic properties at Barking Sands, including Native Hawaiian sites, plantation-era sites, and World War II era military sites. Most of these sites are located within the coastal dunes, which are considered an area of high archaeological sensitivity both because of the known buried cultural deposits and Native Hawaiian human remains, and because of the potential for encountering additional subsurface resources in the future (DON 2005a).

Plantation-era sites include a Japanese cemetery; Kawai'ele Ditch which is mentioned in both Traditional Hawaiian-era and Plantation-era; burial sites; and a dump site. World War II-era sites include concrete pillboxes; concrete boxes; concrete piers and metal gun turret; wooden structures; revetments; and concrete tanks (DON 2005a).

Architectural studies have also identified two World War II-era buildings (Radio Room and Command Post) and one Cold War-era building (Operations and Crash Station) at Barking Sands that are Management Category I sites under Navy Historic and Archaeological Resources Planning Guidelines. There are two World War II-era buildings (Telephone Exchange and Command Post) and three structures from the Plantation-era (Kawai'ele Ditch, Kinikini Ditch, and Nohili Ditch) that are Management Category II under Navy Historic and Archaeological Resources Planning Guidelines. In addition, there are four Cold War-era structures (Regulus missile assembly & storage, Dehumidified Aircraft Storage Container, Hawai‘i Air National Guard, and Hawai‘i Air National Guard War Readiness Material Equipment Storehouse) that are Management Category II under Navy Historic and Archaeological Resources Planning Guidelines (DON 2005a). All management categories I-III are considered eligible for the National Register for Historic Places (NRHP).

3.1.1.5 Regional Land Uses

Barking Sands (Main Base), Mākaha Ridge Tracking Facility, Kōke'e Sites, and Kamokala Magazines are located on the western side of the island of Kaua'i in the Waimea-Kekaha region (Figure 1-1). Historically, the Waimea-Kekaha region has been known for its sugar plantations, but the sugar industry ceased operations in this region in the 1990's. Currently, lands previously used for sugar cultivation are fallow or used for other agricultural purposes. The future use of these former sugar lands has not yet been determined but is likely to remain in agriculture. Other economic activities are being explored and initiated to replace sugar, including alternative crops and aquaculture. Tourism continues to be the major industry on Kaua'i. Visitors are attracted to the western side of Kaua'i by the scenic beauty and outdoor recreation opportunities offered by Polihale State Park (Figure 3-2) and Kōke'e State Park. Only limited visitor amenities are located in the region. It is likely that any future visitor accommodations on the western side would be small in scale.

Barking Sands is designated within the State Conservation District (shown in Figure 3-2) (SOH Land Use Commission [LUC] 2005) which is the most restrictive of the four SOH land use districts. The SOH controls the lands seaward of the upper wash of the waves or vegetation line. Accordingly, the Navy has no direct management control over the shoreline areas. However, public access to the coastline is limited to PMRF employees, active duty, reserve and retired military and dependents, and individuals holding a valid PMRF Recreation Pass (Appendix G4).

3.2 GENERAL PHYSICAL ENVIRONMENT

The discussion of the general physical environment is divided into five subsections (3.2.1 through 3.2.5): (1) physical geography; (2) topography; (3) geology; (4) soils; and (5) hydrology – including surface water resources and hydrogeology (groundwater resources). General island-wide descriptions of these resources are presented in Section 2.2; the following discussion addresses Barking Sands and its environs.

3.2.1 Physical Geography

A general discussion of the physical geography of the Hawaiian Islands and Kaua'i is presented in Section 2.2.1. Barking Sands is located on the west or leeward side of Kaua'i on a low-lying coastal terrace within the Mānā Plain. The site is approximately 120 nm (222 km) northwest of Pearl Harbor, O'ahu, and occupies a land area of approximately 2,060 ac (834 ha), lying just south of Polihale State Park. The Mānā Plain bounds the western flank of the island, forming gentle westerly slopes near the volcanic upland and relatively flat land at the coastal margin (DON 2001).

3.2.2 Topography

A general discussion of the topography of the Hawaiian Islands and Kaua'i is presented in Section 2.2.2. Barking Sands has a generally flat topography with a nominal elevation of 15 ft (4.6 m) above mean sea level. Low beach barrier dunes, mildly undulating blanket sands, and the more prominent Nohili Dunes located at the northern end of the base form local relief. The Nohili Dunes form the highest elevation point on the base, rising to approximately 100 ft (30 m) above mean sea level (DON 2001).

3.2.3 Geology

A general discussion of the geology of Kaua'i is presented in Section 2.2.4. Barking Sands is located on a low-lying coastal terrace within the Mānā Plain. The Mānā Plain bounds the western flank of the island of Kaua'i, forming gentle westerly slopes near the volcanic upland and relatively flat land at the coastal margin. The Mānā Plain is composed of alluvium, lagoon, beach, and dune deposits that overlie a typical volcanic basement (Macdonald *et al*. 1960).

The Nā Pali Coast, located north of the Barking Sands area, is composed of tholeiitic lava flows of the Napali formation. The abrupt cliffs at the shore of the Nā Pali coast have led geologists to speculate that this dramatic topography was caused by a giant landslide that cut deep into the island, removing and transporting much of it to the north or northwest, leaving the cliffs that we see today (Yale 2007).

3.2.4 Soils

The coastline of Barking Sands is dominated by an expanse of beaches backed by large dunes to the north. Dunes consist of hills and ridges of sand formed by wind-driven and piled sand drifts in a continuing dynamic process. However, local strand vegetation helps to stabilize dune formation and accretion. The entire beach berm is approximately 10 ft (3 m) high and is breached only where drainage channels cut through at Nohili Ditch and Kawai'ele Ditch.

Six soil types underlie Barking Sands (Figures 3-3 and 3-4): (1) Jaucus loamy fine sand, 0 to 80 percent slopes (JfB); (2) Beaches (BS); (3) Dune Land (DL); (4) Kaloko clay (Kfa); (5) Kaloko clay loam (Kf); and (6) Fill land (Fd). The majority of the inland portion of Barking Sands is underlain by JfB while BS comprises the majority of the coastal areas except at the northern end where DL exist (USDA 1972).

The Jaucus series consists of excessively drained, calcareous soils that occur as narrow strips on coastal plains, and adjacent to the ocean. They develop in wind- and water-deposited sand from coral and sea shells. Comprised of a single grain, pale brown to very pale brown sandy loam, JfB is neutral to moderately alkaline throughout the profile. Permeability is rapid, runoff is very slow to slow, the water erosion hazard is slight, and the wind erosion hazard is severe where vegetation has been removed (USDA 1972).

Sandy, gravelly, or cobbly areas washed and rewashed by ocean waves are the areas generally comprised of BS. The beaches consist mainly of light-colored sands derived from coral and sea shells (USDA 1972).

Hills and ridges of sand-sized particles drifted and piled by wind describe DL. The hills and ridges are actively shifting or are so recently fixed or stabilized that no soil horizons have developed (USDA 1972).

The Kaloko series is comprised of poorly drained soils on coast plains that are developed in alluvium from basic igneous rock. The alluvium has been deposited over marly lagoon deposits. In a representative profile the surface layer of Kfa is dark-brown clay about 12 in (30 cm) thick. The subsoil is about 8 in (20 cm) thick and is dark reddish-brown and weak-red clay. Below this is mottled, white to light-gray, platy silty clay about 13 in (33 cm) thick. This is underlain by dark greenish-gray and dark gray massive silty clay. The soil is mildly alkaline to neutral throughout

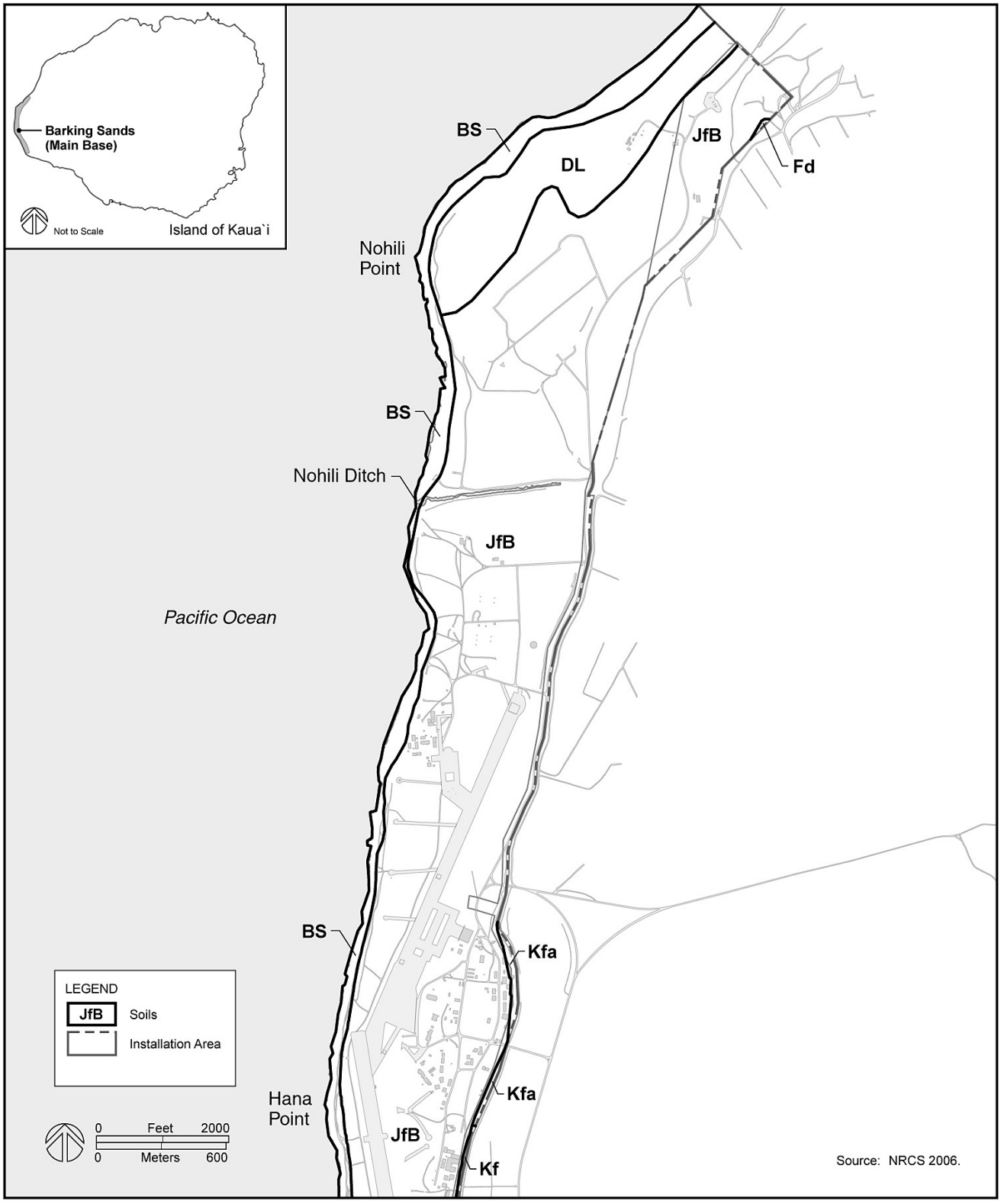


Figure 3-3: Soils, Barking Sands (northern portion), Kaua‘i

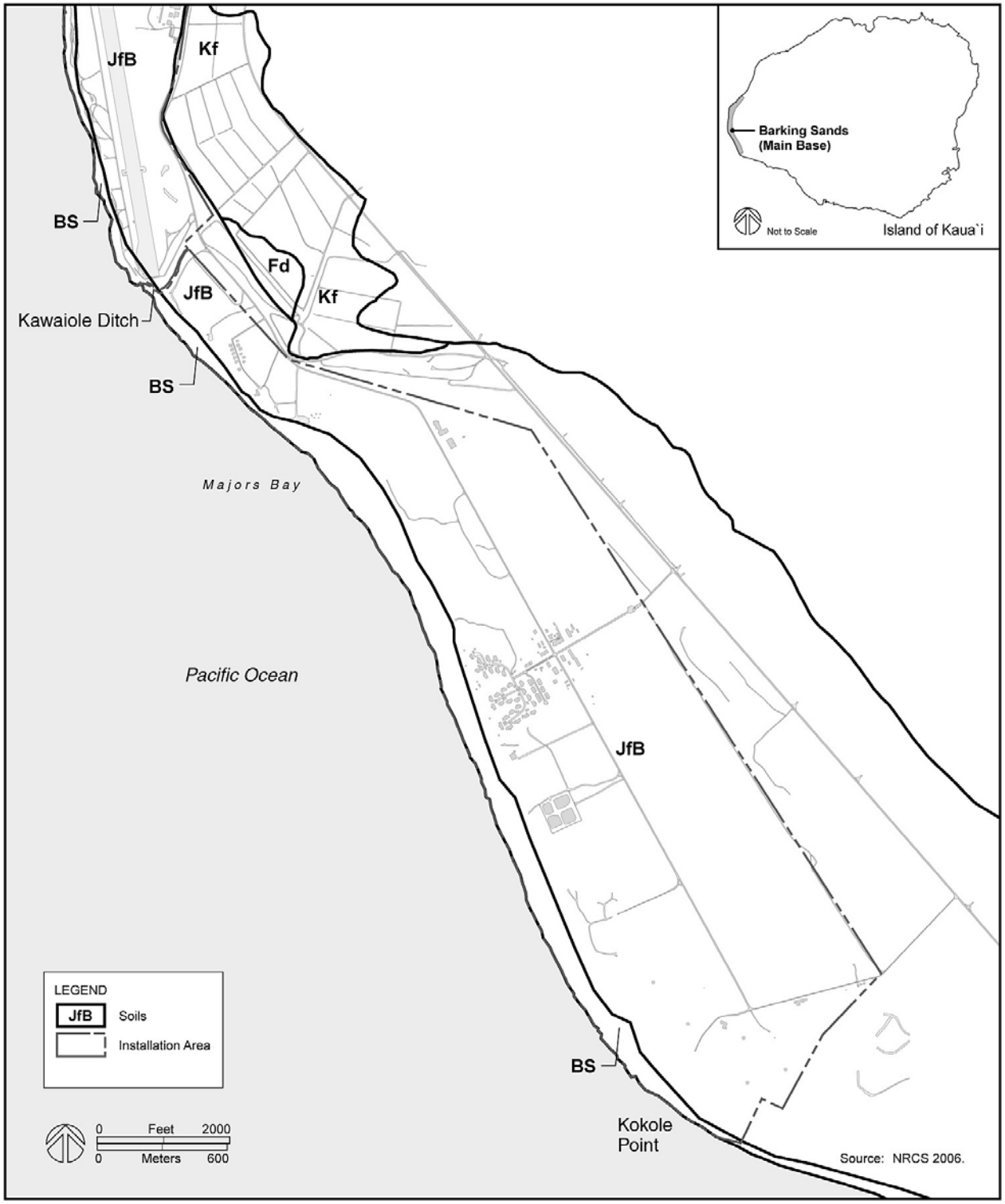


Figure 3-4: Soils, Barking Sands (southern portion), Kaua‘i

the profile. Permeability is moderately slow to slow and runoff is slow to very slow. The erosion hazard is no more than slight. Workability of Kfa is somewhat difficult. Kf is similar to Kfa except for the texture of the surface layer and horizontal lenses of sand in the underlying material. It is easier to work with than Kfa. Runoff is slow and there is no erosion hazard (USDA 1972).

Fd consists of areas filled mostly with bagasse and slurry from sugar mills. A few areas are filled with material from dredging and from soil excavation. Generally, these areas are dumped and spread over marshes, low-lying areas along the coastal flats, coral sand, coral limestone, or areas shallow to bedrock (USDA 1972).

3.2.5 Hydrology

Historically, the Māna Plain on Kaua'i's west side provided nearly 2,000 ac (800 ha) of wetland habitat and once was the largest wetland in the Hawaiian Islands. However, in 1923 the area was drained for sugarcane production, leaving only 200 ac (80 ha) of aquatic habitat comprised mostly of reservoirs and ditches (Hawai'i Wetland Joint Venture 2008). Surface water within Barking Sands is largely concentrated in the drainage ditches that drain the agricultural areas east of the facility. There are two man-made oxidation ponds located in the southern portion of Barking Sands. Surface water in the area of the restricted easement on the Māna Plain is restricted to drains and agricultural irrigation ponds. Within the restrictive easement boundary, the surface water and storm water runoff drain onto former sugarcane lands and agricultural ponds below the Māna cliffs. The Māna Plain is drained by ditches/canals that flow seaward. Typically, the water from these ditches is brackish (DON 2008).

The primary flood hazard at Barking Sands is from overflow of the drainage ditches that drain the Māna Plain. Extended periods of heavy rainfall have resulted in minor flooding of low-lying areas of Barking Sands. In addition, most of Barking Sands is within the tsunami evacuation area (inundation zone) (DON 2008).

3.2.5.1 Hydrogeology

Section 2.2.5 provides a discussion of regional hydrology. On eastern Kaua'i, basal groundwater occurs within 1 or 2 mi (1.6 to 3.2 km) of the coast in Koloa and Napali rocks. In the west, where Barking Sands is located, the flank of the original volcanic dome reaching from Waimea Canyon to the coast is mostly underlain with basal groundwater (Mink and Lau 1992).

The aquifers most susceptible to contamination are those perched in the Koloa lavas as well as those in the Waimea Canyon Series unprotected by a cover of Koloa rocks or sediments. Aquifers in the Waimea Canyon Series lying beneath a cover of Koloa or sediments are less likely to suffer contamination. Sedimentary aquifers are also exposed to contamination, but few significant aquifers of this type occur. The largest extent and thickness of sediments comprises the Māna Plain in western Kaua'i, where Barking Sands is located. The coastal plain is a complicated succession of marine and terrestrial sediments which behave as caprock on underlying Napali rocks. The sediments are saturated with brackish water except at their inland margin (Mink and Lau 1992).

3.2.5.2 Groundwater Classification

Mink and Lau (1992) developed aquifer classification codes which incorporate locational and descriptive indices for the principal aquifers on Kaua'i. Barking Sands is located in the Kekaha

Aquifer System of the Waimea Aquifer Sector which is bounded on the north by Polihale Ridge, on the east by the drainage divide of Waimea Canyon, and on the south and west by the ocean. Kekaha is the driest aquifer system in Kaua'i having an annual rainfall of 33 in (84 cm). Surface drainage is by way of small, non perennial streams that debouch onto the Māna Plain. The Māna Plain was originally a wetland but is now artificially drained to allow agriculture and prevent flooding. The region is part of the southwest flank of the original volcano. Napali lavas terminate as a fossil sea cliff along a 1 mi (1.6 km) wide coastal plain of terrestrial and marine sediments. The Māna Plain is the most extensive and thickest accumulation of sediments in the island. Inland, a few dikes have been mapped (Mink and Lau 1992).

High level dike aquifers may occur in Napali lavas in the interior near the Waimea Canyon divide. Otherwise flank lavas contain basal groundwater. The Napali aquifer beneath the Māna Plain caprock is artesian. This aquifer has been developed as a source of irrigation supply. The sediments are saturated with brackish to salty water. Upward leakage into the sediments from the Napali artesian aquifer is the cause of the original wetlands condition. Potable water is developed from wells near Kekaha and Waimea. The wells are located at the inland edge of the Māna Plain (Mink and Lau 1992).

There are two aquifers underlying Barking Sands: (1) sedimentary and (2) dike-impounded. The sedimentary aquifer (aquifer code 20301116 [22311]) is basal, unconfined and has potential use. It is considered irreplaceable and ecologically important with moderate salinity (250 to 1,000 milligrams per liter [mg/l] chlorides [Cl^-]) and has a high vulnerability to contamination. The dike-impounded aquifer (aquifer code 20301122 [21223]) is basal, confined and has potential use for drinking water. It is mildly saline (250 to 1,000 mg/l Cl^-) and is considered irreplaceable with a low vulnerability to contamination (Mink and Lau 1992).

3.3 GENERAL BIOTIC ENVIRONMENT

Information on biological resources presented in this and subsequent sections are primarily derived from surveys of terrestrial plants, terrestrial animals, and marine ecosystems conducted as part of this INRMP and the 2001 INRMP. The survey reports are listed below and contained in the appendices.

- Appendix A1: PMRF Barking Sands Botanical Survey (NAVFAC PAC 2006a);
- Appendix A6: Botanical Survey of Barking Sands (Char 2000a);
- Appendix B1: Herpetological and Mammal Surveys of Pacific Missile Range Facility (NAVFAC PAC 2006e);
- Appendix B2: PMRF Bird Surveys (NAVFAC PAC 2006f);
- Appendix B3: Survey of Avifauna and Feral Mammals for the INRMP, Barking Sands, Kaua'i, Hawai'i (Bruner 2000);
- Appendix B6: Wedge-Tailed Shearwater Survey Population Summary (Hebshi 2007);
- Appendix C1: Survey of Marine and Fishery Resources for Integrated Natural Resources Management Plan for PMRF, Barking Sands, Kaua'i, Hawai'i (Dollar and Brock 2007); and
- Appendix C2: Survey of Marine and Fishery Resources (Dollar and Brock 2000).

Additional plant and animal information was compiled from the following two primary sources:

- Conservation Mapping (Appendices A10 and B4; NAVFAC PAC 2005);

- INRMP for PMRF (DON 2001).

In addition, to the survey reports listed, input was received from Working Group Members regarding the INRMP, including the discussion of the general biotic environment (Appendices I and J).

The discussion of the general biotic environment is divided into five subsections (3.3.1 through 3.3.5): (1) threatened, endangered and candidate species; (2) wetlands; (3) ecosystem components; (4) fish and wildlife; and (5) vegetation.

3.3.1 Threatened, Endangered and Candidate Species

This section provides a summary of the federally-listed threatened and endangered and federal candidate species at Barking Sands; it is organized in two parts with animal species discussed in Section 3.3.1.1 and plant species in Section 3.3.1.2. Table 3-1 provides a listing of the federally-listed threatened and endangered species and federal candidate species.

Table 3-1: Federally-Listed ESA and Candidate Species at Barking Sands

Latin Binomial	Common Name	Regulatory Status
Anas wyvilliana	Hawaiian Duck (Koloa)	E
Gallinula chloropus sandviciensis	Hawaiian Common Moorhen	E
Fulica alai	Hawaiian Coot	E
Himantopus mexicanus knudseni	Hawaiian Stilt	E
Branta sandvicensis	Hawaiian Goose (Nēnē)	E
Puffinus auricularis newelli	Newell's Shearwater	T
Phoebastria albatrus	Short-Tailed Albatross	E
Pterodroma sandwichensis	Hawaiian Petrel	E
Oceanodroma castro	Band-rumped Storm-Petrel	C
Lasiurus cinereus	Hawaiian Hoary Bat	E
Monachus schauinslandi	Hawaiian monk seal	E
Megaptera novaeangliae	Humpback Whale	E
Pseudorca crassidens	False Killer Whale	C
Chelonia mydas	Green Turtle	T
Eretmochelys imbricata	Hawksbill Turtle	E
Panicum niihauense	lau'ehu	Unoccupied CH

E – endangered; T – threatened; C – candidate; CH – critical habitat

3.3.1.1 Animals

1. Bird Species

There are seven federally-listed endangered bird species that have been observed at Barking Sands: (1) Hawaiian duck or koloa (*Anas wyvilliana*); (2) Hawaiian moorhen or alae ula (*Gallinula*

chloropus sandwichensis); (3) Hawaiian coot or alae keʻokeʻo (*Fulica alai*); (4) Hawaiian stilt or ae o (*Himantopus mexicanus knudseni*); (5) Hawaiian goose or nēnē (*Branta sandvicensis*); (6) Newell's shearwater (*Puffinus auricularis newelli*) or ʻaʻo and (7) short-tailed albatross (*Phoebastria albatrus*) (NAVFAC 2006f). All federally-listed species under ESA are also SOH-listed species.

The Hawaiian petrel (*Pterodroma sandwichensis*) or ʻuaʻu hasn't been seen on Barking Sands, but may also fly over during the breeding season. A federal candidate seabird species, the band-rumped storm-petrel (*Oceanodroma castro*) or ʻakeʻake also travels over Barking Sands during breeding season.

Photo 3-2: Hawaiian duck

Hawaiian Duck: The Hawaiian duck (Photo 3-2) is a federally-listed endangered endemic waterbird that has been observed at the oxidation ponds at Barking Sands (Figure 3-6) (NAVFAC 2006f). This species does not nest at the installation. The Hawaiian duck is generally mottled brown and has a green to blue speculum with white borders. The species is vulnerable due to hybridization with mallards (USFWS 2006). Threats to the species also include: (1) loss of wetlands; (2) introduced predators (dogs [*Canis lupus familiaris*], cats [*Felis catus*], rats [*Rattus spp.*], cattle egrets [*Bulbulcus ibis*], barn owls [*Tyto alba*], and non-native fish); (3) modifications to wetland habitats for flood control or to provide for municipal water sources; (4) invasive species including mangrove (*Rhizophora mangle*), pickleweed (*Batis maritime*); and water hyacinth (*Eichornia crassipes*) which reduce open water, mudflats, and shallows; (5) avian diseases including botulism (*Clostridium botulinum*); and (6) environmental contaminants including oil and fuel spills. Population estimates indicate that there are an estimated 2,200 Hawaiian ducks (non-mallard hybrids) with 2,000 on Kaua'i and 200 on the Island of Hawaiʻi (USFWS 2005).

Hawaiian moorhen: The Hawaiian moorhen (Photo 3-3) is a federally-listed endangered endemic black waterbird. Moorhen have been observed along the ditches at Barking Sands (Figures 3-5 and 3-6); however, they do not nest on the installation. The species uses a variety of freshwater habitats. It is an opportunistic feeder and the diet varies with habitat but may include algae, grass seeds, plant material, insects, and snails. Hawaiian moorhens are very secretive and are thus hard to monitor. Threats to the species include loss of coastal plain wetlands, introduced predators (dogs cats, rats, pig [*Sus scrofa*], cattle egrets, barn owls, and bullfrogs [*Rana catesbeiana*]); modifications to wetland habitats for flood control or to provide for municipal water sources; invasive species (e.g. mangrove, pickleweed, water hyacinth) which reduce open water, mudflats, and shallows; avian diseases including botulism; and environmental contaminants including oil and fuel spills (DOFAW 2005). Population estimates indicate there are up to 300 Hawaiian moorhen in existence (USFWS 2005).

Photo 3-3: Hawaiian moorhen

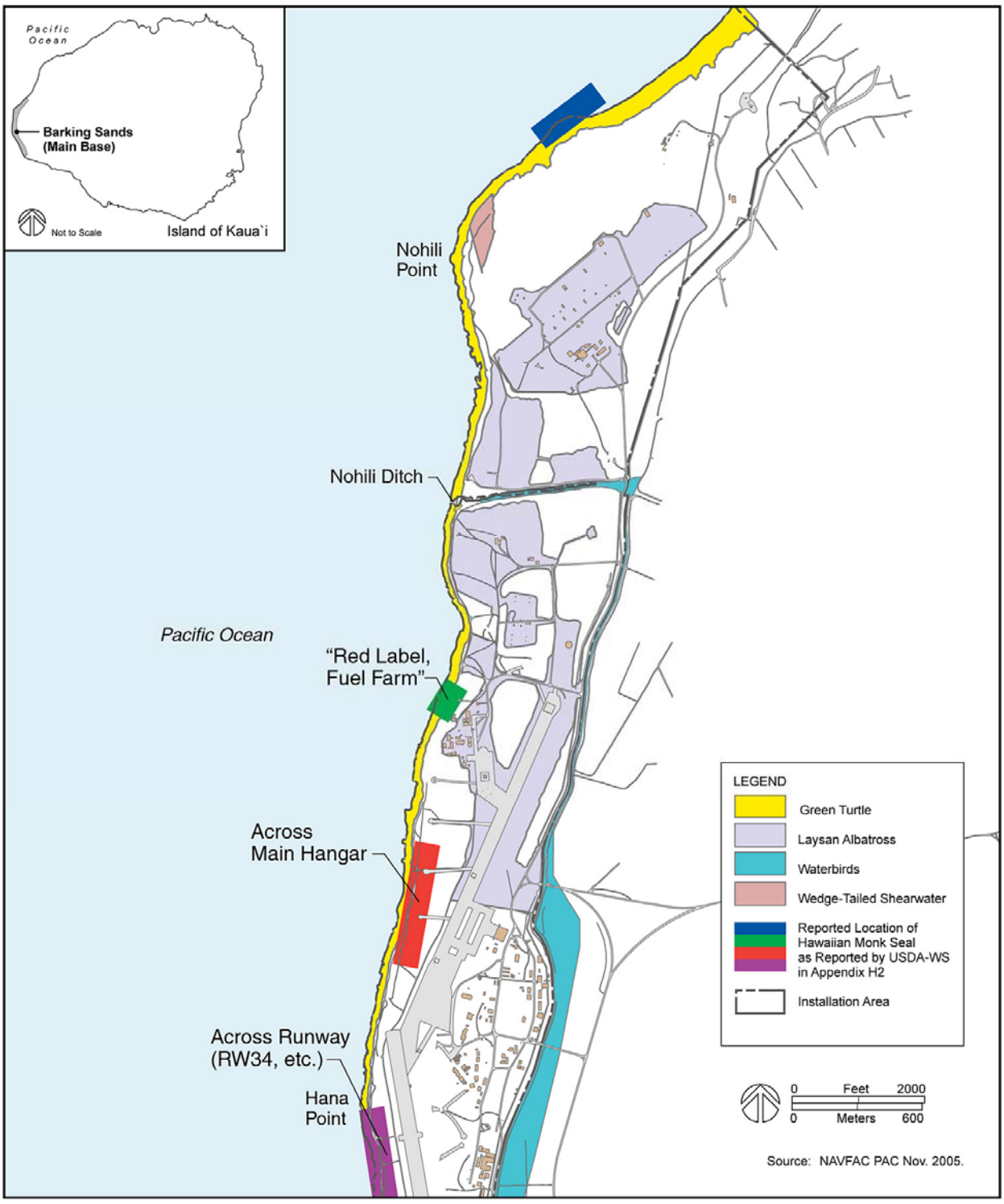


Figure 3-5: Protected Animal Species Habitat, Barking Sands (northern portion), Kaua'i

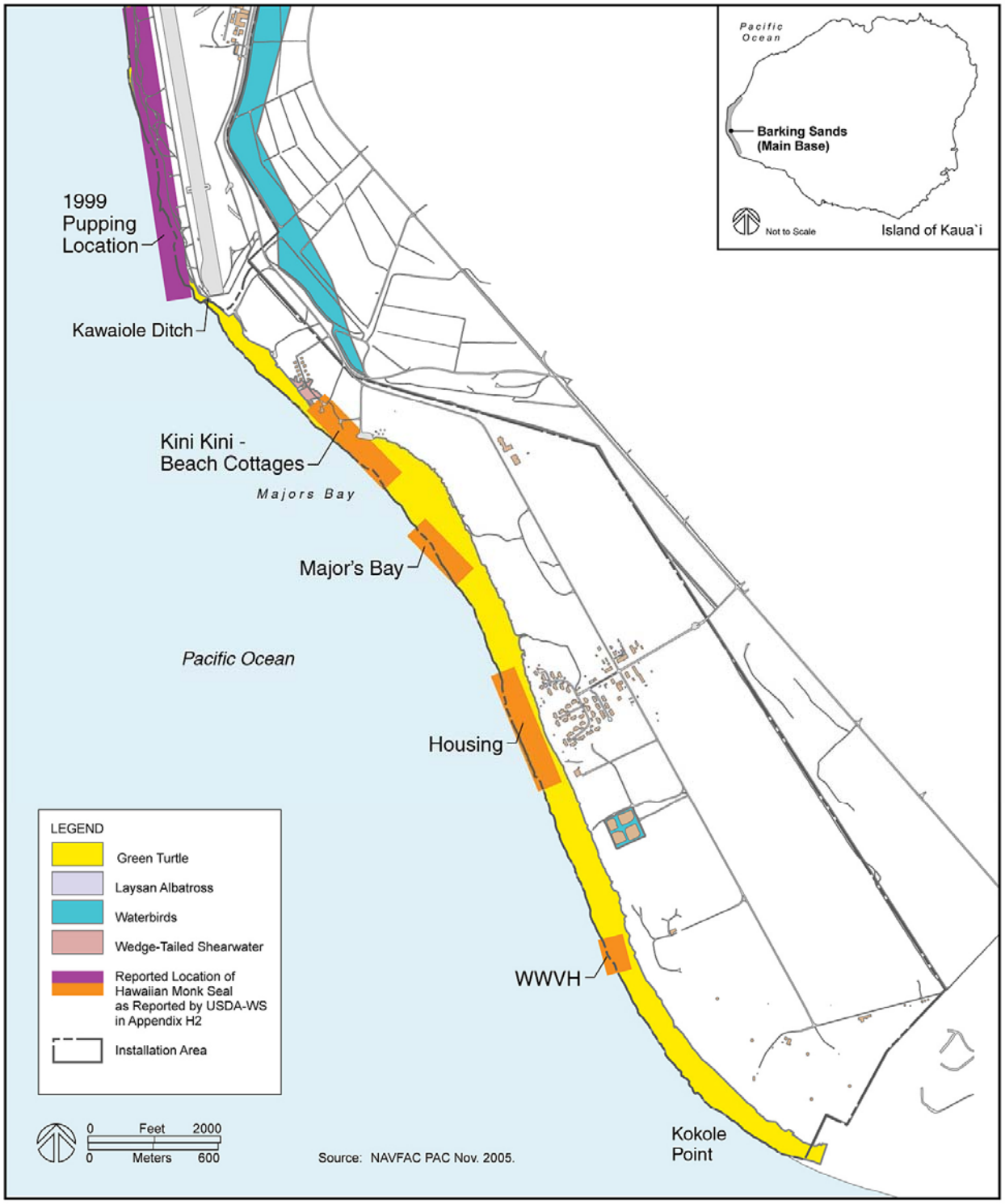


Figure 3-6: Protected Animal Species Habitat, Barking Sands (southern portion), Kaua'i

Hawaiian coot: The Hawaiian coot (Photo 3-4) is a federally-listed endangered endemic waterbird. Coots have been seen in the ditches at Barking Sands (Figures 3-5 and 3-6, NAVFAC 2006f); however, they do not nest on the installation. The species is somewhat gregarious and uses freshwater and brackish wetlands, including agricultural (e.g., taro fields) wetlands and aquaculture ponds. Coots are generalists and feed on land, from the surface of the water or under water; they will also graze on grass adjacent to wetlands. Food items include seeds and leaves, snails, crustaceans, insects, tadpoles, and small fish. Similar to other Hawaiian native waterbird species, the Hawaiian coot is threatened by habitat loss, introduced predators, altered hydrology, non-native invasive plants, and avian diseases (DOFAW 2005). Current total population size of Hawaiian coots is estimated at 2,100 birds (USFWS 2005).

Photo 3-4: Hawaiian coot

Photo 3-5: Hawaiian stilt

Hawaiian stilt: The Hawaiian stilt (Photo 3-5) is a federally-listed endangered endemic waterbird. Stilts have been observed in the ditches (Figures 3-5 and 3-6) and occasionally the beach at Barking Sands (NAVFAC 2006f); however, they do not nest on the installation. They are black above and white below and have long, pink legs. Threats to Hawaiian stilts include introduced predators (dogs, cats, rats, bullfrogs, barn owls) and loss of wetland habitats. Long-term census data suggests that the populations statewide are stable or slightly increasing (NAVFAC 2006f). On Kaua‘i, the stilt population has fluctuated between 125 to 350 individuals over recent years (USFWS 2005).

Hawaiian goose. The federally-listed endangered Hawaiian goose or nēnē (Photo 3-6) is the only native resident goose in Hawai‘i. This species has been observed at Barking Sands near the runway, beach cottages and HIANG complex. On Kaua‘i, Hawaiian geese typically breed and live in areas of managed grass below 984 ft (300 m) elevation; however, some nēnē that were released along the Nā Pali coast have moved to upland areas of managed grass. Hawaiian geese eat leaves of grass and other plants, berries, seeds, and flowers. Their primary predators on Kaua‘i are short-eared owls (*Asio flammeus* or pueo), barn owls, rats, pigs and dogs. Hawaiian goose egg-laying occurs from November to January with an average incubation period of 30 days. The young stay with the parents for about one year (NAVFAC 2006f). The estimated population of Hawaiian geese is between 1,300 and 1,500, with approximately 720 individuals on Kaua‘i (DOFAW 2005).

Photo 3-6: Hawaiian goose

Newell's Shearwater: The federally-listed threatened Newell's shearwater (Photo 3-7) is a pelagic seabird that is endemic to the Hawaiian Islands. Newell's shearwaters nest only at high elevation on Kaua'i and so do not breed on Barking Sands; however, the species does fly over the base when traveling between nesting sites and at-sea foraging areas. Adult males and females are sooty brown above, with white throat and underparts, and have dark bill with a hooked tip. Flight is direct, fast, and usually low over water, powered by rapid wing beats interspersed with glides. This species often forages in large, mixed species flocks associated with schools of large predatory fishes which drive prey species to the surface. They feed mainly by pursuit-plunging; individuals dive into water and swim using their partly folded wings for propulsion. Their diet is not well known, but likely consists of fish and squid (DOFAW 2005).


Photo: Brenda Zaun, USFWS

Photo 3-7: Newell's Shearwater

Newell's shearwaters are colonial and nest on steep mountain slopes with variable amounts of vegetation, where they lay a single egg in burrows, which are often placed at the base of a tree. Breeding is highly synchronous with eggs laid in early June, and most young fledging by November. Both parents incubate the egg and brood and feed the nestling. Parents forage hundreds of kilometers offshore and return to the colony at night to feed the chick (DOFAW 2005).

Newell's shearwaters breed on Kaua'i, the island of Hawai'i, Moloka'i, and Lehua, and also may breed on O'ahu, Maui, and Lāna'i (but not confirmed). Non-breeding season distribution includes the eastern tropical Pacific. Due to the remoteness and terrain of nesting colonies, population estimates are difficult. However, in the early 1990s, a population estimate based on sea densities was 84,000 individuals. Estimates based on demographic data suggest a population of 14,600 breeding pairs, 75 percent of which nest on Kaua'i. Since these estimates were made, demographic modeling and recovery of injured or dead fledglings indicates that the population on Kaua'i is in decline (DOFAW 2005).

Threats to the species include historic hunting by humans, introduced predators (e.g., dogs, pigs, rats, barn owls, cats, etc.), habitat loss, artificial lighting, overfishing, disease (pox lesions), and natural catastrophes (e.g., Hurricane Iniki). Artificial lighting such as street and resort lighting, especially in coastal areas, disorients fledglings, causing them to eventually fall to the ground exhausted or increase their chance of colliding with an artificial structure (i.e., fallout). On Kaua'i approximately 1,500 fledglings are recovered annually from fallouts.


Photo: Forest and Kim Starr, USFWS

Photo 3-8: Short-tailed albatross

Short-tailed albatross. There has been only one sighting of a short-tailed albatross at Barking Sands, and that occurred on 28 March 2000 when a juvenile short-tailed albatross was observed at the installation. The short-tailed albatross (Photo 3-8) is a federally-listed endangered seabird. This species is mostly white with varying amounts of black, mostly on the upper side of the wings, and a golden wash on the head. It has a huge pink bill that has a bluish tip, and legs and feet are pale pink. Threats include bycatch in commercial fisheries, marine pollution, plastics, and oil spills. This bird species is the largest seabird recorded in Hawai'i. The majority of sightings in Hawai'i have been recorded on Midway Atoll (DOFAW 2005). The worldwide population is estimated at 1,700 individuals (DOFAW 2005).

Band-rumped storm-petrel. As with Newell's shearwaters, band-rumped storm-petrels nest at high elevations on Kaua'i and fly over Barking Sands during trips between nesting and foraging sites. The band-rumped storm-petrel (Figure 3-9) occurs throughout the Pacific and Atlantic oceans, breeding in Japan, the Galapagos Islands, Hawai'i, and eastern Atlantic islands off of the coasts of Europe and Africa. While not considered to be threatened across its global range, the band-rumped storm-petrel has been listed as a candidate for endangered species status under the ESA (Slotterback 2002).

Photo: 3-9: Band-rumped storm-petrel

In the Hawaiian Archipelago, band-rumped storm-petrels are known to nest on Kaua'i and are thought to nest on the islands of Hawai'i and Maui. The known breeding colony on Kaua'i is restricted to steep cliffs dominated by native plant species. Although population size has not been well-quantified for this species in Hawai'i, it is thought that more than 100 breeding pairs occur on Kaua'i (Slotterback 2002). Nesting is thought to begin in April in Hawai'i, with juveniles fledging from the nests in October (Slotterback 2002).

Historically, the greatest threat to band-rumped storm-petrel populations in Hawai'i was consumption by humans: middens found on the islands of Kaua'i and Hawai'i have contained band-rumped storm-petrel bones, as well as the bones of other seabirds. Currently, ingested contaminants and plastics, degradation of nesting and foraging habitats, and collisions with structures are considered to be the greatest threats to band-rumped storm-petrel populations (Slotterback 2002).

Photo 3-10: Hawaiian petrel

Hawaiian Petrel: The federally-listed endangered Hawaiian petrel (Photo 3-10) is a large, nocturnal gadfly petrel endemic to Hawai‘i. Hawaiian petrels have not been observed at Barking Sands, but like the Newell's shearwaters may fly over the base when traveling between nesting and foraging areas. Adult males and females are uniformly dark grayish black above forming a collar which contrasts with a white throat, forehead, and cheeks. The birds are entirely white below, except for black tail and leading and trailing edges of the underwings. The bill is black and legs and feet are mostly pink (DOFAW 2005).

Even during the breeding season, Hawaiian petrels often feed thousands of kilometers from colonies, usually foraging with mix-species feeding flocks, typically over schools of predatory fishes. They feed by seizing prey while sitting on the water or by dipping prey while flapping just above the ocean surface, often pattering water with feet. In Hawai‘i, Hawaiian petrels feed primarily on squid, but also on fish, especially goatfish and lantern fish, and crustaceans (DOFAW 2005).

Hawaiian petrels nest in colonies, form long-term pair bonds, and return to the same nest site year after year. Nests are in burrows, crevices or cracks in lava tubes. Most eggs are laid in May and June and most juveniles fledge by December. Both parents incubate a single egg and brood and feed the chick (DOFAW 2005).

Hawaiian petrels breed on Maui, Hawai‘i, and Kaua‘i and possibly on Moloka‘i, Lāna‘i, the sea stacks off of Kaho‘olawe and Lehua off of Ni‘ihau. The total number of individuals is estimated at 20,000 with a breeding population of 4,500 to 5,000 pairs (DOFAW 2005). Colonies are located at 7,500 ft (2,500 m) on Hawai‘i and Maui in xeric habitats with very sparse vegetation, but with suitable substrates for burrowing or with existing crevices in lava. On Kaua‘i, habitat includes wet forests dominated by ‘ōhi‘a (*Metrosideros polymorpha*) with a dense understory of uluhe fern (*Dicranopteris lenearis*). Threats include historic human hunting, introduced predators (dogs, pigs, rats, and cats), feral ungulates (trample burrows), and artificial lighting (DOFAW 2005).

2. Mammal Species

There is one ESA-listed terrestrial mammal species, the Hawaiian hoary bat or *‘*ope ‘ape ‘a *(Lasiurus cinereus semotus*), and two ESA-listed and SOH-listed marine mammal species at Barking Sands: (1) the endangered Hawaiian monk seal or *ilio*-holo-i-ka-uaua *(Monachus schauinslandi*); and (2) the endangered humpback whale or *koholā* (*Megaptera novaeangliae*). In addition, the false killer whale (*Pseudorca crassidens*) has been sighted off of the west coast of Kaua‘i near Barking Sands.

Photo 3-11: Hawaiian hoary bat

Hawaiian hoary bat: The federally-listed endangered and endemic Hawaiian hoary bat (Photo 3-11) has been recorded at Barking Sands. In the past, a group of four bats was observed foraging around the sewage treatment ponds, and another separate group of five bats was tallied just offshore of Recreation Area #1 (Bruner 2000). The Hawaiian hoary bat is Hawai'i's only native terrestrial mammal. Males and females have a wingspan of approximately 1 ft (0.3 m) and have a coat of brown and gray fur. They roost in native and non-native vegetation from 3-29 ft (1 – 9 m) above ground level. They begin foraging either just before or after sunset and feed on a variety of native and non-native night-flying insects including moths, beetles, crickets, mosquitoes, and termites. Coastlines and forest/pasture boundaries appear to be important foraging areas. Mating most likely occurs between September and December, and females give birth to twins between June and August. Mother bats likely stay with their pups until they are six to seven weeks old. Habitat loss, pesticides, predation, and roost disturbance affect bats. A reduction in tree cover (e.g. roost sites) might be the primary reason for the species' decline in Hawai'i (DOFAW 2005).

Photo 3-12: Hawaiian monk seal

Hawaiian monk seal: The federally-listed, endangered Hawaiian monk seal (*Monachus schauinslandi*) is a pinniped, of the family Phocidae. Adult monk seals measure about 7 to 8 ft (2.1 to 2.4 m) in length and weigh about 400 to 600 pounds (180 to 270 kilograms) with females often being larger than males (University of Hawai'i at Manoa 2009). Hawaiian monk seals can live up to 25 to 30 years (Marine Conservation Biology Institute 2009). Mature Hawaiian monk seals are a silver or slate gray on their dorsal side and have a cream coloring on their stomach, chest and throat. Between molts, their coat may fade to brown on their backs and to a yellow-ish tan on their fronts (Photo 3-12). Older seals may become a darker color as they age. All Hawaiian monk seals, except pups, undergo an annual catastrophic molt, shedding their coat and the outer layers of skin. Newborn pups of both sexes are black and weigh approximately 31 to 37.5 pounds (14-17 kilograms) (Kenyon and Rice 1959; Wirtz 1968). Some pups and adults have small white patches of pelage (NOAA Fisheries 2007). Pups shed their black coat at approximately six weeks. Following this first molt, the pups are silvery above with a creamy color below (NOAA Fisheries 2009c).

Status. Current population estimates of Hawaiian monk seals indicate approximately 1,200 seals remaining. This species is listed as endangered under the ESA and as a depleted and strategic stock under the Marine Mammal Protection Act of 1972 (MMPA) (Ragen and Lavigne 1999; Caretta *et al*. 2005). The Hawaiian monk seal is the only endangered marine mammal

whose entire range lies within the U.S. (however, the species has been sighted outside the U.S. Exclusive Economic Zone) (NOAA Fisheries 2007). Monk seals, including the Mediterranean monk seal (*Monachus monachus*), the Caribbean monk seal (*Monachus tropicalis*), and the Hawaiian monk seal, are the most primitive of living phocid species, having anatomical features that resemble those of monk seal fossils from 14 to 16 million years ago.

Monk seals may have arrived in the Hawaiian Islands about 14 to 15 million years ago before the current MHI were formed, and eventually spread to the MHI over the past 6 million years (NOAA Fisheries 2009a). During the 19th and early 20th centuries, Hawaiian monk seal numbers were greatly diminished by seal hunters, sailors, and guano hunters. Activity and use of islands within the Northwest Hawaiian Islands (NWHI) varied during the early part of the 20th century. Examples include airport construction and use at Midway Atoll beginning in the 1930s, a pearl oyster fishery at Pearl Hermes Reef (PHR) from 1926-1930, and Navy training exercises at French Frigate Shoals (FFS) during the 1930s. This variability would have had a varying toll on the subpopulations of Hawaiian monk seals at these islands (NOAA 2009c). Consistent declines in monk seal population trends have been recorded since range-wide surveys began in the 1950s. Between the late 1950s and 1980s, counts at the atolls, islands, and reefs in NWHI suggested a 50 percent decline in this population. In 1987, the total population for the five major breeding locations plus Necker Island was estimated 1,718. In 1992 the estimate was 1,580 and 1,406 in 1993. In 2006, the Hawaiian monk seal population was estimated to be 1,200 animals (NOAA Fisheries 2009a) with only about 77 of them located in MHI in 2005 (NOAA Fisheries 2007).

In 1976, the U.S. government listed the Hawaiian monk seal as endangered under the ESA. In the same year, the MMPA designated the species as “depleted” (NOAA Fisheries 2007). Critical habitat for the Hawaiian monk sea was first designated in 1986 at all beach areas, lagoon waters, and ocean waters out to a depth of 10 fathoms (60 ft or 18 m) around Kure Atoll, Midways Islands (except Sand Island), PHR, Lisianski Island, Laysan Island, Gardner Pinnacles, FFS, Necker Island, and Nihoa Island (April 30, 1986, 51 FR 16047). However, concerns raised by the Marine Mammal Commission, Hawaiian Monk Seal Recovery Team, and non-governmental organizations prompted NOAA Fisheries to reopen the comment period on the critical habitat Environmental Impact Statement, and in 1988 critical habitat was extended to include Maro Reef and waters around the previously identified areas out to the 20 fathom isobath (120 ft, 37 m) (53 FR 18988, May, 26, 1988; 50 CFR 226.201) (NOAA Fisheries 2007). NOAA Fisheries was petitioned to revise the habitat in July of 2008. Ninety days later, in accordance with the process, NOAA Fisheries found that the petition may be warranted. Upon review of the best available information regarding Hawaiian monk seal biology and habitat use, NOAA Fisheries announced its intention to revise critical habitat in June of 2009. The petition was predicated on the importance of terrestrial and marine habitat for monk seals around the entire Hawaiian Archipelago. The petitioners cited studies indicating that while a significant portion of the species’ population is found throughout the NWHI (NOAA Fisheries 2007), it is likely that Hawaiian monk seals are recolonizing the MHI (Baker 2006) since the seals have been sighted on each of the eight MHI and their presence is increasing (NOAA Fisheries 2007). While NOAA Fisheries has not officially identified habitat that may be included in the revision, the petition seeks to include key beach areas, sand spits, and islets, including all beach crest vegetations to its deepest extent inland, lagoon waters, inner reef waters, and ocean waters out to a depth of 100 fathoms or 600 ft (183 m) around the MHI and to extend critical habitat designation in the NWHI out to a depth of 1,640 ft (500 m).

Range and Habitat. There is a tendency for Hawaiian monk seals to frequent remote areas where human presence or access is limited. Most Hawaiian monk seals live in the NWHI including the six main reproductive sites: Kure Atoll, Midway Islands, PHR, Lisianski Island, Laysan Island, and FFS. Smaller breeding subpopulations are also supported within the NWHI on Necker Island and Nihoa Island (NOAA Fisheries 2007). Hawaiian monk seals travel to Maro Reef and Gardner Pinnacles and have occasionally been sighted on nearby island groups such as Johnston Atoll, Wake Island, and Palmyra Atoll (Rice 1998). Within the past 15 years, sightings of Hawaiian monk seals on the MHI have increased considerably (Baker and Johanos 2004; Carretta *et al*. 2005; NOAA Fisheries 2009). Seals have been reported on each of the MHI with at least 45 seals in 2000, 52 in 2001, 77 in 2005, and 83 in 2006. These numbers are considered to be well below true abundance since they are based on non-systematic sightings of tagged and naturally marked seals. It is possible that Hawaiian monk seals may be re-colonizing the MHI, which was likely part of their historic range (NOAA Fisheries 2007). At Barking Sands, Hawaiian monk seals are frequently sighted both in nearshore waters and hauled out on beaches. Figure 3-7 shows the observed monk seal locations at Barking Sands from observations made by USDA-WS personnel on their daily rounds since May 2006. The majority of observations of Hawaiian monk seals are north of Kinikini Ditch.

Haul-out areas for pupping, nursing, and resting are primarily sandy beaches, but virtually all substrates, including emergent reef and shipwrecks, are used at various islands. At Barking Sands, Hawaiian monk seals haulout primarily on sandy beach (vs. emergent reef). The coastline at Barking Sands is a mixture of exposed coralline algal reef, weathered limestone and sandstone (emergent coralline algal reef), and medium to coarse sand. There is considerable variability in the surface textures and elevations along the surf zone, creating pockets of sandy beach and sandy benches, along with long stretches of sandy beach. The latter is particularly apparent from Kinikini Ditch south to Kokole Point. North of Kinikini, there are areas of smooth bench (emergent reef) and other stretches, just above the pounding surf zones, where weathering of the limestone creates pock-marks with sharp points and edges. Hawaiian monk seals are most often observed in areas on the base where sandy beach, smooth bench or sandy pocket(s) are found (Figure 3-7).

Monk seals spend about two-thirds of their time in the water. They are primarily benthic foragers and will search for food in coral reef habitat and on substrate composed of talus and sand on marine terraces of atolls and banks to depths exceeding 1,604 ft (500 m). They have been observed feeding in reef caves that are also used for rest and for refuge from predators. Seals have also been observed breathing from air bubbles trapped on cave ceilings suggesting that this may be a means of extending a seal's underwater time (NOAA Fisheries 2007).

Feeding. Monk seals feed on a wide variety of fishes, cephalopods, and crustaceans. They are considered foraging generalist that prey on benthic and demersal prey. Research suggests that the majority of their diet (~79%) is fish, followed by cephlapods (~16%) and crustaceans (~6%). Fish families reportedly common in their diet include Labridae, Holocentridae, Balistidae, and Scaridae. Cephalapod prey includes seven species of octopus and 19 species of squid. Recent information indicates that monk seals forage in beds of precious coral below 984 ft (300 m) in the subphotic zone (NOAA Fisheries 2007).

Reproduction. Females give birth for the first time between the ages of five and nine years of age. There is a decline in fecundity past an age of 10 to 15 years. Age of sexual maturity for males is unknown but is suggested to be approximately the same as females. Because mating

occurs at sea and is seldom observed, little is known about reproductive success (NOAA Fisheries 2007).

Pregnant females select a site, usually the same each year, for parturition, and give birth to a single offspring. Pups usually nurse for 5-6 weeks and weigh about 110 to 220 pounds (50-100 kilograms) at weaning. Female monks seals usually fast and remain with their pups throughout the nursing period. Nursing monk seal mothers are generally intolerant of other adult seals, including other mothers with pups. However, they do not appear to distinguish consistently their own pups from others' pups and occasional switching of pups occurs on beaches with multiple mother and pup pairs. Switching or fostering of pups appears to have minimal effects on first year survival in cases where the pups are of comparable size (NOAA Fisheries 2009a).

Weaning occurs when the mother abandons her pup and returns to the sea to resume feeding. Over the next few months, she will regain a considerable amount of the mass lost during lactation. About three to four weeks after weaning her pup, she will mate and five to six weeks later, she will haul out again for 10-14 days or more to molt. On average, females that do not give birth in a given year will molt a month earlier (NOAA Fisheries 2007).

For the pup, weaning marks an abrupt and critical transition to independence. During the months following weaning, the pup must learn to live and forage independently. In the process, the pup will lose a considerable amount of the mass gained during nursing. Until they begin to forage, two to four months after weaning, pups lose 0.33% of their weaning body mass per day (NOAA Fisheries 2007).

Annual Hawaiian monk seal births have increased since the mid-1990s with documented births on most of the major islands. Monk seal births have been documented in all months of the year but are most common between February and August, peaking in March and April (NOAA Fisheries 2007). In general, sandy beaches with shallow protected water near shore seem to be preferred habitat for pupping and nursing (NOAA 2007). The last pupping event on PMRF/Barking Sands beach took place in 1999, on a sandy beach between coral/limestone outcroppings. The location was "beach side", across from the 2,000 ft. marker from the Kinikini ditch end of the active runway (Figure 3-7).

Threats. The diminishing population of Hawaiian monk seals makes the species severely vulnerable to natural and anthropogenic factors that may affect their continued existence and recovery. The threats impacting Hawaiian monk seals have been assessed by the Hawaiian Monk Seal Recovery Team based on severity and magnitude, as well as the scope and geographic range. Table 3-1 provides a summary of these threats.

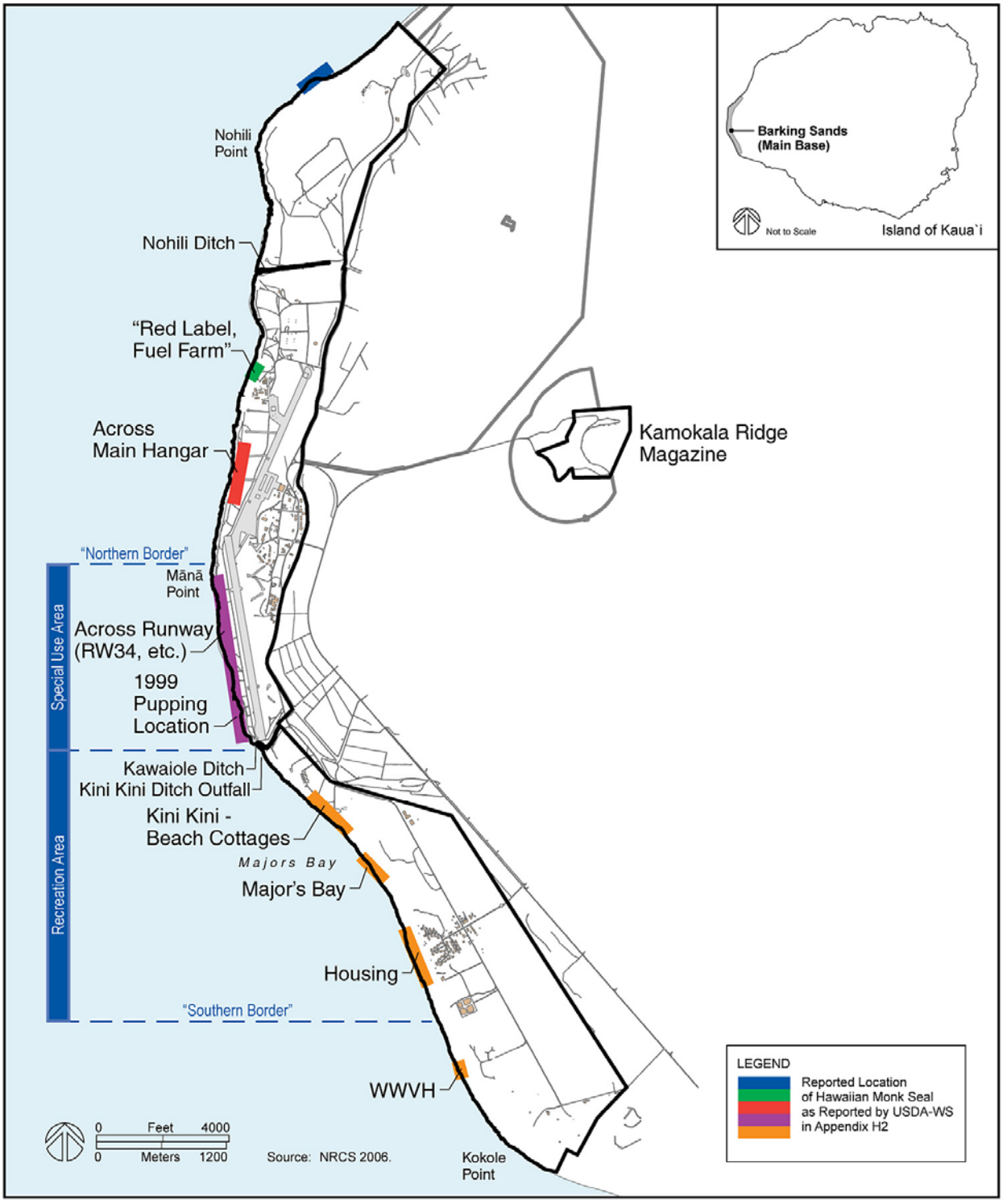


Figure 3-7: Locations Where Hawaiian Monk Seals Have Hauled Out at Barking Sands (May 2006 to July 2009)

Table 3-2: Summary of Threats to Hawaiian Monk Seals

Threat Type	Description
Crucial: ongoing sources of mortality that are apparent at most sites in NWHI	
Food limitation	Food limitation regulates the population growth in NWHI and is evidenced by the decline in juvenile survival rate and significantly smaller pup and juvenile sizes. In contrast, pups in the MHI tend to wean much larger than in NWHI.
Marine debris entanglement	Hawaiian monk seals have one of the highest documented entanglements rates of any pinniped species, and marine debris and fishing gear are chronic forms of pollution affecting the NWHI. Despite dwindling numbers of Hawaiian monk seals, the number of monk seals found entangled has not changed and the accumulation rate of marine debris at NWHI has remained unchanged.
Shark predation	There has been a significant increase in shark predation on monk seal pups born at FFS, where shark related injury and mortality of pre-weaned pups have been conspicuously higher than other sites. Field observations indicate that shark predation may also be compromising recovery of Hawaiian monk seals at Midway and Kure Atoll.
Serious: ongoing impacts with potential for range-wide concern	
Disease	Mortality events in the NWHI have led to concern about the presence of diseases in monk seal populations. There is heightened concern about monk seal exposure to diseases that they have not previously encountered, such as leptospirosis, toxoplasmosis, and West Nile virus. The lack of antibodies in monk seals to these diseases makes them extremely vulnerable to potential infection. The frequency of the outbreaks is rare but the potential for devastating effects is of great concern should the diseases spread throughout the population.
Loss of terrestrial habitat	A significant issue of concern for Hawaiian monk seals in NWHI is the loss of terrestrial habitat as a result of environmental factors such as storms and sea level rise. Sea level rise over the longer term may threaten a large portion of the resting and pupping habitat at NWHI.
Fishery interaction	Species management actions by NOAA Fisheries have limited direct and indirect fisher interactions with Hawaiian monk seals in the NWHI; however, Hawaiian monk seals in the MHI have required interventions due to embedded hooks from recreational fishing and recent mortalities in gillnets.
Male aggression	The primary identified cause of adult and immature female mortality affecting the recovery potential in monk seal population in the 1980s and early 1990s, was injury and often death caused by multiple (Hawaiian monk seal) male aggression. Attacks by single adult males have also resulted in several monk seal mortalities at most or all locations. These behaviors range from normal pinniped male harassment of younger animals to an aberrant level of focused aggression, especially directed toward weaned pups

Table 3-2: Summary of Threats to Hawaiian Monk Seals (Continued)

Threat Type	Description
Human interaction	Hawaiian monk seals in the NWHI avoid beaches for breeding where people have often disturbed them, but sightings of monk seals in the MHI have increased, resulting in increased human interactions by beachgoers. These interactions increase the concern about harassment of seals. Recent successful monk seal pupping events on popular MHI beaches have occurred, despite the major management challenges to staff, volunteers, resources, public outreach, and collaboration. Disturbance of seals on MHI beaches may limit seals' ability to make use of habitats. If the MHI population grows, both in absolute number and proportion of total abundance, disturbance will become a larger management challenge.
Moderate: possible localized impacts but are not considered serious or immediate cause of concern.	
Biotoxins	In 1978, a significant number of Hawaiian monk seals died on Laysan Island, and high levels of ciguatoxin and maitoxin were detected in the livers of two seals. Remote sensing of monk seal habitat has indicted that the potential impact of dangerous algal blooms which could contain harmful species.
Vessel groundings	Hawaiian monk seals may potentially be injured or killed by vessel grounding that result in the release of hazardous materials, including oil or fuel spills, rotting bait, lost gear that creates entanglement hazards, and human disturbance resulting from a grounding incident. These events are typically episodic and affect a limited area when they occur. To date, no seal mortalities have been attributed to vessel groundings.
Contaminants	Hawaiian monk seals are exposed to organochlorines with concentrations of polychlorinated biphenyls found in biological samples. In the NWHI, contaminants originating from human occupation have been identified in Hawaiian monk seal habitat. The effects of these compounds on monk seal health, reproduction, and survival are unknown.

