LIST OF APPENDIXES

M	WAKE ISLAND AIR FIELD SPILL PREVENTION, CONTROL, AND COUNTERMEASURE PLAN
N	STORMWATER POLLUTION PREVENTION PLAN FOR WAKE ISLAND AIR FIELD
O	WAKE ISLAND OPERATING GUIDANCE - ENVIRONMENTAL COMPLIANCE AND PROTECTION OF NATURAL RESOURCES
P	WAKE ISLAND DIVE CLUB CHARTER
Q	KŌKE`E AIR FORCE STATION AND KŌKE`E MICROWAVE ANTENNA STATION DOWNED BIRD LOG
R	UNITED STATES SPECIFIC COMMAND DEFENSE TRANSPORTATION REGULATION PART V – CHAPTER 511
S	CORAL CONSERVATION ACTIONS AT WAKE ATOLL
T	WAKE ATOLL FISH TISSUE SAMPLING AND ANALYSIS THREE YEARS AFTER AN ISLAND WIDE RODENTICIDE APPLICATION

APPENDIX A
REFERENCES CITED IN THE INTEGRATED NATURAL RESOURCES MANAGEMENT PLAN

REFERENCES CITED IN THE INTEGRATED NATURAL RESOURCES MANAGEMENT PLAN

Air Force Deputy Chief of Staff. 2001. *Wake Island Operations*. Memorandum for Service OPSDEPS from Robert H. Foglesong, Lt. Gen., USAF, Deputy Chief of Staff, Air and Space Operations 18 Jun 2001. As referenced in USAF 2008a.

Audubon. 2014. *Red-footed Booby Sula sula*. National Audubon Society, Inc. Available online: http://www.audubon.org/birds/red-footed-booby. Accessed on 30 April 2014.

Bailey, R.G. 1989. *Explanatory Supplement to Ecoregions Map of the Continents*. Environmental Conservation, vol. 16, no. 4, pp 307-309

Bailey, R.G. 1995. *Ecoregions of the Oceans*. United States Department of Agriculture, Forest Service, Washington, D.C. As referenced in USAF 2008a.

Bird Web. 2014. *Pacific Golden Plover Pluvialis fulva.* Bird Web. Seattle Audubon Society. Available online: http://birdweb.org/birdweb/bird/pacific_golden-plover. Accessed on 5 April 2014.

Brainard, R., J. Asher, J. Gove, J. Helyer, J. Kenyon, F. Mancini, J. Miller, S. Myhre, M. Nadon, J. Rooney, R. Schroeder, E. Smith, B. Vargas-Angel, S. Vogt, and P. Vroom. 2008. *Coral reef ecosystem monitoring report for American Samoa: 2000–2006*. Pacific Islands Fisheries Science Center Special Publication, SP-08 002. Honolulu: Pacific Islands Fisheries Science Center.

Brown, D., W. Pitt, and B. Tershy. 2013. *Wake Atoll Rat Eradication Review*. Final Draft, 5 September.

Bruner, P.L. 1990. *Field Survey of the Avifauna and Feral Mammals at Three Sites Located on the Pacific Missile Range Facility at Barking Sands and at Kokee Park Geophysical Observatory, Kauai*. Unpublished. As cited in USAF 2007.

Bruner, P.L. 1992. *Field Survey of the Avifauna and Feral Mammals for a Proposed Mountaintop Sensor Testing and Integration Project Environmental Assessment, Kauai*. Unpublished. As cited in USAF 2007.

Bruner, P.L. 1996. *Wildlife Inventory Report of Hickam Air Force Base and Satellite Installations*. EA, Honolulu, Hawai`i. As cited in USAF 2007.

Bryan, E.H. 1942. *American Polynesia and the Hawai`ian Chain*. Honolulu, Hawai`i. As cited in USAF 2008a.

Bryan, E.H. 1959. *Notes on the Geography and Natural History of Wake Island*. Atoll Research Bulletin No. 66. The Pacific Science Board, National Academy of Sciences, National Research Council, Washington, D.C. As referenced in USAF 2008a.

CH2M HILL. 2010. *Remedial Investigation/Feasibility Study Report for Site OT10 (Peacock Point Burn Area No.1), Wake Island Air Field, Wake Atoll*. Final. April 2010.

Chugach Federal Solutions, Inc. (Chugach). 2011. Wake Island Air Field Activity Standard Operating procedures Invasive Species Prevention and Control. Written for the United States Air Force. August.

Chugach Federal Solutions, Inc. (Chugach). 2013a. *Pest Control and Pesticide/Herbicide Management Plan Wake Island.* 29 August.

Chugach Federal Solutions, Inc. (Chugach). 2013b. *Bird Aircraft Strike Hazard Reduction Plan for Wake Island*. Prepared 20 September.

Chugach Federal Solutions, Inc. (Chugach). 2014. Bird Aircraft Strike Hazard (BASH) Reduction Plan for Wake Island Airfield. Prepared 29 April 2014.

Daniels, D. 2008a. *Sanderling (Calidris alba) at Sunset Beach, North Carolina*. Available online: http://es.wikipedia.org/wiki/Archivo:Sanderling_(Calidris_alba)_RWD1.jpg. Accessed on 8 April 2014.

Daniels, D. 2008b. *Dunlin (Calidris alpina) at Sunset Beach, North Carolina*. Available online: ttp://commons.wikimedia.org/wiki/File:Dunlin_(Calidris_alpina)_RWD.jpg. Accessed on 3 April 2014.

Daniels, D. 2009. *Whimbrel (Numenius phaeopus) at Half Moon Bay, California*. Available online:http://www.bing.com/images/search?q=Numenius+phaeopus&FORM=HDRSC2#a. Accessed on 2 April 2014.

Department of Defense (DOD). 2011. Department of Defense Instruction (DODI) 4715.03, Natural Resources Conservation Program. Department of Defense. United States of America.

Department of Defense (DOD). 2013a. *Integrated Natural Resource Management Plan Implementation Manual*. Number 4715.03. 25 November.

Department of Defense (DOD). 2013b. Defense Transportation Regulation - Part V - Department of Defense Customs and Border Clearance Policies and Procedures, Chapter 511– United States Pacific Command. 24 October.

Department of Defense, U.S. Fish and Wildlife Service, and the Association of Fish and Wildlife Agencies. 2013. Memorandum of Understanding between the U.S. Department

of Defense and the United States Fish and Wildlife Service and the Association of Fish and Wildlife Agencies for a Cooperative Integrated Natural Resource Management Program on Military Lands.

EA Engineering, Science, and Technology, Inc. (EA). 1996. *Resource Inventory Report for Kokee Air Force Station*. EA, Honolulu, Hawai`i. As cited in USAF 2007.

EA Engineering, Science, and Technology, Inc. (EA). 2013a. *Intertidal Benthic Community Structure and Recolonization after Removal of the Peacock Point (Wake Island Air Field) Burn Pile*. Draft Site OT10 Intertidal Survey Report, Wake Island Air Field, Wake Atoll.

engineering-environmental Management, Inc. 2009. *Environmental Assessment Addressing the Systematic Eradication of Rats from Wake Atoll*. Prepared by e²M under the direction of the 15 Air Wing at Hickam Air Force Base and the Air Force Center for Engineering and the Environment.

Fosberg, F.R. 1959. *Vegetation and flora of Wake Island*. Atoll Research Bulletin No. 67. The Pacific Science Board, National Academy of Sciences, National Research Council, Washington, D.C. As referenced in USAF 2008a.

Fosberg, F.R., and M.H. Sachet. 1969. *Wake Island Vegetation and Flora, 1961-1963*. Atoll Research Bulletin No. 123. The Smithsonian Institution, Washington, D.C. As referenced in USAF 2008a.

Fritts, T.A., G.H. Rodda, and M. J. McCoid. Undated. *Lizards of the Marianas. A Checklist and Key to the Amphibians and Reptiles of the Marianas*.

Gagne, W.C., and L.W. Cuddihy. 1990. *Vegetation*. As cited in USAF 2007.

Garg. 2009. *Ruff (Philomachus pugnax) near Hodal, Faridabad, Haryana, India*. Available online: http://en.wikipedia.org/wiki/File:Ruff_(Philomachus_pugnax)_near_Hodal_W_IMG_6534.jpg. Accessed on 1 April 2014.

Gregory, H.E. 1924. Report of the director for 1923. *Bernice P. Bishop Museum Bulletin* 10.

Guest, P. 2005. *Common noddy (Anous stolidus)*. Available online: http://www.bing.com/images/search?q=Anous+stolidus&qpvt=Anous+stolidus&FORM=IGRE#a. Accessed on 1 April 2014.

Gonsalves, M. 2002. Site visit to Kokee AFS by Robert Moyer, scientist (JMWA), personal observation of stable Hawai`ian goose population. June. As cited in USAF 2007.

Harrison, J.J. 2011. *Lesser Sand Plover (Charadrius mongolus), Laem Phak Bia, Ban Laem, Phetchaburi, Thailand*. Available online:

http://en.wikipedia.org/wiki/File:Charadrius_mongolus_-_Laem_Phak_Bia.jpg. Accessed on 4 April 2014.

Hawai`i Audubon Society. 1993. *Hawaii`s Birds*. Fourth edition. Hawai`i Audubon Society, Honolulu, Hawai`i. As cited in USAF 2007.

Hawai`i Department of Land and Natural Resources (DLNR). 1987. Plant *Survey of the Summit Plateau, Mount Kaala Natural Area Reserve*. Natural Area Reserve System Report 1. DLNR, Honolulu, Hawai`i. As cited in USAF 2007.

Hawai`i Department of Land and Natural Resources (DLNR). 1990. *Mount Kaala Natural Area Reserve Management Plan*. Division of Forestry and Wildlife, DLNR, Honolulu, Hawai`i.
As cited in USAF 2007.

Hawai`i Department of Land and Natural Resources (DLNR). 2013. *Comprehensive Wildlife Conservation Strategy*. Hawai`i's CWCS. Available online: http://Hawai`i.gov/dlnr./2013dofaw/cwcs/?searchterm=CWCS. Accessed on 29 November 2013.

Hawai`i Natural Heritage Program (HNHP). 1995. Hawai`i Natural Heritage Program Maps, Keys, Element Occurrence Records, and Maps for Oahu and Kauai Air Force Installations. The Nature Conservancy of Hawai`i. Database search for EA, Honolulu, Hawai`i. As cited in USAF 2007.

Hebshi, A., and T. Patrick. 2007. Wake Island Trip Report and annotated wetland GIS – February 2007.

Hebshi, A., D. Kesler, and C. Zabin. 2011. Project Final Report for Legacy Resource Management Program Project Number: 09-438 Ecological Monitoring on Wake Island Prior to Rat Removal. November.

Hillewaert, H. 2011. *Ruddy turnstone (Arenaria interpres)*. Available online: http://en.wikipedia.org/wiki/File:Arenaria_interpres_(habitus).jpg. Accessed on 1 April 2014.

Hitchcock, L.E. 1996. *Notes: Typhoon report from JTWC at Guam dated 3 OCT 96.* As referenced in USAF 2008a.

International Maritime Organization. 2015. Biofouling. Available online: http://www.imo.org/ourwork/environment/biofouling/Pages/default.aspx. Accessed on 25 February 2015.

International Union for Conservation of Nature. 2015. The IUCN Red List of Threatened Species. Version 2015.1. <http://www.iucnredlist.org>. Downloaded on 01 June 2015.

Kenyon J.C., V. Bonito and C. B. Wilkinson. 2013. *Characterization of Coral Communities at Wake Atoll in the Remote Central Pacific Ocean*. Atoll Research Bulletin No. 600. Smithsonian Institution Scholarly.

Kerr, A.M. 2013. *Illustrated Guide to the Reptiles and Amphibians of the Mariana Islands, Micronesia*. University of Guam Marine Laboratory Technical Report 150. March 2013.

Keystone Center. 1991. Final Consensus Report of the Keystone policy dialogue on biological diversity on federal lands. Keystone, Colorado: The Keystone Center.

Lloyd, J. 2007. *Black Footed Albatross (Phoebastria nigripes)*. Taken on Sand Island, Midway Atoll, February 2007. Available online: http://www.bing.com/images/search?q=Phoebastria+nigripes&FORM=HDRSC2#view=detail&id=4B122BFDB66704A976C33491ED92602E0C11FDC2&selectedIndex=159. Accessed on 8 April 2014.

MacArthur, R.H., and E.O. Wilson. 1967. *The Theory of Island Biogeography*. Princeton University Press, New Jersey. As referenced in USAF 2008a.

Maragos, J. 1979. Personal communication regarding the shallow water coral fauna of Wake Atoll

Maugh J. 2013. *Stump-toad Gecko, Gehyra mutilate*. Available online: http://www.flickr.com/photos/jmaugh/8357503506. Accessed on 31 March 2014.

National Archives and Records Administration. 2011. Electronic Code of Federal Regulations. Available online: http://ecfr.gpoaccess.gov/cgi/t/text/textidx?c=ecfr;rgn=div6; view=text;node=18%3A2.0.2.3.7.2;idno=18; cc=ecfr. Accessed on 10 November 2011.

National Geophysical Data Center – National Oceanic and Atmospheric Administration (NOAA- NGDC). 2010. *Digital Elevation Models of Wake Atoll: Procedures, Data Sources and Analysis.* NOAA Technical Memorandum NESDIS NGDC-32. National Geophysical Data Center Marine Geology and Geophysics Division Boulder, Colorado. July 2010.

National Oceanographic and Atmospheric Administration (NOAA). 2014a. *Is Sea Level Rising?* National Ocean Service. Ocean Facts. Revised: 10 April 2014. Available online: http://oceanservice.noaa.gov/facts/sealevel.html. Accessed on 6 January 2014.

National Oceanographic and Atmospheric Administration (NOAA). 2014b. *Scientists to Monitor Coral Reef Ecosystems Around Wake Atoll, Guam, and the Commonwealth of the Northern Mariana Islands.* NOAA Fisheries. Pacific Islands Fisheries Science Center.

Available online: http://www.pifsc.noaa.gov/cruise/ha1401.php. Accessed on 17 April 2014.

National Oceanographic and Atmospheric Administration (NOAA). 2015. *The Search for Juvenile Bumphead Parrotfish (Bolbometopon muricatum) in the Lagoon at Wake Island*. Administrative Report H-15-02. Prepared by: M. Sundberg, D. Kobayashi, S. Kahng, S. Karl and J. Zamzow. Pacific Islands Fisheries Science Center. February.

Nature Works. 2014. *Whimbrel - Numenius phaeopus*. 2014 New Hampshire Public Television. Available online: http://www.nhptv.org/natureworks/whimbrel.htm. Accessed on 3 April 2014.

Ogden Environmental and Energy Services, Co., Inc. 1999. *Biological Resources Report for Wake Atoll (draft)*. Comprehensive Long-Term Environmental Action Navy (CLEAN) for Pacific Division, Naval Facilities Engineering Command, Pearl Harbor, Hawai`i. As cited in USAF 2008a.

Olson, S. 1996. History and ornithological journals of the *Tanager* expedition of 1923 to the northwestern Hawaiian Islands, Johnston, and Wake Islands. *Atoll Research Bulletin* 433:1-210.

Pacific Islands Conservation Research Association (PICRA). 2008. Work Plan, Monitoring Protocol, and Sampling Designs for Seabird Monitoring, Shorebird Monitoring, Sea Turtle Monitoring, Vegetation Sampling, Arthropod Sampling, and Rodent Population Monitoring on Wake Island. PICRA, Newport, Oregon.

Pacific Islands Conservation Research Association (PICRA). 2009. Data Summary for 2009 Biological Monitoring on Wake Island. Pacific Islands Conservation Research Association, South Beach, Oregon, USA.

Pacific Islands Conservation Research Association (PICRA). 2010. 2010 Data Summary and Report: Biological Monitoring on Wake Island. PICRA, Columbia, Missouri, USA.

Pacific Rim Conservation (PRC). 2009. *Surveys of Endangered Procellariformes and Hawai`ian Hoary Bats at Koke`e AFS/MAS and Recommendations to Minimize Take: Preliminary Trip Report*. Unpublished report prepared for United States Air Force and Air National Guard.

Pacific Rim Conservation (PRC). 2010. *Surveys of Endangered Procellariformes and Hawai`ian Hoary Bats at Koke`e AFS/MAS and Recommendations to Minimize Take: Final Report*. Unpublished report prepared for United States Air Force and Air National Guard.

Pacific Rim Conservation (PRC). 2011. *Wake Island Biological Monitoring*. Final Report March 2011. Prepared for Chugach Support Services Inc. and USAF 611 CES/CEA. March.

Panday, B., C. Choudhury, and K. Shanker. 1998. The Olive Ridley sea turtle (*Lepidochelys olivacea*) in Orissa: an urgent call for an intensive and integrated conservation programme. *Current Science* 75: 1323-1325.

Pratt, H.D., P.L. Bruner, and D.G. Berrett. 1989. *A Field Guide to the Birds of Hawai`i and the Tropical Pacific*. Illustrated by H. Douglas Pratt. Princeton University Press. Fourth printing 1989.

Rauzon, M.J. 2001. *Isles of Refuge: Wildlife and History of the Northeastern Hawai`ian Islands*. University of Hawai`i Press, Honolulu, Hawai`i. As referenced in USAF 2008a.

Rauzon, M.J., and J. Gilardi. 2007. *Project Update: Natural Resource Assessment of Wake Island After Feral Cat Eradication and Super Typhoon Ioke*. Marine Endeavors, 4701 Edgewood Ave., Oakland, California.

Rauzon, M.J., D.P. Boyle, W.T. Everett, and R.B Clapp. 2008. *The Status of the Birds of Wake Atoll*. Atoll Research Bulletin No. 561. Smithsonian Institution, Washington, D.C.

Rauzon, M.J., and J. Gilardi. 2014. *Wake Island Seabird Population Survey.* Final Report 2014.

Rex, K. 2014. Wake Atoll Land Crab Survey Data. Unpublished data.

Rosewater, J. 1965. *The Family Tridacnidae in the Indo-Pacific.* Indo-Pacific Mollusca. 1: 347-393, pls. 263-293.

Sherrod, D.R., J.M. Sinton., S.E. Watkins., and K.M. Brunt. 2007. *Geologic Map of the State of Hawai'i, Sheet 2—Island of Kaua'i.* United States Geological Survey Open-File Report 2007-1089. Version 1.0. Available online: http://pubs.usgs.gov/of/2007/1089/. Accessed on 10 December 2013.

Siers, S.R., Shiels, A.B., Goldade, D.A., Volker, S.F., McAuliffe, T.W., Coad, H.L., and Pitt, W.C. 2015. Wake Atoll fish tissue sampling and analysis three years after an island wide rodenticide application. Final Report QA 2241. USDA, APHIS, WS, NWRC. Hilo, HI. 49 pp. + Appendices.

Space and Missile Defense Command (SMDC). 1999. *Supplemental Environmental Assessment– Wake Island Launch Center*. Final. October.

Spalding, M.D., H.E. Fox, G.R. Allen, N. Davidson, Z.A. Ferdana, M. Finlayson, B.S. Halpern, M.A. Jorge, A. Lombana, S.A. Lourie, K.D. Martin, E. McManus, J. Molnar, C.A. Recchi, and J. Robertson. 2007. Marine ecoregions of the world: a bioregionalization of coastal and shelf areas. *Bioscience* 57(7):573-583. As referenced in USAF 2008a.

Starr, F. and K. Starr. 1999. *Boerhavia repens (with Sterna lunata) on Midway Atoll, Eastern Island*. In Plants of Hawaii. Available online: http://www.bing.com/images/search?q=Onychoprion+lunatus&FORM=HDRSC2#a. Accessed on 2 April 2014.

Teig, D. (Lieutenant Colonel United States Air Force). 2013. *Trip Report – Wake Island.* 29 March.

Telfer, T. 1996. Kauai Wildlife Biologist, Div. Fish and Wildlife. Personal communication. As cited in USAF 2007.

United States Air Force (USAF). 1994a. Air Force Policy Directive (AFPD) 32-70, Environmental Quality. Civil Engineering. 20 July.

United States Air Force (USAF). 1994b. *Environmental Assessment, Transfer and Reuse of Wake Island Air Field.*

United States Air Force (USAF). 2002. *Final Risk Evaluation of Chemical Levels in Fish Tissue Wake Island Air Field, Wake Atoll*. Prepared for: Air Force Center for Environmental Excellence Environmental Restoration Division (AFCEE/ERD), Brooks Air Force Base, Texas and 36 CES/CEVR, Andersen Air Force Base, Guam. Prepared by: URS Group, Inc. 30 September.

United States Air Force (USAF). 2007. *Final Integrated Natural Resources Management Plan 2008 – 2012 Update for Hickam AFB, Oahu – Bellows AFS Oahu – Hickam POL Pipeline, Oahu – Ka`ala AFS, Oahu – Kōke`e AFS, Kauai. Prepared for 15th Airlift Wing, Hickam AFB, Hawai`i*. Prepared by J.M. Waller Associates. December.

United States Air Force (USAF). 2008a. *Integrated Natural Resources Management Plan for Wake Atoll.* Prepared by Argonne National Laboratory for Hickam Air Force Base, 15th Civil Engineering Squadron, Environmental Planning Element. September.

United States Air Force (USAF). 2008b. *Integrated Cultural Resource Management Plan Revision 2, FY08-FY12 for Wake Island Air Field*. February.

United States Air Force (USAF). 2008c. *Integrated Cultural Resource Management Plan Revision 1, FY09-FY13 for Four Air Force Satellite Installations.* 15th Wing, Joint Base Pearl Harbor-Hickam Hawai`i.

United States Air Force (USAF). 2009. *Air Force Instruction 32-1053, Integrated Pest Management Program*. Available online: http://www.e-publishing.af.mil. Accessed on 4 December 2013.

United States Air Force (USAF). 2012a. *Wake Island Lagoon Marine Organism Testing for Brodifacoum*. Memorandum for Record. 611 CES/CEAN. 16 July.

United States Air Force (USAF). 2013. *Trip Report – Wake Island – Biological Assessment*. Memorandum for: 611 CES/CEAN. From: 757AS/DOS. Department of the Air Force, Youngstown Air Reserve Station, Aerial Spray Unit, Vienna, Ohio. June.

United States Air Force (USAF). 2014a. A*ir Force Instruction (AFI) 32-7064, Integrated Natural Resources Management.* Civil Engineering. By order of the Secretary of the Air Force Washington DC. 18 November.

United States Air Force (USAF). 2014b. A*ir Force Instruction 32-7065, Cultural Resources Management Program.* Civil Engineering. By order of the Secretary of the Air Force Washington DC. 19 November.

United States Air Force (USAF). 2014c. *Air Force Instruction 32-1053, Integrated Pest Management Program*. 20 November 2014. Available online: http://www.e-publishing.af.mil. Accessed on 12 June 2015.

United States Air Force (USAF). 2015. *Wake Island Air Field Spill Prevention, Control, and Countermeasure (SPCC) Plan.* Prepared by Weston Solutions, Inc. August.

United States Air Force (USAF). 2016. *Stormwater Pollution Prevention Plan for Wake Island Air Field.* January. Prepared by Chugach Federal Solutions, Inc.

United States Census Bureau. 2010. *2010 American Fact Finder Community Facts for Makaha, Maili, Waialua, and Waianae*. Available online: http://factfinder2.census.gov/faces/nav/jsf/pages/index.xhtml###. Accessed on 2 December 2013.

United States Census Bureau. 2013a. *2012 State and County Quick Facts, Kauai County*. Available online: http://quickfacts.census.gov/qfd/states/15/15007.html. Accessed on 2 December 2013.

United States Census Bureau. 2013b. *2012 American Community Survey, Kauai County*. Available online: http://factfinder2.census.gov/faces/tableservices/jsf/pages/productview.xhtml?pid=ACS_12_1YR_DP03&prodType=table. Accessed on 2 December 2013.

United States Department of Agriculture (USDA)-Natural Resources Conservation Service (NRCS). 2013. *Official Soil Series Descriptions*. Available Online: http://www.nrcs.usda.gov/wps/portal/nrcs/detail/soils/survey/class/?cid=nrcs142p2_053587. Accessed on 10 December 2013.

United States Department of the Interior (DOI). 1999. *Terrestrial Resources Survey, Wake Atoll, Mid-Pacific Ocean, June 18-29, 1998*. Report prepared for the Department of the Army, U.S. Space and Missile Defense Command SMDC-EN-V, Huntsville, Alabama.

Prepared by Chip Demarest, U.S. Department of the Interior, Office of Environmental Policy and Compliance, San Francisco, California. As cited in USAF 2008a.

United States Department of the Interior (DOI). 2014. Wake Atoll. DOI Office of Insular Affairs. Available online: http://www.doi.gov/oia/islands/wakeatoll.cfm. Accessed on 8 April 2014.

United States Fish and Wildlife Service (USFWS). 2008. *Birds of Conservation Concern*. United States Fish and Wildlife Service, Division of Migratory Bird Management, Arlington, Virginia. December.

United States Fish and Wildlife Service (USFWS). 1999. South Florida multi-species recovery plan. Atlanta, Georgia. 2172 pp.

United States Fish and Wildlife Service (USFWS). 2012. *Wake Atoll Rat Eradication Shorebird Survey*. Report prepared by Beth Flint.

United States Fish and Wildlife Service (USFWS). 2013a. *Wandering tattler (Heteroscelus incanus)*. Palmyra Atoll. National Wildlife Refuge US Minor Outlying Isles. Available Online: http://www.fws.gov/refuge/Palmyra_Atoll/wildlife_and_habitat/Wandering_Tattler.html. Accessed on 5 April 2014.

United States Fish and Wildlife Service (USFWS) and National Marine Fisheries Service (NMFS). 1999. Baseline Marine Biological Survey Peacock Point and Other Point-source Discharges Wake Atoll, Pacific Ocean.

United States Fish and Wildlife Service (USFWS). 2017a. *Biological Opinion and Informal Consultation of the U.S. Fish and Wildlife Service for the Proposed Continuing Operations at Kokee Air Force Station and Microwave Antenna Site, Island of Kauai.* Prepared by Pacific Islands Fish and Wildlife Office, Honolulu, HI. February.

United States Fish and Wildlife Service (USFWS). 2017b. *Draft Report, Phase I Marine Benthic Habitat Characterization, Wake Atoll Coral Reef Ecosystem Survey.* Prepared by Kevin Foster, Anthony Montgomery, Adam Griesemer, and Douglas Fenner. April.

Wagner, W. L., D. R. Herbst, and S.H. Sohmer. 1990. Manual of the Flowering Plants of Hawai`i. Volumes 1 and ll. University of Hawai`i Press, Bishop Museum Press, Honolulu, Hawai`i. As cited in USAF 2007.

Wagner et al. 1990. Hawaiian Vascular Plants at Risk: 1999. Bishop Museum Occasional Papers. Number 60, 58 pp. 15 September 1999.

Weatherbase. 2015. Weatherbase – Peacock Point, Wake Island – Monthly Weather Averages Summary. Available Online: http://www.weatherbase.com/weather/weather.php3?s=912450

Wiles, G., J. Bart, R.E. Beck, Jr., and C.F. Aguon. 2003. Impacts of the brown tree snake: patterns of decline and species persistence in Guam's avifauna. *Conservation Biology* 17:1350–1360.

THIS PAGE INTENTIONALLY LEFT BLANK

APPENDIX B
LIST OF ACRONYMS AND ABBREVIATIONS

LIST OF ACRONYMS AND ABBREVIATIONS

°C	Degree Centigrade
°F	Degree Fahrenheit
AF	Air Force
AFCEC	Air Force Civil Engineer Center
AFI	Air Force Instruction
AFPD	Air Force Policy Directive
AFS	Air Force Station
AG	Agricultural Outleasing
amsl	Above mean sea level
BASH	Bird Aircraft Strike Hazard
BCC	Bird of Conservation Concern
BH	Bird Aircraft Strike Hazard
BMDS	Ballistic Missile Defense System
BMP	Best Management Practice
BOS	Base Operation Support
CC	Climate change or Commander
CES	Civil Engineer Squadron
CEIE	Civil Engineer Squadron Environmental Element
CFPE	Facility and Engineering Directorate Pacific Environmental
CFR	Code of Federal Regulations
Chugach	Chugach Federal Solutions, Inc.
CLE	Conservation Law Enforcement
CNMI	Commonwealth of the Northern Mariana Islands
CRP	Cultural Resources Protection
CWA	Clean Water Act
CWCS	Comprehensive Wildlife Conservation Strategy
CZ	Coastal Zone and Marine Resources Management
Det 1	Detachment 1
DLNR	Department of Land and Natural Resources
DOD	Department of Defense
DODI	Department of Defense Instruction
DOI	Department of the Interior
EA	EA Engineering, Science, and Technology, Inc.
EO	Executive Order
EPC/ESHC	Environmental Protection Committee/Environmental, Safety, Occupational Health Committee
ERP	Environmental Restoration Program
ESA	Endangered Species Act

FAA	Federal Aviation Administration
FE	Federally endangered
FM	Forest Management
ft	Foot (feet)
FWM	Fish and Wildlife Resources Management
FY	Fiscal Year
GIS	Geographic Information System
GM	Grounds Maintenance
HACCP	Hazard Analysis and Critical Control Point
HIANG	Hawai`i Air National Guard
HIRAOC	Hawai`i Regional Air Operations Center
HIROCC	Hawai`i Regional Operations Control Center
HMU	Habitat Management Unit
HNHP	Hawai`i Natural Heritage Program
ICRMP	Integrated Cultural Resources Management Plan
in.	Inch(es)
INRMP	Integrated Natural Resources Management Plan
IPM	Integrated Pest Management
IRP	Installation Restoration Program
IUCN	International Union for Conservation of Nature
MAJCOM	Major Command
MAS	Microwave Antenna Station
MBTA	Migratory Bird Treaty Act of 1916
MDA	Missile Defense Agency
MSA	Magnuson-Stevens Fishery Conservation and Management Act
Mt.	Mount
NA	Not applicable
NAR	Natural Area Reserve
NGDC	National Geophysical Data Center
NHPA	National Historic Preservation Act
NMFS	National Marine Fisheries Service
NOAA	National Oceanic and Atmospheric Administration
NPDES	National Pollutant Discharge Elimination System
NRCS	Natural Resources Conservation Service
NRP	Natural Resources Program Management
NT	Near Threatened
OR	Outdoor Recreation and Public Access to Natural Resources
PACAF	Pacific Air Force
PATRIOT	Phased Array Tracking Radar to Intercept of Target
PCB	Polychlorinated biphenyl

PICRA	Pacific Islands Conservation Research Association
PIFCS	Pacific Islands Fisheries Science Center
PM	Program Manager
PO	Public Outreach
POL	Petroleum, Oil, and Lubricant
ppm	Part(s) per million
PRC	Pacific Rim Conservation
PRIMNM	Pacific Remote Islands Marine National Monument
PRSC	Pacific Air Force Regional Support Center
RCRA	Resource Conservation and Recovery Act
SAIA	Sikes Act Improvement Act Amendment of 1997
SCUBA	Self-contained underwater breathing apparatus
SMDC	U.S. Army Space and Missile Defense Command
SOC	Species of Concern
SPCC	Spill Prevention, Control, and Countermeasures
ST	Standard Title
SWPPP	Stormwater Pollution Prevention Plan
TBD	To Be Determined
TE	Threatened and Endangered Species and Habitats Management
THAAD	Terminal High Altitude Area Defense
USACE	United States Army Corps of Engineers
USAF	United States Air Force
U.S.C.	United States Code
USCG	United States Coast Guard
USDA	United States Department of Agriculture
USEPA	United States Environmental Protection Agency
USFWS	United States Fish and Wildlife Service
USGS	United States Geological Survey
VU	Vulnerable
WFM	Wildland Fire Management
WGS	World Geodetic System
WIA	Wake Island Air Field
WP	Wetland Protection and Management
WRP	Water Resources Protection

THIS PAGE INTENTIONALLY LEFT BLANK

APPENDIX C
ANNOTATED SUMMARY OF KEY LEGISLATION

ANNOTATED SUMMARY OF KEY LEGISLATION RELATED TO THE DESIGN AND IMPLEMENTATION OF THE INTEGRATED NATURAL RESOURCES MANAGEMENT PLAN

Federal Public Laws and Executive Orders	
National Defense Authorization Act of 1989, Public Law (P.L.) 101- 189; Volunteer Partnership Cost-Share Program	Amends two acts and establishes volunteer and partnership programs for natural and cultural resources management on Department of Defense (DOD) lands.
Defense Appropriations Act of 1991, P.L. 101-511; Legacy Resource Management Program	Establishes a program for the stewardship of biological, geophysical, cultural, and historic resources on DOD lands.
Executive Order (EO) 11988, Floodplain Management	Provides direction regarding actions of federal agencies in floodplains, and requires permits from state and federal review agencies for any construction within a 100-year floodplain.
EO 11990, Protection of Wetlands	Requires federal agencies to avoid undertaking or providing assistance for new construction in wetlands unless there is no practicable alternative, and all practicable measures to minimize harm to wetlands has been implemented.
EO 11514, Protection and Enhancement of Environmental Quality	Federal agencies shall initiate measures needed to direct their policies, plans, and programs to meet national environmental goals. They shall monitor, evaluate, and control agency activities to protect and enhance the quality of the environment.
EO 11593, Protection and Enhancement of the Cultural Environment	All federal agencies are required to locate, identify, and record all cultural resources. Cultural resources include sites of archaeological, historical, or architectural significance.
EO 13186, Responsibilities of Federal Agencies to Protect Migratory Birds	The United States Fish and Wildlife Service (USFWS) has the responsibility to administer, oversee, and enforce the conservation provisions of the Migratory Bird Treaty Act (MBTA), which includes responsibility for population management (e.g., monitoring), habitat protection (e.g., acquisition, enhancement, and modification), international coordination, and regulations development and enforcement.
EO 11987, Exotic Organisms	Agencies shall restrict the introduction of exotic species into the natural ecosystems on lands and waters that they administer.
EO 12088, Federal Compliance with Pollution Control Standards	Delegates responsibility to the head of each executive agency for ensuring that all necessary actions are taken for the prevention, control, and abatement of environmental pollution. This order gives the United States Environmental Protection Agency (USEPA) authority to conduct reviews and inspections to monitor federal facility compliance with pollution control standards.
EO 12898, Environmental Justice	Requires certain federal agencies, including the DOD, to the greatest extent practicable permitted by law, to make environmental justice part of their missions by identifying and addressing disproportionately high and adverse health or environmental effects on minority and low-income populations.
EO 13112, Exotic and Invasive Species	Prevents the introduction of invasive species and provide for their control and to minimize the economic, ecological, and human health impacts that invasive species cause.
EO 13186, Responsibilities of Federal Agencies to Protect Migratory Birds	Directs executive departments and agencies to take certain actions to further implement the MBTA.