Source: NOAA Fisheries 2007

Photo 3-13: Humpback whale

Humpback Whales: During the winter breeding season from December through April, the federally-listed endangered humpback whale (Photo 3-13) is present in coastal waters, primarily within water depths of 985 ft (300 m) of the MHI, including areas off of Barking Sands, but not within the Navy's jurisdiction. Part of the Hawaiian Islands Humpback Whale National Marine Sanctuary is located along Kaua'i's north shore. According to Kaua'i DAR staff, whales and calves are also spotted in the channel between Kaua'i and Ni'ihau (Dollar and Brock 2007).

Anecdotal accounts from PMRF employees and visitors indicate that humpback whales are sighted off the coast of Barking Sands frequently.

Photo 3-14: False killer whale

False Killer Whales: Two stocks of false killer whale (Photo 3-14) are found within the Hawaiian Exclusive Economic Zone the Hawai‘i pelagic, and the Hawai‘i insular stocks. The Hawai‘i insular stock has been demonstrated to be genetically distinct from the pelagic and other worldwide stocks and is considered by NOAA Fisheries to have candidate ESA status, (Chivers *et al*. 2010). The year-round range includes the islands of O'ahu, Maui, and Hawai'i. False killer whales have been sighted offshore Kaua'i and Ni'ihau, but the stock identity of these animals is unknown.

3. Reptile Species

There are five species of marine turtles that are protected under the ESA. Two of them are known to occur in waters off Kaua‘i. The other three species may pass through the area, but are not considered residents in Hawai‘i. The threatened green turtle, or honu (*Chelonia mydas*), is common in the Hawaiian Islands and is known to forage, bask and nest at Barking Sands. The endangered hawksbill turtle, or honu’ea (*Eretmochelys imbricata*), is considered rare compared to the green turtle and has not been observed on land at Barking Sands.

Green turtles: As adults, green turtles (Photo 3-15) forage and rest in the shallow waters around the MHI. Reproduction in the Hawaiian population occurs primarily in the NWHI, but green turtles have used the Barking Sands sand beaches for nesting (Dollar and Brock 2007). Turtle nesting has been documented during three years at Barking Sands (1989, 1999, and 2010).

Photo 3-15: Green turtle

Adults migrate to the isolated NWHI in the summer to nest and return to the MHI in late summer or early fall. Nesting occurs on sandy beaches above the high tide mark; upon hatching, juvenile green turtles enter the ocean where they take up a pelagic existence until attaining a carapace length of about 12 in (30 cm). At this size, young green turtles take up residence in nearshore waters around the MHI (Dollar and Brock 2007).

In the nearshore habitat, green turtles will rest during the day along ledges or in caves in coastal waters at depths usually from 40 ft to 82 ft (12 m to 25 m). Under the cover of darkness, green turtles will travel inshore to shallow subtidal and intertidal habitats to forage on selected species of marine algae. The normal range of these daily movements between resting and foraging areas is believed to be 0.6 mi (1.0 km) or less. Thus, the ideal green turtle habitat in Hawaiian waters consists of suitable resting areas (caves, depressions, ledges, and undercuts) located within 0.6 mi (1 km) of abundant algal pastures situated in shallow water. The physical habitat at the mouth

of Nohili Ditch provides such an ideal habitat, while also providing potential nesting grounds (Dollar and Brock 2007).

Haul-outs of green turtles elsewhere from Nohili Ditch on Barking Sands are rare. Underwater observations near the Nohili Ditch area revealed an elongated depression approximately 65 ft by 195 ft (20 m by 60 m) in dimension with an area of numerous caves and undercuts directly offshore of Nohili Ditch. Two green turtles, approximately 24 in (60 cm) in carapace length, were observed underwater in resting behaviors within this depression. One green turtle was seen on the surface shoreward of the depression (Dollar and Brock 2007). The emergent limestone bench fronting Nohili Point has a diverse assemblage of macrothalloid algal species, many of which are preferred forage species for green turtles. The apparent lack of green turtles foraging on the bench at distances more than 164 ft (50 m) may be related to the distribution of limu loloa (*Pterocladia capillacea*) that is abundant on the shoreline bench in the vicinity of Nohili Ditch (Dollar and Brock 2007).

The combination of desirable nesting beaches, foraging habitat, and resting habitat all situated within a small geographic area combine to provide an ideal "complete habitat" for green turtles in the immediate area of Nohili Ditch. The suitability of the forage area is enhanced by the combination of ideal intertidal physiography (limestone bench) and the abundance of preferred forage species of algae that are a response to nutrient subsidies provided by the freshwater discharge from Nohili Ditch (DON 2001).

Hawksbill Turtle: The hawksbill turtle (Photo 3-16) has been reported in the open waters offshore of Kaua'i. There are no known records of hawksbills coming ashore or nesting within or adjacent to Barking Sands (DON 2001). Hawksbill turtles are most often found in shallow water around reefs, bays, and inlets. The main threats to the species are the reduction of nesting beaches due to construction and human presence, including vehicles, artificial lighting, nest predation, and exotic vegetation. In addition, marine debris from active and ghost fishing lines and lay nets cause incidental take. Pollutants and boat collisions may also be a threat (DOFAW 2005).

Photo 3-16: Hawksbill turtle

3.3.1.2 Plants

Currently, there are no known threatened or endangered plant species occurring at the Barking Sands facility (NAVFAC 2006a). However, there is unoccupied critical habitat for lau'ehu (*Panicum niihauense*) within the installation. Figures 3-8 and 3-9 show the location of the critical habitat (Section 1.5.5) and vegetation types within Barking Sands. In addition, the federally-listed endangered plant species 'ohai (*Sesbania tomentosa*) is found north of Barking Sands at Polihale State Park.

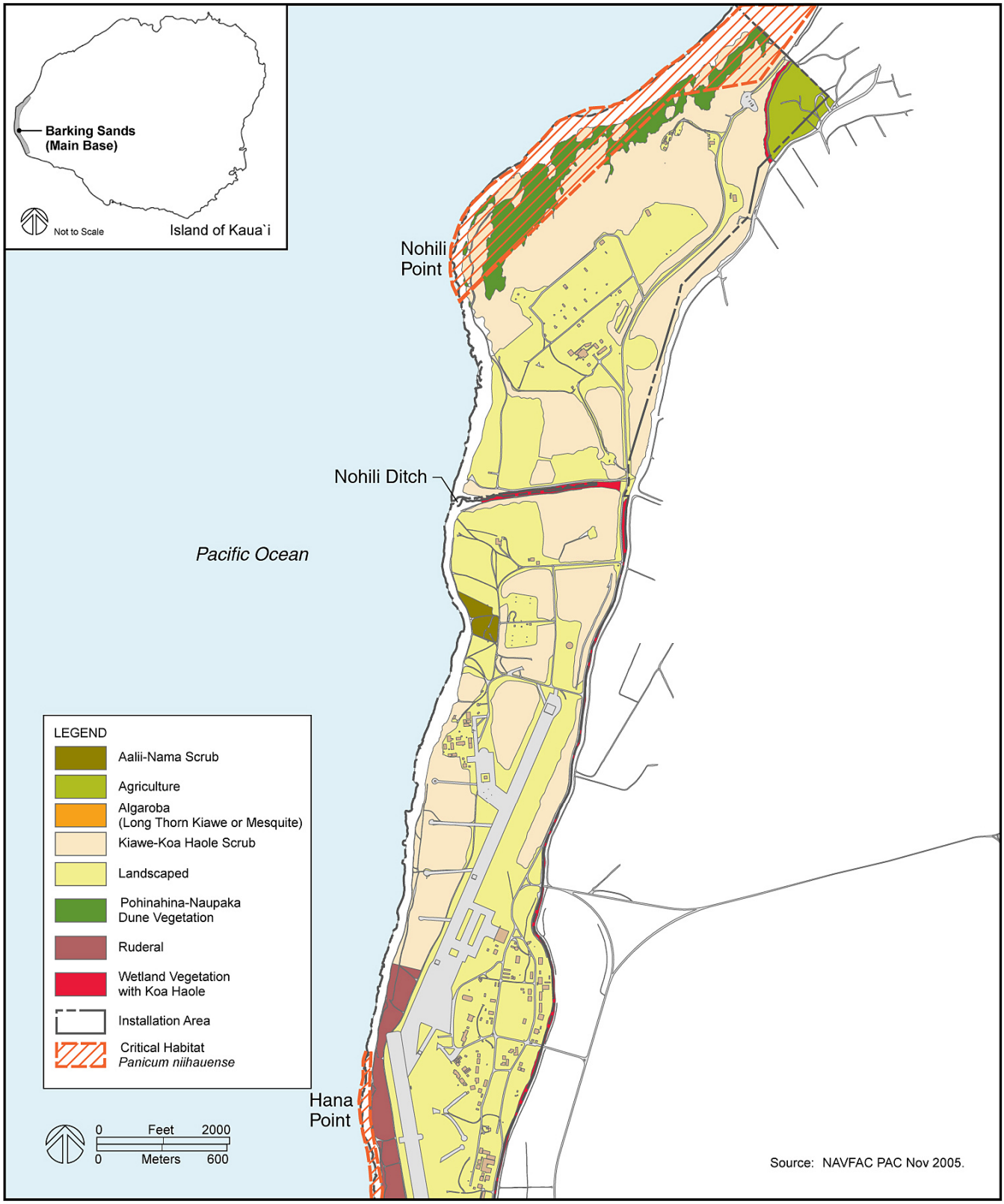


Figure 3-8: Vegetation Types, Barking Sands (northern portion), Kaua'i

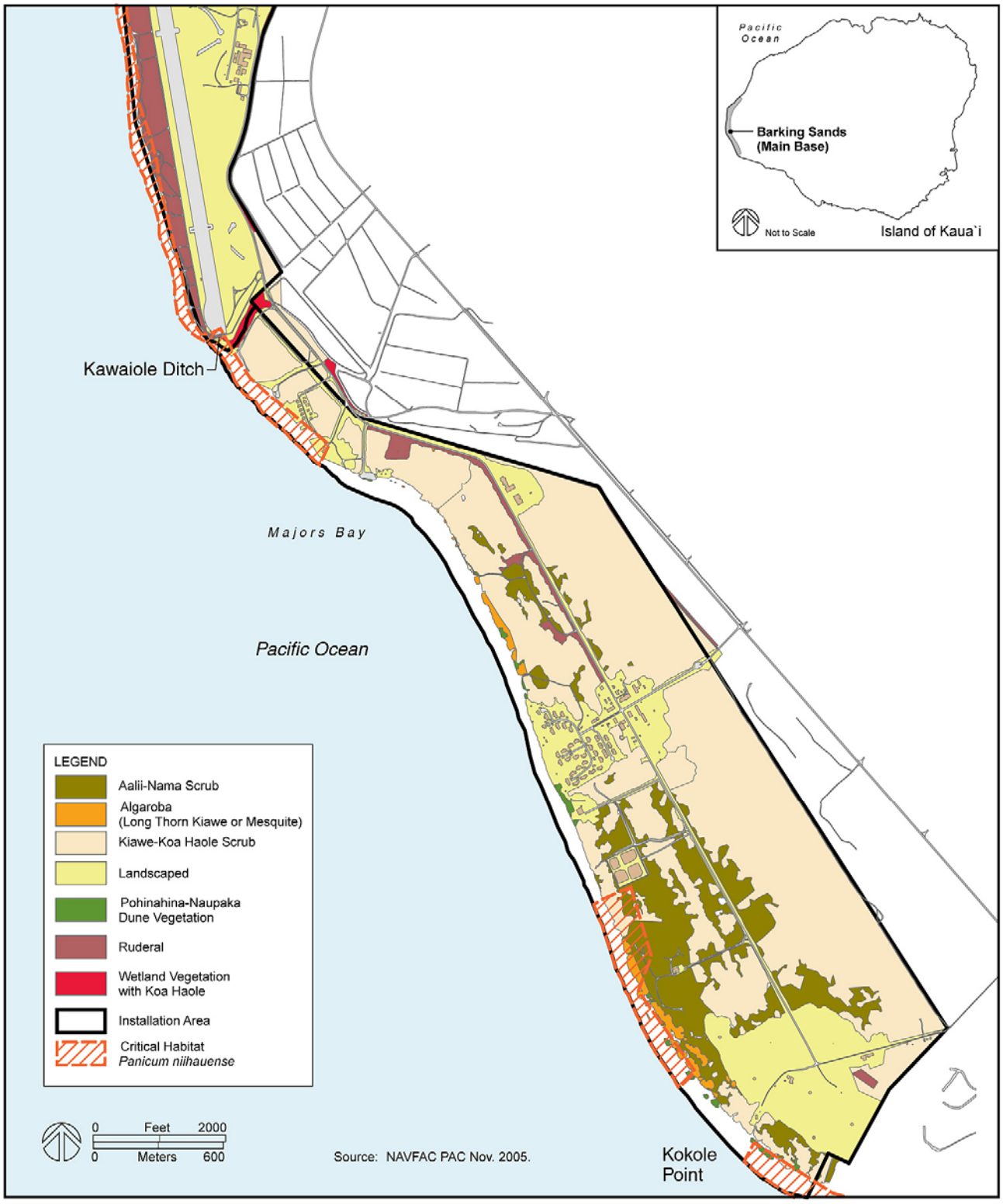


Figure 3-9: Vegetation Types, Barking Sands (southern portion), Kaua'i

Photo 3-17: Lau'ehu

The USFWS designated critical habitat for lau'ehu (Photo 3-17) at Polihale State Park and sections of Barking Sands (Federal Register Volume 68 (39): 9116-9479, February 27, 2003) (Figures 3-8 and 3-9). The Barking Sands section is "unoccupied", meaning that these areas contain the primary constituent elements for the species, but that lau`ehu has not been observed there during botanical surveys and there is no historical record of it having grown there. This designation restricts adverse modification to the primary constituent elements of the species. Threats to the species recovery include competition with non-native species, destruction from off-road vehicles (ORVs), naturally occurring catastrophic events, and reduced vigor due to low genetic representation (NAVFAC 2006a).

'Ohai (Photo 3-18) is a federally-listed endangered plant that is found, and where critical habitat has been designated, north of the Barking Sands northern property line on Polihale State Park. It is a flowering plant in the pea family (Fabaceae) and is endemic to MHI as well as Nihoa and Necker (Mokumanamana) Islands. 'Ohai is found in low shrublands and, rarely, in dry forests. ORVs, wildfire, grazing, and alien species competition have destroyed the preferred habitat on the MHI (National Tropical Botanical Garden Plant Database 2009). No plants were located during past surveys within the Nohili Dunes area of the installation.

Photo 3-18: 'Ohai (*Sesbania tomentosa*)

3.3.2 Wetlands

There are several man-made oxidation ponds and irrigation ditches at Barking Sands that support protected bird species (Figure 3-1); however, there have been no USACE wetland delineations (Section 1.5.2) and they haven't been included in USFWS wetland inventories.

3.3.3 Ecosystem Components

The Mānā Plain, where Barking Sands is located, is historically associated with extensive wetlands separated from the extensive coastal beach by high sand dunes. The four major ecosystem components in the immediate area of Barking Sands are (1) altered and natural wetlands, (2) coastal beach, (3) high dune, and (4) marine, nearshore (Figures 3-10 and 3-11).

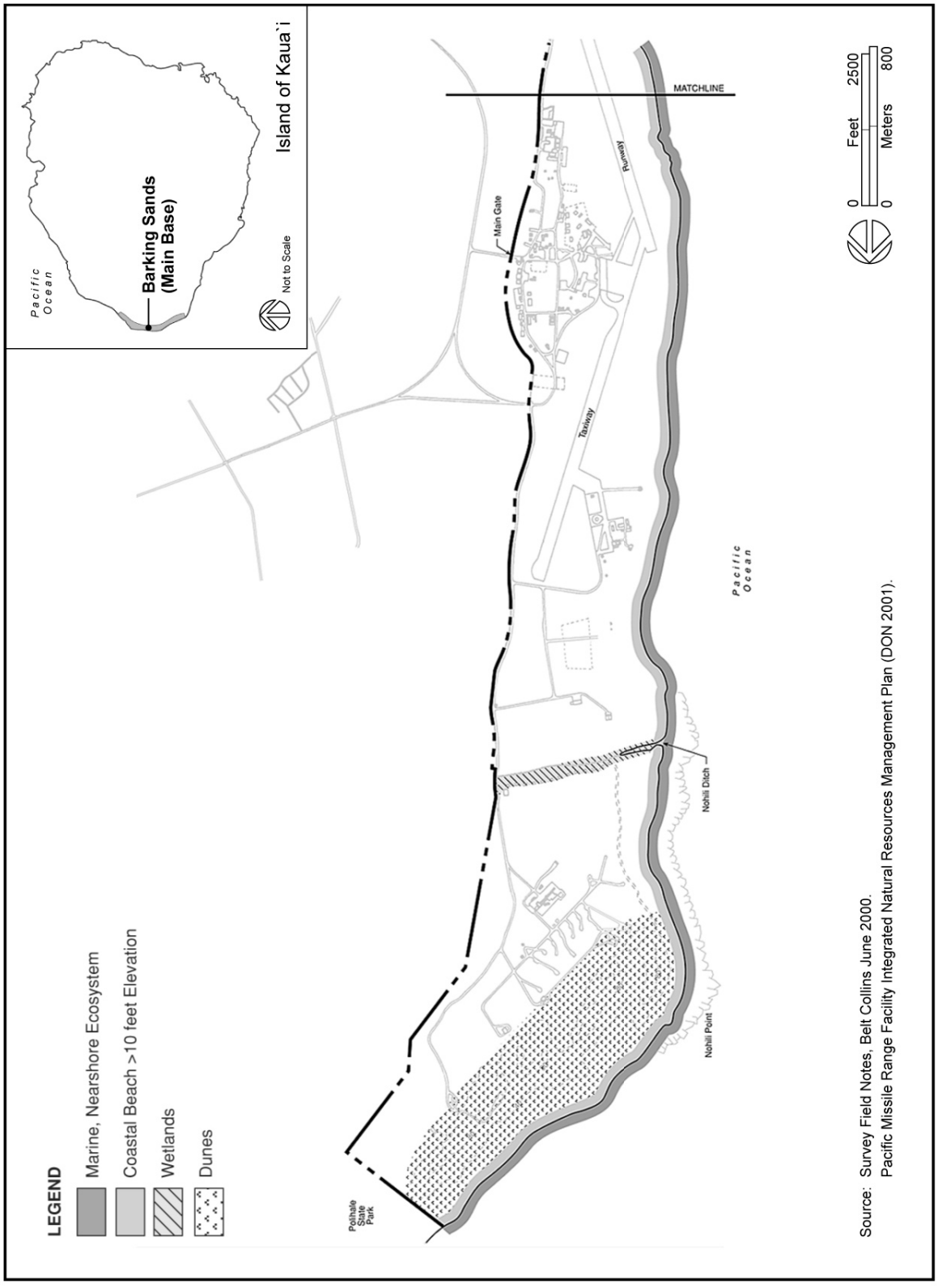


Figure 3-10: Major Ecosystem Components, Barking Sands (northern portion), Kaua‘i

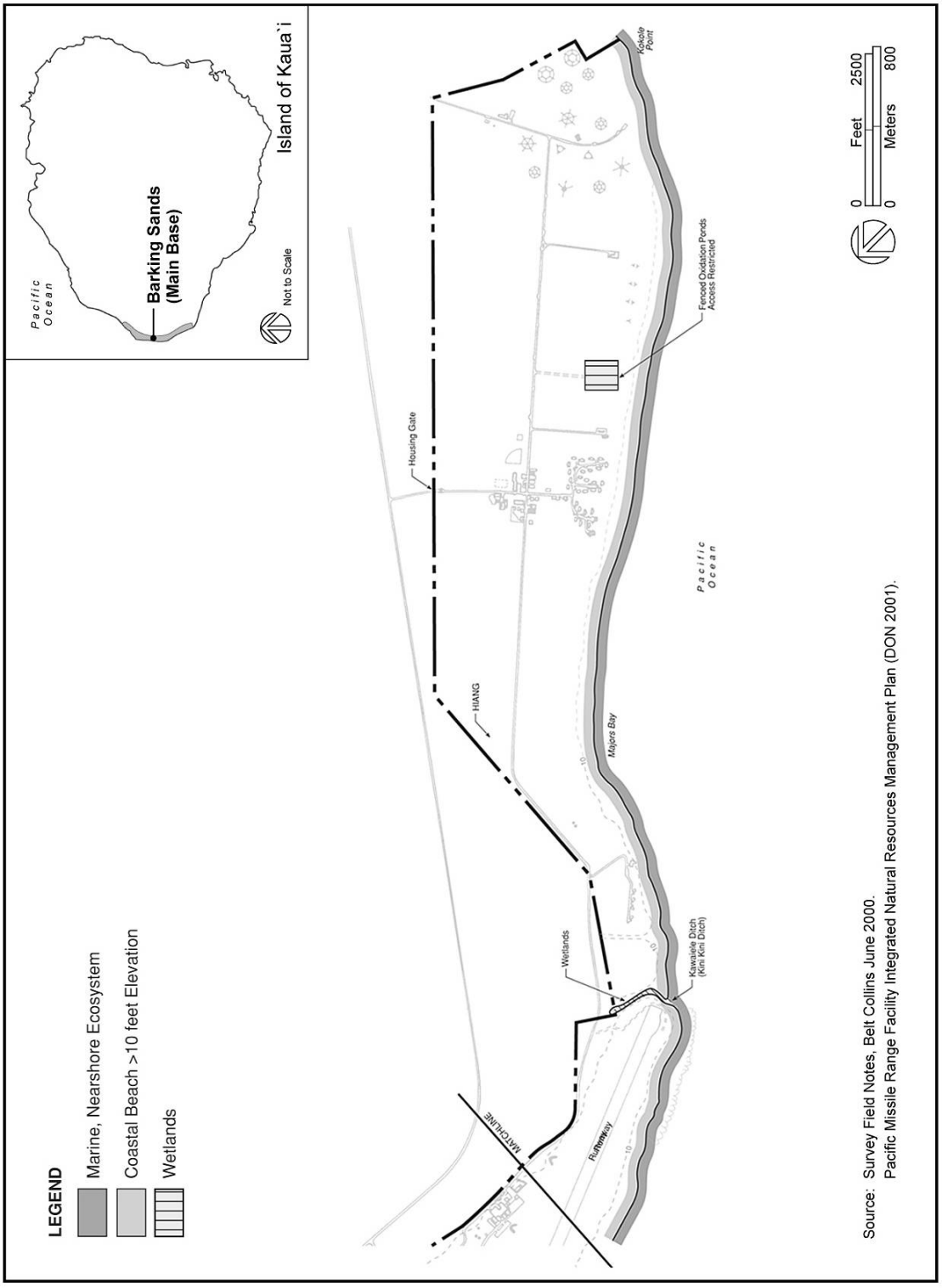


Figure 3-11: Major Ecosystem Components, Barking Sands (southern portion), Kaua‘i

3.3.4 Fish and Wildlife

The discussion of animals not listed under the ESA is divided into four subsections: (1) bird species; (2) mammal species; (3) amphibian and reptile species; and (4) corals, fishes, and macroinvertebrates. This section includes species listed under MBTA, MMPA, and SOH.

3.3.4.1 Bird Species

Bird surveys were conducted at Barking Sands in 2000 in support of the 2001 INRMP (Bruner 2000) and in 2006 in support of this INRMP (NAVFAC 2006f). These surveys indicate that introduced bird species are the most abundant bird species at Barking Sands. This is typical of lowlands in the Hawaiian Islands, where most of the natural habitats have been altered by development and agriculture. Native bird species recorded include non-migratory waterbirds and migratory seabirds, shorebirds, and ducks. The number of waterbird species recorded was substantial given the limited amount and altered nature of wetlands on the facility.

As discussed in Section 3.3.1.1, the ditches at Barking Sands provide habitat for four federally-listed endangered and endemic waterbird species. In addition, the indigenous, MBTA-protected black-crowned night heron uses these wetlands and the exposed rocky intertidal zones for foraging. The oxidation ponds are attractive foraging grounds for all the resident species and other transient vagrants such as the Northern shoveler or koloa moha (*Anas clypeata*) (Table 3-3) (NAVFAC 2006f). Table 3-3 provides a summary of migratory birds observed at Barking Sands.

An important seabird species at Barking Sands is the wedge-tailed shearwater (*Puffinus pacificus*), which nests on the installation from February through November. There are two wedge-tailed shearwater nesting colonies; one is located at Nohili Point and the other in the Beach Cottages area. In 2006, the northern colony had 276 active burrows, with an occupancy rate of 56 percent. The Beach Cottages colony has been monitored for the past several years and in 2008, there was an occupancy rate of 81 percent with a colony-wide estimate of 1,046 active burrows.

Laysan albatross (*Phoebastria immutabilis*) and black-footed albatross are known to occur at Barking Sands. A few individual black-footed albatross have been observed loafing on base during the breeding season, but this species has not attempted to nest at Barking Sands. In contrast, Laysan albatross do attempt to lay eggs, particularly in the vegetated area to the west of the central runway, and in the areas north of Nohili ditch. In the central portion of the base, near the runway area, Laysan albatross activity poses a BASH concern. As part of BASH management activities occurring along the runway, an albatross air hazard abatement program has been carried out at Barking Sands since 1988 (see Appendix G2). This program consists of relocating breeding adults and sub-adult (non-breeding) albatross from Barking Sands to an existing albatross breeding colony, primarily Kilauea Point National Wildlife Refuge (KPNWR) on the north side of Kaua‘i. Beginning in 2004, albatross eggs that have been laid at Barking Sands have been translocated to available nest sites of foster parent birds at KPNWR and on private land.

Fourteen migratory bird species protected under the MBTA have been observed at Barking Sands (NAVFAC PAC 2006f). They are summarized in Table 3-3.

Table 3-3: Summary of Migratory Birds Observed at Barking Sands

Hawaiian Name	Common Name	Latin binomial	Comments
Mōlī	 Photo 3-19: Laysan albatross	*Phoebastria immutabilis*	The Laysan albatross is a native seabird species, with more than 90% of the world population nesting in the Hawaiian archipelago. Laysan albatrosses are monogamous; they arrive at the breeding colony in October each year, with egg laying occurring in November and December. The incubation period lasts a mean of 64 days, with eggs hatching from mid-January through mid-February. Fledging occurs from early June through July. The total population in Hawai‘i was estimated in 1990 as 2.5 million. This species attempts to nest next to the runway and in the KTF area of Barking Sands, and birds are relocated from these areas to prevent BASH.

Table 3-3: Summary of Migratory Birds Observed at Barking Sands

Hawaiian Name	Common Name	Latin binomial	Comments
Not available	 Photo 3-20: Black-footed albatross	*Phoebastria nigripes*	The black-footed albatross is a SOH-listed threatened as well as a MBTA-protected native seabird. Black-footed albatrosses have been observed loafing near the runway at Barking Sands; however, there has been no record of breeding at the installation. In 2009, the USFWS reopened the public information solicitation period on an October 9, 2007, 90-day finding on a petition to list the black-footed albatross as threatened or endangered under the ESA. The petition is still under review.
ʻĀ	 Photo 3-21: Brown booby	*Sula leucogaster*	The brown booby is a native seabird that has been observed foraging off shore at Barking Sands. It most often forages in large, mixed species flocks associated with schools of large predatory fishes that drive prey species to the surface. It is the only ground nesting booby that builds a nest, and its construction is an important part of courtship. In Hawaiʻi, there are an estimated 1,400 breeding pairs with the largest population on Lehua Island (DOFAW 2005). No nesting has occurred on Barking Sands.

Table 3-3: Summary of Migratory Birds Observed at Barking Sands

Hawaiian Name	Common Name	Latin binomial	Comments
ʻUaʻu kani	 Photo 3-22 Wedge-tailed shearwater	*Puffinus pacificus*	Wedge-tailed shearwaters are native pelagic seabirds. There are two breeding colonies located at Barking Sands. Wedge-tailed shearwaters breed from February through November. They are ground-nesting birds. The known predators of adult wedge-tailed shearwaters are rats, domestic dogs, and feral cats. On Kauaʻi, nestlings have also been taken by barn owls (NAVFAC 2006f).
Aukuʻu	 Photo 3-23: Black-crowned night heron	*Nycticorax nycticorax*	The black-crowned night heron is a native, medium-sized heron. The species has been observed in the ditches and oxidation ponds at Barking Sands. They are opportunistic feeders, eating items ranging from aquatic and terrestrial insects to lizards, snakes, eggs, and plant materials.
Not available	 Photo 3-24: cattle egret	*Bubulcus ibis*	The cattle egret is a small, white egret often found in pastures and roadsides. Cattle egrets are found on all grassy areas on Barking Sands. It is an opportunistic feeder that eats insects as well as other birds. USDA-WS personnel harass and shoot cattle egrets at Barking Sands airfield as part of the BASH Program.

Table 3-3: Summary of Migratory Birds Observed at Barking Sands

Hawaiian Name	Common Name	Latin binomial	Comments
Koloa mōhā	 Photo 3-25 Northern shoveler	*Anas clypeata*	The northern shoveler is a common North American dabbling duck that winters in the MHI, typically arriving in September and October and departing for Alaska by March or April. (DOFAW 2005). They utilize a variety of wetland habitats, including freshwater and saline marshes, and agricultural ponds. They have been observed in ditch outfalls and the oxidation ponds at Barking Sands.
Not available	 Photo 3-26: Green-winged teal	*Anas crecca*	The green-winged teal is a very small, brightly patterned duck. It prefers shallow ponds with emergent vegetation. Along the coast, it prefers tidal creeks, mudflats, and marshes. Teals have been observed at the oxidation ponds at Barking Sands.
Kōlea	 Photo 3-27 Pacific golden plover	*Pluvialis fulva*	The Pacific golden plover is a medium-sized plover that, during the winter months, occupies upland and coastal habitats in the Hawaiian Islands. Plovers have been observed in all areas at Barking Sands. They leave Hawai‘i in April to migrate to Alaska to breed and return to Hawai‘i in August (NAVFAC 2006).

Table 3-3: Summary of Migratory Birds Observed at Barking Sands

Hawaiian Name	Common Name	Latin binomial	Comments
Not available	 Photo 3-28: Black-bellied plover	*Pluvialis squatarola*	The black-bellied plover is a large shorebird of coastal beaches. The species has been observed at the beach at Barking Sands. On its wintering grounds, it roosts in dense flocks but spreads out over sandy and muddy flats to forage as the tide recedes. Although generally a coastal bird, it also forages successfully in freshwater and upland habitats (Cornell Lab of Ornithology 2008).
‘Ulili	 Photo 3-29: Wandering tattler	*Heteroscelus incanus*	The wandering tattler winters in the Hawaiian Islands. Adults arrive from July to August and juveniles from September to November. This species forages in intertidal habitats such as coral reefs and less frequently in soft mud or sand. They may also forage in wetlands, fish ponds, and human-modified areas. They have been observed at the beach at Barking Sands.

Table 3-3: Summary of Migratory Birds Observed at Barking Sands

Hawaiian Name	Common Name	Latin binomial	Comments
Not available	 Photo 3-30: Ruddy turnstone	*Arenaria interpres*	The ruddy turnstone is a small, calico-colored shorebird that winters on the shorelines of the MHI. While in Hawai'i, they are almost exclusively coastal, foraging mostly along stony or rocky shorelines with abundant seaweed and commonly on sandy shorelines and in mudflats and river deltas. They have been observed at the beach at Barking Sands.
Huna kai	 Photo 3-31: Sanderling	*Calidris alba*	The sanderling is well-known for its habit of foraging at the edge of the surf zone and running up and down the beach to avoid waves while probing the sand for invertebrates. Sanderlings winter in Hawai'i (as well as other locations) and prefer to forage on sandy beaches, tidal flats, and mudflats. They have been observed at the beach at Barking Sands.
Not available	 Photo 3-32: Laughing gull	*Larus atricilla*	The laughing gull is a smallish gull distinguished by its black head and is an occasional visitor to Hawai'i. The species has been observed at the beach at Barking Sands.

Source: NAVFAC 2006f and DOFAW 2005.

3.3.4.2 Mammal Species

1. Terrestrial Mammals

The only native terrestrial mammal is the endangered Hawaiian hoary bat (Section 3.3.4.1). All other species are non-native. Feral cats and rats (*Rattus rattus, Rattus exulans,* and *Rattus norvegicus*) were the most common species recorded on base (NAVFAC 2006e). Signs of feral pigs (*Sus scrofa*) and black-tailed deer (*Odocoileus columbianus*) were also found on the most recent survey. The common house mouse (*Mus musculus*) was also captured. Rats are of environmental concern to native bird species, as are feral cats.

2. Marine Mammals

Spinner dolphins (*Stenella longirostris*) and bottlenose dolphins (*Tursiops truncata gilli*) are two MMPA marine mammals that have been observed in the waters off of Barking Sands. There are other species of small cetaceans that may be present in coastal waters but are generally cryptic and not often observed (Dollar and Brock 2007).

Spinner Dolphins: One small pod of spinner dolphins (Photo 3-33) was observed near the central portion of Barking Sands in 2006, and two pods were observed in the southern part of the installation in 2000. The pods were observed along the -75 ft (-25 m) isobath moving in a northwest direction. Spinner dolphins are known to rest in bays and other protected waters around the Hawaiian Islands, and there are several schools known to occur around Kaua'i. Spinner dolphins have a well defined home range and can be found with a high degree of regularity in the same area. They spend considerable time close to shores in waters 45 ft (15 m) or less in depth. The typical diurnal activity pattern of spinner dolphins is an early morning period of school movement and high activity, followed by a calmer period lasting the remainder of the day. In the late afternoon, high activity recommences during which time the smaller groups may join together and head seaward, presumably to feed during the night. Prey species consumed by spinner dolphins are primarily mesopelagic fish and epipelagic squid, suggesting the use of offshore feeding areas (Dollar and Brock 2007).

Photo 3-33: Spinner dolphin

Photo 3-34: Bottlenose dolphin

Bottlenose dolphins: Bottlenose dolphins (Photo 3-34) are likely to be found in the coastal waters off of Kaua'i (Dollar and Brock 2007) including Barking Sands. The bottlenose dolphin is a large, robust dolphin with a tall dorsal fin. Color ranges from blue grey to grey to brownish black with lighter sides and belly (International Fund for Animal Welfare 2007).

3.3.4.3 Amphibian and Reptile Species

1. Terrestrial Amphibians and Reptiles

The reptiles mourning gecko (*Lepidodactylus lugubrus*), house gecko (*Hemidactylus frenatus*), and snake-eyed skink (*Cryptoblepharus poecilopleurus*) were documented at Barking Sands. The house gecko was the most common reptile found during the survey (NAVFAC 2006e). The only amphibian recorded on Barking Sands is the marine toad (*Bufo marinus*).

2. Marine Reptiles

ESA-listed turtles are the only marine reptiles recorded at Barking Sands (Section 3.3.3.1).

3.3.4.4 Corals, Fishes, and Macroinvertebrates

Surveys of the marine environment were conducted in April 2000 (Dollar and Brock 2000) and August 2006 (Dollar and Brock 2007). These investigations involved point-to-point underwater swims at each dive site to evaluate abundance and other characteristics of marine communities. The investigations were limited to a maximum depth range of 65 ft (20 m).

While no explicit quantitative surveys have been carried out for the INRMP, repetitive quantitative surveys were conducted in this area on an annual basis from 1994 through 1997 as part of the required compliance for the National Pollutant Discharge Elimination System permit for the Zone of Mixing of the Kekaha Sugar Mill Discharges. These surveys involved quantitative transects that enumerated benthos and fish at 10 sites off of the sugar mill discharges, including discharges via the Nohili and Kawai'ele Ditches within the boundaries of Barking Sands. In addition, a detailed evaluation of the green turtle abundance off shore of Barking Sands was conducted in 1990 in conjunction with planning for the KTF. The results of these previous surveys are used in the evaluation of marine resources for the 2006 survey report (Dollar and Brock 2007).

The nearshore waters of Barking Sands consist of four sectors separated by distinct physiographic and biotic structures. These sectors, shown on Figure 3-12, are:

1. Nohili Sector, which extends from the northern end of the property to approximately 984 ft (300 m) south of Nohili Ditch;

2. Mānā Point Sector, which extends from the southern end of the Nohili Sector to the southern part of Mānā Point;

3. Majors Bay Sector, which extends from the southern end of the Mānā Point Sector to the southern boundary of PMRF at Kokole Point; and

4. Offshore Sector, within the 49- to 65-foot (15- to 20-m) depth contour.

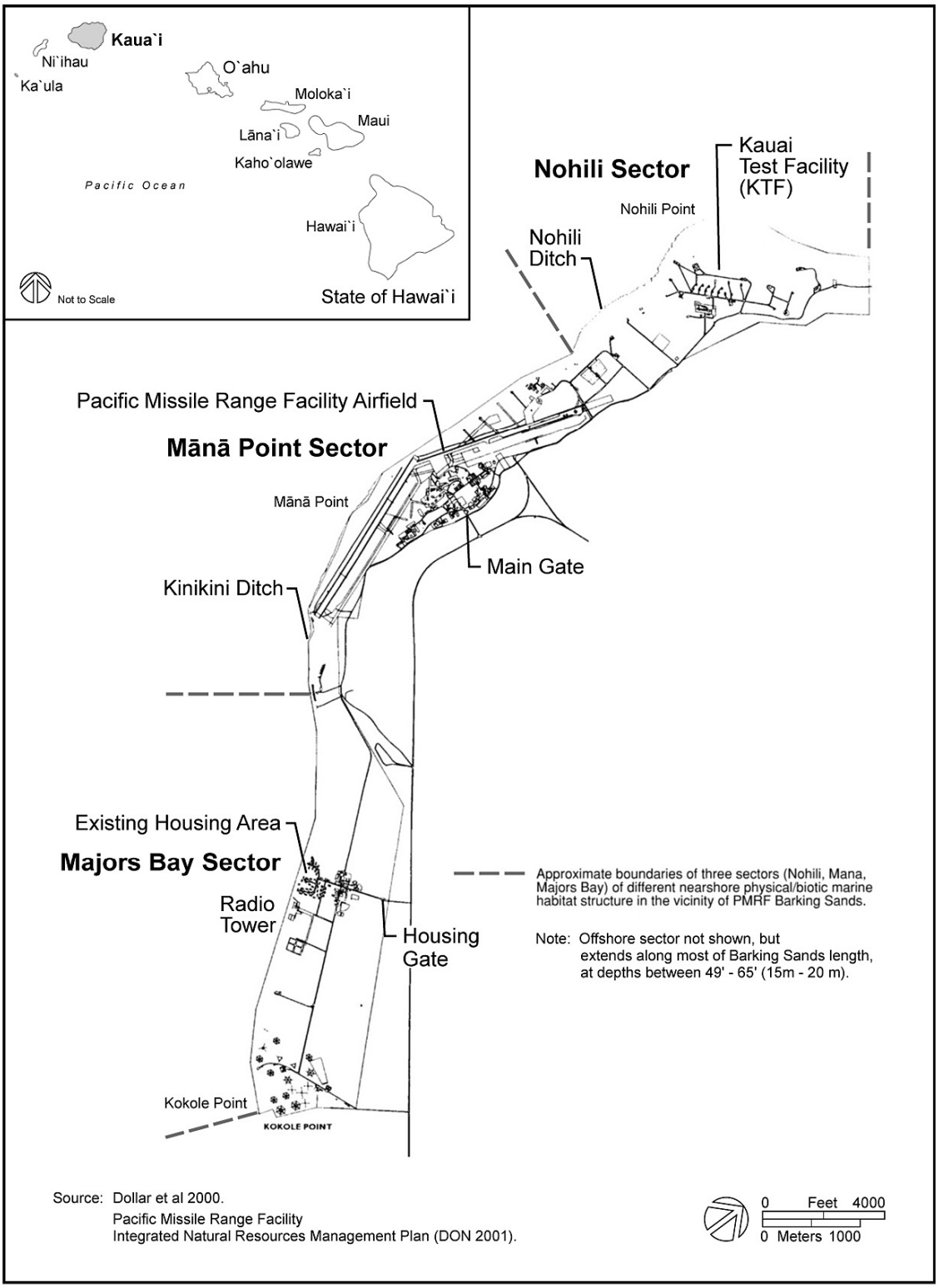


Figure 3-12: Marine Sectors, Barking Sands, Kaua‘i

The Nohili, Mānā Point, and Majors Bay Sectors extend from the shoreline to a depth of approximately 50 ft (15 m). Each of these sectors is characterized by different zones between the shoreline and the edge of the reef at a depth of approximately 40 ft (12 m). The Offshore Sector extends along most of the entire length of PMRF Barking Sands within the depth range of 49 to 65 ft (15 to 20 m).

1. Nohili Sector

Physical Description: The shoreline of the Nohili Sector (Photo 3-35) consists predominantly of a fossilized limestone bench which is emergent at low tidal stands and fronts the sand dunes. Seaward of the bench is a second zone at a depth of 7 to 35 ft (2 to 5 m), which is the primary region that absorbs the impact of breaking waves. A relatively smooth fossilized limestone bottom (Photo 3-36) devoid of most vertical relief as well as biotic assemblages characterizes this area. At approximately 16 ft (5 m) depth, the flat bottom grades into a zone characterized by numerous deep, rubble-filled channels separating massive fossilized limestone fingers which are remnants of fossilized reef-platforms that have been highly eroded into karst-like topography. Such erosion results in numerous outcrops, ledges and caves within the fossilized reef-platform (Figure 3-13). Vertical relief of the reef structures is up to 10 ft (3 m) in height, resulting in a substantially more complex substratum than the other nearshore zones (Dollar and Brock 2007). Part of the substratum appear to be comprised of a fossilized reef of finger coral (*Porites compressa*) that remains as broken blocks scattered around one area of the bottom. Because there are only sparsely distributed small coral colonies in the area at present, the presence of the large fossilized blocks suggests that the physical oceanographic conditions may have been vastly different earlier in the region's geological history. This is evidenced by the fact that *Porites compressa* generally requires relatively calm waters to sustain growth beyond the initial settlement stage. Calm water conditions for extended periods of time (circa 50 years) would be required for the accumulation of these coral reef skeletal structures. Currently, the west facing shoreline of Kaua'i does not experience such long-term calm water conditions (Dollar and Brock 2007).

Photo 3-35: Nohili Sector

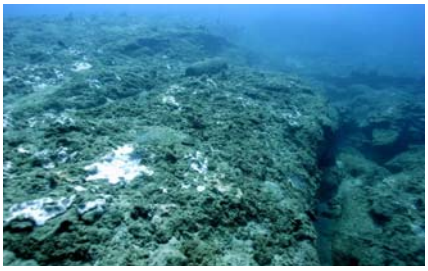


Photo 3-36: Fossil reef platform

Corals: Because the vertical relief afforded by the eroded reef structures provides abundant solid surfaces above the bottom (and shifting sediment), settlement of benthos, particularly reef corals, is substantially higher than anywhere else in the study area. Quantitative transect data from three stations within the Nohili Sector reveal that total coral cover ranged from 32 percent to 39 percent of the total bottom cover. The most abundant species are *Porites lobata*, *Pocillopora meandrina*, and *Montipora patula*. Other less abundant species in the area include *Porites compressa*, *Montipora capitata* (formerly *Montipora verrucosa*), and *Pavona varians*. Several additional corals were noted in the Nohili Sector, including *Porites evermanni*, *Pavona varians*, *P. duerdeni*, *Leptastrea purpurea*, *Montipora flabellata*, and *M. verrilli*. Coverage by these corals was small as a percentage of total living coral, with *P. lobata* and *P. meandrina* comprising the majority of cover. There were no substantial differences in coral community structure in the Nohili sector

between the 2000 and 2006 surveys (Dollar and Brock 2007). A multitude of man-made materials were observed on the reef structure including fouled fishing nets and metal objects (possible ordnance or test materials remnants).

Fishes and Macroinvertebrates: The topographical complexity of the biotope of channels provides considerable shelter for many fish and motile invertebrate species. The standing crop of fishes in the area is estimated to range between 80 to 150 grams per square meter (g/m^2) with the mean in the vicinity of 110 g/m^2 in this biotope. The Nohili Sector contains the most abundant fish populations, in terms of both numbers of species and biomass. Biomass has increased between 2000 and 2006 which suggest that the overall abundance of fish stocks has increased as well (Dollar and Brock 2007). In one 30-minute survey, 78 varieties of fish and species were identified. Appendix B3 provides a listing of the fish and macroinvertebrates observed in the 2000 and 2006 surveys.

2. Mānā Point Sector

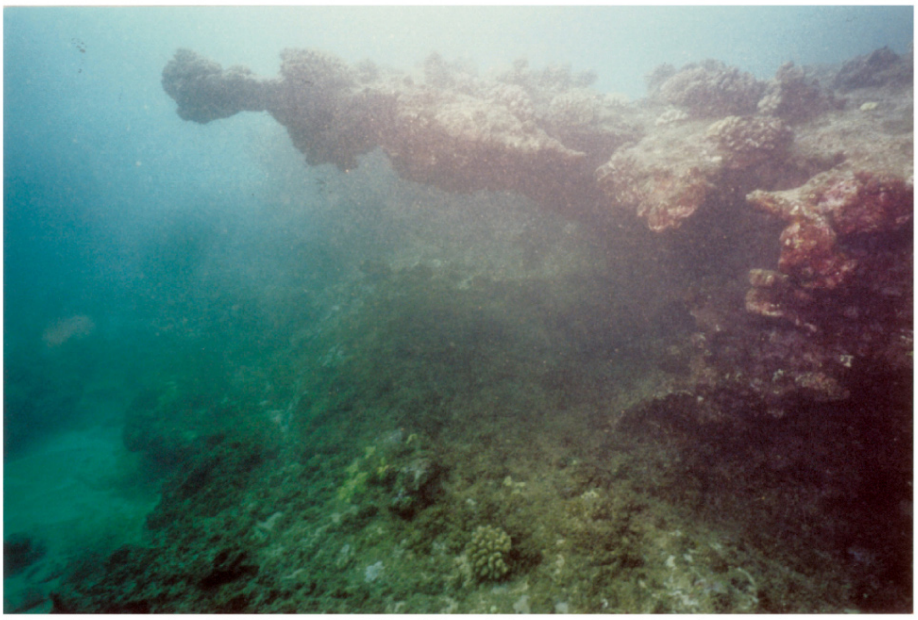
Physical Description: Along the central portion of Barking Sands, the intertidal shoreline bench is less defined and the shoreline consists of a sandy slope that grades to a flat limestone subtidal bench similar to that described in the Nohili Sector. However, unlike the Nohili Sector, the reef in Mānā Point Sector (Photo 3-37) consists of a series of elongated low limestone mounds that often take on the shape of sloping-sided knolls or hummocks that are separated by channels filled with white sand. The knolls are oriented perpendicular to the shoreline, and rise from the sandy bottom 3 to 10 ft (1 to 3 m). The tops of the knolls form reef platforms that are predominantly flat with little structural relief other than low depressions and channels that are filled with coarse white sand. Hence, vertical relief is far less in this area than in the Nohili Sector (Dollar and Brock 2007).

Photo 3-37: Mānā Point Sector

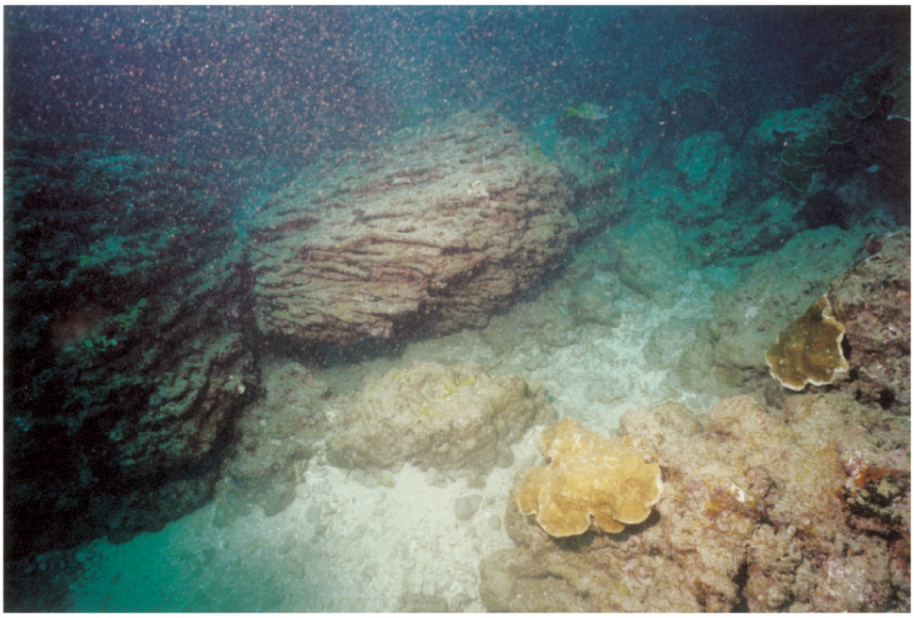
Corals: In the Mānā Point Sector, living corals are more sparsely distributed and occur predominantly as flat encrustations on the flat bottom. The continual wave action resulting in the scouring of sand on the tops of the knolls appears to be a limiting factor for coral growth on the reef platforms. Solitary colonies of *Porites lobata* and *Pocillopora spp*. are the most abundant corals occurring on the knolls. Coral cover is substantially lower in the Mānā Sector than in the Nohili sector (Dollar and Brock 2007).

Fishes and Macroinvertebrates: As with corals, fish were correspondingly less abundant on the flat platforms of the Mānā Point Sector. Where small depressions and undercutting were encountered in the hard bottom, a number of fish species were seen. The estimated standing crop or biomass in the Mānā Point Sector is not high because of the relative scarcity of shelter. The biomass is estimated to range between 50 to 400 g/m^2 and the mean is about 70 g/m^2 in this biotope. This is an increase from 2000 when 30 species of fishes were encountered with a standing crop ranging from 40 to 70 g/m^2 and an estimated mean biomass of 50 g/m^2. Appendix C3 provides a listing of the fish and macroinvertebrates observed in the 2000 and 2006 surveys.

The predominant biotic assemblage on the reef platform is a low algal turf composed of various species of benthic marine algae. The surfaces of the knolls are pitted by bioerosion, mostly as a



Undercut limestone ledge off Nohili Point at PMRF Kauai. Water depth is approximately 10 m. Ledges and caves serve as green sea turtle resting habitat.



Large blocks of broken fossil *Porites compressa* reef off Nohili Point, PMRF Kauai. Very little living *P. compressa* is presently found on the reef, indicating substantially different physical conditions in past decades. Water depth is approximately 12 m.

Source: Pacific Missile Range Facility Integrated Natural Resources Management Plan (DoN 2001).

Figure 3-13: Marine Ledges and Caves, Nohili Sector, Barking Sands, Kauaʻi

result of the boring action of several species of sea urchins. As in the Nohili Sector, limu kohu (*Asparagopsis taxiformis*) is the most abundant macroalgae, covering large areas of the tops of the reef knolls. Four dominant macroalgal and six macroinvertebrate species were observed in the 2006 survey, an increase from one and two in 2000, respectively (Dollar and Brock 2007).

3. Majors Bay Sector

Physical Description: The southernmost sector of Barking Sands consists of a slight indentation in the coastline known as Majors Bay (Photo 3-38) or Waiokapua Bay. The bay terminates to the south at Kokole Point and to the north at Mānā Point. The nearshore region of Majors Bay differs substantially from the two northern sectors in that there is little solid reef structure in the nearshore area within the 65-ft (20-m) depth contours. Rather, nearly the entire bottom consists of shifting sands.

Photo 3-38: Majors Bay Sector

Corals: Results of quantitative transects, conducted at selected areas within this region where at least some hard bottom was encountered, revealed coral cover of less than 2 percent of the total bottom cover (Dollar and Brock 2007).

Fishes and Macroinvertebrates: Results of surveys of fish communities in Majors Bay reveal that in 2000, 22 species of fishes were noted, having an estimated mean standing crop of 10 g/m^2 (range 2 to 30 g/m^2). In 2006, 30 species of fish were recorded having a mean overall biomass of 10 g/m^2 (range from 1 to 80 g/m^2). While the average biomass remained essentially constant during the two surveys, the number of fish species observed increased in 2006 relative to 2000. The algal and macroinvertebrate survey in Majors Bay did not record any species present in the 2000 survey but in 2006 noted four macroalgal and eight macroinvertebrate species present (Dollar and Brock 2007). Appendix C3 provides a listing of the fish and macroinvertebrates observed in the 2000 and 2006 surveys.

4. Offshore Sector

Physical Description: The Offshore Sector is essentially continuous along the northern region of Barking Sands seaward of the Nohili and Mānā Point Sectors described above (Figure 3-11). The predominant physical structure of the area is a flat, pitted limestone surface. The seaward extent of this biotope is defined by the limestone shelf break encountered at 65 to 82 ft (20 to 25 m) in depth. This shelf break ranges from a vertical face to a 20 degree slope dropping away into sand at about 82 to 98 ft (25 to 30 m) of water (Dollar and Brock 2007).

Corals: The predominant coral found in this zone is *Pocillopora eydouxi* (Photo 3-39), which occurs as single large branching colonies. Because of the lack of wave forces at depth, these fragile branching forms are able to grow to heights of up to approximately 3 ft (1 m). Other corals found on the platform are primarily smaller species that have a collective coverage of approximately 5 percent of bottom cover. Coral species recorded in the area include *Pocillopora meandrina*, *P. eydouxi, Porites lobata, Pavona varians, P. duerdeni, Montipora*

Photo 3-39: *Pocillopora eydouxi*

flabellata, M. patula, M. verrilli, M. verrucosa, Leptastrea purpurea, and *Fungia scutaria*. Also present along the shelf break are black coral (*Antipathes dichotoma*) and wire coral (*Cirrhipathes anguina*) (Dollar and Brock 2007).

Fishes and Macroinvertebrates: The general lack of cover and shelter sites for organisms is a prominent feature of this deep offshore plain. Thus, fishes and macroinvertebrates are concentrated in the areas of available shelter. In 2000, 61 species of fishes were recorded having a mean overall biomass of 50 g/m^2. In 2006 less emphasis was given to this offshore biotope because of its distance from the shoreline; however, the low level of survey effort in this biotope resulted in 62 fish species seen, again having an estimated standing crop of 50g/m^2. In 2000, 17 species of macroinvertebrates were seen and in the limited 2006 survey two macroalgal and 11 macroinvertebrates species were recorded (Dollar and Brock 2007). Appendix C3 provides a listing of the fish and macroinvertebrates observed in the 2000 and 2006 surveys.

3.3.5 Vegetation

Botanical surveys were conducted at Barking Sands in 2000 (Char 2000a). In addition, the vegetation was classified by the Navy's Conservation Mapping Project in 2005 (NAVFAC PAC 2005). In February 2006, NAVFAC PAC conducted a botanical survey at Barking Sands which focused on the Nohili dunes and updated major changes from the 2000 botanical survey (NAVFAC PAC 2006a).

3.3.5.1 Terrestrial Plants

The 2000 botanical survey of Barking Sands recognized six vegetation types on the undeveloped portions of the PMRF Barking Sands, which cover roughly 600 ac (240 ha) of the facility (Char 2000a) (Figures 3-8 and 3-9).

1. Kiawe-koa haole scrub occupies roughly 400 ac (160 ha) and is found throughout the facility. This scrub vegetation varies from tall, dense forests in the more protected areas along the inland portion of the facility to low, windswept thickets along the oceanfront.

2. A'ali'i-nama scrub covers about 100 ac (40 ha) and is found on the southern half of the property.

3. Pōhinahina-naupaka dune vegetation occurs on the seaward facing slopes of the sand dunes at Nohili Point.

4. Strand vegetation occurs as a narrow band along the coastline and is poorly developed in most places.

5. Drainageway/wetlands vegetation is found along and in the two drainage ditches crossing the base and in association with the ditch that runs along a portion of the mauka (inland) boundary. The ditch easement is reserved to the SOH for operations and maintenance.

6. Ruderal vegetation is found along the roadways and on areas that are infrequently maintained.

1. Kiawe-Koa Haole Scrub

Photo 3-40: Kiawe-koa haole scrub vegetation

The following paragraphs summarize the kiawe-koa haole scrub (Photo 3-40) at Barking Sands as described in Char (2000a). Kiawe (*Prosopis pallida*), native to Peru, Colombia, and Ecuador, was introduced to Hawai'i in 1828 and quickly spread. Today, kiawe is a dominant component of the vegetation in dry, lowland, disturbed habitats. It is a fairly large tree with furrowed bark and a wide-spreading crown. The branches bear slender, stipular spines measuring one-quarter to 0.5 in (0.3 to 1.7 cm) long. Koa haole (*Leucaena leucocephala*), a shrub or small tree native to tropical America, was first observed in Hawai'i in 1837. It is abundant in low-elevation, dry, disturbed sites throughout the MHI.