EO 13352, Facilitation of Cooperative Conservation	Ensures that the Departments of the Interior, Agriculture, Commerce, Defense, and USEPA implement laws relating to the environment and natural resources in a manner that promotes cooperative conservation, with an emphasis on appropriate inclusion of local participation in federal decision-making, in accordance with their respective agency missions, policies, and regulations.
EO 13045, Protection of Children from Environmental Health and Safety Risks	Makes it a high priority to identify and assess environmental health and safety risks that could disproportionately affect children. It also directs agencies to ensure that policies, programs, activities, and standards address such risks if identified.
EO 13443, Facilitation of Hunting Heritage and Wildlife Conservation	Directs federal agencies that have programs and activities that have a measurable effect on public land management, outdoor recreation, and wildlife management, including the Department of the Interior and the United States Department of Agriculture (USDA) to facilitate the expansion and enhancement of hunting opportunities and the management of game species and their habitat.
United States Codes	
National Environmental Policy Act of 1969 (NEPA), as amended; P.L. 91-190, 42 United States Code (U.S.C.) 4321 et seq.	Requires federal agencies to utilize a systematic approach when assessing environmental impacts of government activities. Establishes the use of environmental impact statements. NEPA proposes an interdisciplinary approach in a decision-making process designed to identify unacceptable or unnecessary impacts on the environment.
Council on Environmental Quality Regulations for Implementing NEPA; 40 CFR Parts 1500–1508	Provides regulations applicable to and binding on all federal agencies for implementing the procedural provisions of NEPA, as amended.
Conservation Programs on Military Installations (Sikes Act), as amended; P.L. 86-797, 16 U.S.C. 670(a) et seq.	Requires federal military installations with adequate wildlife habitat to implement cooperative agreements with other agencies and develop long-range Integrated Natural Resources Management Programs. Thereby, it is appropriate to manage natural resources for multipurpose uses and provide the public access to those uses to the extent consistent with the military mission. The Act also sets guidelines for the collection of fees for the use of natural resources such as hunting and fishing.
Leases: Non-Excess Property of Military Departments, 10 U.S.C. 2667, as amended	Authorizes DOD to lease to commercial enterprises federal land that is not currently needed for public use. Covers agricultural outleasing program.
Federal Land Use Policy and Management Act, 43 U.S.C. 1701–1782	Requires management of public lands to protect the quality of scientific, scenic, historical, ecological, environmental, and archaeological resources and values; and to preserve and protect certain lands in their natural condition for fish and wildlife habitat. This Act also requires consideration of commodity production such as timbering.
Clean Air Act, 42 U.S.C. 7401–7671q, 14 July 1955, as amended	As amended, is known as the Clean Air Act of 1970. The amendments made in 1970 established the core of the clean air program. The primary objective is to establish federal standards for air pollutants. It is designed to improve air quality in areas of the country that does not meet federal standards and to prevent significant deterioration in areas where air quality exceeds those standards.
Federal Water Pollution Control Act (Clean Water Act [CWA]), 33 U.S.C. 1251–1387	Is a comprehensive statute aimed at restoring and maintaining the chemical, physical, and biological integrity of the nation's waters. Primary authority for the implementation and enforcement rests with USEPA.
Migratory Bird Treaty Act 16 U.S.C. 703–712	The MBTA implements various treaties for the protection of migratory birds. Under the Act, taking, killing, or possessing migratory birds is unlawful without a valid permit.

Endangered Species Act (ESA) of 1973, as amended; P.L. 93-205, 16 U.S.C. 1531 et seq.	Protects threatened, endangered, and candidate species of fish, wildlife, and plants and their designated critical habitats. Under this law, no federal action is allowed to jeopardize the continued existence of an endangered or threatened species. The ESA also requires consultation with the USFWS and the National Marine Fisheries Service and the preparation of a biological assessment when such species are present in an area that is affected by government activities.
National Historic Preservation Act, 16 U.S.C. 470 et seq.	Requires federal agencies to take account of the effect of any federally assisted undertaking or licensing on any district, site, building, structure, or object that is included in or eligible for inclusion in the National Register of Historic Places (NRHP). Provides for the nomination, identification (through listing on the NRHP), and protection of historical and cultural properties of significance.
Federal Noxious Weed Act of 1974, 7 U.S.C. 2801-2814	Provides for the control and management of no indigenous weeds that injure or have the potential to injure the interests of agriculture and commerce, wildlife resources, or the public health.
Sale of certain interests in land, 10 U.S.C. 2665	Authorizes sale of forest products and reimbursement of the costs of management of forest resources.
32 CFR Part 989, as amended, Environmental Impact Analysis Process	Provides guidance and responsibilities in the Environmental Impact Analysis Process for implementing INRMPs. Implementation of an INRMP constitutes a major federal action and therefore is subject to evaluation through an environmental assessment or an environmental impact statement.
DOD Policy, Directives, and Instructions	
DOD Directive 4715.1, Environmental Security	Establishes policy for protecting, preserving, and (when required) restoring and enhancing the quality of the environment. This directive also ensures that environmental factors are integrated into DOD decision-making processes that could impact the environment, and are given appropriate consideration along with other relevant factors.
DOD Instruction (DODI) 4715.3, Environmental Conservation Program	Implements policy, assigns responsibility, and prescribes procedures under DOD Directive 4715.1 for the integrated management of natural and cultural resources on property under DOD control.
United States Air Force (USAF) Instructions and Directives	
Air Force Instruction (AFI) 32-7064, Integrated Natural Resources Management	Implements Air Force Policy Directive (AFPD) 32-70, Environmental Quality; DODI 4715.3, Environmental Conservation Program; and DODI 7310.5, Accounting for Sale of Forest Products. It explains how to manage natural resources on USAF property in compliance with federal, state, and local standards.
Policy Memo for Implementation of Sikes Act Improvement Amendments, HQ USAF Environmental Office (USAF/ILEV) on 29 January 1999	Outlines the USAF's interpretation and explanation of the Sikes Act and Improvement Act of 1997.
AFPD 32-70, Environmental Quality	Outlines USAF mission to achieve and maintain environmental quality on all USAF lands by cleaning up environmental damage resulting from past activities, meeting all environmental standards applicable to present operations, planning its future activities to minimize environmental impacts, managing responsibly the irreplaceable natural and cultural resources that it holds in public trust, and eliminating pollution from its activities wherever possible. AFPD 32-70 also establishes policies to carry out these objectives.
AFI 32-7062, USAF Comprehensive Planning	Provides guidance and responsibilities related to the USAF comprehensive planning process on all USAF-controlled lands.
AFI 32-7065, Cultural Resources Management	Implements AFPD 32-70 and DOD Directive 4710.1, Archaeological and Historic Resources Management. It explains how to manage cultural resources on USAF property in compliance with federal, state, and local standards.

THIS PAGE INTENTIONALLY LEFT BLANK

APPENDIX D

MEMORANDUM OF AGREEMENT BETWEEN THE DEPARTMENT OF THE AIR FORCE AND THE UNITED STATES DEPARTMENT OF THE INTERIOR CONCERNING THE CIVIL ADMINISTRATION OF WAKE ISLAND

AGREEMENT BETWEEN THE DEPARTMENT OF THE AIR FORCE
AND THE UNITED STATES DEPARTMENT OF THE INTERIOR
CONCERNING THE CIVIL ADMINISTRATION OF WAKE ISLAND

This Agreement is entered into by and between the United States Department of the Interior (hereafter Interior), and the Department of the Air Force (hereafter Air Force), pursuant to authority contained in Executive Order No. 11048, September 4, 1962.

WHEREAS the Secretary of the Interior is vested with executive and legislative authority necessary for the civil administration of Wake Island and all judicial authority respecting that Island other than that contained in the Act of June 15, 1950 (64 Stat. 217), as amended, and

WHEREAS the Air Force has primary use, jurisdiction, control, and responsibility and interest in the facilities on Wake Island;

NOW, THEREFORE, in consideration of the above, Interior and Air Force hereby covenant and agree as follows:

(a) Exercise of Authority. All executive, legislative and judicial authority for the civil administration of Wake Island, now or hereafter vested by law in the Secretary of the Interior, shall be exercised by such person or persons (which shall include a position or positions) as may be designated by the Secretary of the Air Force.

(b) Rules and Regulations. All authority invested by law in Interior to make necessary rules and regulations for the orderly maintenance and the civil administration of Wake Island shall be exercised by the person or persons designated pursuant to paragraph (a).

(c) Reports. The Air Force shall submit annual reports to Interior outlining the rules and regulations adopted pursuant to this Agreement and covering administrative action with respect to such rules and regulations.

(d) Funding. The Air Force assumes responsibility for the administration of Wake Island and assumes the necessary funding obligations for such purposes, subject to arrangements it may make with Department of Transportation or other Government agencies. It is further agreed that the administration of and operation on Wake Island shall be without expense to Interior, except that expenses incurred by Interior in discharging functions not delegated pursuant

(e) Facilities. The Air Force has exclusive responsibility for all matters relating to the operation, maintenance, improvement, and administration over all facilities, structures and equipment on Wake Island, which are or may hereafter become the property of Air Force. It is hereby agreed that Interior will take no action that may be in derogation of this authority, and no action or directive of Interior will be construed to be in derogation of this authority.

(f) Support. Interior will provide such assistance to Air Force as may be mutually agreed upon in the future.

(g) Law Enforcement. Interior and Air Force shall cooperate to obtain the appointment of persons to such positions as United States Magistrate and Deputy United States Marshal, and to other positions as may be necessary at Wake Island not within the appointing authority of Interior or Air Force.

(h) Duration. This Agreement shall become effective June 24, 1972, and shall continue in force until terminated by mutual agreement. This Agreement may be renewed or modified thereafter, as Interior and Air Force may mutually agree.

Rogers C B Morton JUN 13 1972

Secretary of the Interior Date

(E) Sec Seamans June 1972

Secretary of the Air Force Date

APPENDIX E
VEGETATION AND WILDLIFE SPECIES LISTS

Table E-1. Vegetation Species Found on Wake Atoll

Scientific Name	**Common Name**
Abutilon albescens	Sweet monkeybush
Abutilon asiaticum var. albescens	Indian mallow
Agave americana	American century plant
Agave angustifolia	century plant
Agave sisalana	Sisal
Agave sp.	agave sp.
Aglaonema commutatum	Aglaonema
Allium cepa	Onion
Allium fistulosum	Green onion
Allium sp.	Onion sp.
Allium tuberosum	Chinese chive
Aloe vera	Aloe
Alpinia galanga	Greater galangal
Alpinia purpurata	Pink ginger; Jungle Queen
Amaranthus dubius	Spleen amaranth
Amaranthus graecizans	Tumbleweed
Amaranthus tricolor	Joseph′s coat
Amaranthus viridis	Slender amaranth
Ananas comosus	Pineapple
Anethum graveolens	Dill
Annona muricata	Soursop
Annona squamosa	Sweetsop
Apium petroselinum	Garden parsley
Araucaria heterophylla	Norfolk Island pine
Asparagus densiflorus	Sprenger asparagus fern
Asplenium nidus	Bird’s-nest fern
Barringtonia asiatica	Fish poison tree
Bauhinia sp.	Camel’s foot tree
Bidens alba	white beggar-ticks
Bidens pilosa var. minor	Beggar-ticks
Boerhavia albiflora var. powelliae	--
Boerhavia diffusa	Red Spiderling
Boerhavia repens	anena
Boerhavia sp.	Spiderling sp.
Bothriochloa pertusa	Indian blue grass
Bougainvillea spectabilis	bougainvillea
Brassica nigra	Mustard
Brassica oleracea var. italica	Brocolli
Caesalpinia bonduc	Grey nickers
Caladium bicolor	Caladium
Calotropis gigantea	Crown flower
Capsicum frutescens	Cayenne pepper
Capsicum annuum	chili pepper

Table E-1. Vegetation Species Found on Wake Atoll

Scientific Name	**Common Name**
Carica papaya	Papaya
Casuarina equisetifolia	Casuarina
Catharanthus roseus	periwinkle
Cenchrus brownii	Brown's sandbur
Cenchrus echinatus	Sandbur
Chamaesyce hirta	hairy spurge
Chamaesyce hypericifolia	Graceful spurge
Chamaesyce prostrata	Prostrate spurge
Chamaesyce thymifolia	Gulf sandmat
Chloris barbata	swollen fingergrass
Chlorophytum comosum	Spider plant
Chrysophyllum cainito	Star apple
Citrus hystrix	Kaffir lime
Citrus sp.	Citrus
Cleome gynandra	wild spider flower
Coccinia grandis	Ivy gourd
Coccoloba uvifera	Sea grapes
Cocos nucifera	coconut palm
Codiaeum variegatum	Croton
Coleus scutellarioides	Common coleus
Colocasia esculenta	Taro
Conyza bonariensis	Hairy horseweed
Conyza canadensis var. pusilla	Canada horseweed
Cordia subcordata	Cordia
Cordyline fruticosa	Ti
Cordyline terminalis	Coco yam
Coriandrum sativum	Chinese parsley
Corymbia citriodora	Lemon-scented gum
Crassula ovata	Jade plant
Crinum amabile	Sumatran giant-lily
Crinum angustum	Queen Emma-lily
Crinum sp.	Lily sp.
Crinum asiaticum	Giant lily
Cucumis melo	Cantaloupe
Cucumis sativus	Cucumber
Cucurbita pepo	Squash
Cuscuta pentagona	Fiveangled dodder
Cymbopogon citratus	lemon grass
Cynodon dactylon	Bermuda grass
Cyperus pumilus	Low flatsedge
Cyperus rotundus	nutgrass
Cyperus involucratus	Umbrella plant
Dactyloctenium aegyptium	crowfoot grass

Table E-1. Vegetation Species Found on Wake Atoll

Scientific Name	**Common Name**
Delonix regia	royal poinciana
Desmanthus pernambucanus	slender mimosa
Dieffenbachia seguine	Dumb cane
Digitaria ciliaris	Henry's crabgrass
Digitaria gaudichaudii	--
Digitaria insularis	Sourgrass
Digitaria setigera	Itchy crabgrass
Digitaria sp.	crabgrass species
Digitaria bicornis	Asian crabgrass
Dracaena marginata	Money tree
Eichhornia crassipes	Water hyacinth
Eleusine indica	goosegrass
Epipremnum pinnatum	Taro vine
Eragrostis amabilis	Japanese love grass
Eragrostis minor	little lovegrass
Eragrostis scabriflora	Fijian lovegrass
Eryngium foetidum	False Chinese parsley
Erythrina variegata var. orientalis	Indian coral tree
Euphorbia cyathophora	wild poinsettia
Euphorbia lactea	Mottled candlestick tree
Euphorbia milii	Crown of thorns
Euphorbia pulcherrima	Poinsettia
Euphorbia tirucalli	Pencil tree
Eustachys petraea	Pinewoods fingergrass
Ficus carica	Edible fig
Ficus microcarpa	Chinese banyan
Ficus rubiginosa	Port Jackson fig
Ficus sp	fig sp.
Fimbristylis cymosa	button sedge
Fimbristylis dichotoma	Forked fimbry
Gardenia taitensis	Tahitian gardenia
Gomphrena globosa	Globe amaranth
Gossypium hirsutum	Cotton
Gossypium hirsutum	upland cotton
Hedychium coronarium	White ginger
Helianthus annuus	Common sunflower
Heliotropium anomalum	Hinahina
Heliotropium procumbens var. depressum	four-spike heliotrope
Hibiscus sp	hibiscus sp..
Hibiscus tiliaceus	Hau
Hymenocallis littoralis	Beach spider lily
Hymenocallis pedalis	Spider lily

Table E-1. Vegetation Species Found on Wake Atoll

Scientific Name	**Common Name**
Ipomoea aquatica	Swamp morning-glory
Ipomoea batatas	Sweet potato
Ipomoea pes-caprae spp. brasiliensis	beach morning glory
Ipomoea tuba	moon flower
Ipomoea violacea	beach moonflower
Ixora sp.	Ixora
Jasminum sambac	Arabian jasmine
Jatropha integerrima	Rose-flowered Jatropha
Kalanchoe pinnata	Cathedral bells
Kalanchoe daigremontiana	Kalanchoe
Kalanchoe delagoensis	Chandelier plant
Kalanchoe pinnata	Air plant
Lactuca sativa	Lettuce
Lepidium bidentatum	Kunana pepperwort
Lepturus gasparricensis	--
Lepturus repens	Pacific Island thintail
Leucaena leucocephala	Tangantangan
Lobularia maritima	Sweet alyssum
Mangifera indica	Mango
Manilkara zapota	Chicle
Momordica charantia	bitter melon
Morella faya	Fire tree
Morinda citrifolia	Indian mulberry
Moringa oleifera	Horseradish tree
Musa acuminata	Banana
Nerium oleander	Oleander
Nicotiana tabacum	Tobacco
Nidularium sp.	Nest bromeliad
Noronhia emarginata	Madagascar olive
Nymphaea sp.	Waterlily
Ocimum basilicum	sweet basil
Ocimum tenuiflorum	holy basil
Opuntia littoralis	coastal pricklypear
Opuntia cochenillifera	Cochineal nopal cactus
Pandanus tectorius	Screwpine
Pandanus tectorius - variegated form	Variegated screwpine
Paspalum setaceum	thin pasplum
Paspalum vaginatum	seashore pasplum
Paspalum scrobiculatum	Knotgrass
Passiflora foetida var. hispida	Passion fruit
Passiflora sp.	Passion fruit
Pedilanthus bracteatus	Candelilla Slipper
Pedilanthus tithymaloides	Redbird flower

Table E-1. Vegetation Species Found on Wake Atoll

Scientific Name	**Common Name**
Pemphis acidula	Pemphis
Pennisetum polystachion	Feathery pennisetum
Petroselinum crispum	Parsley
Phaseolus coccineus	Scarlet runner bean
Phaseolus lunatus	Lima bean
Phaseolus vulgaris	String bean
Philodendron undulatum	Philodendron
Philodendron hederaceum var. oxycardium	Philodendron
Phoenix sp.	Date palm
Phyllanthus acidus	Otaheite gooseberry
Phyllanthus amarus	carry me seed
Phymatosorus scolopendria	Laua'e fern
Pilea microphylla	Artillery plant
Piper lolot	Lolot
Pisonia grandis	Pisonia
Pithecellobium dulce	Manila tamarind
Pluchea carolinensis	Sour bush
Pluchea odorata	Sweetscent
Plumeria obtusa	Singapore Plumeria
Plumeria rubra	Red Plumeria
Plumeria sp.	plumeria sp.
Polyscias fruticosa	Ming aralia, Elegans
Polyscias guilfoylei	Wild coffee
Polyscias scutellaria	Balfour aralia, Balfourniana
Portulaca australis	Purslane
Portulaca cv.	Wildfire
Portulaca lutea	yellow purslane
Portulaca oleracea	Common purslane
Portulaca pilosa	Akulikuli
Portulaca samoensis	--
Portulaca sp	purslane sp.
Pseuderanthemum carruthersii var. atropurpure	Purple false eranthemum
Pseuderanthemum carruthersii var. carruthersii	Eldorado
Psidium guajava	Guava
Psophocarpus tetragonolobus	Wing bean
Raphanus sativus	Daikon
Raphanus sativus	Radish

Table E-1. Vegetation Species Found on Wake Atoll

Scientific Name	**Common Name**
Ricinus communis	Castor bean
Rosa hybrid	Rose
Sansevieria trifasciata	Bowstring hemp
Sansevieria roxburghiana	--
Scaevola sericea var. taccada	scaevola
Schefflera actinophylla	Octopus tree
Sedum sp.	stonecrop sp.
Sempervivum tectorum	Common houseleek
Sesbania grandiflora	Sesban
Sesuvium portulacastrum	seaside purslane
Setaria verticillata	Bristly foxtail
Sida fallax	ilima
Solanum lycopersicum	Tomato
Solanum torvum	Wild tomato
Solanum melongena	eggplant
Solenostemon scutellarioides	Coleus
Sonchus oleraceus	thistle Aztec
Sorghum bicolor	Sweet sorghum
Spondias pinnata	Amra
Stachytarpheta cayennensis	Nettle-leaved vervain
Stachytarpheta jamaicensis	Jamaican vervain
Strelitzia reginae	Bird-of-paradise
Syngonium auritum	Syngonium
Tagetes erecta	marigold
Tagetes patula	French marigold
Tamarindus indica	Tamarind
Terminalia catappa	Indian almond
Thespesia populnea	Milo
Tournefortia argentea	tournefortia
Tradescantia pallida	Purple Tradescantia
Tradescantia spathacea	Oyster plant
Tribulus cistoides	Puncture vine
Tribulus terrestris	Puncture vine
Tridax procumbens	coatbuttons
Vigna unguiculata ssp. sesquipedalis	Yard-long bean
Vitex trifolia	Blue vitex
Waltheria indica	uhaloa
Zea mays	Corn
Zinnia violacea	Zinnia
Ziziphus mauritiana	Indian jujube
Zoysia matrella	Manila grass

Sources: Fosberg 1959, USAF 2008a

Table E-2. Vegetation Species Found on Koke`e Air Force Station

Scientific Name	**Common Name**
Acacia koa	Koa
Acacia mearnsii	black wattle
Adenophorus tamariscinus	wahine noho mauna
Alyxia stellata	maile
Antidesma platyphyllum var. hillebrandii	hame, ha`a
Astelia argyrocoma	pa`iniu
Axonopus fissifolius	narrow-leaved carpetgrass
Bobea brevipes	ahakea lau li` i
Carex meyenii	Meyen's sedge
Carex wahuensis ssp. wahuensis	Oahu sedge
Cheirodendron trigynum	olapa
Claoxylon sandwicense	po`ola
Coprosma kauensis	koi
Crocosmia crocosmiiflora	montbretia crocosmia
Cuphea carthagenensis	Tar weed
Cyrtandra longifolia	ha`iwale
Deparia petersenii	Petersen's spleenwort
Dianella sandwicensis	`uki`uk
Dicranopteris linearis	uluhe
Digitaria eriantha ssp. pentzii	pangola grass
Diplazium sandwichianum	ho`i`o
Dodonaea viscosa	`a`ali`i
Dryopteris wallichiana	laukahi, `i`o nui
Elaeocarpus bifidus	kalia
Elaphoglossum aemulum	laukahi
Elaphoglossum hirtum	maku`e, laukahi
Emilia fosbergii	Florida tasselflower
Erigeron karvinskianus	Daisy fleabane
Fragaria vesca	Woodland Strawberry
Fuchsia magellanica	hardy fuschia earring flower, kulapepeiao
Grammitis tenella	kolokolo mahina lua
Grevillea robusta	silk oak
Hedychium flavescens	Yellow ginger
Hedychium gardnerianum	Kahili ginger
Hedyotis centranthoides	manono
Hedyotis terminalis	ko iko
Holcus lanatus	common velvet grass
Hydrangea macrophylla	hydrangea
Hypochaeris glabra	smooth cat`s ear
Ilex anomala	Hawaii holly
Kalanchoe pinnata	Cathedral bells
Kyllinga brevifolia	shortleaf spikesedge
Lantana camara	Lantana
Melicope anisata	fragrant mokihana

Table E-2. Vegetation Species Found on Koke`e Air Force Station

Scientific Name	**Common Name**
Melinis minutiflora	Molassesgrass
Metrosideros polymorpha	`ohi`a
Microlepia strigosa	palapala`i
Mimosa pudica	Sensitive plant
Morella faya	Firetree
Myrsine alyxifolia	kolea
Nestegis sandwicensis	olopua
Odontosoria chinensis	pala`a
Paspalum urvillei	Vasey's grass
Passiflora tarminiana	banana poka
Pennisetum clandestinum	Kikuyugrass
Perrottetia sandwicensis	olomea
Persea americana	avocado, alligator pear
Pinus sp	pine
Plantago lanceolata	Narrowleaf plantain
Pouteria sandwicensis	`aulu
Prunus cerasifera	methley plum
Psidium cattleianum	Strawberry guava
Psidium sp.	guava
Pyrus communis	common pear
Pyrus malus	apple
Rubus argutus	Sawtooth blackberry
Sadleria cyatheoides	`ama`u
Scaevola gaudichaudiana	naupaka kuahiwi
Sechium edule	Chayote
Setaria palmifolia	Palm grass
Setaria parviflora	yellow foxtail
Sophora chrysophylla	mamane mamani
Sporobolus indicus var. capensis	African dropseed
Stenogyne purpurea	Purplefruit stenogyne
Styphelia tameiameiae	Pukiawe
Syzygium cumini	Java plum
Syzygium sandwicensis	`ohi`a ha
Taraxacum officinale	common dandelion
Tetraplasandra sp.	`ohe sp.
Thelypteris parasitica	wood-fern
Vaccinium calycinum	tree ohelo, `ohelo kau la`au
Vicia sativa	common vetch
Vinca major	trailing periwinkle
Zantedeschia aethiopica	Calla lily

Source: USAF 2007, Kinsla undated a

Table E-3. Vegetation Species Found on Mt. Ka`ala Air Force Station

Scientific Name	**Common Name**
Adenophorus tamariscinus	wahine noho mauna
Ageratina adenophora	Maui pamakani
Araucaria columnaris	Cook pine
Argyranthemum sp.	Dill daisy
Asplenium contiguum	Forest spleenwort
Astelia menziesiana	kalusha, pa`iniu
Athyrium microphyllum	`akolea
Axonopus fissifolius	narrow-leaved carpetgrass
Broussaisia arguta	kanawa`o
Buddleja asiatica	Dogtail
Casuarina equisetifolia	Casuarina
Cerastium fontanum	chickweed
Cheirodendron platyphyllum	lapalapa
Cheirodendron trigynum	`olapa
Cibotium chamissoi	hapu`u `i`i
Cibotium glaucum	hapu`u pulu
Clidemia hirta	Koster's curse
Coprosma granadensis	heads makole
Coprosma ochracea	Maui mirrorplant
Crocosmia x crocosmiiflora	montbretia, crocosmia
Cynodon dactylon	Bermuda grass
Cyperus javanicus	`ahu`awa
Cyperus polystachyos var. polystachyos	manyspike flatsedge
Dianella sandwicensis	`uki uki
Dicranopteris linearis	false staghorn fern, uluhe
Diplazium sandwichianum	Hawai`i teinsorus fern
Drymaria cordata	drymaria, pipili
Dubautia laxa ssp. hirsuta	na`ena`e pua melemele
Elaeocarpus angustifolius	blue marble tree
Freycinetia arborea	`ie`ie
Gunnera petaloidea	`ape`ape
Hedychium flavescens	Yellow ginger
Hedychium gardnerianum	Kahili ginger
Hedyotis terminalis	manono
Hydrangea macrophylla	Hydrangea, popo-hau
Hymenophyllum lanceolatum	palai hinahina
Ilex anomala	Hawaii holly
Impatiens walleriana	impatiens
Juncus bufonius	common toad rush
Juncus planifolius	rush
Kyllinga brevifolia	Green kyllinga, kili`o`opu
Labordia waiolani	kamakahala lau li`i
Lellingeria saffordii	kihi

Table E-3. Vegetation Species Found on Mt. Ka`ala Air Force Station

Scientific Name	**Common Name**
Lepisorus thunbergianus	pakahakaha
Lycopodium cernuum	wawae-`iole
Lythrum maritimum	pukamole
Machaerina angustifolia	`uki
Melicope clusiifolia	anise-scented alani
Metrosideros polymorpha	`ohi`a
Myrsine lessertiana	kolea lau nui
Nasturtium microphyllum	watercress, leko
Odontosoria chinensis	pala`a, pala- ala`a
Paspalum conjugatum	hilo grass
Paspalum urvillei	Vasey's grass
Pennisetum clandestinum	Kikuyugrass
Peperomia membranacea	`ala`ala wai nui
Perrottetia sandwicensis	olomea
Phyllostegia grandiflora	kapana
Pipturus albidus	mamaki
Pityrogramma calomelanos	gold fern
Plantago lanceolata	Narrowleaf plantain
Plantago major	common plantain
Pluchea carolinensis	sourbush
Poa annua	annual bluegrass
Poa sp.	grass sp.
Polypodium pellucidum	`ae
Prunus cerasifera	Methley plum
Psidium cattleianum	Strawberry guava
Rubus argutus	Sawtooth blackberry
Sacciolepis indica	glenwood grass
Sadleria cyatheoides	ama`u
Smilax melastomifolia	hoi kuahiwi, aka`awa
Sporobolus indicus	West Indian dropseed
Styphelia tameiameiae	pukiawe
Syzygium sandwicensis	`ohi`a ha
Thelypteris cyatheoides	kikawaio
Thelypteris parasitica	wood-fern
Trematolobelia macrostachys	koli`i
Vaccinium calycinum	`ohelo kau la`au
Youngia japonica	oriental hawksbeard

Source: USAF 2007, Kinsla undated b

Table E-4. Bird Species Found on Wake Atoll

Common Name	Scientific Name
Accipitridae (hawks, eagles, kites)	
Black kite	*Milvus migrans*
Sea eagle	*Haliaeetus* sp.
Anatidae (Ducks, Geese, Swans)	
Aleutian cackling goose	*Branta hutchinsii leucopareia*
Common goldeneye	*Bucephala clangula*
Eurasion green-winged teal	*Anas crecca crecca*
Eurasian wigeon	*Anas penelope*
Garganey	*Anas querquedula*
Northern pintail	*Anas acuta*
Northern shoveler	*Anas clypeata*
Tufted duck	*Aythya fuligula*
Ardeidae (herons, egrets, and bitterns)	
Cattle egret	*Bubulcus ibis*
Pacific reef heron	*Egretta sacra*
Charadriidae (plovers, dotterels, lapwings)	
Lesser sand plover	*Charadrius mongolus*
Pacific golden plover	*Pluvialis fulva*
Columbidae (pigeons and doves)	
Rock pigeon	*Columba livia*
Cuculidae (cockoos)	
Long-tailed cuckoo	*Eudynamis taitensis*
Diomedeidae (albatrosses)	
Black-footed albatross	*Phoebastria nigripes*
Layasan albatross	*Phoebastria immutabilis*
Estrildidae (old world sparrows)	
Java sparrow	*Padda oryzivora*
Fregatidae (frigatebirds)	
Great frigatebird	*Fregata minor*
Lesser frigatebird	*Fregata ariel*
Fringillidae (true finches)	
Common canary	*Serinus canaria*
Hydrobatidae (storm petrels)	
Leach's Storm Petrel	*Oceanodroma leucorrhoa*
Laridae (seagulls)	
Glaucous-winged gull	*Larus glaucescens*
Laughing gull	*Larus atricilla*
Phasianidae (pheasants, chickens)	
Feral chicken	*Gallus gallus*
Phaethontidae (tropicbirds)	
Red-tailed tropicbird	*Phaethon lepturus*
White-tailed tropicbird	*Phaethon lepturus*

Table E-4. Bird Species Found on Wake Atoll

Procellariidae (petrels, sheerwaters, and prions)	
Black-winged petrel	*Pterodroma nigripennis*
Christmas sheerwater	*Puffinus nativitatus*
Newell's shearwater	*Puffinus auricularis newelli*
Sooty shearwater	*Puffinus griseus*
Wedge-tailed shearwater	*Puffinus pacificus*
Scolopacidae (sandpipers)	
Bristle-thighed curlew	*Numenius tahitiensis*
Common sandpiper	*Actitis hypoleucos*
Common snipe	*Gallinago gallinago*
Dunlin	*Calidris alpina*
Gray-tailed tattler	*Heteroscelus brevipes*
Greater yellowlegs	*Tringa melanoleuca*
Long-billed dowitcher	*Limnodromus scolopaceus*
Pectoral sanderling	*Calidris melanotos*
Ruddy turnstone	*Arenaria interpres*
Ruff	*Philomachus pugnax*
Sanderling	*Calidris alba*
Sharp-tailed sandpiper	*Calidris acuminata*
Wandering tattler	*Heteroscelus incanus*
Whimbrel	*Numenius phaeopus*
Sternidae (terns)	
Black noddy	*Anous minutus*
Brown noddy	*Anous stolidus*
Gray-backed tern	*Onychoprion lunatus*
Sooty tern	*Onychoprion fuscatus*
White tern	*Gygis alba*
Strigidae (true owl)	
Short-eared owl	*Asio flammeus*
Sulidae (boobies and gannets)	
Brewster’s brown booby	*Sula leucogaster brewsteri*
Brown booby	*Sula leucogaster*
Masked booby	*Sula dactylatra*
Red-footed booby	*Sula sula*

Source: Rauzon et al. 2008; PRC 2011

Table E-5. Bird Species Found on or near Koke`e Air Force Station

Common Name	***Scientific Name***
Anatidae (Ducks, Geese, Swans)	
Hawai`ian goose	*Branta sandvicensis*
Cardinalidae (cardinals)	
Northern cardinal	*Cardinalis cardinalis*
Red-crested cardinal	*Paroaria coronate*
Charadriidae (plovers, dotterels, lapwings)	
Pacific Golden Plover	*Pluvialis fulva*
Columbidae (pigeons and doves)	
Zebra dove	*Geopelia striata*
Fringillidae (true finches)	
`anianiau	*Hemignathus parvus*
`apapane	*Himatione sanguinea*
Common `amakihi	*Hemignathus virens*
House finch	*Carpodacus mexicanus*
`i`iwi	*Vestiaria coccinea*
Monarchidae (monarch flycatchers)	
`elepaio	*Chasiempis sandwichensis*
Phasianidae (pheasants, chickens)	
Red junglefow	*Gallus gallus*
Procellariidae (petrels, sheerwaters, and prions)	
Hawai`ian petrel	*Pterodroma phaeopygia*
Newell`s shearwater	*Puffinus auricularis newelli*
Sturnidae (starlings)	
Common myna	*Acridotheres tristis*
Strigidae (true owl)	
Hawaiian owl	*Asio flammeus sandwichensis*

Source: Bruner 1990, 1992; Hawai`ian Audubon Society 1993

Table E-6. Bird Species Found on or near Mt. Ka`ala Air Force

Common Name	***Scientific Name***
Charadriidae (plovers, dotterels, lapwings)	
Pacific Golden Plover	*Pluvialis fulva*
Cettiidae (warblers)	
Japanese bush-warbler	*Cettia diphone*
Fringillidae (true finches)	
`apapane	*Himatione sanguinea*
Common `amakihi	*Hemignathus virens*
`i`iwi	*Vestiaria coccinea*
Zosteropidae (white eyes)	
Japanese white-eye	*Zosterops japonicus*

Source: Hawai`i DLNR 1990

Table E-7. Scleractinian Corals, Octocorals, Hydrozoan Corals and Other Anthozoa Reported at Wake Atoll from 1979 to 2017 Surveys.

	Data Source				Records		Habitats Observed		
SCLERACTINIAN CORALS	Maragos 1979	Molina 1998	Kenyon & Bonito 2005	Foster et al. 2017	Sample	Photo	Fore reef	Reef flat	Lagoon
Acanthastrea echinata	X	X	X			X	X	X	X
A. hillae			X		X	X	X		
Acropora abrotanoides			X		X	X	X		
A. aculeus (RL)		X					X		
A. acuminate (RL)	X							X	X
A. cf. *cerealis*			X				X		
A. formosa	X							X	X
A. globiceps				X		X	X		
A. humilis			X		X	X	X		
A. hyacinthus			X		X		X		
A. lutkeni			X			X	X		
A. cf. *microclados*			X		X	X	X		
A. nasuta	X	X					X	X	X
A. ocellata sensu Randall			X				X		
A. palmerae (RL)			X				X		
A. retusa				X		X	X		
A. cf. *striata*			X		X	X			X
A. surculosa			X		X	X	X		
A. valida	X	X	X		X	X	X	X	X
Acropora sp. (1)			X		X	X	X	X	X
Acropora sp. (2)			X		X	X	X		
Acropora sp. (3)			X		X	X	X		X
Acropora sp. (4)			X		X	X	X		
Astreopora myriophthalma		X	X		X	X	X	X	
A. randalli			X			X	X		
Cyphastrea chalcidicum			X		X	X	X	X	X
C. microphthalma		X	X		X	X	X		
C. serailia	X	X	X			X	X	X	X
Echinopora lamellosa		X	X		X	X	X		
Favia favus		X	X			X	X		
F. helianthoides			X		X	X	X		
F. matthai			X		X	X	X	X	X
F. pallida	X	X	X		X	X	X	X	
F. speciosa	X							X	
F. stelligera	X	X	X		X	X	X	X	
Favia sp.			X			X	X		
Favites abdita	X	X					X	X	X
F. complanata			X				X		
F. flexuosa	X	X					X	X	
F. halicora	X	X			X		X	X	
Fungia scutaria		X	X		X	X	X		
Goniastrea edwardsi			X		X	X	X		X
G. favulus		X	X		X	X	X		
G. pectinata	X	X	X		X	X	X	X	

Table E7. Continued	Data Source				Records		Habitats Observed		
SCLERACTINIAN CORALS	Maragos 1979	Molina 1998	Kenyon & Bonito 2005	Foster et al 2017	Sample	Photo	Fore reef	Reef flat	Lagoon
G.retiformis	X	X					X	X	
Hydnophora exesa			X		X	X	X		
Leptastrea aequalis			X		X			X	
L. purpurea	X	X	X		X	X	X	X	
L. transversa			X		X	X	X		
Leptoria phrygia		X					X		
Leptoseris mycetoseroides		X	X		X	X	X		
Lobophyllia hemprichi	X						X		
Merulina ampliata		X	X		X	X	X		
Montastrea curta		X	X		X	X	X	X	
M. valenciennesi		X	X		X	X	X	X	X
Montipora danae		X							
M. foveolata	X	X	X		X	X	X		
M. grisea			X		X	X	X	X	X
M. hoffmeisteri	X	X	X			X	X	X	X
M. incrassata			X		X	X	X		
M. informis	X	X	X		X	X	X	X	
M. lobulata (RL)	X		X		X	X	X	X	X
M. marshallensis	X							X	
M. monasteriata		X	X				X		
M. tuberculosa			X		X	X	X		
M. verrucosa		X					X		
Montipora sp. (2) *sensu* Randall			X		X	X	X		
Montipora sp. (5)			X		X	X	X		X
Montipora sp. (6)			X		X	X	X		
Montipora sp. (7)			X			X	X		
Montipora sp. (8)			X		X	X	X		X
Pavona duerdeni			X		X	X	X		
P. maldivensis			X		X	X	X		
P. varians		X	X		X	X	X	X	X
Pavona sp. (1) *sensu* Randall			X		X	X	X		
Platygyra daedalea		X	X		X	X	X	X	
P. lamellina			X			X	X		
P. sinensis		X			X		X		
Pocillopora damicornis	X		X		X	X		X	X
P. elegans (RL)			X			X			
P. eydouxi	X	X	X			X	X		
P. meandrina	X	X	X			X	X		
P. setchelli			X				X	X	
P. verrucosa	X	X	X		X	X	X	X	X
Porites lichen			X		X	X			
P. lobata	X		X		X	X	X	X	X
P. lutea	X	X	X			X	X	X	X
P. rus			X		X	X			
P. solida	X	X	X		X	X			

Table E7. Continued	Data Source				Records		Habitats Observed		
SCLERACTINIAN CORALS	Maragos 1979	Molina 1998	Kenyon & Bonito 2005	Foster et al 2017	Sample	Photo	Fore reef	Reef flat	Lagoon
Psammocora profundacella	X		X		X	X	X		
Psammocora sp.			X		X	X	X	X	
Scapophyllia cylindrica			X		X	X	X	X	
Seriatopora hystrix	X							X	
Stylophora mordax			X		X	X	X		
Symphyllia radians		X							
S. recta		X	X		X	X	X		
Tubastrea sp.			X		X	X	X		
OCTOCORALLIA CORALS									
Lobophytum sp.			X		X	X	X		
Sarcophyton sp.			X		X	X	X	X	
Sinularia sp.			X		X	X	X		
Stereonephthya sp.			X		X	X	X		
HYDROZOANCORALS									
Millepora exaesa		X					X		
M. platyphylla	X		X		X	X	X		
ZOANTHIDS									
Palythoa sp.			X		X	X	X		

(1) caespitose colonies; tubular incipient axial corallites are common; (2) thick-branched, with nariformradial corallites; (3) corymbose colonies with nariform radial corallites; (4) caespitose colonies with tubular radial corallites ; (5) encrusting colonies with coenosteal papillae; (6) encrusting colonies with prominent thecal papillae; (7) encrusting colonies with coenosteal papillae, often forming short ridges; (8) encrusting colonies with coenosteal papillae mostly forming short ridges.

Species denoted "sensu Randall" identified according to characteristics described in Randall and Myers (1983). RL = IUCN Red List of Threatened Species.

Sources: Kenyon et al. 2013; USFWS 2017b.

Table E-8. Fish Species Found on Wake Atoll

RHINCODONTIDAE (Whale Shark)
Rhincodon typus
CARCHARHINIDAE (Requiem Sharks)
Carcharhinus amblyrhynchos
Carcharhinus melanopterus
Eulamia commersoni
Triaenodon obesus
MYLIOBATIDAE (Eagle Rays)
Aetobatus narinari
MOBULIDAE (Manta Rays)
Albula glossodonta
MORINGUIDAE (Spaghetti Eels)
Moringua abbreviata
CHLOPSIDAE (False Morays)
Kaupichthys sp.
MURAENIDAE (Moray Eels)
Anarchias sp.
Anarchias cantonensis
Anarchias seychellensis
Echidna leucotaenia
Gymnomuraena zebra
Gymnothorax buroensis
Gymnothorax enigmaticus
Gymnothorax fiavimarginatus
Lycondontis flavomarginata
Gymnothorax javanicus
Gymnothorax meleagris
Gymnothorax pictus
Gymnothorax ruppelliae
Gymnothorax undulatus
Lycodontis undulata
Uropterygius macrocephalus
Uropterygius xanthopterus
OPHICHTHIDAE (Snake Eels)
Myrichthys colubrinus
Myrichthys maculosus
Scolecenchelys gymnota
CONGRIDAE (Conger and Garden Eels)
Conger cinereus
Heteroconger hassi
CHANIDAE (Milkfish)
Chanos chanos
MYCTOPHIDAE (Lanternfishes)
Myctophum spinosum
Dasyscopelus spinosus
BYTHITIDAE (Livebearing Brotulas)
Dinematichthys ilucoeteoides
MUGILIDAE (Mullets)
Crenimugil crenilabis
Liza vaigiensis
Neomyxus leuciscus
CLUPEIDAE (Herrings)
Spratelloides sp.
EXOCOETIDAE (Flyingfishes)
Cypselurus poecilopterus
Exocoetus volitans
Cypselurus rondelitii
HEMIRAMPHIDAE (Halfbeaks)
Hyporhamphus acutus acutus
Oxyporhampus micropterus
HOLOCENTRIDAE (Soldierfishes and Squirrelfishes)
Myripristis adusta
Myripristis amaena
Myripristis berndti
Myripristis kuntee
Myripristis murdjan
Myripristis violacea
Holocentrus opercularis
Holocentrus sammara
Sargocentron melanospilos
Holocentrus microstomus
Holocentrus laeteoguttatus
Neoniphon opercularis
Sargocentrum spiniferum
Holocentrus spinifer
Sargocentron tiere
SYGNATHIDAE (Pipefishes and Seahorses)
Corythoichthys conspicillatus
Doryrhampus excisus
AULOSTOMIDAE (Trumpetfishes)
Aulostomus chinensis
FISTULARIIDAE (Cornetfishes)
Fistularia commersonii
SCORPAENIDAE (Scorpionfishes)
Pterois antennata
Scorpaenodes guamensis
Sebastapistes ballieui
Sebastapistes coniorta
Sebastapistes fowleri
Sebastapistes mauritiana
Sebastapistes tinkhami
CARACANTHIDAE (Orbiculate Velvetfishes)
Caracanthus maculatus
Caracanthus unipinna
Family SERRANIDAE (Groupers and Sea Basses)
Aporops bilinearis
Cephalopholis argus
Cephalopholis spiloparaea
Cephalopholis urodeta
Epinephelus fasciatus
Epinephelus hexagonatus
Epinephelus lanceolatus

Table E-8. Fish Species Found on Wake Atoll

Family SERRANIDAE (Groupers and Sea Basses)
Epinephelus merra
Epinephelus polyphekadion
Epinephelus microdon
Epinephelus tauvina
Pseudanthias pascalus
Epinephelus spilotoceps
Epinephelus tauvina
Liopropoma tonstrinum
Plectranthias longimanus
Pleetranthias nanus
Plectranthias winniensis
Pseudanthias pascalus
Pseudanthias ventralis
Pseudogramma polyacantha
Variola louti
CIRRHITIDAE (Hawkfishes)
Amblycirrhitus bimacula
Cirrhitus maculatus
Neocirrhites armatus
Paracirrhites arcatus
Paracirrhites forsteri
Paracirrhites hemistictus
PSEUDOCHROMIDAE (Dottybacks)
Pseudochromis sp.
Pseudoplesiops sp.
PRIACANTHIDAE (Bigeyes, Glasseyes)
Heteropriacanthus cruentatus
APOGONIDAE (Cardinalfishes)
Apogon eoeeineus
Apogon cyanosoma
Apogon doryssa
Apogon exostigma
Apogon fuscus
Apogon kallopterus
Apogon savayensis
Apogon susanae
Apogon taeniophorus
Cheilodipterus macrodon
Cheilodipterus quinquelineata
Powleria isostigma
MALACANTHIDAE (Sand Tilefishes)
Malaeanthus brevirostris
ECHENEIDAE (Remoras)
Remora remora
Remora osteoehi
CORYPHAENIDAE (Dolphinfishes)
Coryphaena hippurus
CARANGIDAE (Jacks)
Seomberoides lysan
Seriola rivoliana
Traehinotus baillonii
LUTJANIDAE (Snappers)
Aphareus furea
Aprion vireseens
Lutjanus fulvus
Lutjanus monostigma
Macolor niger
LETHRINIDAE (Emperors)
Lethrinus obsoletus
Lethrinus rubriopereulatus
Monotaxis grandoculis
Lethrinus kallopterus
Lethrinus ramak
MULLIDAE (Goatfishes)
Mulloidichthys flavolineatus
Mulloidichthys vanicolensis
Parupeneus barberinus
Parupeneus cyclostomus
Parupeneus insularis
Parupeneus multifasciatus
Parupeneus pleurostigma
Upeneus arge
Mulloides vanicolensis
Parupeneus bifasciatus
PEMPHERIDAE (Sweepers)
Pempheris oualensis
CHAETODONTIDAE (Butterflyfishes)
Chaetodon auriga
Chaetodon ephippium
Chaetodon lineolatus
Chaetodon lunula
Chaetodon ornatissimus
Chaetodon punctatofasciatus
Chaetodon quadrimaculatus
Chaetodon reticulatus
Chaetodon semeion
Chaetodon ulietensis
Chaetodon unimaculatus
Forcipiger flavissimus
Forcipiger longirostris
Hemitaurichthys thompsoni
Heniochus acuminatus
Chaetodon oxycephalus
POMACANTHIDAE (Angelfishes)
Centropyge flavissima
Centropyge loricula
Centropyge multicolor
KYPHOSIDAE (Rudderfishes, Sea Chubs)
Kyphosus bigibbus
Kyphosus cinerascens
KUHLIIDAE (Flagtails)
Kuhlia sandvicensis
OPLEGNATHIDAE (Knifejaws)
Oplegnathus punctatus

Table E-8. Fish Species Found on Wake Atoll

CARANGIDAE (Jacks)
Carangoides ferdau
Carangoides orthogrammus
Caranx ignobilis
Caranx lugubris
Caranx melampygus
Caranx sexfaseiatus
Deeapturus maearellus
Elagatis bipinnulatas
Gnathanodon speeiosus
Decapterus macarellus
Carangoides orthogrammus
Caranx lugubris
Caranx melampygus
Caranx sexfaciatus
POMACENTRIDAE (Damselfishes)
Abudefduf septemfasciatus
Abudefduf sordidus
Abudefduf vaigiensis
Abudefduf saxatilis
Chromis acares
Chromis agilis
Chromis vanderbilti
Chromis viridis
Chrysiptera biocellata
Chrysiptera brownriggii
Chrysiptera glauca
Dascyllus aruanus
Plectroglyphidodon dickii
Plectroglyphidodon imparipennis
Plectroglyphidodon johnstonianus
Plectroglyphidodon lacrymatus
Plectroglyphidodon phoenixensis
Stegastes albifasciatus
Stegastes fasciolatus
Stegastes nigricans
LABRIDAE (Wrasses)
Ammolabrus diems
Anampses caeruleopunctatus
Bodianus anthioides
Cheilinus chlorourus
Cheilinus fasciatus
Cheilinus trilobatus
Cheilinus undulatus
Coris aygula
Epibulis insidiator
Gomphosus varius
Halichoeres biocellatus
Halichoeres margaritaceus
Halichoeres ornatissimus
Halichoeres trimaculatus
Hemigymnus fasciatus
Iniistius sp.
Labroides bicolor
Labroides dimidiatus
Labroides pectoralis
Labroides rubrolabiatus
Novaculichthys taeniouris
Oxycheilinus diagrammus
Oxycheilinus orientalis
LABRIDAE (Wrasses)
Oxycheilinus unifasciatus
Pseudodcheilinus hexataenia
Pseudocheilinus ocellatus
Pseudocheilinus octotaenia
Pseudocheilinus tetrataenia
Pseudocoris aurantiofasciata
Pseudojuloides atavai
Pseudojuloides cerasinus
Stethojulis bandanensis
Cheilinus unifasciatus
Halichoeres hartzfeldii
Halichoeres chrysus
Halichoeres melanurus
Halichoeres melapterus
Thalassoma ambylycephalum
Thalassoma lutescens
Thalassoma quinquevittatum
Thalassoma hardwicke
Thalassoma lutescens
Thalassoma purpureum
Thalassoma quinquevittatum
Thalassoma trilobatum
Xyrichtys sp.
SCARIDAE (Parrotfishes)
Bolbometopon muricatum
Callyodon borborus
Cetoscarus bicolor
Chlorurus frontalis
Chlorurus microrhinos
Chlorurus sordidus
Hipposcarus longiceps
Scarus forsteni
Scarus altipinnis
Scarus ghobban
Scarus globiceps
Scarus oviceps
Scarus psittacus
Scarus rubroviolaceus
PINGUIPEDIDAE (Sandperches)
Parapercis schauinslandii
CREEDIDAE (Sand Burrowers)
Limnichthys nitidus
TRIPTERYGIDAE (Triplefins)
Enneapterygius nigricauda
Helcogramma chica
BLENNIIDAE (Blennies)
Blenniella gibbifrons
Blenniella paula
Cirripectes polyzona
Cirripectes quagga
Cirripectes varioloms
Entomacrodus marmoratus
Entomacrodus striatus
Istiblennius edentulus
Plagiotremus tapienosoma
Rhabdoblennius ellipes
CALLIONYMIDAE (Dragonets)
Synchiropus laddi
Callionymidae

Table E-8. Fish Species Found on Wake Atoll

GOBIIDAE (Gobies)
Amblygobius phalaena
Asterropteryx semipunctatus
Bathygobius fuscus
Cabillus tongarevae
Coryphopterus duospilus
Coryphopterus neophytus
Coryphopterus sp.
Ctenogobiops aurocingulus
Ctenogobiops feroculus
Ctenogobiops pomastietus
Eviota alfelei
Eviota epiphanes
Eviota saipanensis
Favonigobius sp.
Gnatholepis cauerensis
Gobiodon rivulatus
Paragobiodon lacunicolus
Priolepis kappa
Priolepis semidoliatus
Trimma sp.
MICRODESMIDAE (Dartfishes and Wormfishes)
Ptereleotris evides
Ptereleotris microlepis
SIGANIDAE (Rabbitfishes)
Siganus argenteus
ZANCLIDAE (Moorish Idol)
Zanclus cornutus
ACANTHURIDAE (Surgeonfishes)
Acanthurus achilles
Acanthurus blochii
Acanthurus guttatus
Acanthurus leucopareius
Acanthurus nigricans
Acanthurus nigricauda
Acanthurus nigrofuscus
Acanthurus nigroris
Acanthurus nubilus
Acanthurus olivaceus
Acanthurus thompsoni
Acanthurus triostegus
Ctenochaetus cyanocheilus
Ctenochaetus hawaiiensis
Ctenochaetus striatus
Naso brevirostris
Naso hexacanthus
Naso lituratus
Naso unicornis
Naso vlamingii
Zebrasoma flavescens
Zebrasoma veliferum
SPHYRAENIDAE (Barracudas)
Sphyraena barracuda
SCOMBRIDAE (Tunas and Mackerels)
Acanthocybium solanderi
Euthynnus affinis
Katsuwonus pelamis
Thunnus alalunga
Thunnus albacares
Thunnus obesus
ISTIOPHORIDAE (Billfishes)
Istiophorus platypterus
Makaira indica
Makaira mazara
Tetrapturus angustirostris
Tetrapturus audax
NOMEIDAE (Driftfishes)
Cubiceps pauciradiatus
BOTHIDAE (Lefteye Flounders)
Bothus mancus
Bothus pantherinus
BALISTIDAE (Triggerfishes)
Balistoides viridescens
Melichthys niger
Melichthys vidua
Rhinecanthus aculeatus
Rhinecanthus rectangulus
Sufflamen bursa
Xanthichthys mento
MONACANTHIDAE (Filefishes)
Aluterus scriptus
Cantherhines dumerilii
OSTRACIIDAE(Trunkfishes, Boxfishes)
Ostracion cubicus
Ostracion meleagris
TETRAODONTIDAE (Puffers)
Arothron hispidus
Arothron meleagris
Arothron stellatus
Canthigaster amboinensis
Canthigaster janthinoptera
Canthigaster solandri
DIODONTIDAE (Porcupinefishes)
Diodon hystrix
ALBULIDAE (Bonefish)
Albula vulpes

Source: USFWS and NMFS 1999

APPENDIX F
UNITED STATES ENVIRONMENTAL PROTECTION AGENCY SUPPLEMENTAL LABEL FOR BRODIFACOUM-25W CONSERVATION AND UNITED STATES FISH AND WILDLIFE SERVICE MIGRATORY BIRD TREATY ACT PERMIT FOR THE TAKE OF BIRDS DURING RAT ERADICATION EFFORTS WITH THE 2012 ANNUAL REPORT

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
WASHINGTON, D.C. 20460

OFFICE OF CHEMICAL SAFETY
AND POLLUTION PREVENTION

Stephanie Stephens
Biological Scientist
USDA APHIS PPD
Environmental and Risk Analysis Services, Unit 149
4700 River Rd.
Riverdale, MD 20737

APR 0 4 2012

Dear Ms. Stephens:

Subject: Supplemental Label for Brodifacoum-25W Conservation to Control and Eradicate Polynesian and Asian House Rats on Wake Atoll
EPA Registration No. 56228-36
Submission Date: March 6, 2012

The proposed labeling referred to above, submitted in connections and registration under the Federal Insecticide, Fungicide, and Rodenticide Act, is acceptable with the following requirement:

- A monitoring plan must be submitted to the Agency that includes the monitoring actions prior to, during, and after the implementation of the eradication within one year of completion of the eradication project.

To allow successful restoration of native species to Wake Atoll, all rats must be killed. To achieve this goal, the eradication program involves multiple application methods, including aerial broadcast application as well as bait application to tree canopies. These bait application methods will consequently result in accessibility of bait to nontarget species. However, the benefits of the long term goals of protecting and restoring the native species and habitat of Palmyra by removing non-native rats are believed to be justified and outweigh the associated risks involved.

A stamped copy of the label is enclosed for your records. This supplemental label will expire 2 years from September 1, 2012. Please submit one (1) final printed copy for the above mentioned label including the expiration date before releasing the product for shipment. If you have any questions regarding this label, please contact Jennifer Gaines at (703) 305-5967 or via e-mail, gaines.jennifer@epa.gov.

Sincerely yours,

Jennifer Gaines for

John Hebert
Product Manager (07)
Insecticide-Rodenticide Branch
Registration Division (7505P)

RESTRICTED USE PESTICIDE

DUE TO HAZARDS TO NON-TARGET SPECIES

For retail sale only to: USDA Animal and Plant Health Inspection Service Wildlife Services, U.S. Fish and Wildlife Service, and the U.S. National Park Service to be used only by Certified Applicators or persons under their direct supervision and only for those uses covered by the Certified Applicators certification.

SUPPLEMENTAL LABELING
BRODIFACOUM-25W CONSERVATION

For control and eradication of Polynesian rats (Rattus exulans) and Asian house rats (Rattus tanezumi) or other invasive rodents on Wake Atoll

This supplemental label is only for use on Wake Atoll and expires on September 1, 2014 and must not be used or distributed after this date.

KEEP OUT OF REACH OF CHILDREN

ACCEPTED
with COMMENTS
In EPA Letter Dated
APR 04 2012
Under the Federal Insecticide, Fungicide, and Rodenticide Act, as amended, for the pesticide registered under EPA Reg. No. 56228-36

CAUTION

(EPA REG. NO. 56228-36, EPA Est. No. 056228-ID-1)

THIS SUPPLEMENTAL LABELING AND THE PACKAGE LABELING FOR BRODIFACOUM-25W CONSERVATION (EPA REG. NO. 56228-36) MUST BE IN THE POSSESSION OF THE USER AT THE TIME OF APPLICATION. READ THIS SUPPLEMENTAL LABEL AND THE PACKAGE LABEL BEFORE APPLYING BRODIFACOUM-25W CONSERVATION. ALL APPLICABLE DIRECTIONS, RESTRICTIONS AND PRECAUTIONS ON THIS SUPPLEMENTAL LABEL AND ON THE PACKAGE LABEL MUST BE FOLLOWED.

DIRECTIONS FOR USE

USE RESTRICTIONS:

This supplemental label applies only to the control and eradication of Polynesian rats (*Rattus exulans*) and Asian house rats (*Rattus tanezumi*) or other invasive rodents on Wake Atoll. All modifications to EPA Reg. No. 56228-36 contained in this label apply to the use of this product on Wake Atoll only.

The maximum amount of bait to be applied by broadcast application under this label to Wake Atoll may not exceed 40,728 pounds (18,474 kg). Determination of the final project broadcast application rate will be calculated from the total amount of bait applied via broadcast baiting to the emergent land area of Wake Atoll. In addition, a maximum of 1,499 pounds (680 kg) of bait may be applied in bait stations under this label. In the event rats or rat sign are found after baiting operations, small scale hand broadcast applications are permitted in the area of the evidence in an effort to eliminate the few remaining survivors.

DIRECTIONS FOR USE, continued:

CANOPY BAITING (bait placement in the canopy of trees and shrubs): Hand bait tree and shrub canopies that do not receive bait delivered during broadcast applications. These canopies will likely be in areas treated by bait station or hand broadcast application techniques. Bait these habitats using bait bolas, consisting of two biodegradable bags, each bag containing up to 0.9 ounces (25 grams) of bait, tied together by a short length of string. Sling or place bolas into branches and fronds of every stand-alone palm or every third interconnected palm tree per treatment.

BAIT STATIONS: Tamper-resistant bait stations must be used when applying this product to areas in and around human habitation to keep bait out of reach of children, non-target wildlife, or domestic animals. Apply up to 4.23 ounces (120 grams) of bait per bait station. Bait stations must be checked weekly and restocked regularly (eight weeks post application, checks will be extended for a maximum of two weeks) to maintain an uninterrupted supply of fresh bait. Place bait stations inside and around all inhabited structures that cannot be treated with hand or aerial broadcast. Space bait stations at intervals no greater than 160 ft (50 meters).

BROADCAST APPLICATION: Broadcast bait using aerial (helicopter) or by gloved hand. Two aerial broadcast applications may be made during the initial eradication attempt. The first application is to be targeted at 16 lbs/acre (18 kg/ha). The second application is to be targeted at 8 lbs/acre (9 kg/ha). The second broadcast application should be timed to maximize the probability of baiting weanling rats that may emerge from the nest after the first application, but will also be dependent on local weather conditions. The same rates must be used for hand baiting. These application rates have been established to ensure that the entire land mass is treated with sufficient bait to present a minimum of one lethal dose for each rat present (in each potential rat territory), for long enough that rats can find and consume the bait (typically 3-4 days) and to account for loss of bait to terrestrial crabs and other invertebrates, as well as degradation of bait over that time period.

At points where flight lines overlap, the amount of bait applied might locally exceed the prescribed application rate. This could occur along adjacent borders of parallel swaths, at the end of swaths where they intercept the swaths created by shoreline baiting, or in areas missed during the initial baiting operations, as indicated by the GPS flight path data. Minimize areas where the allowable application rate is exceeded as much as possible while ensuring that all areas are baited sufficiently.

If bait application is interrupted due to poor weather conditions, "back baiting" of previously baited swaths is permitted to ensure rats are exposed to the bait Use the following rules to determine the extent of back baiting.

Application Delay	Resume baiting strategy
1-3 days	At drop boundary
>3 days	2-4 swath widths behind the drop boundary

Do not make aerial (helicopter) applications in sustained winds higher than 35 mph (30 knots). Pilot in command has final authority for determining safe flying conditions.

DIRECTIONS FOR USE, continued:

Baiting abandoned structures at, or within a day of, the time when bait is broadcast to the same land mass. Abandoned structures, including underground structures such as bunkers and sewers, will be baited by hand broadcast at the same application rates used to treat unenclosed areas. Where bait will not be exposed to ambient climate and may not degrade if unconsumed, bait should be placed such that it can be recovered, and disposed of upon conclusion of the project.

For all methods of baiting, monitor the baited area at least twice per week until 3 weeks have passed since the last broadcast application and, using gloves, collect and dispose of any dead animals and spilled or spoiled bait properly.

UNITED STATES DEPARTMENT OF AGRICULTURE
ANIMAL AND PLANT HEALTH INSPECTION SERVICE
4700 River Road, Unit 149
Riverdale, MD 20737-1237

Expires 09/01/2014

DEPARTMENT OF THE INTERIOR
U S FISH AND WILDLIFE SERVICE

FEDERAL FISH AND WILDLIFE PERMIT

2. AUTHORITY-STATUTES
16 USC 703-712

REGULATIONS
50 CFR Part 13
50 CFR 21.27

1. PERMITTEE

U.S. AIR FORCE 611 ASG/CC
dba WAKE ATOLL
10471 20TH ST
SUITE 302
JBER, AK 99506-2201
U.S.A.

3. NUMBER
MB73909A-0

4. RENEWABLE	5. MAY COPY
☒ YES ☐ NO	☒ YES ☐ NO

6. EFFECTIVE	7. EXPIRES
05/01/2012	03/31/2015

8. NAME AND TITLE OF PRINCIPAL OFFICER *(If #1 is a business)*
ROBYN M BURK, COL
COMMANDER, 611TH AIR SUPPORT GROUP

9. TYPE OF PERMIT
SPECIAL PURPOSE - MISCELLANEOUS

10. LOCATION WHERE AUTHORIZED ACTIVITY MAY BE CONDUCTED
Physical Location: Wake Island
Records:US Air Force 611th Air Support Group (Address in Block 1)
PACIFIC ISLANDS

11. CONDITIONS AND AUTHORIZATIONS:

A. GENERAL CONDITIONS SET OUT IN SUBPART D OF 50 CFR 13, AND SPECIFIC CONDITIONS CONTAINED IN FEDERAL REGULATIONS CITED IN BLOCK #2 ABOVE, ARE HEREBY MADE A PART OF THIS PERMIT. ALL ACTIVITIES AUTHORIZED HEREIN MUST BE CARRIED OUT IN ACCORD WITH AND FOR THE PURPOSES DESCRIBED IN THE APPLICATION SUBMITTED. CONTINUED VALIDITY, OR RENEWAL, OF THIS PERMIT IS SUBJECT TO COMPLETE AND TIMELY COMPLIANCE WITH ALL APPLICABLE CONDITIONS, INCLUDING THE FILING OF ALL REQUIRED INFORMATION AND REPORTS.

B. THE VALIDITY OF THIS PERMIT IS ALSO CONDITIONED UPON STRICT OBSERVANCE OF ALL APPLICABLE FOREIGN, STATE, LOCAL, TRIBAL, OR OTHER FEDERAL LAW.

C. VALID FOR USE BY PERMITTEE NAMED ABOVE

D. You are authorized to take, possess, and transport the migratory birds listed below in the course of eradication of the introduced Polynesian rat (Rattus exulans) and Asian house rat (Rattus tanizumi) at Wake Island. This permit is issued pursuant to 50 CFR 21.27 (benefit to the migratory bird resource). Complete details and analysis are contained in the "Final Environmental Assessment addressing the Systematic Eradication of Rats from Wake Atoll" Wake Island Rat Eradication Project, U.S. Department of Air Force, Pacific Air Forces.

Bristle-thighed Curlew - 12	Whimbrel - 1
Pacific Golden-Plover - 500	Ruddy Turnstone - 30
Wandering Tattler - 75	Gray-tailed Tattler - 2
Greater Yellowlegs - 1	Sanderling - 2
Pectoral Sandpiper - 2	Dunlin - 2
Sharp-tailed Sandpiper - 24	Long-billed Dowitcher - 1
Lesser Sand Plover - 1	Common Snipe - 1
Ruff - 2	Cattle Egret - 1
Cackling Goose - 2	Eurasian Wigeon - 5

☒ ADDITIONAL CONDITIONS AND AUTHORIZATIONS ALSO APPLY

12. REPORTING REQUIREMENTS
ANNUAL REPORT DUE: 01/31
You must submit an annual report to your Regional Migratory Bird Permit Office each year, even if you had no activity. Form: www.fws.gov/forms/3-202-7.pdf.