Kiawe trees and koa haole shrubs are present in about equal numbers throughout most of the scrub vegetation at Barking Sands. The tallest and densest scrub cover is found in the area behind the Nohili Point sand dunes, between Nohili Road and the former sugarcane fields. In this more protected area, the kiawe trees are from 30 to 45 ft (9 to 14 m) tall, and the tree canopy cover is closed in most places (i.e., the crowns of the trees interlock). Koa haole cover is somewhat patchy with the shrubs occurring primarily along the margins of the tree cover or in areas where the canopy is more open; the shrubs are from 5 to 12 ft (1.5 to 4 m) tall. Guinea grass (*Panicum maximum*), 2 to 3 ft (0.6 to 1 m) tall, is locally abundant with smaller, scattered clumps of lantana (*Lantana camara*) shrubs, 2 to 3 ft (0.6 to 1 m) tall.

On the southern half of the installation, from the end of the runway near Wai'eli Drive to just south of the gate to the housing area, kiawe-koa haole scrub is more open, with 30 to 50 percent scrub cover. Kiawe trees vary in height from 20 to 30 ft (6 to 9 m), and koa haole range from 5 to 12 ft (1.5 to 4 m) tall. Lantana shrubs are abundant and form dense thickets, 5 to 7 ft (1.5 to 2 m) tall, in the open areas between the trees. Wild basil shrubs (*Ocimum gratissimum*) are also abundant in some open areas. Kupala (*Sicyos pachycarpus*), an endemic member of the gourd or squash family (Cucurbitaceae), is also seasonal and abundant.

In the area around Majors Bay and the comfort station, agave (*Agave sisalana*) plants are abundant in the kiawe-koa haole scrub. The agave forms a huge rosette of long, thick, stiff, straight leaves; each leaf is tipped with a purple to dark black spine. The larger rosettes are about 10 ft (3 m) tall. Flowers are borne on long stalks, 20 to 25 ft (6 to 8 m) tall.

2. A‘ali‘i-Nama Scrub Vegetation

The following paragraphs summarize the a‘ali‘i-nama scrub (Photo 3-41) at Barking Sands, as described in Char (2000a). The a‘ali‘i-nama scrub is found on the southern half of the property, from about the housing area to the antenna fields. The best example of this vegetation type is found in the area around the oxidations ponds.

Photo 3-41: A‘ali‘i-Nama scrub vegetation (top) and *Nama sandwicensis* (bottom)

Native plants are the dominant components of this vegetation type. A‘ali‘i shrubs (*Dodonaea vicosa*) are abundant, forming an open, patchy cover, 5 to 8 feet (1.5 to 2 m) tall. Nama is an annual to short-lived perennial herb, which is more abundant during the wetter parts of the year. It has a wide distribution range, occurring in sandy soils or raised limestone reefs on Hawai‘i, Maui, Moloka‘i, Lāna‘i, O‘ahu, Kaua‘i, Lisianski, and Laysan (Char 2000a). It can also be found in smaller numbers in the Pōhinahina-naupaka scrub at Nohili Point and in the ruderal vegetation (NAVFAC 2006a).

Other native plants which are common to occasional in this vegetation type include naupaka (*Scaevola sericea*), ilima (*Sida fallax*), uhaloa (*Waltheria indica*), alena (*Boerhavia repens*), pōhinahina (*Vitex rotundifolia*), and aki‘aki (*Sporobolus virginicus*). The pololei fern (*Ophioglossum polyphyllum*) is frequently encountered, growing in low lying areas on the sand substrate and forming fairly large colonies.

Kiawe is found scattered throughout the a‘ali‘i-nama scrub as individual trees or small stands of trees. Clumps of buffel grass (*Cenchrus ciliaris*) and Guinea grass as well as lantana shrubs are found under and around the kiawe. Koa haole shrubs tend to occur along the edges of the a‘ali‘i-nama scrub where it has been disturbed.

The only area that has been dramatically altered since the 2000 botanical survey is at the Terminal High Altitude Area Defense System (THADD) facility which was built on the southern part of the base. A‘ali‘i-nama scrub was cleared for this project and the area was paved and fenced. An inventory of all the plants recorded on Barking Sands is presented in the checklist at the end of the report in Appendix A1.

3. Pōhinahina-Naupaka Dune Vegetation

Photo 3-42: Pōhinahina-naupaka dune vegetation

The following paragraphs summarize the pōhinahina-naupaka dune vegetation (Photo 3-42) at Barking Sands, as described in Char (2000a). This vegetation type occurs on the seaward facing slopes of the large dunes at Nohili Point. Pōhinahina, a woody, branching, sprawling shrub with bluish-purple flowers, forms low mats, 1 to 3 ft (0.3 to 1 m) tall. Scattered here and there are low thickets of naupaka *(Scaevola sericea),* 2 to 4 ft (0.6 to 1 m) tall. ʻAkoko *(Chamaesyce celastroides),* a succulent shrub belonging to the spurge family with milky sap, is locally abundant, especially seaward of the launch pads, but very sparse elsewhere. Closer to the beach, mats of akiʻaki grass, pohuehue or beach morning glory vines *(Ipomoea pescaprae),* and hunakai vines *(Ipomoea imperata)* are common to abundant. Other native plants found here include ilima, alena, kaunaoa pehu *(Cassytha filiformis),* akulikuli *(Sesuvium portulacastrum),* and aʻaliʻi.

Scattered throughout the native dune vegetation are small, low, windswept patches of kiawe, most common on the mauka side of the dunes, and koa haole scrub, locally abundant seaward of the launch pad. A few clumps of buffel grass, Bermuda grass *(Cynodon dactylon),* sourbush *(Pluchea carolinensis),* golden crown beard (*Verbesina encelioides*), ironwood trees (*Casuarina equisetifolia*), a few patches of swollen-fingergrass (*Poaceae*), and *Portulaca pilosa* are occasionally encountered. Inland of the pōhinahina-naupaka dune vegetation is dense kiawe-koa haole scrub.

The 2006 botanical survey of Barking Sands noted that the Nohili dunes contain native dominant vegetation that appears contiguous with Polihale State Park. The surveys found no federally-listed species. Nama, which was noted in the Nohili dunes in the 2000 survey, was not observed during the 2006 survey. The 2006 survey (NAVFAC PAC 2006a) noted that there appeared to be more golden crown beard than was observed in 2000.

4. Strand Vegetation

The following paragraphs summarize the strand vegetation at Barking Sands, as described in Char (2000a). The strand vegetation occurs as a narrow band along the coastline and is bordered on the mauka (inland) side by weedy fields (ruderal vegetation), or, in most places, by kiawe-koa haole scrub. Along the northern half of the facility, the strand vegetation consists of a few scattered low shrubs of naupaka and pōhinahina as well as koa haole and Indian fleabane *(Pluchea indica);* the woody components are 2 to 3 ft (0.6 to 1 m) tall and windswept. Along the seaward side, mats of akiʻaki grass are abundant. Other plants observed occasionally in this area are ʻilima, buffel grass, paʼuohiʻiaka *(Jacquemontia ovalifolia),* akulikuli, Australian saltbush *(Atriplex semibaccata),* uhaloa, Bermuda grass, *Portulaca pilosa,* and hunakai. Strand vegetation is not shown on Figures 3-8 and 3-9 because it is depicted as algaroba and pohinahina-naupaka dune vegetation on those graphics.

On the southern half of the facility, from Waiʻeli Drive to the end of the housing area, the strand vegetation is somewhat patchy and occurs as scattered clumps behind the sandy beaches. The two native species, which are most frequently observed on this portion of the strand, are the pohuehue and akiʻaki grass. Introduced species such as buffel grass, Bermuda grass, golden

crown-beard, and Australian saltbush are common. Patches of low, windswept kiawe are also common. Individual trees to small stands of ironwood are found scattered along the coastline. A few pockets of native strand vegetation are found in some places. These contain shrubs of naupaka, pōhinahina, and a‘ali‘i; low mats of aki‘aki, hunakai, and pohuehue; and a tangle of kaunaoa pehu vines.

Saplings and large trees of the invasive species long-spined algarroba or mesquite *(Prosopis juliflora)* or long-thorn kiawe (LTK) are found along the coastline in the southern part of the installation. Unlike the kiawe, this species of *Prosopis* has longer spines, 1.0 to 4.0 in (2.5 to 10.1 cm) long. The bluish-green leaflets are larger and fewer in number; and the trees form rounded hummocks, 10 to 30 ft (3 to 10 m) tall, branching close to the ground with the lower branches running along the ground for some distance. The plants tend to be more prolific than kiawe and have large clusters of pale yellowish brown pods. From the southern end of the housing area to the south end of the installation by the antenna fields, the strand vegetation consists of dense thickets of LTK. Several of these plants have been observed as far north as the beach cottages situated between Kawai‘ele Ditch and Majors Bay.

5. Drainageway/Wetlands Vegetation

Drainageway/wetlands vegetation type (Photo 3-43) occupies only a small area on the facility and includes habitat utilized by various waterbird species, including the protected Hawaiian Moorhen and the Hawaiian Coot. Large mats of seashore paspalum *(Paspalum vaginatum)* line the ditches, often forming floating mats. Along the lower banks of the ditches, there are dense thickets of Indian fleabane and tall, solid mats of California grass *(Brachiaria mutica).* A narrow band of koa haole shrubs and scattered trees of kiawe and milo *(Thespesia populnea)* is found along the top of the banks. Where the drainage ditches cross onto the beach area, a few components of the strand vegetation are found; these include pōhinahina, Australian saltbush, naupaka, and akulikuli. The drainage ditches and associated wetlands vegetation are remnants from a once extensive wetland on the Mānā Plain (Char 2000a).

Photo 3-43: Drainageway/wetlands vegetation

6. Ruderal Vegetation

The following paragraph summarizes the ruderal vegetation at Barking Sands, as described in Char (2000a). Ruderal vegetation is found alongside the paved and unpaved roads which transect the facility; some of these areas are mowed regularly, others infrequently. Ruderal vegetation also occurs on disturbed, overgrown parcels.

The most abundant species along the roadside are buffel grass, which forms low, lumpy clumps, and Bermuda grass, which forms a low, somewhat thick mat. Weedy, mostly annual species, which are associated with this vegetation type include Spanish needle (*Bidens pilosa*), *Portulaca pilosa*, lovegrass (*Eragrostis amabilis*), Cuba jute (*Sida rhombifolia*), buttonweed (*Spermacoce assurgens*), crabgrass (*Digitaria sp.*), and several spurges—hairy spurge (*Chamaesyce hirta*), graceful spurge (*C. hyericifolia*), prostrate spurge (*C. prostrata*), and *C. hyssopifolia*. In places, golden crown-beard and false mallow (*Malvastrum coromandelianum*) are locally abundant.

Also included in the ruderal vegetation is the “daisy field” vegetation type recognized in the earlier Botanical Consultants survey (1985). The “daisy field” vegetation type is found in areas that have

been cleared and a dense cover of golden crown-beard, a member of the daisy family, develops. Golden crown-beard is an early invader (pioneer) of disturbed sites. Other weedy species as well as a few native species, which prefer more open habitats, soon replace it. These more closely resemble the components that characterize the ruderal vegetation. A large open parcel near the northern drainage ditch supports low-growing clumps of buffel grass and Bermuda grass. Scattered here and there are koa haole and lantana shrubs that have been reduced to low stubs, 2 to 6 in (5 to 15 cm) tall. Patches of golden crown-beard are locally abundant. A few native plants associated with the strand vegetation can also be found here and include nama, hunakai, alena, ʻilima, paʻu o hiʻiaka, naupaka, and pōhuehue.

3.3.5.2 Marine Plants

Marine plant surveys have not been conducted at Barking Sands. However, observations made during the 2000 and 2006 marine surveys provide limited information on algae observed growing on the bench fronting Nohili Point (Dollar and Brock 2000 and 2007). These algae species include:

- Limu lipuupuu (*Dictyospheria versluysii*)
- Limu pahalahala (*Ulva fasciatus*)
- Limu kala-lau-nunui (*Sargassum echinocarpum*)
- Limu kala (*S. obtusifolium*)
- *Acanthophora specifera*
- Limu pepe-iao (*Amansia glomerata*)
- Limu manauea (*Gracilaria coronopifolia*)
- Limu huna (*Hypnea spp.*)
- Limu huluilio *(Jania sp.)*
- Limu maneoneo (*Laurencia nidifica*)
- Limu plaewawae *(Laurencia sp.)*
- *Spyridia filamentosa*
- *Desmia hornemannii*
- Limu loloa (*Pterocladia capillacea*).

In addition, large pastures of limu kohu (*Asparagopsis taxiformis*) grow on the offshore reef bench throughout the Nohili Point area.

On rocky intertidal coasts, *P. capillacea* occurs as a well-developed band in the lower intertidal zone from about mean low tide (zero) to about 12 in (30 cm) below mean low tide. These algal bands develop best in areas receiving some freshwater input such as the outflow from Nohili Ditch. On the beach fronting the ditch, *P. capillacea* is found from a point commencing about 263 ft (80 m) north of the ditch discharge to the southern terminus of the limestone bench approximately 1,476 ft (450 m) to the south of the ditch. *Pterocladia* is an alga of the preferred forage genera for green turtles *(*DON 2001*).*

3.4 CURRENT MANAGEMENT

This section describes the current management at Barking Sands in the following categories: (1) project-specific management actions; (2) natural resources studies; (3) use of GIS systems; (4) forestry; (5) community outreach; (6) outdoor recreation; (7) land management; (8) flood plains; (9) law enforcement; (10) wildland fire; and (11) leases and encroachment.

3.4.1 Project-Specific Management Actions

3.4.1.1 Bird Air Strike Hazard

PMRF Instruction 5090.5: BASH Plan (Appendix G1) was created to establish procedures to minimize the hazard at PMRF. The following actions describe the current management actions with respect to protected species and BASH.

Waterbirds

Hawaiian duck, Hawaiian moorhen, Hawaiian coot, and Hawaiian stilt are found in the SOH-owned irrigation ditches at Barking Sands, primarily the Kinikini Ditch, and in the PMRF oxidation ponds. Their presence has been determined to not pose a BASH hazard because of their restricted habitat use and terrestrial habits (i.e., they are sedentary).

Nēnē

As the nēnē population continues to increase in Kauaʻi, nēnē are expected to become more abundant on the installation. USDA-WS has had a USFWS permit to haze nēnē from Barking Sands since 2005. The hazing is intended to prevent nēnē from using the area near the runway and to prevent nesting.

In December 2009, a nēnē pair nested behind the Hawaiʻi Air National Guard Facility. The proximity of this nest to the airfield (1/3 mi [0.5 km]), and the flight pattern of the birds observed by the PMRF Environmental Coordinator, suggested that these birds posed a BASH threat. A Section 7 consultation was conducted and the family was translocated to the Hanalei National Wildlife Refuge on the North Shore of Kauaʻi. A nēnē management plan will be written to address methods to discourage nēnē from areas near the Barking Sands airfield.

Albatross

Black-footed albatross are occasionally sighted at Barking Sands, but no nesting has occurred in historical times at the installation. If nesting should occur, policies should be adopted similar to that of Laysan albatross to balance protection of the species with BASH requirements.

Laysan albatross are considered a BASH hazard due to their nesting proximity to the airfield and large body size. Management for this species attempts to balance their protection with the safety requirements defined by the BASH program. Traditionally, breeding and non-breeding Laysan albatross have been moved from Barking Sands since 1988. Each year, approximately 160 albatross that are attempting to nest and 140 non-breeding albatross are captured at Barking Sands and moved by vehicle to KPNWR. The majority of non-breeding birds are removed from Barking Sands just once and are not seen on base again that year. In contrast, albatross that are attempting to nest usually return to their potential nest sites at Barking Sands multiple times, such

that breeding individuals are relocated up to six or seven times through the course of the breeding season.

In addition to relocating birds from Barking Sands to KPNWR, beginning in 2004, albatross eggs that were laid at Barking Sands were removed from the nests and placed in incubators to be translocated to foster nests at KPNRW and on private lands (Photo 3-44). Foster nests were those that were identified by the KPNWR biologist as containing inviable eggs. At those nest sites, the parents' inviable egg was removed, and an egg translocated from Barking Sands was placed in the nest. Translocated eggs are accepted by the foster parents as their own, such that the chicks are raised successfully to fledging by their foster parents. In 2007, a pilot study was conducted in the KTF area of Barking Sands, in which eggs that had been laid were left under the biological parent for up to two weeks, rather than being placed in an incubator. Naturally-incubated eggs had a higher hatching success than did artificially-incubated eggs (100% versus 70%), and breeding albatrosses that were left to incubate their eggs for two weeks, rather than being relocated immediately, subsequently returned to Barking Sands fewer times after removal of their egg relative to the number of relocations of those same individual birds in previous years.

Photo 3-44: Successful placement of a PMRF Laysan albatross egg with a surrogate parent at KPNWR.

The egg translocation program at Barking Sands has experienced four seasons of successful placement of eggs at KPNWR. The program supports both the PMRF BASH program and the enhancement of the Laysan albatross colony at KPNWR.

In December 2007, USFWS made seven recommendations to improve the efficacy of the BASH program (Appendix F5):

1. To reduce the number of birds flying through Barking Sands airspace and staff time and resources expended on the BASH program, the Navy will leave incubating adults at nest sites when eggs are removed from nests and discontinue all capture and transport of breeding albatrosses as these birds will return to the base.

2. The Navy coordinates the release of all captured non-breeding adult birds with KPNWR staff to improve knowledge of post-release status and behavior.

3. To reduce egg mortality, improve hatch success, and minimize the resources and staff time expended on the BASH program, the Navy will allow albatrosses to incubate their eggs until viability can be determined.

4. To reduce egg mortality, the Navy will draft and circulate for review a protocol for moving albatross eggs that minimizes vibration and jarring and minimizes their time in transport between nests or between nest and incubator.

5. In partnership with USFWS, the Navy will determine the viability of albatross eggs at PMRF and in foster colonies as soon as possible (seven days) after laying and move Barking Sands eggs off base and eliminate or minimize artificial incubation.

6. The Navy will provide KPNWR with complete data sheets to improve knowledge of life history and behavior of Laysan albatross.

7. The Navy will make the areas near the runway and missile launch sites inhospitable to nesting albatross (ground cloth, vegetation changes, etc.) to encourage nesting pairs to find other places to nest.

During the 2008-2009 albatross breeding season, recommendations 3, 4, and 5 were followed in the KTF section of Barking Sands, and data are currently being analyzed to determine the potential effects of recommendations 1, 3, and 5 on the BASH program throughout Barking Sands. The Navy is also in the process of coordinating with KPNWR staff to carry out recommendations 2 and 6 and is researching methods to carry out recommendation 7.

The current management strategy is outlined in a 2009 report (NAVFAC PAC 2009b; Appendix G12) that calls for a three-pronged approach: (1) Allow adults nesting in the KTF area to remain there, but remove their eggs, translocate the eggs to nests on the North Shore; (2) remove eggs and adults around the immediate vicinity of the airfield; and (3) translocate subadults to breeding colonies on Kaua'i's North Shore.

3.4.1.2 Base-wide Predator Control

Since 2006, there has been an ongoing base-wide predator control conducted by USDA-WS personnel to protect native species on the installation from dogs, cats, rats, barn owls, deer and pigs. The base-wide predator control provides direct protection to the following species:

- Hawaiian waterbirds within the vicinity of the ditches and oxidation ponds;
- Wedge-tailed shearwaters utilizing the two colonies;
- Laysan albatross while on the installation;
- Nēnē while on the installation;
- Threatened and endangered seabirds that may fall out on the installation;
- Hawaiian monk seals; and
- Native vegetation.

3.4.1.3 Protected Species Monitoring and Management

Currently, the PMRF Officer of the Day and installation security staff utilize a "Natural Resources Incident Checklist" that identifies the correct response and actions to be taken in the event of federally-listed threatened or endangered or otherwise protected species incidents or other wildlife interactions on base. The checklist provides telephone contact information for the PMRF Environmental Coordinator as primary contact, and contact numbers for associated federal and SOH agencies such as USFWS, DLNR, or USDA-WS.

1. Newell's Shearwater and Hawaiian Petrel Monitoring and Management

The PMRF Environmental Coordinator and NAVFAC PAC biologists completed a monitoring project for potential threatened and endangered seabird tower strikes and fallout at Barking Sands between October and December 2008 (Burger *et. al* 2009). The goal of the program was to determine the extent to which tower/antenna strikes and fallout due to lighting conditions may affect federally threatened or endangered seabirds during over-flights at Barking Sands. The program addressed the following objectives:

- Compile over-flight information for Barking Sands based on ornithological surveillance radar;
- Monitor identified towers and antennas for bird strikes;
- Map any tower strikes or fallout of threatened or endangered seabirds;
- Monitor and record information on threatened and endangered seabirds brought to the Save Our Shearwaters (SOS) Station at Barking Sands.

Data from past ornithological radar surveillance studies on the south and west sides of Kaua‘i indicate that Barking Sands is located in an area of the island in which numbers of over-flights by Hawaiian petrels and Newell’s shearwaters are very low: approximately eight to 35 birds per hour compared to greater than 100 to greater than 800 birds per hour at sites on the north and east sides of the island.

During the nocturnal seabird fledging period of 1 October through 15 December, 2010, surveys will be conducted at communication towers at PMRF to quantify the risk of tower strikes to these species. Surveys will be carried out at all communication towers greater than 26 ft (8 m) in height at PMRF Main Base - Barking Sands, Mākaha Ridge, and Kōke‘e sites, and as per USFWS protocols will include downed bird surveys, searcher efficiency trials, and scavenger trials.

Results of carcass searches at the towers and antennas at Barking Sands (a total of 14 locations) in 2008 indicated no mortality of Hawaiian petrels or Newell’s shearwaters. Two zebra doves (non-protected species) were apparently killed by striking towers or guy wires, with results of searcher efficiency trial indicating that an estimated 2.22 dove strikes may have occurred. Based upon this information, it is unlikely that towers or antennas at Barking Sands pose a threat to Hawaiian petrels or Newell’s shearwaters making over-flights across the base. In contrast, the fallout of two Newell’s shearwaters at Barking Sands in 2008, and 11 in 2009, and one band-rumped storm-petrel in 2008 indicates that night lighting conditions on some areas of the base may cause disorientation for these nocturnally-migrating seabirds.

Exterior lights at the KTF facilities at Barking Sands were turned off at night to avoid negative impacts to Hawaiian petrels and Newell’s shearwaters (photo 3-45); the PMRF Environmental Coordinator is in the process of working with Barking Sands personnel to determine whether lights in other areas can be extinguished or shielded. Some locations at Barking Sands do require lighting at night to fulfill Navy operational and AT/FP requirements; for those sites at which lighting currently consists of white, unshielded bulbs, the PMRF Environmental Coordinator is working to determine whether white lights can be replaced by green bulbs. Past studies have indicated that birds flying at night were disoriented and attracted by red and white lights, while being less disoriented by blue and green lights (Poot *et al.* 2008).

Photo 3-45. View of Barking Sands from Mākaha Ridge (shows lighting and green test light).

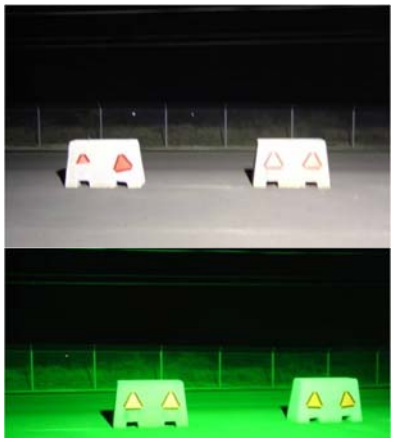


Photo 3-46: Comparison of visibility using white and green lights at Barking Sands.

In 2010, PMRF began determining the extent of lighting at Barking Sands and the feasibility of installing green bulbs on the installation (Photo 3-46). Visibility, for security purposes, was also tested and found to be acceptable in certain situations (Photo 3-47). Presently, the PMRF Environmental Coordinator is working with Facilities and Operations to determine areas where green bulbs may be installed. If installing green bulbs in operationally not possible, then additional shielding of white lights will be carried out in areas where this can be done while continuing to meet operational and AT/FP requirements (Burger 2009).

PMRF has supported the Kaua'i Humane Society's SOS program in training volunteers for banding and proper handling of birds prior to the onset of the Newell's shearwater fledging season. This training occurs in the wedge-tailed shearwater colony at Barking Sands. The Navy works with the SOS program to recover shearwaters that fall out by having a fallout station (photo 3-47) located inside the gate and reporting when birds fall out.

Photo 3-47: Shearwater Aid Station

2. Wedge-tailed Shearwater Management

Wedge-tailed shearwater colonies are located at the Barking Sands Beach Cottages and on the seaward side of Nohili Dune. In 2005, the Navy established the following short-term goals for managing the wedge-tailed shearwater colony at the Beach Cottages:

- Provide a revised information sheet on wedge-tailed shearwater biology and habits to guests staying at the Beach Cottages.
- Discourage burrow excavations on the mowed grassy areas at the Beach Cottages.
- Flag active burrows in areas where people regularly walk.
- Improve the nesting habitat within the fenced areas to encourage nesting in the "approved" locations.
- Resume predator control around the colony.
- Determine the geographic coverage of the nesting colony.
- Determine the burrow occupancy rate and shearwater breeding population size.
- Estimate reproductive success.
- Install permanent monitoring plots.

Photo 3-48: Reinforced shearwater burrow

During the non-nesting period in 2006, a major rehabilitation of the Beach Cottage colony was undertaken. Non-native vegetation was cleared and native beach plants were planted within the colony boundary. This effort involved the cooperative efforts between PMRF Environmental and Facilities Maintenance teams, KISC field crew, and NAVFAC PAC Natural Resources staff. To encourage colony expansion away from underneath the elevated cottages and support footings, several beach cottages were removed and additional areas adjacent to the Beach Cottage colony were cleared to enhance flight patterns and burrow construction. In addition, NAVFACPAC Natural Resources staff constructed artificial burrows using 8-in (20-cm) polyvinyl chloride (PVC) pipes and installed them in the cleared areas (Photo 3-48). Signs alerting the public to the presence of the colonies, the on-going restoration efforts and the restricted access to the colonies were installed.

In addition to the on-going enhancement/restoration project and predator controls, population monitoring within the beach cottage colony has been undertaken. NAVFAC Pacific contracted with a wildlife biologist to prepare a population survey of the shearwater colonies (Hebshi 2007; Appendix B5). This original survey recommended a population sampling plan including annual plot-monitoring surveys and whole-colony censuses and area delineations every three years. Surveys occurred in 2007, 2008, and 2009. The restoration efforts and population monitoring show that the number of wedge-tailed shearwaters using the area has been increasing in number and area (NAVFAC PAC 2008 and 2009b; Appendices B7 and B8).

3. Short-tailed Albatross

As discussed in section 3.3.1.1, a short-tailed albatross was observed on the installation in 2000. Although the likelihood of future sightings is small, the Navy is required to report sightings to USFWS within 24 hours. Any individual would not be hazed or disturbed in any way unless it presented a hazard to human health and safety (e.g., threat to aviation or itself). If the bird is observed at Barking Sands, training activities that may harm or harass the albatross would cease. In the June 25, 2009 consultation concurrence letter regarding the Advanced Radar Detection Laboratory (ARDEL) (on file with NAVFAC HI), USFWS requires the Navy to conduct a pre-operation visual survey within the vicinity of the facility. If a short-tailed albatross is observed, operations must cease until the individual leaves on its own accord.

4. Waterbird Species and Nēnē

Regular monitoring of Hawaiian waterbirds is conducted to note increases or decreases in the populations. In addition, the installation is patrolled by USDA-WS on a daily basis and by PMRF security personnel several times a day. These personnel report daily observations of protected bird species, monk seals, sea turtles, and anything unusual. For example, USDA-WS collects data on banded nēnē that are hazed at Barking Sands. When feasible, USDA-WS reads visible bands on nēnē and enters into a tracking database. This data was used to determine where the nēnē were originally banded. The majority had been banded at the Kōke‘e Sites.

5. Hawaiian Hoary Bat

As discussed in Section 3.3.1.1, Hawaiian hoary bats are known to forage at Barking Sands. Nesting has not been documented, although nesting and roosting may occur at the installation. Installation activities that may affect bats include tree cutting, if indeed nesting/roosting occurs on the installation, electro-magnetic frequency radiation from radar transmissions, and possibly barbed wire. Management and operations requirements with respect to bats stem from a USFWS consultation letter, (June 25, 2009 – on record at NAVFAC HI) with regard to the ARDEL facility. The letter states that "prior to operation the radar units at nighttime, personnel will visually survey for bats in the area of impact using ANABAT, or the closed circuit television cameras, and if one or more bats are present in the area of impact, RF emission will not begin until the bat(s) has left of its own accord."

6. Hawaiian Monk Seals

PMRF, NAVFAC PAC and NAVFAC HI Natural Resources Staff, and the CNRH Natural Resource Program Manager coordinate with federal and SOH agencies regarding Hawaiian monk seals. PMRF has been involved with monk seal recovery since 2005 which has included responding to hooked animals and reporting tag numbers to DAR for monk seal reporting and rescue. The Navy has provided NOAA Fisheries with input regarding the presence of Hawaiian monk seals on the beaches at Barking Sands through routine coordination and communication between Range environmental staff and agency personnel (DON 1998, 2001, 2008a, 2008b; NOAA Fisheries 2008, 2009a, 2009b).

As described in the December 2008 *Final Programmatic Biological Opinion on U.S. Navy Activities in the Hawaii Range Complex 2008-2013* (NOAA Fisheries 2008) and the *Hawaii Range Complex Final Environmental Impact Statement (FEIS)/Overseas Environmental Impact Statement (OEIS)* (DON 2008a) the actions listed below will occur prior and during any training/operations activities. Training activities include missile launches and expeditionary assault landing activities.

- If marine mammals (including Hawaiian monk seals) are observed during prelaunch safety clearance activities, the launch is delayed until marine mammals (including monk seals) are clear of the launch safety zones. If monk seals are observed in the launch safety zone, the launch is delayed until the animals voluntarily leave. Amphibious landings at Barking Sands adhere to all guidance regarding the protection of Hawaiian monk seals on the beach relative to those areas. Mitigation measures are instituted to assure minimal impacts to these species. Specifically, prior to conducting a landing exercise, an inspection and survey protocol include:
    a. Within one hour prior to the commencement of an amphibious landing exercise, observers survey affected beaches for Hawaiian monk seals.
    b. Should Hawaiian monk seals be found on the beach, the landing is delayed until the animal(s) has (have) voluntarily left the area; or the landing is moved to another location free of such animals.
    c. Landing craft and their crew are made aware of the potential presence of Hawaiian monk seals and other protected species (NOAA Fisheries 2008).

A Fisheries Species Recovery Plan (2007) has documented the continued sharp decline in numbers of this species to approximately 1,200 individuals in the NWHI and MHI. In the MHI, the plan specifies a goal to:

> "Ensure the continued natural growth of the Hawaiian monk seal in the MHI by reducing threats including interactions with recreational fisheries, disturbance of mother-pup pairs, disturbance of hauled out seals, and exposure to human and domestic animal diseases. This should be accomplished with coordination of all federal, state, local and non-government parties, volunteer networks, and increased outreach and education in order to develop a culture of co-existence between humans and seals in the MHI."

The Navy has provided NOAA Fisheries input regarding the presence of Hawaiian monk seals on the beaches at Barking Sands through routine coordination and communication between PMRF environmental staff and agency personnel (DON 1998, 2001, 2008a, 2008b; NOAA Fisheries 2008, 2009a, 2009b). Current management for the species at PMRF, including Barking Sands, is guided by this document and, in part, by the December 2008 *Final Programmatic Biological Opinion on U.S. Navy Activities in the Hawaii Range Complex 2008-2013* (NOAA Fisheries 2008). The *Hawaii Range Complex FEIS/OEIS* (DON 2008a) did not identify specific threats to Hawaiian monk seals from activities associated with the Navy's activities in the Hawaii Range Complex. Mitigation measures identified in Section 6.1 of the Hawaii Range Complex FEIS/OEIS would mitigate the effects of missile launches and expeditionary assault exercises at Barking Sands. The following Navy programs are currently in place at Barking Sands in an effort to conserve, protect, and provide benefit to Hawaiian monk seals to ensure their long-term conservation, consistent with the Species Recovery Plan.

Marine Debris Entanglement at Sea: As part of Hawaii Range Complex activities, expended training materials do enter the ocean. When possible, these materials are retrieved. Expended training materials that cannot be retrieved settle to the ocean bottom and are covered by sediment deposition over time (DON 2008a). These activities provide a benefit to and aid the recovery of the species.

In accordance with the Marine Debris Research, Prevention and Reduction Act (PL 104-449, 22 DEC 2006) and the Marine Plastic Pollution Research and Control Act (33 U.S.C. Section 1914), the Navy participates as a member of a federal Interagency Marine Debris Coordinating Committee which includes NOAA, USEPA, the Marine Mammal Commission and others. The committee is responsible for developing and recommending approaches to reduce the sources and impacts of marine debris. In addition, the Navy has assisted NOAA Fisheries and DOFAW biologists in two monk seal rescue operations in west Kaua'i. One event involving a seal with a fishing hook embedded in its mouth and another event with a seal that had debris entangled around its neck and abdomen.

Consistent with its mission and conforming to Navy policy to reduce and prevent adverse impacts on the environment through the environmental planning process, the Navy consistently seeks ways to reduce the amount of waste generated by its afloat forces. This is done, in part, by choosing items with less packaging and consistently improving the manner in which waste is handled. Many Navy ships not only meet existing legal requirements regarding waste management but exceed those requirements. For example, many ships have aboard plastic waste processors to consolidate, melt and store plastics into large discs. Those discs are then retained on board until they can be transferred to shore for potential reuse or disposal.

In addition to exercising strict discipline and accountability regarding the Navy's environmental protection obligations, the Navy promotes excellence in environmental protection through its Secretary of the Navy environmental awards program. For example, the USS PAUL HAMILTON, home-ported at Pearl Harbor, received a Secretary of the Navy award in 2009 for its environmental protection program which included holding all of its plastics, metal and glass

aboard the ship until all could be transferred to a port. While in port, the ship's crew participated in a number of O'ahu beach cleanups.

In Hawai'i, the Navy has participated for more than a decade with the University of Hawai'i Sea Grant Extension program's Interagency Task Force and the Ocean Conservancy's International Coastal Cleanups to raise awareness and facilitate mitigation of marine debris. When mission priorities allow and when determined to be of training value, Navy members have worked in partnership with other agencies in removing derelict fishing gear caught on the ocean floor in the NWHI. Navy members and those employed by or affiliated with the Navy often organize and participate in community shoreline cleanups, using those opportunities to educate and bring attention to the issue. Marine debris is frequently a topic of a display at the annual Navy Region Hawai'i Earth Day Fair with its focus on children and education regarding protection of the environment. On the island of Kaua'i, PMRF has an active marine debris awareness/outreach program. Base volunteers routinely gather on their lunch break to collect beach debris and record what they collect. When participating in local educational fairs and gatherings, the displayed materials include a photo presentation on the impacts of marine debris on marine species, including seabirds, which inadvertently consume plastics and perish as a consequence.

These Navy programs, policies, and activities serve to minimize marine debris associated with Navy activities and provide a benefit to and aid the recovery of Hawaiian monk seals.

Disease: Introduction of disease is a serious threat to Hawaiian monk seals as they may lack the antibody to fight the disease. With a small population, the introduction of lethal disease could devastate the recovery of the species. In the MHI, concern lies with the introduction of infectious disease via transmission from livestock, feral animals, pets, or humans.

Loss of Terrestrial Habitat: Loss of terrestrial habitat as a result of such factors as storms and sea level rise is a serious threat to Hawaiian monk seals in the NWHI. At Barking Sands, the terrestrial habitat for Hawaiian monk seals has been largely unchanged during the Navy's tenure. The combination of access restrictions over much of Barking Sands, and minimization of interactions with Hawaiian monk seals through signage, cordoning of haul out areas, and security patrols, provide undisturbed terrestrial habitat.

Due to global warming, sea level is expected to rise as much as 3 ft (1 m) by the end of the 21st century (University of Hawai'i School of Ocean, Earth Science, and Technology 2009). Barking Sands is sited on a 2,060-ac (834 ha) parcel of land located at elevations ranging from sea level to100 ft (30 m) above mean sea level with a nominal elevation of 15 ft (4.6 m) above mean sea level. The coastline at Barking Sands is characterized by a wide emergent fossil reef and sandy beach with moderately sloping dunes reaching elevations as high as 100 ft (30 m). The built environment at Barking Sands is generally at elevations greater than 15 ft (4.6 m) and away from the beach and dunes. It is unlikely that the predicted sea level rise within the next century will result in a loss of terrestrial habitat for Hawaiian monk seals at Barking Sands. The maintenance of the terrestrial habitat for monk seals provides a conservation benefit to and aids the recovery of the species.

Fishery Interaction: Within the MHI, fishery interaction with Hawaiian monk seals is a serious threat to the species. At Barking Sands, there is potential to reduce the number of hooking/entanglements related to pole fishing by significantly reducing the accessible areas and the times of access. The Navy limits shore fishing at Barking Sands to the Recreation Area between 5:00 A.M. to 10:00 P.M and the Special Use Area between 5:00 A.M. to 10:00 P.M on weekends and holidays (Figure 3-7). The fishing restrictions imposed in the Recreation Area and

the Special Use Area (Figure 3-7) allow only for pole, throw net, and spear fishing. Of the three methods, only pole fishing poses any potential risk to Hawaiian monk seals as the other two methods (throw net and spear fishing) would never be intentionally geared to seals. While there is some potential for interaction, the frequency and locations of Hawaiian monk seal haul-out areas recorded over the past three years suggests a preference for the northern half of Barking Sands whereas the vast majority of fishing opportunities - both temporal and spatial - are along the southern half. The area of greatest potential for fishery interaction with Hawaiian monk seals is in the Special Use Area where the seals have most commonly observed. However, due to its location (e.g., requires fisherpersons to walk to the area) and the previously described controlled access, fishery interaction with the seals is substantially reduced. Fishing and beach access restrictions are enforced by installation security details which patrol the beach several times per day.

Human Interaction: Human interaction is a serious threat to Hawaiian monk seals in the MHI; however, public access is limited and controlled at the beach at Barking Sands and as a result limits human interaction with the seals. At Barking Sands, there is some potential for disturbance of Hawaiian monk seals (human interaction) through beach access and fishing activities, but much less than a comparable public beach. The locations of the majority of the observations of Hawaiian monk seals at Barking Sands are north of Kinikini Ditch in the Special Use Area (Figure 3-7) extending up to the northern property boundary. Installation security enforces beach restrictions and ensures that beach users stay at least 150 ft (46 m) distance from any Hawaiian monk seals hauled out on the beach. This includes the placement of cones, rope and signage to exclude disturbance in public access areas. The beach is patrolled once a day, five days a week by USDA-WS personnel and several times a day by installation security details. Hawaiian monk seal sightings are reported/recorded by both. If any entangled or injured monk seal is observed, PMRF Environmental personnel contact information is provided to both Security Dispatch and contained in the Command Duty Officer's handbook and the necessary notifications are made. In addition, natural resources literature is provided in the Beach Cottages and in Welcome Aboard packages for new personnel/residents describing Hawaiian monk seals, their status as protected species, and requirements for not disturbing or harassing the animals as well as keeping at least 150 ft (46 m) distance from the animals (Appendix G9). In addition, PMRF has prepared a Hawaiian Monk Seal Protocol for PMRF (Appendix G8) and a Marine Mammal Response Protocol for PMRF (Appendix G5). These protocols provide information about seals in distress, problem seals, seal pupping, and dead seals and include notification requirements.

Biotoxins: Biotoxins are a moderate threat to Hawaiian monk seals; however, they have not been identified as a threat at Barking Sands. Navy activities at Barking Sands are not likely to trigger biotoxin outbreaks in the marine environment.

Vessel Groundings: Vessel groundings are considered a moderate threat to Hawaiian monk seals. There have been no vessel groundings at Barking Sands during the Navy's tenure at Barking Sands. The only Navy watercraft located in the nearshore waters at Barking Sands are amphibious landing craft and their carrier vessels that are used in RIMPAC Expeditionary Assault landing exercises which occur every other year (on even numbered years). During the four to five days of these exercises, these craft come ashore at Majors Bay. Personnel then train in the rapid, yet safe, offloading of equipment and personnel onto shore from smaller landing craft that were contained in the larger off shore ship. They then reload the equipment and personnel into the small landing craft and return to the larger ship sitting offshore. The carrier vessels stay offshore throughout the exercises. Although the Navy rigorously trains personnel to avoid grounding water craft, any grounding incidents would be immediately addressed and appropriately mitigated to

avoid harm to Hawaiian monk seals and their habitat. These Navy protocols reduce the potential for vessel groundings to occur and the potential harm to Hawaiian monk seals from any incident of vessel grounding.

Contaminants: The presence of contaminants in Hawaiian monk seal habitat is a moderate threat to the species. The Navy is not aware of instances of environmental contamination within or from Barking Sands that would impact Hawaiian monk seal terrestrial or aquatic habitat. The Navy has in place environmental compliance and restoration programs at Barking Sands that address the proper handling, use, storage, and disposal of hazardous and regulated materials.

7. Pelagic Cetaceans

No Barking Sands shore activities interact with cetaceans. However the Letter of Authorization (LOA) for Fleet training activities issued by NOAA Fisheries defines minimization and mitigation requirements to reduce the effects of sonar training on these animals. These requirements, as stipulated in the LOA, call for observer monitoring and cessation of sonar use within the vicinity of a marine mammal. Fleet is responsible of implementing the requirements of the LOA. LOAs are re-issued annually, and the most recent can be obtained through the Fleet Natural Resources Program Manager. A recent LOA is attached as reference in Appendix F7.

Occasionally, beached and/or dead whales are found along the installation's shoreline. A partnership with NOAA Fisheries has been established whereby the agency can use the Barking Sands installation for necropsy examination. The PMRF is to coordinate with NOAA Fisheries for beached whales and necropsies.

PMRF has participated in the NOAA Ocean Count on the last Saturday of December, January, and February of each year since 2002 in order to provide locations and frequencies of humpback whale sightings in the waters off Barking Sands. The PMRF has facilitated NOAA volunteer access to the base and should continue to do so.

8. Sea Turtles

While green turtles are abundant onshore at Nohili Ditch outfall and in nearshore waters, hawksbill turtles are rare around PMRF. PMRF is patrolled by USDA-WS on a daily basis and by PMRF security personnel several times a day. These personnel report daily observations of sea turtles. PMRF initiated a log book of green turtle basking observations at Nohili Ditch, including sightings, and tracks, starting in 2006. This record confirms the routine sightings of green turtles throughout the year, in varying number, basking at Nohili Ditch. Haul-outs of green turtles elsewhere on Barking Sands beach are extremely rare. Kaua'i DLNR staff documented one case of nesting by a green turtle at Barking Sands approximately 1.3 mi (2 km) north of Kokole Point in 1989 (Figure 3-2). In 1999, two documented green turtle nests producing 38 hatchlings, and four indications of further nesting activity such as digs and pits were recorded in the Nohili Ditch area (Dollar and Brock 2007). In 2010, there were two green turtle nesting events that occurred on the beach between the runway complex and Nohili Ditch. Both nests were protected, monitored, and recorded successfully hatched. PMRF staff have assisted and will assist properly authorized or permitted state or federal wildlife officials in rescuing, removing, moving turtles including the hand excavation of nests to allow hatched turtles to emerge to the surface and reach the ocean.

In the *Hawaii Range Complex FEIS/OEIS* informal consultation letter from USFWS dated June 13 2008 (on file with NAVFAC HI and NAVFAC PAC) USFWS discounted any potential training effects to hawksbill turtles. However, beaches are required to be surveyed one hour prior to

beach landing excercises, and if sea turtles are present (most likely green turtles), then training is to be delayed until the animal(s) voluntarily leave the area.

3.4.1.4 Marine Debris Program

As discussed in Section 3.4.1.3 item 6 Hawaiian Monk Seals, the Navy consistently seeks ways to reduce the amount of waste generated by its afloat forces. Many Navy ships not only meet existing legal requirements regarding waste management but exceed those requirements. The Navy does not dispose of plastics at sea. Instead, Navy ships retain all plastics on board, melting and compressing the accumulated materials into disks which are held on the ship until the ship reaches its next port for land-based recycling or disposal. At a workshop on marine debris at the Waikiki Aquarium, former Navy Region Hawaii Commander, Admiral John Townes, showed a sample consolidated plastic disk to workshop attendees (Photo 3-49). In addition, Navy members have worked in partnership with other agencies in removing derelict fishing gear caught on the ocean floor in NWHI.

Photo 3-49: Admiral John Townes displaying a plastic disk created from a Navy afloat recycling program.

Photo 50: (Above) Navy volunteers participating in NMDMP and (below) typical marine debris collected during NMDMP surveys.

PMRF participated in the National Marine Debris Monitoring Program (NMDMP) with two teams of volunteers to collect and survey two 1,640 ft (500 m) Global Positioning System (GPS)-located reaches of Barking Sands beaches on 28-day intervals (Photo 3-50). PMRF collected/collated the data and forwarded it to the Ocean Conservancy/USEPA Contractor. The NMDMP concluded in the spring of 2008, and a summary report has been issued to include specific findings as they relate to the nature and quantities of marine debris washing up on U.S. shorelines.

Marine debris entanglement is a crucial threat to Hawaiian monk seals. The Navy voluntarily participates in beach cleanups at Barking Sands. PMRF was the only location on Kaua‘i that participated in the NMDMP. During the study period, an estimated 95% of the materials recovered were plastic, ranging from small fragments to massive entanglements of lines/nets/hawsers. Large entanglements were rare with most under 5 pounds (2.3 kilograms); however, there were two large entanglements of several hundred pounds. The bulk of materials were plastic fragments, plastic bottles, crates, tube spacers, short pieces of line (less than 5 ft [1.5 m]) and small sections of fish net. The seasonal surf tends to accumulate from the south/southeast during the summer months and from the north/northwest during the winter season. However, in contrast to the windward side of Kaua‘i, marine debris is sparse and the beaches are relatively clean throughout the year. The removal of marine debris from PMRF’s beaches, including fishing nets, reduces the risk of entanglement to Hawaiian monk seals.

3.4.1.5 Beach and Dune Access Restrictions

Security restrictions instituted to address AT/FP concerns at Barking Sands have limited access to the shoreline in this area to military personnel, residents, DOD-employees, and persons having a valid PMRF Recreation Pass. Changes in security made at PMRF after the 11 September 2001 terrorist attacks have benefited protection of beach habitat for several species. Restricting vehicular access and pedestrian traffic to the Nohili Ditch area has provided protection for green turtles basking and foraging in the area. A sign was installed above the area to alert pedestrians of the presence of the protected species (green turtles) and to stay out of the area. All personnel conducting security patrols receive training on all beach and dune access restrictions.

Changes in security made at PMRF after the 11 September 2001 terrorist attacks have benefited protection of beach habitat for several species. Restricting vehicular access and pedestrian traffic to the Nohili Ditch area has provided protection for green turtles basking and foraging in the area. A sign was installed above the area to alert pedestrians of the presence of the protected species (green turtles) and to stay out of the area.

Personnel living on Barking Sands are allowed to keep cats and dogs as pets as long as the animals are restricted to the family housing area. Only animals on leashes are allowed on the beach at Barking Sands. Leash laws for residents are enforced by the PMRF Security patrols, and all non-residents, whether PMRF employees or recreational pass holders, or guests, are stopped at the gate and not allowed to enter with dogs. This action has protected the wedge-tailed shearwater colony at the Beach Cottages, which is near the Major's Bay recreation area and likely reduces the possibility of introduction of certain diseases to Hawaiian monk seals.

Vehicle access restrictions to 75 percent of the Barking Sands beachfront has resulted in observable recovery of beach and strand vegetation. Only base security is allowed to drive on the beaches and the drivers of those vehicles utilize established paths to access the beach. Troops at Barking Sands are directed to avoid sensitive vegetation, including the dune areas, in accordance with current guidelines through the PMRF Environmental Coordinator.

With restricted access and shore fishing restricted between 5:00 A.M. to 10:00 P.M. at the Recreation Area and from 5:00 A.M. to 10:00 P.M. on weekends and holidays at the Special Use Area (Figure 3-7), fishing pressure at Barking Sands is likely to be less than other nearshore environments on the west side of Kaua‘i, the majority of which do not have fishing restrictions.

Shearwaters feed at sea at night and are inclined to fish for hooked bait at the end of fishing line. This behavior may lead to entanglement, injury, or death. PMRF restricts shoreline fishing in the evening and night in the vicinity of the shearwater colonies in order to minimize the impact to shearwaters.

3.4.1.6 Invasive Species Prevention and Control

The airstrip is a potential port of entry for invasive plant and animal species that may adversely natural resources. Most incoming flights to Barking Sands stop in Honolulu prior to flying to Barking Sands. While in Honolulu, these aircraft are for inspected by SOH Department of Agriculture (DOA) (domestic flights) or U.S. Customs (international flights). On occasion, a domestic flight may fly directly to Barking Sands. PMRF informs the DOA Quarantine Officer of any planes arriving directly from the U.S. mainland or Alaska. PMRF coordinates with DOA for the inspection of the flight's cargo and the processing of the agriculture declaration. All inbound flights carrying cargo from areas outside of Hawai‘i and landing at Barking Sands are advised to

inspect and secure cargo in accordance with OPNAVINST 6210.2, Quarantine Regulations of the Navy prior to shipment to ensure that it is free of invasive species. These regulations are intended to prevent the introduction and dissemination, domestically or internationally originated, of diseases affecting humans, plants, and animals; prohibited or illegally taken wildlife; arthropod vectors; and pests of health and agricultural importance.

Furthermore, all Navy and contractor vehicles are required to be washed down prior to mobilization to Barking Sands and other PMRF facilities and are washed down again after completion of activities in order to minimize the potential for introducing alien and/or invasive species. In addition, PMRF maintains SOPs for personnel training and provides natural resources information to personnel relocating to PMRF. Welcome Aboard packages for incoming Navy personnel currently include information regarding the sensitive habitats at Barking Sands and other PMRF installations and the necessity for cooperation from military forces, personnel, and residents on preventing the introduction of invasive species. PMRF includes information on the effects of alien plant and animal species to native ecosystems, and threatened and endangered species.

The botanical survey of Nohili Dunes (NAVFAC PAC 2006a, Appendix A1) identified additional invasive noxious plants to be controlled which will be addressed by PMRF Environmental and NAVFAC PAC Natural Resources staff in their ongoing efforts to restore native dune vegetation (see below). In addition, all grounds-keeping equipment (e.g., mowers, equipment, tools) is washed down and blown dry by the grounds keepers prior to movement from each installation in order to prevent invasive species introductions.

3.4.1.7 Dune Restoration

Nama, a species of concern, is found on the southern half of the property, from the vicinity of the housing area to the antenna fields. The Navy monitors the critical habitat for lau'ehu, has restrictions on use (e.g., training, access), and has actively removed LTK from critical habitat as well as other areas on base (Section 3.3.1.2). PMRF avoids disturbing the vegetation in these areas in order to preserve the native vegetation, including nama. Personnel training at Barking Sands are directed to avoid sensitive vegetation, including the dune areas, in accordance with current guidelines. However, the integrity of this critical habitat and dune vegetation continues to be compromised by invading weeds such as haole koa, kiawe, and non-native grasses.

1. Long-Thorned Kiawe Control

LTK or algarroba (mesquite) is an invasive plant that creates a monotrophic condition along some of Barking Sands beach stands. It is being successfully controlled through the cooperative efforts of PMRF Environmental, NAVFAC PAC Natural Resources, KISC, and a local heavy equipment operator. Between 2005 and 2007, there have been three operations by this team that have developed an innovative approach to remove the plant, prevent regrowth, and enhance the recovery of the native beach vegetation. Starting at the south end (Kokole Point) and working northward, the mixture of grinding and

Photo 3-51: LTK removal site at Barking Sands

windrowing LTK around clusters of native vegetation (marked and identified by NAVFAC PAC Natural Resources staff), followed by saw-cutting the stumps and chemical treatment (KISC), has been undertaken as a first phase in each evolution (Photo 3-51). Subsequently, regrowth from the seed bed and any missed stumps has been prevented by KISC, who routinely returns for re-spraying. NAVFAC PAC Natural Resources staff has collected and spread native seeds as part of each evolution. After three episodes, KISC has determined this to be the most cost-effective method of LTK control, with one week of grinding/cutting/treatment effort approximately equal to a full year of effort by a 10-person crew working with hand tools. In addition, USFWS has commended the Navy on the LTK control at Barking Sands and recommended continued funding and implementation of the program. Since 2005, the Navy, in cooperation with KISC removed approximately 19 ac (7.7 ha) of LTK. The LTK at Barking Sands represented the largest coastal stand of this invasive tree species on the island.

Photo 3-52: Beach naupaka

NAVFAC PAC Natural Resources staff have collected seeds from native beach vegetation and planted them along the Barking Sands beach strand and dunes in an effort to enhance and improve native habitat. Koa haole, kiawe, and buffel grass should be selectively removed to maintain native species (photo 3-52) dominance in undeveloped areas of the dunes. In addition, USFWS has commended the Navy on the native habitat improvement at Barking Sands and recommended continued funding and implementation of the program.

3.4.1.8 Wetlands

Photo 3-53: Oxidation Pond

The Navy maintains a policy to protect wetlands from dredging, filling, or otherwise destroying without the proper permits and necessary minimization and mitigative actions. PMRF maintains oxidation ponds (Photo 3-53) at Barking Sands which are part of the installation's sewage system. These ponds, along with the irrigation ditches at Barking Sands, are utilized by protected waterbird species (Section 3.3.2). The irrigation ditches are maintained by the SOH Agricultural Development Corporation (ADC). The ADC or its contractor ensures compliance with CWA and ESA prior to and during maintenance activities at the ditches (e.g., mowing, dredging, or other activities). ADC shall not disturb endangered and threatened species and their habitat. The ADC shall carefully protect in-place and report immediately to the Navy any endangered and threatened species discovered in the course of work. The ADC shall stop work in the immediate area of the discovery until directed to resume work. In addition, the Navy avoids wetlands and other environmentally sensitive habitats in its regular training areas and transit routes at Barking Sands.

3.4.2 Natural Resources Studies

The following natural resources studies were completed or are underway at Barking Sands:

- In 2005, NAVFAC PAC Natural Resources staff completed a conservation mapping project of Barking Sands to assist with planning requirements (showing natural resources constraints) (Appendix A10 and B4).
- NAVFAC PAC Natural Resources staff completed botanical and fauna surveys (birds, herpetological and mammal surveys) in 2006 in order to support this INRMP (Appendices A1, B1 and B2).
- PMRF Environmental Department funded a follow-on marine resources and fisheries survey of the coastal/marine environment at Barking Sands in 2006 (Appendix C1). This survey documented what appears to be an increase in the size, diversity, and quantity of both commercial and recreational fisheries and marine resources (Dollar and Brock 2007). Theoretically, a decline in fishing activities should result in increased sizes and abundance of fish, and/or a potential shift in their behavior. The 2000 and 2006 surveys suggest such change may be occurring for certain fish species in certain areas; however, further and more thorough investigation is required.
- The ANABAT system is being used and standardized by U.S. Geological Survey (USGS) for Hawaiian hoary bat surveys on PMRF to help in determining distribution and abundance.
- In compliance with the *NOAA Fisheries Biological Opinion* and requirements of the MMPA LOA for the Hawaii Range Complex (NOAA 2009a and b), the Navy has developed a monitoring plan, *Hawaii Range Complex Monitoring Plan December 2008* (HRCMP; DON 2008b), to provide marine mammal and sea turtle monitoring. HRCMP was designed as a collection of focused studies pertaining to marine mammals and sea turtles and the use of mid-frequency sonar and explosives during Hawaii Range Complex training activities. Some studies pertain to exposure and behavioral responses of marine mammals and sea turtles to Navy training activities. The studies include aerial surveys, marine mammal observers on board Navy ships, tagging of marine mammals and sea turtles, and shore based surveys. Hawaiian monk seals are one of the focus species in the HRCMP and COMPACFLT has collaborated with NOAA Fisheries to gather additional data on the distribution, movement, and behavior of monk seals. This additional knowledge will provide a net conservation benefit to the species as well as meet the Navy's MMPA and ESA requirements.

3.4.3 Use of Geographic Information Systems

The installation's natural resources data is integrated into the installation's GIS system and made available to planners and land managers to aid in decision-making. PMRF and NAVFAC PAC Natural Resources staff ensure that newly acquired or updated natural resources information is integrated into the installation GIS database on a regular basis. NAVFAC PAC has created GIS layers in a geodatabase format for Barking Sands for the following data: (1) fauna habitat; (2) fauna special species areas; (3) wildlife management areas; (4) flora special species areas; and (5) land vegetation cover.

3.4.4 Forestry

DOD installations can support commercial forestry operations on DOD lands that are compatible with operational and natural resource protection objectives. While PMRF has no traditional lumber/forest resources for commercial sale, the two invasive kiawe species offer a limited source of raw-wood material for furniture, crafts, charcoal, wood chips, or biomass energy production. While a market survey has not been conducted to assess the commercial value of kiawe at Barking Sands, it is likely that the product value is less than removal costs. Selling forestry products cannot be used to explicitly offset the costs of removal, but a contractor may seek to submit a low bid for kiawe removal with the knowledge that they can sell the product offsite and recoup some of their removal costs. A project is described in Chapter 9 to conduct a market survey of kiawe products and to tabulate the tonnage of potentially available kiawe on the installation.

3.4.5 Community Outreach

PMRF's natural resources education campaign includes: (1) educating the community by widely distributing posters, brochures, and signs about the installation's natural resources; (2) providing maps identifying restricted or sensitive areas to installation personnel, residents, and visitors; and (3) including references to the cultural significance of the resource as well as Hawaiian names of plants, animals, and ecosystems in all natural resources information.

PMRF has created a central repository of natural resources education material at the Pass & Identification office at the main gate to Barking Sands. The information is provided in the form of posters depicting the protected species at the installation. Brochures, flyers, and educational materials from partner agencies are also available.

PMRF and NAVFAC PAC Natural Resources staff have placed signs indicating appropriate behavior to protect and preserve threatened and endangered species and other protected species at several key locations within Barking Sands. In addition, PMRF prints vinyl signs showing educational and cautionary information at various locations including MBTA bird nesting areas, and fragile habitats such as coastal dunes and wetlands. The signs explain legal and regulatory implications of interacting with federally-listed threatened and endangered or otherwise protected species. The signs have been placed where such interactions are most likely, such as green turtle habitat at Nohili Ditch and areas of frequent monk seal activity at Barking Sands or nēnē activity at Mākaha Ridge Tracking Station.

Natural resource volunteer projects include beach cleanups, invasive plant control, and humpback whale and Hawaiian monk seal counts. The PMRF Environmental Coordinator is responsible for facilitating volunteer groups.

Natural resources staff have worked with Camp Malama Kaua'i's (an environmental education group) teachers and students in efforts to increase awareness of the wedge-tailed shearwater colonies at Barking Sands.

Biomes, depicting the major habitat types at PMRF, have been constructed with the help of volunteers outside of the Pass and ID office as an educational tool for visitors and employees. This project should continue to be supported. On a 200 ac (80 ha) leased area (see Sections 3.4.8 and 3.4.11), the Navy has constructed a visitors' center that includes a medicinal and native plant garden (Photo 3-54) as well as displays and signs pertaining to the natural resources that can be found at Barking Sands.

Photo 3-54: Community volunteers installing native plant garden at Barking Sands

3.4.6 Outdoor Recreation

The beach fronting PMRF is exposed to the open ocean. High surf, particularly during winter and spring, generates dangerous water conditions, including pounding shorebreaks, strong backwashes, and powerful rip currents. Fringing reefs adjoin the shoreline at Nohili and Mānā points but do not offer any protection to the shoreline for swimming. To the north of PMRF is Polihale State Park. Recreational and subsistence fishermen at Barking Sands and Polihale State Park are typically fishing for jacks (carangids, papio) and squirrelfishes (holocentrids, alaihi) (photo 3-55).

Photo 3-55: Fishing at Barking Sands

Public access to Barking Sands's coastline is outlined in a PMRF Memorandum dated 29 January 2008. 5530.7 (Appendix G2). PMRF

employees, active duty, reserve and retired military and dependents have recreational access to approximately 2.0 mi (3.2 km) of coastline (Figure 3-14). Also, under the PMRF Recreation Pass Program, any U.S. citizen who completes the application process and passes the national background check can receive an annual Recreation Pass, which allows them the same access to beach areas as above. Recreational activities include surfing, fishing, and boating. The physical areas accessible for fishing/surfing/recreation/and socializing run from Shenanigans (All-Hands Club) up to Kinikini Ditch (south end of runway), Monday through Friday, and extend into the Special Use Recreation Area (Kinikini to the northern windsock of the runway) on weekends and holidays, except during heightened force protection conditions or range operational periods. Beach use hours are from 5 a.m. to 10 p.m. PMRF does not authorize the collection of marine resources outside of the recreation areas.

PMRF's Morale Welfare and Recreation department manages the Recreation Pass program. PMRF Range Operations maintains a 24-hour hotline, which is updated daily in order to provide information on recreational area access.

Missile launches at the northern portion of KTF temporarily affect the southern portion of Polihale Beach Park, a popular site for tourists and island residents. There is no fence or barrier between the beach park and the base, and the beach is an easy path for civilian encroachment on foot or via four-wheel-drive vehicle. The Navy works with the DLNR State Parks Division to establish safety controls during missile launches and restricts entry beginning 20 minutes prior to launches to minimize closure of the road to the park. Through a 24-hour hotline at Barking Sands advance notification of beach closure times is provided, so minimal impacts on outdoor recreation and are expected. Closure of the southern portion of Polihale State Park would occur for no more than 30 minutes per launch or up to 15 hours total per year. This would only affect the southern end of the park, which in turn would only affect the ability of minority and low-income populations to subsistence fish for short periods during the year.

3.4.7 Land Management

The land management program involves balancing the operational and human-use requirements of the installation with protection and enhancement of natural resources. Land management areas can be classified as developed, ruderal, or undeveloped. Developed areas include locations of facilities and roads. Ruderal areas include cleared areas surrounding facilities that require some maintenance (e.g., mowing around the airfield, minimal landscaping), but whose surface is not hardened. Undeveloped areas include sites with varying degrees of natural resource value, but which are currently unmaintained by grounds maintenance crews. The land management program element contains three components: (1) base planning to ensure minimization of natural resource impacts while meeting operational needs; (2) landscaping within ruderal and developed areas compatible with natural resources; and (3) protection of natural resources in undeveloped areas.

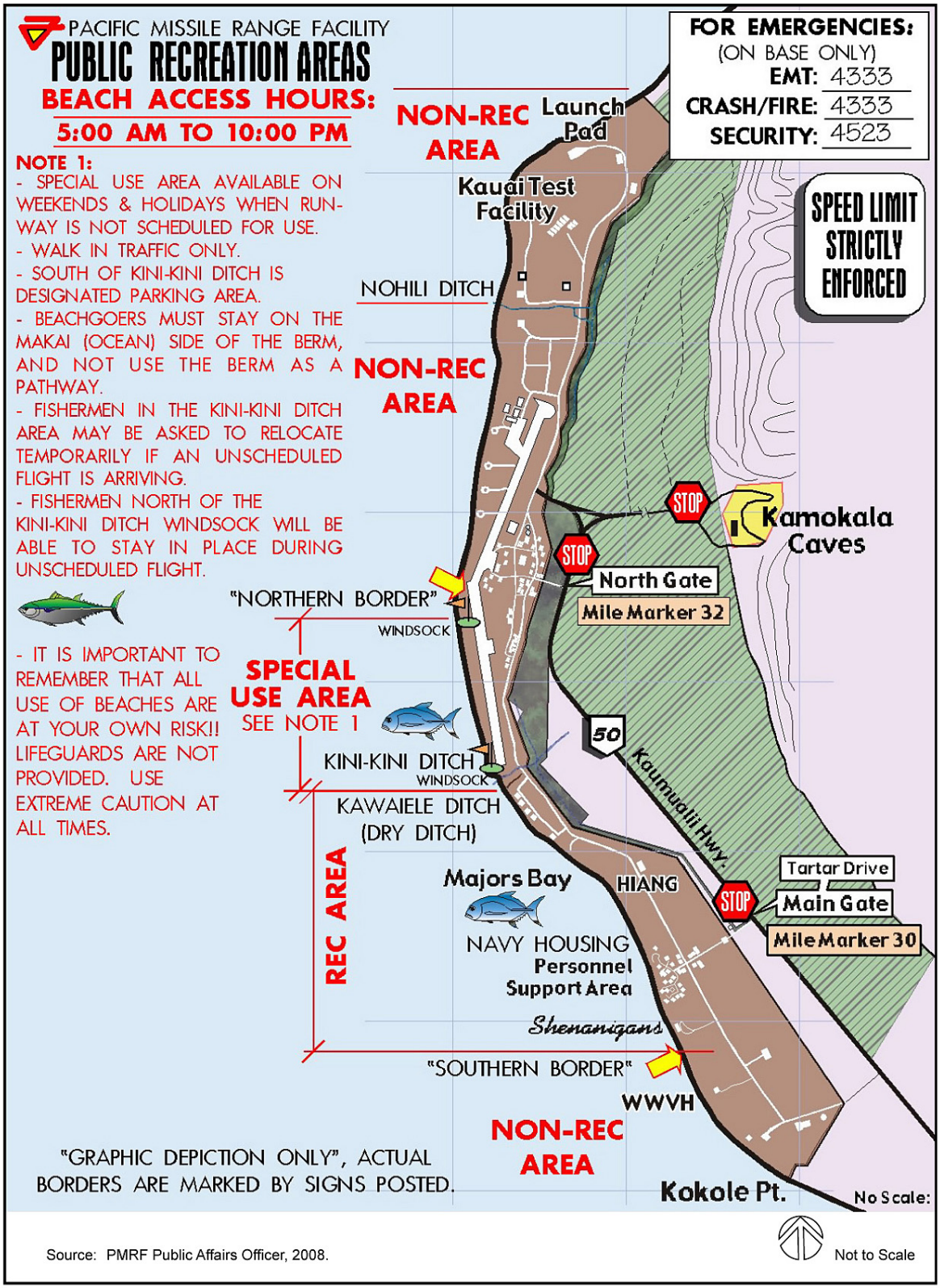


Figure 3-14: Barking Sands Public Recreation Areas

3.4.7.1 Base Planning

PMRF staff follow a routine procedure to assure coordination among facilities planners, resource managers, and government agencies. The PMRF Environmental Coordinator is the primary point of contact to provide relevant information on issues with potential to affect natural resources. All new construction projects at Barking Sands and other PMRF locations are vetted by thePMRF Environmental Coordinator to minimize natural resource impacts while meeting operational needs. New facilities are sited preferentially in ruderal or developed land-use categories. The PMRF Environmental Coordinator reviews base activities to ensure compliance with natural resources laws and regulations, including wetlands protection, migratory bird protection, critical habitat protection, and erosion control.

3.4.7.2 Landscape Design

Landscaping guidelines for DOD Installations are documented in UFC 3-201-02, 2009 (Appendix G11). As discussed in Section 3.1.5 of the guidance, landscaping projects within developed and ruderal areas should incorporate xeriscaping and use native plants where possible. Landscaping immediately adjacent to undeveloped areas with natural resource value, such as at Major's Bay and the Beach Cottages, should be done exclusively with native vegetation. The landscape architect and PMRF Environmental Coordinator should coordinate on landscaping projects to ensure compliance with this INRMP and in accordance with DOD guidelines.

3.4.7.3 Protection of Natural Resources in Undeveloped Areas

As discussed in Section 3.3.5, undeveloped areas of base have significant natural resources value in that they contain large tracts of native habitat and plant species, such as dodonea, nama, ilima, and other dry-land coastal plants. In areas with heavy growth of kiawe, clearing of this non-native overgrowth has allowed re-generation of native species from the seed bank. As discussed in Chapter 9, non-native, invasive vegetation should be aggressively managed to reduce encroachment of non-native species, and restore, where applicable, the native vegetation community.

3.4.8 Floodplains

The primary floodplain program at Barking Sands is the maintenance of the drainage ditches (by SOH) and drainage pumps. The Navy currently leases about 200 ac (81 ha) of land in the area between the current fence line and the highway. The lease of this land allows the Navy to repair and maintain the drainage pumps that prevent the Mānā Plain from flooding (Section 3.4.11).

3.4.9 Law Enforcement

PMRF military, civilian, and contractor security forces are responsible for patrolling the installation several times a day. They work with PMRF Environmental in reporting any incidents observed pertaining to Barking Sands natural resources including the presence of sea turtles and monk seals on the beach and any concerns regarding protected bird species. They enforce beach and fishing restrictions, access restrictions to Nohili Dunes, and ensure that the public does not disturb monk seals and sea turtles basking on the beach.

3.4.10 Wildland Fire

There have been no historic wildland fires at Barking Sands. The Base Operations Support (BOS) contracted fire department would respond to any fires at the facility.

3.4.11 Leases and Encroachment Management

The Navy leases 200 ac (80 ha) from the SOH for an AT/FP buffer zone. The Navy, through its encroachment program, must continue to be vigilant on development plans adjacent to Barking Sands along Mānā Plain. If re-zoning is proposed, the Navy should consider leasing additional land to minimize encroachment.

For many years, the land adjacent to Barking Sands was used for sugarcane cultivation, which was compatible with the Navy's military mission and PMRF operations. Since the cessation of sugarcane cultivation in the area there is now the possibility of incompatible developments on this land. Encroachment via development of the adjacent agricultural lands would impede the Navy's ability to train and conduct research because of interference from light, smoke, and electromagnetic emissions, as well as public concerns over safety and noise. Ground Hazard Arcs extend out into the adjacent agricultural lands at Barking Sands. These areas must be cleared of all personnel during certain operations on Barking Sands.

A form of encroachment partnering is employed at Barking Sands through an Agricultural Preservation Initiative (API). The API is a partnership between the Navy and the governments of SOH and Kaua'i County to permanently preserve roughly 5,000 ac (2,023 ha) of land adjacent to Barking Sands for agricultural purposes (Figure 3-15). The API ensures that the Navy can continue to safely conduct important research and training operations at Barking Sands in the future. The API does not lease the 5,000 ac (2,023 ha) to the Navy, however it does grant the Navy first right of refusal for activities within the API zone that are not compatible with PMRF operations. The request was approved by unanimous vote of the DLNR Board in May 2004, and, after an extensive review and final approval process by both the SOH and Kaua'i County governments, was signed on June 1, 2007. The API is in effect until the year 2029.

In addition, the Navy leases an approximately 200 ac (81 ha) strip of land along Barking Sands' eastern border in the area of the highway (Figure 3-15). The lease of this narrow strip of land allows the Navy to repair and maintain the drainage pumps that help to minimize flooding onto PMRF property and roadways during periods of heavy rainfall. In addition, the lease of this land is required because federal law forbids using public funds to maintain infrastructure on land that is not owned or leased by the federal government. In order for Navy funds to be lawfully spent to maintain these pumps, the Navy must have a legal interest in the land they are located on. In addition, the leased area supports AT/FP requirements. Leasing this small area provides a buffer for PMRF allowing new construction within a larger area of the original installation boundary. The only construction the Navy has undertaken within the leased area is a small visitor's center and Pass and ID office where visitors receive base passes prior to driving onto base. This facility was approved as part of the original proposal during the May 2004 DLNR meeting. The Navy has no other plans for construction within the new leased area.

Figure 3-15: Lease Area and API Area

CHAPTER FOUR: MĀKAHA RIDGE TRACKING STATION

4.1 CURRENT CONDITIONS AND USE

4.1.1 Installation Information

Mākaha Ridge Tracking Station is located on a Nā Pali finger ridge to the north of and in the sight line of Barking Sands (photo 4-1). At a maximum elevation of approximately 1,850 ft (564 m) overlooking the Mānā Plain, it is PMRF's secondary operations area for missile tracking. The facility consists of approximately 244 ac (99 ha) of land leased from the SOH. Public access is restricted. Authorized personnel reach the facility via the road through Kōke'e State Park (Figure 4-1).

Photo 4-1: View from Mākaha Ridge looking south toward Barking Sands

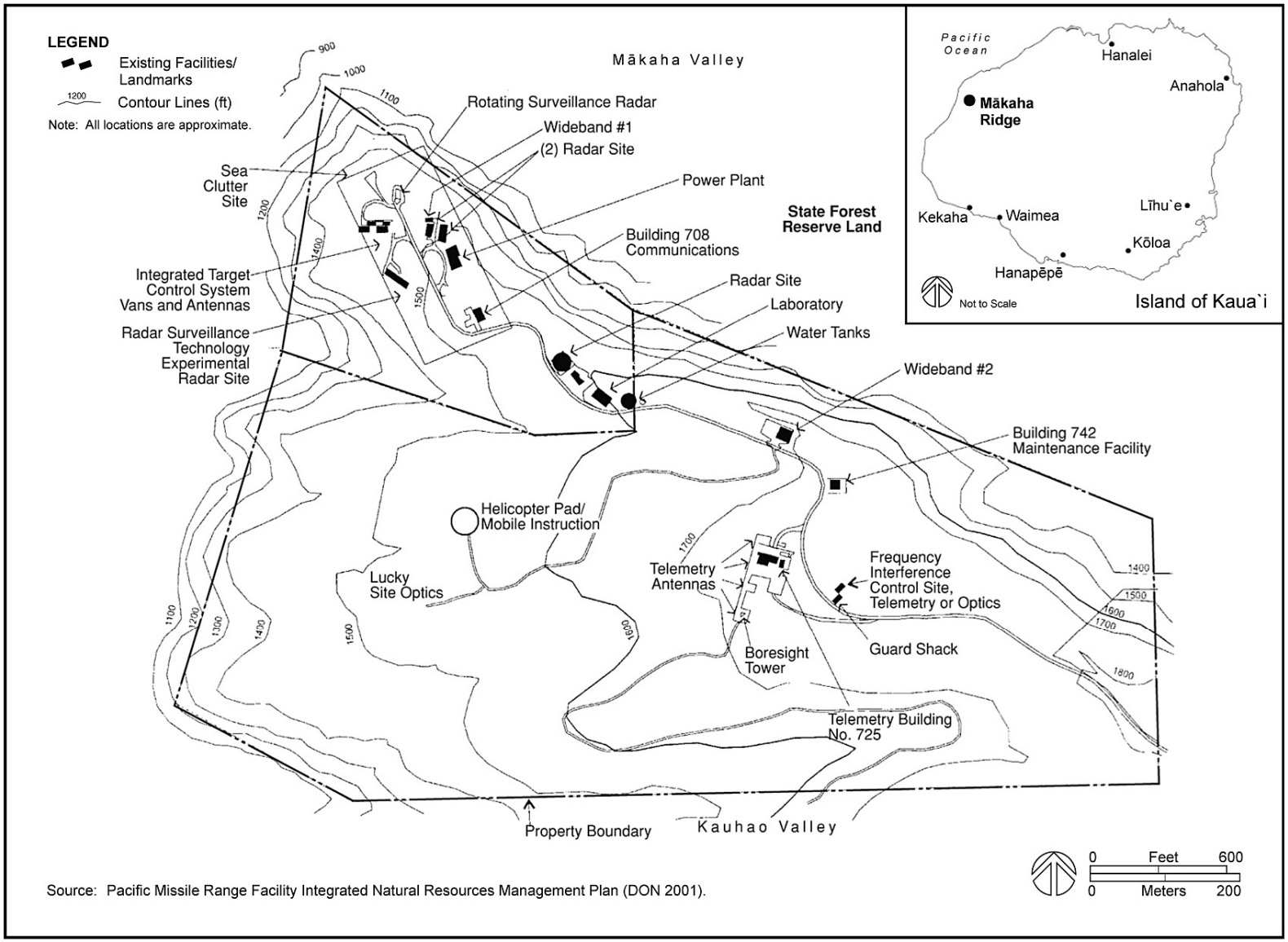
4.1.1.1 General Description

Photo 4-2: Mākaha Ridge Tracking Station

As shown on Figure 4-1, Mākaha Ridge Tracking Station (photo 4-2) contains a guard shack at the entrance way, a Frequency Interference Control Building, Maintenance Facility (Building 742), Telemetry Building (Building 725), a boresight tower, telemetry antennas, water tanks, a laboratory, various radar sites, communications (Building 708), a power plant, antennas, a helicopter pad, and a "sea clutter site." The majority of the structures are purposefully located on top of the ridge line to provide unobstructed lines of sight (Figure 4-2).

4.1.1.2 Land Use Constraints

Land use constraints at Mākaha Ridge Tracking Station result from both the military mission and sensitive habitats and species located on the station. The military land use constraints include the requirement for unobstructed lines of sight and the presence of electromagnetic zones (Figure 4-2 and Section 3.1.1.2). Access is limited to assigned personnel and visitors on official business. The environmental land use constraints are defined by the presence of ESA-protected plant species (see Figure 4-2) and the steep slopes that surround the station on the south, west, and north. Section 4.3 presents a description of the protected species and habitats located at the Mākaha Ridge Tracking Station.



Source: Pacific Missile Range Facility Integrated Natural Resources Management Plan (DON 2001).

Figure 4-1: Mākaha Ridge Tracking Station, Kaua‘i

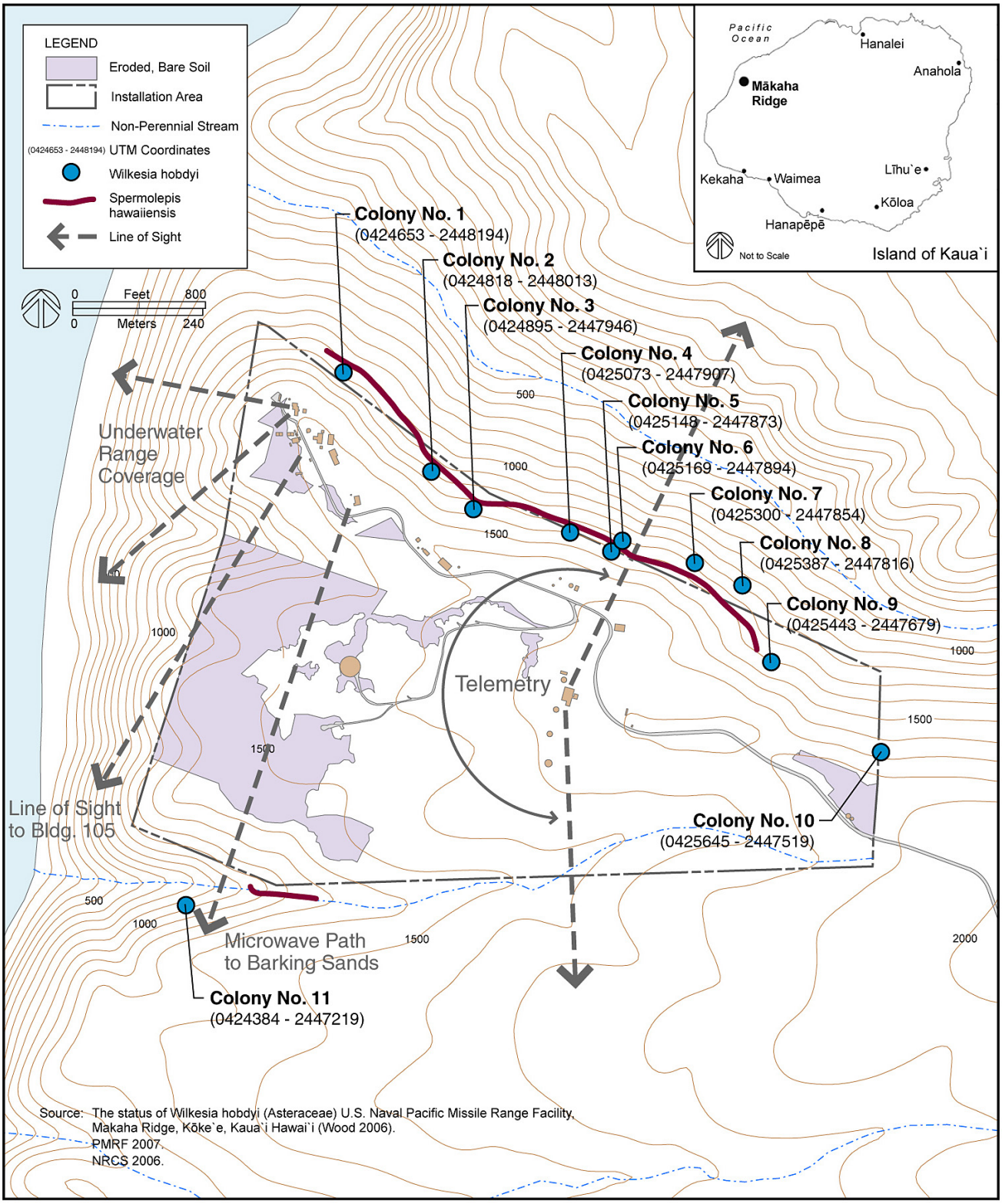


Figure 4-2: Constraints, Mākaha Ridge Tracking Station, Kaua‘i

4.1.1.3 Operations and Activities

The Mākaha Ridge Tracking Station provides radar tracking and surveillance, primary telemetry receiving and recording, frequency monitoring, target control, and electronic warfare and networked operation.

4.1.1.4 Abbreviated History and Pre-Military Land Use

The Navy has leased lands at Mākaha Ridge since 1965 for communication, research, development, testing, tracking, evaluation, guidance, and related government purposes (NAVFAC PAC Real Estate 2007). Previous cultural resources surveys conducted at the Mākaha Ridge Tracking Station have not identified any historic sites (DON 2005a).

4.1.1.5 Regional Land Uses

Mākaha Ridge Tracking Facility is located on the western side of the island of Kauaʻi in the Waimea-Kekaha region. Section 3.1.1.6 provides a general discussion of the land use in the Waimea-Kekaha region. The SOH LUC has designated Mākaha Ridge as in the State Conservation District (SOH LUC 2005).

4.2 GENERAL PHYSICAL ENVIRONMENT

The discussion of the general physical environment is divided into five subsections (4.2.1 through 4.2.5): (1) physical geography; (2) topography; (3) geology; (4) soils; and (5) hydrology – including surface water resources and hydrogeology (groundwater resources). General island-wide descriptions of these resources are presented in Section 2.2; the following discussion addresses Mākaha Ridge Tracking Station and its environs.

4.2.1 Physical Geography

A general discussion of the physical geography of the Hawaiian Islands and Kauaʻi is presented in Section 2.2.1. The Mākaha Ridge Tracking Station consists of approximately 244.7 ac (99.1 ha) and is approximately 7 mi (11 km) north of Barking Sands on the Nā Pali ridgeline. Nā Pali is characterized by high volcanic uplands segmented by deeply incised V-cut valleys and bounded by exceptionally steep coastal cliffs. It overlooks the Mānā Plain.

4.2.2 Topography

A general discussion of the topography of Kauaʻi is presented in Section 2.2.2. The station is located on the Nā Pali ridgeline. These precipitous cliffs average 1,400 ft (426 m) in height. Elevations at the station range from approximately 1,800 ft (548.6 m) at the eastern perimeter, to a low of 1,400 ft (426.7 m) at the cliff face. Terrain is variable across the site but the sloping topography generally runs west to southwest. A steep, narrow, and twisting road passing through the dense forests of the Kokeʻe region provides access to the station.

4.2.3 Geology

A general discussion of the geology of Kaua‘i is presented in Section 2.2.4. The station is located on a prominent ridge of Nā Pali coast, a coastal cliff formation composed of lavas of the Napali formation of the Waimea Canyon series. These are the lava flows and associated pyroclastic rocks that accumulated on the flanks of the major Kaua‘i shield volcano, outside the boundaries of the caldera.

4.2.4 Soils

Areas of the station experience severe erosion (photo 4-3); this is part of a much broader erosion problem of the Mākaha Ridge and the Na Pali Coast which are comprised of soil types with severe erosion hazards. Further exacerbating these soil conditions is the presence of feral goats which eat erosion-inhibiting vegetation. These regional conditions result in silt-laden runoff to flow down the cliff-face and into the coastal waters directly below. As shown on Figure 4-3, the soils at the station include Rock outcrop (rRO), Rough broken land (rRR), Badlands (BL), Badland-Mahana complex (BM), Niu Series soils, Pakala Series soils, and Pu‘u ‘Ōpae Series.

Photo 4-3: Soil erosion at Mākaha Ridge Tracking Station

Rock outcrop or rRO consists of areas where exposed bedrock covers more than 90 percent of the surface. The rock outcrops are mainly basalt and andesite. This land type is gently sloping to precipitous. Rough broken land or rRR consists of very steep land broken by numerous intermittent drainage channels located in gulches and on mountainsides. In most places, rRR is not stony. Runoff is rapid, and geologic erosion is active. These soils are variable. In most places some weathered rock fragments are mixed with soil material. Small areas of rock outcrop, stones, and soils slips are common. BL are steep to very steep and nearly barren. Runoff is very rapid, and geologic erosion is active. BM is comprised of 60 percent BL and Mahana silt loam, 20 to 35 percent slopes, makes up 40 percent of the acreage. Most of the BL part of the complex is barren (USDA 1972).

The Niu Series consists of well-drained upland soil developed in material weathered from basic igneous rock, possibly mixed with volcanic ash. Niu silty clay loam, 12 to 20 percent slopes (NcD) has rapid runoff and the erosion hazard is severe. Niu silty clay loam, 20 to 35 percent slopes (NcE2) is found on the top of ridges in the uplands. The substratum is soft, weathered rock. Permeability is moderate. Runoff is rapid, and the erosion hazard is severe.

The Pakala Series consists of well-drained soils on alluvial fans and bottom lands. They are nearly level to moderately sloping. Pakala clay loam, 0 to 2 percent slopes (PdA) consists of a 16-in (41 cm) thick surface layer of dark reddish-brown clay loam. The next layer, about 6 in (15 cm) thick, is a massive dark reddish-brown very fine sandy loam. Below this is stratified

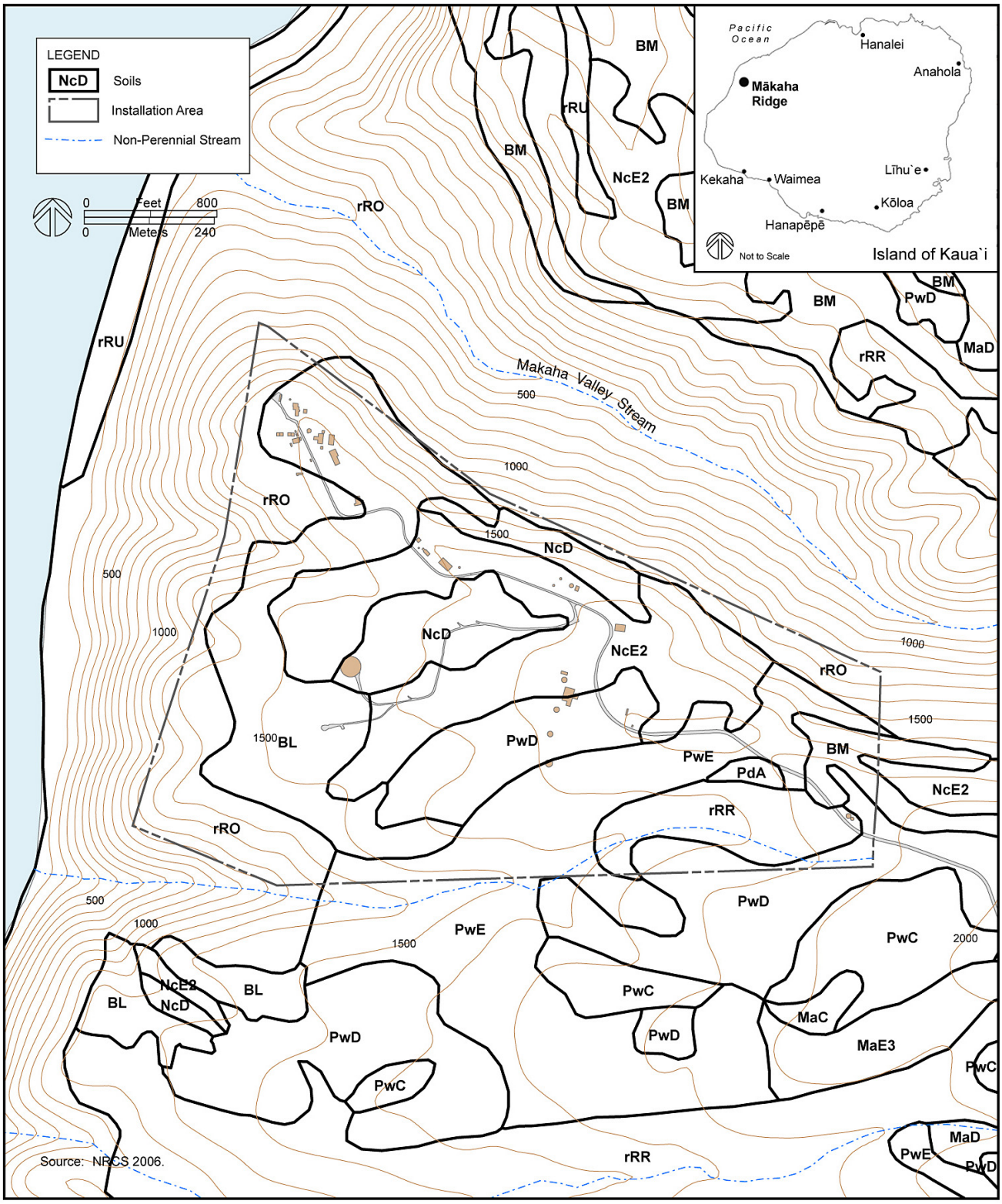


Figure 4-3: Soils, Mākaha Ridge Tracking Station, Kaua‘i

alluvium that ranges from sandy loam to clay loam in texture. Permeability is moderate. Runoff is very slow, and the erosion hazard is no more than slight.

The Puʻu ʻŌpae Series consists of well-drained upland soils developed in material weathered from basic igneous rock. Puʻu ʻŌpae silty clay loam, 15 to 25 percent slopes (PwD), has medium runoff and the erosion hazard is moderate. Puʻu ʻŌpae silty clay loam, 25 to 40 percent slopes (PwE), has rapid runoff and the erosion hazard is moderate.

4.2.5 Hydrology

A general discussion of the hydrogeology of the island of Kauaʻi is presented in Section 2.2.5. There are no surface water resources at the station. There are several drainage paths on and adjacent to the station, however, there are no perennial surface water features.

Although there are currently no groundwater resources developed at the station (i.e., no wells), it is underlain by two aquifers which are part of the Waimea Aquifer Sector of the Kekaha Aquifer System (Section 2.2.5.2). One aquifer (aquifer code 20301212 [21111]) is a high-level, unconfined dike-confined aquifer that has potential use. This aquifer is considered an irreplaceable fresh drinking water source (<250 mg/l Cl^-) and has a high vulnerability to contamination. The second aquifer (aquifer code 20301112 [11111]) is a basal, unconfined, dike aquifer that is currently used for drinking water. It is fresh (<250 mg/l Cl^-) and is also considered irreplaceable with a high vulnerability to contamination (Mink and Lau 1992).

4.3 GENERAL BIOTIC ENVIRONMENT

Information on biological resources presented in this and subsequent sections are primarily derived from surveys of terrestrial plant and terrestrial animal conducted as part of the 2006 INRMP update process and the 2001 INRMP. These reports are listed below and contained in the appendices.

- Appendix A2: The Status of *Wilkesia hobdyi* (Asteraceae) U.S. Navy Pacific Missile Range Facility, Mākaha Ridge, Kōkeʻe, Kauaʻi, Hawaiʻi (Wood 2006);
- Appendix A3: PMRF Mākaha Ridge Tracking Station Botanical Survey (NAVFAC PAC 2006b);
- Appendix A7: Botanical Survey of Mākaha Ridge (Char 2000b);
- Appendix B1: Herpetological and Mammal Surveys of PMRF (NAVFAC PAC 2006e);
- Appendix B2: Bird Surveys of PMRF (NAVFAC PAC 2006f);and
- Appendix B3: Survey of Avifauna and Feral Mammals for the INRMP, Barking Sands, Kauaʻi, Hawaiʻi (Bruner 2000).

Additional information about plants and animals was compiled from the following two primary sources:

- Conservation Mapping (Appendix A10 and B4; NAVFAC PAC 2005); and
- INRMP for PMRF (DON 2001).

In addition, to the survey reports listed, input was received from Working Group Members regarding the INRMP, including the discussion of the general biotic environment (Appendices I and J).

The discussion of the general biotic environment is divided into five subsections (4.3.1 through 4.3.5): (1) threatened and endangered species; (2) wetlands; (3) ecosystem components; (4) fish and wildlife; and (5) vegetation.

4.3.1 Threatened and Endangered Species

This section provides a summary of the federally-listed threatened and endangered species at Mākaha Ridge Tracking Station; it is organized in two parts with animal species discussed in Section 4.3.1.1 and plant species in Section 4.3.1.2. Table 4-1 provides a listing of the federally-listed threatened and endangered species.

Table 4-1: Federally-Listed ESA Species at Mākaha Ridge Tracking Station

Latin Binomial	Common Name	Regulatory Status
Branta sandviciensis	Hawaiian Goose (Nēnē)	E
Puffinus auricularis newelli	Newell's Shearwater	T
Pterodroma phaeopygia sandwichensis	Hawaiian Dark-Rumped Petrel	E
Lasiurus cinereus	Hawaiian Hoary Bat	E
Wilkesia hobdyi	Dwarf Iliau	E
Spermolepis hawaiiensis	No common name	E

E – endangered; T – threatened;

4.3.1.1 Animals

1. Bird Species

A group of six federally-listed endangered Hawaiian geese (nēnē) are observed regularly at the Mākaha Tracking Facility. Nēnē are further described in Section 3.3.1.1. Newell's shearwater and Hawaiian petrel may fly over the station.

2. Mammal Species

The federally-listed endangered Hawaiian hoary bat is known to frequent the general area of Mākaha Ridge and may forage or roost on the property or surrounding forested areas (Bruner 2000). Section 3.3.1.1 provides further detail on the Hawaiian hoary bat.

4.3.1.2 Plants

Photo 4-4: Dwarf iliau

Dwarf Iliau: The dwarf iliau *(Wilkesia hobdyi)* (photo 4-4), a federally-listed endangered plant species, occurs on the cliffs overlooking Mākaha Valley. The USFWS officially listed dwarf iliau as endangered in 1992. Dwarf iliau, a member of the daisy or sunflower family *(*Asteraceae*),* is a shrub generally 2 ft (0.6 m) tall that branches somewhat profusely from the base. Each branch bears a tuft of narrow leaves 0.5 inch (1.3 cm) wide and about 3 to 6 in (7.5 to 15 cm) long. The flower heads occur in clusters 10 to 18 in (25 to 45 cm) long. Each flower head is cream colored and about 0.75 inch (2 cm) in diameter (Char 2000b).

Only ten populations of *Wilkesia hobdyi* with a total population of 759-809 individuals are thought to exist. These populations occur along the northwestern region of Kauaʻi (Wood 2006). Around the Mākaha Ridge Tracking Station, 11 colonies were documented, totaling 214 individuals. The Mākaha Ridge Tracking Station populations range in size from one individual to 50 individuals. The plants are found on the denser, harder rock outcrops with nearly vertical faces and out of the reach of the goats that frequent the area (Wood 2006).

Photo 4-5: *Spermolepis hawaiiensis*

***Spermolepis hawaiiensis*:** *Spermolepis hawaiiensis* is a small ephemeral annual herb of around 2 to 8 inches (5 to 20 cm) in height (photo 4-5). It is endemic to the Hawaiian Islands and is federally-listed as endangered. A member of the parsley family (Apiaceae), *S. hawaiiensis* has finely dissected leaves and small white flowers arranged in loose, compound umbel-shaped inflorescences arising from leaf axils. Two significant colonies of *S. hawaiiensis* grow on north facing, precipitous slopes around the Mākaha Ridge Tracking Station and represent approximately 700 individuals (Wood 2006).

4.3.2 Wetlands

There are no surface water bodies, including wetlands, at the Mākaha Ridge Tracking Station.

4.3.3 Ecosystem Components

The classification of the Mākaha Ridge Tracking Station native terrestrial ecosystem is a lowland dry (less than 50 in [120 cm] of rainfall/year) and mesic (moist – 50 to 100 in [120 to 250 cm] of rainfall/year) forest, woodland, and shrubland. Forests and woodlands are dominated by trees; a forest canopy is dense (60 to 100 percent cover), while a woodland canopy is more open (10 to 60 percent). Shrublands are distinguished by multi-branched shrubs over 3.3 ft (1 m) in height (Juvik *et al* 1998).

4.3.4 Fish and Wildlife

The discussion of terrestrial animals at Mākaha Ridge Tracking Station is divided into three subsections: (1) bird species; (2) mammal species; and (3) amphibian and reptile species.

4.3.4.1 Bird Species

Bird surveys were conducted at the Mākaha Ridge Tracking Station in 2000 (Bruner 2000) and in 2006 (NAVFAC 2006f). Non-native bird species dominate the site both in overall abundance and in number of species. The most numerous introduced species encountered at the facility was the Japanese white-eye (*Zosterops japonicus*) which are abundant. The second most abundant species was the common myna (*Acridotheres tristis*). A listing of the bird species observed during the 2000 and 2006 bird surveys is presented in Appendix B5.

ESA-protected bird species are discussed in Section 4.3.1.1. There are three MBTA-protected bird species that may occur at the station: (1) cattle egret (Section 3.3.4.1) (2) Pacific golden plover (Section 3.3.4.1); and (3) white-tailed tropicbird or koa e kea (*Phaethon lepturus*).

White-tailed tropic bird: Protected under the MBTA, the white-tailed tropic bird (photo 4-6) is a medium-sized, aerial seabird and one of the smallest of the tropicbirds. On Kauaʻi they nest at Waimea Canyon, Kīlauea Point, and along the Nā Pali Coast and may occur at the Mākaha Ridge Tracking Station. While out to sea, white-tailed tropicbirds forage on small surface-dwelling pelagic fish and squid. In Hawaiʻi, they nest from March through October and lay one egg. It is estimated that incubation lasts between 70 and 80 days. A 1990 estimate of the population around the MHI was 300 to 500 pairs (NAVFAC 2006f).

Photo 4-6: White-tailed tropic bird

4.3.4.2 Mammal Species

Mammal species Mākaha Ridge Tracking Station include Hawaiian hoary bat (Section 4.3.1.1), feral goats (*Capra hircus*), pigs, deer (*Odocoileus henionus*), and cats. Feral goats are abundant at this site (photo 4-7). Herds of up to 68 have been counted (NAVFAC 2006e). They are relatively tame due to the lack of hunting pressure. Signs of feral pigs, black-tailed deer, and feral cats were also seen on the property (NAVFAC 2006e and Bruner 2000). Feral ungulates in Hawaiʻi have been identified as a leading cause of the decline of native ecosystems and a threat to threatened and endangered Hawaiian plants.

Photo 4-7: Aerial view of goats at Mākaha Ridge Tracking Station

4.3.4.3 Amphibian and Reptile Species

The reptiles green anole (*Anolis carolinensis*), mourning gecko, and house gecko were documented at Mākaha Ridge Tracking Station (NAVFAC 2006e). None of these species are protected.

4.3.5 Vegetation

4.3.5.1 Terrestrial Plants

A botanical survey was completed at Mākaha Ridge Tracking Station in 2000 (Char 2000b) and follow on surveys were completed in April 2006 (Wood 2006, NAVFAC PAC 2006b). In addition, station vegetation was classified by the Navy's Conservation Mapping Project in 2005 (Figure 4-4, Appendix B4). The plants around the Station are composed of some 114 species of vascular plants from 42 families. Of these, 77 are dicotyledons, 26 are monocotyledons, ten are pteridophyts, and one represents a gymnosperm. Thirteen of those taxa are endemic species known only from the Hawaiian Islands, 14 are indigenous, three are considered Polynesian introductions, and the remaining 84 are non-native naturalized species (Wood 2006).

Within the boundaries of Mākaha Ridge Tracking Station, 13 endemic plant species (confined only to Hawai'i) are currently known to occur and include: (1) *Artemisia australis* ('ahinahina); (2) *Bidens sandwicensis* (ko'oko'olau); (3) *Carex wahuensis*; (4) *Gahnia beecheyi*; (5) *Pteridium aquilinum* var. *decompostium*; (6) *Acacia koa* (koa); (7) *Scaevola guadichaudii* (naupaka kuahiwi); (8) *Eragrostis variabilis* (kāwelu); (9) *Panicum torridum* (kākonakona); (10) *Doryopteris decipiens* (kumuniu); (11) *Selaginella arbuscula* (lepelepe a moa); (12) *Spermolepis hawaiiensis*, and (13) dwarf iliau. *Spermolepis hawaiiensis* and dwarf iliau are federally-listed endangered species (Section 4.3.1.1). The remaining 11 endemic plants are quite common with the majority of them occurring on many of the other high islands of Hawai'i (Wood 2006).

The 14 indigenous plant species (i.e., also found outside of Hawai'i) observed at Mākaha Ridge Tracking Station include: (1) *Cyperus polystachyos*; (2) *Leptecophylla tameiameiae* (pūkiawe); (3) *Dianella sandwicensis* ('uki'uki); (4) 'ilima; (5) *Cocculus orbiculatus* (huehue); (6) *Myoporum sandwicense* (false sandalwood or naio); (7) *Digitaria setigera* (kū'kaepuaa); (8) *Psilotum nudum* (moa); (9) *Psydrax odorata* (alahe'e); (10) *Dodonaea viscosa* ('a'ali'i); (11) *Chrysopogon aciculatus* (manieni ula); (12) *Heteropogon contortus* (pili); (13) *Solanum americanum* (pōpolo); and (14) 'uhaloa. All of these indigenous taxa are common and can also be found occurring naturally in other archipelagos of Oceania (Wood 2006).

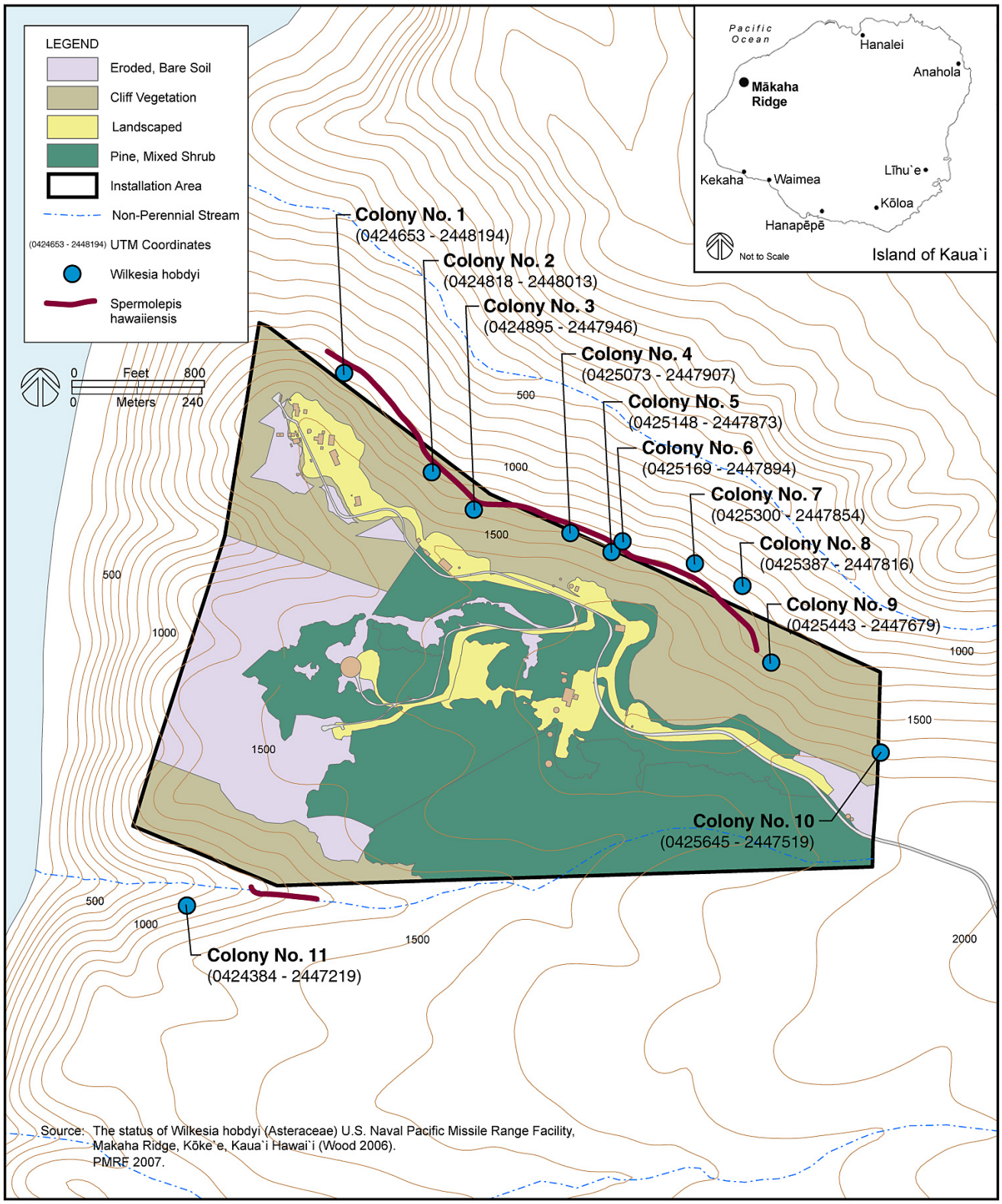


Figure 4-4: Vegetation Types, Mākaha Ridge Tracking Station, Kaua‘i

The 2000 survey (Char 2000b) described several different plant communities occurring at Mākaha Ridge Tracking Station: (1) Cliff Vegetation; (2) Pine Plantings/Mixed Scrub; and (3) Ruderal Vegetation. These vegetation types as described by Char (2000b) are summarized in the following paragraphs.

Cliff Vegetation. The rugged and spectacular cliffs and steep valley walls of Nā Pali are composed of thin-bedded lava of the Napali formation and are continually eroded by running water. In some places, rocky outcrops of denser, harder material can be found along the weathered cliff face. Vegetation on these steep areas is sparse, with five percent cover of shrubs and 10 to 20 percent cover of grasses. Most plants occur in small patches scattered across the cliff face and on ledges or long, narrow terraces (photo 4-8). Cliff vegetation is also found on severely eroded portions of the ridge top (Figure 4-4).

Photo 4-8: Cliff vegetation

Within the station, federally-listed endangered plants dwarf iliau and *Spermolepis hawaiiensis* occur in a dry cliff community which is comprised of low shrubs of false sandalwood, 2 ft to 4 ft (0.6 m to 1 m) tall. The 2000 survey (Char 2000b) indicated that rounded clumps of kāwelu, a bunch grass, were the most frequently observed native species on the cliffs. The 2006 survey noted that there was a decrease in the abundance of kāwelu (Wood 2006).

Shrubs: Native shrubs associated with the dry cliff community include: (1) ahinahina; (2) aalii; and (3) ʻilima. Non-native shrubs include: (1) *Indigofera suffruticosa* (indigo); (2) lantana; (3) *Opuntia ficus-indica* (panini); and (4) *Verbena litoralis* (vervain).

Grasses: Native grasses associated with the dry cliff community include: (1) kāwelu; (2) pili; and (3) kākonakona – an ephemeral species that grows after rains. Non-native grass species associated with the dry cliff community include: (1) *Bothriochloa hordeaceus* (soft chess); (2) *Setaria parviflora* (yellow foxtail); and (3) *Melinis repens (*Natal redtop).

Herbs: The only native herb observed in the dry cliff community is the federally-listed endangered *Spermolepis hawaiiensis*. This is an annual and seems to appear around the spring months after rains. Non-native herbs associated with the dry cliff community include: (1) *Ageratum conyzoides* (maile hohono); (2) *Anagallis arvensis* (scarlet pimpernel); (3) *Boerhavia coccinea*; (4) *Polycarpon tetraphyllum*; (5) *Centaurium erythraea* (bitter herb); (6) *Ciclospermum leptophyllum* (fir-leaved celery); (7) *Conyza bonariensis* (hairy horseweed); (8) *Cyanthillium cinereum* (little ironweed); (9) *Daucus pusillus* (carrot family); (10) *Erodium ciuctarium* (pin clover); (11) *Gamochaeta purpurea* (purple cudweed); (12) *Plantago lanceolata* (narrow-leaved plantain); and (13) *Ageratina riparia* (Hamakua pamakani).

Ferns (pteridophytes): Native ferns associated with the dry cliff community include: (1) kumuniu; (2) lepelepe a moa; and (3) moa. Non-native ferns associated with the dry cliff community include: (1) *Pityrogramma calomelanos* (silverfern); and (2) *Adiantum raddianum* (maidenhair fern).

Threats: The main threats to the dry cliff community include: (1) habitat degradation by feral goats; (2) competition with non-native plant taxa especially lantana, indigo, panini, vervain,

Bothriochloa pertusa, yellow foxtail, and natal redtop; and (3) reduced reproductive vigor of rare native species as a result of limited numbers of existing individuals.

Pine Plantings/Mixed Scrub. This vegetation type covers most areas of the station (Figure 4-4), where it occurs primarily on the areas with soils of the Niu and Puʻu ʻOpae Series. Sections of this vegetation type are typically covered in five percent *Pinus elliotti* (slash pine) which average 21 ft (7 m) in height. In addition, there are shrubs of lantana or trees of *Grevillea robusta* (silk oak) which will often cover around 20 to 30 percent of an area. *Schizachyrium condensatum* (little bluestem grass) or *Andropogon glomeratus* (beardgrass) can have a 25 percent cover. The remaining 40 to 50 percent being bare exposed soil, highly disturbed by goats, with small and large boulders lying on the surface unanchored by any top-soil (Wood 2006).

A mixed scrub composed primarily of lantana shrubs and molasses grass *(Melinis minutiflora)* with scattered shrubs of guava *(Psidium guajava)* forms a dense matrix between the trees. In some places, lantana forms a dense, prickly thicket, 3 ft to 7 ft (1 to 2 m) tall.

On the ridge around the helicopter landing site (Figure 4-4), there are large, barren, eroded areas. The vegetation cover is patchy, covering approximately 40 to 50 percent. Tree cover is open with most of the plant cover consisting of low, rounded clumps of lantana, 2 ft to 3 ft (0.6 m to 1 m) tall, and mats of molasses grass. In this more open scrub, clumps of kilau fern *(Pteridium aquilinum)* are locally abundant. Mats of golden beardgrass and tufted clumps of little bluestem grass are common.

On the southern portion of the station, the unnamed gulch supports a large planting of Eucalyptus trees, 70 ft to 80 ft (21 m to 24 m) tall. The lower slopes of this gulch support rather dense thickets of guava, 16 ft to 20 ft (5 m to 6 m) tall. Alaheʻe shrubs *(Psydrax odorata)* are abundant in some places. Native koa trees are occasional in this area.

Besides the alaheʻe and koa mentioned above, other native plants which can be found associated with the pine plantings/mixed scrub include: shrubs of naupaka kuahiwi, naio, and pūkiawe *(Styphelia tameiameiae);* huehue vine; sedges such as *Gahnia beechyii* and *Carex wahuensis;* and ʻukuʻuki, a member of the lily family with dark blue berries.

Ruderal Vegetation. Ruderal or weedy wayside vegetation is found on areas that have been disturbed but are infrequently maintained. It is usually associated with the dirt roads and the interface area where grassy lawns adjoin barren, eroded sections or pine plantings/mixed scrub (Char 2000b).

The vegetation consists of a mixture of various grasses and weedy, mostly annual herbaceous species. A few small lantana shrubs are also scattered through this vegetation type. Molasses grass, natal redtop, and pitted beardgrass are the most frequently observed grasses. Among the herbaceous species, the following are usually widespread: (1) narrow-leaved plantain; (2) Spanish clover (*Desmodium incanum*); (3) black medick (*Medicago lupulina*); (4) broad-leaved plantain (*Plantago major*); (5) virgate mimosa (*Desmanthus virgatus*); (6) sensitive plant (*Mimosa pudica*); and (7) fuzzy rattlepod (*Crotalaria incana*) (Char 2000b).

Other species such as maile hohono *(Ageratum houstonianum),* spiny bur *(Acanthospermum australe),* daisy fleabane *(Erigeron karvinskianus),* and primrose willow *(Ludwigia octovalvis)*

are more restricted in distribution and were encountered only once during the survey (Char 2000b).

4.3.5.2 Marine Plants

The Mākaha Ridge Tracking Station is an upland site. It is not directly adjacent to or affecting the marine environment. Therefore, a discussion of the marine flora is not warranted.

4.4 CURRENT MANAGEMENT

4.4.1 Project-Specific Management Actions

4.4.1.1 Bird Aircraft Strike Hazard

Mākaha Ridge Tracking Station has a helicopter pad; however, no BASH issues have been identified at the facility.

4.4.1.2 Protected Species Monitoring and Reporting

1. Nēnē

NAVFAC PAC completed a bird survey of Mākaha Ridge Tracking Station in 2006 which included Hawaiian geese (nēnē). In subsequent years, nesting has been recorded at Mākaha Ridge Tracking Station. The nests occur near buildings where there is human presence, most likely because that is where vegetation occurs and goats do not go near humans (photo 4-9). Currently, the presence of feral goats at the Mākaha Ridge Tracking Station discourages Hawaiian geese (nēnē) from nesting in all areas of the installation.

Photo 4-9: Nēnē at Mākaha Ridge Tracking Station

2. Hawaiian Hoary Bat

Similar to Barking Sands, little is known about the Hoary bat at the Mākaha Ridge Tracking Station. Surveys are currently being conducted to determine the occurrence of Hawaiian hoary bats throughout the PMRF facilities.

3. Dwarf Iliau and *Spermolepis hawaiiensis*

A botanical survey of the status of the dwarf iliau a federally-listed endangered plant species was completed in 2006 which identified the locations and number of this plant. In addition, this survey identified the locations and numbers of the federally-listed endangered plant *Spermolepis hawaiiensis* (Wood 2006).

4.4.1.3 Invasive Species Prevention and Control

Section 3.4.1.7 discusses invasive species prevention and control. Goats are present at the Mākaha Ridge Tracking Station. The goats interfere with nesting of nēnē at the station, contribute to soil erosion, and threaten the native vegetation including the federally-listed plants, dwarf iliau and *Spermolepis hawaiiensis*.

1. Ungulate Management

In FY09, the Navy contracted for an ungulate management plan to identify and assess all aspects of feral ungulate management for Mākaha Ridge Tracking Station. The plan is a practical long-term, sustained reduction program for non-native ungulates, which is required to ensure continued, safe access to Mākaha Ridge Tracking Station for military operations while providing natural resources stewardship. The plan aims to guide ungulate management with the following goals:

1. Correct past and ongoing disturbances to Mākaha Ridge ecosystems caused by introduced non-native ungulates;
2. Prevent further listing of federally threatened or endangered species;
3. Protect native plant and animal species by controlling non-native ungulates;
4. Benefit soil, water, infrastructure, and general integrity of Mākaha Ridge by controlling nonnative ungulates;
5. Decrease the environmental costs associated with siltation of streams, watersheds, and marine environments;
6. Decrease the potential for modification of vegetative structure brought about by selective ungulate browsing;
7. Implement effective ungulate management in a way that has a high probability of success;
8. Minimize long-term diversion of Navy personnel and resources from other resource management projects; and
9. Maximize the area extent of military lands available to support the installation mission.

The native species this plan is specifically intended to protect are nēnē, dwarf iliau and *Spermolepis hawaiiensis*.

4.4.2 Natural Resources Studies

Fauna surveys of Mākaha Ridge Tracking Station were completed in 2006 in support of this INRMP (Appendices B1 and B2). The Navy intends to periodically update these surveys in support of the INRMP. In addition, the Navy intends to remove/control feral goats in an effort to protect native species and decrease the on-going soil erosion.

A botanical survey of the Mākaha Ridge Tracking Station was conducted in 2006 (Appendix A3, NAVFAC PAC 2006b) which updated the 2000 botanical survey of the station conducted by Char (2000b). A botanical survey of the status of the federally-listed endangered plant species

dwarf iliau was completed in 2006 which identified the locations and number of this plant. In addition, this survey identified the locations and numbers of the federally-listed endangered plant *Spermolepis hawaiiensis* (Appendix A2, Wood 2006). The Navy intends to periodically update these surveys in support of the INRMP.

NAVFAC Pacific contracted a Feral Ungulate Management Plan for Mākaha Ridge Tracking Station, which was completed in August 2009 (Section 4.4.1.3).

4.4.3 Use of Geographic Information Systems

NAVFAC PAC Natural Resources staff are in the process of updating their GIS database to include the locations of protected plant and animal species. This updated GIS layer will include the federally-listed endangered plants (dwarf iliau and *Spermolepis hawaiiensis*) and bird species (nēnē) at Mākaha Ridge Tracking Station. Currently the GIS coverage for the facility includes vegetation types (Figure 4-4).

4.4.4 Forestry

No forestry programs are currently in place at the installation.

4.4.5 Community Outreach

The closed nature of this installation does not provide for valuable community outreach opportunities.

4.4.6 Outdoor Recreation

Mākaha Ridge Tracking Station is a restricted area and generally does not offer any outdoor recreation opportunities.

4.4.7 Land Management

Land management program elements currently in place at Mākaha Ridge Tracking Station include base planning (Section 3.4.7) and landscape design (Section 3.4.7.2). Since 2001, PMRF has evaluated and addressed areas of extensive erosion around portions of the developed site (photo 4-10).

Photo 4-10: A developed portion of Mākaha Ridge Tracking Station before and after the construction of a retaining wall to protect site structures.

4.4.8 Floodplains

Not present.

4.4.9 Law Enforcement

The Mākaha Ridge Tracking Station is a restricted area policed by the BOS security contractor.

4.4.10 Wildland Fire

Wildland fires have not impacted the Mākaha Ridge Tracking Station in recent years; however, during dry conditions, wildland fires can impact the ridge line. The County of Kauaʻi fire department, DLNR, and BOS contracted fire department would respond to any fires at the facility.

4.4.11 Leases and Encroachment Management

Not applicable.

CHAPTER FIVE: KŌKEʻE SITES

5.1 CURRENT CONDITIONS AND USE

5.1.1 Installation Information

5.1.1.1 General Description

PMRF includes five small parcels within the boundaries of Kōkeʻe State Park collectively referred to as the "Kōkeʻe Sites". The parcels (Sites "A" through "E") parallel Kōkeʻe Road, east of and above Mākaha Ridge (photo 5-1). Sites A through D are staffed and maintained by the Navy with supporting facilities related to the PMRF mission and operations. Table 5-1 and Figure 5-1 provide information on and locations of each site. NASA operates its Kōkeʻe Geophysical Observatory at Site E. Total acreage for the Kōkeʻe sites is approximately 16 ac (6.6 ha). Much of each site is graded and paved with asphalt. Open areas consist mainly of mowed lawns. The property boundaries extend beyond the fenceline into adjacent forested areas, but this area is included within the 16 ac.