ISSUED BY	TITLE	DATE
[signature]	PERMIT BIOLOGIST - FWS REGION 1	05/03/2012

Garganey - 2
Northern Shoveler - 3
Tufted Duck - 1
Laughing Gull - 2
Wedge-tailed Shearwater - 2
Brown Booby - 2
Great Frigatebird - 3
Sooty Tern - 1200
White Tern - 5
Northern Pintail - 26
Green-winged Teal - 8
Common Goldeneye - 2
Short-eared Owl - 1
Masked Booby - 1
Red-footed Booby - 30
Black Noddy - 2
Grey-backed Tern - 1
Other Migratory Birds - 1

E. All activities must be conducted as described in detail in the application materials, including the following measures to avoid and minimize the take of migratory birds:

1. Timing of the eradication is scheduled to coincide with the dates that the lowest number of shorebirds have been recorded in previous years at the island. Application of rodenticide will occur after migrating shorebirds have typically departed from Wake on their way to the northern breeding grounds.
2. Staff must make every attempt to capture and keep safe any bird which appears to have been exposed. Supplies will be kept on hand to trap, contain and treat birds.
3. Color and size of the rodenticide bait were selected to minimize the attractiveness of the bait to migratory birds.
4. Regular surveys will be conducted and all carcasses found that could potentially be a source of secondary poisoning will be removed.
5. Special measures to prevent the bait from entering the water include hand broadcast of narrow strands and tiny islands and baiting the canopy trees that overhang the water by hand.
6. If bait accidently drifts from hoppers onto sand flats and beaches and can reasonably be retrieved, it will be retrieved by onsite observers.
7. Bird carcasses found during the rat eradication will be collected and analyzed for the cause of death and for presence of rodenticide residue; carcasses of vulnerable shorebird species will be collected and analyzed for a period of 1 year after the eradication.

F. Report capture, injury, and/or mortality of endangered species within 24 hours of discovery to the Portland Migratory Bird Permit Office (503-872-2715).

G. You and your subpermittees must carry a copy of this permit when exercising its authority.

H. The following subpermittees are authorized under this permit:

USAF - Joint Base Elmendorf-Richardson: Matt Moran, Kristen Warren, Wesley Walker
Island Conservation NGO: Chad Hanson, Alex Webmann, David Will, Peter Gardner, Richard Griffiths, Rory Stansbury
USFWS: Susan White, Beth Flint, Leona Laniawe, Ricardo Colon-Merced, John Klavitter, Benita Mahanta

In addition, any other person who is (a) employed by you or under contract to you for the activities specified in this permit or (b) otherwise designated a subpermittee by you in writing to Portland permit office may exercise the authority of this permit.

I. You must maintain records as required in 50 CFR 13.46 and 50 CFR 21.27.

K. You must submit a report of activities by January 31, 2013 and 2014, listing the number and species of migratory birds taken, date taken, the manner in which they were taken, condition of the bird as a result of the taking (e.g., killed, injured, unharmed), disposition of the bird (e.g., released, euthanized, buried), and an evaluation of how to avoid similar incidents in the future.

U.S. FISH & WILDLIFE SERVICE - MIGRATORY BIRD PERMIT OFFICE

(See attached addresses)

Office Use Only
Date Completed Report rec'd in Regional Office
____/____/____
Initials: _____

SPECIAL PURPOSE - MISCELLANEOUS - ANNUAL REPORT

PERMITTEE: U.S. Air Force 611 CES/CEAN

PERMIT NUMBER: MB73909A-0

ADDRESS: 10471 20th Street, Suite 339

REPORT FOR CALENDAR YEAR: 2012

JBER, AK 99506-2201
City State Zip Code

REPORT DUE DATE: 01/31/2013

✓ **Check here if reporting a change of name, address, or contact information**

PHONE: 907-552-0788 **Email:** matthew.moran.3@us.af.mil

INSTRUCTIONS: Type or print the information requested below for all birds taken or held under your permit during the report year and return the completed report to the above address by the due date. Use of this form is not mandatory, but the same information must be submitted. A supplemental sheet is available if needed. Filing an annual report is a condition of your permit. Failure to file a timely report could result in suspension of your permit. You must submit a report even if you had no activity during the report year.

NOTE: If your permit conditions require report information that is different from that requested below, please provide that on a separate sheet. MAKE SURE YOU SIGN & DATE THE CERTIFICATION STATEMENT BELOW BEFORE YOU SUBMIT YOUR REPORT. (Ref. 50 CFR parts 13 & 21)

SPECIES (Common Name)	WHEN & WHERE ACQUIRED		NUMBER TAKEN			NUMBER SALVAGED			DISPOSITION	COMMENTS
	Date	Location (County & State)	Birds	Nests	Eggs	Birds	Nests	Eggs		
Pacific Golden Plover	5/28/12	Wake Island	1						dead	Assumed take from Bird Fracoun. Never confirmed
Ruddy Turnstone	5/30/12	Wake Island	1						dead	"

CERTIFICATION: I certify that the information in this report is true and correct to the best of my knowledge. I understand that any false statement herein may subject me to the criminal penalties of 18 U.S.C. 1001.

Signature: _____ Date: 01/03/2013

SUPPLEMENTAL SHEET - SPECIAL PURPOSE - MISCELLANEOUS ANNUAL REPORT

PERMITTEE: _____ **PERMIT NUMBER:** _____ **REPORT YEAR:** _____ **SUPPLEMENTAL PAGE NO:** _____

SPECIES (Common Name)	WHEN & WHERE ACQUIRED		NUMBER TAKEN			NUMBER SALVAGED			DISPOSITION	COMMENTS
	Date	Location (County & State)	Birds	Nests	Eggs	Birds	Nests	Eggs		

Form 3-202-7 Rev 9/2010

OMB Control No. 1018-0022 Expires 02/28/2014

APPENDIX G
ENTOMOLOGIST TRIP REPORTS – MARCH AND APRIL 2013

29 Mar 2013

TRIP REPORT - WAKE ISLAND

Mr. Matt Moran, Natural Resources manager for the 611 CES/CEAN, requested support from the 910 AW to provide DoD Certified Entomologists to evaluate the effectiveness of aerial application of rodenticides conducted in May 2012 to control invasive rats that were devastating populations of migratory ground nesting birds and chewing through belts on the airfield arresting system (BAK-12).

Lt Col Teig and Capt Mundal traveled to Wake Island 4-24 Mar 13 to evaluate the effectiveness of the aerial application of rodenticides and develop Integrated Pest Management methods for control of invasive rats. Kirsten Rex, representing the 611 CES/CEAN, joined Lt Col Teig and Capt Mundal at Hickam AFB prior to boarding the rotator to Wake Island.

BACKGROUND

Wake Island is located19.2900° N, 166.6181° E, 2300 miles East of Honolulu and 1500 miles West of Guam, just across the International Date Line. Wake Island lies in the tropical zone, but it is subject to typhoons and periodic temperate storms during the winter. Average temperatures were 85°F during the day, 72°F at night. Wake Island is a coral atoll with 1,821 acres created by volcanic activity. It is a U.S. Territory subject to all U.S. laws. The U.S. Air Force operates a 9,800-foot runway for refueling and emergency landings. The Missile Defense Agency operates facilities on the island. A marina for barges and supplies is also located on the island.

Wake Island was attacked by the Japanese 8 Dec 1941 on during WWII (same day as Pearl Harbor). Several pillboxes and artifacts from WWII remain throughout the island. Unexploded ordinance continues to be located.

Only 4 military personnel are stationed on Wake Island. They oversee a Base Operations Support Contractor (Chugash) that operates all facilities on the island.

OBSERVATIONS

The "Rat Team" arrived on Wake Island on 7 Mar 13. After obtaining a van for transportation, the team located where lodging and mess facilities were located. Limited telephone and internet capabilities were available. Water contained lead and copper levels that were not safe for long-term consumption so only filtered water obtained from the Water Plant was used for drinking.

An inventory of supplies (for trapping and baiting rats) stored in a conex box was conducted. Rodenticides available included Contrac Blox (with and without lumitrack), Final Bait Blocks, First Strike Soft Bait, and LiquiTox. Insecticides available included Niban Granular Bait (for ants and roaches), Advion ant gel and Optigard ant gel. Several T-Rex and large wooden rat snap traps were available as well as top-loading and traditional rodenticide bait stations. Other PPE such as gloves and Tyvek suits were stored in the conex. Supplies for flagging and labeling traps was available as well as a cooler for transporting bait and water coolers for working in hot environment were stored in the conex.

The "Rat Team" began by becoming familiarized with the habitat of the Polynesian rat (Rattus exulans) on the golf course. Evidence of holes in the ground were found around the base of several trees where there was ground cover. Preferred habitat includes ironwood trees (an invasive tree), cotton plants, and coconut palms. Ironwood trees (Australian Pine) http://en.wikipedia.org/wiki/Casuarina_equisetifolia resemble long leaf pines but are not a conifer tree. They produce large quantities of small seed pods that rats consume as well as dropping long "pine needles", creating a thick ground cover for rats to hide (up to 12 inches thick). Coconut was preferred bait for snap traps. Other rhizomes of flowering weeds on the golf course were also being eaten by the rats. Additional information on control of Polynesian rats can be found at http://icwdm.org/handbook/rodents/PolynesianRats.asp.

Based on observations from personnel on Wake Island, the rodent population has decreased significantly (up to 99%) from the previous year following the aerial application of rodenticide (Island Conservation formulation of brodifacoum). A larger rat, the Asian house rat, *Rattus tanezumi*, may have been eradicated during this effort.

Wake Island is home to a very large population of hermit crabs, with some as large as softballs. Hermit crabs are very active and scavenge any foods available including, coconut, dead rats and rodenticides in baits stations. During the day, both rats and crabs take refuge in shaded areas with heavy vegetation. At night, crabs and rats become active, seeking food. Night surveys with bright flashlights identified the greatest activity for both species was located on the golf course and the dump.

It was confirmed that rodenticides were being consumed by rats (as well as crabs and ants) throughout the island. One rat in a trap was partially consumed by another scavenger (crab or rat) and green rodenticide was observed in the stomach contents. Other observations of sick, lethargic rats indicated that they had consumed a lethal dose of rodenticide.

The greatest challenge to baiting and trapping was competition from ants and crabs. Crabs are unable to crawl up smooth surfaces or reach more than 8-12 inches above the ground. Traps and bait stations placed above the ground on plastic or metal containers were effective for trapping rats. Rodenticides hung by wires 8-12 inches above the ground could not be consumed by crabs but were subject to molestation by ants. Use of ant bait gels near the branches and on bait stations often prevented ants from molesting the bait. Mousetraps and T-Rex rat traps were superior to wooded rat traps for trapping the small Polynesian rats.

Baits were distributed throughout the island in bait stations and hung by wires from branches near the ground. Periodic inspections were conducted to ensure crabs and ants were not molesting the baits. Nighttime surveys with flashlights beginning at dusk identified some rodent activity (usually one or two) however, activity increased after heavy rainfall. A rat hunt was conducted on 21 Mar on the golf course - A total of 9 rats were collected (most belonged to one nest). Approximately 12 rats were observed in areas surrounding the golf course clubhouse where coconut and other trees provided abundant food and ground cover.

Inspection of the BAK-12 Aircraft Arresting System on the flightline identified past activity evident in bait boxes located near belts on the flightline and shacks. In a couple bait stations, rodents collected vegetation for nesting material and while another station was filled with rodent droppings, indicating the empty bait stations are being utilized for nesting and harborage.

CURRENT SITUATION

Wake Island has a "bugman" for pest control working for the Chugash contractor. He is not State Certified in Pest Management as required by DoDI 4150.07 and AFI 32-1053. He is from Thailand and speaks very little english. All contractors that apply any pesticides to DoD property must be State Certified Applicators (a Major ESOHCAMP and IG finding). Wake Island has no state certification, therefore their pest control contractor would need to obtain certification from another state (probably Hawaii). EPA pesticide certification categories required for Wake Island would include ornamental and turf (3), structural (7), and possibly forestry (2). There are currently no public health pests present but conditions are favorable for mosquitoes that transmit Dengue fever (common throughout Asia).

The current Chugash contract is primarily for structural pest control and some limited weed control. Baiting and trapping rodents outside the industrial and living areas would require additional manpower to be accomplished. In addition, control of ironwood trees with herbicides would require significantly more effort than is currently being conducted.

The Chugash contractor does appear to practice safe pest management – he was observed wearing proper PPE while operating a backpack sprayer. The Chugash pest management storage area had proper security and secondary containment but lacked air conditioning. It is recommended that window air conditioners be added to the storage area to maintain temperatures below 80°F.

The Wake Island Pest Management Plan needs to be revised to the format for in DoDI 4150.07, Enclosure 5 http://www.afpmb.org/sites/default/files/pubs/directives_mous/DOI4150.07.pdf.

An IPM Plan (Enclosure 5.2) for each pest should be developed to outline all mechanical, structural, trapping, and chemical controls to include coordination. Copies of the Wake Island Invasive Species Management Plan and Biosecurity Plan should be attached.

INVASIVE SPECIES MANAGEMENT PLAN

The Wake Island Invasive Species Management Plan was completed in 2008. Information in this plan needs to be revised to reflect the current situation on Wake Island following the aerial

application of rodenticides. This plan assumed that all rats would be eliminated and has no plans for follow-up surveillance and control efforts to keep the Polynesian rat under control.

Chemical and mechanical control of Ironwood trees should also be revised. These trees have a shallow root system and could be mechanically removed using chainsaws or heavy equipment. It is recommended that a controlled burn be used to eliminate thatch on the ground also.

Efforts to control approximately 50 ironwood trees using ready-to-use Pathfinder herbicide (triclopyr) using basal bark cut/painting methods were tried. A follow-up visit may determine how effective this method worked on large and small ironwood trees.

Vines were located throughout the open areas of Wilkes Island where ground nesting birds nested. These vines are probably a nuisance species that could be controlled easily with a boom sprayer with a broadleaf herbicide when birds are not present.

BIOSECURITY PLAN

Several potential opportunities for rats and other invasive species to enter or leave Wake Island are present. Despite having rat guards on barges, it was observed that invasive rates could easily get on/off barges by jumping directing onto the adjacent pier or running up the ramp. Other invasive species could also enter or exit the island from the port area.

Invasive and quarantined pests can also enter and exit the island on aircraft. It was noted that no stocks of d-Phenothrin aerosol was available in the Pest Management storage for aircraft disinsection as required by Defense Transportation Regulations (DTR) and Foreign Clearance Guide (FCG).

Conex containers can easily transport invasive rodents, lizards, crabs and other insect pests (such as stored product pests). Rodenticide bait left over from the aerial rodenticide application was being stored in a conex container and was heavily infested with stored grain beetles. It was recommended that at least two No Pest Strips (20% dichlorvos) be placed in each container for shipping to fumigate the contents.

A review of the Biosecurity Plan signed in January was completed. It is not likely that eradication of invasive rats will be achieved on Wake Island due to competition for baits by

crabs and ants. A long-term IPM strategy to remove invasive ironwood trees, thatch, and continued efforts to bait and trap rodents will be necessary to prevent the rodent population from rebounding. Improved baiting techniques could also be developed.

Retrograde cargo such as heavy equipment being shipped to/from Wake Island should be thoroughly washed and inspected to prevent accidental transport of seeds or soil microorganisms.

A Rapid Response Team of DoD Certified Pesticide Applicators (from Hickam AFB or other location) could be designated to respond in the event of a significant threat from invasive species. An updated survey of flora and fauna with a reference guide for identification of plants and animals would be helpful for residents and personnel conducting rodent control efforts.

BIRD/WILDLIFE AIRCRAFT SAFETY HAZARDS (BASH)

There was little evidence of BASH threats on the airfield however conditions are favorable for some species of birds. A stormwater containment area holding fresh water is adjacent to the flightline – this could be an attraction to some species of birds. Recently two geese have arrived on the island but do not pose an immediate threat to aircraft operations. Large populations of breeding birds at the end of Wilkes Island may pose a threat to aircraft during take-off or landing. No large animals are present on Wake Island that would pose a threat to aircraft.

CLEAN WATER ACT PERMIT FOR PESTICIDES (NPDES)

There is no longer a requirement to maintain a permit to apply insecticides, herbicides or rodenticides on Wake Island. Application of these pesticides is very limited following the aerial rodenticide application in 2012. No fish kills or other non-target impacts were observed.

RECOMMENDATIONS

Quarterly surveillance and baiting of Polynesian rats should continue by a team of DoD Certified Pesticide Applicators. A baiting and trapping strategy should be developed to improve success. Night time surveys will help identify if populations are growing.

Removal of ironwood trees and thatch (controlled burns) would reduce favorable food and harborage for these rats. This could be accomplished with chainsaws or heavy equipment in

some areas of the island. Herbicides or other mechanical methods would be needed to keep ironwood trees from sprouting.

Spraying of weedy vines with a broadleaf herbicide on Wilkes Island when birds are not nesting would enhance the open nesting areas on the ground.

SUMMARY

This trip was an excellent opportunity for Air Force Entomologists to identify and develop long-term management strategies for rodent control on Wake Island. This trip also provided valuable insight into the effectiveness of aerial rodenticide baiting and some of the potential issues that may prevent successful eradication efforts from succeeding.

Thank you to the 611 CES/CEAN for the opportunity to assist in this important project.

Donald Teig, Lt Col, USAF

Medical Entomologist

757 Airlift Squadron

Youngstown ARS, Ohio

DEPARTMENT OF THE AIR FORCE
YOUNGSTOWN AIR RESERVE STATION
AERIAL SPRAY UNIT
VIENNA OH 44473-5924

26 June 2013

MEMORANDUM FOR: 611 CES/CEAN

FROM: 757AS/DOS

SUBJECT: Trip Report – Wake Island – biological assessment

1. Purpose: LtCols Mark Breidenbaugh and Karl Haagsma visited Wake Island at the request of the 611th CES/CEAN (PACAF) to follow up on an analysis of rodent eradication efforts begun by a team of biologists the previous month (March 2013). Directed by their initial findings, this trip's objective was to further examine the scope of rodent infestations on Wake as well as to develop a preliminary course of action for future invasive species control. Please see trip reports by Ms. Kristen Rex and Lt Col Don Teig for additional background information.

2. General observations, impressions and recommendations:

Accounts of the residents of Wake Island indicate that the intensive aerial and ground application of baits was initially quite successful in significantly suppressing the island rat populations. However, increasing numbers of rat sightings and increased trap catch indicate that the population certainly was not eradicated and populations are in all probability, expanding. Our trapping and surveillance activities suggested that although the population may be growing, a majority of the rats may be located in a few generalized areas, most notably, in and around the landfill area, and in and around the golf course area adjacent to "heel point".

In terms of effective ground baiting, we believe several forms of competition may be responsible for lack of effectiveness. First, it appears that the bait may not be competitive with the natural food sources over time. Although we never witnessed any "feeding events" by rats, several individuals have suggested that the rats, in addition to undoubtedly feeding on a wide variety of foodstuffs (snails? See photograph), have been seen consuming the fruits of ironwood trees and may be also feeding on Asteraceae flower heads and sedge rhizomes. None of these food supplies are in short supply on Wake Island. Second, it appears that ants might be a significant competitor for the ground based baits. We witnessed complete sachets of soft bait formulation removed by ants within a 24 hour period, and the block baits seem also quite susceptible to ant attack. Some semblance of ant control was attempted with gel baits (AI –thiomethoxoam) around bait stations. Foraging ants readily recruited to the gel baits and completely removed them. However, it appeared that populations of ants (presumably mainly *Solenopsis sp*.) were such that the small amount of bait applied had little short term effect in reducing ants at the bait stations. Furthermore, it is quite probable that ground based bait stations when even minimally infested with ants, might prove to be very unwelcoming to rats. It is likely that rats that have been attacked by *Solenopsis* sp. learn quickly to avoid ants perhaps any ants. We did observe that water was an excellent barrier to exclude ants from the bait. Obviously, the handling and

replacement of a water barrier adds an additional labor load to effective baiting. Finally, in addition to ants, competitors for baits include other organisms such as the hermit crab population (hermit crabs were seen actively feeding on block baits) and cockroaches (e.g., *Periplaneta americana*).

Ground station baiting undoubtedly remains one of the best options for rodent population suppression. One of the key factors is to maintain availability of the baits and prevent infestation of unwanted organisms into the bait stations. During our visit, none of the countless bait stations we serviced contained "viable" bait materials and some of these stations had presumably been serviced as recently as 4 weeks prior. This is understandable, as the numbers of ground bait stations is far too great for a few people to adequately service and the harsh environmental conditions "age" the baits quickly. If ground baiting is to continue, we suggest focusing the baiting efforts in areas which appear to have the densest populations of rodents, with the caveat that steps be taken simultaneously to prevent bait uptake by competing organisms. Even focusing on localized areas, this might prove to be a huge task as it probably would also entail large-scale ant control efforts, as well as adequate bait station screening from the other non-target pest species. Without a doubt, this level of effort would require, in our opinion, several personnel committed to these activities on a full-time permanent or semi-permanent basis. Because of this expense we suggest that an intense trapping period with multiple workers be utilized. This level of labor is also a good argument for another aerial eradication attempt in the future if the alternative food source and refugia issue can be adequately addressed.

We used snap traps extensively as population monitoring devices. While snap traps remain useful for this purpose when properly deployed, we would not recommend snap traps as an efficient tool for population reduction (see graph). Our trapping efficiency was quite low probably because it was difficult to set a trap where it would not be molested by non-target species, and because apparently many of these rats live charmed lives and are able to clean off the baiting materials on the triggering pads without setting off the mechanism. Additionally, the marine environment apparently degrades the functionality of the snap traps, just a little bit of oxidation of the metal surfaces can lower the trigger response.

Perhaps a concurrent approach might include habitat modification along with limited ground baiting. We suggest that the ironwood trees and the detritus they produce create ideal resting habitat for rats (refugia). The ironwood population is fairly mature, dense, and well developed. Ground thatch produced is thick and provides excellent day cover for a large populations of rats. Earlier efforts on the part of our colleagues indicated that tree bark scarification and application of herbicidal triclopyr quickly and effectively killed ironwood trees. Unfortunately, the demise of the tree really does not solve the problem of thatch buildup, and the sheer number of trees on the island presents a daunting challenge. Controlled burns hold promise for tree and thatch control. However, the isolation of the island and the resources necessary to safely monitor a controlled burn may beyond the available resources and prevent this course of action.

In summary, it is apparent that aerial baiting did not eliminate the rat population on Wake Island. It is obvious that it did severely suppress the population however. Before any consideration of further aerial bait applications, it would be wise to consider habitat modification as a tool prior to any baiting activities for reasons aforementioned. On a positive note, it appears that rat populations remain relatively low at this time in comparison to previous population levels and that the only rats encountered were the species *Rattus exulans*. Further, it also appears that rats may still be absent from Wilkes and Peale Islands.

3. Daily diary of events, actions, and observations:

20 April (Arrival)
Met with MSgt Bolt and Mr. Leffler to discuss rat problem. Retrieved supplies and toured Dump site with Tao the pest controller. Toured marina (2 rats found in live traps set by Tao). Asked Tao to suspend his pest management activities at the Dump in order to develop a monitoring project at this location.

21 April (Day 2)
Set 6 live traps and 11 snap traps (rat) at Dump. Next visited the Marina and set 4 snap traps and added bait to all Marina stations including Bldg. 1705, warehouse, tanks and wharf (approx. 25 stations). During night surveillance snap trap 9 was found to have collected 1 male and trap was reset. 1 rat was seen at the Dump during surveillance. Provoke rat attractant and coconut used on all snap traps. Night surveillance conducted with spotlight and vehicle headlights. No rats were seen at the golf course or marina night surveys.
Rat total: 1

22 April (Day 3)
Dump trap numbers 5&11 had females. 1 live trap collected (juvenile). Bait was taken from 2,3,6,9,10 some traps were triggered most remained set. Feel that smaller trap may be more effective. Note that most sprung traps had both coconut and provoke removed, those that didn't had ants present. Marina surveillance: no collections from snap traps, no bait taken at warehouse, no bait taken around tanks. 3 additional snap traps and 2 live traps added. Next began work along the gravel road on the golf course. Added bait to 46 bait stations, soft and hard baits where appropriate, all bait stations were empty when opened. Two snap traps set. We then moved to Heel Point where all bait stations were reloaded (>25 stations), evidence of ants; baits had been removed (only seeds were left or small holes in soft bait). All stations were empty. No evidence of rat activity observed.
PM: renewed lure/bait on all live trap and snap trap locations at the Dump. No rats seen.
Rat total: 4

23 April (Day 4) rainfall overnight
Picked up mouse snap traps and ant bait from supply; Liquid-tox from conex. Marina trap checks: No rats taken; some live and snap traps sprung by hermit crab others with bait missing. No evidence of rat feeding at bait stations. Dump: live traps 2,3 with one male. Snap trap 6, 11 with rat. Snaps 1,2,7,9,11 were sprung, no bait left. Golf course review found no discernible rat activity, except one soft bait torn up. All bait stations had attracted ants. The 2 snap traps were untouched. Next we scouted and reviewed the Heel Point bait stations. Again, all stations had ant infestations. In some cases, soft baits had been completely removed in 24 hrs. Ant baits were added to nearly all stations (thiomethoxoam), immediate recruitment to ant bait was noted. Nassian granular did not seem to recruit ants to it immediately. Met with Tao and he showed us where he was baiting at Heel Point. His current belief is that rats are living near the old houses and crossing the road at night to feed. Traps were reset at Dump site, deployed 10 mouse traps removing some rat traps. During this time we saw approximately 6 rats engaging in physical interactions (playing, courting, territorial assertions?) under the vines growing on the largest ash pile (aka ash mountain). Also, 1 large rat observed at unused gasifier. Set 2 snap traps at the Code 4 houses at Heel Point. Night survey around golf course, with black light was inconclusive

regarding movement of lumintrax out of the station. One rat seen at the bend by the Golf Course main road.
Rat total: 8

24 Apr 13 (Day 5)
Marina check AM. No rat activity at warehouse. Bait taken at two stations at 1705. Two stations at the science shack on the edge. No traps were sprung and no bait nibbled, etc. Dump: 1 juv taken from trap 7. Bait taken from live trap 6. 1 juv male taken from snap trap 6. Snap trap 5 was cleaned out. 1 male caught in mouse trap. Bait was taken from trap and rat feces noted near lab facility.
Heel Point: 1 live and 4 snap traps on the North Side of Heel access Road and 6 snap traps were deployed around the homes (Code 4). Ant baits (insecticide) were ineffective at curtailing rat bait removal by ants.
PM: reset all traps at the Dump. Set one live trap and 8 snap traps (mouse and rat mixed); added baits to some stations around the DV quarters.
Rat total: 11

25 Apr 13 (Day 6)
No evidence of rats at DV quarters as no baits were chewed and no traps were sprung. Checked Marina snap traps. 2 were sprung, cleaned out; 1 hermit crab victim. Added 4 snap traps on the channel side near conex boxes and tanks/vegetation, based on clear bait block nibbling by vegetation and tanks. Checked arrester cable shack. Two rats (decomposed) from previous trapping here. Baits were gone, looked like ants had removed. Re-baited just the snap traps. Dump check: 1 male in live trap 5. 1 male in snap trap 9. 1 juv in mouse trap at pill box. Snap traps 4&7 were cleaned out. Traps near ash pile were cleaned out. Deployed 7 snap traps around the golf club shack. Checked live traps, no collections. Also added bait. Checked snap traps on Heel Point housing. No collections and no activity noted. Re-baited all, some with banana. Briefed Maj Van Gilder and MSgts Bolt and McChesney on status and findings.
PM: reset all traps at Dump found 1 juv in mouse trap near discarded metal shelves. Fed rat to hermit crabs at the hermit crab petting zoo. Approximately 20 minutes later, the crabs had completely dismembered and eaten the rat. No bones were left. This was the work of perhaps 15 crabs, no more and serves to point out that some snap traps may appear empty because the victims have been carted off. Full moon.
Rat total: 15

26 April 13 (Day 7)

Met with Rick Noggle and received approval to pick up Pathfinder. Met with Tao and picked up Pathfinder and drill. Went to golf shack area, found 1 bait station with First Strike half-eaten by rodent. No evidence of any other rat activity. No snap traps sprung (7 total). None of the 5 live traps were triggered or bait taken. Snap traps on golf course dirt road were picked up since they had not been sprung. Ants were continuing to remove bait or had already removed bait from stations in that area. Visited church, found evidence of rat nest in one bait station. Remainder of stations had no baits. On to Heel Point. No rats in the 10 snap traps. 4 were removed because of zero rat activity. 4 were sprung (not the ones removed). Next visited the Marina and 15 bait stations were examined with no activity noted but there were fewer ants. 4 snap traps and 1 live trap not triggered. Made the observation that there appear to be less natural food availability here (no fruit trees or daisies). Dump: 1 male at ST6 (T-Rex); 1 juv at live trap by incinerator shack;

1 female at ST5; 1 juv taken at mouse traps at 6.5. Nine traps were cleaned out or tripped. Visited the arrestor cable shack. No bait taken, no traps sprung or bait taken (no sign of rat activity)
PM: set 5 snap and 2 live traps at church. Reset traps at Dump.
Rat total: 19

27 April (Day 8)
Pre-dawn surveys (1 hr before sunrise): at Dump, no rats seen. First bend at golf course, 1 rat seen. Heel Point: 6 remaining snap traps were negative (2 sprung, the rest had ants). No rats in the live and snap traps and ants in the majority of the rebaited stations. Marina: no rats, 2 snap traps were cleaned out, no collections. Dump: 1 juv in live trap near incinerator, 2 taken at pill box; one at steel I-beam near gas tanks. 7 snap traps cleaned out. Set 5 snap traps and bait boxes and 2 live traps along the main road at second bend around golf course. Visited Peale Island: added baits to approximately 10 stations found there. No evidence of rat activity observed. Reset the Dump traps.
Post-sunset survey (1 hr): Using truck lights only. May have seen rat near water plant. Saw 5 rats along the road near second bend by golf course where traps had previously been set. Saw 3 rats along the Heel Point road. Saw 2 rats inside concrete bunker next to road (vegetation on top).
Rat total: 23

28 April (Day 9)
Met with Sandy at the Medical Clinic and received some isopropyl alcohol and containers for insect collections. Checked traps along golf course and were discouraged that even with all the activity observed the previous night there were no rats caught. Some baits were cleaned out but not snapped others had ant infestations (7 traps); 2 live traps negative also. Collected ants at the bait stations (vial #1). Traps on Heel point were checked, 3 completely cleaned out the other 3 were invested with ants. Bunker: checked for signs of rat activity. Dump: 1 rat taken at live trap #7. All other traps had bait taken or were sprung, or had ants. Began to question the mechanical integrity of these traps as some of the rat traps have a heavy trigger pull, almost as if the trigger wire is too long, also some weathering of the springs and other parts could be dulling the response. Marina: 3 traps checked no bait taken. One rat trap sprung. One carrion beetle was collected from that trap location and put into vial #2. Visited Wilkes Island. Iron wood trees (*Casuarina* sp.)appear to be very susceptible to the Pathfinder applications applied into wounds (see photos). Observed bird skeletons and also dead birds. Also saw one sick bird with tattered feathers and one lethargic bird standing the shade. These appear to be the same species (brown black petrels?). Observed some damaged eggs but did not appear to be rat damage. Also, baited approximately 10 stations. Saw large holes that look like burrows, saw one bird sitting in a hole. Observed chicks from the brown and masked boobies. Also many sooty terns had eggs.
PM: Rebaited golf course traps just before dusk saw one rat during that time. Also set a live trap and two snap traps in the concrete bunker. All traps at the Dump were rebaited.
Rat count: 24

29 April (Day 10)
Pre-dawn survey: no rats observed when walked to second bend near golf course. No rats collected again along the golf course main road. 3 were tripped and other traps with ants. Again frustrations leading to hypotheses of either faulty equipment or lack of interest by rats with many alternative food stuffs. No rats taken at concrete bunker, rat trap was cleaned out and not sprung.

When an empty styrofoam cup was dropped onto the trigger the trap sprung. Apparently these rats have an extremely soft touch. Our Dump collections restored our faith in the live traps as we collected 3 juv rats in individual traps (LT 2, 6, ash mtn); 1 big male from rat trap on I-beam near tanks, 1 female ST5, 1 female from ST6.5, 1 juv in mouse trap on block nr ash mtn. In trying to explain the record 7 rats caught this morning we noted that all the live traps had collected young, ostensibly inexperienced rats.
PM: rebaited and set traps on the golf course road and at the Dump.
Rat count: 31

30 April (Day 11)
Checked rats at golf course clubhouse. No activity at the 4 live traps. Vertical rat trap sprung. Soft bait pouch completely gone, ants had removed about half of the illumin-trax bait. No rats caught in snap traps, so those traps were removed. Zero rats collected on the golf course road; majority of traps were infested with ants and the 8 snap traps completely cleaned out. Bunker, no rats collected. One mouse trap was sprung, 1 rat trap still set but with bait cleaned out. Dump site: snap trap 7, 1 large male; st6 1 juv (t-rex); LT#6 1 female; 1 juv in mouse trap by gas fire; ST9 1 large male; 1 juv in live trap at incinerator building; 1 juv on mouse trap by ash mountain; 1 in t-rex by ash mtn; 1 juv in mouse trap on pole on hill; 1 male on top of ash mountain; 2 juv at the pill box. 2 mouse traps cleaned out; 3 rat snap traps cleaned out; 2 live traps were cleaned out. Just missed that baker's dozen (12 rats collected).
Called and discussed ironwood situation with Ms. Rex. Added bait to stations at water plant and adjacent road. Added bait to stations located at the fuel farm and Industrial area. Returned to Peale Island and checked bait. Only one possibly questionable bait block but not clear rodent teeth. Likely the work of ants. Added baits to 15 white buckets (first strike and illumin-trax). Rebaited and set traps at the main golf course road, bunker and Dump. Night surveillance along the dirt road of the golf course found zero rats.
Rat count: 43

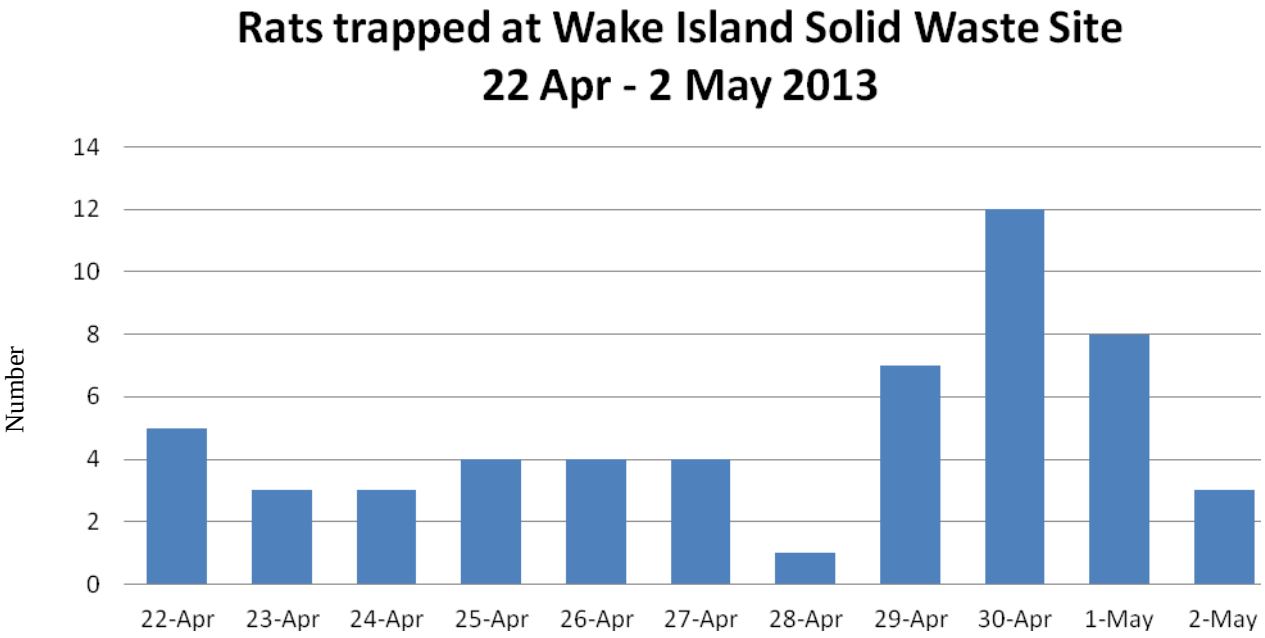
1 May (Day 12)
1 rat had been run over on golf course road. Zero rats captured or killed along golf course road, 1 first strike bait half consumed, presumed by rat, no ants. Most traps were not touched, one appeared to have bait stolen. Removed traps from golf course club house area. Zero collected at concrete bunker. Dump: ST#7 1 male; ST#6 (T-rex) 1 juv; LT#6 1 female; 1 juv in rat trap by gassifier; 1 male in mouse trap. ST#5 1 juv; 1 female in rat trap on top of ash mountain (7 total). Note all remaining stations were snapped or had bait cleaned out (all were apparently visited). Visited the arrestor cable station, 2 snap traps untouched. 6 stations rebaited. Coordinated with the technician to toss rats found snapped. Went to Marina and removed the remaining for snap traps and rebaited.
Drove through MDA and added baits to all stations encountered including Pad 1 & 2, Peacock Point and associated outbuildings.
PM: rebaited the golf course, bunker, and Dump (found 1 juv caught in snap traps during the day at the pill box (8 total). Night survey with truck saw 1 rat on gravel road thru golf course and 3 rats on main road of golf course.
(Rat count 51)

2 May (Day 13)
Pre-dawn surveys, no rats seen from DV to pet cemetery and no rats seen from DV to Marina. Nothing collected at golf course but first strike bait completely consumed on top of white bail

with associated rock and water as an ant excluder (see picture). Zero at bunker, traps removed. Dump: station #7 caught 1 male; 1 female collected on ash mtn; 1 collected in live trap near ash mtn. 12 snap traps were cleaned out but remained set (these guys are good!). (3 total)
Treated (40-60 trees) on the Marina side of Wilkes Island (tide was high). Used the machete method to remove bark and paint tree. Tried to treat all trees from the water back to the road. Smaller trees were topped and then painted. No traps set at PM.
(Rat count 54)

3 May (Day 14)
Collected all snap traps from golf course and Dump. 1 female collected in live trap. Returned unused bait and other supplies to conex. Returned live traps, used snap traps, and herbicide to Tao and discussed our findings with him. Returned Wilkes Island key to Mr. Leffler and discussed our findings.
(Rat count 55)

4 May (Day 15)
Departed Wake Island for JB Hickam – Pearl Harbor.



Rats were trapped with consistent effort over time at the Solid Waste Disposal Area (Dump). A total of 20 traps (6 live traps/7 rat traps/7 mouse traps) were set nightly for 11 nights. Our initial assumptions were that collections would be higher at the beginning of the survey as naïve rats were easily caught and then taper off as rats became wary of the traps. Instead, collections were relatively consistent with an average collection rate of 4.9 rats a night. There was some minor rainfall overnight on 23 Apr and a full moon occurred on the night of 25 Apr, neither of these two events appeared to influence trapping. A few more days of trapping may have been able to distinguish some additional patterns or if a population increase was in progress.

//signed//
Karl Haagsma, Lt Col, USAFR
DoD Certified Pest Management Professional

//signed//
Mark Breidenbaugh, Lt Col, USAFR
DoD Certified Pest Management Professional

4. Supporting photographs

All rats collected appeared to be the same species

Bait station at Heel Point

Bark split on trees killed by herbicide treatment

Pathfinder appeared to be very active in killing ironwood trees

The DV quarters were sampled with snap and baited over several nights

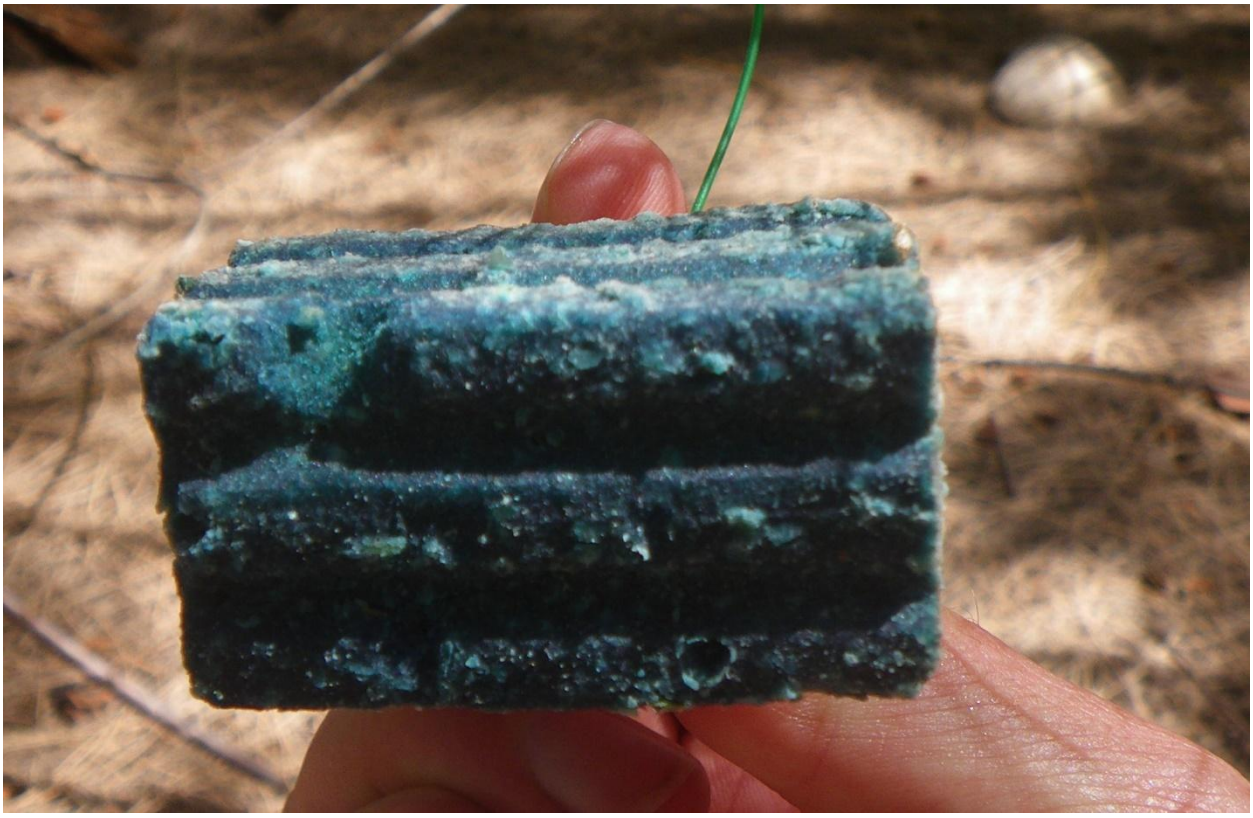
First Strike was very successful at the golf course once water had been added to thwart the ants. This photo shows that all of the bait was taken and multiple rat droppings were left

Several plant species provide natural food resources for rats

The Marina area was extensively baited

This section of the Marina was baited and trapped for over a week with no kills recorded. Some rat activity was suspected (sprung traps and chewed baits)

Other species compete with rats for baits



A suspicious bait block. We concluded that the rounded edges indicated ants were responsible and no rat activity was confirmed on Peale.

An example of a rat nest inside a bait station. Location: Arrestor cable shack.

What is predating the terrestrial snails, rats or birds?

Sick and dead birds of a single species were seen on Wilkes.

APPENDIX H
PACIFIC ISLANDS CONSERVATION RESEARCH ASSOCIATION MONITORING PLAN PROTOCALS AND UNITED STATES DEPARTMENT OF AGRICULTURE MODIFIED MONITORING PROTOCALS

The following recommendations are provided for updating the Pacific Islands Conservation Research Association (PICRA) Monitoring Plan Protocols

The USDA modified the PICRA Monitoring Plan Protocols for monitoring and survey work they are conducting on Wake Atoll. The project which is being conducted in 2014 includes looking at the efficacy of rodenticide baits for control of rats (*Rates explains*), and Pacific seabird and shorebird surveys. For the seabird and shorebird surveys, the USDA took the PICRA Monitoring Protocols and modified them to include components of the USDA Protocols. The USDA modified protocols are included in Appendix H following the PICRA Protocols. It is recommended that new monitoring plan protocols be developed for Wake Atoll using the included USDA Protocols.

ATTACHMENT E
PICRA MONITORING PLAN PROTOCOLS

WORK PLAN, MONITORING PROTOCOL, AND SAMPLING DESIGNS FOR SEABIRD MONITORING, SHOREBIRD MONITORING, SEA TURTLE MONITORING, VEGETATION SAMPLING, ARTHROPOD SAMPLING, AND RODENT POPULATION MONITORING ON WAKE ISLAND

Submitted to:
Aaron Hebshi
15 CES/CEVP
75 H Street
Hickam AFB HI 96853
USA

Submitted by:
Pacific Islands Conservation Research Association
PO Box 302
6255 SE Ash
South Beach OR 97366
United States of America

Address Correspondence to:
PICRA
2609 Braemore Rd.
Columbia, MO 65203
United States of America

PACIFIC ISLANDS CONSERVATION RESEARCH ASSOCIATION

I. INTRODUCTION

Background

Wake Atoll, an unincorporated territory of the United States, is maintained and operated by the United States Air Force, 15th Airlift Wing of Pacific Air Forces. The facility contains an airfield for the Department of Defense and for emergency use by Trans-Pacific aircraft. As an active military installation, approximately 120 contract and military personnel reside on the island at any given time.

Wake Atoll is located in the central Pacific Ocean (19º18'55" N, 166º38'21" E) and approximately 2,460 mi. (3,956 km.) west of Honolulu and 1,590 mi. (2,545 km.) east of Guam. The island complex is comprised of three islets, including Wilkes, Wake, and Peale (Figure 1). These islets form a broken V-shape with a shallow lagoon in the center. The total area of the complex is 739 hectares and reaches a maximum elevation of 21ft. above sea level.

Biogeographically, Wake Atoll lies within the Trade Winds Division of the Tropical Domain (Bailey 1995) and is closest to the Marshall Islands. Wake has significant biological resources, including seabird colonies of regional importance, stands of Pisonia (*Pisonia grandis*) forest, and a healthy and diverse reef system. Table 1 lists the atoll's 15 breeding seabird species, as well as other rare and/or protected species and habitats.

The large bird populations have drawn significant conservation attention. A cat (*Felis sylvestris*) elimination program undertaken to protect the seabirds, was declared successful in 2007. Rat (*Rattus* spp.) eradication is also being planned for the island, to occur as early as summer 2009. Further, the Wake Atoll Integrated Natural Resources Management Plan (Hickam AFB 2008) considers Wake an ideal candidate location to experimentally translocate the endangered Guam Rail (*Gallirallus owstoni*) as a surrogate species to ecologically replace the now extinct Wake Island Rail (*Gallirallus wakensis*).

Purpose and Need

Authority for the Air Force to protect and restore natural resources on the Wake Island complex is supported by Federal laws and regulations, and elaborated upon and interpreted by Air Force policy. The following laws, regulations, and instructions provide the framework for the work carried out in this monitoring plan.

- Endangered Species Act of 1973, P.L. 93-205, 87 Statute 884, 16 USC 1531.
- Migratory Bird Treaty Act of 198, 16 USC 703-712, Chapter 128, 40 Statue 755.

- Lacey Act Amendments of 1981, P.L. 97-79, 95 Statute 1073, 16 USC 3371-3378 as amended by P.L. 98-327, 98 Statue 271.
- Code of Federal Regulations (CFR) 50 CFR Part 17, Endangered and Threatened Wildlife and Plants.
- Executive Order (E.O.) 13112, 1999; Invasive Species.
- Sikes Act Improvement Act, 1 USC 670a et seq.
- Department of Defense Instruction 4715.3, Environmental Conservation Program.
- Air Force Instruction 32-7064, Integrated Natural Resources Management.
- Wake Atoll Integrated Natural Resources Management Plan (2008-2012).

Natural Resource Management on Wake Island is conducted by Chugach Support Services Incorporated (CSSI), a base operations support contractor, with oversight from the 15 Air Wing Detachment 1 Commander and the Environmental Flight based at Hickam AFB.

Figure 1. Islands comprising the Wake Atoll Complex in the Central Pacific Ocean.

Table 1. Species of interest occurring on Wake Island.

Species	**Protected status**
Laysan Albatross (*Phoebastria immutabilis*)	Migratory Bird Treaty Act Species of Conservation Concern
Black-footed Albatross (*Phoebastria nigripes*)	Migratory Bird Treaty Act Candidate for listing as threatened under Federal Endangered Species Act
Wedge-tailed Shearwater (*Puffinus pacificus*)	Migratory Bird Treaty Act
Christmas Shearwater (*Puffinus nativitatis*)	Migratory Bird Treaty Act
Red-tailed Tropicbird (*Phaethon rubricauda*)	Migratory Bird Treaty Act
White-tailed Tropicbird (*Phaethon lepturus*)	Migratory Bird Treaty Act
Great Frigatebird (*Fregata minor*)	Migratory Bird Treaty Act
Red-footed Booby (*Sula dactylatra*)	Migratory Bird Treaty Act
Brown Booby (*Sula leucogaster*)	Migratory Bird Treaty Act
Masked Booby (*Sula dactylatra*)	Migratory Bird Treaty Act
Sooty Tern (*Sterna fuscata*)	Migratory Bird Treaty Act
Grey-backed Tern (*Sterna lunata*)	Migratory Bird Treaty Act
Brown Noddy (*Anous stolidus*)	Migratory Bird Treaty Act
Black Noddy (*Anous minutus*)	Migratory Bird Treaty Act
White Tern (*Gygis alba*)	Migratory Bird Treaty Act
Bristle-thighed Curlew (*Numenius tahitiensis*)	Migratory Bird Treaty Act Species of Conservation Concern
Green sea turtle (*Chelonia mydas*)	Threatened, Endangered Species Act
Hawaiian monk seal (*Monachus schauinslandi*; occasional, none recently observed)	Endangered, Endangered Species Act Marine Mammal Protection Act
Bumphead parrotfish (*Bolbometopon muricatum*)	"vulnerable", IUCN red list NOAA species of concern
Napoleon wrasse (*Cheilinus undulatus*)	"endangered", IUCN red list NOAA species of concern
Giant clam (*Tridacna gigas*)	"threatened, low risk, conservation dependent", IUCN red list
Lepturus gasparricencis (near endemic grass)	
Coral Reefs (321 species of fish, 41 species of coral)	EO 13089
Wetlands (58 acres)	EO 11990, Clean Water Act

Under the Wake Atoll Integrated Natural Resources Management Plan (INRMP), the following requirements have been identified:

7.2.2.1 Monitor and Protect Nesting of Sensitive species. The 15 breeding seabird species and the migratory shorebirds and waterfowl that stop over on Wake Island need to be monitored to ensure their populations remain healthy and are not adversely impacted by human activities. In addition, knowledge of their population sizes and phenology (timing of breeding) over the course of the year will assist the Bird Airstrike Hazard (BASH) program in assessing and mitigating the risk of bird strikes. To implement this project, bird monitoring protocols will need to be created, with several alternative levels of effort built in to the protocols to take advantage of periods when more effort can be expended. At a minimum, however, yearly population estimates need to be conducted for each of the breeding seabirds, and reproductive success needs to be measured for the two species of albatross. Ideally, reproductive success estimates would be made for the remaining species, and relative abundances of migratory shorebirds and waterbirds would be determined. USFWS should review any monitoring plan.

7.2.2.2 Entomological surveys. Little information is known on the terrestrial arthropods of Wake Island. Basic baseline surveys need to be conducted in order to identify the presence of native arthropods in addition to the land crabs. Also, by providing a baseline, these surveys would assist in the early detection and identification of newly-arriving, potentially-invasive arthropods. Entomological surveys require special knowledge and tools and should be performed by a contractor with the assistance of the University of Hawaii and Bishop Museum.

7.2.2.3 Monitor Sea Turtle Activity - AFI 32-7064 (7.2) requires that all installations conduct basic reconnaissance surveys for federally listed threatened or endangered species. Follow-up reconnaissance surveys are required for federally listed species that may occur on the installation. It is common knowledge that the green sea turtle frequents the lagoon, nearshore reefs, and channel between Peale and Wake Island. Other species of sea turtles may also visit Wake Atoll, as may the Hawaiian monk seal. A formal monitoring program seems to be required. Short of that, at least a formalized documentation of all sightings should be prepared noting the species, dates, times, locations, and behavior of federally listed species. Especially important would be the documentation of "crawls," suggesting nesting behavior. Photo documentation would be a beneficial addition. USFWS should be consulted to assist in development of a monitoring plan.

In addition to these specific requirements, the planned rat eradication has provided an opportunity to evaluate the effects of rat predation on the whole atoll's biological community. Conducting ecological monitoring across several taxonomic and functional groups allows for the creation of a pre-eradication baseline, from which we can compare species composition and abundance once the eradication is complete. Lessons learned from this investigation can then be applied to other tropical atolls whose biota may benefit from rat eradications.

Scope of Work

The ecological monitoring protocol laid out in this document seeks to establish ecological baseline data for the following groups of organisms: seabirds, shorebirds, vegetation, terrestrial arthropods, sea turtles (on land), and rats. Section 2 details the protocols for each specific group of organisms. The aim of this document is to detail a set of repeatable methodologies for CSSI to follow as part of their continuous monitoring responsibilities, and for more detailed follow-up work post-rat eradication. When followed appropriately, the protocols will provide thorough data on species occurrence, composition, population sizes, and other biological attributes for terrestrial organisms on Wake Atoll. The protocols outlined herein are separated into *primary* requirements that must be fulfilled, and *secondary* requirements that are not essential but nevertheless provide valuable information for successful resource management. Properly implemented protocols will provide data needed to establish baseline information for the focal fauna, and continued use will provide data to evaluate changes in species occurrence and abundance. However, methodologies used to evaluate data collected with these protocols can take many forms, none of which are included in this plan.

II. ECOLOGICAL MONITORING PROTOCOLS

Seabirds

Goal: To assess changes in phenology and abundance of focal populations on Wake Island. Breeding success of specified species will also be monitored. General nesting areas are illustrated schematically below (Figure 2).

Laysan Albatross (LAAL) and Black-footed Albatross (BFAL)

Primary requirements

Initial surveys will be conducted at previously known locations (Figure 2). Nest searches will begin during the first week of October, or as soon as albatross arrive on the island. Additional searches will be conducted weekly, and reports of nesting albatrosses will be verified immediately.

Laysan Albatross begin to lay eggs in late November or early December on Midway (*see* Whittow 1993). Hatching generally occurs from late January through mid-February. Incubation stage is 63-66 days. Fledgling is expected in the middle of July, but can occur at any time between late June and early August.

Black-footed Albatross may start breeding earlier. Egg laying may occur in early November (*see* Awkerman et al. 2008). Similar to Laysan Albatross, hatching occurs in late-January and early February after a mean incubation period of 65.6 ± 1.18 days. Fledglings may leave the nest as early as the middle of June.

The entire island complex will be searched for Laysan Albatross nests every two weeks, starting in early November and continuing through March. The number and location of nests will be recorded, along with the data and observer location. Once nests are identified, reproductive status will continue to be monitored every two weeks or as soon as possible after storm events. Data will include location (geographic coordinates), date, time, status (number of eggs, nestlings, or fledged), and band number or color band combination if present. Occasionally, nests are found with two eggs; however, one egg may be removed from the nest after a few weeks (Young, pers. comm.). Egg loss and nest lost due to predation, abandonment, or storm events will be recorded.

Secondary requirements

Persons authorized by the United States Geological Survey (USGS) Patuxent Bird Banding Laboratory may mark adults and nestlings of sufficient size.

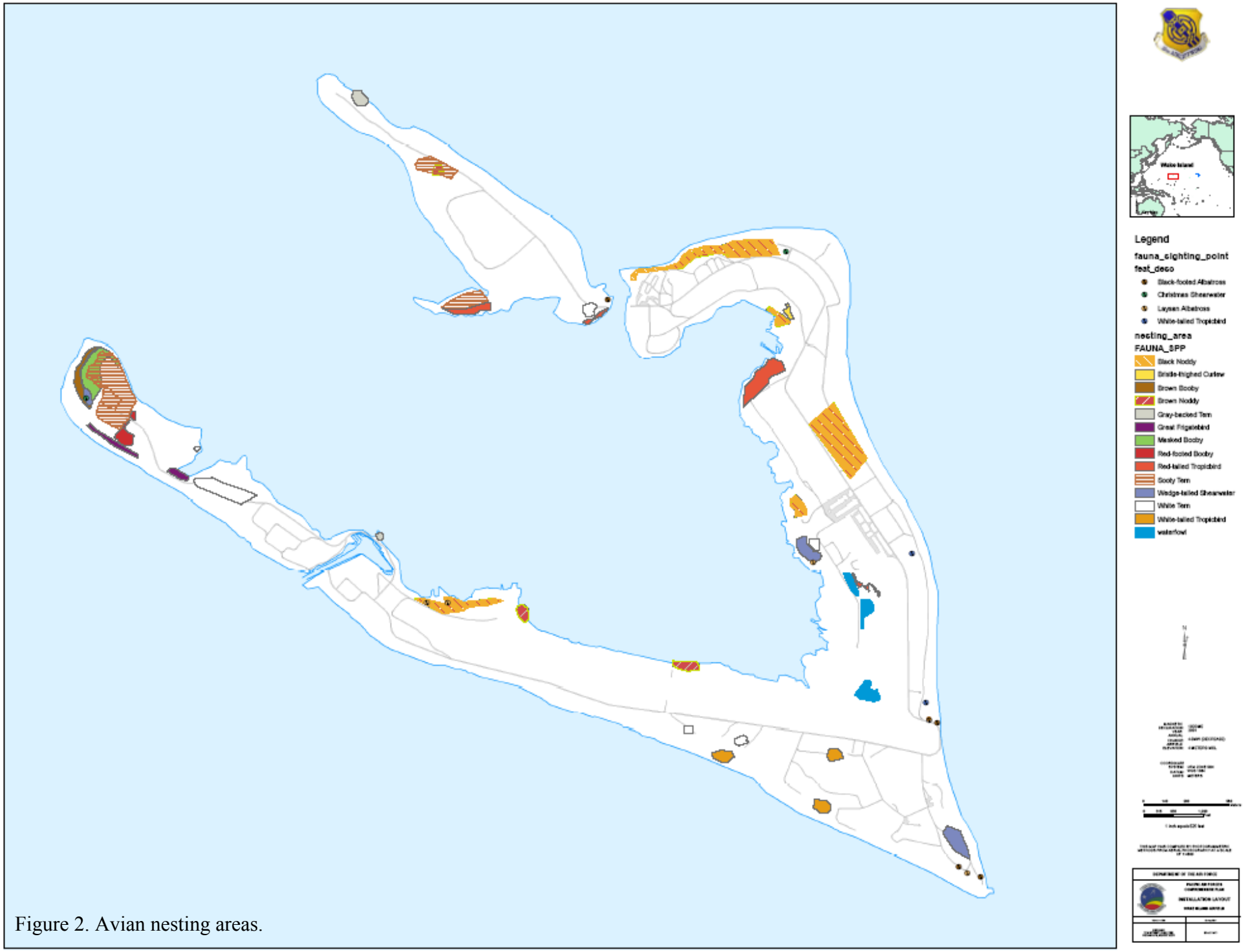


Figure 2. Avian nesting areas.

Sooty Tern (SOTE)

Sooty Terns are a widely dispersed seabird found in tropical and subtropical oceans (Schreiber et al. 2002). The breeding periodicity and degree of synchrony within populations vary throughout the range. Variation is likely due to environmental cues or a lack thereof (Ashmole 1965). Sooty Terns on Wake Island are asynchronous, leading to a range of developmental stages (incubation, nestling and post-fledgling) that occur simultaneously. Sooty Terns nest on the ground and in areas of sparse vegetation. Nest densities can be between 0.23 nest/m^2 to 9.29 nest/m^2. Mean incubation period is 28-30 days. Pipping may occur up to 36 hours prior to hatch. Chicks are vocal during this period (Dinsmore 1972 *in* Schreiber et al. 2002).

Nestlings are semi-precocial and capable of moving away from the nest site shortly after hatching, although they usually remain nearby for 4-10 days post-hatch. Nestlings may progressively spend more time away from the nest site, or abandon the nest site entirely. Chicks weigh 17.5–32.0 grams at hatch. Nestling mass increases to an average of 121 grams in three weeks. Adults weigh 178-208 grams. Growth is not uniform across the body (Ricklefs and White 1981). Age of fledging varies from 56 days to 9 months and relates to environmental conditions. Sooty Terns have extended post-fledge care. Young capable of flying may remain on the island for 18-21 days, however, adults and juveniles may remain together for two to three months.

Primary requirements

Monthly visits to known breeding areas will be used to assess breeding phenology. Timing of new nesting groups will be noted. The Sooty Tern colony will be mapped in a Geographic Information System (GIS; ArcView 9.2, ESRI, Redlands, CA) or through hand drawings later transcribed in a GIS to estimate colony area. The average density from experimental plots (see below) will be used to extrapolate Sooty Tern abundance. If experimental plots are not assessed because of limitations in manpower, density data from previous monitoring efforts will be used. Breeding phenology will be more precisely evaluated using data from each of the monitoring plots, if available.

Secondary requirements

From the colony areas, twelve permanent 7x7 m plots will be randomly selected and established to assess breeding population stage and density. These study plots will remain consistent throughout the monitoring period and from year to year. Plots will be marked at the corners with brightly painted wooden stakes and anodized aluminum tags. All nests will be counted inside of the plots to establish breeding bird densities. Developmental stage and breeding phenology will be monitored for up to 30 nests within each plot. If there are more than 30 nests in any particular plot, 30 nests will be randomly selected for research focus.

Grey-backed Tern (GBTE)

A relatively small population of Grey-backed Terns breed on Wake Atoll. Similar to other tropical species, Grey-backed Tern breeding is asynchronous and varies from year to year (Mostello et al. 2000). The incubation period is approximately 30 days. The nestling period is 38–47 days.

Primary requirements

Monthly surveys of known breeding areas will be made to assess presence and breeding phenology. Daily surveys will be made during the potential breeding season for the colony near the airfield, as part of daily airfield safety checks, to ensure that no nesting develops on the airfield. Population estimates will be made through direct counts on a monthly basis to assess changes in population size during the breeding period.

Brown Noddy (BRNO) and Black Noddy (BLNO)

Primary requirements

Noddies have asynchronous and unpredictable breeding seasons. Eight random locations within known breeding areas have been identified (Table 1, Figure 3). Four survey plots (15m x 15m) will be established at the first four suitable random locations to monitor BRNO and BLNO. The random locations will identify the northeast corner of each plot. If plots extend outside the nesting area, another random location will be selected and another plot will be established. Within each plot, the number of nests, and the stage of each nest will be recorded every two weeks to assess breeding chronology and changes in relative abundance.

Table 1. Random GIS locations for Black and Brown Noddy monitoring plots.

ID	Easting	Northing
1	672703	2135736
2	670479	2136318
3	672090	2135725
4	673131	2134646
5	672767	2135291
6	672084	2135658
7	672664	2135351
8	672640	2135381

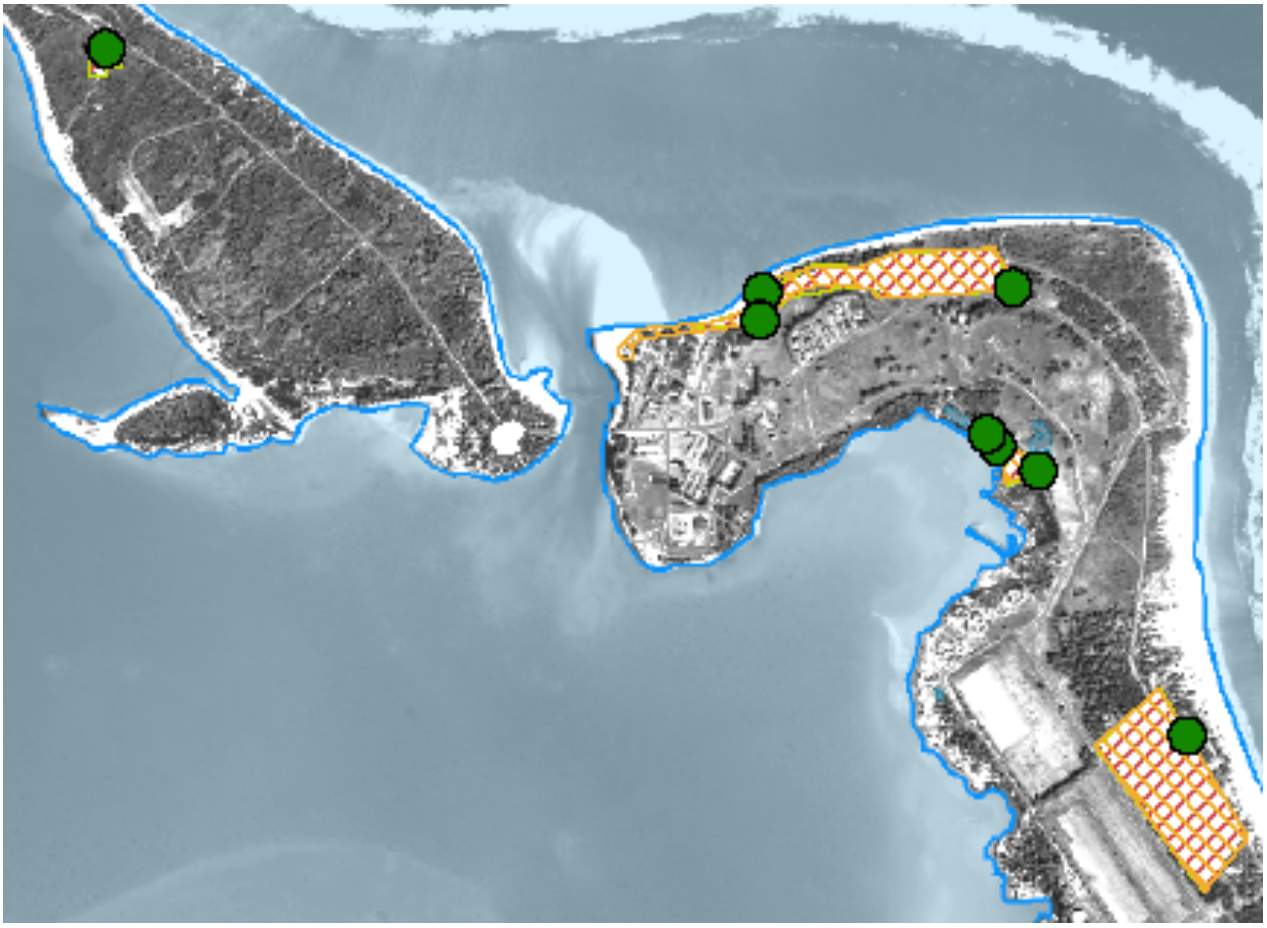


Figure 3. Randomly selected monitoring plots for Brown Noddies and Black Noddies

Brown Booby (BRBO)

The breeding period for BRBO is protracted. Brown Boobies are a ground nesting species weighing 950-1,700 grams. One to three eggs are laid in a nest built of materials including bones, branches, grasses, and human debris. Siblicide is common and pairs rarely fledge more than one young per nesting attempt. The incubation period lasts 40-47 days. Nestlings become mobile at 2-3 weeks and progressively increase activity. Juveniles fledge at 95-120 days after clutch initiation, but this may be delayed if food is limited. Post-fledgling care continues for 3-8 weeks or longer (up to 51 weeks). The breeding colony delineation is depicted in Figure 2.

Primary requirements

Population census and determination of phenology will be carried out every three months. Three-month intervals account for the incubation period and the time for chicks to acquire retrices/remiges. Observations will include total number of nests and developmental stage (egg/small chick, downy chick, large downy/gawky, mostly feathered, fully feathered). Similar to photographs in Figure 5.