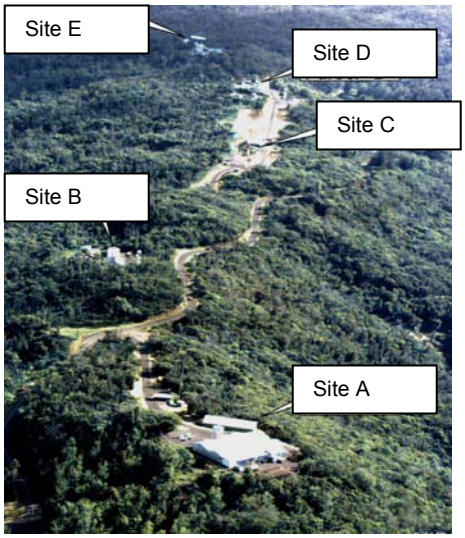


Photo 5-1: Kōkeʻe Sites

Table 5-1: Kōkeʻe Sites Summary

Kōkeʻe Site	Area ac (ha)	Location	Primary Facilities and Infrastructure
Site A	3.8 (1.5)	Southernmost site	Support buildings (tracking, command, training, administration, logistics)
Site B	1.2 (0.5)	North across Kōkeʻe Road from Site A	Power plant and fuel storage facility
Site C	0.4 (0.2)	Approximately 1,500 ft (457 m) north of Site B	Boresight equipment, microwave antenna, radar, support buildings
Site D	5.3 (2.2)	Farther up-slope from Site C	Transmitter building, antenna support facilities
Site E	5.3 (2.2)	900 ft (243 m) north of Site D	NASA's Kōkeʻe Geophysical Observatory with large antenna arrays
Total Area	16.0 (6.6)		

Source: DON 1998

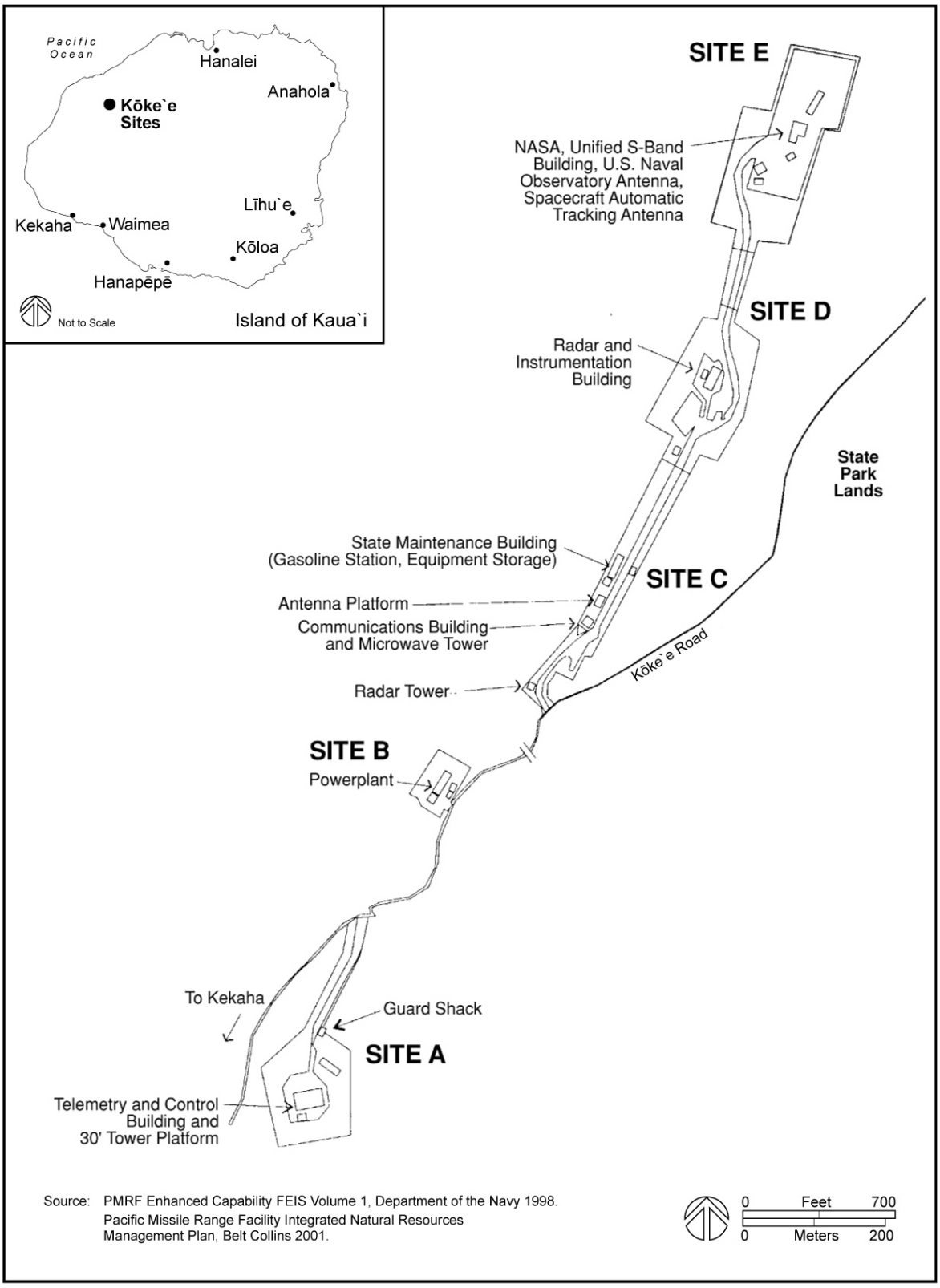


Figure 5-1: Kōke'e Sites, Kaua'i

5.1.1.2 Land Use Constraints

Land use constraints at the Kōkeʻe Sites result from both the military mission and sensitive habitats and protected species. The military constraints include restricted areas which are limited to assigned personnel and visitors on official business. Natural resource land use constraints include the critical habitat for Hawaiian picture-wing fly (*Drosophila musaphilia*) adjacent to the Kōkeʻe Sites (Figure 5-2).

5.1.1.3 Operations and Activities

The Kōkeʻe Sites support tracking radar, telemetry, communications, and command and control systems. Site A accommodates tracking and command, training and administration, and logistics support buildings. Site B is a power plant and fuel storage facility. Site C has boresighting equipment, operations and maintenance support buildings, a microwave antenna, and radar. Site D has a transmitter building and facilities to support Spacecraft Antenna on Medium Pedestal (SCAMP). Site E is occupied by NASA's Kōkeʻe Geophysical Observatory, which is dominated by large domed antenna arrays.

5.1.1.4 Abbreviated History and Pre-Military Land Use

The Navy has leased lands at Kōkeʻe Sites from SOH since 1964 for communication, research, development, testing, tracking, evaluation, guidance and related government purposes (NAVFAC PAC Real Estate 2007). Previous cultural resources surveys conducted at the Kōkeʻe Sites have not identified any historic sites (DON 2005a).

5.1.1.5 Regional Land Uses

The Kōkeʻe Sites are located on the western side of the island of Kauaʻi in the Waimea-Kekaha region. Section 3.1.1.6 provides a general discussion of the land use in the Waimea-Kekaha region. The Kōkeʻe Sites are located in the SOH Conservation District (SOH LUC 2005).

5.2 GENERAL PHYSICAL ENVIRONMENT

The discussion of the general physical environment is divided into six subsections (5.2.1 through 5.2.5): (1) physical geography; (2) topography; (3)) geology; (4) soils; and (5) hydrology – including surface water resources and hydrogeology (groundwater resources). General island-wide descriptions of these resources are presented in Section 2.2; the following discussion addresses the Kōkeʻe Sites and environs.

5.2.1 Physical Geography

A general discussion of the physical geography of the Hawaiian Islands and Kauaʻi is presented in Section 2.2.1 of this document. The Kōkeʻe Sites are located on the Kaunuohua Ridge, a north-northeasterly ridgeline diverging from Highway 550 near the northwestern terminus of Waimea Canyon. It is part of the Puʻu Ka Pele Dissected Upland, a highly eroded volcanic terrain characterized by numerous major valleys and established major drainage patterns.

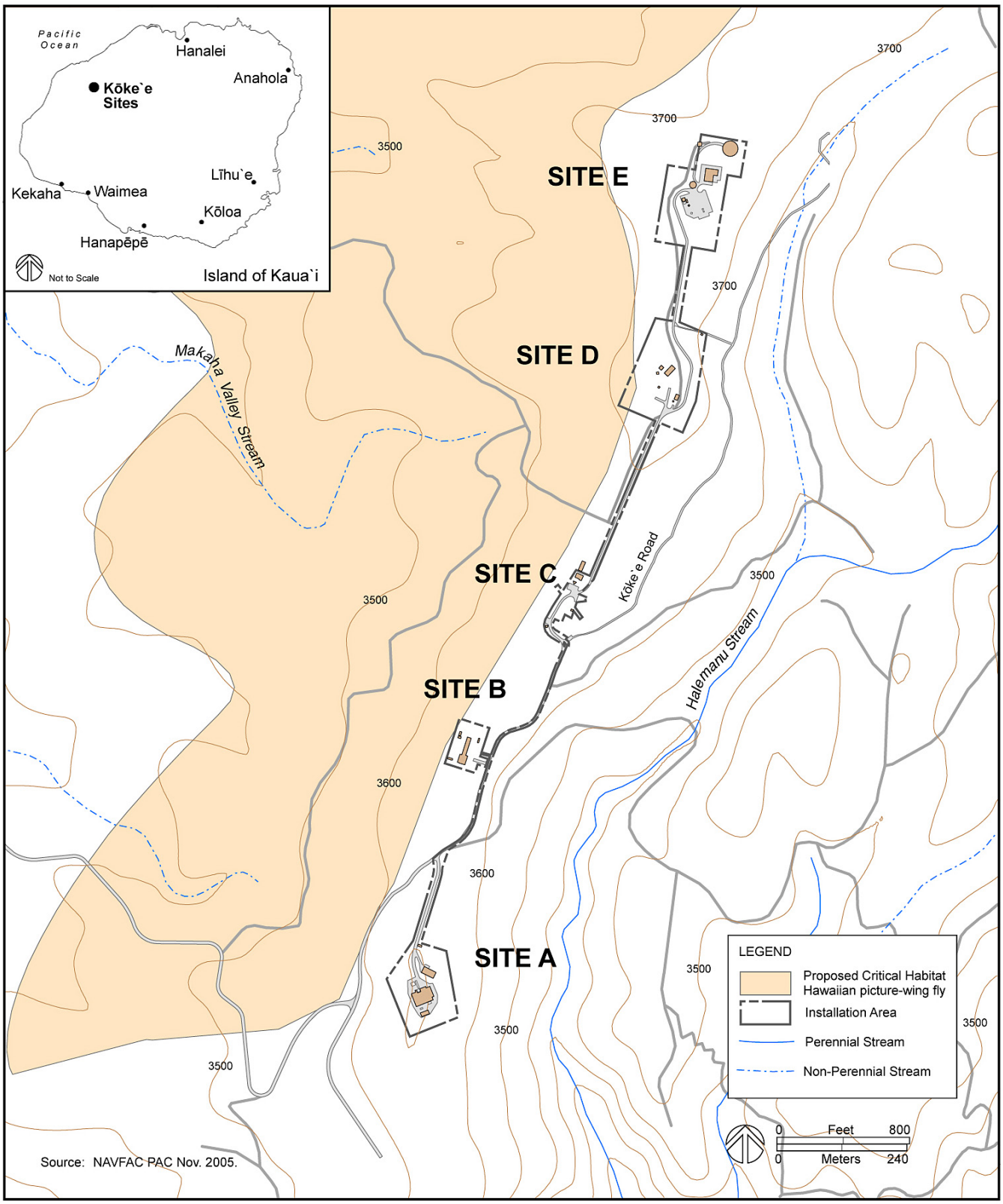


Figure 5-2: Constraints, Kōke'e Sites, Kaua'i

5.2.2 Topography

A general discussion of the topography of Kauaʻi is presented in Section 2.2.2 of this document. The elevation differential of the Kōkeʻe Sites describes a gentle ridgeline sloping to the southwest. Therefore, hydrology of surface water runoff generally follows a northwesterly/southeasterly course. The Kōkeʻe Sites are located adjacent to the main road through Kōkeʻe State Park at an average elevation of 3,710 ft (1,130 m) above mean sea level. Site E has the highest elevation at 3,800 ft (1,158 m). Site A (Support Buildings) is at an elevation of 3,710 ft (1,131 m), the lowest of the five sites. Sites D and E lie within the same general elevation.

5.2.3 Geology

A general discussion of the geology of Kauaʻi is presented in Section 2.2.4. The Kōkeʻe Sites are located on a prominent ridge of Nā Pali coast, a coastal cliff formation composed of lavas of the Napali formation of the Waimea Canyon series. These are the lava flows and associated pyroclastic rocks that accumulated on the flanks of the major Kauaʻi shield volcano, outside the boundaries of the caldera (Section 2.2.4).

5.2.4 Soils

As shown on Figure 5-3, the Kōkeʻe Sites are largely underlain by Kōkeʻe silty clayey loam, 0 to 35 percent slopes (KSKE) which is part of the Kōkeʻe Series. This soil series consists of well-drained soils on uplands which are derived from basic igneous rock, probably mixed with volcanic ash. They are gently sloping to very steep and are used for water supply, wildlife habitat, and woodland. In a representative profile of KSKE, the surface layer is about 8 in (20 cm) thick, is dark-brown silty clay loam and silt loam that has subangular blocky structure. The surface soils are underlain by a 34-in (86-cm) thick subsoil comprised of strong-brown and dark-brown silty clay loam and silty clay with subangular blocky structure. The substratum is soft, weathered rock. The soil is strongly acid throughout the profile. Permeability is moderately rapid, runoff is medium, and the erosion hazard is slight to moderate. A small portion of Site A is underlain by Kōkeʻe silty clayey loam, 35 to 70 percent slopes (KSKF) which is similar to KSKE except that the runoff is rapid and the erosion hazard is severe (USDA 1972). There is no evidence of significant soil erosion from the Kōkeʻe Sites.

5.2.5 Hydrology

A general discussion of the hydrogeology of the Hawaiian Islands and Kauaʻi is presented in Section 2.2.5 of this document. There are no surface water resources at the Kōkeʻe Sites. The aquifer identification and classification for Kauaʻi (Mink and Lau 1992) indicates that there is one aquifer underlying the Kōkeʻe Sites which is located in the Waimea Aquifer Sector within the Kekaha Aquifer System (Section 2.2.5.2). The aquifer (aquifer code 20301212 [21111]) is a high-level, unconfined dike-confined aquifer that has potential use. This aquifer is considered an irreplaceable fresh drinking water source (<250 mg/l Cl^-) and has a high vulnerability to contamination.

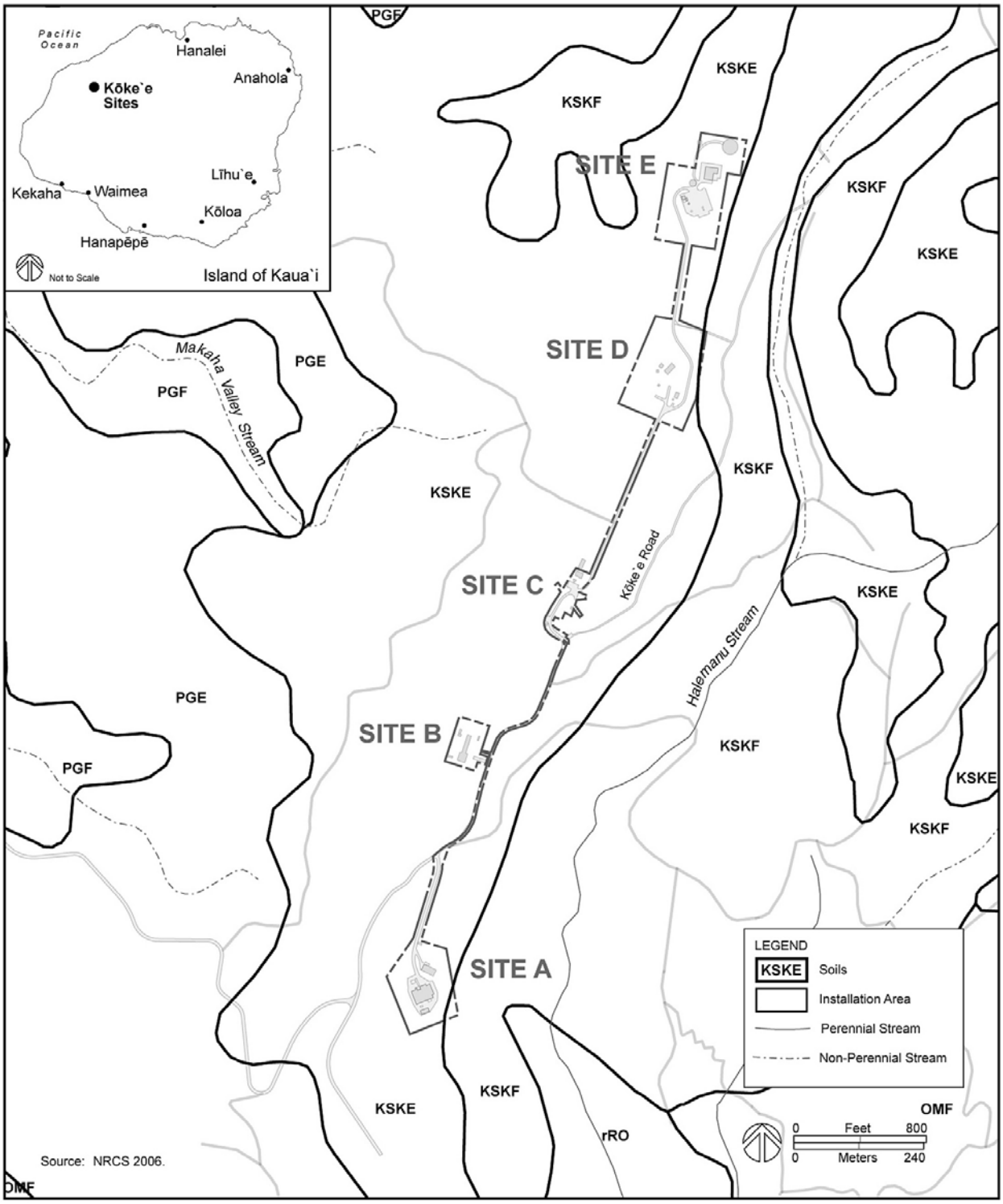


Figure 5-3: Soils, Kōke'e Sites, Kaua'i

5.3 GENERAL BIOTIC ENVIRONMENT

Information on biological resources presented in this and subsequent sections are primarily derived from surveys of terrestrial flora and terrestrial fauna conducted as part of the 2006 INRMP update process and the 2001 INRMP. These surveys, listed below, are contained in the appendices.

- Appendix A4: PMRF Kōkeʻe Botanical Survey (NAVFAC PAC 2006c);
- Appendix A8: Botanical Survey of Kōkeʻe Sites (Char 2000c);
- Appendix B1: Herpetological and Mammal Surveys of PMRF (NAVFAC PAC 2006e);
- Appendix B2: Bird Surveys of PMRF (NAVFAC PAC 2006f); and
- Appendix B3: Survey of Avifauna and Feral Mammals for the INRMP, Barking Sands, Kauaʻi, Hawaiʻi (Bruner 2000).

Additional information about flora and fauna was compiled from the following two primary sources:

- Conservation Mapping (Appendices A10 and B4; NAVFAC PAC 2005); and
- INRMP for PMRF (DON 2001).

In addition, to the survey reports listed, input was received from Working Group Members regarding the INRMP, including the discussion of the general biotic environment (Appendices I and J).

The discussion of the general biotic environment is divided into five subsections (5.3.1 through 5.3.5): (1) threatened and endangered species; (2) wetlands; (3) ecosystem components; (4) fish and wildlife; and (5) vegetation.

5.3.1 Threatened, Endangered and Candidate Species

This section provides a summary of the federally-listed threatened and endangered species and federal candidate species at Kōkeʻe Sites; it is organized in two parts with animal species discussed in Section 5.3.1.1 and plant species in Section 5.3.1.2. Table 5-2 provides a listing of the federally-listed threatened and endangered and federal candidate species.

Table 5-2: Federally-Listed ESA and Candidate Species at the Kōkeʻe Sites

Latin Binomial	Common Name	Regulatory Status
Branta sandviciensis	Hawaiian Goose (Nēnē)	E
Puffinus auricularis newelli	Newell's Shearwater	T (May fly over)
Pterodroma sandwichensis	Hawaiian Petrel	E (May fly over)
Oceanodroma castro	Band-rumped Storm-Petrel	C (May fly over)
Lasiurus cinereus	Hawaiian Hoary Bat	E (May occur)
Drosophila musaphilia	Hawaiian picture-wing fly	E (Critical Habitat designated near property)

Drosophila sharpi	Hawaiian picture-wing fly	E (Critical Habitat designated near property; presence unknown)

E – endangered; T – threatened; C - candidate

5.3.1.1 Animals

Bird Species: Hawaiian geese were observed flying over the installation in 2006 (NAVFAC PAC 2006f). Newell's shearwaters, Hawaiian petrels and band-rumped storm-petrels, may fly over these sites. Section 3.3.1.1 provides more detail on these species.

Mammal Species: Federally-listed Hawaiian hoary bats have been observed at the Kōke'e Sites (Bruner 2000). At Site C, three endangered Hawaiian hoary bats (Section 3.3.1.1) were observed foraging above the forest at dusk on January 22, 2000 (Bruner 2000).

Insect Species: The USFWS has designated critical habitat for the endangered Hawaiian picture-wing fly in vicinity of the Kōke'e Sites (see Figure 5-2). *Drosophila musaphilia*, a Hawaiian picture-wing fly, is historically known in four sites on the island of Kaua'i. The host plant is native koa occurring within mesic, montaine, ohia and koa forest (Federal Register Volume 72, No. 228, 67428 to 67522, November 28, 2007).

On 13 April 2010, 75 FR 18960 19165, USFWS determined endangered status for *D. sharpi* on Kauai. Similar to the *D. musaphilia* designated critical habitat, part of its designated critical habitat is adjacent to the Kōke'e Sites.

5.3.1.2 Plants

There are no known threatened or endangered or otherwise protected plant species or critical habitat (for plants) at the Kōke'e Sites (NAVFAC PAC 2006c).

5.3.2 Wetlands

There are no surface water bodies, including wetlands, at the Kōke'e Sites.

5.3.3 Ecosystem Components

The classification of the Kōke'e Sites native terrestrial ecosystem is a lowland dry and mesic forest, woodland, and shrubland (Juvik *et al* 1998).

5.3.4 Fish and Wildlife

The discussion of fish and wildlife at Kōke'e Sites is divided into three subsections (5.3.4.1-5.3.4.3): (1) bird species; (2) mammal species; and (3) amphibian and reptile species.

5.3.4.1 Bird Species

Bird surveys of the five Kōke'e Sites were conducted in 2000 (Bruner 2000) and 2006 (NAVFAC PAC 2006f). The most abundant native forest bird species observed in 2000 and 2006 was the 'apapane (*Himatione sanguinea*). The Kaua'i 'amakihi (*Hemignathus kauaiensis*) and Kaua'i 'elepaio (*Chasiempis sandwichensis sclateri*) were also observed in small numbers throughout

the Kōke'e Sites. However, the 'i'iwi (*Vestiaria coccinea*) was not observed at the Kōke'e Sites in 2006. Appendix B5 presents the data obtained during the bird surveys of the Kōke'e Sites conducted for the INRMP. The relative abundance estimates for each species include aggregated totals for all five sites. These properties are small and close enough to each other that to try to indicate relative abundance for every species at each site is not warranted.

The 2006 bird survey of the facility noted that Pacific golden plover, a MBTA-protected bird species, has been observed at the Kōke'e Sites (Section 3.3.4.1; Appendix A4, NAVFAC PAC 2006c). There are no specific concerns regarding MBTA-protected bird species at the Kōke'e Sites.

The bird survey conducted in 2006 identified protected and non-protected bird species (Appendix B2, NAVFAC PAC 2006f). This survey updated the 2000 bird survey completed by Bruner (2000). Appendix B5 provides a complete listing of the bird species observed at the facility in 2000 and 2006.

5.3.4.2 Mammal Species

Mammal species known to occur at the Kōke'e Sites include Hawaiian hoary bats (Section 5.3.1.1), rats, pigs, and cats. *Rattus rattus* along with *Rattus norvegicus* were found at Kōke'e sites. Signs of feral pigs were common during the survey, and feral cats were present (NAVFAC PAC 2006e and Bruner 2000).

5.3.4.3 Amphibian and Reptilian Species

The herpetological survey found only the metallic skink (*Lampropholis delicata*) at Kōke'e (NAVFAC PAC 2006e).

5.3.5 Vegetation

Botanical surveys were conducted at the Kōke'e Sites in 2000 (Char 2000c) and in 2006 (NAVFAC PAC 2006c). In addition, installation vegetation types were classified as part of the Navy's Conservation Mapping Project in 2005.

5.3.5.1 Terrestrial Plants

Following are descriptions of vegetation found on the five Kōke'e sites. No threatened or endangered plant species were identified during the botanical survey conducted as part of the INRMP process, either within the parcels or within the areas bordering the fence lines. The vegetation types shown on Figure 5-4 include: (1) blackberry thicket; (2) blackberry/lantana thicket; (3) koa ohia mixed montane mesic forest; (4) landscaped (areas); (5) mixed koa, non-native forest; and (6) non-native mixed oak/blackberry/lantana.

Site A

Much of Site A is comprised of intact koa-ohia mesic native forest (Figure 5-4, classified as "mixed koa, non-native forest"). The overstory is koa and ohia lehua (*Metrosideros*

polymorpha), along with silk oak. Mid canopy species are halapepe (*Pleomele aurea*), uahiapele (*Melicope barbigera*), and strawberry guava (*Psidium cattleianum*). Ground cover is primarily pūkiawe, maile (*Alyxia oliviformus*), *Carex meyenii*, *Carex wahuensis*, ohelo (*Vaccinium sp*.), and kawelu/lovegrass (*Eragrostris variabilis).* Blackberry (*Rubus* sp.) thickets can be found around the forest edge at the fenceline, of this parcel (Figure 5-4, classified as "blackberry, lantana thicket"). The road to Site A is lined with firetree (*Myrica faya*); however, the forest inside the site boundary is still fairly intact (NAVFAC PAC 2006c).

The area next to the Administration Building has been graded and paved with asphalt. Inside the fenceline, grassy lawns are found around the other buildings (Figure 5-4, classified as "landscaped"). The main vegetation consists of: (1) kikuyu grass (*Pennisetum clandestinum*); (2) narrow-leaved carpetgrass (*Axonopus fissifolius*); (3) dandelion (*Taraxacum officinale*); (4) cocksfoot (*Dactylis glomerata*); (5) smutgrass (*Sporobolus africanus*); (6) firetrees; (7) ti leaf (*Cordyline fruticosa*); and (8) hydrangea shrubs (*Hydrangea macrophylla*) (Char 2000c).

Along the outside of the fence line, the vegetation is periodically maintained and there is a grassy strip 3 ft to 5 ft (1 m to *2* m) wide. This kikuyu grass strip is composed largely of: (1) hairy cat's ear (*Hypochoeris radicata*); (2) narrow-leaved plantain (*Plantago lanceolata*); (3) weed verbena (*Verbena litoralis*); and (4) daisy fleabane (*Erigeron karvinskianus*). Nearby outside of the grassy strip there are dense, prickly thickets of Florida blackberry (*Rubus argutus*) (Char 2000c).

Site B

Site B is located about 1,400 ft (428 m) north of Site A, across Kōkeʻe Road. The power plant, fuel storage, and electric substation are located here. As shown on Figure 5-4, most of Site B is contained within the fenceline, and is landscaped and paved. There is a small lawn behind the power plant that allows for a small grove in the kikuyu grass and plantings of ti leaf. Fruiting trees of plum *(Prunus cerasifera* x *salicina),* avocado *(Persea americana),* and pear *(Pyrus communis)* grow on site*.* To the south of the power plant, a semi-wooded slope inside the fence line contains a few trees of koa, ohia, and firetree, and shrubs of pilo (*Coprosma kauaensis*), aʻaliʻi, and pūkiawe along with a few planted plum trees and ti (Char 2000c). Outside the fence line on the north side, more grassy lawn and more plum, avocado, and banana *(Musa* x *paradisiaca)* plantings can be found. The rest of the area immediately outside the fence is dominated by dense blackberry thickets and kikuyu grass mats (classified as "blackberry, lantana thicket" on Figure 5-4). Remnant native forest (classified as "koa-ohia mixed montane mesic forest" on Figure 5-4) also exists. The predominant species observed here is hame (*Antidesma platyphyllum*). Other native species include: (1) manono (*Hedyotis terminalis*); (2) ʻālaʻa (*Pouteria sandwicensis*); (3) kōlea (*Myrsine laniaensis*); (4) naupaka kuahiwi (*Scaevola procera*); (5) *Carex meyenii*; (6) maile; (7) koa; and (8) ohia (NAVFAC PAC 2006c).

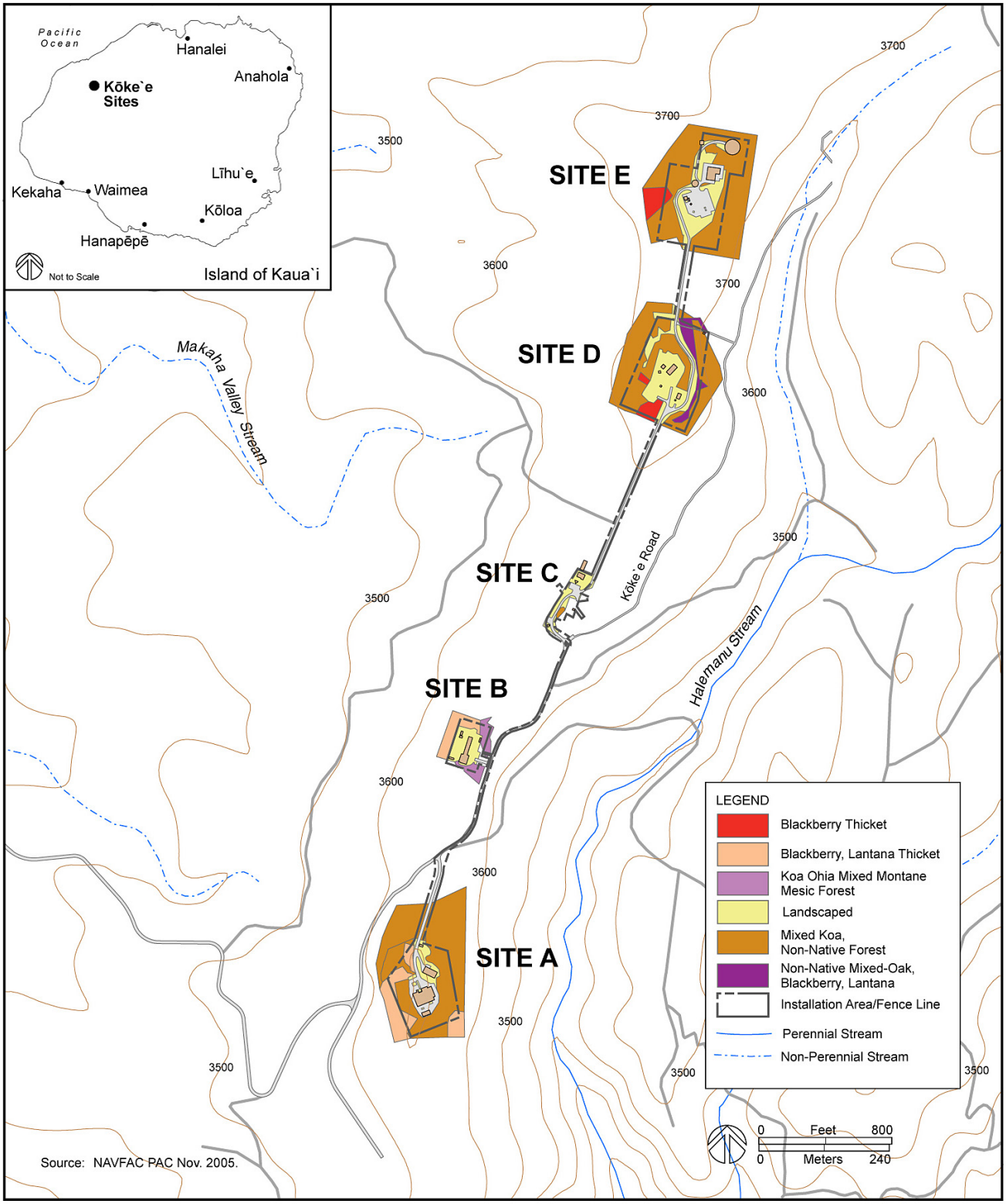


Figure 5-4: Vegetation Types, Kōke'e Sites, Kaua'i

Site C

A common fence line surrounds sites C, D, and E. The entrance gate is located on the access road to the south of Site C. Site C includes the Boresight Tower, Facilities Building, and a microwave antenna. Site C is entirely landscaped and paved and the fenceline is the property boundary (classified as "landscaped" on Figure 5-4). Much of the parcel is covered with asphalt paving; the rest is open, grassy lawn. The area immediately adjacent to the outside the fenceline is covered by low thickets of blackberry or lumpy mats of kikuyu grass with scattered plants of firetree and firethorn *(Pyracantha angustifolia),* another invasive species (Char 2000c).

Site D

Site D (5.3 ac [2.2 ha]) includes the SCAMP Antenna and Transmitter Building and the AN/FRS-16 radar building. The areas around the buildings are either paved or support grassy lawns of kikuyu grass (classified as "landscaped" on Figure 5-4). Site D contains remnant, native forest (classified as "mixed koa, non-native forest" on Figure 5-4) outside the fenceline which is bordered by a thick boundary of blackberry and firetree (classified as "non-native mixed-oak, blackberry, lantana" on Figure 5-4). On the east side of the site, the forest is more intact; the west side contains several areas that have been previously cleared, resulting in abundant weeds (NAVFAC PAC 2006c).

On the west side of Site D, two large ohe'ohe (*Tetraplasandra kavaiensis*) trees exist along with the blackberry and 'uluhe understory. To the northeast of the AN/FRS-16 building, the hillside supports a small-forested section composed primarily of introduced tree species — silk oak and firetree. A few koa trees and shrubs of pūkiawe and naupaka kuahiwi *(Scaevola gaudichaudiana)* are found here. Ground cover is composed of molasses grass with a few clumps of ricegrass *(Paspalum scrobiculatum).* There are dense thickets of blackberry, scattered mats of kikuyu grass, and stands of koa and ohia trees in the areas immediately adjacent to the perimeter fence (Char 2000c).

Outside of the fenceline, the forest is fairly intact with a healthy, native forest overstory of: (1) koa; (2) kaulia (*Alphitonia ponderosa*); (3) ohia; (4) olopua (*Nestigis sandwicensis*); and (5) iliahi/sandalwood (*Santalum freycinetianum*). The overstory is also comprised of natives such as: (1) *M. barbigera*; (2) mokihana (*Melicope anisata*); (3) kōlea (*Myrsine lanaiensis*); (4) *M. alyxifolia*; (5) *'*ahakea (*Bobea brevipes*); (6) 'ōlapa (*Cheirodendron trigynum*); (7) *Pouteria sandwicensis*; and (8) hōʻawa (*Pittosporum sp.*). The midstory is comprised of natives as well, including: (1) laukea (*Clayoxylon sandwicense*), (2) aʻiaʻa (*Streblus pendulinus*); (3) maile; (4) maua (*Xylosma hawaiiense*); (5) aʻe (*Zanthoxylum dipetalum*); (6*)* pilo; (7) *'*aiea (*Ilex anomala*); and (8) manono. Ground cover is almost entirely native and consists of uluhe (*Dicranoptorus linearis*), uki (*Gahnia beecheyi*), *Peperomia sp.*, and ferns in the genus Dryopteris and Microlepia (NAVFAC PAC 2006c).

According to the 2006 botanical survey of the Kōkeʻe Sites (NAVFAC PAC 2006c), other agencies have conducted surveys in adjacent areas to the Navy property that have yielded several individual federally-listed endangered 'akoko (*Chamaesyce halemanui*). However, none were found on the Navy property (NAVFAC PAC 2006c).

A small patch of the invasive plant species Asian melatome (*Melastome candidum*) was found near the roadside at Site D (NAVFAC PAC 2006c).

Site E

Site E covers 5.3 ac (2.1 ha) and houses the Unified S-Band (USB) Building and antenna, the Spacecraft Automatic Tracking Antenna receiver antenna, and the Very Long Baseline Interferometry Facility. The areas around the buildings and antenna have been graded and paved. Lawn areas support kikuyu grass and various weedy species such as dandelion, narrow-leaved plantain, clover *(Trifolium repens),* and green kyllinga *(Kyllinga brevifolia*) (classified as "landscaped" on Figure 5-4). A few pear, plum, and apple *(Malus sp.*) trees are planted in the lawn areas. Around the front of the USB building is a planting of hybrid roses *(Rosa* cultivar) and akulikuli lei *(Lampranthus glomerata)* (Char 2000).

Much of the area immediately adjacent to the outside of the fence is densely forested, with similar native forest species as those existing at Site D (classified as "mixed koa, non-native forest" on Figure 5-4); however, it appears to contain fewer sandalwood trees. It also contains the non-native paperback (*Melaleuca quinquenervia*) which was not observed in the other Kōke'e sites (NAVFAC PAC 2006c). There are fewer areas with dense blackberry thickets or deep mats of kikuyu grass. Koa and ohia along with non-native firetree are abundant. Shrubs include pūkiawe, pilo, manono *(Gouldia terminalis),* a'ali'i, kōpiko *(Psychotria* sp.), mokihana *(Pelea anisata),* kōlea *(Myrsine sp*.), and the introduced strawberry guava and lantana (Char 2000c).

5.3.5.2 Marine Plants

The Kōke'e Sites are upland sites not directly adjacent to or affecting the marine environment. Therefore, a discussion of the marine flora is not warranted.

5.4 CURRENT MANAGEMENT

This section describes the current management at the Kōke'e Sites in the following categories: (1) project-specific management actions; (2) natural resources studies; (3) use of GIS systems; (4) forestry; (5) community outreach; (6) outdoor recreation; (7) land management; (8) flood plains; (9) law enforcement; (10) wildland fire; (11) leases and encroachment.

5.4.1 Project-Specific Management Actions

5.4.1.1 Protected Species Monitoring and Reporting

1. Seabirds

PMRF is currently evaluating lighting at the Kōke'e Sites in an effort to limit night lighting conditions on some areas of the base as they may cause disorientation for nocturnally-migrating seabirds such as the Newell's Shearwater and Hawaiian Dark-Rumped Petrel.

2. Hawaiian Hoary Bat

Similar to Barking Sands, little is known about the Hawaiian hoary bat at the Kōke'e Sites. Bat surveys are currently being conducted (2101-2011) by USGS under contact with the Navy at Kōke'e Sites.

3. Hawaiian Picture-Wing Fly

The USFWS has designated critical habitat for Hawaiian picture-wing flies in areas adjacent the Kōke'e Sites. NAVFAC PAC conducted an initial field survey at the Kōke'e Sites for one species of Hawaiian Picture-Wing Fly, *Drosophila musaphilia* (photo 5-2), from 23-26 March 2010 to determine the presence or absence of this federally-listed species. Surveys were planned and conducted in response to the USFWS determination of the fly's endangered species status on 9 May 2006 in 71 FR 26835 26852 and proposed designation of its critical habitat adjacent to the Kōke'e Sites on 15 August 2006 in 71 FR 46993 47054. NAVFAC PAC received a recovery permit from USFWS on 26 August 2009 which permits the Navy to conduct surveys for this endangered fly. A SOH scientific permit to conduct surveys for other non-endangered native *Drosophila* species was received on 23 September 2009. The initial survey for *D. musaphilia* was planned with the participation of a USFWS entomologist and a contracted entomologist who was one of four experts recommended by the USFWS entomologist.

Photo 5-2: Hawaiian picture-wing fly (*Drosophilia musaphilia*).

Surveys at each Kōke'e Site started with locating its host plant, *Acacia koa*, the presence of slime flux exuding from host plants, the presence of native vegetation, and shaded, accessible areas to place baited sponges or baited multi-lure traps around the fenced Kōke'e Sites. Before dusk or dawn, baits were placed as close to the fence line as possible, because it was sometimes difficult to determine the boundaries of the Navy leased areas. Mushrooms fermented with yeast and banana baby food fermented with yeast were used as baits. GPS coordinates were recorded at each bait site for mapping with GIS. Only Kōke'e Sites A, B, D, and E were surveyed, because Kōke'e Site C did not have characteristics of *D. musaphilia* habitat. Two *D. musaphilia* specimens, one teneral male and one female, were caught at Kōke'e Site B less than 30 ft (10 m) outside the southwest corner of the fence. No other *D. musaphilia* were caught during this initial survey. An *Acacia koa* tree (photo 5-3) with fresh slime flux exuding from its trunk was found just over 30 ft (10 m) to the east of where the two *D. musaphilia* were caught. It is possible that the discovered slime flux serves as a food and breeding source for *D. musaphilia.*

Photo 5-3: Acacia koa tree at a Kōke'e Site

3. ʻAkoko

Federally-listed endangered ʻakoko, a native understory shrub, has been observed growing outside of Navy property near Site D (NAVFAC PAC 2006C – Appendix A4). When visiting Kōkeʻe Site D, biologists conduct cursory surveys to note presence or absence of ʻakoko (*Chamaesyce halemanui*).

5.4.1.2 Invasive Species Prevention and Control

All vehicles and equipment mobilized to and from the Kōkeʻe Sites are washed down prior to mobilization and are washed down again after completion of activities in order to minimize the potential for introducing alien and/or invasive species.

Native forest is mixed in among invasive tree species such as strawberry guava, faya tree, blackberry, banana poka, and others. The invasive plant species, Asian melastome, was observed along the roadway near Site D. NAVFACPAC biologists treated much of the patch with Garlon to aid with control. KISC, Navy or SOH biologists should be provided access to this area to eradicate this population.

5.4.2 Natural Resources Studies

A herpetological and mammal survey of the PMRF facilities, including the Kōkeʻe Sites, has been conducted (Appendix B1, NAVFAC PAC 2006e). A bird survey of the facility was also conducted in 2006 which identified protected and non-protected bird species (Appendix B2, NAVFAC PAC 2006f). This survey updated the 2000 bird survey completed by Bruner (2000). Appendix B5 provides a complete listing of the bird species observed at the facility in 2000 and 2006. The Navy intends to periodically update these surveys in support of the INRMP.

In 2006, NAVFAC PAC completed a botanical survey of the Kōkeʻe Sites (Appendix A4, NAVFAC PAC 2006c) which updated the 2000 survey conducted by Char (Appendix A8, Char 2000c).

5.4.3 Use of Geographical Information Systems

NAVFAC Natural Resources staffs are in the process of updating their GIS database to include the locations of protected plant and animal species. Currently the GIS coverage for the facility includes proposed critical habitat for drosophila fly (Figure 5-2) and vegetation types (Figure 5-4).

5.4.4 Forestry

No forest management for market purposes is appropriate at the Kōkeʻe Sites.

5.4.5 Community Outreach

The closed nature of this installation does not provide for valuable community outreach opportunities.

5.4.6 Outdoor Recreation

The Kōke'e Sites are restricted areas and generally do not offer any outdoor recreation opportunities.

5.4.7 Land Management

No land management programs were identified for Kōke'e Sites other than those discussed in Section 3.4.9 (e.g., base planning, landscape design).

5.4.8 Floodplains

Not present.

5.4.9 Law Enforcement

The Kōke'e Sites are within a restricted area policed by the BOS security contractor.

5.4.10 Wildland Fire

Wildland fires have not impacted the Kōke'e Sites in recent years; however, during dry conditions, wildland fires can impact the ridge line. The County of Kaua'i Fire Department, DLNR, and BOS contracted fire department would respond to any fires at the facility.

5.4.11 Leases and Encroachment Management

Not applicable.

CHAPTER SIX: KAMOKALA RIDGE MAGAZINES

6.1 CURRENT CONDITIONS AND USE

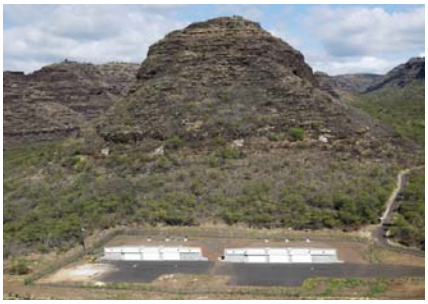


Photo 6-1: Kamokala Ridge Magazines

6.1.1 Installation Information

6.1.1.1 General Information

The 89-ac (36-ha) Kamokala Ridge Magazines (photo 6-1) are located 1.5 mi (2.4 km) east of Barking Sands at the base of Kamokala Ridge (Figure 6-1). The magazines have been excavated into the cliff face of Kamokala Ridge, at elevations between approximately 240 ft (73 m) and 320 ft (97 m). A surface road from the highway to the magazines loops through the fenced facility and provides access to individual munitions cave storage units.

6.1.1.2 Land Use Constraints

No natural resources land use constraints were identified other than the steep terrain. Military land use constraints include ESQD arcs (Section 3.1.1 and Figure 6-1). These arcs define hazard areas associated with the magazines. Personnel access is restricted to those engaged in ordnance storage activities and public works maintenance.

6.1.1.3 Operations and Activities

The Kamokala Ridge Magazines provide secure storage with 12 magazines approved for Class 1.1 explosives. The Navy leases the site from the SOH and maintains 12 tunnel storage magazines. Ordnance is stored for the Navy, Hawai‘i Air National Guard, DOE, and intermittently for other military commands with training and storage requirements.

6.1.1.4 Abbreviated History and Pre-Military Land Use

The Navy has leased lands at Kamokala Ridge Magazines since 1964 for magazine use (NAVFAC PAC Real Estate 2007). Ten of the 12 magazines were built in the World War II era (DON 2005a). Two additional magazines were constructed in 2004 (PMRF 2007).

The undeveloped areas on Kamokala Ridge Magazines have not been systematically surveyed for archaeological resources, but during a 1992 field check, rock alignments were observed that could represent traditional Hawaiian agricultural features. The 10 World War II-era ammunition magazines at Kamokala have been evaluated as eligible for the NRHP (DON 2005a).

6.1.1.5 Regional Land Uses

The Kamokala Ridge Magazines are located on the western side of the island of Kaua‘i in the Waimea-Kekaha region. Section 3.1.1.6 provides a general discussion of the land use in the Waimea-Kekaha region. The Kamokala Ridge Magazines are located in the State Agricultural District (SOH LUC 2005).

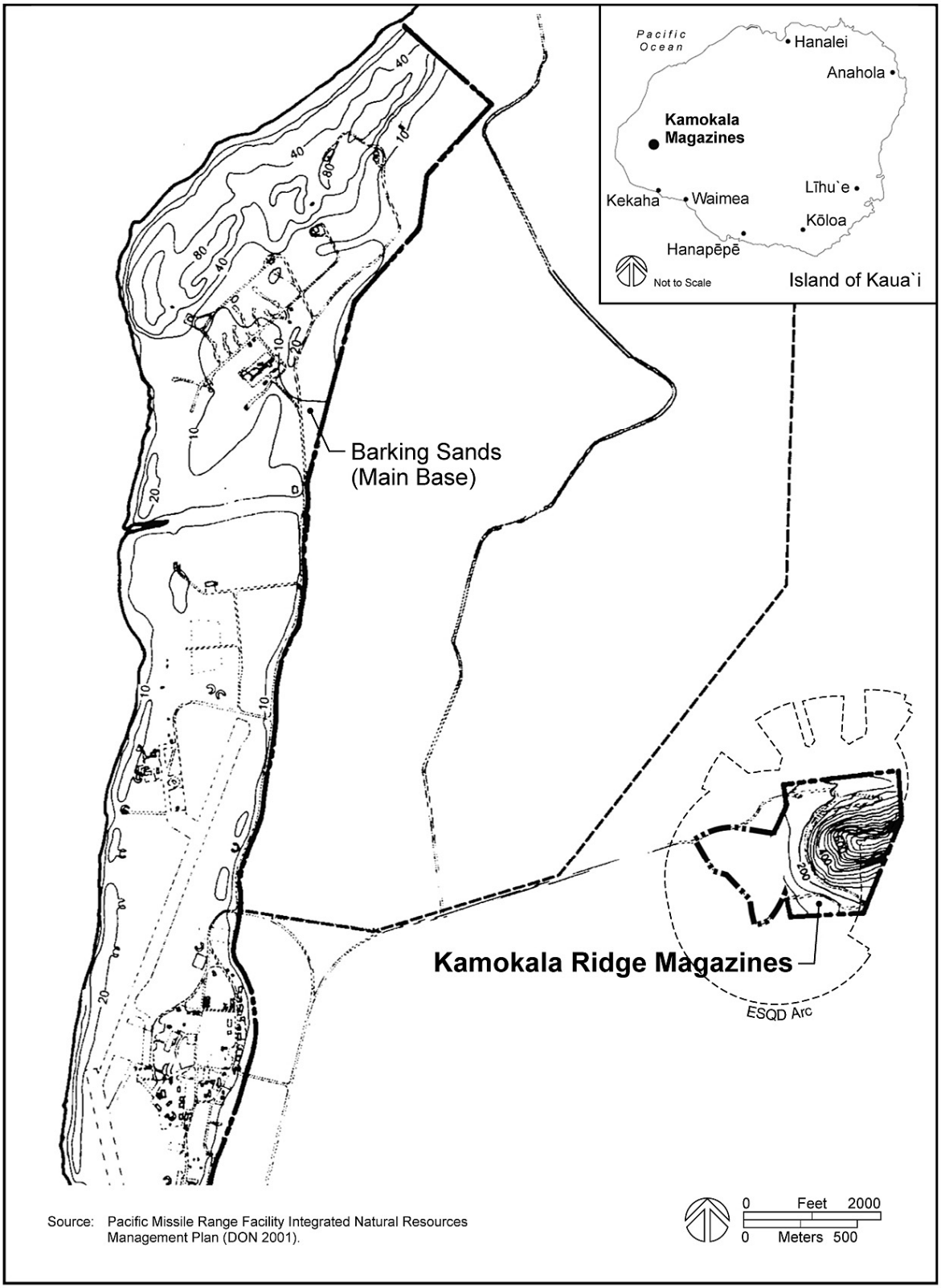


Figure 6-1: Kamokala Ridge Magazines, Kaua'i

6.2 GENERAL PHYSICAL ENVIRONMENT

The discussion of the general physical environment is divided into five subsections (6.2.1 through 6.2.5): (1) physical geography; (2) topography; (3) geology; (4) soils; and (5) hydrology – including surface water resources and hydrogeology (groundwater resources). General island-wide descriptions of these resources are presented in Section 2.2; the following discussion addresses Kamokala Ridge Magazines and its environs.

6.2.1 Physical Geography

A general discussion of the physical geography of the Hawaiian Islands and Kaua‘i is presented in Section 2.2.1. The Kamokala Ridge Magazines are located on the western edge of the Pu‘u Ka Pele upland area, which forms the back scarp of the eastern boundary of the Mānā Plain.

6.2.2 Topography

A general discussion of the topography of the Hawaiian Islands and Kaua‘i is presented in Section 2.2.2. Elevations at the Kamokala Ridge Magazines range from approximately 80 ft to 760 ft (25 to 232 m). The installation slopes moderately to steeply from east to west.

6.2.3 Geology

A general discussion of the geology of Kaua‘i is presented in Section 2.2.4. The Kamokala Ridge Magazines are located on the western edge of the Pu’u Ka Pele upland area, a highly eroded volcanic terrain characterized by numerous valleys with established drainage patterns. The volcanic terrain was truncated by an ancient and higher sea level that carved the cliffs into familiar but less prominent versions of nearby and younger Nā Pali. The Kamokala Ridge Magazines are underlain by lavas of the Napali formation of the Waimea Canyon series. These are the lava flows and associated pyroclastic rocks that accumulated on the flanks of the major Kauai shield volcano, outside the boundaries of the caldera (Section 2.2.4).

6.2.4 Soils

The soils at Kamokala are categorized as silty clay developed on elevated alluvial fans of the Mānā Plain. The area is also unique in being locally stony with volcanic boulder rubble. The area forms a transition between the irrigated agricultural fields below and the extremely stony, silty clays that coalesce at the base of Nahomalu Valley. Surface water drains north and south into bounding ephemeral stream channels of both the Nahomalu Valley and Ka‘awaloa Valley, respectively, and down to the Mānā Plain below. Four soil series underlie the Kamokala Ridge Magazines (Figure 6-2): (1) Kekaha Series; (2) Rubble Land (rRU); (3) rRO (Section 4.2.4); and (4) Waiawa Series.

6.2.4.1 Kekaha Series

Within Kamokala Ridge Magazines there are two soil types of the Kekaha Series: (1) Kekaha clay, 0 to 6 percent slopes (KoB); and (2) Kekaha extremely stony silty clay loam, 0 to 35 percent slopes (KOYE). The Kekaha Series soils are characterized by well-drained soils on alluvial fans and flood plains. These soils developed in alluvium washed from upland soils. The annual rainfall amounts to 20 to 25 in (51 to 64 cm). The surface layer for KoB is dark reddish-

brown silty clay about 21 in (53 cm) thick. The subsoil is 49 in (124 cm) thick and consists dark reddish-brown silty clay and clay. The substratum is clayey alluvium. The soil is mildly alkaline to neutral throughout the profile. Runoff is medium and the erosion hazard is slight to moderate. KOYE is similar to KoB only the soil runoff is slow to medium and the erosion hazard is no more than moderate (USDA 1972).

6.2.4.2 Rubble Land

Rubble land or rRU consists of areas where 90 percent of the surface is covered by stones or boulders. It occurs at the base of very steep to precipitous slopes where the annual rainfall ranges from 22 to 55 inches (56 to 140 cm) (USDA 1972). Below the magazine tunnels and road on the south and west portions of the site, the soil type is mapped as rRU. On the Kamokala Ridge Magazines site, there are places where boulders cover 70 to 80 percent of the surface.

6.2.4.3 Rock Outcrop

Rock outcrop or rRO consists of areas where exposed bedrock covers more than 90 percent of the surface. Runoff is rapid and the erosion hazard is severe (USDA 1972). On the Kamokala Ridge Magazines site, rock outcrops cover about 50 percent of the surface.

6.2.4.4 Waiawa Series

Within Kamokala Ridge Magazines there is one soil type of the Waiawa Series: (1) Waiawa extremely rocky clay, 30 to 80 percent slopes (WJF). The Waiawa Series soils consist of well-drained, very shallow, extremely rocky soils on the uplands. These soils developed in colluvium and in material weathered from basic igneous rock. The annual rainfall ranges for these types of soils from 22 to 40 inches. In a representative profile, the surface layer of WJF is dark reddish-brown, strong, granular heavy clay loam about 2 inches thick. This layer is underlain by dark reddish-brown clay about 12 inches thick. It has angular blocky structure. The substratum is hard rock. The soil is slightly acid to neutral throughout the profile. Permeability is moderate to moderately slow. Runoff is very rapid and the erosion hazard is severe (USDA 1972). The very steep slopes above the magazine tunnels are mapped as WJF.

6.2.5 Hydrology

Section 2.2.5 provides a discussion of regional hydrology. The Kamokala Ridge Magazines are underlain by a single aquifer that is located in the Waimea Aquifer Sector within the Kekaha Aquifer System (Section 2.2.5.2). The aquifer (aquifer code 20301112 [11111]) is a basal, unconfined, dike aquifer that is currently used for drinking water. It is fresh (<250 mg/l Cl^-) and is considered irreplaceable with a high vulnerability to contamination (Mink and Lau 1992).

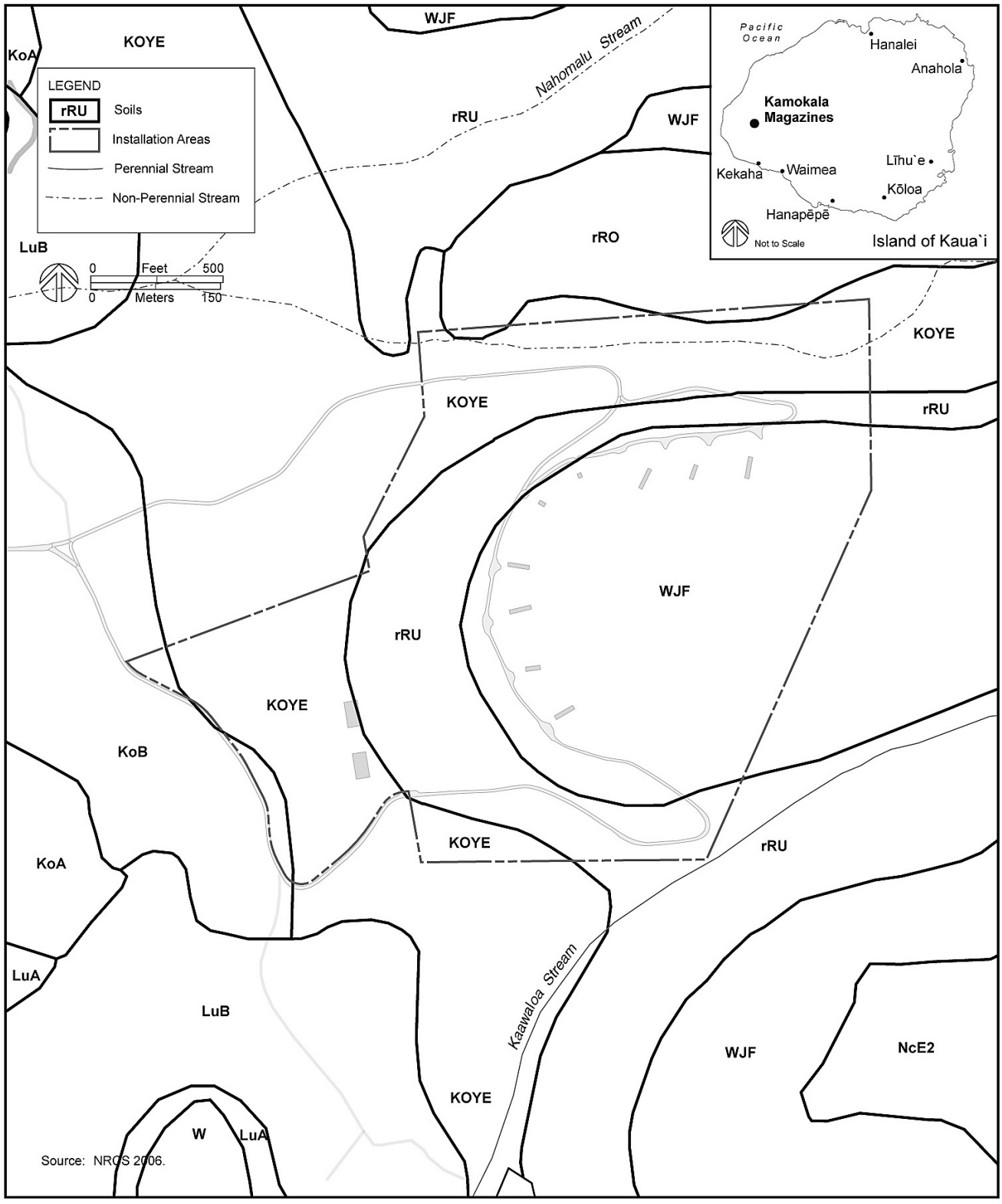


Figure 6-2: Soils, Kamokala Ridge Magazines, Kaua‘i

6.3 GENERAL BIOTIC ENVIRONMENT

Information on biological resources presented in this and subsequent sections are primarily derived from surveys of terrestrial flora, terrestrial fauna, and marine ecosystems conducted as part of the INRMP update process and the 2001 INRMP. These reports, listed below, are contained in the appendices.