Secondary requirements

To assess reproductive success, Brown Booby nests will be monitored by tracking those nearest to randomly selected geographic coordinates (Figure 4, Table 2). Twenty Brown Booby nests will be visually monitored using a scope and tripod biweekly, until fledge or fail. If twenty nests cannot be found, all nests will be monitored. Observations will include date, time, nest identification number, and nest development stage.

Table 2. Random GIS locations for Brown Booby nest monitoring locations.

ID	Easting	Northing
BB1	668122	2134990
BB2	668179	2134743
BB3	668106	2134873
BB4	668127	2134973
BB5	668132	2134996
BB6	668119	2134878
BB7	668126	2135003
BB8	668112	2134948
BB9	668138	2134899
BB10	668196	2135092
BB11	668122	2134949
BB12	668209	2135104
BB13	668149	2134813
BB14	668121	2134897
BB15	668136	2135003
BB16	668118	2134860
BB17	668114	2134979
BB18	668161	2134774
BB19	668122	2134886
BB20	668250	2135125
BB21	668125	2134981
BB22	668148	2134794
BB23	668126	2134856
BB24	668116	2134962
BB25	668151	2135028
BB26	668128	2134944
BB27	668217	2135115
BB28	668110	2134940
BB29	668107	2134884
BB30	668196	2135108

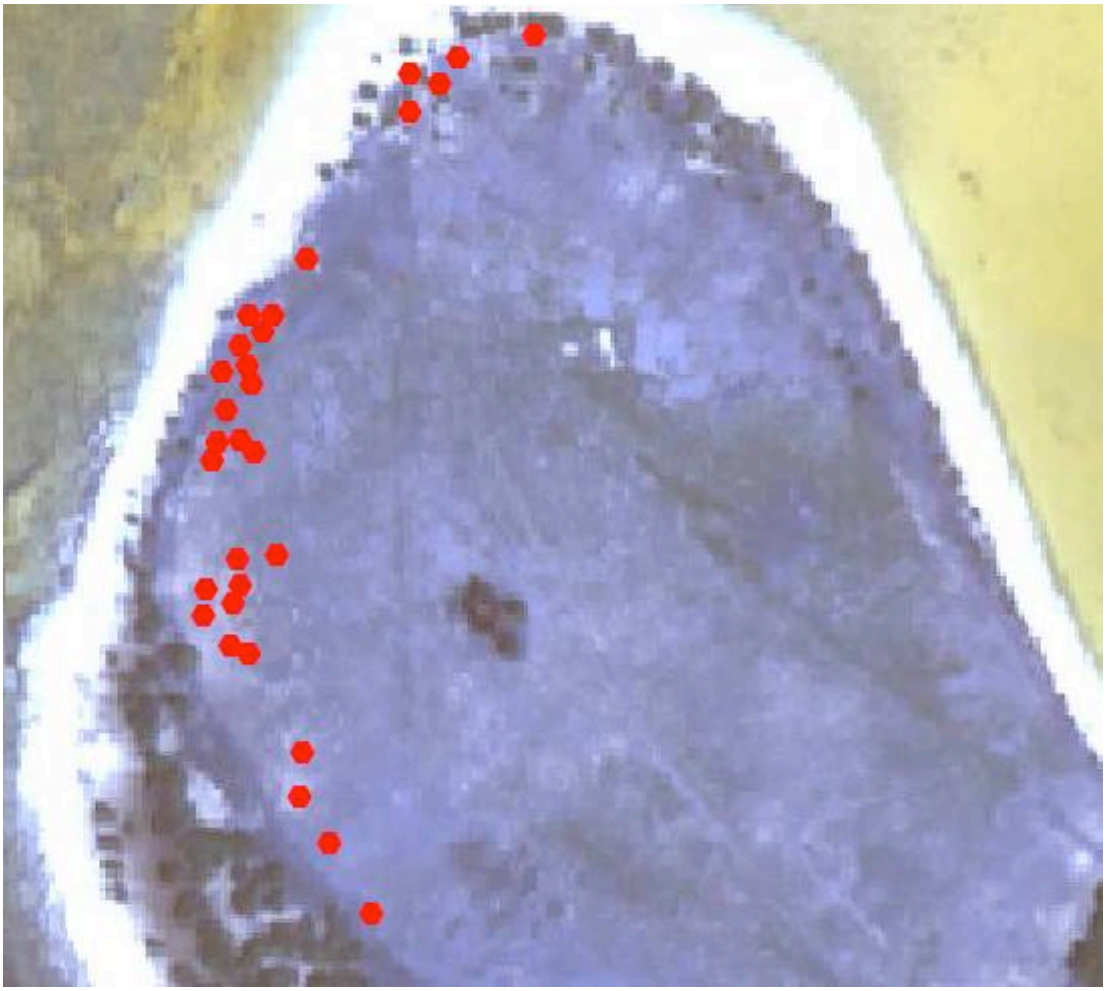


Figure 4. Randomly selected locations for monitoring nesting Brown Boobies.

Masked Booby (MABO)

Primary requirements

Population census will be performed every three months at the Wilkes Island colony (Figure 2). Three-month intervals account for the incubation period and the time for chicks to acquire retrices and remiges. Each survey will include date, number of new nests, and nest developmental stage, to assess annual abundance. Annual population size will be calculated by adding the number of new breeding pairs per check.

Adult with eggs

Downy chick

Large downy/gawky chick

Feathered juvenile with adult

Figure 5. Booby developmental stages. Photos are of masked boobies, but the same developmental stages are appropriate for Brown Boobies and Red-footed Boobies.

Red-footed Booby (RFBO)

Primary requirements

Nesting areas for RFBO will be indentified and visited monthly. Abandonment and die-off events will be recorded and described thoroughly. New breeding areas will also be documented as this may indicate population increases.

Shorebird and Waterbird Monitoring

Goal: To assess species composition, population sizes, and time of occurrence of wetland bird species.

Primary requirements

Shorebird and waterbird species composition and abundance is expected to vary through time and with season. Wetland species surveys occur weekly from three observation points within the wetland complex. Observation locations are depicted in Figure 6. Species composition may also be related to tidal fluctuations so initial surveys will be conducted to determine when in the tidal cycle surveys should be conducted to maximize bird counts. Using a scope and tripod, bird species and abundance will be recorded along with the date, time, and observation location.

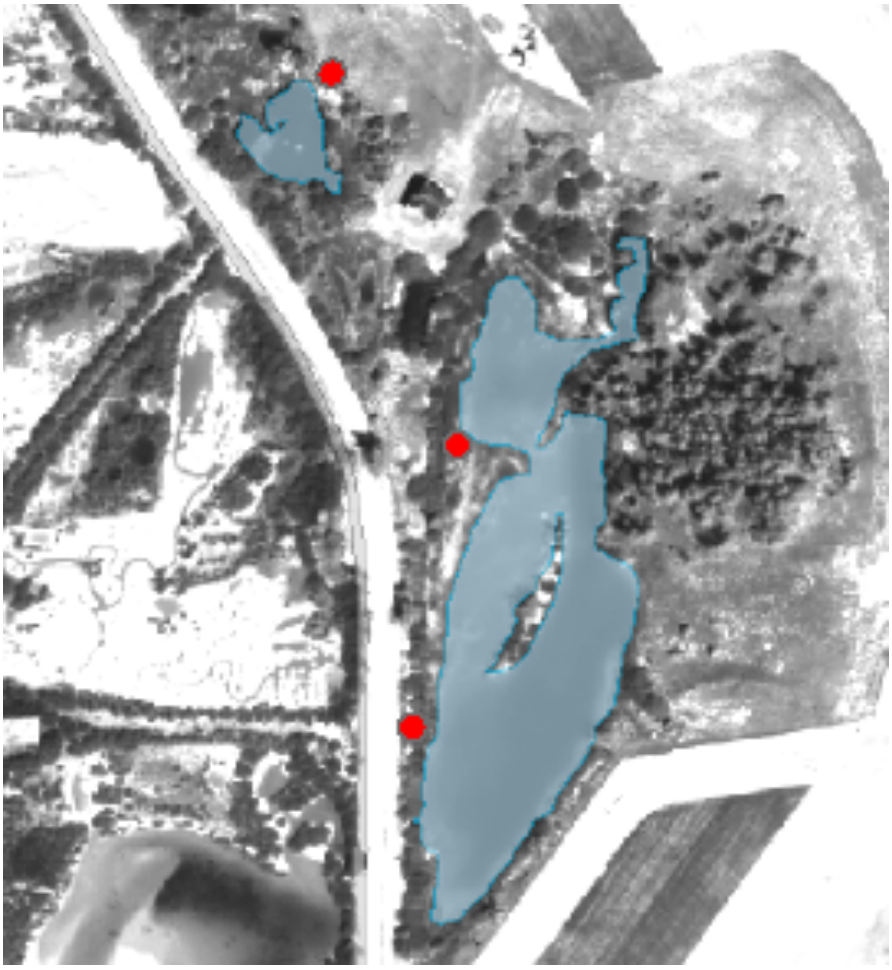


Figure 6. Wetland bird observation locations.

Sea Turtle Monitoring

Goal: To document and monitor number of nests and beach crawls (beach visits) by sea turtles. If breeding occurs, hatch success will be recorded.

Primary requirements

Although sea turtle nesting has not been documented on Wake, frequent monitoring can help determine if the atoll becomes a breeding site. Sea turtles come to shore at night to breed. The best time to monitor activity is in the early morning after rain as new tracks should be more visible. Green sea turtles (*Chelonia mydas*) are commonly found in the waters around Wake Atoll. Leatherback (*Dermochelys coriacea*), hawksbill (*Eretmochelys imbricate*), loggerhead (*Caretta caretta*) and olive ridley (*Lepidochelys olivacea*) turtles may also visit the island as their distributions include the tropical and subtropical regions of the Pacific Ocean.

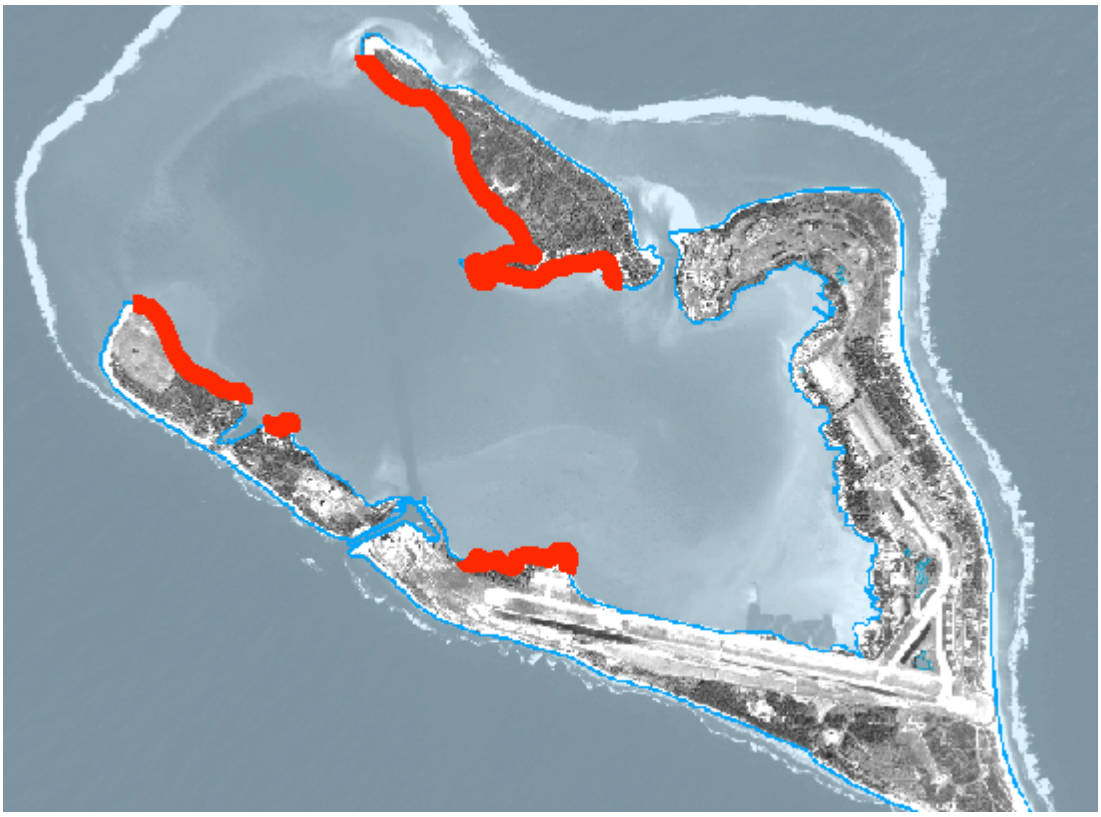


Figure 7. Beaches to be surveyed for turtle activity are delineated in red, if suitable habitat is present.

Surveys will focus on suitable nesting habitat for sea turtles. Currently, this includes the inner margin of Wilkes and Peale lagoons and the area around commander's beach house (northwest of west end or runway; Figure 7). Habitat conditions may be altered by storm events. Beaches can be selectively eliminated if site surveys reveal that habitat is not suitable for nesting (e.g., too coarse, rubble). Survey locations may be altered to reflect these changes.

Surveys will be conducted weekly in the early mornings, preferably after nighttime rain events. Tide levels may affect beach accessibility in some areas so survey times may be accordingly altered. Rain-smoothed beaches should increase detectability of new tracks. Surveys will not occur when high winds and blowing sand obscure tracks. Surveyor(s) will walk along the both the lower and upper portion of the beach. If tracks or nests are found the following data will be recorded:

- Species assessed by track size (see Figure 8).
- Date, time and current conditions.
- Nest found or beach crawl.
- Geographic coordinates for nest or highest point on the beach.
- Photos should be taken of tracks and nests.
- Comments on disturbance, erosion, or predation.
- If nests are found, area will be marked to reduce nest loss due to disturbance and trampling.

Identifying Turtle Tracks

SYMMETRIC
Leatherback
150-230 cm
Green
100-130 cm

ASYMMETRIC
Loggerhead
70-90 cm
Hawksbill
70-85 cm

Leatherback track

Loggerhead track

Green turtle track

Hawksbill track

Figure 8. Depiction and width of turtle tracks (material provided by COTERC).

Rat Abundance

Goal: To document and track changes in relative abundance of rats on Wake Island.

Primary requirements

An index of abundance will be based on driving transects that begin at downtown and terminate at boat harbor (red line, Figure 9). On the return trip, an additional segment through the water plant area along the dirt road on the lagoon side of the golf course will be surveyed (green line).

Figure 8. Transect route for rat abundance monitoring.

Transects will begin approximately one hour after sunset. The vehicle will travel at 25mph with high-beam lights illuminated to detect rats farther ahead. Data will include start time, end time at the marina, start and end time for the additional segment, and total number of rats seen on or near the road of each route. Counts will be tabulated separately for the different route components: 1) Town to east end of runway; 2) along runway; 3) return along runway; 4) east end of runway to spur; 5) spur; 6) end of spur to town. Driving transects will be conducted weekly.

Secondary requirements

Snap trap lines will be deployed once every two weeks to give a second estimate of seasonal changes in relative rat abundance. Lines of 10 traps will be deployed in each of the six segments described above. However, only one trap line will be deployed each week and all traps will be placed within a single segment. Focal segments will be rotated so that traps are placed in each approximately once three months. Within each trap line, traps will be placed 30m apart. Each trapping occasion will consist of two nights. On night 1, traps will be pre-baited with attractive bait but not set. Bait will be removed the following morning. On night 2, traps will be set. Traps will be mounted on plastic buckets to exclude crabs. Traps will be removed and the following data will be recorded: date, time, captured rats, trap tripped but no catch, trap not tripped, current weather conditions, weather conditions during previous 24 hours.

Vegetation Monitoring

Goal: To assess seedling abundance and survival of key species (Pisonia, Cordia, Tournefortia, and Ilima).

Secondary requirements

Twenty randomly selected points will be mapped within healthy native mixed Pisonia/Cordia/Tournefortia habitat on Wilkes and Peale islets (Figure 10 and 11). The points will be used as the start location for 20m plant transects. Starting points will be identified using Table 7 and then permanently marked. Orientation of the line transect will be randomly chosen from 0-360 degrees. Seedlings of *P. grandis*, *Cordia subcordata*, *Tournefortia argentea*, and *Sida fallax* that are within 0.5 m of the center of the 20m transect line will be identified and counted. Photos of each 5 m section of the transect line and close-ups of any unknown species will be recorded. Surveys will be conducted twice per year. Data will include date, transect number, species, and height of seedling.

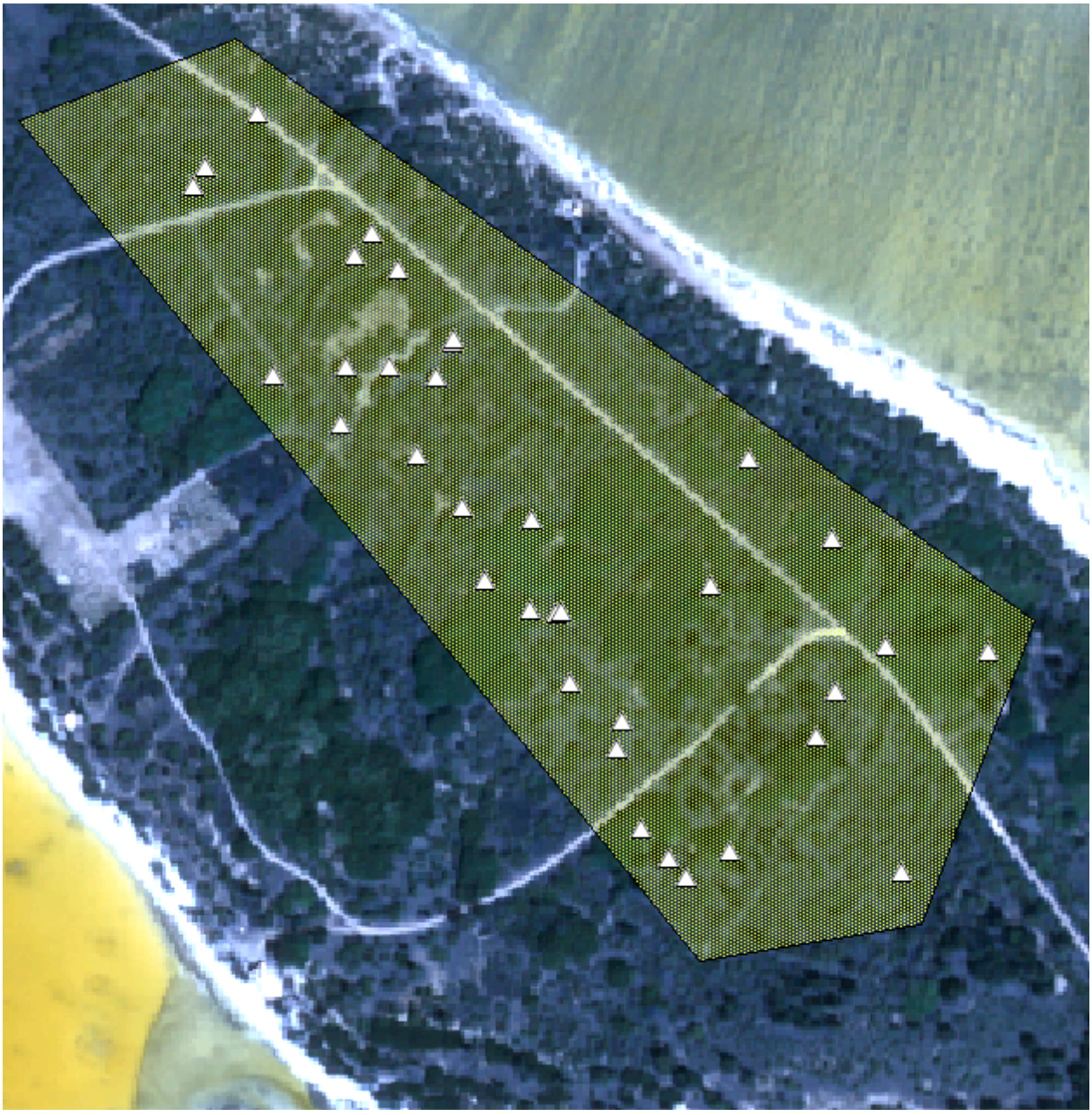


Figure 10. Randomly selected locations for vegetation monitoring on Peale.

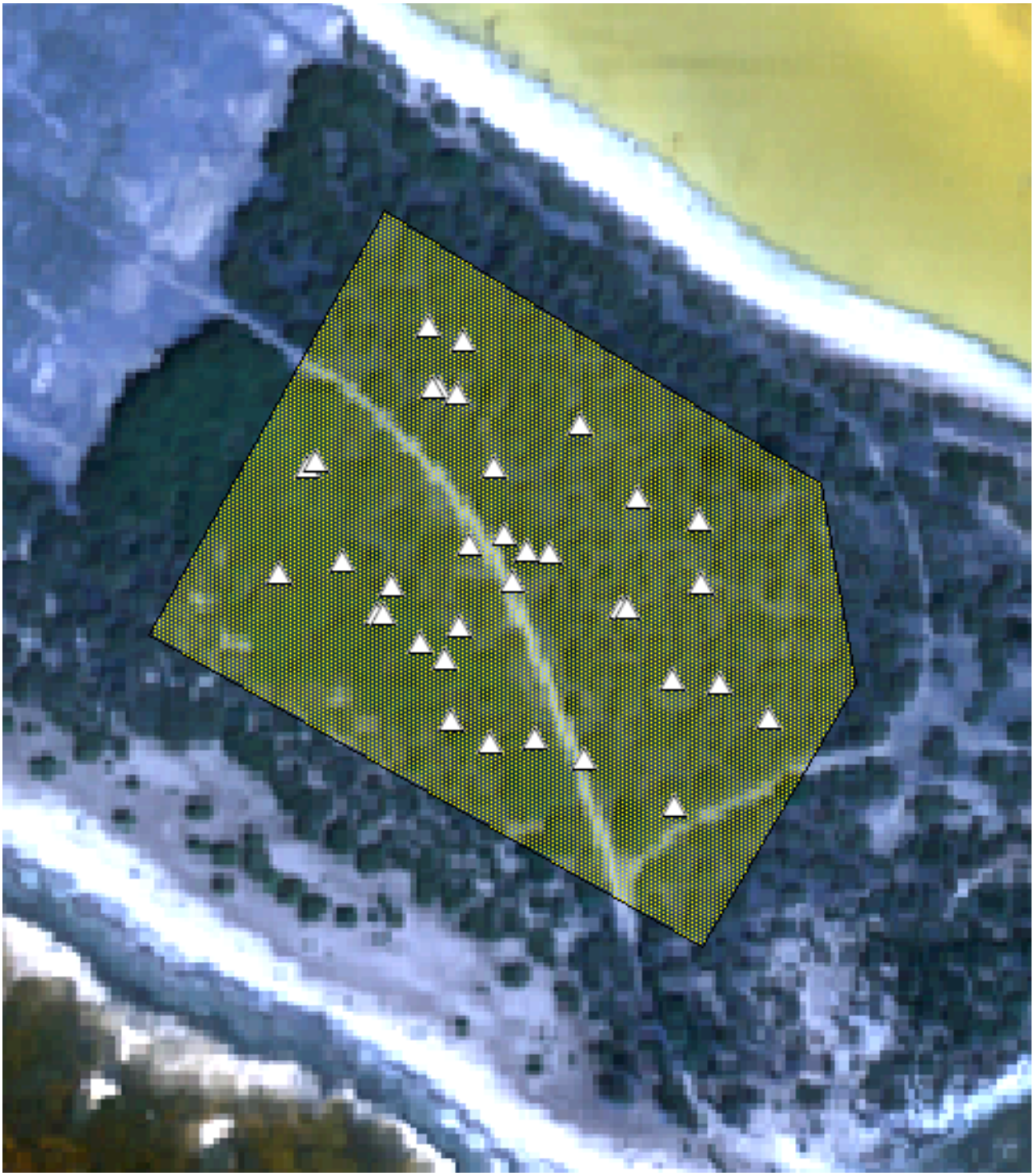


Figure 11. Randomly selected locations for vegetation monitoring on Wilkes.

Table 3. Geographic coordinates for random vegetation sampling locations on Peale and Wilkes islands. Multiple points are shown in case originals cannot be used for surveys.

Peale			Wilkes		
ID	Easting	Northing	ID	Easting	Northing
1	671113	2135776	1	668594	2134485
2	671011	2135692	2	668600	2134560
3	670738	2136025	3	668662	2134548
4	671053	2135696	4	668558	2134517
5	670824	2136098	5	668555	2134628
6	670692	2136168	6	668560	2134492
7	671067	2135967	7	668651	2134457
8	670917	2135925	8	668553	2134628
9	670979	2135786	9	668530	2134535
10	670862	2136048	10	668565	2134647
11	670794	2136107	11	668629	2134538
12	671124	2135912	12	668564	2134530
13	671040	2135880	13	668650	2134509
14	670992	2135712	14	668563	2134625
15	671172	2135682	15	668669	2134507
16	670943	2135813	16	668636	2134583
17	670683	2136155	17	668502	2134595
18	670818	2136031	18	668568	2134564
19	670884	2135883	19	668632	2134538
20	670975	2135767	20	668533	2134535
21	670728	2136206	21	668490	2134552
22	670869	2135934	22	668505	2134598
23	670933	2135861	23	668661	2134574
24	670838	2135969	24	668591	2134561
25	670785	2135991	25	668614	2134476
26	670807	2136123	26	668613	2134613
27	671232	2135834	27	668578	2134595
28	670851	2136023	28	668576	2134483
29	671161	2135838	29	668585	2134549
30	670916	2135863	30	668551	2134653
31	671127	2135807	31	668689	2134493
32	670863	2136050	32	668536	2134547
33	670937	2135862	33	668516	2134557
34	670789	2136031	34	668582	2134568
35	671024	2135678	35	668548	2134524

Arthropod Monitoring

Goal: To collect baseline information on the arthropod fauna, to identify the presence of native arthropods, and to assist in detection of harmful resident and newly arrived pest species.

Primary requirements

Twenty-four random points will be established to aid in the sampling of arthropods. Four points will be randomly selected in each of the 6 following habitat types; *Pisonia*/*Cordia*, *Tournifortia*, *Pemphis* wetland, seabird breeding colony, grassland, and *Casuarina* (Table 4, Figure 12). Pitfall traps will be set for three days at each point twice per year. Traps will be made using 24-ounce plastic containers so that the contents are protected from rain and sun. A six-ounce collecting cup will be placed inside the trap and will be 3/4 filled with water and 3-5 drops of a surfactant. The collecting cup will be flush with the ground. Pitfall traps will be removed upon collection.

Sweep nets and other opportunistic methods will be used to collect additional insects at each of the 24 sampling points. Captured insects will be aspirated into a 2-4 dram vial and filled with 80-95% ethyl alcohol. All collections will be carefully labeled with the geographic coordinates of the collection location, date, and collector. All samples will be stored in 80-95% ethyl alcohol for immediate shipping off Wake Atoll.

Figure 11. Arthropod sampling locations (see table 3 for geographic coordinates). Pink = seabird colony; blue = *Tournefortia*; brown = *Casuarina*; red = *Pemphis*; green = *Pisonia/Cordia*; purple = grassland.

Table 4. Random geographic coordinates for sampling arthropods. The first four locations listed below that fall within predicted habitat type will be used for sampling.

Id	Habitat	Northing	Easting
1	Casuarina	2134392	668661
2	Casuarina	2132646	671787
3	Casuarina	2134299	669146
4	Casuarina	2132569	672452
5	Casuarina	2135530	672988
6	Casuarina	2134037	669558
1	Grassland	2136308	670540
2	Grassland	2136275	670345
3	Grassland	2136310	670454
4	Grassland	2136287	670562
5	Grassland	2136255	670536
6	Grassland	2136338	670359
1	Pemphis	2134872	672497
2	Pemphis	2133561	673353
3	Pemphis	2133484	673309
4	Pemphis	2133725	672885
5	Pemphis	2134302	668936
6	Pemphis	2135405	670797
7	Pemphis	2133542	673288
8	Pemphis	2133486	673352
9	Pemphis	2135336	671349
10	Pemphis	2134806	672462
1	Pisonia	2136210	670810
2	Pisonia	2135633	671312
3	Pisonia	2135689	671266
4	Pisonia	2135917	670887
5	Pisonia	2135845	671167
6	Pisonia	2136153	670815
7	Pisonia	2135890	670966
8	Pisonia	2135911	670932
9	Pisonia	2135902	670990
10	Pisonia	2136045	670819
1	Seabird	2134771	668281
2	Seabird	2134611	668377
3	Seabird	2134993	668353
4	Seabird	2134814	668450
5	Seabird	2135010	668189
6	Seabird	2134959	668252
1	Tournefortia	2134590	668667
2	Tournefortia	2134548	668569
3	Tournefortia	2134033	669219
4	Tournefortia	2133083	673577
5	Tournefortia	2131931	673709
6	Tournefortia	2136001	670795
7	Tournefortia	2132342	672466
8	Tournefortia	2132271	672857

III. LITERATURE CITED

Ashmole, N. P. 1965. Adaptive variation in the breeding regime of a tropical seabird. Zoology 53:311-318.

Awkerman, J. A., D. J. Anderson, and G. C. Whittow. 2008. Black-footed Albatross (*Phoebastria nigripes*), The Birds of North America Online (A. Poole, Ed.). Ithaca: Cornell Lab of Ornithology; Retrieved from the Birds of North America Online: http://bna.birds.cornell.edu/bna/species/065

Bailey, R. G. 1995. Ecoregions of the Oceans. US. Department of Agriculture, Forest Service, Washington D.C.

Canadian Organization for Tropical Education and Rainforest Conservation (COTERC). Marine Turtle Monitoring Program- Daytime Protocol: Playa Norte, Tortuguero. Pickering, Ontario. Available at: http://www.coterc.org.

Hickam AFB. 2008. Wake Atoll Integrated Natural Resources Management Plan (Pre-Final).

Mostello, C. S., N. A. Palaia, and R. B. Clapp. 2000. Gray-backed Tern (Sterna lunata), The Birds of North America Online (A. Poole, Ed.). Ithaca: Cornell Lab of Ornithology; Retrieved from the Birds of North America Online: http://bna.birds.cornell.edu/bna/species/525

Ricklefs, R. E., and S. C. White. 1981. Growth and energetic of chicks of the Sooty Tern (*Sternafuscata*) and Common Tern (*S. hirundo*). Auk 98:361-378.