- Appendix A5: PMRF Kamokala Magazine Botanical Survey (NAVFAC PAC 2006d);
- Appendix A9: Botanical Survey of Kamokala Magazines (Char 2000d);
- Appendix B1: Herpetological and Mammal Surveys of PMRF (NAVFAC PAC 2006e);
- Appendix B2: PMRF Bird Surveys (NAVFAC PAC 2006f); and
- Appendix B3: Survey of Avifauna and Feral Mammals for the INRMP, Barking Sands, Kaua'i, Hawai'i (Bruner 2000).

Additional information about flora and fauna was compiled from the following two primary sources:

- Conservation Mapping (Appendices A10 and B4; NAVFAC PAC 2005); and
- INRMP for PMRF (DON 2001).

In addition, to the survey reports listed, input was received from Working Group Members regarding the INRMP, including the discussion of the general biotic environment (Appendices I and J).

The discussion of the general biotic environment is divided into five subsections (6.3.1 through 6.3.5): (1) threatened and endangered species; (2) wetlands; (3) ecosystem components; (4) wildlife; and (5) vegetation.

6.3.1 Threatened and Endangered Species

6.3.1.1 Animals

There are no known federally-listed threatened or endangered animal species or critical habitat at the Kamokala Ridge Magazines.

6.3.1.2 Plants

There are no known federally-listed threatened or endangered plant species or critical habitat at the Kamokala Ridge Magazines (NAVFAC PAC 2006d).

6.3.2 Wetlands

There are no surface waters, including wetlands, at the Kamokala Ridge Magazines.

6.3.3 Ecosystem Components

The classification of the Kamokala Ridge Magazines' native terrestrial ecosystem is a lowland dry and mesic forest, woodland, and shrubland (Juvik *et al* 1998).

6.3.4 Fish and Wildlife

The discussion of terrestrial animals at Kamokala Ridge Magazines is divided into three subsections: (1) bird species; (2) mammal species; and (3) amphibian and reptile species.

6.3.4.1 Bird Species

Four MBTA-protected bird species have been observed at Kamokala Ridge Magazines: (1) white-tailed tropic bird (Section 4.3.4.1); (2) the Pacific golden plover (Table 3-3); (3) cattle egret (Table 3-3); and (4) black-crowned night-heron (Table 3-3). Figure 6-3 shows the recorded locations of the Pacific golden plover at the installation.

The most commonly observed bird species at Kamokala Ridge Magazines were cattle egrets, chukars (*Alectoris chukar*), red junglefowl (*Gallus gallus*), spotted doves (*Streptopelia chinensis*), zebra doves (*Geopelia striata*), northern cardinals (*Cardinalis cardinalis*), and Erckel's francolins (*Francolinus erckelii*). No native species were recorded during the 2006 survey. The species recorded during the 2006 survey were consistent with previous surveys conducted on or around Kamokala Ridge (Bruner 2000). Appendix B5 provides a list of all species recorded at Kamokala Ridge Magazine (NAVFAC PAC 2006e). No particularly unusual or unique habitats utilized by native bird species were observed on the magazine property (Bruner 2000).

6.3.4.2 Mammal Species

Black-tailed deer, pigs, cows (family Bovidae), and feral cats have been observed at Kamokala Ridge Magazines (NAVFAC PAC 2006e).

6.3.4.3 Amphibian and Reptile Species

Herpetological surveys have not been performed at the Kamokala Ridge Magazine.

6.3.5 Vegetation

Botanical surveys were conducted at the Kamokala Ridge Magazines in 2006 (NAVFAC PAC 2006d) and in 2000 (Char 2000d). In addition, the installation was classified by the Navy's Conservation Mapping Project in 2005.

6.3.5.1 Terrestrial Plants

The vegetation at Kamokala Magazine consists largely of two vegetation types (Figure 6-4): (1) koa haole scrub/forest, with scattered wiliwili *(Erythrina sandwicensis*) (photo 6-2) and kiawe trees; and (2) a narrow band of ruderal vegetation which occurs around the paved areas, including roadsides. Both of these vegetation types were unchanged from the 2000 botanical survey (NAVFAC Pac 2006d).

Photo 6-2: Wiliwili at Kamokala Ridge Magazines

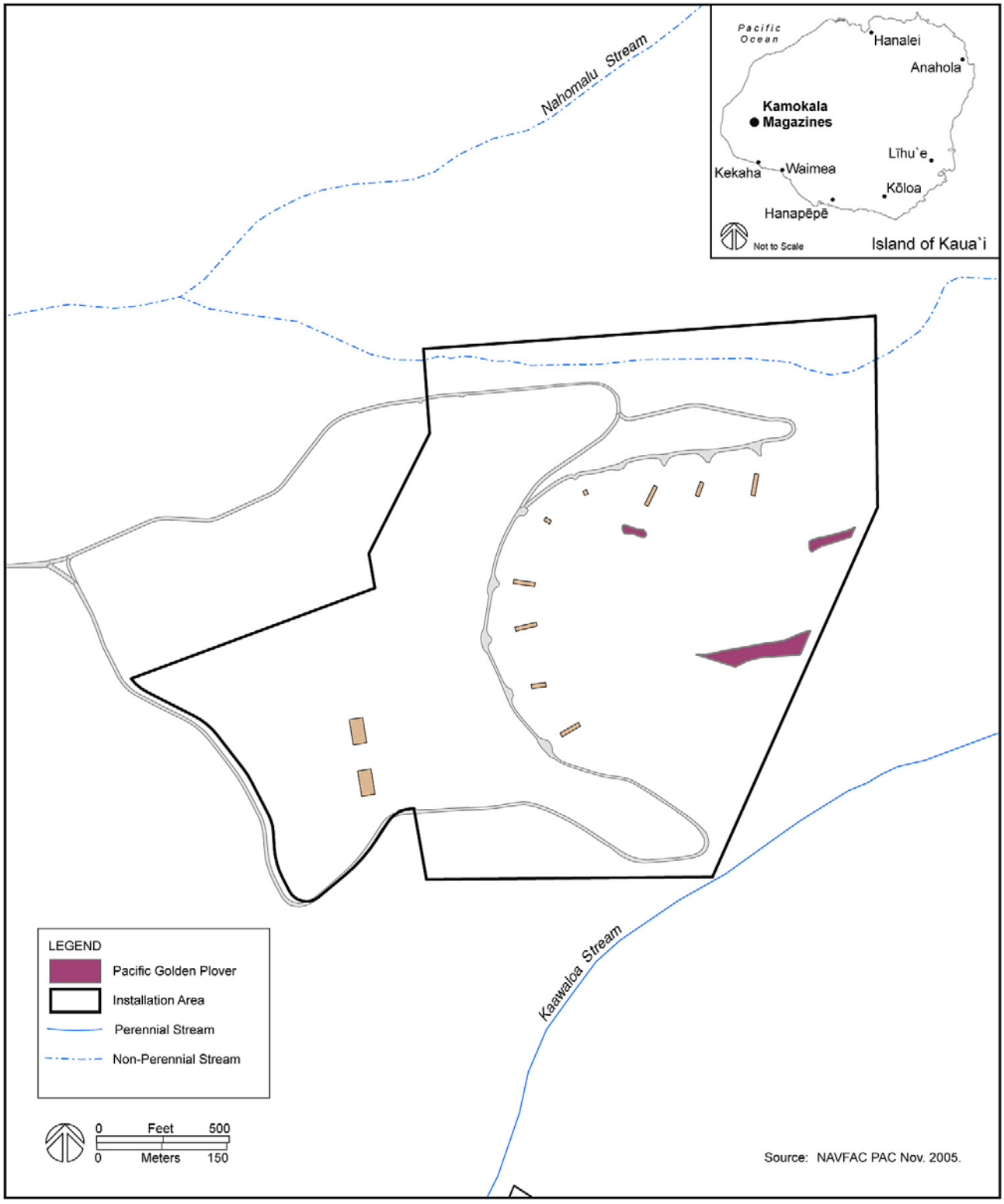


Figure 6-3: Protected Animal Species Habitat, Kamokala Ridge Magazines, Kaua'i

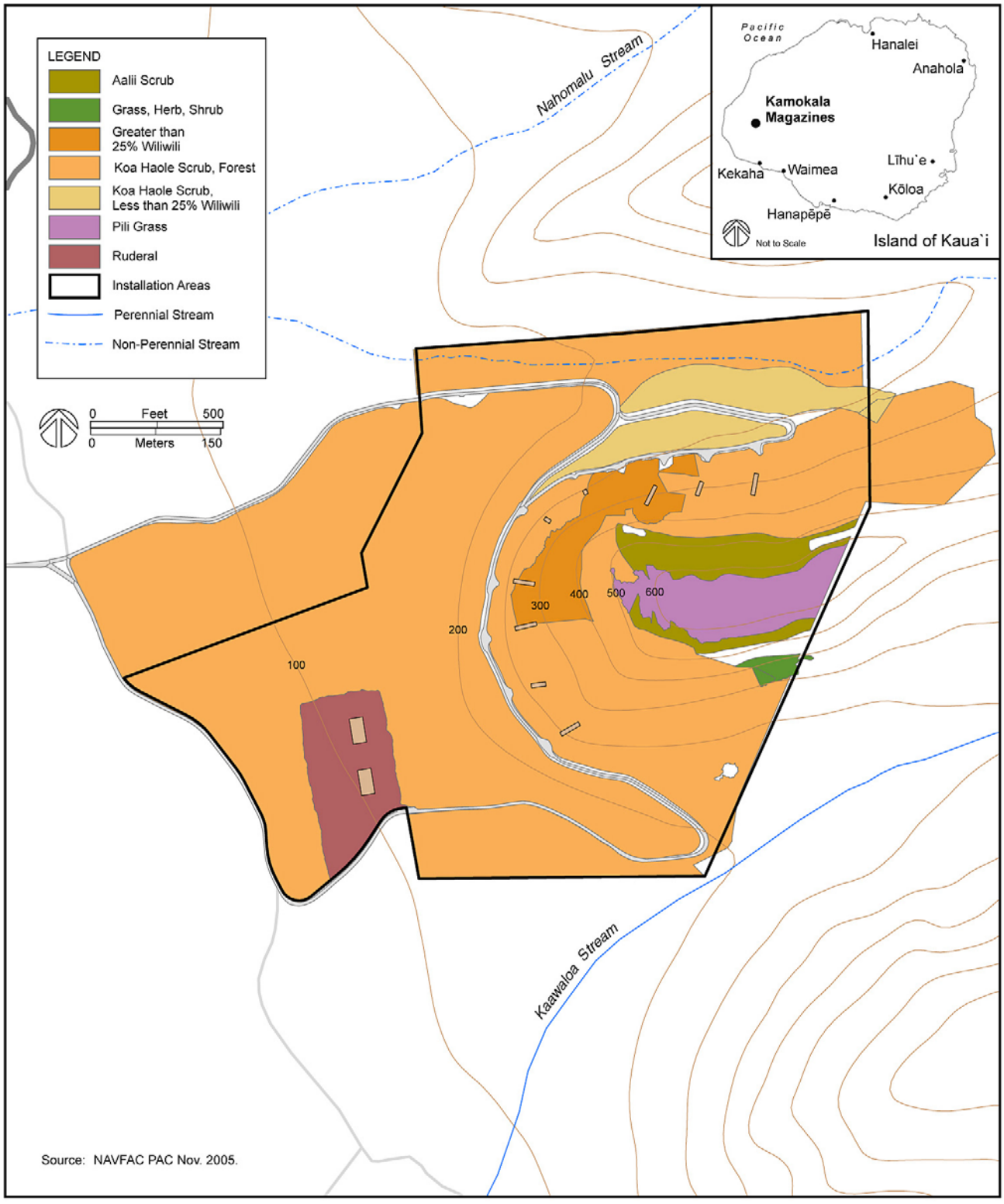


Figure 6-4: Vegetation Types, Kamokala Ridge Magazines, Kaua‘i

A summary of the vegetation types (and their variations) is shown in Figure 6-4. An inventory of all the plant species observed during the field studies is presented in the checklist at the end of the report in Appendix A4.

1. Koa Haole Scrub/Forest

Koa haole scrub/forest covers the majority of the Kamokala Magazine site. On the steeper slopes above the road and magazine tunnels, koa haole forms an open, patchy scrub, 6 ft to 12 ft (2 m to 4 m) tall. Below the road, the koa haole becomes a dense forest, 20 to 25 ft (6 to 8 m) tall, with scattered kiawe trees, 30 ft to 45 ft (9 m to 14 m) tall (NAVFAC Pac 2006d).

Vegetation cover is about 50 percent and consists primarily of koa haole shrubs, 6 ft to 12 ft (2 m to 4 m) tall, which form an open, patchy scrub. Scattered along the lower slopes are small stands of wiliwili and scattered individuals of kiawe; tree cover is about 15 percent to 20 percent and tree height ranges from 20 ft to 30 ft (6 m to 9 m) (Char 2000d). Ground cover is a mixture of grasses, small shrubs, and herbaceous species that includes: (1) Guinea grass; (2) bristly foxtail (*Setaria verticillata*); (3) sourgrass (*Digitaria insularis*); (4) natal redtop; (5) *Bothriochloa sp*.; (6) virgate mimosa (*Desmanthus pernambucanus*); (7) klu (*Acacia farnesiana*); (8) hairy abutilon (*Abutilon grandifolium*); (9) *Portulaca pilosa*'; (10) false mallow (*Malvastrum coromandelianum*); and (11) barleria (*Barleria cristata*).

Lion's ear *(Leonotis nepetifolia)* is abundant on the lower slopes. *Parmelia sp.*, a grayish-white foliose lichen, is abundant on some of the exposed rock faces (Char 2000d). Also associated with the rock outcrops and ledges are a few native plants, which include: (1) ʻilima; (2) pili; (3) ilieʻe (*Plumbago zeylanica*); (4) ʻalaʻala wai nui (*Peperomia leptostachya*); (5) hoary abutilon or mao (*Abutilon incanum*); (6) aʻaliʻi; and (7) lance fern (*Doryopteris decora*).

Below the magazine tunnels and road on the south and west portions of the site, koa haole shrubs form a tall dense forest with scattered trees of wiliwili and kiawe on the somewhat gently sloping terrain. Soil between the boulders support robust clumps of Guinea grass, which may reach 3 ft (1 m) tall. The white-flowered barleria shrub and virgate mimosa are also locally abundant among the boulders. In more open areas, sourgrass and buffel grass form somewhat large patches. A few large Chinese banyan *(Ficus microcarpa)* and be-still tree *(Cascabela thevetia)* occur along the lower boundary (Char 2000d).

On the north side of the site (Nahomalu Valley), dense koa haole forest with scattered trees of kiawe and wiliwili are found. The terrain is nearly level to gently sloping. A barbed wire fence line runs parallel to the access road. North of the fence the property is used for grazing cattle. As a result, ground cover is patchy with scattered, low clumps of Guinea grass, 6 in to 1 ft (15 cm to 0.3 m) tall. Areas with bare soil are common. The intermittent stream, which passes along the valley floor, is usually dry and boulder-strewn. A few Java plum (*Syzygium cumini*), kiawe, wiliwili and kukui (*Aleurites moluccana*) line the stream (Char 2000d).

2. Ruderal Vegetation

This vegetation type occupies only a small area on the property and is associated with the roadsides, loading areas, and other sites that are occasionally mowed or trimmed back. It consists of low mats of grasses and weedy, mostly annual herbaceous species. Buffel grass is the most abundant grass with smaller sections along the road supporting patches of *Bothriochloa sp*., swollen fingergrass (*Ghloris barbata*), and Bermuda grass. Weedy

herbaceous species commonly observed here include hairy spurge, false mallow, Spanish needle, *Heliotropium procumbens,* and purple cudweed *(Gamachaeta purpurea)* (Char 2000d).

Where the soil is stonier or where the pavement borders a rocky shelf, the ruderal vegetation supports low clumps of Guinea grass, 6 in to about 1 foot (15 cm to 0.3 m) tall. Koa haole and lantana shrubs that have been cut back to almost ground level also occur on these areas (Char 2000d).

6.3.5.2 Marine Plants

The Kamokala Ridge Magazines is an upland site, not directly adjacent to or directly affecting, the marine environment. Therefore, a discussion of the marine flora is not warranted.

6.4 CURRENT MANAGEMENT

This section describes the current management at the Kōkeʻe Sites in the following categories: (1) project-specific management actions; (2) natural resources studies; (3) use of GIS systems; (4) forestry; (5) community outreach; (6) outdoor recreation; (7) land management; (8) flood plains; (9) law enforcement; (10) wildland fire; (11) leases and encroachment.

6.4.1 Project-Specific Management Actions

Project-specific management actions were not identified for Kamokala Ridge Magazines.

6.4.2 Natural Resources Studies

NAVFAC PAC completed a bird survey of the Kamokala Ridge Magazines in 2006 (Appendix B2; NAVFAC PAC 2006f). This survey updated the 2000 avifauna (and feral mammals) survey conducted by Bruner in 2000 (Appendix B3). Appendix B5 has a complete listing of the bird species observed during both surveys. The Navy intends to periodically update the fauna surveys for the installation in support of the INRMP.

NAVFAC PAC completed a botanical survey of the Kamokala Ridge Magazines in 2006 (Appendix A5; NAVFAC PAC 2006d). This survey updated the 2000 survey conducted by Char (Appendix A9; Char 2000d). The Navy intends to periodically update the botanical survey for the installation in support of the INRMP.

In 2010, a Hawaiian hoary bat survey was initiated using the ANABAT system that is being standardized by USGS for Hawaiian hoary bat on PMRF to help determine potential distribution and abundance.

6.4.3 Use of Geographic Information Systems

NAVFAC PAC Natural Resources staff are in the process of updating their GIS database to include the locations of protected plant and animal species. This updated GIS layer will include the federally-listed bird species (nēne) at the Kamokala Ridge Magazines. Currently the GIS coverage for the facility includes protected animals (Figure 6-3) and vegetation types (Figure 6-4).

6.4.4 Forestry

No forest management for market purposes is appropriate at Kamokala Ridge Magazines.

6.4.5 Community Outreach

The closed nature of this installation does not provide for valuable community outreach opportunities.

6.4.6 Outdoor Recreation

The Kamokala Ridge Magazines is a restricted area and generally does not offer any outdoor recreation opportunities.

6.4.7 Land Management

No land management programs were identified at Kamokala Ridge Magazines other than those discussed in Section 3.4.7 (e.g., base planning, landscape design).

6.4.8 Floodplains

Not present.

6.4.9 Law Enforcement

The Kamokala Ridge Magazines are policed by the BOS security contractor.

6.4.10 Wildland Fire

Wildland fires have not impacted the Kamokala Ridge Magazines in recent years; however, during dry conditions, wildland fires can impact the ridge line. The County of Kaua‘i Fire Department, DLNR, and BOS contracted fire department would respond to any fires at the facility.

6.4.11 Leases and Encroachment Management

Not applicable.

CHAPTER SEVEN: KA‘ULA ISLAND

7.1 CURRENT CONDITIONS AND USE

7.1.1 Installation Information

7.1.1.1 General Description

Ka‘ula Island (photo 7-1) is comprised of approximately 108 ac (44 ha) of which the Navy uses approximately 9 percent or about 10 ac (4 ha) on the southern tip of the island to train aviators in air-to-surface (inert) weapons delivery. The island, located 35 nm (64 km) southwest of Kaua‘i, is owned by the U.S. Government and is under the jurisdiction, control, accountability, and custody of the Navy.

Photo 7-1: Ka‘ula Island Aerial Photo

7.1.1.2 Land Use Constraints

Land use constraints at Ka‘ula Island result from military mission and protected species. The military land use constraints include unexploded ordnance (UXO) and the presence of a target area used to train aviators in air-to-surface delivery of non-explosive practice ordnance. Past use included military bombing and strafing training with explosive ordnance. As a result of those activities, there are UXO hazards that remain in the area. Therefore, public access to the island is not permitted. A Ka‘ula Island Danger Zone is published in 33 CFR Section 334.1340(a). The District Engineer USACE usually establishes danger zones where UXO is present. The Ka‘ula Danger Zone extends in a 3-mi (4.8-km) radius from the island. No vessel or craft shall enter or remain in the zone except as authorized by CNRH.

Natural resource land use constraints include the presence of numerous Migratory Bird Treaty Act (MBTA)-protected bird species which pose a safety concern due to being a Bird Aircraft Strike Hazard (BASH). Personnel access to Ka‘ula Island is limited due to safety concerns from BASH as well as UXO and is restricted to those engaged in official business. It is often difficult to safely transport personnel on and off the island either by boat or helicopter to conduct authorized functions. Helicopter aircrews report the high of BASH risk when attempting helicopter insertions and extractions of personnel. The Navy allows federal and SOH natural resources professionals access to the island to conduct natural resource surveys and assessments; however, access has been limited in recent years due to safety concerns (e.g., UXO and BASH).

7.1.1.3 Operations and Activities

The southeast end of Ka‘ula Island (Figure 7-1), approximately 9 percent of its total landmass, is used to train aviators in air-to-surface (inert) weapons delivery.

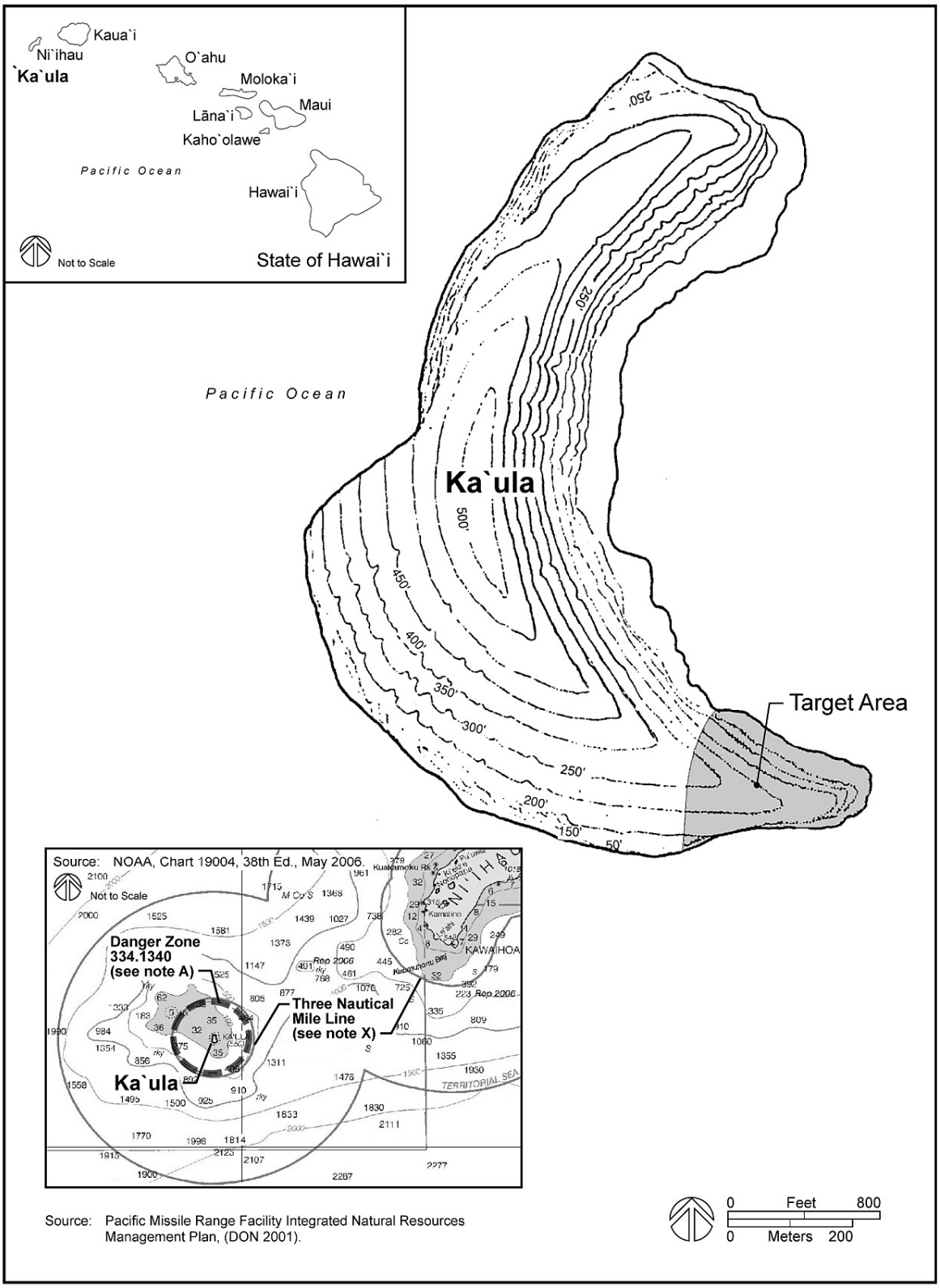


Figure 7-1: Ka‘ula Island

7.1.1.4 Abbreviated History and Pre-Military Land Use

There are a few legendary accounts of Hawaiians who visited Ka'ula Island, but no evidence of extensive human habitation is known. Ni'ihau residents may have gone to Ka'ula to gather eggs and feathers. In 1924, Ka'ula Island was set aside for public purposes within the jurisdiction of the U.S. by the Territory of Hawai'i. In July 1925, a party of men sent to the island to build a lighthouse found two stone structures, which may have been heiau (places to worship), on the northern part of the crest. In addition, a shelter cave likely used by visiting Hawaiians was found on the east side (concave) side of the island at this time. A lighthouse was commissioned at Ka'ula Island on August 18, 1932 by the U.S. Government under the jurisdiction of the U.S. Lighthouse Service (Bryan 1939 in DON 2001). In 1939, the U.S. Coast Guard (USCG) succeeded to the rights of the Lighthouse Service and thus assumed control of the island (DON 1971 in DON 2001). The lighthouse was in operation until 1947. On 11 June 1965, Ka'ula Island was transferred from the USCG to the Navy.

The southeast portion of the island has been used by the Navy to train aviators in air-to-surface ordnance delivery since 1952. Opposition to the use of the island as a target was initiated in 1961, as part of the general anti-war movement at the time. The Kaua'i County Board of Supervisors passed a resolution on 7 April 1965 asking the Navy to cease bombing operations at the island until a study could be made to determinate its value as a bird sanctuary. In 1971, the Navy consented to periodically allow fishermen to enter the 3-mi (4.8 km) restricted zone surrounding the island for which the Navy controls access when bombing exercises were not taking place. In 1971, in response to a Biological Opinion from NOAA Fisheries related to humpback whales, the Navy ceased live fire training at Ka'ula Island and since that time have used only the southern-most 10 ac (4 ha) of the island for training in aircraft gunnery and inert ordnance dropping. In 1976, the Navy completed an Environmental Impact Statement indicating that the bombing activities at Ka'ula Island did not represent an adverse impact to the island. According to DLNR, the Hawai'i State Seabird Sanctuary consists of and includes 40 SOH-owned or controlled islands, islets, and rocks. Ka'ula was listed erroneously by SOH as one of these islands. Ka'ula remains federally owned and controlled.

7.2 GENERAL PHYSICAL ENVIRONMENT

The discussion of the general physical environment is divided into six subsections (7.2.1 through 7.2.6): (1) physical geography; (2) topography; (3) climate; (4) geology; (5) soils; and (6) hydrology – including surface water resources and hydrogeology (groundwater resources). General island-wide descriptions of these resources are presented in Section 2.2; the following discussion addresses Ka'ula Island and its environs.

7.2.1 Physical Geography

A general discussion of the physical geography of the Hawaiian Islands is presented in Section 2.2.1. Ka'ula Island is located at 21° 39' North latitude and 160° 33' West longitude. It is a small, uninhabited, crescent-shaped volcanic island of approximately 108 ac (43 ha). It is located approximately 35 nm (64 km) southwest of Kaua'i and 20 nm (37 km) west-southwest of Ni'ihau on a 27-square-mile (70-km^2) shoal outlined by the 100-fathom (0.2-km) depth contour. The Navy inert ordnance target area is located on the southeast tip of the island (Figure 7-1).

7.2.2 Topography

Elevations at Ka'ula Island range from sea level to approximately 540 ft (165 m) above mean sea level. Elevations at the target area range from sea level to 250 ft (76 m) above mean sea level.

7.2.3 Climate

Ka'ula Island is exposed to a harsh, wind-swept, open-ocean climate. Information on Ka'ula Island's climate was not readily available. Rainfall is estimated to be less than 20 in (51 cm) per year (DON 1971 in DON 2001).

7.2.4 Geology

Ka'ula Island is a remnant of a crescent-shaped volcanic crater rim. The main structure of the island is comprised of tuff, a consolidated volcanic ash. Walls of the remnant crater are steep-sloping and, on the inner side, form a small bay. Near the outer side of the crater at the northern "horn" of the island is a large sea cave, approximately 100 ft (30 m) deep with a 50-ft (15-m) ceiling. Most of the inner curve of Ka'ula has a rock terrace or bench along the shore, ranging from 10 to 80 ft (3.1 to 24 m) wide. It is believed that the bench was formed by wave action that occurred during a period when sea level differed from its present height.

7.2.5 Soils

Information regarding soils of Ka'ula Island was not readily available.

7.2.6 Hydrology

The island has no perennial streams and no groundwater. Rain waters collect in the small gullies on the island, percolate downward, or evaporate (DON 1971 in DON 2001). A freshwater source was discovered approximately 1,000 ft (305 m) from the target point (Figure 7-1) during a deployment to the island in August 1971. The rate of flow from the source was estimated to be "1 pint per hour."

7.3 GENERAL BIOTIC ENVIRONMENT

The first plant and animal survey of Ka'ula Island was conducted in August 1932 by Bryan (1939 in DON 2001). Nine natural resources surveys were conducted by the Navy in August 1971, January 1976, September 1976, August 1978, March 1979, June 1979, April 1980, June 1993, and November 1998 (DON 1998). In addition, to the survey reports listed, input was received from Working Group Members regarding the INRMP, including the discussion of the general biotic environment (Appendices I and J).

The discussion of the general biotic environment is divided into four subsections (7.11.1 through 7.11.5): (1) threatened and endangered species; (2) wetlands; (3) ecosystems; (4) wildlife; and (5) vegetation.

7.3.1 Threatened and Endangered Species

This section provides a summary of the federally-listed threatened and endangered species at Ka'ula Island; it is organized in two parts with animal species discussed in Section 7.3.1.1 and plant species in Section 7.3.1.2. Table 7-1 provides a listing of the federally-listed threatened and endangered species.

Table 7-1: Federally-Listed ESA Species at Ka'ula Island

Latin Binomial	Common Name	Regulatory Status
Monachus schauinslandi	Hawaiian monk seal	E
Megaptera novaeangliae	Humpback Whale	E
Eretmochelys imbricata	Hawksbill Sea Turtle	E

Chelonia mydas	Green Sea Turtle	T

E – endangered; T – threatened

7.3.1.1 Animals

There are no known federally-listed threatened or endangered terrestrial animal species, or critical habitat at Ka'ula Island. There are two federally-listed endangered marine mammals that frequent the waters of Ka'ula Island: (1) humpback whales and (2) Hawaiian monk seals. These species are discussed in the following paragraphs.

Humpback Whales. Ka'ula Island's shoal area is visited seasonally by large pods of endangered humpback whales (Section 3.3.1.1). Calambokidis *et al.* (2008) investigated the population and level of abundance of humpback whales in the North Pacific, including Hawai'i between 2004 and 2006; however, the survey investigation did not include Ka'ula Island. Surveys conducted by NOAA Fisheries over four consecutive years (1976 through 1979) showed that humpback whales occur annually, frequenting the shoals in the nearshore waters of Ka'ula during the peak winter season (NOAA Fisheries in DON 2001).

Hawaiian Monk Seals. Recent surveys have reported three to 15 Hawaiian monk seals at Ka'ula Island (NOAA Fisheries 2009; NAVFAC PAC 2009). Baker and Johanos (undated) reported that three federally-listed Hawaiian monk seals were observed during aerial surveys conducted over Ka'ula Island in 2000 and incidental sightings and reports by casual observers indicate that approximately eight Hawaiian monk seals may be resident in Ka'ula's waters. In addition, there have been reports of groups of up to four seals hauled out on a 328-foot (100 m) wide rock ledge along the eastern side of the island. Section 3.3.1.1 provides a general description of Hawaiian monk seals as well as their range and habitat, feeding habits, reproduction, and threats to the species.

Hawaiian monk seals have been provided protection from harassment and disturbance by the Navy through restricted access to the island. In addition, there are mitigation measures associated with inert ordnance air to surface target practice training activities that take place at the southern tip of the island. Pursuant to the Biological Opinion received from NOAA (NOAA Fisheries 2007), the Navy agreed to mitigations that reduce or eliminate any potential impacts to Hawaiian monk seals from training activities (inert ordnance air to surface target practice at the southern tip of the island). These mitigations include the use of non explosive rounds, limiting the impact to the southern tip of the island, seasonal use (this applies to humpback whales), and surveying the waters off Ka'ula to ensure Hawaiian monk seals are not present (DON 2008). Current management for the species at PMRF, including Ka'ula Island, is guided by this document and, in part, by the December 2008 *Final Programmatic Biological Opinion on U.S. Navy Activities in the Hawaii Range Complex 2008-2013* (NOAA Fisheries 2008). The Hawaii Range Complex FEIS/ OEIS (DON 2008a) did not identify specific threats to Hawaiian monk seals from activities associated with the Navy's activities in the Hawaii Range Complex. Mitigation measures identified in Section 6.1 of the Hawaii Range Complex FEIS/OEIS would mitigate the effects of inert ordnance air to surface target practice. Subsection 7.4.1.2, provides a discussion of the Navy's management actions at Ka'ula Island geared to protect, benefit, and aid the recovery of Hawaiian monk seals. The discussion is organized to parallel the discussion of threats to the species detailed in Table 3-1 (Section 3.3.1.1) and in the *Hawaiian Monk Seal Recovery Plan* (NOAA Fisheries 2007).

7.3.1.2 Plants

There are no known threatened or endangered or otherwise protected plant species or critical habitat at Ka'ula Island.

7.3.2 Wetlands

There are no surface waters, including wetlands, at Ka'ula Island.

7.3.3 Fish and Wildlife

The discussion of animals at Ka'ula Island is divided into four subsections: (1) bird species; (2) mammal species; (3) amphibian and reptile species; and (4) fishes and coral species.

7.3.3.1 Bird Species

There are 21 MBTA-protected bird species that have been observed on the island (Table 7-2). The first bird survey of Ka'ula Island was conducted in 1932. The Navy conducted a bird surveys in 1971, 1976, 1978, 1979, 1980, 1993, and 1998 (DON 1998). Avian surveys at Ka'ula Island were conducted by NAVFAC PAC for COMPACFLT in 2009 and 2010 via a research vessel (Appendix G11). Additional ship-based surveys will be conducted annually or twice per year over the next three years.

Currently, an estimated 16 species of seabird nest on the island. Six introduced, exotic bird species have been observed in small numbers. The complete list of bird species observed in surveys from 1932 to 1998 on Ka'ula Island is presented in Appendix B5. Ka'ula Island may have a rat infestation problem that could adversely affect the protected bird species on the island (SOH DBEDT CZM 2008).

Table 7-2: MBTA-Protected Bird Species Observed on Ka'ula Island

Hawaiian Name	Common Name	Latin Binomial	Comments
Ka'upu	Black-footed albatross	*Diomedea nigripes*	See Section 3.3.4.1
Mōlī	Laysan albatross	*Diomedea immutabilis*	See Section 3.3.4.1
'Ūlili	Wandering Tattler	*Heteroscelusin canus*	See Section 3.3.4.1
Pakalakala	 Photo 7-2: Gray-backed tern	*Stern lunata*	The gray-backed tern is an indigenous bird that is mostly slate gray above and white below with a black crown and nape. The forehead has a narrow white patch that is continuous with white eye-brow that extends above and past the eye and is completely bordered with black. They nest in shallow depressions in sand or gravel and lay a single egg per season. In Hawai'i, nesting varies from year to year but most eggs are laid in February and March and most nestlings fledge by July (. There are an estimated 44,000 breeding pairs in Hawai'i (DOFAW 2005).

Table 7-1: MBTA-Protected Bird Species Observed on Ka'ula Island (Continued)

Hawaiian Name	Common Name	Latin Binomial	Comments
'Ewa 'ewa	 Photo 7-3: Sooty tern	*Sterna fuscata*	The sooty tern is an abundant and gregarious tern that has long, slender wings and a deeply forked tail. They are blackish above, except for a white forehead and white on the edges of the outermost tail feathers, and entirely white below. The sharp bill, legs, and feet are black. Individuals return to the natal colony to breed. There are over one million breeding pairs in Hawai'i (DOFAW 2005).
Manu-o-kū	 Photo 7-4: White tern	*Gygis alba*	The white tern is a small, entirely white tern. Breeding adults remain close to nest sites and forage in inshore areas such as shoals and banks with occasional forays into offshore waters. They nest in loosely associated groups or singly. No nest is constructed; a single egg is laid wherever a suitable depression is found. Most nests are on tree branches, buildings, rock ledges, or on the ground. Breeding occurs year round and some pairs successfully raise two or three broods per year. In the Hawaiian archipelago, there are an estimated 15,000 breeding pairs (DOFAW 2005).
Not applicable	 Photo 7-5: Blue-gray noddy	*Procelsterna cerulea*	The blue-gray noddy is the world's smallest tern. It is an indigenous bird that is entirely bluish gray, has a partial white eye-ring, a short, slender bill, and shallow fork tail. They nest in aggregations among cavities or crevices in lava flows. They nest throughout the year. There are an estimated 3,600 breeding pairs in Hawai'i (DOFAW 2005).

Table 7-1: MBTA-Protected Bird Species Observed on Ka'ula Island (Continued)

Hawaiian Name	Common Name	Latin Binomial	Comments
Noio kōhō	 Photo 7-6: Brown noddy	*Anous stolidus*	The brown noddy is a medium-sized, abundant tern that is very similar to the black noddy. They have slender wings and a wedge-shaped tail and are dark brown with a white cap and black bill, legs, and feet. They breed in large, dense colonies on the ground or cliffs or trees. Breeding is synchronous with peaks occurring in the spring or summer. Pairs stay together throughout the year. There are an estimated 112,000 breeding pairs in Hawai'i (DOFAW 2005).
Noio	 Photo 7-7: Black noddy	*Anous minutus*	The black noddy is a medium sized, abundant, and gregarious tern that have slender wings, a wedge-shaped tail, and black bill which is slightly curved. They are sooty black with a white cap and have reddish brown legs and feet. Nests in large, dense colonies that include non-breeding juvenile birds. Established pairs return to the same nest site year after year. Breeding is highly variable and egg laying occurs year-round. There are an estimated 12,000 breeding pairs in Hawai'i (DOFAW 2005).
'Ua'u kani	Wedge-tailed shearwater	*Puffinus pacificus*	See Section 3.3.4.1

Table 7-1: MBTA-Protected Bird Species Observed on Ka'ula Island (Continued)

Hawaiian Name	Common Name	Latin Binomial	Comments
Not applicable	 Photo 7-8: Christmas shearwater	*Puffinus nativitatis*	The Christmas shearwater is a medium-sized, dark-brown shearwater with a short, wedge-shaped tail and a shiny, black bill. They are entirely dark brown, although underparts are lighter than upperparts. They breed in their natal colonies and lay only one egg per season. They nest in rock crevices or under dense vegetation. In Hawai'i, eggs are laid beginning in February, and nestlings fledge in October or November. There are less than 3,000 breeding pairs in Hawai'i (DOFAW 2005).
'Ou	 Photo 7-9: Bulwer's petrel	*Bulweria bulwerii*	The Bulwer's petrel is a pelagic bird that only comes to shore to breed. It is a medium to large shearwater with white underparts and underwings and gray upperparts with dark outer wing and diagonal bar across inner wing and a dark cap. There are between 75,000 and 103,000 breeding pairs in Hawai'i (DOFAW 2005).
Not applicable	 Photo 7-10: Bonin petrel	*Pterodroma hypoleuca*	The Bonin petrel is a small, nocturnal gadfly petrel. In Hawai'i eggs are laid in mid-January and chicks fledge by June. They nest in burrows which they excavate in sandy soils. They breed in natal colonies, form long-term pair bonds, have high site fidelity, lay only one egg per season, and both parents participate in all aspects of raising young . In Hawai'i, there are an estimated 270,000 to 395,000 breeding pairs (DOFAW 2005).

Table 7-1: MBTA-Protected Bird Species Observed on Ka'ula Island (Continued)

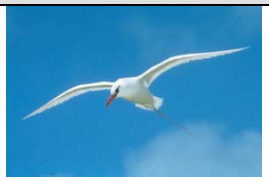
Hawaiian Name	Common Name	Latin Binomial	Comments
Koa'e'ula	 Photo 7-11: Red-tailed tropicbird	*Phaethon rubricauda*	The red-tailed tropicbird is a showy, white seabird that breeds in Hawai'i. Ground nests are built and breeding can occur throughout the year but most nests are active from February through June. A single egg is laid per season. In Hawai'i, there are an estimated 9,000 to 12,000 breeding pairs (DOFAW 2005).
Koa'e kea	White-tailed tropicbird	*Phaethon lepturus*	See Section 4.3.4
'A	 Photo 7-12: Masked booby	*Sula dactylatra*	The masked booby is the largest booby. These birds have long pointed wings and a short, wedge-shaped tail. They are white overall except for a brownish black tail, black trailing wing edges, and black facial skin around the bill. They nest on open ground often near a cliff edge or on low sandy beaches; eggs are laid in a shallow scrape. Typically they lay two eggs per breeding season. The eggs hatch asynchronously, and the first chick to hatch usually pushes the other chick out of the nest. Adults continue to breed young up to six months after fledging. Approximately, 450 breeding pairs occur in the MHI (DOFAW 2005).
'A	Brown booby	*Sula leucogaster*	Section 3.3.4.1

Table 7-1: MBTA-Protected Bird Species Observed on Ka'ula Island (Continued)

Hawaiian Name	Common Name	Latin Binomial	Comments
'A	 Photo 7-13: Red-footed booby	*Sula sula*	The red-footed booby has long-pointed wings and a relatively long, wedge-shaped tail. Several color phases exist, ranging from all brown to all white; almost all Hawaiian birds are white. They roost and build their nests in shrubs or trees. In Hawai'i, breeding is synchronous, but can occur throughout the year. Egg laying peaks in February through April and most young have fledged by September. There are an estimated 7,000 to 10,000 breeding pairs in Hawai'i (DOFAW 2005).
'Iwa	 Photo 7-14: Great frigate bird	*Fregata minor*	The great frigate bird is a large, graceful seabird related to boobies and tropicbirds. Adult males are almost entirely black, with varying amounts of a dark green sheen on head and neck. Adult females are larger than males, and are black with a white breast patch and gray throat. They nest in colonies and pairs. They usually switch partners every breeding season. There are an estimated 10,000 breeding pairs in Hawai'i (DOFAW 2005).
'Akekeke	Ruddy turnstone	*Arenaria ininterpres*	See Section 3.3.4.1
Kōlea	Pacific golden plover	*Pluvialis fulva*	See Section 3.3.4.1

7.3.3.2 Mammal Species

Rats, an introduced species, may be present on the island. Marine mammals that frequent the waters around the island include humpback whales (Section 7.3.1.1), Hawaiian monk seals (Section 7.3.1.1), and spinner dolphins (Section 3.3.4.1).

7.3.3.3 Amphibian and Reptile Species

No terrestrial herpetological surveys have been performed at the Ka'ula Island. Collectively, four species of endangered sea turtle and one species of threatened sea turtle occur in the open ocean and coastal waters of the Hawaiian Islands. Coastal waters of Ka'ula are considered viable foraging habitat for green turtles; however, no definitive sightings of turtles have been documented from Ka'ula.

7.3.3.4 Fish and Coral Species

The waters within a 3-mi (4.8 km) radius of Ka'ula Island have been established as a danger zone. As such, no vessel or other craft may enter or remain in the danger zone except as authorized by the Navy. Although the Navy restricts access to the waters off of Ka'ula Island for safety reasons it does not have management responsibility for the natural resources in these waters. The complete fish species list from surveys conducted by Bishop Museum in 1996 (Earl 1996 in DON 2001) is presented in Appendix C4 for the purposes of providing general background information. Among the species reported was the whale shark (*Rhincodon typus*) which is rarely sighted in the MHI as well as several commercially important fishes, including tunas and carangids (jacks) observed spawning in the area. Appendix C4 lists commercial fishery catch statistics from the waters around Ka'ula Island.

Ka'ula Island is surrounded by Ka'ula Bank. The entire bank has been identified as a habitat area of particular concern in the Fishery Management Plan for Coral Reef Ecosystems. Ka'ula Bank and Penguin Bank (off Moloka'i) contain the only two significant coral resources within federal waters for the MHI.

7.3.4 Vegetation

Information on the terrestrial plants was obtained from previous investigations by Caum (1936 in DON 2001) and Wagner et al. (1990 in DON 2001).

7.3.4.1 Terrestrial Plants

Semi-arid and strand plants of low-growing shrubs and herbaceous plants are the dominant vegetation on Ka'ula Island. Five endemic Hawaiian species, 10 indigenous species, and 14 introduced exotic species from the island have been recorded. Table 7-3 gives a partial list of species recorded on the island. None of the plant species believed to occur on Ka'ula is listed as threatened or endangered.

Table 7-3: Vegetation of Ka'ula Island

Hawaiian Name	Common Name	Latin Binomial	Notes and Status
Chenopodiaceae			
aheahea	—	*Chenopodium sandwicheum*	Endemic; found on all the main Hawaiian Islands

Table 7-2: Vegetation of Ka'ula Island (Continued)

Hawaiian Name	Common Name	Latin Binomial	Notes and Status
Amarantacea			
paki	Slender amaranth	*Amaranthus virdis*	Naturalized; found in low elevation disturbed habitats
Portulacaceae			
ihi	—	*Portulaca caumii*	Endemic; found on all of the main Hawaiian islands except Ni'ihau and Kaua'i.
ihi	—	*P. lutea*	Indigenous; occurring in coastal, strand habits.
Capparaceae			
maiapilo	—	*Capparis sandwichiana*	Endemic; USFWS listed Species of Concern; coastal rocky habitats.
Zygophyllaceae			
nohu	puncture vine	*Tribulus cistoides*	Indigenous, coastal habitats
Euphorbiaceae			
akoko	—	*Euphorbia celastroides*	Endemic; coastal habitats and mesic forests
Convolvulaceae			
koali awa	Morning glory	*Ipomoea indica*	Indigenous, found throughout the Hawaiian Islands
Solanaceae			
popolo	Glossy night shade	*Solanum americanum*	Indigenous, found in disturbed habitats throughout the Hawaiian Islands

7.3.4.2 Marine Plants

Information on the marine plants was not readily available for Ka'ula Island.

7.4 CURRENT MANAGEMENT

This section describes the current management at Ka'ula Island in the following categories: (1) project-specific management actions; (2) natural resources studies; (3) use of GIS systems; (4) forestry; (5) community outreach; (6) outdoor recreation; (7) land management; (8) flood plains; (9) law enforcement; (10) wildland fire; (11) leases and encroachment.

7.4.1 Project-Specific Management Actions

7.4.1.1 Bird Aircraft Strike Hazard

Due to the large numbers of birds that live on Ka'ula Island, BASH is a concern for aircraft (helicopters) trying to land there. Therefore, the Navy has prohibited aircraft from landing on the island.

7.4.1.2 Protected Species Monitoring and Reporting

1. Hawaiian Monk Seal and Sea Turtles

As described in Section 3.3.1.1, Part 2 Mammals, Hawaiian Monk Seals, the Navy has developed a monitoring plan, *Hawaii Range Complex Monitoring Plan December 2008* (DON 2008b), to provide marine mammal and sea turtle monitoring. The monitoring plan outlines the necessary monitoring and reporting the Navy must perform to comply with the terms and conditions of the NOAA Fisheries Biological Opinion and requirements of the Marine Mammal Protection Act (MMPA) Letter Of Authorization (LOA)for the Hawaii Range Complex (NOAA 2009a and b). The HRCMP was designed as a collection of focused studies pertaining to marine mammals and sea turtles and the use of mid-frequency sonar and explosives during Hawaii Range Complex training activities. This additional knowledge will provide a net conservation benefit to the species as well as meet the Navy's MMPA and ESA requirements.

2. Hawaiian Monk Seal

The following Navy programs are currently in place at Ka'ula Island in an effort to conserve, protect, and provide benefit to Hawaiian monk seals to ensure their long-term conservation, consistent with the Species Recovery Plan, according to the three Navy criteria (Section 1.13).

Food limitation: In the NWHI food limitation is a crucial threat to the recovery of Hawaiian monk seals but that is not the case for the MHI or Ka'ula Island, in particular. Due to limited access to Ka'ula Island, there is likely to be less fishing pressure than other nearshore environments in the MHI. The *de facto* reserve at Ka'ula Island likely provides a benefit to and aids the recovery of the species.

Marine Debris Entanglement: Marine debris entanglement is a crucial threat to Hawaiian monk seals. As discussed in Section 3.4.1.3 (item 6), the Navy voluntarily limits the quantity of expended training materials that enter the ocean during Hawaii Range Complex activities, is a member of a federal interagency marine debris coordinating committee, seeks ways to reduce the amount of waste generated by its afloat forces, works to raise awareness and facilitate mitigation of marine debris, and has worked in partnership with other agencies in removing derelict fishing gear caught on the ocean floor in the NWHI. These programs and activities likely provide a benefit to and aid the recovery of the species.

Disease: Introduction of disease is a serious threat to Hawaiian monk seals as they may lack the antibody to fight the disease. With a small population, the introduction of lethal disease could devastate the recovery of the species. In the MHI, concern lies with the introduction of infectious disease via transmission from livestock, feral animals, pets, or humans. There are no human inhabitants, pets, or livestock at Ka'ula Island. Because of Ka'ula Island's remote location, the introduction of lethal diseases from visitors and animal inhabitants is considered low. The restricted access to the island likely provides a benefit to and aids the recovery of the species there.

Loss of Terrestrial Habitat: Loss of terrestrial habitat as a result of such factors as storms and sea level rise is a serious threat to Hawaiian monk seals in the NWHI. At Ka'ula Island, the terrestrial habitat for Hawaiian monk seals has been largely unchanged during the Navy's tenure. As a result of global warming, sea level is expected to rise as much as 3 ft (1 m) by the end of the 21st century (University of Hawai'i School of Ocean, Earth Science, and Technology 2009). The coastline at Ka'ula Island is characterized by wide rock benches or platforms and steep rock cliffs. The island is largely undeveloped. The predicted sea level rise within the next century may result in a redistribution of haul-out habitat for Hawaiian monk seals at Ka'ula Island, with potential increases or decreases. Regardless, the absence of human development in the terrestrial habitat for the monk seals provides a conservation benefit to and aids the recovery of the species.

Fishery Interaction: Within the MHI, fishery interaction with Hawaiian monk seals is a serious threat to the species. Ka'ula Island is a restricted area (e.g. Ka'ula Danger Zone). No vessels or watercraft may enter or remain in the zone except as authorized by the Navy. These restrictions reduce the number of fishing interactions, including fisher harassment of seals and fishing gear entanglement, that the Hawaiian monk seals endure and, therefore, provide a benefit to and aid the recovery of the species.

Human Interaction: Human interaction is a serious threat to Hawaiian monk seals in the MHI; however, access to Ka'ula Island is restricted, reducing human disturbance to hauled-out animals. Therefore, this restricted access provides a benefit to and aid the recovery of the species.

Biotoxins: Biotoxins are a moderate threat to Hawaiian monk seals; however, they have not been identified as a threat at Ka'ula Island. Navy activities at Ka'ula Island are not likely to trigger biotoxin outbreaks in the marine environment.

Vessel Groundings: Vessel groundings are considered a moderate threat to Hawaiian monk seals. The Navy restricts access to Ka'ula Island which reduces the potential for vessel groundings to occur and the potential harm to Hawaiian monk seals from any incident of vessel grounding.

Contaminants: The presence of contaminants in Hawaiian monk seal habitat is a moderate threat to the species. The Navy is not aware of instances of environmental contamination within or from Ka'ula Island that would impact Hawaiian monk seal terrestrial or aquatic habitat. The Navy restricts access to Ka'ula Island which reduces the potential for the release of chemical contaminants on the island.

Training/Operational Activities. Ka`ula Island contains a target area used to train aviators in air-to-surface delivery of inert ordnance. If marine mammals including monk seals are present within the target area, the range is considered "fouled" and the operation is aborted. Section 6.1 of the Hawaii Range Comples FEIS/OEIS describes the applicable training of personnel in detection of marine mammals (DON 2008a). The Navy has developed a monitoring plan, Hawaii Range Complex Monitoring Plan December 2008 (DON 2008b), to provide marine mammal and sea turtle monitoring during training. The monitoring plan outlines the necessary monitoring and reporting the Navy must perform to comply with the terms and conditions of the NOAA Fisheries Biological Opinion and requirements of the MMPA LOA for the Hawaii Range Complex (NOAA 2009a and b). This additional knowledge will provide a net conservation benefit to the species as well as meet the Navy's MMPA and ESA requirements.

Coordination with Regulatory Agencies. PMRF, NAVFAC PAC Natural Resources Staff, and the CNRH Natural Resource Program Manager coordinate with federal and SOH agencies regarding Hawaiian monk seals. PMRF has been involved with Hawaiian monk seal recovery

since 2005 which has included responding to hooked animals and reporting tag numbers to DAR for monk seal reporting and rescue. The Navy has provided NOAA Fisheries input regarding the presence of Hawaiian monk seals on the beaches at Ka'ula Island through routine coordination and communication between Range environmental staff and agency personnel (DON 1998, 2001, 2008a, 2008b; NOAA Fisheries 2008, 2009a, 2009b).

Use of Geographic Information Systems. As described in Section 7.4.3, the installation's natural resources data, including Hawaiian monk seal data, will be integrated into the installation's GIS system and made available to planners and land managers to aid in decision-making.

Fleet Air Control and Surveillance Facility Reporting. All sorties flown to Ka'ula check in to Fleet Air Control and Surveillance Facility (FACSFAC), which controls air operations into the Ka'ula danger zone. FACSFAC issues authorization to proceed and advises on the prohibition of dropping or firing of practice munitions if marine mammals are present. A. preliminary survey pass is flown prior to commencing the exercise to ensure the range is not fouled due to presence of marine mammals or vessels.

Ka'ula Monk Seal Monitoring. The Navy, with funding from COMPACFLT, initiated seabird and monk seal surveys in 2009 on Ka'ula. Due to the logistical difficulties of surveying the rock, surveys have been restricted to the use of ships with observers to count seabirds and monk seals on the island. One survey was conducted in 2009, and two were conducted in 2010. Future surveys are scheduled as such: one in 2011, two in 2012, and one in 2013. The results of the first survey are attached in a monitoring report in Appendix B9. The limited surveys on Ka'ula have precluded the accumulation of a robust data set on monk seal numbers at this site. Given this, NOAA has advised that unique animal IDs (either from scar recognition or bleach-mark identifications) are useful pieces of information that can be readily attained. The Navy and NOAA will work closely together to develop survey techniques to identify individual animals for future trips. Additional surveys, using NOAA vessels, may also be conducted during NOAA trips to and from the Northwest Hawaiian Islands. The Navy will work closely with NOAA to coordinate access to the island during these opportunities on a not-to-interfere basis. NAVFAC PAC Natural Resources staff are also exploring the use of remote-sensing technology to conduct seabird and monk seal surveys as the technology permits.

Annual review meetings with Regulatory Agencies. Near the end of each calendar year, Navy Natural Resources staff meet with regulatory agency personnel from USFWS, NOAA Fisheries, and SOH DLNR to review the progress of INRMP implementation. This process allows the regulatory agencies to ensure Navy's compliance with the INRMP, as well as provide adaptive feedback if additional measures should be implemented or current measures become obsolete.

3. Humpback Whale

The Letter of Authorization (LOA) for Fleet training activities issued by NOAA Fisheries defines mitigation requirements to reduce the effects of sonar training on these animals. These requirements, as stipulated in the LOA, call for observer monitoring and cessation of sonar use within the vicinity of a marine mammal. Fleet is responsible of implementing the requirements of the LOA. LOAs are re-issued annually, and the most recent can be obtained through the Fleet Natural Resources Program Manager. A recent LOA is attached as reference in Appendix F7.

4. Green and Hawksbill Turtles

Fleet training activities do not effect sea turtles on Ka'ula Island. Although, sea turtles are not known to rest on Ka'ula's ledges they may be found in nearshore waters. The probability that

inert ordnance misses the target and strikes a turtle is very small. During annual Ka'ula surveys, observations of turtles are to be made.

7.4.2 Natural Resources Studies

Avian and Hawaiian monk seal surveys at Ka'ula Island were conducted by NAVFAC PAC for COMPACFLT in 2009 and 2010 via research vessel (see Appendix B9 for the 2009 survey). Due to safety issues, access to Ka'ula Island is prohibited; NAVFAC PAC Natural Resources staff are exploring the use of remote-sensing technology to conduct natural resources surveys as the technology permits. Appendix G3 provides NAVFAC PAC's Ka'ula Island Draft Seabird Monitoring Plan.

7.4.3 Use of Geographical Information Systems

Because the existing natural resources data was collected many years ago and no spatial data exists for it (e.g., coordinates/GPS points), it cannot be added to the Navy's GIS database. NAVFAC PAC Natural Resources staff are planning to conduct natural resources surveys as remote-sensing technology permits. Information from these surveys will be added to the Navy's GIS.

7.4.4 Forestry

No forest management for market purposes is appropriate at Ka'ula Island.

7.4.5 Community Outreach

Due to the restricted and remote nature of Ka'ula Island, opportunities for community outreach are not available for this location.

7.4.6 Outdoor Recreation

Ka'ula Island is a restricted area, outdoor recreation opportunities are not applicable.

7.4.7 Land Management

No land management issues have been identified for Ka'ula Island.

7.4.8 Floodplains

Not present.

7.4.9 Law Enforcement

The Navy has jurisdiction of Ka'ula Island. Access to the island is restricted due to safety concerns (e.g., BASH and unexploded ordnance [UXO]).

7.4.10 Wildland Fire

No wildland fire issues have been identified for Ka'ula Island.

7.4.11 Leases and Encroachment Management

Not applicable.

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CHAPTER EIGHT: MAUNA KAPU FACILITY

8.1 CURRENT CONDITIONS

8.1.1 Installation Information

8.1.1.1 General Description

The Navy and the DOE use a small area (1.9 ac [0.8 ha]) at Mauna Kapu within the Honouliuli Forest Reserve on O'ahu (Figure 8-1) for communications and radar tracking facilities needed to support the PMRF mission (Photo 8-1). Electronic warfare and radio frequency communications facilities supporting DOE operations are conducted at the Mauna Kapu Communications and Radar Tracking Facility ("Mauna Kapu Facility").

Photo 8-1: Mauna Kapu Facility

8.1.1.2 Land Use Constraints

No natural resources land use constraints were identified at the Mauna Kapu Facility; however, land use constraints result from the military mission. They include the requirement for unobstructed lines of sight. Personnel access to the installation is restricted to those engaged in official business.

8.1.1.3 Operations and Activities

The Mauna Kapu Facility houses Building 204 and a radar equipment tower within the fenced property boundary. This facility provides electronic warfare and radio frequency communication support.

8.1.1.4 Abbreviated History and Pre-Military Land Use

The Navy began leasing the Mauna Kapu Facility from the James Campbell Company in 1963 (NAVFAC PAC Real Estate 2007). Cultural resources surveys have not been conducted at the Mauna Kapu Facility.

8.1.1.5 Regional Land Uses

The Mauna Kapu Facility is in the SOH Conservation District (SOH LUC 2005). Honouliuli Preserve and the Nānākuli State Forest Reserve are located in the vicinity of the facility.

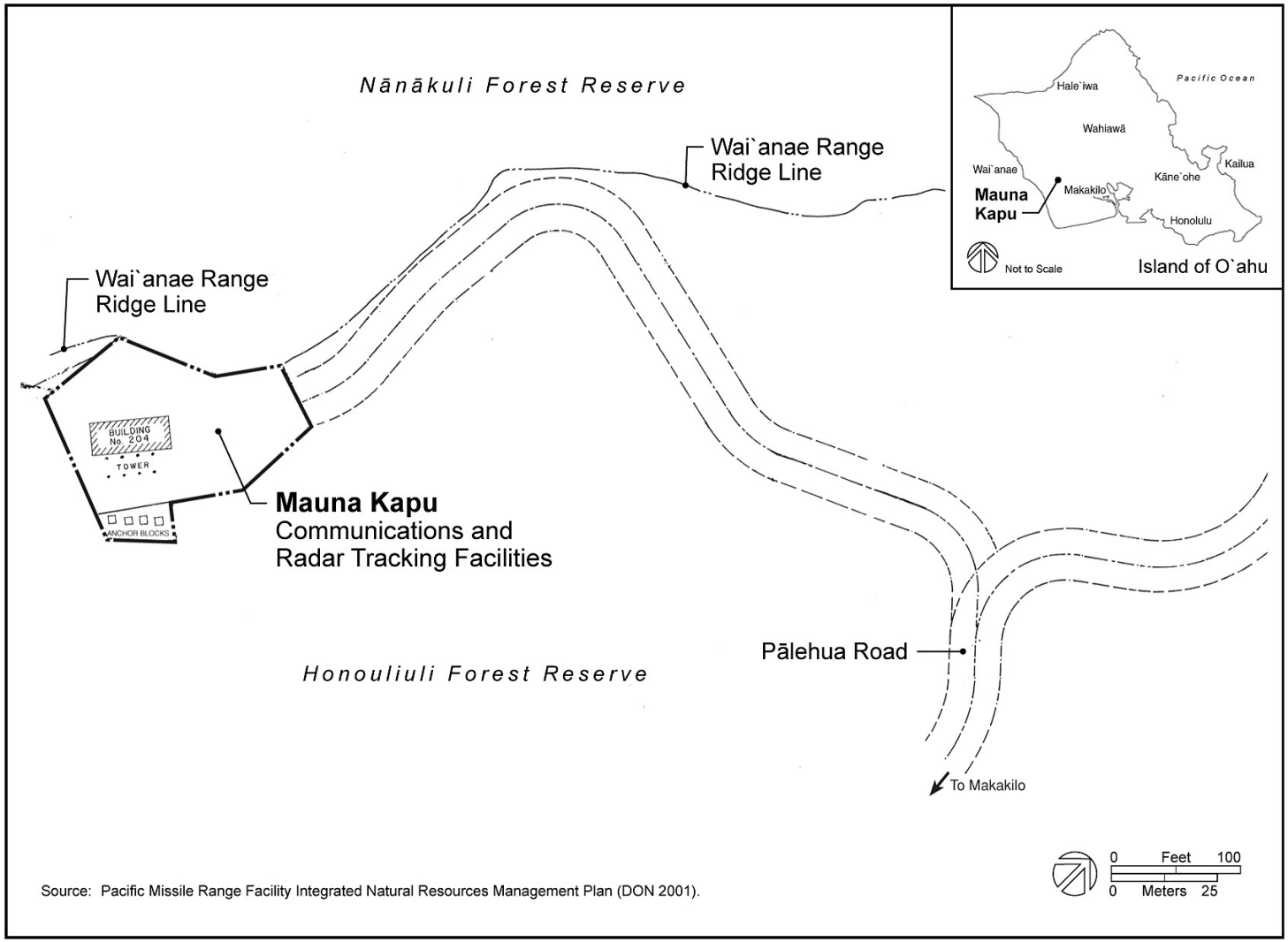


Figure 8-1: Mauna Kapu Facility, O‘ahu

8.2 GENERAL PHYSICAL ENVIRONMENT

The discussion of the general physical environment is divided into six subsections (8.2.1 through 8.2.6): (1) physical geography; (2) topography; (3) climate; (4) geology; (5) soils; and (6) hydrology – including surface water resources and hydrogeology (groundwater resources).

8.2.1 Physical Geography

The island of O‘ahu is located at 21° 26’ North latitude and 157° 58’ West longitude and it encompasses 597.1 mi^2 (1,546.5 km^2). The Mauna Kapu site encompasses 2 ac (0.8 ha) used by the Navy on the uppermost ridge of the Wai‘anae Range on the western portion of O‘ahu.

8.2.2 Topography

The Mauna Kapu Facility is located along the uppermost ridgeline at an elevation of approximately 2,720 ft (829 m) above mean sea level in the Wai‘anae Range.

8.2.3 Climate

The climate of O‘ahu is mild and semi-tropical. A combination of prevailing northeasterly tradewinds, which are present 70 percent of the time, and milder southerly winds blowing 15 percent of the time provide for virtually constant air movement on the windward side of O‘ahu, while the leeward side is often hotter due to less consistent prevailing winds. The average temperature for the island of O‘ahu ranges from 78 to 89 ° F (26 to 32 ° C) during the day and from 59 to 73 ° F (15 to 23 °C) at night. Average annual precipitation ranges from over 250 in (635 cm) in the Ko‘olau Range to 20 in (50.8 cm) in Wai‘anae. Mauna Kapu’s climate is typical of a semi-tropical montane system. The higher elevation accounts for a cloudbank capturing a higher moisture and rainfall rate than the average at lower elevations.

8.2.4 Geology

The island of O‘ahu is formed by the remnants of two coalesced shield volcanoes, the Ko‘olau Volcano to the east and the Wai‘anae Volcano to the west. The Wai‘anae Volcano is older than the Ko‘olau and both volcanoes likely erupted at the same time during at least part of their active lifespans. The shield-building lavas emanated mainly from prominent rift zones of the two volcanoes. Near the end of the growth of the shield, the summits of the volcanoes collapsed and formed calderas. After a long period of subsidence and erosion, the rejuvenated stage of the volcanoes began with eruptive activity resuming at scattered vents at the southern ends of the Ko‘olau and Wai‘anae Ranges. Rocks of the Wai‘anae rejuvenated stage are called the Kolekole Volcanics and those of the Ko‘olau rejuvenated stage are called the Honolulu Volcanics (Nichols et al 1996).

The Mauna Kapu Facility is located within the Wai‘anae Range which forms the western part of the island. The Wai‘anae Range is 22 mi (35 km) long and is comprised of shield lava beneath a thick layer of alkalic basalt. Mount Ka‘ala, the highest point on O‘ahu, is 4,025 ft (1,227 m) high. Huge valleys have been carved by erosion into the Wai‘anae Range; most of them discharge to the southwest. The range is composed almost entirely of basaltic rock (Stearns 1985). Subaerial eruptions of the Wai‘anae Volcano occurred between 3.9 and 2.5 million years ago (USGS 1996). The Wai‘anae Volcano became extinct before the Ko‘olau as evidence by the lava flows of the

Ko‘olau overlapping the eroded, soil-covered Wai‘anae lava flows. The mountain range is nearly buried in its own debris as a result of submergence and long erosion (Stearns 1985). The volcano has subsided more than 6,000 ft (1,829 m) and erosion has destroyed all but the eastern part of the Wai‘anae Volcano (USGS 1996).

8.2.5 Soils

The Mauna Kapu Facility is underlain by tropohumults-Dystrandepts Association (rTP) (Figure 8-2). Areas mapped as rTP consist of mountainous areas in the Wai‘anae Range. These areas are dominated by deep, V-shaped drainageways and narrow ridges. The slopes range from 30 to 90 percent. The soils in the association are mainly comprised of tropohumults and dystrandepts. Histosols make up a smaller part of the association. Areas of rock and rockland outcrop occur in the drainageways (USDA 1972).

Tropohumults are well-drained, strongly acid to extremely acid soils on narrow ridgetops at higher elevations. The surface layer consists of reddish-brown silty clay that has strong structure and high bulk density. The subsoil has strong subangular blocky structure and is underlain by an ironstone pan or by saprolite. A hard crust that has purplish cast forms on these soils in some places where the vegetation has been depleted (USDA 1972).

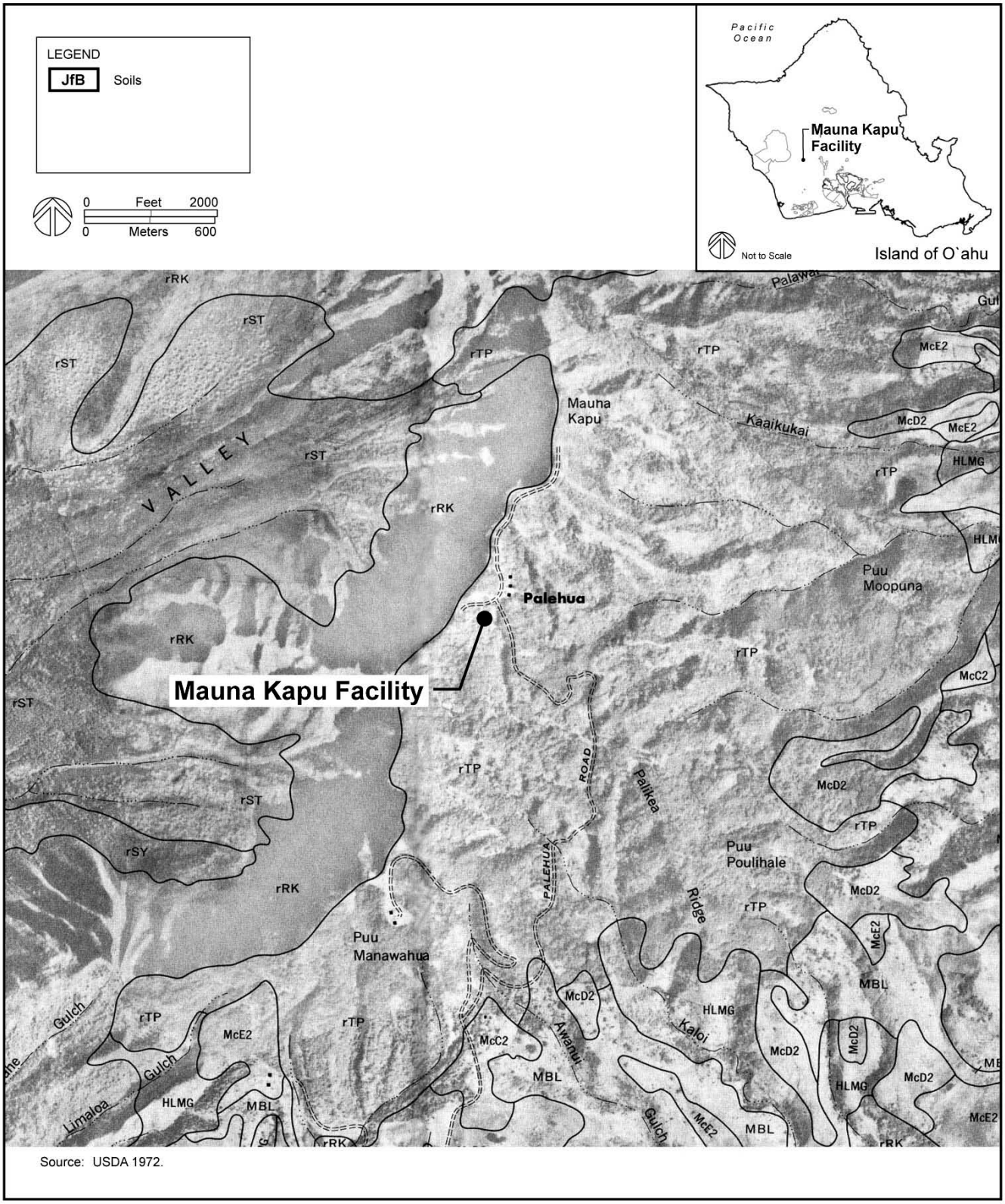
Drystrandepts are dark-colored friable soils on steep side slopes and narrow ridge tops at lower elevations. The surface layer is usually silty clay with a subsoil that is generally massive. These soils generally form in volcanic ash and are well drained and medium to strongly acid (USDA 1972)

Histosols occupy small, wet positions near mountain peaks. They are poorly drained and have accumulations of organic matter as much as 3 ft (1 m) thick (USDA 1972).

8.2.6 Hydrology

There are no surface water resources at the Mauna Kapu Facility. The following paragraphs discuss the hydrogeology (groundwater resources) at Mauna Kapu.

Although they are surrounded by seawater, the Hawaiian Islands are underlain by large quantities of fresh groundwater which are the result of the large island landmasses causing orographic rainfall. The Hawaiian Islands obstruct oceanic winds, causing air to rise and moisture to precipitate (orographic rainfall) with as much as 276 to 394 in (700 to 1,000 cm) of mean annual rainfall in the mountainous uplands of the larger islands. The permeable soils and rocks that comprise the uplands allow easy infiltration of the abundant rainfall to accumulate as fresh groundwater. These geologic conditions allow for subsurface movement of water and low-permeability geologic features impound large amounts of water in the thick groundwater reservoirs (Hunt *et al*. 1988). The hydrogeology, or distribution and movement of groundwater in soil and rocks, of O‘ahu is controlled by local and regional hydrologic conditions that influence the supply and distribution of water in the sedimentary deposits and volcanic rocks (basalts) that compose the island.



Source: USDA 1972.

Figure 8-2: Soils, Mauna Kapu Facility, O‘ahu

On O‘ahu, groundwater occurs chiefly as either basal water, a lens of fresh to brackish water that floats on seawater, or high-level water, freshwater that does not rest on sea water. Basal water occurs principally in the thin, bedded lava layers of the volcanic flanks. Because the flanks are the most regionally extensive volcanic formations, basal water is the most abundant form of groundwater. The height of the basal water table above sea level is called the head. Because of the density difference between fresh and salt water, about 40 feet (13 m) of freshwater is present below sea level for every foot of freshwater above sea level. That is, the lens thickness below sea level is equal to 40 times the head. A high basal head (more than 5 ft [1.6 m]) within 1 mi (0.62 km) of a coast result from the impedance of coastal discharge by a wedge of low-permeability sediments called caprock (Juvik *et al* 1998). Throughout much of O‘ahu, groundwater is generally present in unconfined conditions, although artesian conditions exist in locations where low-permeability marine silts and volcanic tuffs (caprock) overlie the aquifer. Water-bearing zones may occur above, below, and within the caprock unit.

A general description of four major aquifer types which occur on Kaua‘i as well as O‘ahu is presented in Section 2.2.5.2 of this document. The Mauna Kapu Facility is located within the ‘Ewa Aquifer System of the Pearl Harbor Aquifer Sector. The underlying aquifer is a high-level, unconfined, dike aquifer that has potential use as drinking water. Water within this aquifer is fresh (less than 250 mg/l Cl^-), irreplaceable, and, has a high vulnerability to contamination (Mink and Lau 1990).

8.3 GENERAL BIOTIC ENVIRONMENT

No biological surveys were conducted at the Mauna Kapu Facility in preparation of this INRMP. The discussion of the general biotic environment is divided into five subsections (8.3.1. through 8.3.5): (1) threatened and endangered species; (2) wetlands; (3) ecosystem components; (4) wildlife; and (5) vegetation.

8.3.1 Threatened and Endangered Species

8.3.1.1 Animals

There are no known federally-listed threatened or endangered species or critical habitat at the Mauna Kapu Facility.

8.3.1.2 Plants

There are no known federally-listed threatened or endangered species or critical habitat at the Mauna Kapu Facility.

8.3.2 Wetlands

There are no surface water bodies, including wetlands, at the Mauna Kapu Facility.

8.3.3 Ecosystem Components

The classification of Mauna Kapu Facility native terrestrial ecosystem is a lowland dry and mesic forest, woodland, and shrubland (Juvik *et al* 1998).

8.3.4 Fish and Wildlife

The discussion of at the Mauna Kapu Facility is divided into three subsections: (1) bird species; (2) mammal species; and (3) amphibian and reptile species.

8.3.4.1 Bird Species

A formal animal survey of the Mauna Kapu Facility was not conducted for this INRMP due to the small land area of the facility itself. However, the surrounding areas such as the Honouliuli Preserve provides habitat for several threatened and endangered species including the federally-listed O‘ahu ‘elepaio (*Chasiempis sandwichensis gayi*), and the SOH-listed (for O‘ahu) Hawaiian owl (*Asio flammeus sandwichensis*).

8.3.4.2 Mammal Species

Mammal surveys were not performed at the Mauna Kapu Facility in preparation for this INRMP.

8.3.4.3 Amphibian and Reptilian Species

No herpetological surveys were performed at Mauna Kapu Facility in preparation for this INRMP.

8.3.5 Vegetation

8.3.5.1 Terrestrial Plants

The Mauna Kapu Facility is small and contains only a discrete, enclosed area of lawn and some cultivars. However, the areas around the facility contain a wide variety of introduced and native flora including native koa trees. Farther up the ridgeline in the Nature Conservancy’s Honouliuli Preserve and in the Nānākuli State Forest Reserve, rare remnant native montane forest habitat persists.

8.3.5.2 Marine Plants

Mauna Kapu is an upland site located approximately 3 mi (4.8 km) from the shoreline and does not directly impact O‘ahu’s marine environment. Therefore, a discussion of marine flora is not warranted.

8.4 CURRENT MANAGEMENT

8.4.1 Project-Specific Management Actions

There are no project-specific management actions at the Mauna Kapu Facility.

8.4.2 Natural Resources Studies

There have been no natural resources studes at the Mauna Kapu Facility.

8.4.3 Use of Geographical Information Systems

Currently, there are no natural resources data for the Mauna Kapu Facility in the Navy's GIS.

8.4.4 Forestry

No forest management for market purposes is appropriate at the Mauna Kapu Facility.

8.4.5 Community Outreach

The closed nature of this installation does not provide for valuable community outreach opportunities.

8.4.6 Land Management

No land management programs have been identified for the Mauna Kapu Facility other than those discussed in Section 3.4.9 (e.g., base planning, landscape design).

8.4.7 Floodplains

Not present.

8.4.8 Law Enforcement

Law enforcement at Mauna Kapu is provided by military police.

8.4.9 Wildland Fires

In the event of a wildland fire at the Mauna Kapu Facility, the City and County of Honolulu Fire Department with assistance, if necessary, from DLNR and the Federal Fire Department would respond.

8.4.10 Outdoor Recreation

The Mauna Kapu Facility is a restricted area and generally does not offer any outdoor recreation opportunities.

8.4.11 Leasing and Encroachment Management

Not applicable.

CHAPTER NINE: IMPLEMENTATION PLAN

9.1 INTRODUCTION

Natural resources management actions to be funded by CNRH and executed by CNRH and PMRF will be completed in order to manage natural resources within the context of the military mission. This implementation plan includes adaptive management options for conserving and protecting native habitat and threatened and endangered species and other protected species while providing natural resource based outdoor recreational opportunities for base residents, personnel, and visitors.

Should the PMRF military mission or security requirements change, natural resources management actions could conflict with the new mission/requirements. In such cases, a re-evaluation and adjustment of natural resources management actions may be necessary.

9.2 MANAGEMENT RESPONSIBILITIES

NAVFAC HI is the primary party responsible for implementing the INRMP on behalf of the PMRF Installation's Commanding Officer. COMPACFLT is responsible for ensuring implementation of certain projects and SOPs, as stipulated in their training LOAs from the regulatory agencies. The PMRF Environmental Coordinator (NAVFAC HI) and the Hawaii Range Sustainment (HRS) Environmental Coordinator (as designated by COMPACFLT) are the primary on-site points of contact for all day-to-day natural resources management issues, concerns, plans, projects, facilities planning, design and construction, security services, and outdoor recreation. These two positions are also responsible for raising staff and community awareness about conserving unique resources and protecting threatened and endangered species. NAVFAC HI and COMPACFLT, with the support of NAVFAC PAC, coordinate natural resource management projects with relevant agencies and provide support to those same agencies in their efforts to manage species and ecosystems associated with PMRF lands and waters.

NAVFAC HI's Environmental Planning branch is responsible for planning, budgeting, and monitoring the progress of the INRMP management actions on a programmatic level. Progress monitoring includes scheduling or conducting periodic evaluations, making mid-course adjustments when needed, and documenting follow-up actions. NAVFAC HI Environmental Planning branch also provides reachback support to the PMRF Environmental Coordinator for day-to-day operations that require specialized natural resources expertise. NAVFAC PAC provides this reachback support to the COMPACFLT HRS Environmental Coordinator.. NAVFAC PAC directly supports projects for which COMPACFLT is responsible for implementing, and provides execution oversight, financial management oversight, and reachback support to NAVFAC HI. Many of the management actions provide opportunities for the Navy to partner with key federal and SOH resource agencies (USFWS, NOAA Fisheries, USDA, DLNR), and various county agencies, community organizations, non-profits, environmental groups, and schools.

9.3 PROPOSED ACTIONS

The program elements sections of the installation chapters (i.e. Sections 3.4 -8.4) describe the requirements and goals for natural resource management at PMRF. Sections 9.3.1 through 9.3.9 provide descriptions of planned natural resources management actions at PMRF. For each natural resources program element, there are two categories of financial support: (1) normal operating costs (e.g., comes from base operations); and (2) funded projects. There are three funding priorities which are summarized in Table 9-1. Section 9.14 provides a summary of Navy funding programs. Table 9-8 (at the end of this chapter) presents the 10-year fiscal plan for the implementation plan actions and projects.

Because the INRMP is a public document that requires the mutual agreement of the installation and Working Group members, it is important to have a common understanding regarding projects contained in the plan that are most likely to be funded under existing policy. INRMP funding reflects an annual strategy that addresses legal requirements. As the Working Group defines objectives, identifies legal drivers, and collaborates with each other to develop land and natural resource management goals, the subsequent outcome is a list of projects necessary to implement the INRMP. This project list includes "must fund" compliance-type projects as well as stewardship-type projects.

There is also a DOD budget scheme which includes four classes (0 through 3). Class 0, recurring natural and cultural resources conservation management requirements, includes INRMP actions necessary to rehabilitate or prevent source degradation that may affect military readiness. Class 1, current compliance requirements, includes requirements to manage species and habitats of concern to prevent listing of species that could affect military readiness. Class 2, current maintenance requirements, includes projects and activities needed that are not currently out of compliance, but would be out of compliance if projects or activities are not implemented in time to meet an established deadline. Class 3, enhancement actions beyond compliance, includes projects and activities that enhance conservation resources or the integrity of the installation mission, or are needed to address overall environmental goals and objects, but are not specifically required under a regulation or EO and are not of an immediate nature.

Table 9-1: Funding Priorities

Funding Priority	Description
Priority 1	Priority 1 projects are those that would meet the definition for Class 1 funding. These are actions that are required within the current fiscal year in order to correct a noncompliance situation.
Priority 2	Priority 2 projects meet the definition of Class 2 funding. These are actions that are required to remain in compliance with legal requirements or to meet established deadlines. Priority 2/Class 2 funding ensures continued compliance with laws and regulations or efforts needed to meet established deadlines.
Priority 3	Priority 3 projects are feasible actions that would enhance natural resources, but are not required to comply with laws or regulations or to meet established deadlines. Funding for Class 3 actions may not be readily available. If funds are provided, the Priority 3 projects could be initiated in the order proposed by the PMRF Environmental Coordinator and approved by the appropriate command structure. Priority 3/Class 3 funding is for all other enhancement projects

9.4 BARKING SANDS PROPOSED ACTIONS

Table 9-2 provides a summary of the recommended management actions for PMRF's Barking Sands facility. These recommended actions along with their 10-year fiscal plan are listed in Table 9-8 (end of the chapter).

Table 9-2: Recommended Management Actions for Barking Sands

Item No.	Recommendation	Management Action	Funding
1	**Bird Aircraft Strike Hazard.** Continue hazing program under the USDA-WS permit and all other actions as described in Chapter 3.	Project-Specific	P2/NOC
2	**Base-wide Predator Control**: Continue base-wide predator control (dogs, cats, owls, rodents, barn owls, and cattle egrets) to protect the following species: • Endangered Hawaiian waterbirds within the vicinity of the ditches and oxidation ponds; • Threatened and endangered seabirds that may fall out on the installation; • Endangered nēnē while on the installation; • Endangered Hawaiian monk seals; • MBTA-protected wedge-tailed shearwaters utilizing the two colonies; • MBTA-protected Laysan albatross while on the installation; and • Native vegetation. For cat control, cage traps are to be the primary method of control, although shooting, snares, leghold traps, and chemical baits may also be utilized. Shotguns will be employed to control barn owls and cattle egrets	Project-Specific (protected species)	P2/C2
3	**Sea Turtle Management**: Continue log book of sea turtle (most likely green turtles) observations including sightings, tracks, and nesting events. Continue to protect, monitor, and record any sea turtle nests. Continue SOPs which require that beaches are surveyed one hour prior to beach landing excercises, and if sea turtles are present, then delay training until the animal(s) voluntarily leave the area.	Project-Specific (protected species)	P2/NOC
4	**Nocturnal Seabird Fallout Monitoring and Management:** Due to the 2008 and 2009 fall outs of Newell's shearwaters and band-rumped storm-petrels, threatened and endangered seabird management at Barking Sands is increasing. DON is currently in Section 7 consultation with USFWS regarding fallout minimization and mitigation for the two above species and Hawaiian Petrel. The negotiated actions from the consultation will be incorporated into INRMP implementation.	Project-Specific Program (protected species)	P1/C1
5	**Use of Green Lights and Light Shielding to Protect Seabirds.** As stated in Chapter 3, PMRF is installing and operating green bulbs at multiple locations on Barking Sands. If this project is approved by security and AT/FP personnel, green lighting will be used at PMRF. Other actions where green lights are not feasible include: shielding of white lights, installing motion sensor lights, and determining areas where lights may be safely turned off. These initial actions are Priority 1 Funding and would move into Priority 2 funding at the maintenance phase.	Project-Specific Program (protected species)	P1 /C1 and P2/C2
6	**Protection of Wildlife from Potential EMR Impacts**: PMRF should follow an SOP which requires that existing radars at Barking Sands do not radiate lower than at least 4 to 6 degrees above horizontal. This would preclude EMR impacts on wildlife on the ground including waterbirds, seabirds, and bats.	Project-Specific (protected species)	P2/NOC

Table 9-2: Recommended Management Actions for Barking Sands (Continued)

Item No.	Recommendation	Management Action	Funding
7	**Enhance and Improve Beach Cottages Shearwater Colony.** The Beach Cottages wedge-tailed shearwater colony project continues the work to maintain and enhance the shearwater colony. Additional signs should be posted on the fence corners next to the beach dune crest on either side of the fenced area. Currently, wedge-tailed shearwaters appear to be most negatively impacted by owl predation, human interactions, and saturation of suitable breeding habitat. The following actions are recommended to alleviate these impacts: • Continue to have USDA-WS remove barn owls and haze the pueo from the area (Item 3). • Provide additional educational material to guests staying at the beach cottages, including but not limited to: a. Information on watching for burrows and what happens when a burrow is crushed; and b. Locations where burrows are most likely occur (the beach side of the fenced area). • Consider blocking off the road behind the fenced area to vehicle traffic during the night while the birds are in residence. • Consider installing a few boardwalks from the grassy area down to the beach flats (the berm) where the birds are most likely to dig burrows. • Consider installing a viewing boardwalk on the beach side of the fenced area to reduce burrow crushing. • To control shearwater burrowing under beach cottages, sidewalks, and other infrastructure, unoccupied problem burrows should be crushed as soon as possible when observed. Burrows can legally be crushed anytime between burrow initiation (usually around March when the birds arrive to the colony) and when eggs are laid (during the 1st or 2nd week of June). • Remove kiawe in undeveloped areas adjacent to the colony in order to provide additional nesting habitat.	Project-Specific (protected species)	P2/C2
8	**Waterbird Species:** Initiate formal Navy participation in the state-wide waterbird counts that occur at the Barking Sands oxidation ponds in January and August. These counts are coordinated by DLNR/DOFAW. DOFAW sends an email several weeks before the count with all protocols and forms included.	Project-Specific (protected species)	P2/NOC
9	**Hawaiian Hoary Bat**: When the ARDEL project becomes operational the following actions will be implemented. Prior to the operation of the radar units at nighttime, personnel will visually survey for bats in the area of impact using ANABAT, or closed circuit television cameras. If one or more bats are present in the area of impact, operation of the radar units will not begin until the bat(s) has voluntarily left the area.	Project-Specific (protected species)	P1/C1

Table 9-2: Recommended Management Actions for Barking Sands (Continued)

Item No.	Recommendation	Management Action	Funding
10	**Hawaiian Monk Seal Protection:** PMRF personnel will continue to employ a number of SOPs to protect monk seals that haul out on the beach or are observed injured or struggling in nearshore waters. • PMRF environmental personnel will continue to maintain their training and contacts with NOAA's Marine Mammal Stranding Network and execute a quick response to any beaching or entanglement events on PMRF beaches or nearshore waters. Coordination with NOAA Fisheries for any associated necropsies, if required, will also be ensured. • PMRF personnel will continue to record all sightings of monk seals and report tag numbers to DAR. To ensure protection from disturbance, any animals hauled up on the beach within the public use area will be cordoned off by security forces and reported to PMRF Environmental Coordinator. • PMRF will continue to restrict recreational shore fishing to designated areas between Kinikini Ditch and the Navy housing area in order to reduce the proability of entanglement with stray fishing line while still providing some recreational opportunities (item 34), and to promote healthy nearshore reef-fish stocks. • PMRF will continue to restrict dogs off leashes along the beach to limit the potential for seal-dog interactions. • PMRF will continue to control feral animals (dogs, cats) on base that can transfer diseases to monk seals. • The Navy will continue to ensure training activities do not affect hauled-out seals at PMRF beaches. Prior to conducting a beach landing exercise, Navy observers will survey beaches for Hawiian Monk Seals. Should a monk seal be found on the beach, the landing will be delayed until the animal has voluntarily left the area. • PMRF will continue to sponsor marine debris clean up events (item 12).	Project-Specific (protected species)	P2/NOC
11	**Humpback Whales and Other Cetaceans:** Continue to participate in the NOAA Ocean Count on the last Saturday of December, January and February of each year.	Project-Specific (protected species)	P3/NOC
12	**Marine Debris Cleanup.** Continue participation in marine debris clean up events. For example, the Ocean Conservancy sponsors an International Coastal Cleanup Day every year in September and October. Personnel that participate would be requested to record the amount and types of marine debris removed from beaches. The data cards can be retrieved at http://www.hawaiiatolls.org/research/NWHIED2005/resources/MDM/ICC%20Data%20Card%20English.pdf	Project-Specific (protected species)	P2/NOC

Table 9-2: Recommended Management Actions for Barking Sands (Continued)

Item No.	Recommendation	Management Action	Funding
13	**Invasive Species Prevention and Control:** Continue all invasive species prevention and control actions (including cargo inspections and grounds equipment cleaning) as described in Chapter 3. PMRF should continue to maintain SOPs for sailor training and provide natural resources information to personnel relocating to PMRF. Natural resources information includes the effects of alien plant and animal species to native ecosystems and federally-listed threatened and endangered or otherwise protected species. PMRF should continue to work with KISC and other stakeholders on a coordinated approach to alien plant species control for Barking Sands. Alien plant control measures should be evaluated in the context of wildlife management needs. For example, wedge-tailed shearwater burrowing areas should be excluded from any weeding or planting activities during the nesting season to avoid impacts to burrows. Similarly, wetland areas (excluding the ditches) should not be completely cleared of vegetation, as dense growth provides important habitat for endangered, endemic waterbirds. PMRF should continue to require inspection of cargo and aircraft bound for PMRF facilities before departure. PMRF should continue preventive measures to avoid the introduction of alien species and inadvertent destruction of the environment via cargo on inbound aircraft). In addition, PMRF should continue to report all inbound aircraft arriving directly from the U.S. mainland or Alaska at Barking Sands to the DOA for the inspection of the flight's cargo and the processing of the agriculture declaration. All inbound flights carrying cargo from areas outside of Hawai'i and landing at Barking Sands should continue to be advised to inspect and secure cargo in accordance with OPNAVINST 6210.2, Quarantine Regulations of the Navy prior to shipment to ensure that it is free of invasive species. These regulations are intended to prevent the introduction and dissemination, domestically or internationally originated, of diseases affecting humans, plants, and animals; prohibited or illegally taken wildlife; arthropod vectors; and pests of health and agricultural importance. In addition, PMRF should continue to comply with HRC EIS/OEIS Sections mitigation measures for the introduction of invasive species (Section 6.10.2 and Appendix C, C3).	Project-Specific (invasive species)	P2/NOC
14	**Develop a Biosecurity Program for PMRF**: Preventing the introduction and transportation of alien invasive species is important to the Navy mission. By planning and investing in biosecurity measures upfront, the Navy can prevent the introduction of potentially harmful alien species thereby reducing potential long-term costs. In developing a biosecurity program the recommended measures include with HRC EIS/OEIS Sections mitigation measures for the introduction of invasive species (Section 6.10.2 and Appendix C, C3) as well as the following: 1. All Navy and contractor vehicles coming to Hawai'i should be pressure washed on the mainland or point of origin to minimize the amount of, invertebrates (insects, snails, slugs), eggs, seeds or propagules of non-native species being transported. 2. Vehicles should also be washed down after completion of activities in order to minimize the potential of transporting non-native and/or invasive species between training and storage areas. 3. All construction materials including sand, gravel, aggregate, or road base should be inspected and certified as weed and invertebrate free prior to transport. 4. Following a planning system such as, Hazard Analysis and Critical Control Point (HACCP), the Navy should regularly monitor to detect, assess, and eliminate non-native species. These include invasive terrestrial as well as marine organisms. 5. Activities using a method such as HACCP should focus on the following areas: a. Where equipment and construction materials come ashore. b. Where there is movement of equipment and personnel. c. Areas of soil and vegetation disturbance, where invasive species are more likely to become established. 6. The Navy should continue its efforts to establish native vegetation in areas where non-native vegetation is present. By establishing native plants in disturbed areas and areas recently cleared of non-natives, the native vegetation can reduce the resurgence of the non-native plants. 7. The Navy should prohibit living plant materials from being brought to Hawai'i from outside the state. Horticultural imports are high risk for harboring hitchhiking organisms including seeds, eggs, and invertebrates.	Project-Specific (invasive species)	P2/C2

Table 9-2: Recommended Management Actions for Barking Sands (Continued)

Item No.	Recommendation	Management Action	Funding
15	**Critical Habitat and Dune Vegetation Restoration Project:** PMRF should continue to eradicate and control LTK growing in the southern part of Barking Sands in cooperation with KISC. This project involves conducting on-site dune vegetation restoration at Barking Sands through removal of kiawe, haole koa, and other invasive vegetation to include buffel grass, crown flower (*Calotropis gigantea*), and Golden-crown beard. This project should be conducted in areas not slated for operational use (e.g., land-use classified as undeveloped), and, if in areas with LTK, then after mature LTK has been removed. This project requires a combination of mechanical and herbicide removal techniques. While restoration efforts are ongoing, a study should be conducted to help guide best restoration practices. Monitoring plots should be established in areas where adult non-native trees have been removed. Two plots should be established, each containing one vegetation removal treatment type; (1) haole koa and kiawe seedling removal; and (2) haole koa and kiawe seedling, and buffel grass removal. Within each plot three revegetation subplots should be established: (1) a control (no outplanting); (2) seed broadcast; and (3) seedling/sapling outplanting.	Project-Specific (protected and invasive species)	P2/C2
16	**Plant Nursery Development:** PMRF is in the planning stages of establishing a plant nursery at Barking Sands to propagate native plants for landscaping and habitat restoration. PMRF believes that collaboration with the National Tropical Botanical Garden would result in positive cooperation toward conservation efforts. A layout of the garden has been determined as well as the cost of plants and construction. The National Tropical Botanical Garden would contribute plants and funding to support this project.	Project-Specific	P3/C3
17	**Wetlands Maintenance:** It is the SOH's responsibility to maintain the irrigation ditch systems at Barking Sands. However, the Navy has taken on the role of ensuring proper permitting and no-net-loss of wetland acreage. Project reviews for ditch work are to be properly coordinated with SOH and Army Corps of Engineers (ACOE) through NAVFAC HI's environmental compliance section.	Project-Specific (wetlands)	P2/NOC
18	**Oxidation Pond Improvements:** Develop a plan for improvements to the oxidation ponds at Barking Sands to enhance waterbird habitat. Design improvements would include sludge management and effluent reuse at the sewage aeration lagoon system, which would support the cultivation of native aquatic and beach vegetation. Appropriate procedures are being explored to support the acquisition of grant monies to study and potentially design/build improvements to the current system. The concept of a plant nursery and beneficial reuse of treated effluent through such a partnership would reduce the Navy's financial commitment and at the same time be in accordance with EO 13352 (Facilitation of Cooperative Conservation) through local partnerships.	Project-Specific (wetlands)	P3/C3
19	**Beach and Dune Access Restrictions**: Continue all beach and dune access restrictions as described in Chapter 3. Continue to avoid disturbing dune areas in order to maintain native vegetation, including nama. The PMRF Environmental Coordinator will continue to be responsible for working with Barking Sands' security forces to ensure excessive dune disturbance does not occur, either through security forces own patrolling operations, or through other contractor operations. In addition, monitoring for excessive traffic at areas adjacent to the beach cottages and other high-use recreational areas should be conducted and if necessary, areas should be temporarily corded off to re-establish the vegetation. If significant changes in beach access are to occur, additional policies and procedures would need to be put in place to limit human disturbance of Hawaiian monk seals.	Project-Specific	P2/NOC
20	**Kawaiele Wetlands Waterbird Sanctuary**: Continue to be involved with DLNR in the planning process for the restoration of the Kawaiele wetland which is part of the Kawaiele Wildlife Sanctuary located immediately east of Barking Sands. In addition, the Navy should enlist volunteers to help support wetland restoration.	Project-Specific (wetlands)	P3/NOC
21	**INRMP Annual and 5-year Updates.** Continue to update Navy metrics builder, meet with INRMP Working Group Members, and update document as required.	Natural Resources Studies	P2/C2
22	**Fauna Surveys Update/Initiate.** Update fauna surveys and mapping, including protected bird species, in preparation for subsequent INRMP updates. PMRF should continue to coordinate with DLNR-DOFAW to collect population-monitoring data for protected species. Population monitoring data should continue to be evaluated for any necessary changes or improvements in management actions.	Natural Resources Studies	P2/C2
23	**Botanical Surveys and Mapping:** Provide a 5-year update of botanical survey data. The Navy should update the 2006 botanical surveys and vegetation maps as well as update the status of protected species in preparation for the next INRMP.	Natural Resources Studies	P2/C2

Table 9-2: Recommended Management Actions for Barking Sands (Continued)

Item No.	Recommendation	Management Action	Funding
24	**Marine Resources and Fisheries Survey Update**: Fund a follow on survey to the 2006 marine resources and fisheries survey of the coastal/marine environment at Barking Sands (Appendix C1). Follow-up surveys should focus on fisheries shown to be targeted by recreational fishers, as well as coral. Surveys should also include an assessment of the level of derelict fishing line in the nearshore reef.	Natural Resources Studies	P3/C3
25	**Fishing Survey:** Level of fishing activity and ecosystem health, as it relates to fish stock abundance, monk-seal hookings, and marine debris, should be monitored through surveys investigating level of fishing activity. A fee for fishing-gear rental and for fishing access to base should be instituted to cover costs. Surveys should quantify fishing effort by geographical sector of Barking Sands, and trends over time. Sampling should occur at random times and locations at a sufficiently extensive rate to provide a statistically reliable quantification of fisher activity that can be tracked over time.	Natural Resources Studies	P3/C3
26	**Integrate Natural Resources Survey Data in GIS Database:** PMRF should continue to manage, integrate, access and report natural resources GIS data into PMRF GIS database (Section 2.4).	GIS	P2/NOC
27	**Kiawe and Pine Forest Products:** Explore potential buyers of forestry products, and include energy producers, as well as craft store markets interested in kiawe wood for firewood/woodchips, and pine for timber. Tonnage of available wood biomass should be calculated based on density of trees per acre, estimated biomass per tree, and number of acres covered. Resources to make this calculation, and to assist in the market survey, can be obtained through the University of Hawai'i's College of Tropical Agriculture and companies such as Hawaiian Mahogany, Inc.	Forestry	P3/C3
28	**Natural Resources Information Center**: Continue to distribute natural resources information to reporting personnel, residents, and base visitors through a variety of printed materials and venues. Materials should continue to be placed for distribution at the Pass and Identification Center near the main gate at Barking Sands and other strategic locations. Natural resource information brochures should continue to be provided to the Personnel Support Center for inclusion in "Welcome Aboard" packages given to all Navy personnel and family members, Navy civilian workers, and BOS personnel. The packet should continue to include information on PMRF's natural resources, and a brief summary of all PMRF policies and applicable federal and SOH regulations. This information identifies volunteer and recreational opportunities sponsored by the base and the community such as habitat restoration projects, wildlife monitoring projects, or bird watching and nature walks. PMRF Environmental Department should develop brochures and other materials promoting self-guided nature walks and bird watching opportunities both on base and in the surrounding areas. Information on threats to native Hawaiian ecosystems and threatened and endangered species should be included, with particular emphasis on the introduction and spread of alien plant species and the negative effects of ORVs in sensitive environments and measures that can be taken to avoid such impacts.	Community Outreach	P3/C3
29	**Natural Resources Signs**: Continue to install, maintain, and update, as necessary, natural resources signs at the facility. PMRF and NAVFAC PAC Natural Resources staffs have prepared signs indicating appropriate behavior to protect and preserve threatened and endangered species and other protected species. Additional signs indicating appropriate behavior to protect and preserve threatened and endangered species and fragile habitats such as coastal dunes and wetlands should be placed in appropriate locations. The signs should explain legal and regulatory implications of interacting with federally-listed threatened or endangered or otherwise protected species. The signs should be placed where such interactions are most likely, such as green turtle habitat at Nohili Ditch and areas of frequent Hawaiian monk seal activity at Barking Sands or Hawaiian goose activity.	Community Outreach	P3/C3
30	**Native Medicinal Plant Garden Development/Maintenance:** Continue to maintain the native medicinal plant garden/display in the grassy area adjacent to the new Pass and Identification building at the Tartar Drive Gate (Main Gate) (see Section 3.4.5). This should include educational signs as well as a walking tour of various plants found on Kaua'i used by Native Hawaiians prior to arrival of western medicine.	Community Outreach	P3/C3
31	**Educational Outreach Partnership:** An educational outreach partnership should be considered between NOAA, west side kupuna, and PMRF staff, to develop a combined natural resource and cultural resource program focused on the beachfront in a recovering and remote location on Barking Sands. The goal would be to develop the curriculum to initially provide an experience of what would have been native cultural practices at the site before the arrival of Captain Cook. This could then be taken to local schools for consideration as another field trip option. Vegetation recovery should be associated with curriculum development.	Community Outreach	P3/NOC

Table 9-2: Recommended Management Actions for Barking Sands (Continued)

Item No.	Recommendation	Management Action	Funding
32	**SOS Support and Shearwater Banding.** Continue to coordinate with the Kaua'i Humane Society's SOS program along with coordinating with USFWS and DLNR-DOFAW to conduct shearwater banding training at the wedge-tailed shearwater colony at Barking Sands Beach Cottages. This training should be done prior to the onset of the Newell's shearwater fledging season.	Community Outreach	P3/NOC
33	**Fishing, Surfing, Windsurfing, and Beach Activities:** Continue to provide beach access through Barking Sands for surfing, fishing, and boating to PMRF employees, active duty, reserve, and retired military and dependents, as well as any U.S. citizen who possess a valid annual PMRF Recreation Pass. A fee instituted on the issuance of a Recreation Pass is to be explored. This could be used to fund the fisher survey project (item 24 of this table) as well as operational costs for disseminating natural resources information to base visitors.	Outdoor Recreation	P3/NOC
34	**Dissemination of Pertinent Natural Resources Information to Recreation Pass Program Applicants**: Provide PMRF Recreation Pass Program applicants with information on invasive species, aquatic hitchhikers, and other pertinent natural resources information as part of the application process.	Outdoor Recreation	P3/NOC
35	**Base Planning:** A routine procedure should continue to be implemented to assure coordination among facilities planners, resource managers, SOH, and county officials. The PMRF Environmental Coordinator should continue to be the point of contact to provide relevant information on issues with potential to affect wildlife and native habitat, such as military operations and training, and tower and other construction and repair projects. Protected birds may be affected by overflights, sound levels, direct habitat loss due to clearance and construction, proximity to neighboring habitats, and sensitivity of the bird species to disturbance. Natural resources surveys may be required and mitigation measures developed to assure protection of federally-listed threatened and endangered or otherwise protected species and their habitats. The proposed Maritime Directed Energy Test Center at Barking Sands should be sited to avoid protected species and their habitat. All new construction projects should continue to follow standard methods to control erosion during construction.	Land Management	P2/NOC
36	**Landscape Design:** Continue to evaluate all future landscape design and installation projects for the potential to include habitat restoration and the use of native plants whenever possible. The preference for plant materials from immediately adjacent areas, as well as the importance of using sterile soil to prevent the introduction of pests such as nematodes and weeds, should continue to be emphasized.	Land Management	P2/NOC
37	**Protection of Natural Resources in Undeveloped Areas**. Construction and maintenance projects at PMRF are to be reviewed by the PMRF Environmental Coordinator and/or NAVFAC personnel to ensure contractors are aware of guidelines to avoid impacting sensitive vegetation. These guidelines include establishing work-arounds, whenever possible, so equipment lay-down and construction-footprint areas are located outside of areas of native vegetation. Barking Sands has particularly sensitive areas of native vegetation that should be avoided when possible.	Land Management	P2/NOC
38	**Drainage Pumps and Ditch Maintenance**: Continue to maintain the drainage pumps and ditches located within the 200 ac (81 ha) lease area (Section 3.4.8 and 3.4.11). Continue to lease land at Barking Sands in order to maintain the drainage pumps and ditches to prevent flooding of the facility (Section 3.4.8 and 3.4.11).	Flood Plains; Leases and Encroachment Management	P2/NOC
39	**Wildland Fire Control:** Any wildland fires at all PMRF facilities should continue to be addressed by the appropriate fire departments. In addition, a portable blast deflector should be used on the launch pads to prevent wild land fires. The Navy should also clear vegetation from around the launch pads, and wet the vegetation near the launch pads just prior to launch in order to prevent wildland fires. Emergency fire crews should be available during launches to extinguish any fire and minimize its effects. When possible, fire crews should utilize open spray nozzle to extinguish fires minimizing erosional damage to nearby habitats and destruction of cultural resources.	Wildland Fire	P2/NOC
40	**Law Enforcement.** Continue to use existing law enforcement at its installations. Any incidents related to natural resources should continue to be reported to the PMRF Environmental Coordinator.	Law Enforcement	P2/NOC

9.5 MĀKAHA RIDGE TRACKING STATION PROPOSED ACTIONS

Table 9-3 provides a summary of the recommended management actions for PMRF's Mākaha Ridge Tracking Station. These recommended actions along with their 10-year fiscal plan are listed in Table 9-8 (end of the chapter).

Table 9-3: Recommended Management Actions for Mākaha Ridge Tracking Station

Item No.	Recommendation	Management Action	Funding
1	**Protected Species Monitoring and Reporting:** The following protected species monitoring and reporting projects should be completed: • **Hawaiian Geese Monitoring**. Continue monitoring the occurrence of nēnē at Mākaha Ridge Tracking Station. • **Hawaiian Hoary Bats Surveys.** If Hawaiian hoary bats are observed up at Mākaha Ridge Tracking Station, the results should be evaluated to determine if regular monitoring is required. • **Dwarf Iliau and Spermolepis hawaiiensis Monitoring and Management.** Annual monitoring and status of protected species (dwarf iliau and Spermolepis hawaiiensis).	Project-Specific (protected species)	P2/C2
2	**Nocturnal Seabird Fallout Monitoring and Management:** Due to the 2008 and 2009 fall outs of Newell's shearwaters and band-rumped storm-petrels, threatened and endangered seabird management at Barking Sands is increasing. DON is currently in Section 7 consultation with USFWS regarding fallout minimization and mitigation for the two above species and Hawaiian petrel. The negotiated actions from the consultation will be incorporated into INRMP implementation.	Project-Specific (protected species)	P1/C1
3	**Use of Green Lights and Light Shielding to Protect Seabirds.** As stated in Chapter 3, PMRF is installing and operating green bulbs at multiple locations on Barking Sands. If this project is approved by security and AT/FP personnel, green lighting will be used at PMRF. Other actions where green lights are not feasible include: shielding of white lights, installing motion sensor lights, and determining areas where lights may be safely turned off. These initial actions are Priority 1 Funding and would move into Priority 2 Funding at the maintenance phase.	Project-Specific (protected species)	P1 /C1 and P2/C2
4	**Protection of Wildlife from Potential EMR Impacts**: PMRF should follow an SOP which requires that existing radars at the Station do not radiate lower than at least 4 to 6 degrees above horizontal. This would preclude EMR impacts on wildlife on the ground including nēnē and bats.	Project-Specific (protected species)	P2/NOC
5	**Native Plant Restoration.** The 2009 Feral Ungulate Management Plan calls for revegetation of selected eroded areas within the facility with native species expected to be found in and around Mākaha Ridge Tracking Station. Planning will consider multiple revegetation techniques, including hydomulching, woodchipping, broadcast seeding, installing a watering system, and canopy tree outplanting. National Tropical Botanical Garden can be used as an information source or a even a contractor to assist in restoration effort. Strategies to remove introduced plant species should be combined with a market research study, exploring opportunities to sell pine or other forestry products.	Project-Specific	P3/C0
6	**Feral Goat Control:** Install exclusion fencing to exclude the goats from Mākaha Ridge Tracking Station, including the cliffs where the native plants are located. An ungulate management plan, provided on contract to NAVFAC PAC (SWCA Environmental Consultants 2009), suggested several fencing alternatives. The alternative that meets the requirements for facility and vegetation protection, and at the cheapest cost, includes a perimeter goat fence encompassing the majority of the installation, with the inland-facing fence line raised to exclude deer as well. To control goats until fencing is installed, several options are available, including a trial archery goat hunting program with the Barking Sand Archery Club in coordination with the DLNR DOFAW, or a Work Plan developed with USDA-WS. Goat eradication may increase coastal water quality.	Project-Specific (invasive species)	P2/C0
7	**Predator Control**. This project should be funded annually to protect Hawaiian geese (nēnē) if it is determined that predators are affecting nēnē nests at the station.	Project-Specific (protected species)	P2/C2

Table 9-3: Recommended Management Actions for Mākaha Ridge Tracking Station (Continued)

Item No.	Recommendation	Management Action	Funding
8	**Trial Goat Hunting**. Institute a trial goat hunting program with the Barking Sand Archery Club or other organization in coordination with the DLNR DOFAW to reduce the presence of goats at the Mākaha Ridge Tracking Station.	Project Specific (invasive species); Outdoor Recreation	P3/C3
9	**Fauna Surveys Update/Initiate.** Update fauna surveys and mapping, including protected bird species, in preparation for subsequent INRMP updates. Population monitoring data should continue to be evaluated for any necessary changes or improvements in management actions.	Natural Resources Studies	P2/C2
10	**Botanical Surveys and Mapping:** Provide a 5-year update of botanical survey data. The Navy should update the 2006 botanical surveys and vegetation maps as well as update the status of protected species (dwarf iliau and *Spermolepis hawaiiensis*)) in preparation for the next INRMP.	Natural Resources Studies	P2/C2
11	**Integrate Natural Resources Survey Data in GIS Database:**Continue to manage, integrate, access and report natural resources GIS data into PMRF GIS database (Section 2.4).	GIS	P2/NOC
12	**Base Planning:** A routine procedure should continue to be implemented to assure coordination among facilities planners, resource managers, SOH, and county officials. The PMRF Environmental Coordinator should continue to be the point of contact to provide relevant information on issues with potential to affect wildlife and native habitat, such as new construction activities. Natural resources surveys may be required and mitigation measures developed to assure protection of federally-listed threatened and endangered or otherwise protected species and their habitats. All new construction projects should continue to follow standard methods to control erosion during construction. At Mākaha Ridge Tracking Station, plans for the FORCEnet integration laboratory should be sited in a previously disturbed area. The FORCEnet integration laboratory portable trailer activities should avoid periods of bird fallout and, if that is not practicable, the Navy should conduct monitoring for seabird fallout near the antennas as appropriate.	Land Management	P2/NOC
13	**Landscape Design:** Continue to evaluate all future landscape design and installation projects for the potential to include habitat restoration and the use of native plants whenever possible. The preference for plant materials from immediately adjacent areas, as well as the importance of using sterile soil to prevent the introduction of pests such as nematodes and weeds, should continue to be emphasized.	Land Management	P2/NOC
14	**Protection of Natural Resources in Undeveloped Areas**. Construction and maintenance projects at PMRF should continue to be reviewed by the PMRF Environmental Coordinator and/or NAVFAC personnel to ensure contractors are aware of guidelines to avoid impacting sensitive vegetation. These guidelines include establishing work-arounds, whenever possible, so equipment lay-down and construction-footprint areas are located outside of areas of native vegetation.	Land Management	P2/NOC
15	**Soil Erosion Control.** As described in Section 4.2.4, several soil types at Mākaha Ridge Tracking Station (rRO, BL, NcD, NcE2) have severe erosion hazards. In addition, feral goats located on SOH lands, of which Mākaha Ridge Tracking Station is a small part, exacerbate soil erosion by eating erosion-inhibiting vegetation. The Navy has installed textiles to prevent erosion in walkways and in the vicinity of the built environment. However, soil erosion over the mostly undeveloped environment at Mākaha Ridge, including portions of the Mākaha Ridge Tracking Station, is largely the result of naturally occurring soil conditions and the presence of feral goats. While there is nothing the Navy can do to address the natural soil types at the station, projects for goat removal and fencing are described in item 6 of this table. Restrictions should continue to limit vehicle access to paved roads and designated paved parking areas. Parking in grassy or bare earth areas should continue to be discouraged. Pedestrian traffic should continue to be limited to established walkways. A concept design for soil erosion control was developed. It requires slope stabilization and herbivore exclusion. Erosion control should be achieved through the use of a soil stabilizing cloth such as Geojute in combination with out plantings of native drought tolerant plant species. An herbivore exclusion fence should be coordinated with PMRF and DLNR DOFAW to enclose protected plants and re-planted areas.	Land Management	P3/C0
16	**Wildland Fire Control:** Any wildland fires at all PMRF facilities should continue to be addressed by the appropriate fire departments. .	Wildland Fire	P2/NOC
17	**Law Enforcement.** PMRF should continue to use existing law enforcement at its installations. Any incidents related to natural resources should continue to be reported to the PMRF Environmental Coordinator.	Law Enforcement	P2/NOC

9.6 KŌKE'E SITES PROPOSED ACTIONS

Table 9-4 provides a summary of the recommended management actions for PMRF's Kōke'e Sites. These recommended actions along with their 10-year fiscal plan are listed in Table 9-8 (end of the chapter).

Table 9-4: Recommended Management Actions for Kōke'e Sites

Item No.	Recommendation	Management Action	Funding
1	**Nocturnal Seabird Fallout Monitoring and Management:** Due to the 2008 and 2009 fall outs of Newell's shearwaters and band-rumped storm-petrels, threatened and endangered seabird management at Barking Sands is increasing. DON is currently in Section 7 consultation with USFWS regarding fallout minimization and mitigation for the two above species and Hawaiian petrel. The negotiated actions from the consultation will be incorporated into INRMP implementation.	Project-Specific (protected species)	P1/C1
2	**Use of Green Lights and Light Shielding to Protect Seabirds.** As stated in Chapter 3, PMRF is installing and operating green bulbs at multiple locations on Barking Sands. If this project is approved by security and AT/FP personnel, green lighting will be used at PMRF. Other actions where green lights are not feasible include: shielding of white lights, installing motion sensor lights, and determining areas where lights may be safely turned off. These initial actions are Priority 1 Funding and would move into Priority 2 Funding at the maintenance phase.	Project-Specific (protected species)	P1 /C1 and P2/C2
3	**Protection of Wildlife from Potential EMR Impacts**: PMRF should follow an SOP which requires that existing radars at the Kōke'e Sites do not radiate lower than at least 4 to 6 degrees above horizontal. This would preclude EMR impacts on wildlife on the ground including bats.	Project-Specific (protected species)	P2/NOC
4	**Hawaiian Hoary Bats**: As with the other PMRF facilities, distribution and abundance surveys currently being conducted at the Kōke'e Sites should be evaluated, and if bats are detected, surveys should be performed on a routine periodic basis.	Project-Specific (protected species)	P2/C2
5	**Hawaiian Picture-Wing Fly:** Surveys for the recently listed *Drosophila sharpi* are required and should be performed. When these surveys occur, *Drosophila musaphilia* should also be included.	Project-Specific (protected species)	P1/C1
6	**Native Plant Habitat Improvement:** Conduct invasive vegetation removal at the Kōke'e Sites using methods similar to the project for native plant habitat improvement at Barking Sands. Work should initiate at Site B, where the *Drosophila musaphilia* was located. Work should be focused on the most invasive plants including strawberry guava, faya tree, yellow ginger, and blackberry. Revegetation actions are unnecessary at this location due to the existing preponderance of native species. Alien plant control priorities should be coordinated with the DLNR Parks Division. Vegetation should be managed to selectively remove invasive vegetation and allow native forest regeneration.	Project-Specific (protected and invasive species)	P2/C2
7	**Melastome Eradication**: Provide KISC, Navy or SOH biologists access to a small patch of Asian melastome found near the roadside at Kōke'e Site D in order to eradicate this population. This area may or may not be on Navy property; however, the Navy should coordinate with KISC to target the patch to ensure eradication.	Project-Specific (invasive species)	P2/C2
8	**Fauna Surveys Update/Initiate.** Update fauna surveys and mapping, including those for protected bird species, in preparation for subsequent INRMP updates. Population monitoring data should continue to be evaluated for any necessary changes or improvements in management actions.	Natural Resources Studies	P2/C2
9	**Botanical Surveys and Mapping:** Provide a 5-year update of botanical survey data. The Navy should update the 2006 botanical surveys and vegetation maps as well as update the status of protected species ('akoko) in preparation for the next INRMP.	Natural Resources Studies	P2/C2
10	**Integrate Natural Resources Survey Data in GIS Database:** Continue to manage, integrate, access and report natural resources GIS data into PMRF GIS database (Section 2.4).	GIS	P2/C2

Table 9-4: Recommended Management Actions for the Kōkeʻe Sites (Continued)

Item No.	Recommendation	Management Action	Funding
11	**Base Planning:** A routine procedure should continue to be implemented to assure coordination among facilities planners, resource managers, SOH, and county officials. The PMRF Environmental Coordinator should continue to be the point of contact to provide relevant information on issues with potential to affect wildlife and native habitats, Natural resources surveys may be required and mitigation measures developed to assure protection of federally-listed threatened and endangered or otherwise protected species and their habitats. In addition, locations and plans for any new equipment towers should be reviewed by Navy natural resources personnel in order to minimize effects on protected species and their habitat. All new construction projects should continue to follow standard methods to control erosion during construction. At the Kōkeʻe Sites, plans for the FORCEnet integration laboratory should be sited in a previously disturbed area. The FORCEnet integration laboratory portable trailer activities should avoid periods of bird fallout and if that is not practicable the Navy should conduct monitoring for seabird fallout near the antennas as appropriate.	Land Management	P2/NOC
12	**Landscape Design**: Continue to evaluate all future landscape design and installation projects for the potential to include habitat restoration and the use of native plants whenever possible. The preference for plant materials from immediately adjacent areas, as well as the importance of using sterile soil to prevent the introduction of pests such as nematodes and weeds, should continue to be emphasized.	Land Management	P2/NOC
13	**Protection of Natural Resources in Undeveloped Areas**. Construction and maintenance projects at PMRF are to be reviewed by the PMRF Environmental Coordinator and/or NAVFAC personnel to ensure contractors are aware of guidelines to avoid impacting sensitive vegetation. These guidelines include establishing work-arounds, whenever possible, so equipment lay-down and construction-footprint areas are located outside of areas of native vegetation. Kōkeʻe Sites have particularly sensitive areas of native vegetation that should be avoided when possible.	Land Management	P2/NOC
14	**Wildland Fire Control:** Any wildland fires at all PMRF facilities should continue to be addressed by the appropriate fire departments. .	Wildland Fire	P2/NOC
15	**Law Enforcement.** PMRF should continue to use existing law enforcement at its installations. Any incidents related to natural resources should continue to be reported to the PMRF Environmental Coordinator.	Law Enforcement	P2/NOC

9.7 KAMOKALA RIDGE MAGAZINES PROPOSED ACTIONS

Table 9-5 provides a summary of the recommended management actions for PMRF's Kamokala Ridge Magazines. These recommended actions along with their 10-year fiscal plan are listed in Table 9-8 (end of the chapter).