Schreiber, E. A., C. J. Feare, B. A. Harrington, B. G. Murray, Jr., W. B. Robertson, Jr., M. J. Robertson, and G. E. Woolfenden. 2002. Sooty Tern (Sterna fuscata), The Birds of North America Online (A. Poole, Ed.). Ithaca: Cornell Lab of Ornithology; Retrieved from the Birds of North America Online: http://bna.birds.cornell.edu/bna/species/665

Whittow, G. Causey. 1993. Laysan Albatross (Phoebastria immutabilis), The Birds of North America Online (A. Poole, Ed.). Ithaca: Cornell Lab of Ornithology; Retrieved from the Birds of North America Online: http://bna.birds.cornell.edu/bna/species/066

Young, Lindsay. Personal Communication 12 December 2008. Department of Zoology, University of Hawaii Manoa. lindsayc@hawaii.edu

APPENDIX: SAMPLE DATA SHEETS

Laysan Albatross (LAAL) and Black-footed Albatross (BFAL)

Nest Number	Location	Date	Time	Status	Band Numbers
1	Marina (672703, 2135736)	12/12/2008	1300	1 Egg	

Sooty Tern (SOTE)

Primary requirements: Density

Plot Number	Location	Date	Time	Number of nests
1	672703, 2135736	12/12/2008	1300	50

Secondary requirements: Nest monitoring

Plot Number	Nest Number	Location	Date	Time	Status
1	1	672703, 2135736	12/12/2008	1300	Egg

Grey-backed Tern (GBTE)

Location	Date	Time	Number of individuals	Number of nests	Number of nest with eggs	Number of nest with chicks
Airfield (672703, 2135736)	12/12/2008	1300	34	16	10	6

Brown Noddy (BRNO) and Black Noddy (BLNO)

Plot Number	Location (GPS)	Date	Time	Number of nests
1	672703, 2135736	12/12/2008	1300	50

Plot Number	Nest Number	Location (GPS)	Date	Time	Status
1	1	672703, 2135736	12/12/2008	1300	Egg

Brown Booby (BRBO)

Primary requirements: Census

Date	Number of nests	Number of nest with eggs/small chicks	Number of nest with downy chicks	Number of nest with large downy chicks	Number of mostly feathered chicks	Number of nest with fully feathered chicks
12/12/2008	30	10	6	6	4	4

Secondary requirements: Reproductive success

Nest Number	Location (GPS)	Date	Time	Status	Band Numbers
1	Marina (672703, 2135736)	12/12/2008	1300	1 Egg	

Masked Booby (MABO)

Date	Number of nests	Number of nest with eggs/small chicks	Number of nest with downy chicks	Number of nest with large downy chicks	Number of mostly feathered chicks	Number of nest with fully feathered chicks
12/12/2008	30	10	6	6	4	4

Shorebird and Waterbird Monitoring

Observation location	Date	Time	Species	Number of individuals	Cloud cover	Precipitation	Glare	Wind
1	12/12/2008	1300	RUTU	2	5%	None	5%	Calm

Sea Turtle Monitoring

Location (GPS)	Date	Time	Track size	Nests or beach crawl	Previous rain	Wind	Comments
672703, 2135736	12/12/2008	1300	100cm	Beach crawl	Yes	Calm	6

Rat Abundance

Date	Start time	End time	Segment	Number of rats
12/12/2008	1925	1945	1	7

Secondary requirements: Snap trap lines

Current weather conditions:

Previous (24 hours) weather conditions:

Location (GPS)	Segment	Date	Number of traps set	Number of traps tripped	Number of rats captured
672703, 2135736	3	12/12/2008	10	2	5

Vegetation Monitoring

Date: 12-15-2008
Location: Wilkes
Transect number: 5
Transect direction: 220 degrees

Dist. along transect	Date	Species	Height
5m	12/12/2008	*Pisonia*	10cm

United States Department of Agriculture
Animal and Plant Health Inspection Service/Wildlife Services
National Wildlife Research Center

PROTOCOL COVER PAGE

Study Title:	Wake Island: Efficacy of rodenticide baits for control of rats (Rattus exulans), and Pacific seabird and shorebird surveys."
NWRC Study Director:	Will Pitt
Approved NWRC Project:	

PROTOCOL CLASSIFICATION

1 ☐	NWRC staff are not involved in study design, data collection, experiments, or animal studies, **and** there is generally no commitment of NWRC resources other than personnel time, **and** activities are not regulated research activities*. Complete & Submit: ☐ Cover Page ☐ Part 1 (Signature Page) ☐ Part 3 (Description of Activities)	Examples: • Writing or collaborating on review papers and synthesis reports • Student committee participation • Analyzing or writing up data collected under operational or other contexts
2 ☐	NWRC staff are not involved in study design, data collection or experiments, **but** the activity involves regulated research activities*. Complete & Submit: ☐ Cover Page ☐ Part 1 (Signature Page) ☐ Part 3 (Description of Activities) ☐ Attach the NWRC or collaborating institution's appropriate regulated documentation and approval (IACUC, Biosafety, NEPA, ESA) as applicable. ☐ Attach the NWRC Material Transfer Agreement [Standard Form (for intellectual property), Chain of Custody, or Animal/Animal Tissue Transfer Form, as applicable]	Examples: • Activities requiring the use of animals, such as service on student Advisory Committees resulting in authorship, specific training programs, etc. • Providing intellectual property to other organizations for their research purposes (standard Material Transfer Agreement required) • Providing animals, tissues or samples to other organizations for their research purposes (Material Transfer Agreement for animal/animal tissue required)
3 ☐	NWRC staff actively participate in all or some aspects of the research, **and** the study involves NWRC facilities and staff, **but** the NWRC portion of the study does not include regulated research activities*. Complete & Submit: ☐ Cover Page ☐ Part 1 (Signature Page) ☐ Part 4 (full NWRC Study Protocol) ☐ Attach the collaborating institution's appropriate regulated documentation and approval (IACUC, Biosafety, NEPA, ESA, MTA/CoC) as applicable.	Examples: • Collaborating on study design, data analysis, or economic analysis. • Minor participation on a regulated study at the collaborating host institution • A study that does not include animal use, etc.
4 ☒	NWRC staff actively participate in all or some aspects of the research, **and** the study involves NWRC facilities and staff, **and** the study includes regulated research activities*. Complete & Submit: ☒ Cover Page ☒ Part 1 (Signature Page) ☒ Part 2 (Regulatory Considerations) ☒ Part 4 (full NWRC Study Protocol) ☒Complete and attach any appendices required under Part 2 including collaborating institution's appropriate regulated documentation and approval (IACUC, Biosafety, NEPA, ESA, MTA/CoC) as applicable.	Examples: • A typical NWRC led study • Major NWRC staff participation in regulated activity • Study takes place on NWRC facilities

* Regulated research activities include the use of animals, controlled materials, microbiological/biohazardous agents, test material/device; impacts historical resources, the environment or endangered species. See the Animal Use Appendix for a definition of "animal" and "animal use".

PART ONE: SIGNATURE PAGE

Study Director: _____ Date: _____
(signature)

Position (check one):

☒ Biologist/Chemist/Technician
Supervisor signature required:

_____ Date_____ ☐ Res. Scientist ☐ Proj. Leader

☐ Research Scientist

☐ Project Leader

☐ Visiting Scientist: NWRC Representative/Contact:_____

☐ Student: NWRC Representative/Contact:_____

Concur:
NWRC Research Project Leader _____ Date _____

Review and Processing:
QAU:_____ Date _____

Concur:
NWRC Assistant Director _____ Date _____

Approved:
NWRC Director _____ Date _____

Note: Additional approvals are located in the attached appendices.

PART TWO: REGULATORY CONSIDERATIONS

NO	YES	Item
A.	**Animal Use**	
☐	☒	Will study include the use of animals? An "Animal" is defined as any vertebrate. "Use" includes manipulating the behavior of wild animals in their natural habitat, as well as capturing and/or handling animals. ☒ NWRC is responsible for all or part of live animal phase; attach **NWRC Animal Use Appendix** ☐ Collaborating institution is responsible for all or part of live animal phase; attach **IACUC protocol & approval** ☐ Animal samples will be incidentally collected and received from existing WS operations. NWRC personnel are not involved in collection or design of the operation.
B.	**Microbiological/Biohazardous Materials**	
☒	☐	Will any Microbiological/Biohazardous Materials be used? If yes, please complete and attach **Microbiological/Biohazardous Materials Use Appendix**.
☒	☐	Will this study require space, equipment or personnel from the NWRC Biological Laboratory System? If yes, date of consult with Laboratory Specialist: _____
C.	**Permits**	
☒	☐	Will permits be required (e.g., collecting, marking, banding, or sampling permit)? If yes, list all pertinent State and Federal animal use/scientific collection permits, Migratory Bird Treaty Act or Endangered Species Act permits, Animal Health certificate, chemical experimental use permits, agreements, permit for controlled organisms, etc. Include all required permit numbers and approval dates. _____ _____ _____ _____ _____ _____ Permit(s) description Number Date
D.	**National Environmental Policy Act (NEPA) and Endangered Species Act (ESA)**	
☒	☐	Will study result in mortality, removal, live-capture/release, harassment of animals from/in the wild, impact their natural habitat (including application of test materials/devices) or impact non-target animal populations (i.e., could or may result in their death or serious injury)? If yes, complete the **NEPA & ESA Appendix.**
☒	☐	Could study result in the disturbance, capture or death of a state or a federally listed threatened or endangered species or the possible incidental take of eagles? If yes, complete the **NEPA & ESA Appendix**. Contact QA/NEPA staff for ESA or eagle incidental take requirements.
☒	☐	Does this study involve interstate transport of live wildlife? If yes, contact QA/NEPA staff for Lacey Act requirements.
☒	☐	Will this involve the international import or export of animal tissues or specimens? If yes, add permit information above.
E.	**Regulatory Standard and Test Guidelines**	
☒	☐	Does this study have the potential to be part of a product registration data submission? If yes, date of consult with Registration Manager: _____
☒	☐	Will this study be conducted under any regulatory standard? If yes please check: ☐ *CFR Title 40, Part 160: Good Laboratory Practice Standards (EPA FIFRA)* ☐ Other:_____
☒	☐	Will this study be conducted under any testing guideline (e.g., EPA Testing Guidelines)? If yes, please list the guideline:
F.	**Test, Control and Reference Material/Devices**	
☐	☒	Will this study include the testing of any article, material or device? If yes, attach the **Test, Control and Reference Material/Devices Formulation and Use Appendix**. Please indicate if otherwise described in the protocol.
G.	**Historical Resources**	
☒	☐	Does the research involve any major ground disturbance, loud noises, or other activity that has the potential to adversely affect historic resources (e.g. placing exclusion devices/noises around historic places)? If yes, provide information and consult with the State Historic Preservation Office.
H.	**Material Transfer Agreement /Chain of Custody**	
☒	☐	Does the research involve the transfer of materials (intellectual property, controlled materials, animals, animal tissues, etc.) to another facility? If yes, complete the appropriate **MTA or CoC Appendix**.
I.	**Analytical Chemistry**	
☒	☐	Will any chemical analysis be required of the NWRC Analytical Chemistry Project (ACP)? If yes, attach **Analytical Chemistry Appendix**.

PART FOUR: FULL NWRC STUDY PROTOCOL

1. Key Personnel

Name	Organization	Role in Study
Study Director		
Will Pitt, Supv. Wildlife Biologist	NWRC, Hilo Field Station	Study Director
Other Investigators, Collaborators, Cooperators, and Consultants		
Dean Foster, Bio tech.	NWRC, Hilo Field Station	Project leader, Field Work
Tom Mcauliffe, Bio Tech.	NWRC, Hilo Field Station	Field Work

2. Testing Facilities

Name	Address	Role in Study
NWRC	210 N Amauulu Rd. Hilo Hi 96721	Design and conduct a rodenticide efficacy
		and palatability study on wild-caught rats on Wake Island, as well as conduct standardized bird monitoring/census activities

3. Sponsor

Name	Address	Contract No.
Department of the Air Force		

4. Schedule

Proposed Experimental Start Date: February 22, 2014
Proposed Experimental Termination Date: March 16, 2014
Proposed Study Completion/Archive Date: January 14,2015

5. Background and Justification

Wake Island is an unincorporated U.S.territory located between Hawaii and Guam in the Pacific ocean and managed by the Department of Defense, U.S. Air Force. Guam island has approximately 12 miles of coastline and is an important breeding area for many species of seabirds. Two species of rats were inadvertently introduced onto Wake Island: Polynesian rats (*Rattus exulans*) and Asian house rat (*Rattus tanezumi*). A recent rodent eradication effort on Wake Island is thought to have extirpated *R. tanezumi*.

We will be working on two concurrent projects following a failed rat eradication effort on Wake Island. The projects will occur during an approximately 4 week period. First we will be testing the efficacy and palatability of toxicant rodenticide baits on resident Wake Island Polynesian rats. Second we will be doing seabird and shorebird surveys.

The efficacy of rodenticide baits against introduced rodent species found the Pacific Islands has been shown to vary by both rodenticide type and rodent species (Ashton et al. 1987, Pitt et al. 2011, Witmer et al. 2010). Effective anticoagulant toxic baits are necessary for conducting rodent eradication efforts within the Pacific Basin and beyond. Brodifacoum baits were used for the recent eradication efforts on Wake Island, but it is unknown if brodifacoum is efficacious against the local population of *R. exulans* or if the baits are palatable and thus consumed by the rats. Previous rodenticide studies determined that brodifacoum was lethal to Polynesian rats at 0.32 mg/kg (LD50, O'Conner and Booth 2001). Similar bait consumption and lethality rates were found in black rats wild–caught in Hawaii fed 2-choice brodifacoum baits (0.0025%) for three days (Pitt et al. 2011).

6. Related Protocols

QA-1344 Efficacy of rodenticide baits for the control of black rats, Polynesian rats, and mice.
QA-1428 Evaluating commercially available rodenticide baits for efficacy with Gambian giant pouched rats
QA-1605 A test of the efficacy of two commercial diphacinone baits on roof rats from Egmont Key, Florida
QA-1941 An efficacy test of a cholecalciferol plus diphacinone rodent bait for California voles resistant to chlorophacinone baits.

7. Assurance of Non-Duplication of Studies

An on-line literature search was conducted on 12/12/2013 using both Google Scholar and Digitop. No published rodenticide efficacy studies were found to have been previously conducted using wild-caught Polynesian rats (*Rattus exulans*) on Wake Island.

The bird survey portion of this protocol intentionally complements previous long term bird monitoring and census surveys on Wake Island in order to track seabird and shorebird population changes, seasonal resource use (nesting and feeding areas).

8. Objective/Hypotheses

We will be conducting palatability and efficacy tests of brodifacoum rodenticide baits upon wild caught exotic rats (*Rattus exulans*) from Wake Island. We hypothesize that Wake Island rats will consume brodifacoum baits and the baits will prove efficacious (≥80% mortality).

The second objective is not an experimental test. We will be conducting standardized bird counts and monitoring activities of seabirds and shorebirds on Wake Island following established Pacific Islands Research Conservation Association (PICRA) methods. The purpose of the ongoing bird monitoring activities is to determine if rat eradication efforts have impacted bird populations at Wake Island.

The third objective, if time and resources permit, will be to determine the distribution and relative abundance of rats across the Wake Island complex.

9. Methods/Procedures

Polynesian rat rodenticide trials and population census

1. Rodenticide efficacy and palatability trials

This rodenticide study is designed to be conducted in three parts. Two no-choice rodenticide efficacy trials will be conducted with exposure periods of 5 and 10 days each. The no-choice trials will determine if consumption of baits will cause mortality of resident Wake Island Polynesian rats when no alternative food is available. An efficacious rodenticide should cause greater than 80% mortality amongst consumers. The third trial, a bait palatability trial, will be conducted to determine if wake island rats will consume the rodenticide baits if another food item is available.

Wild-caught Wake Island rats will be captured alive using rat-sized Sherman® folding traps baited with coconut chunk or another suitable bait. Rats will be placed into cages, made on site or re-used from previous studies, and allowed to acclimate to the new surroundings and feeding pattern for up to 3 days before initiating the feeding trials. It is unknown what current animal care facilities exist, if any do, on Wake Island, and thus it is possible that we will need to make our own using existing materials and shade structures and natural ventilation and lighting. It is possible that previously used wooden racks inside an old bunker still exist and we can re-use this facility for the feeding trials (Katie Swift, personal communication). All rodents will be at least 2 months of age (i.e., sexually mature). The rodents will be provided with commercial laboratory rodent chow (5001 Rodent Diet, PMI Nutrition International, LLC, Brentwood, MO), or a similar rodent maintenance diet, and water ad libitum. Rats will be weighed and sexed within a week of the start of the trials.

Thirty rats are required for the 2 no-choice efficacy tests, 15 rats per trial. For each trial 5 females and 5 males will be randomly selected to receive the rodenticide baits no-choice and 5 rats (2 or 3 females, remaining males) will be fed non-toxic control baits (maintenance diet). A ten day efficacy test will be initiated first as it will take the longest time to complete. Next, a 5 day efficacy test will be initiated as soon as enough rats have been collected and acclimatized for up to 3 days.

Rats will be given 20g of toxic rodenticide baits per day during the trials and provided with water ad libitum. Daily and total rodenticide bait consumption will be monitored by weighing baits when the trial begins, as bait is replenished, and subtracting spillage accumulating below the wire cage on the tray, and that remaining in the cage. All rodenticide baits will be removed at the end of the fifth and tenth days respectively (if the rodent persists that long) in an effort to simulate two time periods aerially-broadcast bait might be available to rodents before it is consumed by rodents and/or other animals (especially crabs and other invertebrates) or weathered and deteriorated.

Fifteen rats are required for the two-choice bait palatability test and will be selected as above. A two-choice feeding “preference” test will be conducted for three days. During this time 20g of both toxic rodenticide baits and alternative foods will be offered to test rats. Control baits will be a combination of laboratory maintenance diet and fresh wild foods collected on Wake Island. Water will be provided ad libitum. Daily consumption of baits and challenge food will be monitored by weighing each when the trial begins, as baits/food is replenished, and subtracting that accumulating below the wire cage on the tray, and that remaining in the cage. Both daily and overall (3 days) palatability of the toxic baits to the challenge food will be calculated as follows for each test rat: (toxic bait eaten/(toxic bait eaten + challenge bait eaten))*100.

All rodents will be examined at least once daily by the study director or his designee and the condition/symptoms of the rodents and any mortalities will be recorded on a data sheet. The study director will be notified and consulted if any symptoms of pain or stress are noted. If an animal is experiencing excessive pain or death is imminent, the study director may euthanize the animal. Dead rodents will be placed in a labeled zip-lock bag and refrigerated for later necropsy. The

bag will be labeled with the QA number, study director's name, date, and cage number. When necropsied, they will be weighed, sexed, and examined for signs of anticoagulant poisoning as described by Stone et al. 1999. Rats will be euthanized either by isoflurane overdose in a small chamber (bucket with viewing port) followed by cervical dislocation. This euthanasia method was chosen since we will not have access to our standard laboratory CO2 euthanasia equipment.

Surviving rodents will be observed for another 10 days after the rodenticide bait is removed before all remaining rodents are euthanized and processed as described above. During the 10-day period, all rodents will be maintained on rodent chow and water. Any mortalities that occur in that 10 day period will be recorded and carcasses processed as described above. After necropsy, all carcasses from the study will be frozen and eventually buried in a landfill.

All test material containers will be labeled with the QA number and the Study Director's name. Additional labeling (as prescribed by FIFRA, Section 160.105 Test, control, and reference substance characterization [c]) will include: "Each storage container for a test, control, or reference substance shall be labeled by name, chemical abstracts service number (CAS) or code number, batch number, expiration date, if any, and, where appropriate, storage conditions necessary to maintain the identity, strength, purity, and composition of the test, control, or reference substance." All of the substances tested are commercially available and we will receive the identity, strength, and purity of all test materials (GLP certificates of analysis) from the manufacturer prior to use (40 CFR160.105).

If time and resources allow we will initiate rodent trapping on the entire Wake Island complex to determine the occurrence of rats and relative abundance based on catch per unit effort. The rodent monitoring protocols given in PICRA 2009 will be enhanced and are summarized here for the reader’s benefit and can be referred to in appendix A. PICRA prescribed monitoring activities involve road-cruising and the limited use of 10 baited snap traps, all on the main Wake Island only. Road cruising begins at town and continues to the boat harbor. Driving speed is 25 mph with headlights on bright. The return route is the same except for taking the spur road down along the water plant area. Driving commences 1 hour after sundown and all rat occurrences are noted.

Our Wake Island rodent monitoring efforts will likely need to be modified to reflect available equipment, supplies, and personnel, but is roughly as follows. Road cruising will not occur and we will instead increase the trapping effort. For operations purposes the Wake Atoll complex has been divided into six sampling blocks (Figure 5). Sixty to eighty snap traps will be set in each sampling block per sampling event and will be run for two consecutive nights before they are pulled and reset in another sampling block. We will collect the following data during rodent trapping efforts: weight, sex, reproductive state, location, bait condition, trap sprung/not sprung, catch/no catch, and CPUE by sampling block.

Seabird and shorebird surveys

We will be surveying seabird and shorebird populations on Wake Atoll following the established protocols and routes initiated by PICRA (PICRA attachment E 2009) and produced in their entirety in appendix A.. Monitoring efforts will need to be modified so that they can be conducted within a 4 week stay with only two biological technicians also tasked with rodent testing. Seabird population monitoring on Wake Atoll will be limited to the following 9 species: Laysan and black-footed albatrosses, sooty and grey-backed terns, brown and black noddies, and brown, masked, and red-footed boobies. Shorebird monitoring will opportunistically ID and quantify all shorebirds within the wetland areas from 3 observation points. Historic locations of breeding colonies are shown in figure 1.

Beginning the first week of October, initial albatross surveys (both species) will be focused on

previously known nesting locations and reports of arriving albatross will be verified immediately. Albatross egg incubation lasts 63-66 days with hatching occurring in late January or early February. Layson Albatross chicks on Wake Atoll fledge in mid-July whereas black-footed albatross fledge beginning in mid-June. Every two weeks Wake Atoll will be searched for Layson Albatross nests, starting in early November and continuing through March. Nest locations will be recorded and monitored every two weeks or following storm events and the following data will be collected: Observer, location, date, time, status(# of eggs, nestlings, or fledged), bird band number or color combination, egg loss or abandonment due to predation or storm events.

Sooty terns nest year-round on Wake Atoll in large breeding colonies with nest densities of 0.23 9.29 nests/m^2. Egg incubation persists for 28-30 days. Nestlings are semi-precocious and leave the nest soon after hatching but may remain nearby for 4-10 days port-hatch. Fledging occurs in 56 days to 9 months depending on environmental conditions and flying young may remain on the island for an additional 2 or 3 weeks. Sooty tern colonies will be mapped monthly to determine size (m^2). The average density from 12 7x7m plots within a particular colony will be used to extrapolate sooty tern abundance. The plots will be randomly selected and will be used throughout the study period and from year to year as long as the colony is still in the same location. All nests will be counted inside of the monitoring plots to establish breeding bird densities. Developmental stage and breeding phenology will be monitored for up to 30 nests within each plot.

Grey-backed terns will be surveyed monthly at known breeding locations to assess presence and breeding phenology. The incubation period is 30 days and the nestling period is about 38-47 days. Population estimates will be made using direct counts. Breeding is asynchronous on Wake Atoll and daily surveys will be made for the colony near the airfield as part of the daily airfield check by local staff to ensure that no nesting develops on the airfield.

Brown noddy and black noddy have asynchronous and unpredictable breeding seasons on Wake Atoll. Eight known breeding areas have been identified and map coordinates are given below (Table 1, Figure 2). Four 15x15 m plots will be established at the first 4 suitable random locations. Suitable plots will not extend outside of the breeding colony. The GPS coordinates signify the NE corner of each plot. Within each plot we will count the number of nests and record the breeding phenology for both species of noddy. Map boundaries of colonies if feasible.

Table 1. Random GIS locations for Black and Brown Noddy monitoring plots

ID	Easting	Northing
1	672703	2135736
2	670479	2136318
3	672090	2135725
4	673131	2134646
5	672767	2135291
6	672084	2135658
7	672664	2135351
8	672640	2135381

Brown boobies on Wake Atoll lay 1-3 eggs but rarely fledge more than one chick as siblicide is common. Incubation is 40-47 days with fledging 95-120 days post clutch initiation. Population estimates and phenology determinations will be conducted every 3 months and thus once during our 1-month stay on Wake Atoll. Observations will include total number of nests and developmental stage (egg/small chick, downy chick, large downy/gawky, mostly feathered, fully feathered).

To assess reproductive success, brown booby nests will be monitored by tracking those nearest to randomly selected geographic coordinates (Table 2, Figure 3). Twenty Brown Booby nests will be visually monitored using a scope and tripod biweekly, until fledge or fail. If twenty nests cannot be found, all nests will be monitored. Observations will include date, time, nest identification number, and nest development stage.

Table 2. Random GIS locations for Brown Booby nest monitoring locations.

ID	Easting	Northing
BB1	668122	2134990
BB2	668179	2134743
BB3	668106	2134873
BB4	668127	2134973
BB5	668132	2134996
BB6	668119	2134878
BB7	668126	2135003
BB8	668112	2134948
BB9	668138	2134899
BB10	668196	2135092
BB11	668122	2134949
BB12	668209	2135104
BB13	668149	2134813
BB14	668121	2134897
BB15	668136	2135003
BB16	668118	2134860
BB17	668114	2134979
BB18	668161	2134774
BB19	668122	2134886
BB20	668250	2135125
BB21	668125	2134981
BB22	668148	2134794
BB23	668126	2134856
BB24	668116	2134962
BB25	668151	2135028
BB26	668128	2134944
BB27	668217	2135115
BB28	668110	2134940
BB29	668107	2134884
BB30	668196	2135108

Every three months a brown booby population census will be performed at the Wilkes Island Colony. Surveys will record the number of nests and nest developmental stage. These quarterly surveys will be used to calculate an annual population size on Wake Atoll.

Nesting areas for red-footed booby will be identified and visited monthly and nest number and phenology recorded. Abandonment and die-off events will be noted as well. New breeding areas that are encountered during other bird census work will also be recorded and re-visited monthly. Population estimates will be made via direct counts of all red-footed boobies.

Shorebird and wading bird species composition and abundance counts will be made via

observations from three prescribed observation points (Figure 4). Observations will be made weekly utilizing spotting scopes and binoculars. Species composition may also be related to tidal fluctuations so initial surveys will be conducted to determine when in the tidal cycle surveys should be conducted to maximize bird counts. Using a scope and tripod, bird species and abundance will be recorded along with the date, time, and observation location.

Figure 1. Historic bird nesting areas

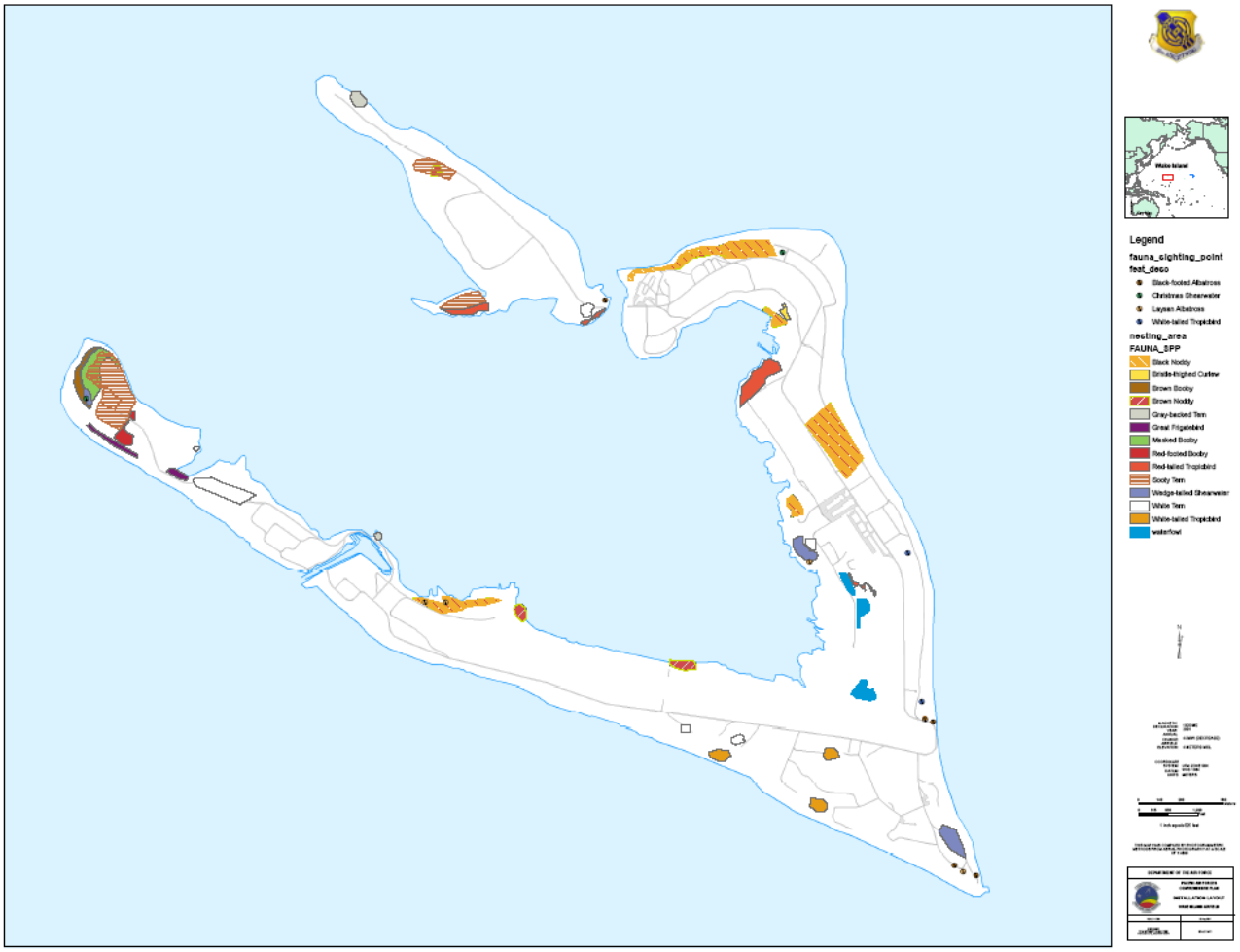


Figure 2. Randomly selected monitoring plots for Brown Noddies and Black Noddies

Figure 3. Randomly selected locations for monitoring nesting Brown Boobies.

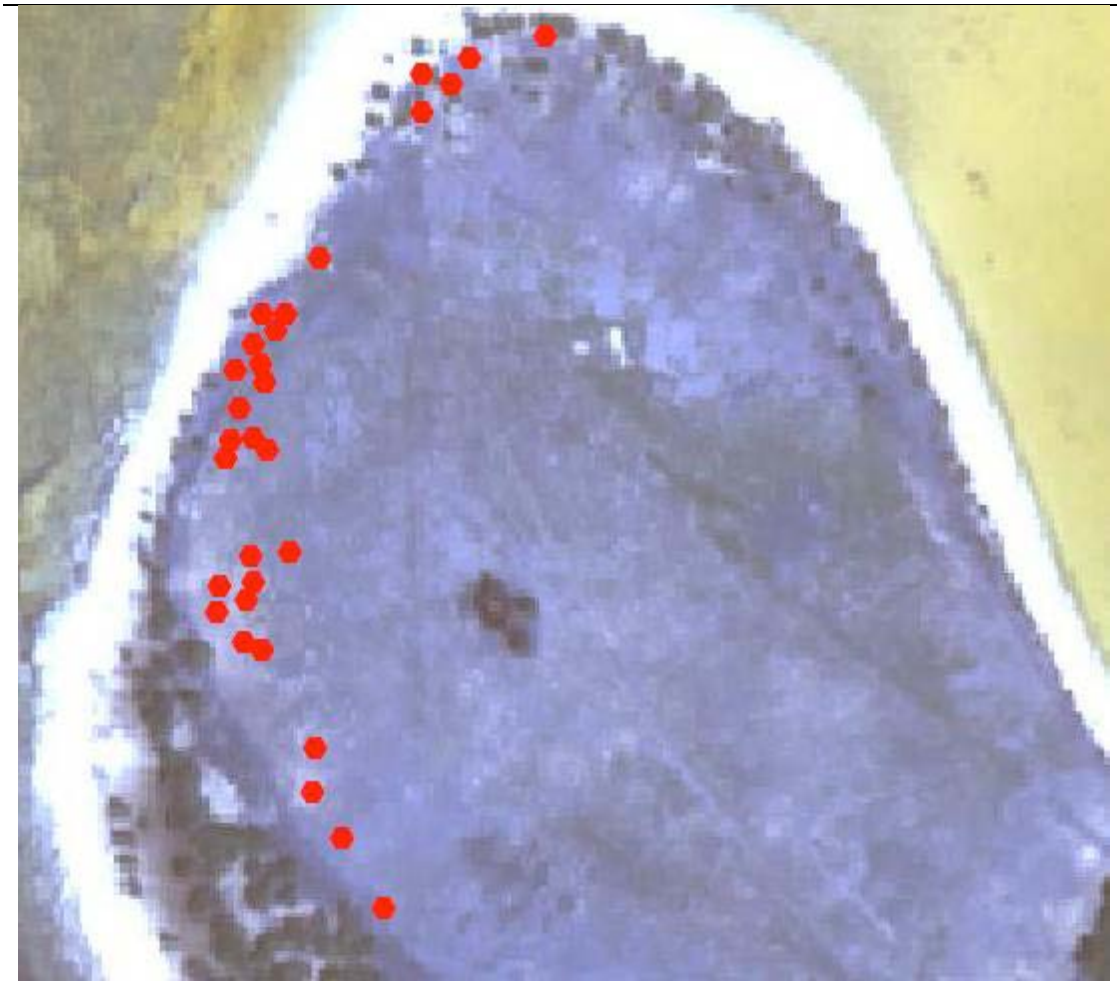


Figure 4. Wetland observation locations.

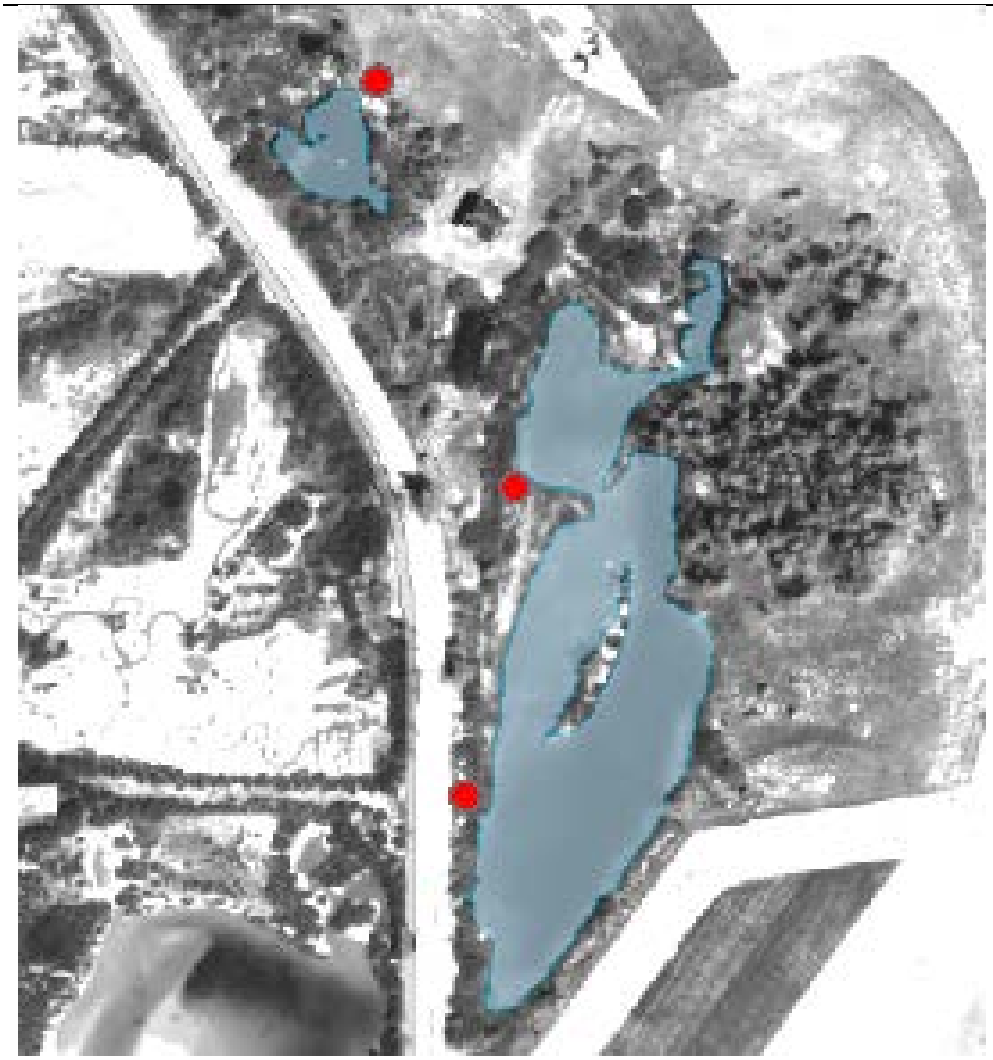


Figure 5. Sampling blocks for rodent census.