Table 9-5: Recommended Management Actions for Kamokala Ridge Magazines

Item No.	Recommendation	Management Action	Funding
1	**Native Plant Habitat Improvement.** Conduct invasive vegetation removal using methods of selective removal of invasive species. The focus should be on removal of haole koa, particularly in areas around existing native vegetation such as a'ali'i and wiliwili.	Project-Specific (invasive species)	P3/C3
2	**Fauna Surveys Update/Initiate.** Update fauna surveys and mapping, including protected bird species, in preparation for subsequent INRMP updates. Population monitoring data should continue to be evaluated for any necessary changes or improvements in management actions.	Natural Resources Studies	P2/C2
3	**Botanical Surveys and Mapping:** Provide a 5-year update of botanical survey data. The Navy should update the 2006 botanical surveys and vegetation maps as well as update the status of protected species in preparation for the next INRMP.	Natural Resources Studies	P2/C2
4	**Integrate Natural Resources Survey Data in GIS Database:** PMRF should continue to manage, integrate, access and report natural resources GIS data into PMRF GIS database (Section 2.4).	GIS	P2/C2
5	**Base Planning:** A routine procedure should continue to be implemented to assure coordination among facilities planners, resource managers, SOH, and county officials. The PMRF Environmental Coordinator should continue to be the point of contact to provide relevant information on issues with potential to affect wildlife and native habitat. Natural resources surveys may be required and mitigation measures developed to assure protection of federally-listed threatened and endangered or otherwise protected species and their habitats. All new construction projects should continue to follow standard methods to control erosion during construction.	Land Management	P2/NOC
6	**Landscape Design**: Continue to evaluate all future landscape design and installation projects for the potential to include habitat restoration and the use of native plants whenever possible. The preference for plant materials from immediately adjacent areas, as well as the importance of using sterile soil to prevent the introduction of pests such as nematodes and weeds, would continue to be emphasized.	Land Management	P2/NOC
7	**Protection of Natural Resources in Undeveloped Areas**. Construction and maintenance projects at PMRF would continue to be reviewed by the PMRF Environmental Coordinator and/or NAVFAC personnel to ensure contractors are aware of guidelines to avoid impacting sensitive vegetation. These guidelines include establishing work-arounds, whenever possible, so equipment lay-down and construction-footprint areas are located outside of areas of native vegetation.	Land Management	P2/NOC
8	**Wildland Fire Control:** Any wildland fires at all PMRF facilities would continue to be addressed by the appropriate fire departments. .	Wildland Fire	P2/NOC
9	**Law Enforcement.** PMRF would continue to use existing law enforcement at its installations. Any incidents related to natural resources would continue to be reported to the PMRF Environmental Coordinator.	Law Enforcement	P2/NOC

9.8 KA'ULA ISLAND PROPOSED ACTIONS

Table 9-6 provides a summary of the recommended management actions for PMRF's Ka'ula Island. These recommended actions along with their 10-year fiscal plan are listed in Table 9-8 (end of the chapter).

Table 9-6: Recommended Management Actions for Ka'ula Island

Item No.	Recommendation	Management Action	Funding
1	**Hawaiian Monk Seal Protection:** • The Navy continues to prohibit vessel landing on Ka'ula Island due to UXO concerns. This policy will be maintained for the foreseeable future, and has the added benefit of reducing potentially harmful interactions between hauled-out monk seals and humans. • Fishing is limited at Ka'ula Island which limits fishing pressure. This may result in a healthy marine environment with ample fish biomass and reduced stray fishing lines and nets, providing a benefit to the seals. All sorties that are flown to Ka'ula will continue to check in to Fleet Air Control and Surveillance Facility (FACSFAC), which controls air operations into the Ka'ula danger zone. FACSFAC issues authorization to proceed based on, in part, the absence of a monk seal within the drop zone. The Navy has developed a monitoring plan, Hawaii Range Complex Monitoring Plan December 2008, to provide marine mammal and sea turtle monitoring related to Hawaii Range Complex activities include use of inert ordnance at Kaula Island	Project-Specific (protected species)	P2/NOC
2	**MBTA Compliance:** At Ka'ula Island, to minimize take of MBTA-protected seabird species, the Navy should continue to limit inert ordnance target training on the predetermined area (~9 percent of the land area) at the southern tip of the island.	Project-Specific (protected species)	P2/NOC
3	**Fauna Surveys Update/Initiate.** Update fauna survey results, including those for MBTA-protected bird species, in preparation for subsequent INRMP updates. Population monitoring data will continue to be evaluated for any changes in species presence or absence and population sizes. Any Ka'ula Island seabird monitoring will be conducted via boat survey by circumnavigating the perimeter of the island. Unmanned aerial vehicle surveys may also be used to more accurately survey the island.	Natural Resources Studies	P2/C2
4	**Botanical Surveys and Mapping:** If high-resolution surveys for plant species could be carried out via overflights of unmanned aerial vehicles at Ka'ula Island, an updated botanical survey should be conducted.	Natural Resources Studies	P3/C3
5	**Integrate Natural Resources Survey Data in GIS Database:** Continue to manage, integrate, access and report natural resources GIS data into PMRF GIS database (Section 2.4).	GIS	P2/C2

9.9 MAUNA KAPU FACILITY PROPOSED ACTIONS

Table 9-7 provides a summary of the recommended management actions for PMRF's Mauna Kapu Facility. These recommended actions along with their 10-year fiscal plan are listed in Table 9-8 (end of the chapter).

Table 9-7: Recommended Management Actions for Mauna Kapu Facility

Item No.	Recommendation	Management Action	Funding
1	**Fauna Surveys Initiate.** Initiate fauna surveys at the Mauna Kapu Facility in preparation for subsequent INRMP updates. Population monitoring data should continue to be evaluated for any necessary changes or improvements in management actions.	Natural Resources Studies	P2/C2
2	**Botanical Surveys and Mapping Initiate:** This project would initiate botanical surveys, create vegetation maps, report the status of any protected species at the Mauna Kapu Facility in preparation for the next INRMP.	Natural Resources Studies	P2/C2
3	**Integrate Natural Resources Survey Data in GIS Database:** Continue to manage, integrate, access and report natural resources GIS data into PMRF GIS database (Section 2.4).	GIS	P2/NOC
4	**Base Planning:** A routine procedure should continued to be implemented to assure coordination among facilities planners, resource managers, SOH, and county officials. All new construction projects should continue to follow standard methods to control erosion during construction.	Land Management	P2/NOC
5	**Landscape Design:** Continue to evaluate all future landscape design and installation projects for the potential to include habitat restoration and the use of native plants whenever possible. The preference for plant materials from immediately adjacent areas, as well as the importance of using sterile soil to prevent the introduction of pests such as nematodes and weeds, would continue to be emphasized.	Land Management	P2/NOC
6	**Protection of Natural Resources in Undeveloped Areas**. Construction and maintenance projects at PMRF are to be reviewed by the PMRF Environmental Coordinator and/or NAVFAC personnel to ensure contractors are aware of guidelines to avoid impacting sensitive vegetation. These guidelines include establishing work-arounds, whenever possible, so equipment lay-down and construction-footprint areas are located outside of areas of native vegetation.	Land Management	P2/NOC
7	**Wildland Fire Control:** Any wildland fires at all PMRF facilities should continue to be addressed by the appropriate fire departments. .	Wildland Fire	P2/NOC
8	**Law Enforcement.** PMRF should continue to use existing law enforcement at its installations. Any incidents related to natural resources should continue to be reported to the PMRF Environmental Coordinator.	Law Enforcement	P2/NOC

9.10 ENVIRONMENTAL PLANNING AND MISSION SUSTAINABILITY

The natural resources mission statement (below) for PMRF focuses management efforts and available funding on priority projects and tasks while setting clear conservation priorities. It also provides a standard against which to measure the effects of decisions made in the INRMP.

"The United States Navy recognizes that the PMRF military mission and daily functions are dependent upon and both directly and indirectly affect the surrounding natural air, sea, and land environment. It is with a full understanding of and with recognition of this large-scale ecosystem interdependency dynamic that natural resources management decisions would be made. While fulfilling its primary mission of the defense of the United States, PMRF's continuing mission in terms of natural resources is to maintain an excellent level of stewardship over all its leased and owned lands, with priority given to the protection of threatened and endangered species and their habitats. To fulfill this mission, PMRF would extend and expand its natural resources stewardship by fully integrating its primary military mission and base operations with the management of its resources, and by continuing to cooperate and consult with appropriate federal, state, and county agencies such as the U.S. Fish and Wildlife Service, National Marine Fisheries Service, and Hawai'i's Department of Land and Natural Resources." (DON 2001)

9.11 ACHIEVING NO NET LOSS OF MILITARY MISSION

Through the implementation of this INRMP, PMRF should experience no net loss in achieving its military mission. None of the actions proposed should take away training or operations capabilities.

9.12 USE OF COOPERATIVE AGREEMENTS

PMRF effectively cooperates with federal and SOH agencies in the management of natural resources at PMRF installations. The USDA-WS provides BASH control for the Barking Sands airfield, predator control for the Barking Sands oxidation ponds and seabird nesting colonies, and monitors for the presence of Hawaiian monk seals and sea turtles. USFWS and USDA-WS cooperate with PMRF for the Laysan albatross surrogate parenting program initiated from Barking Sands. PMRF supports the NOAA Fisheries marine mammal rescue team to the extent possible with available resources and personnel. PMRF has been working with KISC and others in the removal of LTK from Barking Sands. PMRF is working with DLNR in the planned removal of goats from the Mākaha Ridge Tracking Station in order to combat soil erosion, prevent the further loss of native vegetation including protected plant species in this area, and allow for nesting by Hawaiian geese (nēnē).

9.13 NEPA COMPLIANCE

As discussed in Section 1.5.2, NEPA compliance for this INRMP was achieved through an EA prepared as part of the initial INRMP in 2001. Annual updates and revisions to the initial INRMP are covered under the original EA, as there have been no major changes to installation mission or scope from the 2001 INRMP.

9.14 FUNDING

"Must fund" conservation requirements are those projects and activities that are required to meet recurring natural and cultural resources conservation management requirements or current legal compliance needs, including EOs. These projects are designated as Environmental Readiness Level (ERL) 4 in the Navy funding classification system. ERL4

supports: (1) all actions specifically required by law, regulation, or EO (DOD Class 1 and 2 requirements) just in time; and (2) recurring administrative, personnel, and other costs associated with managing environmental programs that are necessary to meet applicable compliance requirements (DOD Class 0).

Examples of ERL 4 projects include development and revision of INRMPs, baseline surveys for INRMP development and revision, salaries and training of professional personnel developing and implementing INRMPs. In addition, other ERL4 projects include biological surveys to determine population status of endangered, threatened and sensitive species; survey and monitoring programs to support the migratory bird rule; wetlands surveys for planning, monitoring and/or permit applications; and erosion control measures required to remain in compliance with natural resources protection regulations and to maintain land condition for realistic military training operations.

INRMPs also include valid projects and programs that enhance an installation's natural resources, promote proactive conservation measures, and support investments that demonstrate Navy environmental leadership and proactive environmental stewardship. These projects would fall under ERL 1, 2, or 3 in the Navy classification system.

ERL 3 supports: (1) all capabilities provided by ERL 4; (2) existing Navy executive agent responsibilities, participation in the Office of the Secretary of Defense (OSD) sponsored inter-department and inter-agency efforts, and OSD mandate regional coordination efforts; (3) proactive involvement in the legislative and regulatory process to identify and mitigate requirements that will impose excessive costs or restrictions on operations and training; and (4) proactive initiatives critical to the protection of Navy operational readiness.

ERL2 supports: (1) all capabilities provided under ERL3; (2) enhanced proactive initiatives critical to the protection of Navy operational readiness; (3) all Navy and DOD requirements; and (4) investments in pollution reduction, compliance enhancement, energy conservation, and cost reduction.

ERL1 supports: (1) all capabilities provided under ERL2; (2) proactive actions required to ensure compliance with pending/strong anticipated laws and regulations in a timely manner; and (3) investments that demonstrate Navy environmental leadership and proactive environmental stewardship.

There are restrictions on how different Navy funding sources for natural resources management can be used. The following are the primary funding sources for Navy natural resources programs: (1) Operations and Maintenance, Navy (O&MN) funds; (2) Legacy funds; (3) forestry revenues; (3) agricultural outleasing; (4) fish and wildlife fees; (5) recycling funds; and (6) non-DOD funds.

O&MN Environmental Funds. The majority of natural resource projects are funded with O&MN environmental funds that are programmed through the Environmental Program Requirements (EPR) process. These appropriated funds are the primary sources of resources to support must-fund, just-in-time environmental compliance (ERL4 projects). O&MN funds are generally not available for ERL1 through ERL3 projects. Only the initial procurement, construction, and modification of a facility or project are considered valid environmental funding requirements. In addition, when natural resources are tied to a specific construction project or other action, funds for the natural resource requirements should be included in the overall project costs.

The Navy prepares environmental program requirements submissions for consideration during the development of the Baseline Assessment Memorandum (BAM). The BAM is a direct input to the programming phase of the Planning, Programming and Budgeting and Execution System

(PPBES) cycle. PPBES is a two-year budget cycle (depicted in Figure 9-1). A Program Objective Memorandum (POM) is used to submit programming proposal during even numbered (on-budget years) identifying the total program resources for six years. A Program Review (PR) addresses urgent issues during odd number (off budget years) and proposed program increases must be offset by proposed program decreases. This document provides Navy leadership with a fully validated minimum funding requirement to comply with all applicable environmental laws and implementing regulations.

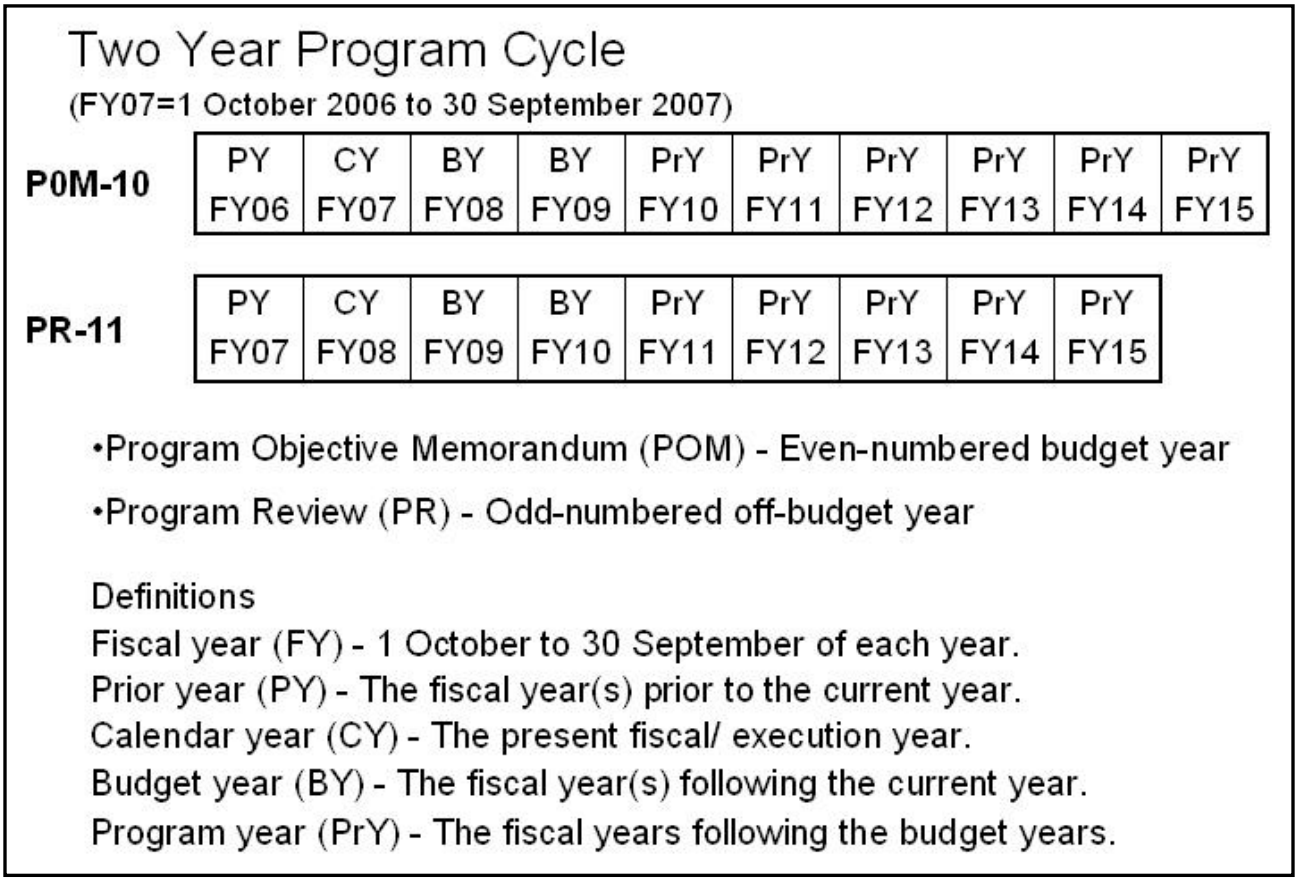


Figure 9-1: Two Year Program Cycle

Legacy Funds. The Legacy Resource Management Program (Legacy Program) is a special congressionally mandated initiative to fund military conservation projects. The Legacy Program can provide funding for a variety of conservation projects such as regional ecosystem management initiatives, habitat preservation efforts, invasive species control, monitoring and predicting patterns of migratory birds and animals. The availability of Legacy Program funds is uncertain early in the year and pre-proposals are due in March and submitted to the Legacy Program. All Legacy Program proposals are reviewed by the Navy chain of command prior to submittal to the Legacy Program Office for final project selection.

Forestry Revenues. Revenues from sales of forest products on Navy lands area source of funding for natural resources management programs. The revenues provide finds for (1) Annual Navy Forest Funds and (2) DOD Forestry Reserve Account. The Annual Navy Forest Funds support commercial forestry operations at installations. Forestry operations must be commercially viable to be eligible for these funds. Under the DOD Forestry Reserve account,

revenues are first used to reimburse commercial forestry expense and then 40 percent of the installation net proceeds for the fiscal year can be distributed to the state that contains the installation. Any remaining amount is transferred into the reserve account to be used to improve forest lands, fund unanticipated contingencies in the administration of forest lands and the production of forest products, and natural resources management that implements approved plans and agreements.

Agricultural Outleasing. Money collected through the leasing of Navy-owned property for agricultural use is directed back into the natural resources program and reallocated throughout the Navy by NAVFAC headquarters. These are the broadest-use funds available exclusively to natural resource managers. The funds must be used exclusively to fund natural resources management requirements and administrative expenses of agricultural and grazing leases. Revenues can be used for administrative expenses of agricultural lease; initiation, improvement, and perpetuation of agricultural outleases; and implementation of INRMP stewardship projects.

Fish and Wildlife Fees. In addition to state and federal licenses, the installation may issue permits and collect user fees for fishing, hunting, and trapping activities on base. These fees may only be used for protection, conservation, and management of fish and wildlife, including habitat improvements and related actions. Money received from these fees can only be spent on the installation where it was collected and they may accumulate over time.

Recycling Funds. Any installation with a qualified recycling program (QRP) may use proceeds for some types of natural resource projects. Proceeds must first be used to cover QRP costs. Up to 50 percent of the net proceeds may then be used for pollution abatement, pollution prevention, composting, alternative fueled vehicle infrastructure support, vehicle conversion, energy conversion, or occupational safety and health projects, with first consideration given to projects included in the installation's pollution prevention plan. Remaining funds may be transferred to the non-appropriated MWR account for approved programs, or retained to cover anticipated future program costs. Natural resources projects can be funded as pollution prevention/abatement (e.g., wetlands or riparian forest restoration) or MWR projects (e.g., trail construction and maintenance).

Non-DOD Funds. Many grant programs are available for natural resources management projects, such as watershed management and restoration, habitat restoration, and wetland and riparian area restoration. When federally funded, these programs typically require non-federal matching funds. However, installations may partner with other groups to propose eligible projects.

Table 9-8: INRMP Ten-Year Fiscal Plan

Item No.	Recommendation	Management Action	Funding Class	Y1 (2011)	Y2 (2012)	Y3 (2013)	Y4 (2014)	Y5 (2015)	Y6 (2016)	Y7 (2017)	Y8 (2018)	Y9 (2019)	Y10 (2020)	Total	Comments
A. Barking Sands															
1	Bird Aircraft Strike Hazard.	Project-Specific	P2/NOC	Costs are included in the day-to-day functions of the PMRF Air Operations Department, no additional funding is required.											
2	Base-wide Predator Control.	Project-Specific (protected species)	P2/C2	$21,788	$22,660	$23,566	$24,509	$25,489	$26,508	$27,569	$28,672	$29,818	$31,011	$261,589	Increase in predator control funds includes supplies and increased USDA-WS manpower hours.
3	Sea Turtle Management.	Project-Specific (protected species)	P2/NOC	Costs are included in the day-to-day functions of the PMRF Environmental Department, no additional funding is required.											
4	Nocturnal Seabird Fallout Monitoring and Management.	Project-Specific (protected species)	P1/C1	$50,000	$52,000	$54,000	$56,200	$58,500	$60,900	$63,300	$65,800	$68,400	$71,200	$600,300	Fallout monitoring, offbase mitigation
5	Use of Green Lights and Light Shielding to Protect Seabirds.	Project-Specific (protected species)	P1 /C1 and P2/C2	$15,000	$15,000	$0	$0	$0	$0	$0	$0	$0	$0	$30,000	
6	Protection of Wildlife from Potential EMR Impacts.	Project-Specific (protected species)	P2/NOC	Costs are included in the day-to-day functions of the PMRF Environmental Department, no additional funding is required.											
7	Enhance and Improve Beach Cottages Shearwater Colony.	Project-Specific (protected species)	P2/C2	$3,000	$3,100	$3,200	$3,400	$3,500	$3,600	$3,800	$3,900	$4,100	$4,300	$35,900	Includes labor and supplies.
8	Waterbird Species.	Project-Specific (Protected Species)	P2/NOC	Costs are included in the day-to-day functions of the PMRF Environmental Department, no additional funding is required.											

Table 9-8: INRMP Ten-Year Fiscal Plan (Continued)

Item No.	Recommendation	Management Action	Funding Class	Y1 (2011)	Y2 (2012)	Y3 (2013)	Y4 (2014)	Y5 (2015)	Y6 (2016)	Y7 (2017)	Y8 (2018)	Y9 (2019)	Y10 (2020)	Total	Comments
9	Hawaiian Hoary Bat.	Project-Specific (protected species)	P1/C1	$5,000	$5,200	$5,400	$5,600	$5,800	$6,100	$6,300	$6,600	$6,800	$7,100	$59,900	
10	Hawaiian Monk Seals.	Project-Specific (protected species)	P2/NOC	Costs are included in the day-to-day functions of the PMRF Environmental Department, no additional funding is required.											
11	Humpback Whales and Other Cetaceans.	Project-Specific (protected species)	P2/NOC	Costs are included in the day-to-day functions of the PMRF Environmental Department, no additional funding is required.											
12	Marine Debris Cleanup.	Project-Specific (protected species)	P2/NOC	Costs are included in the day-to-day functions of the PMRF Environmental Department, no additional funding is required.											
13	Invasive Species Prevention and Control.	Project-Specific (Invasive Species)	P2/NOC	Costs are included in the day-to-day functions of the PMRF Environmental Department, no additional funding is required.											
14	Develop a Biosecurity Program for PMRF.	Project-Specific (invasive species)	P2/C2	$0	$50,000	$5,000	$5,000	$5,000	$5,000	$5,000	$5,000	$5,000	$5,000	$90,000	
15	Critical Habitat and Dune Vegetation Restoration Project.	Project-Specific (protected species and invasive species)	P2/C2	$50,000	$52,000	$54,000	$56,000	$58,000	$61,000	$63,000	$66,000	$68,000	$71,000	$599,000	Includes labor, materials, and supplies, ltk contract removal
16	Plant Nursery Development.	Project-Specific	P3/C3	$0	$0	$0	$0	$65,000	$0	$0	$0	$0	$0	$65,000	
17	Wetlands Maintenance.	Project-Specific (wetlands)	P2/NOC	Costs are included in the day-to-day functions of the PMRF Environmental Department, no additional funding is required.											

Table 9-8: INRMP Ten-Year Fiscal Plan (Continued)

Item No.	Recommendation	Management Action	Funding Class	Y1 (2011)	Y2 (2012)	Y3 (2013)	Y4 (2014)	Y5 (2015)	Y6 (2016)	Y7 (2017)	Y8 (2018)	Y9 (2019)	Y10 (2020)	Total	Comments
18	Oxidation Pond Improvements.	Project-Specific (wetlands)	P3/C3	$0	$0	$8000	$0	$0	$3,000	$0	$0	$0	$3,000	$14,000	Includes costs for materials, supplies, and labor to make improvements to waterbird habitat.
19	Beach and Dune Access Restrictions.	Project-Specific	P2/NOC	Costs are included in the day-to-day functions of the PMRF Environmental Department, no additional funding is required.											
20	Kawaiele Wetlands Waterbird Sanctuary.	Project-Specific (wetlands)	P3/NOC	Costs are included in the day-to-day functions of the PMRF Environmental Department, no additional funding is required.											
21	INRMP Annual and 5-year Updates.	Natural Resources Studies	P2/C2	$10,000	$10,000	$11,000	$80,000	$12,000	$12,000	$13,000	$13,000	$90,000	$14,000	$265,000	
22	Fauna Surveys Update/Initiate.	Natural Resources Studies	P2/C2	$0	$0	$0	$15,000	$0	$0	$0	$0	$$18,000	$0	$33,000	Includes materials and labor.
23	Botanical Surveys and Mapping.	Natural Resources Studies	P2/C2	$0	$0	$0	$40,000	$0	$0	$0	$0	$45,000	$0	$85,000	Includes federally-listed species dwar iliau and *Spermolepis hawaiiensis* at Mākaha Ridge Tracking Station and akoko at Kōkeʻe Sites.
24	Marine Resources and Fisheries Survey Update.	Natural Resources Studies	P3/C3	$0	$0	$0	$40,000	$0	$0	$0	$0	$45,000	$0	$95,000	
25	Fishing Survey.	Natural Resources Studies	P3/C3	Funded through Fish and Wildlife fees.											

Table 9-8: INRMP Ten-Year Fiscal Plan (Continued)

Item No.	Recommendation	Management Action	Funding Class	Y1 (2011)	Y2 (2012)	Y3 (2013)	Y4 (2014)	Y5 (2015)	Y6 (2016)	Y7 (2017)	Y8 (2018)	Y9 (2019)	Y10 (2020)	Total	Comments
26	Integrate Natural Resources Survey Data in GIS Database.	GIS	P2/C2	$0	$0	$0	$8,000	$0	$0	$0	$0	$9,000	$0	$17,000	
27	Kiawe and Pine Forest Products.	Forestry	P3/C3	$0	$0	$6,000	$0	$0	$0	$0	$0	$0	$0	$6,000	
28	Natural Resources Information Center.	Community Outreach	P3/C3	$6,000	$500	$500	$500	$500	$6,000	$500	$500	$500	$500	$16,000	Includes costs for updating the Natural Resources Information Center within the Pass and Identification center, and labor for renewing educational materials.
29	Natural Resources Signs.	Community Outreach	P3/C3	$5,000	$0	$0	$0	$5,000	$0	$0	$0	$5,000	0	$15,000	Materials and supplies.
30	Native Medicinal Plant Garden Development/ Maintenance.	Community Outreach	P3/C3	$800	$800	$900	$900	$1,000	$1,000	$1,100	$1,100	$1,100	$1,100	$9,600	Materials and supplies
31	Educational Outreach Partnership.	Community Outreach	P3/NOC	Costs are included in the day-to-day functions of the PMRF Environmental Department, no additional funding is required.											
32	SOS Support and Shearwater Banding.	Community Outreach	P3/NOC	Costs are included in the day-to-day functions of the PMRF Environmental Department, no additional funding is required.											
33	Fishing, Surfing, Windsurfing, and Beach Activities.	Outdoor Recreation	P3/NOC	Costs are included in the day-to-day functions of the PMRF Environmental Department, no additional funding is required.											

Table 9-8: INRMP Ten-Year Fiscal Plan (Continued)

Item No.	Recommendation	Management Action	Funding Class	Y1 (2011)	Y2 (2012)	Y3 (2013)	Y4 (2014)	Y5 (2015)	Y6 (2016)	Y7 (2017)	Y8 (2018)	Y9 (2019)	Y10 (2020)	Total	Comments
34	Dissemination of Pertinent Natural Resources Information to Recreation Pass Program Applicants.	Outdoor Recreation	P3/NOC	Costs are included in the day-to-day functions of the PMRF Environmental Department, no additional funding is required. Fish and Wildlife Fees may be used to augment NOCs.											
35	Base Planning.	Land Management	P2/NOC	Costs are included in the day-to-day functions of the PMRF Environmental Department, no additional funding is required.											
36	Landscape Design.	Land Management	P2/NOC	Costs are included in the day-to-day functions of the PMRF Environmental Department, no additional funding is required.											
37	Protection of Natural Resources in Undeveloped Areas.	Land Management	P2/NOC	Costs are included in the day-to-day functions of the PMRF Environmental Department, no additional funding is required.											
38	Drainage Pumps and Ditch Maintenance.	Flood Plains; Leases and Encroachment Management	P2/NOC	Costs are included in the day-to-day functions of the PMRF Environmental Department, no additional funding is required.											
39	Wildland Fire Control.	Wildland Fire	P2/NOC	Costs are included in the day-to-day functions of the PMRF Environmental Department, no additional funding is required.											
40	Law Enforcement.	Law Enforcement	P2/NOC	Costs are included in the day-to-day functions of the PMRF Environmental Department, no additional funding is required.											
B. Mākaha Ridge Tracking Station															
1 a.	Hawaiian Geese Monitoring.	Project-Specific (protected species)	P2/C2	$3,000	$3,100	$3,200	$3,400	$3,500	$3,600	$3,800	$3,900	$4,100	$4,300	$35,900	
1b.	Hawaiian Hoary Bat Surveys.	Project-Specific (protected species)	P2/C2	Costs included in item 9 of Section A											

Table 9-8: INRMP Ten-Year Fiscal Plan (Continued)

Item No.	Recommendation	Management Action	Funding Class	Y1 (2011)	Y2 (2012)	Y3 (2013)	Y4 (2014)	Y5 (2015)	Y6 (2016)	Y7 (2017)	Y8 (2018)	Y9 (2019)	Y10 (2020)	Total	Comments
1c.	Dwarf iliau and *Spermolepis hawaiiensis* Monitoring and Management.	Project-Specific (protected species)	P2/C2	$3,500	$3,500	$3,500	$3,500	$3,500	$3,500	$3,500	$3,500	$3,500	$3,500	$35,000	
2	Nocturnal seabird fallout monitoring and management	Project-Specific (protected species)	P1/C1	Costs included in item 4 of Section A											
3	Use of Green Lights and Light Shielding to Protect Seabirds	Project-Specific (protected species)	P1/C1 and P2/C2	Costs included in item 5 of Section A											
4	Protection of Wildlife from Potential EMR Impacts	Project-Specific (protected species)	P2/NOC	Costs are included in the day-to-day functions of the PMRF Environmental Department, no additional funding is required.											
5	Native Plant Restoration.	Project-Specific (invasive species)	P3/C0	$0	$40,000	$30,000	$10,000	$10,000	$11,000	$11,000	$12,000	$12,000	$13,000	$149,000	
6	Feral Goat Control.	Project-Specific (invasive species)	P2/C0	$300,000	$8,000	$8,300	$8,700	$9,000	$9,400	$9,700	$10,000	$11,000	$11,000	$385,100	Cost includes fencing, goat removal, and annual structure maintenance
7	Predator Control.	Project-Specific (protected species)	P2/C2	$0	$5,000	$5,200	$5,400	$5,600	$5,800	$6,100	$6,300	$6,600	$6,800	$52,800	Includes costs for labor and materials to remove feral cats to protect nesting nēnē

Table 9-8: INRMP Ten-Year Fiscal Plan (Continued)

Item No.	Recommendation	Management Action	Funding Class	Y1 (2011)	Y2 (2012)	Y3 (2013)	Y4 (2014)	Y5 (2015)	Y6 (2016)	Y7 (2017)	Y8 (2018)	Y9 (2019)	Y10 (2020)	Total	Comments
8	Trial Goat Hunting.	Project-Specific (invasive species); Outdoor Recreation	P3/C3	Funded through Fish and Wildlife Fees											
9	Fauna Surveys Update/Initiate.	Natural Resources Studies	P2/C2	Costs are included in Item 22 of Section A.											
10	Botanical Surveys and Mapping	Natural Resources Studies	P2/C2	Costs are included in Item 23 of Section A.											
11	Integrate Natural Resources Survey Data in GIS Database.	GIS	P2/C2	Costs are included in Item 26 of Section A.											
12	Base Planning.	Land Management	P2/NOC	Costs are included in the day-to-day functions of the PMRF Environmental Department, no additional funding is required.											
13	Landscape Design.	Land Management	P2/NOC	Costs are included in the day-to-day functions of the PMRF Environmental Department, no additional funding is required.											
14	Protection of Natural Resources in Undeveloped Areas.	Land Management	P2/NOC	Costs are included in the day-to-day functions of the PMRF Environmental Department, no additional funding is required.											
15	Soil Erosion Control.	Land Management	P3/C0	$0	$60,000	$12,000	$3,000	$3,100	$3,200	$3,400	$3,500	$3,600	$3,800	$95,600	
16	Wildland Fire Control.	Wildland Fire	P2/NOC	Costs are included in the day-to-day functions of the PMRF Environmental Department, no additional funding is required.											
17	Law Enforcement.	Law Enforcement	P2/NOC	Costs are included in the day-to-day functions of the PMRF Environmental Department, no additional funding is required.											
C. Kōkeʻe Sites															
1	Nocturnal seabird fallout monitoring and management	Project-Specific (protected species)	P1/C1	Costs included in item 4 of Section A											

Table 9-8: INRMP Ten-Year Fiscal Plan (Continued)

Item No.	Recommendation	Management Action	Funding Class	Y1 (2011)	Y2 (2012)	Y3 (2013)	Y4 (2014)	Y5 (2015)	Y6 (2016)	Y7 (2017)	Y8 (2018)	Y9 (2019)	Y10 (2020)	Total	Comments
2	Use of Green Lights and Light Shielding to Protect Seabirds	Project-Specific (protected species)	P1/C1 and P2/C2	Costs included in item 5 of Section A											
3	Protection of Wildlife from Potential EMR Impacts.	Project-Specific (protected species)	P2/NOC	Costs are included in the day-to-day functions of the PMRF Environmental Department, no additional funding is required.											
4	Hawaiian Hoary Bats.	Project-Specific (protected species)	P2/C2	Costs are included in Item 9 of Section A											
5	Hawaiian Picture-Wing Fly.	Project-Specific (protected species)	P1/C1	$13,000	$14,000	$14,000	$15,000	$15,000	$16,000	$16,000	$17,000	$18,000	$19,000	$157,000	
6	Native Plant Habitat Improvement.	Project-Specific (invasive species)	P2/C2	$12,000	$12,000	$13,000	$13,000	$14,000	$15,000	$15,000	$16,000	$16,000	$17,000	$143,000	
7	Melastome Eradication.	Project-Specific (Invasive Species)	P2/C2	Costs are included in Item 6 of Section C											
8	Fauna Surveys Update/Initiate.	Natural Resources Studies	P2/C2	Costs are included in Item 22 of Section A.											
9	Botanical Surveys and Mapping.	Natural Resources Studies	P2/C2	Costs are included in Item 23 of Section A.											
10	Integrate Natural Resources Survey Data in GIS Database.	GIS	P2/C2	Costs are included in Item 26 of Section A											
11	Base Planning.	Land Management	P2/NOC	Costs are included in the day-to-day functions of the PMRF Environmental Department, no additional funding is required.											

Table 9-8: INRMP Ten-Year Fiscal Plan (Continued)

Item No.	Recommendation	Management Action	Funding Class	Y1 (2011)	Y2 (2012)	Y3 (2013)	Y4 (2014)	Y5 (2015)	Y6 (2016)	Y7 (2017)	Y8 (2018)	Y9 (2019)	Y10 (2020)	Total	Comments
12	Landscape Design.	Land Management	P2/NOC	Costs are included in the day-to-day functions of the PMRF Environmental Department, no additional funding is required.											
13	Protection of Natural Resources in Undeveloped Areas.	Land Management	P2/NOC	Costs are included in the day-to-day functions of the PMRF Environmental Department, no additional funding is required.											
14	Wildland Fire Control .	Wildland Fire	P2/NOC	Costs are included in the day-to-day functions of the PMRF Environmental Department, no additional funding is required.											
15	Law Enforcement.	Law Enforcement	P2/NOC	Costs are included in the day-to-day functions of the PMRF Environmental Department, no additional funding is required.											
D. Kamokala Ridge Magazines															
1	Native Plant Habitat Improvement.	Project-Specific (invasive species)	P3/C3	$4,000	$4,200	$4,300	$4,500	$4,700	$4,900	$5,100	$5,300	$5,500	$5,700	$48,200	
2	Fauna Surveys Update/Initiate.	Natural Resources Studies	P2/C2	Costs are included in Item 22 of Section A.											
3	Botanical Surveys and Mapping.	Natural Resources Studies	P2/C2	Costs are included in Item 23 of Section A.											
4	Integrate Natural Resources Survey Data in GIS Database.	GIS	P2/C2	Costs are included in Item 26 of Section A											
5	Base Planning.	Land Management	P2/NOC	Costs are included in the day-to-day functions of the PMRF Environmental Department, no additional funding is required.											
6	Landscape Design.	Land Management	P2/NOC	Costs are included in the day-to-day functions of the PMRF Environmental Department, no additional funding is required.											
7	Protection of Natural Resources in Undeveloped Areas.	Land Management	P2/NOC	Costs are included in the day-to-day functions of the PMRF Environmental Department, no additional funding is required.											
8	Wildland Fire Control.	Wildland Fire	P2/NOC	Costs are included in the day-to-day functions of the PMRF Environmental Department, no additional funding is required.											

Table 9-8: INRMP Ten-Year Fiscal Plan (Continued)

Item No.	Recommendation	Management Action	Funding Class	Y1 (2011)	Y2 (2012)	Y3 (2013)	Y4 (2014)	Y5 (2015)	Y6 (2016)	Y7 (2017)	Y8 (2018)	Y9 (2019)	Y10 (2020)	Total	Comments
9	Law Enforcement.	Law Enforcement	P2/NOC	Costs are included in the day-to-day functions of the PMRF Environmental Department, no additional funding is required.											
E. Ka'ula Island															
1	Hawaiian Monk Seal Protection	Project-Specific (protected species)	P2/NOC	Costs are included in the day-to-day functions of the PMRF Environmental Department, no additional funding is required.											
2	MBTA Compliance.	Project-Specific (protected species)	P2/NOC	Costs are included in the day-to-day functions of the PMRF Environmental Department, no additional funding is required.											
3	Fauna Surveys Update/Initiate.	Natural Resources Studies	P2/C2	Funding is provided by COMPACFLT in support of military training operations											
4	Botanical Surveys and Mapping.	Natural Resources Studies	P3/C3	Costs are included in Item 23 of Section A.											
5	Integrate Natural Resources Survey Data in GIS Database.	GIS	P2/C2	Costs are included in Item 26 of Section A											
F. Mauna Kapu Facility															
1	Fauna Surveys Initiate.	Natural Resources Studies	P2/C2	Costs are included in Item 22 of Section A.											
2	Botanical Surveys and Mapping.	Natural Resources Studies	P2/C2	Costs are included in Item 23 of Section A.											
3	Integrate Natural Resources Survey Data in GIS Database.	GIS	P2/NOC	Costs are included in Item 26 of Section A											
4	Base Planning.	Land Management	P2/NOC	Costs are included in the day-to-day functions of the PMRF Environmental Department, no additional funding is required.											
5	Landscape Design.	Land Management	P2/NOC	Costs are included in the day-to-day functions of the PMRF Environmental Department, no additional funding is required.											

Table 9-8: INRMP Ten-Year Fiscal Plan (Continued)

Item No.	Recommendation	Management Action	Funding Class	Y1 (2011)	Y2 (2012)	Y3 (2013)	Y4 (2014)	Y5 (2015)	Y6 (2016)	Y7 (2017)	Y8 (2018)	Y9 (2019)	Y10 (2020)	Total	Comments
6	Protection of Natural Resources in Undeveloped Areas.	Land Management	P2/NOC	Costs are included in the day-to-day functions of the PMRF Environmental Department, no additional funding is required.											
7	Wildland Fire Control.	Wildland Fire	P2/NOC	Costs are included in the day-to-day functions of the PMRF Environmental Department, no additional funding is required.											
8	Law Enforcement.	Law Enforcement	P2/NOC	Costs are included in the day-to-day functions of the PMRF Environmental Department, no additional funding is required.											

Y – Year; P – Priority; C – Class; NOC – Normal Operating Costs; SOS – Save Our Shearwaters; GIS – Geographic Information System; EMR – Electromagnetic Radiation; MBTA – Migratory Bird Treaty Act; USDA-WS – U.S. Department of Agriculture- Wildlife Services

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CHAPTER TEN: REFERENCES AND RESOURCES

Baker J.D. 2006. The Hawaiian monk seal: abundance estimation, patterns in survival, and habitat issues. PhD Thesis. University of Aberdeen, UK. 182 p.

Baker, J. D. and T. C. Johanos. 2004. *Abundance of the Hawaiian monk seal in the main Hawaiian Islands.* Biological Conservation. 116: 103-110.

Boyd, I.L., P. Stanfield. 1998. Circumstantial evidence for the presence of monk seals in the West Indies. Oryx 32(4): 310-316.

Balazs, G.H. 1979. Bibliography of Kaula Island, Hawaiian Archipelago*. Hawaii Institute of Marine Biology.*

Belt Collins Hawaii 2000. Field Survey Notes. June 2000.

Botanical Consultants. 1985. Flora, Fauna and Water Resources Report of the Pacific Missile Range Facility, Hawaii Area. Kauai, HI.

Bruner, P.L. 2000. Survey of the Avifauna and Feral Mammals for the Integrated Natural Resources Management Plan for Kauai Sites, PMRF.

Carretta, J.V., Forney, K.A., Muto, M.M., Barlow, J., Baker, J., Hanson, B. and M.S. Lowry. 2005. *Draft U.S. Pacific Marine Mammal Stock Assessments: 2005.* NOAA-TM-NMFS-SWFSCTechnical Memorandum. 80 p.

Char, W.P. 2000a. Botanical Surveys: Barking Sands for the Integrated Natural Resources Management Plan (INRMP) Pacific Missile Range Facility (PMRF), Barking Sands, Kauai, Hawaii. June 2000.

_____2000b. Botanical Survey of Makaha Ridge for the Integrated Natural Resources Management Plan (INRMP) Pacific Missile Range Facility (PMRF), Barking Sands, Kauai, Hawaii. June 2000.

_____2000c. Botanical Survey of Kokee Sites for the Integrated Natural Resources Management Plan (INRMP) Pacific Missile Range Facility (PMRF), Barking Sands, Kauai, Hawaii. June 2000.

_____2000d. Botanical Survey of Kamokala for the Integrated Natural Resources Management Plan (INRMP) Pacific Missile Range Facility (PMRF), Barking Sands, Kauai, Hawaii. June 2000.

Chivers S.J., Baird R.W., Martien K.M., Taylor B.L., Archer E., Gorgone A.M, Hancock B.L, Hedrick N.M., Matilla D., McSweeney D.J., Oleson E.M., Palmer C.L., Pease V., Robertwon K.M., Robbins J., Salinas J.C., Schorr G.S., Schultz M., Thieleking J.L., and Webster D.L. 2010. *Evidence of Genetic Differentiation for Hawai'I Insular False Killer Whales*. US Department of Commerce NOAA Technical Memorandum NOAA-TM-NMFS-SWFSC-458, 49 p. May.

Code of Federal Regulations (CFR) 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 Parts 10, 18, 216, 228. *Regulations Concerning Marine Mammals*.

_____Title 50 Part 424.02. Listing Endangered and Threatened Species and Designating Critical Habitat

_____Title Part 40300.600. National Oil and Hazardous Substances Contingency Plan.

Cornell Lab of Ornithology 2008. https://bna.birds.cornell.edu

Department of Defense (DOD) 1996. Directive 4715.3. *Environmental Conservation Program.* May 1996.

DOD, U.S. Fish and Wildlife Service (USFWS), and International Association of Fish and Wildlife Agencies 2006. Memorandum of Understanding (MOU) 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 Resources Management Program on Military Installations. January 2006.

Deputy Under Secretary of Defense (Installations and Environment) 2002. Memorandum: *Implementation of Sikes Act Improvement Act*. 10 October 2002.

Division of Forestry and Wildlife (DOFAW) 2005. *Hawai'i's Comprehensive Wildlife Conservation Strategy.* State of Hawai'i (SOH), Department of Land and Natural Resources (DLNR).

DLNR 1993. June 1-2, 1993. *Kaula Trip Report*. Prepared by Walker, Ronald L.

_____1998. *Kaula Rock Seabird Survey Report-November*. Prepared by Telfer, T.C.

Department of the Navy (DON) 1988. *Natural Resource Management Plan PACMISRANFAC Barking Sands*. Prepared by the Traverse Group.

_____1998. *Pacific Missile Range Facility Enhanced Capability Final Environmental Impact Statement.* Vol. 1-3. Prepared for Commander, Pacific Missile Range Facility, Kekaha, Hawaii.

_____2001. Pacific Missile Range Facility Integrated Natural Resources Management Plan. Prepared by Belt Collins. October 2001.

_____2002. Office of the Chief of Naval Operations Instruction 11010.36B *AICUZ Program Procedures and Guidelines for Department of Navy Air Installations*. 19 December 2002.

_____2005a. Integrated Cultural Resources Management Plan for Pacific Missile Range Facility (PMRF), Island of Kauai, State of Hawaii. Prepared by Naval Facilities Engineering Command Pacific (NAVFAC PAC). April 2005.

_____2005b. *Environmental Requirements Guidebook Updated Fiscal Year 2002* (see http://155.252.252.6/wrs/guidebook/WRSGB_TOC.HTM).

_____2005c. Draft Guidelines for Preparing INRMPs for Navy Installations. 19 July 2005.

_____2005d. Marine Resources Assessment for the Hawaiian Islands Operating Area. December 2005. Prepared by Geo-Marine Inc.

_____2006. *Comprehensive Infrastructure Plan*, Volume 1 of 2, Pacific Missile Range Facility, Barking Sands. Draft June 2006.

_____2007. Office of the Chief of Naval Operations Instruction 5090.1C, *Environmental and Natural Resources Program Manual*. 30 October 2007.

_____2008a. Hawai'i Range Complex Final Environmental Impact Statement/Overseas Environmental Impact Statement. May 2008.

_____2008b. *Hawaii Range Complex Monitoring Plan*. December 2008.

Dollar, S. and R. Brock 2007. Marine and Fishery Resources, An Integrated Natural Resources Management Plan (INRMP) for the Pacific Missile Range Facility (PMRF), Barking Sands, Kauai, Hawaii. June 2007.

_____2000. Marine and Fishery Resources, An Integrated Natural Resources Management Plan (INRMP) for the Pacific Missile Range Facility (PMRF), Barking Sands, Kauai, Hawaii. June 2000.

Executive Order (EO) EO 11990. *Protection of Wetlands.*

_____13089. *Coral Reef Protection*, 11 June 1998.

_____13112. *Invasive Species.*

_____13148, Part 6, Section 601. Greening the Government Through Leadership in Environmental Management. 21 April 2000.

_____13158. *Marine Protected Areas*. 26 May 2000

_____13186. Responsibility of Federal Agencies to Protect Migratory Birds

_____13352. Facilitation of Cooperative Conservation. 26 August 2004

Federal Emergency Management Agency 2005. Flood Insurance Rate Map 150020100.

Hawai'i Administrative Rules Section 11-54-03

Hawa'i Wetland Joint Venture, 2008. *Hawai'i Wetland Monitor*. Volume 2, No. 1. March 2008.

Hebshi, Aaron 2007. Pacific Missile Range Facility Wedge-Tailed Shearwater Population Survey Project Summary. Prepared for NAVFAC Pacific. January 2007.

Hinds, Norman 1930. *The Geology of Kauai and Niihau*. Bernice P. Bishop Museum Bulletin 71.

Hunt, Charles D. Jr. 1996. *Geohydrology of the Island of Oahu, Hawaii*. U.S. Geological Survey (USGS) Pacific Islands Water Science Center

International Fund for Animal Welfare 2007. *Bottle Nose Dolphin*. http://www.ifawa.org/ifawa/general

Juvik, S.P. and J.O. Juvik (Eds.) 1998. *Atlas of Hawaii.* Third Edition. University of Hawai'i Press, Honolulu, Hawai'i.

Kenyon, K. W. 1977. *Caribbean monk seal extinct*. Journal of Mammalogy 58:97-98.

Kenyon, K. W., and D. W. Rice. 1959. *Life history of the Hawaiian monk seal.* Pacific Science 31:215-252.

Mac Donald, Gordon, Dan A. Davis, and Doak C. Cox, 1960. *Geology and Ground-Water Resources of the Island of Kauai, Hawaii.* U.S. Geological Survey 1960.

Mac Donald, Gordon and Agatin T. Abbott, 1977. *Volcanoes in the Sea*. University Press of Hawai'i. Honolulu, Hawai'i 1977.

Marine Conservation Biology Institute 2009. *Hawaiian Monk Seal Facts.*

Mink, John and L. Stephen Lau 1990. *Aquifer Identification and Classification for O'ahu: Groundwater Protection*. Water Resources Research Center, University of Hawai'i. 1990.

_____1992. *Aquifer Identification and Classification for Kaua'i: Groundwater Protection*. Water Resources Research Center, University of Hawai'i. 1992.

NAVFAC PAC 2005 Conservation Mapping

_____2006a. Pacific Missile Range Facility Barking Sands INRMP Botanical Survey. May 2006.

_____2006b. Pacific Missile Range Facility Makaha Ridge INRMP Botanical Survey. May 2006.

_____2006c. Pacific Missile Range Facility Kamokala Ridge Magazine INRMP Botanical Survey. May 2006.

_____. 2006d. Pacific Missile Range Facility Kokee INRMP Botanical Survey. May 2006.

_____2006e. Herpetological and Mammal Surveys at Pacific Missile Range Facility. September 2006.

_____2006f. *PMRF Bird Surveys*. October 2006.

_____2007. NAVFAC PAC Real Estate 2007

_____2008. Wedge-Tailed Shearwater Conservation at Barking Sands, Pacific Missile Range Facility, Kaua'i, Hawai'i. Prepared by Vanessa Pepi. July 2008.

_____2009a. Wedge-Tailed Shearwater Conservation at Barking Sands, Pacific Missile Range Facility, Kaua'i, Hawai'i CY 2008. Prepared by Vanessa Pepi. February 2009.

_____2009b. Barking Sands Pacific Missile Range Facility, Proposed Laysan Albatross Management Plan to Reduce Bird-Aircraft Strike Hazard Potential. Prepared by A.D. Anders, J.R. Burger, and V.E. Pepi. 24 November 2009.

National Oceanic and Atmospheric Administration (NOAA) Fisheries Service (NOAA Fisheries) 2007. *Recovery Plan for the Hawaiian Monk Seal (Monachus schauinslandi)*. August 2007.

NOAA Fisheries 2008. Final Programmatic Biological Opinion on U.S. Navy Activities in the Hawaii Range Complex 2008-2013. December 2008.

NOAA Fisheries 2009a. Final Biological Opinion on 2009 Letter of Authorization for U.S. Navy Activities in the Hawaii Range Complex. January 2009.

NOAA Fisheries 2009b. Department of Commerce, National Oceanic and Atmospheric Administration, National Marine Fisheries Serve, Letter of Authorization. January 2009.

National Tropical Botanical Gardens 2010. http://ntbg.org/resources/databases/php

Poot, Hanneke, Bruno J. Ens, Hand de Vries, Maurice A.H. Donners, Marcel R. Wernard, and Joop M. Marquenie 2008. *Green Light for Nocturnally Migrating Birds*. *Ecology and Society* 13 92): 47. http://www.ecologyandsociety.org/vol13/iss2/art47/

Ragen, T.J., and D.M. Lavigne. 1999. The Hawaiian Monk Seal: Biology of an Endangered Species. *In J. R. Twiss and R. R Reeves (Editors),* Conservation and Management of Marine Mammals*, p. 224-245. Smithsonian Institution Press, Washington, D.C.*

Rice, D.W., 1998. Marine mammals of the world: Systematics and distribution. *Society for Marine Mammalogy Special Publication. 4: 1-231*

Slotterback, John W. 2002. Band-rumped Storm-Petrel (Oceanodroma castro). *The Birds of North America Online (A. Poole Ed.). Ithaca: Cornell Lab of Ornithology; Retreived from Birds of North America Online.* bna.birds.cornell.edu/bna/species/673a/articles/conservation

SWCA Environmental 2009. *Feral Ungulate Management Plan, Makaha Ridge Tracking Station, Pacific Missile Range Facility, Kaua'i, Hawai'i.* Prepared for NAVFACPAC. 2009. Prepared by SWCA Environmental Consultants. December 2009.

State of Hawai‘i Land Use Commission 2005. *Land Use Maps of Hawaii*. luc.state.hi.us/luc_maps.htm

United States Code (U.S.C.) Title 7 Section 136 et seq. (PL 92-516). *Federal Insecticide, Fungicide, and Rodenticide Act of 1947*.

_____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 670. Sikes Act Improvement Amendments

_____Title 16 Parts 703-712 (PL 65-186). *Migratory Bird Treaty Act of 1918*

_____Title 16 Parts 1361-1407 (PL 92-522). *Marine Mammal Protection Act of 1972*

_____Title 16 Part 1451-1464 (PL 92-583). *Coastal Zone Management Act of 1972*

_____Title 16 Part Part1531-1544 (PL 93-205). *Endangered Species Act*

_____Title 16 Part 4701 et seq. (PL 91-190). *National Environmental Policy Act*

_____Title 25 Sections 30011 et seq. (PL 104-332). *Native American Graves and Repatriation Act of 1990*

_____Title 26 Sections 4611-4682 (PL 96-510). Comprehensive Environmental Response Compensation, and Liability Act of 1980

_____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 2701 et seq. (PL 101-380). *Oil Pollution Act of 1990*

_____Title 42 Section 9601 et seq. Comprehensive Environmental Response Compensation, and Liability Act of 1980

U.S. Army Corps of Engineers 1987. *Final Wetlands Delineation Manual.* Wetlands Research Program Technical Report Y-87-1. Prepared by Environmental Laboratory. January 1987.

U.S. Department of Agriculture, 1972. Soil Survey of the Islands of Kauai, Oahu, Maui, Maolokai, and Lanai, State of Hawaii.

U.S. Fish and Wildlife Services, 2003. Endangered and Threatened Wildlife and Plants; Final Designation or Nondesignation of Critical Habitat for 95 Plant Species from the Island of Kauai and Niihau, HI. Federal Register, February 27, 2003, Volume 68, Number 39.

_____2005. *Draft Revised Recovery Plan for Hawaiian Waterbirds*. U.S. Fish and Wildlife Service, Portland, OR.

University of Hawaii at Manoa 2009. Hawaiian Monk Seals at Waikiki Aquarium. http://www.waquarium.org/_library/documents/marine-life-profiles/himonkseal12.08.pdf *Accessed 12 August 2009.*

Western Pacific Regional Fishery Management Council 2001. The Final Fishery Management Plan for Coral Reef Ecosystems (FMPCRE) of the Western Pacific Region . October 2001.

Woods, K, 2006. The Status of Wilkesia hobdyi (Asteraceae) U.S. Navy Pacific Missile Range Facility, Makaha Ridge, Koke'e, Kaua'i, Hawai'i.

Wirtz, W. O. II. 1968. Reproduction, growth and development, and juvenile mortality in the Hawaiian monk seal. *Journal of Mammology 49:229-238.*

Yale 2007. http://earth.geology.yale.edu/

Photo Credits

Photo #	Description	Source
3-1	Barking Sands, Kaua‘i	John Burger
3-2	Hawaiian duck	Richard Palmer/DOFAW 2005
3-3	Hawaiian moorhen	NRCS/DOFAW 2005
3-4	Hawaiian coot	NAVFAC PAC 2006f
3-5	Hawaiian stilt	NAVFAC PAC 2006f
3-6	Hawaiian goose	NAVFAC PAC 2006f
3-7	Newell’s shearwater	Brenda Zaun, USFWS
3-8	Short-tailed albatross	DOFAW 2005/Forest and Kim Starr, USFWS
3-9	Band-rumped storm-petrel	T.Laman/Vireo
3-10	Hawaiian petrel	C. Hodges, National Park Service
3-11	Hawaiian hoary bat	DOFAW 2005/USFWS
3-12	Hawaiian monk seal	NAVFAC PAC
3-13	Humpback whale	USFWS
3-14	False killer whale	Vanessa Pepi 2010
3-15	Green turtle	NAVFAC PAC
3-16	Hawksbill turtle	Johan Chevalier/NOAA Fisheries
3-17	Lau‘ehu	NAVFAC PAC
3-18	‘Ohia (Sesbania tomentosa)	Julie Rivers/COMPACFLT
3-19	Laysan albatross	DOFAW 2005/David Leonard, USFWS
3-20	Black-footed albatross	DOFAW 2005/David Leonard, USFWS
3-21	Brown booby	USFWS
3-22	Wedge-tailed shearwater	DOFAW 2005/Forest and Kim Starr, USFWS
3-23	Black-crowned night heron	Richard Palmer/DOFAW 2005
3-24	Cattle egret	Peter S. Wobar/USGS
3-25	Northern shoveler	D.A. Rintoul/USGS
3-26	Green-winged teal	Paul Conover/USGS
3-27	Pacific golden plover	DOFAW
3-28	Black-bellied plover	Peter S. Weber/USGS
3-29	Wandering tattler	Eric VanderWerf/DOFAW 20005
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3-31	Sanderling	Marcus Martin/USGS
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Photo #	Description	Source
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4-10	A developed portion of Mākaha Ridge Tracking Station before and after the construction of a retaining wall to protect site structures	John Burger 2009
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7-3	Sooty tern	DOFAW 2005/Forest and Kim Starr, USFWS
7-4	White tern	DOFAW 2005/David Leonard, USFWS
7-5	Blue-gray noddy	DOFAW 2005/Fefer, USFWS
7-6	Brown noddy	DOFAW 2005/Forest and Kim Starr, USFWS
7-7	Black noddy	USFWS
7-8	Christmas Island shearwater	DOFAW 2005/Forest and Kim Starr, USFWS
7-9	Bulwer's petrel	Forest and Kim Starr 2008
7-10	Bonin petrel	DOFAW 2005/Rachel Seabury, USFWS
7-11	Red-tailed tropicbird	DOFAW 2005
7-12	Masked booby	DOFAW 2005/Holly Freifeld, USFWS
7-13	Red-footed booby	DOFAW 2005/Jack Jeffrey
7-14	Great frigate bird	David Smith/DOFAW 2005
8-1	Mauna Kapu Facility	NAVFAC PAC 2008

CHAPTER ELEVEN: PREPARERS AND CONTRIBUTORS

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