10. Experimental Design and Statistical Analyses

Rodents will be randomly assigned to the treatment and control groups. The percent mortality of treatment groups and the control group will be compared with a Chi-square contingency test. The food consumption by groups will be compared with a multiple analysis of variance test. The pre and post-trial weights of groups will be compared with a multiple analysis of variance test. Necropsy results will be tabulated and described by treatment.

11. Standard Operating Procedures (SOPs) and Analytical Methods

SOP/Method No.	*Title*
	Rodent Euthanasia via cervical dislocation
AC/HI 003.00	Rodent necropsy
AC/HI 004.00	Storage of rodent feed
AC/HI 007.00	Live trapping and care of rats
HS 004.01	Personal Protective Equipment

12. List of Records to be Maintained

A. Protocol and Amendments
B. Correspondence, telephone logs and related records
C. Data records including:
    a. Rodent cage assignments
    b. Rodenticide name, CAS number, U.S. EPA label, source, date acquired, expiration date, and batch number for each rodenticide bait used
    c. Trial start and end dates
    d. Sex and initial and final rodent weights
    e. Treatment assignment for each rodent
    f. Food consumption by each rodent
    g. Daily condition of each rodent
    h. Mortality of rodents by treatment
    i. Necropsy results
    j. Final Report
D. _____

13. Cost Estimate for Each Fiscal Year

	FY-xx	FY-xx	FY-xx	
A. Salary and Benefits				
B. Facilities (in addition to existing facility or space costs)				
C. Equipment				
D. Supplies				
E. Animal Care Costs				
F. Operating Costs (travel, misc. services, etc)				
TOTAL	$0	$0	$0	

14. Human Health and Safety

This study is not expected to cause adverse human safety issues. Adherence to all applicable SOPs will be mandatory and all persom1el will be adequately trained to perfonn the required tasks.

15. Staff Qualifications

All study participants have documentation on file, which verifies their training and qualifications for the work they will perform in this study, including SOP training logs. All SOPs and study specific training logs will be completed and documented in study or personnel records prior to participation in that aspect of the study. Other individuals (volunteers, helpers) assisting with the study will work together with trained staff.

Will Pitt Dean Foster
Thomas McAuliffe

16. Archiving

All raw data, documentation, records, protocols, specimens, correspondence and other documents relating to interpretation and evaluation of data, and final reports generated as a result of this study will be retained in the archives of the National Wildlife Research Center at Fort Collins, Colorado

17. Protocol Amendments

Any changes in this protocol will be documented on the Study Protocol Amendment Form, reviewed by appropriate personnel (e.g., IACUC, IBC, ACP, QA, etc.), and signed and dated by the Study Director, Project Leader, Assistant Director, and for regulated studies the Sponsor. Amendments will be distributed to all study participants as appropriate.

18. References

Ashton A.D., Jackson W.B., and H Peters. 1987. Comparative evaluation of LD50 values for various anticoagulant rodenticides. In: Richards CGJ, Ku TY (eds) Control of mammal pests. Taylor & Francis, London, pp 187–197

O'Connor, C.E. and L.H. Booth 2001. Palatability of rodent baits to wild house mice. Department of Conservation, Wellington, New Zealand.

PICRA monitoring plan protocols, Attachment E, 2009. CAC-FIN-P041/Rev. 6. PICRA, 2609 Braemore rd., Columbia, Mo. 65203.

Pitt, W.C., Driscoll, L.C., & Sugihara, R.T. 2011. Efficacy of Rodenticide Baits for the Control of three Invasive Rodent Species in Hawaii. Archives of Environmental Contamination and Toxicology 60:533-542.

Stone, W., J. Okoniewski, and J. Stedelin. 1999. Poisoning of wildlife with anticoagulant rodenticides in New York. Journal of Wildlife Diseases 35:187-193.

Witmer, G..W., Snow N.P., and P.W. Burke. 2010. Evaluating commercially available rodenticide baits for invasive Gambian giant pouched rats (Cricetomys gambianus). Crop Protection 29:1011-1014.

19. Appendices

Indicate none or check attached appendices:

☐ None
☐ Animal Use Appendix
☐ Analytical Chemistry Appendix
☐ Column E Explanation
☐ Material Transfer Agreement/Chain of Custody
☐ Microbiological/Biohazardous Materials Formulation and Use Appendix
☐ NEPA and ESA Appendix
☐ Test, Control and Reference Material/Device Use Appendix
☐ Other: Appendix 1._____

☐ Collaborating institution is responsible for live animal phase; IACUC protocol & approval attached

Animal Use Appendix

An “Animal” is defined as any vertebrate. “Use” includes manipulating the behavior of wild animals in their natural habitat, as well as capturing and/or handling animals.

Note: A consultation with the NWRC Attending Veterinarian must be performed prior to submitting this appendix to the IACUC for review. Allow a minimum of 2 weeks for the IACUC review process.

A. Animal Description

1) Animals:

Species, subspecies (if applicable): *Rattus exulans*
Breed, strain and substrain (if applicable): Wake Island free-ranging population
Total Number and Sex: 45, equal sex
Body weight range: rats ≥20 g,
Age: all ≥2 months old

B. Rationale for involving animals, for appropriateness of species, and for numbers.
Provide justification why this study requires the use of animals, and for the numbers to be used.

1) Rationale for involving animals: Eradication of Polynesian rats (*R. exulans*) on Wake Island in 2011 failed. We need to better understand rodenticide efficacy and palatability to Wake Island rats prior to conducting an additional eradication effort on Wake Island.

2) Rationale for appropriateness of the species to be used: Both introduced *R. exulans* and R. *tanezumi* were naturalized on Wake Island prior to a rodent eradication effort in 2011. The eradication effort apparently eliminated *R. tanezumi* but not *R. exulans*. Thus, the proposed feeding trials will investigate the efficacy and palatability of rodenticide on a sample of the remaining *R. exulans* population.

3) Rational for numbers of animals to be used (include description of any animals to be obtained as extra if appropriate): Forty-five Polynesian rats is the minimum number of rats required to run both the efficacy trials (5 and 10 day trials) and palatability trials (3 days).

C. Source
Free-ranging rats (most likely only Polynesian rats, *R. exulans*) will be obtained from local wild populations on Wake Island.

D. Method of identification of animals
Each rodent will be assigned and maintained in an individual cage or that will have a unique number attached to the cage; that number will correspond to the rodent's ID number.

E. Trapping/Collecting
The rodents will be trapped according to established protocols using cage, box, and snap traps (AC/HI 006.00, AC/HI 007.00). Baiting and pre-baiting will use fresh coconut chunk and shreds from Wake Island coconuts.

F. Transport

Animals will remain in the live traps and be transported a short distance from the point of capture to the animal testing facility on Wake Island. Traps will be kept out of the sun so as to not overheat the captured animals. We likely will be transporting the animals using bicycles and backpacks.

G. Handling/restraint

Rodents will be handled only as necessary (i.e., when weighing and determining sex or when transferring from one cage to another). Personnel will use leather gloves and a heavy cloth sack to facilitate handling and to assure safety (HS 004.01; AC/HI 007.00).

H. Quarantine

3 days prior to testing

I. Housing/maintenance

Rats will be housed in plastic animal bins or wire cages made on site and fed maintenance diet and provided with clean water ad libitum.

J. Dietary contaminant exposure

There is no expected dietary contaminant exposure in this study, and it is non-applicable due to there being no housing in this study.

K. Disposition of animals

Rats that did not expire during the toxicant feeding trials will be euthanized with cervical dislocation at the completion of the trials (AC/HI 002.00). Mortalities (rats) will be necropsied to determine if the cause of death is consistent with anticoagulant toxicants. All carcasses will be disposed in a sanitary landfill or buried under at least 3 feet of soil in a location designated by the Air Force officer in charge of Wake Island or his designee.

L. Animal pain or distress

1) Consultation with Attending Veterinarian:
Consult with the Attending Veterinarian in advance to address any animal care and use issues. The Attending Veterinarian will determine if any portion of the study might cause more than momentary or slight pain or distress. Consultation should include discussion of alternative procedures, sedatives, analgesics, anesthetics, surgery and euthanasia.

Note: Consult separately, and with appropriate advance notice, the Animal Facilities Supervisory Personnel for space allocation in designated Animal Facilities.

Name of Attending Veterinarian: _____Gordon Gathright, DVM_____

Date of Consultation: _____ 12/20/2013_____

2) Is this study expected to cause more than momentary or slight pain or distress as determined by the Attending Veterinarian ?

☐ No

☒Yes If yes, continue with the following items.

a) Alternative procedures: None. Laboratory bioassays with live animals are a common, standard, and necessary method for determining the efficacy of candidate toxicants. We know of no other means of accomplishing this purpose.

b) Sedatives, analgesics, or anesthetics or Column E Explanation: None. The use of sedatives, analgesics, or antidotes would interfere with the objectives of the test and would invalidate the data.

If sedatives, analgesics, anesthetics will be withheld, attach the **Column E Explanation Appendix** and complete items #4—6.

c) Surgery: N/A

M. Euthanasia

Isoflurane overdose followed by cervical dislocation.

N. IACUC Approval

Date of IACUC Approval Letter: _____

Column E Explanation

1. Registration Number: 84-F-0001

2. Number of animals used in this study during this reporting period: 45

3. Species (common name) of animals used in study during this reporting period: *Rattus exulans*

4. Explain procedure producing pain and/or distress: Brodifacoum anticoagulant rodenticides will be fed to wild-caught rats, *Rattus exulans.* Rats feeding on the brodifacoum baits may experience more than momentary pain or distress. Animals will be monitored at least twice daily. Observations will be recorded in the animal observation log.

5. Provide scientific justification why pain or distress could not be relieved. State method or means used to determine that pain and/or distress relief would interfere with test results. The explanation should be scientific in nature, yet easily comprehensible to an educated lay person. (For federally mandated testing, see item 6 below):

Rodenticide palatability and efficacy determination requires testing the materials on live, target animals. Introduced rodents are serious pests of natural resources, human food stuffs, and human and livestock health. They are the target species of these pen trials to improve control and eradication techniques. The number of rodents per group for rodenticide efficacy trials recommended by the U.S. EPA is 10. Each rodent in a group will represent 10% of that group; hence 8 or the 10 rodents in a group must die to achieve the target efficacy level of ≥80%. Because there are 3 treatment groups and 2 control groups, a minimum of 45 rodents is required.

6. What, if any, federal regulations require this procedure?

Agency: None CFR: N/A

NEPA and ESA Appendix

A categorical exclusion (CE) is based on consideration of all environmental issues relevant to this study, including consideration of cumulative impacts on wild animals and other environmental parameters, such as removal caused by the study combined with other reasonably foreseeable removals by other causes (e.g., sport harvest, wildlife damage management actions, and any other known causes of mortality) pursuant to APHIS NEPA Implementing Procedures at 7 CFR Part 372.5(c)(2)(i). Examples of projects which would likely require more than a CE include, field trials that will have future effects (the registration of chems.), projects that result in death of a large number of animals or a large proportion of the population, projects which may adversely affect T&E species, and projects with uncertain environmental impacts.

A. This study qualifies for a Categorical Exclusion because:

☐ It is a research and development activity that will be carried out in laboratories, facilities, or other areas designed to eliminate the potential for harmful environmental effects--internal or external--and to provide for lawful waste disposal and does not include the use of free-ranging wildlife.

☐ It is a routine measures activity, such as surveys, sampling that does not cause physical alteration of the environment

☒ It includes the lawful use of chemicals, pesticides, or other potentially hazardous or harmful substances, materials, and target-specific devices or remedies, however such use will:

- ☒ A) be localized or contained in areas (<10 acres) where humans are not likely to be exposed, and is limited in terms of quantity
- ☒ B) not cause contaminants to enter water bodies
- ☒ C) not adversely affect any federally protected species or critical habitat
- ☒ D) not cause bioaccumulation

☐ This study does not qualify for a Categorical Exclusion.

B. Will this activity occur anyway even without involvement by NWRC?

☒ No

☐ Yes If yes, describe why this activity will occur and attach written confirmation from those conducting activity.

C. Address the potential to impact target species populations (including *cumulative impacts* of all activities on such populations, where relevant) and steps to be taken to minimize it.

Polynesian rats are significant pests in agricultural and conservation areas of pacific islands and are routinely controlled with the use of rodenticides to reduce damage levels. Our rodenticide trials will be limited to caged wild-caught rats and will no significant acute or cumulative impact upon the local Wake Island population of exotic Polynesian rats.

D. Address the potential to impact non-target species populations (including *cumulative impacts* on such populations, where relevant) or non-target domestic animals (e.g. pet cats, ducks, etc.) and steps to be taken to minimize it.

Our rodenticide trials will be limited to caged wild-caught rats and will not impact non-target species in any foreseeable way.

Effects on T&E species and eagles:

E. Could study result in the disturbance, harassment, capture or death of a state or a federally listed threatened or endangered species or the possible incidental take of eagles?

☒ No

☐ Yes If yes, describe species, potential impact and measures to be taken to minimize impact:

☐ Other: *Highly unlikely (risk is negligible) because ……..*

Consultations:

F. Did you consult with a state or federal agency specifically on this action?

☐ No

☒ Yes If yes, describe the date/mode/contact person and outcome of this consultation:

US Air Force. MORAN, MATTHEW T GS-12 USAF PACAF AFCEE/AFCEC/CZO Alaska IST <matthew.moran.3@us.af.mil>; charlie.taylor@us.af.mil charlie.taylor@us.af.mil; and Kris Rex. December 23 2011 and prior dates. Outcome: Support and concurrence of the needed efficacy and palatability trials.

G. Landowner Permission: Do you have an agreement or permission to conduct the action on property owned or managed by a land manager or landowner.

☐ No, permission not needed because:

☒ Yes

☐ Other: *Permission will be obtained prior to entering property…..*

Test, Control and Reference Material/Devices Formulation and Use Appendix

A. Describe the test material/devices

As appropriate, for each material provide the chemical, bait or device

1) name or code	25 W Conservation, EPA reg. #: 56228-36, or a substitute labeled rodenticide
a) Concentration and purity:	Brodifacoum (CAS No. 56073-10-0) 0.0025%
b) Source:	Not yet purchased
c) Batch number:	Not yet purchased

For non-standard materials, describe the material/device in detail and provide the name and location of the formulation laboratory or facility that will prepare the material.

B. Describe any control or reference materials/devices

As above, for each material provide the chemical, bait or device

1) name or code	Purina® Labdiet® rodent chow
a) Concentration and purity:	
b) Source:	Purina
c) Batch number:	Not yet purchased

C. Carriers, mixtures and material preparation

Commercial rodenticide baits will be obtained directly from the supplier

D. Route of administration

Oral, free-feeding.

E. Dosage

Commercial baits formulated at the standard EPA pesticide label dosage.

F. Test, control, and reference substance accountability

Cite the appropriate SOP(s) (e.g., AD 012) for substance accountability or describe how these materials will be appropriately documented, handled, tracked and disposed of. For all TCRSs to be used in a regulated or potentially regulated study, for which NWRC characterization is required, or when required by the Study Director or Sponsor, a retention sample must be taken and provided to the Analytical Chemistry Project/QA for archive. For studies meeting these requirements, indicate the TCRS tracking number below.

TCRS tracking number(s):_____

G. Material verification

Include how and when the test material will be sampled and tested for identity, strength, purity, stability and uniformity, as appropriate.

Supplier will supply an assay.

APPENDIX I
BIOLOGICAL AND INFORMAL CONSULTATION OF THE USFWS FOR THE PROPOSED CONTINUING OPERATIONS AT KOKEE AIR FORCE STATION AND MICROWAVE ANTANNA SITE, ISLAND OF KAUAI.

FEBRUARY 2017

Biological Opinion and Informal Consultation of the U.S. Fish and Wildlife Service for the Proposed Continuing Operations at Kōkeʻe Air Force Station and Microwave Antenna Site, Island of Kauaʻi

Photo Credit: Kristen Rex, CSU CEMML

February 14, 2017
(01EPIF00-2016-F-0497)

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

United States Department of the Interior

FISH AND WILDLIFE SERVICE
Pacific Islands Fish and Wildlife Office
300 Ala Moana Boulevard, Room 3-122
Honolulu, Hawai'i 96850

In Reply Refer To:
01EPIF00-2016-F-0497

FEB 2 8 2017

Lt. Col. Jeremiah J. Hammill
Commander
Department of the Air Force
Pacific Air Forces
611th Civil Engineer Squadron
10471 20th Street, Suite 302
JBER, Alaska 99506-2201

Subject: Biological Opinion and Informal Consultation for the United States Air Force Pacific Air Forces Regional Support Center Proposed Continuing Operations at Kōke'e Air Force Station and Microwave Antenna Site, Island of Kaua'i

Dear Lt. Col. Hammill:

This document transmits the U.S. Fish and Wildlife Service's (Service) Biological Opinion (BO) based on our review of the United States Air Force Pacific Air Forces Regional Support Center (USAF) proposed continuing operations at Kōke'e Air Force Station (AFS) and Microwave Antenna Site (MAS), on the island of Kaua'i, and its effects on the federally threatened Newell's Shearwater (*Puffinus auricularis newelli*), endangered Hawaiian Petrel (*Pterodroma sandwichensis*), and the endangered Hawai'i population (distinct population segment (DPS)) of the band-rumped storm-petrel (*Oceanodroma castro*) in accordance with section 7 of the Endangered Species Act of 1973 as amended (Act) (16 U.S.C. 1531 *et seq.*). Your request for formal consultation was received on August 11, 2016.

A separate informal consultation is found in Appendix A for project impacts that may affect but are not likely to adversely affect the federally endangered Hawaiian hoary bat (*Lasiurus cinereus semotus*) and endangered Hawaiian goose (*Branta sandvicensis*).

This biological opinion is based on information provided in: (1) the August 11, 2016, Biological Assessment (BA) for your proposed project; (2) email and verbal communication between the USAF staff and our office; (3) survey and reports; and (4) other information available to us. A complete administrative record of this consultation is on file in our office. Our log number for this consultation is 01EPIF00-2016-F-0497.

CONSULTATION HISTORY

The Service has been working with the USAF to assist in the conservation and management of listed species. Correspondence applicable to the completion of conservation measures and other consultation requirements after issuance of the 2011 BO is not discussed below. The following represents a detailed chronology of actions and correspondence applicable to beginning work on this BO.

August 7, 2015 – The Service received information regarding one dead Newell's shearwater and one dead Hawaiian petrel at Kōkeʻe AFS. Both birds had brood patches and were transmitted to the Waimea Fire Station and later received by the Kauaʻi Humane Society – Save Our Shearwaters Program (SOS).

August 11, 2015 – The Service received information regarding another Hawaiian petrel found dead at Kōkeʻe AFS.

August 27, 2015 – The Service emailed the USAF requesting follow up information regarding the August 7 and 11 fallout reports.

August 31, 2015 – The USAF emailed the Service regarding interest for a site visit during the migratory bird and fallout refresher training for the staff at Kōkeʻe AFS. It was arranged for October 2, 2015, to allow for the widest information dissemination of training refresher for staff.

September 2, 2015 – The SOS updated the Service on total birds received by the Kōkeʻe AFS: two Hawaiian petrels (one dead, one alive) and 10 Newell's shearwaters (one dead, nine alive). The Service informed, via email, the USAF of the updated information.

September 2, 2015 – The USAF emailed their downed bird log report to the Service. Records included all endangered species from February 26, 2013 to September 1, 2015. A total of 12 fallouts (identified all as Newell's shearwaters by Kōkeʻe AFS point of contact) was documented during thick fog events on the night of September 1. The USAF requested initiation of dialogue regarding the use of lasers or other light emitting devices to identify "lines" on property. The Service requested more detailed information regarding conditions of the station during the fallout. The USAF provided more information regarding the fog and green lighting conditions, as well as the timing of fallouts throughout the night.

September 8, 2015 – The USAF emailed an update to their downed bird log report to include one live Newell's shearwater downed on September 5. The USAF also updated the Service on additional information regarding facility lighting conditions and the request for staff to replace any missing window blinds.

September 9, 2015 – The Service received an unofficial phone update and emailed the USAF that 26 birds were downed at Kōkeʻe on September 8: all were breeding adults (10 dead and 16 alive in various conditions). We requested the USAF to get personnel on site to evaluate and shut off all non-essential lights prior to the Service October 2 site visit.

September 9, 2015 – The Service received an email from the SOS stating that 22 Newell's shearwaters (16 alive; 6 dead) were brought down from Kōkeʻe AFS on the morning of September 9. The Service called the USAF and discussed efforts to minimize continued fallout, as well as have Service and seabird biologists to assist in assessment and retrieval of birds for the night of September 9. The USAF provided an updated downed bird report and maps for these September 8 and 9 birds.

September 10, 2015 – The Service received reports of 43 Newell's shearwaters and one Hawaiian petrel found at Kōkeʻe AFS at midnight on September 9. The Service emailed and phone called the USAF to take immediate action to preclude additional take of birds by nightfall on September 10. The USAF emailed a request of review for several intermittent fixes to attempt to reduce the fallout. The USAF stated the perimeter lights would be turned off from 9:00 pm to 11:00 pm and request for an electrician to re-orient lights to a downward facing position. Lighting within the perimeter would be turned off at the determination of Kōkeʻe personnel for safety requirements. Seabird biologists and a Service biologist provided assistance for the evening at the USAF site.

September 11, 2015 – The USAF turned off lights from 6:00 pm to 11:00 pm on September 10, and found 20 Newell's shearwaters and one Hawaiian petrel from the night of September 10. The USAF found an additional 6 Newell's shearwaters that came down after lights were turned on at 11:00 pm. The Service notified the USAF that all lights need to be turned off for the entire night through the dark moon phase, for two weeks, and until the USAF could address the required light modifications which they have submitted for a work order. The USAF emailed the Service that the command and leadership has been briefed on the current topic and previous nights' observations via three separate teleconferences (relayed importance of making installation less attractive via interim fixes as well as longer term more expensive fixes; perimeter lights would be off all night, except when required for safety or security; Department of Defense electricians have been scheduled for redirecting upward pointing perimeter lights to the downward position; and Service and seabird biologists would be on site to assess facility minimization measures and assist with the retrieval of any downed birds.

September 12, 2015 – The SOS notified the Service that they received eight Newell's shearwaters that morning and received a phone call that two Newell's shearwaters had been dropped off at the Waimea Fire Station (one found on the road by tourists and the second by Kōkeʻe AFS staff) (10 total retrieved Newell's shearwaters for September 12).

September 14, 2015 – The SOS emailed the Service of their receipt of two Newell's shearwaters on Sunday, September 13 (one from an individual who found it on the road outside the Kōkeʻe AFS), and one Newell's shearwater on September 14.

September 24, 2015 – The USAF notified the Service of the cooperative agreement award for avian monitoring in 2015.

October 8, 2015 – The USAF emailed the Service regarding a refined plan of action for employment of additional labor to monitor effects of the installation operations on protected seabird species. The timing and parameters of a proposed green light trial (post re-alignment;

only perimeter lights) were described within the email. The USAF requested comment on proposed monitoring for efficacy of retrofitted lights.

October 9, 2015 – The Service responded via email and agreed that such trial should take place in order to evaluate the re-adjustment of errant perimeter lights which may have spilled excessive light into the night sky. Additionally, the Service recommended the USAF avoid the week of October 12, 2015, due to new moon conditions.

October 15, 2015 – The USAF emailed the Service and State of Hawai‘i Department of Land and Natural Resources – Department of Forestry and Wildlife (DOFAW) biologists regarding a proposed lighting attraction trial for the purposes of determining how seabirds respond to the re-angled green security perimeter lights. The proposed plan would be to accomplish a thorough seabird sweep right at dusk to ensure there were no hiding seabirds on site prior to the testing of the lights. Approximately 30 minutes after full darkness only the green perimeter security lights will be turned on. The USAF biologist would be standing by to observe and respond to any attraction or potential fallout that might occur. Should the biologist note either unusual attraction to the lights by the birds or any fallout, the lights will be turned off and any downed birds recovered. The DOFAW seabird biologist suggested the trial project be postponed a couple more weeks to a more appropriate moon phase to minimize fallout of birds.

October 16, 2015 – The USAF emailed regarding the postponement of the light attraction trial at Kōke‘e AFS due to a more appropriate moon phase. A USAF biologist would be on site the night of October 16, to monitor any seabird activity while the station was still dark.

October 22, 2015 – The USAF emailed the Service and DOFAW biologists regarding details of the proposed lighting trial targeted for the next full moon on Tuesday, October 27, 2015. The parameters of the lighting trial would include: only the recently re-angled green perimeter security lights will be tested; all other facility lighting be turned off; the perimeter security lights be turned on approximately 30 minutes after full darkness; the USAF hired biologist present for the light trial; the lights remain on until any unusual attraction to the security perimeter lights is noted, or if any fallout occur.

October 23, 2015 – The DOFAW emailed the USAF and the Service stating they would have a seabird biologist on site for the October 27 lighting trial.

October 27, 2015 – The USAF notified the Service that evaluation of re-adjustments to lighting infrastructure begins with monitoring for seabird species.

November 18, 2015 – The USAF emailed the Service that their USAF biologist found a fledgling Newell’s shearwater at Kōke‘e AFS during her nightly monitoring the night of November 16. The bird was taken down for care at the SOS. The USAF confirmed the end of perimeter light trial due to downed bird trigger. The USAF requested from their USAF leadership to have blackout lighting conditions through December 15 based on this November 18 bird documentation. The USAF discussed the perimeter lighting trial had been ongoing since October 27, 2015, with no observed birds during the interim period, giving some hope that the re-alignment would be successful, however, based on the discovery of a fledgling fallout, they

would assume the bird was attracted by their newly modified green lights and would move forward with a revised approach. The USAF reiterated their previous phone conversation with Service staff on re-initiation of their section 7 consultation.

November 18, 2015 – The Service emailed the USAF about a potential opportunity for the USAF to fund a seabird conservation project for a barn owl control team to work the Northwestern part of Kaua‘i. The funding source for this project was expiring and there would be potential to continue the program.

November 19, 2015 – The USAF emailed and discussed their questions regarding the barn owl control work and Service recommendations for the proposed seabird conservation project.

January 26, 2016 – The USAF notified the Service that they have solicited for a contract or cooperative agreement for barn owl control work and wanted to notify the Service that the $100,000 solicitation was placed on Grants.gov from 12 Dec - 19 Jan. There was no interest, but would be discussing interest or non-interest from current implementers with seabird management experience and would update the Service on a status update once it was discussed. This solicitation pre-empts the delivery of the formal re-initiation package, but the USAF was already putting efforts to focus on the 2016 late summer-fall period at Kōke‘e AFS. This solicitation was for seabird research/management/monitoring support at Kōke‘e AFS. Additionally, the USAF would be funding work for on-site monitoring during fallout periods, specifically fall 2016. The project tasks were listed in the version of the draft BA and would be forthcoming.

March 11, 2016 – The Service emailed the USAF requesting a status of re-initiation. The Service also requested status of lighting conditions, specifically if there would be blackout conditions, for the upcoming breeding season. We emphasized that adult seabirds are likely prospecting for sites and would not want to attract adult birds.

March 11, 2016 – The USAF emailed the Service stating the BA was awaiting approval of the walking path light concept from their Security Forces, which would be used during a “mutually agreeable fallout period,” and would call to discuss that element further. The USAF agreed the fallout period not only includes fledgling seabirds, but also adults, and would include a wider time period given the previous year’s data of fallout birds. Additionally, the USAF Fiscal Year (FY) 2016 site monitoring and execution of conservation measures was granted authority to sole source to the University of Hawai‘i (UH), and a proposal for the statement of work would be worked out towards this conservation measure. Finally, the USAF would call to discuss the time periods of usage of the walking path lights so the Service and the USAF would be both in agreement.

March 25, 2016 – The USAF emailed to let the Service know that they funded a cooperative agreement to continue progress towards achievement of current conservations measures. The USAF wanted to document and ensure the Service that the USAF had been making attempts in FY16 to fund tasks that would result in the monitoring of potential impacts to threatened and endangered species and would further contribute to invasive species removal.

April 4, 2016 – The USAF emailed the Service requesting our thoughts on a recommended blackout period for high mountain installations on the island of Kauaʻi of April 1 to December 30 based on the natural history and behavior of Newell's shearwaters and Hawaiian petrels. The Service emailed the USAF and agreed on the knowledge of the seabird expert for his recommended dates to be as conservative as possible and to minimize take of adult breeding birds.

April 5, 2016 – The USAF requested a written documentation from the Service on our recommended blackout period dates.

April 21, 2016 – The Service received the 2016 *Monitoring of Endangered Seabirds on Kōkeʻe Airforce Station and off-site Predator Control* work plan and staff list.

May 3, 2016 – The Service mailed a hard copy and digital copy (via email) (Service File: 01EPIF00-2016-TA-0292) letter recommending a complete shut off of all lights (blackout conditions) from April 1 to December 30, the adult prospecting and breeding period as well as the fledgling fallout period, to minimize the incidental take of Newell's shearwaters and Hawaiian petrels.

May 4, 2016 – The USAF notified the Service that the cooperative agreement had been approved for continued monitoring efforts and some off site invasive owl work.

May 9, 2016 – The Service received an email from the UH stating the SOS had been notified of a downed Newell's shearwater from Kōkeʻe AFS the morning of May 9. The Service emailed the USAF regarding a report of a downed Newell's shearwater on the night of May 8 and for an update of the status of approval for blackout conditions.

May 9, 2016 – The USAF notified the Service (via email and phone call) that on Monday, May 9, 2016, on-site installation notified the 611th EV office of a single Newell's shearwater individual. The bird was taken to the SOS location. Additionally, the Service letter requesting blackout of lights had been forwarded via email to the USAF decision authority and was awaiting their response and action.

May 10, 2016 – The USAF notified the Service (via email and phone call) that a second Newell's shearwater had been found on the night of May 9 and that according to Kōkeʻe AFS Chief at approximately at 8:07 pm, the night of May 9, the perimeter security lights were off, while the building exterior lights were on. A security officer found the downed Newell's shearwater on the grass near the guard shack. The bird was picked up and placed into a cardboard box and taken to the Waimea fire station on the morning on May 10.

May 10, 2016 – The Service requested the USAF to expedite the approval for blackout conditions to prevent further fallout.

May 10, 2016 – The USAF emailed the Service stating the perimeter lights were not on at Kōkeʻe AFS the night of May 9.

May 10, 2016 – The Service received an email from SOS regarding the Newell's shearwater received from Kōkeʻe AFS from the night of May 9.

May 10, 2016 – The USAF emailed the Service that the Commander had issued the edict for lights out at Kōkeʻe AFS in order to address impacts to seabirds.

May 19, 2016 – The Service emailed the USAF requesting the status of the USAF BA.

June 2, 2016 – The Service emailed the USAF requesting the status of the USAF BA.

June 3, 2016 – The USAF responded to the Service (via email) on the status of their BA. The USAF anticipated a complete draft by the end of the week and welcomed the Service to provide feedback on the preliminary list of measures provided in email.

August 11, 2016 – The USAF submitted a digital copy of the BA and cover letter requesting re-initiation of section 7 consultation. The Service responded with confirmation of receipt of both documents.

August 18, 2016 – The Service emailed the USAF regarding the band-rumped storm-petrel, a species proposed for listing as endangered, and requested the USAF to confirm if they would like to include in their section 7 consultation request.

August 25, 2016 – The USAF emailed the Service requesting the initiation of a formal conference to address the band-rumped storm-petrel. The Service responded to the USAF with receipt of their request.

August 24, 2016 – The USAF requested to have a meeting to discuss the BA.

September 1, 2016 – The Service met with The USAF to discuss the conservation measures and the BA. The Service was satisfied with the information provided in the BA and discussed moving forward on the consultation.

September 7, 2016 – The Service sent a letter to the USAF confirming our initiation of formal consultation.

September 19, 2016 – The USAF requested the Service comment on the proposed light model for the walking path at Kōkeʻe AFS.

October 6, 2016 – The Service provided other examples of bollard style lighting for the USAF to consider.

October 7, 2016 – The USAF emailed the Service stating they had reviewed the options we sent in regarding the type of bollard lights and would be discussing two of them with the contractor.

October 26, 2016 – The USAF emailed to schedule a possible Service site visit to Kōkeʻe AFS.

November 7, 2016 – The USAF and the Service conducted a site visit at Kōkeʻe AFS and discussed the proposed bollard lighting path locations and existing exterior lights. It was agreed that all exterior lights on the building would be kept off during the adult prospecting and breeding period as well as the fledgling fallout season (April 1 to December 30) and only used in cases of emergency. The Service and USAF also discussed the walking path bollard light locations and discussed that lights should only be used to illuminate the walking path and an insert could be installed to block all other lights that are not directed onto the path.

November 10, 2016 – The USAF emailed requesting our review and comment of the USAF proposed bollard pathway lighting route.

November 17, 2016 – The Service responded (via email) to the USAF regarding the proposed bollard pathway lighting route.

Description of the Proposed Action

Project Description

The USAF Pacific Air Forces Regional Support Center (PRSC) proposes to continue operations at Kōkeʻe AFS and Kōkeʻe MAS on the island of Kauaʻi.

Since the establishment of the Kōkeʻe AFS in 1961, its mission has been to detect and track all aircraft operating in the area of the Hawaiian Islands. The 150th Aircraft Control and Warning Flight, of the 154th Wing of the HIANG Guard, operates Kōkeʻe AFS and Kōkeʻe MAS as a critical component of the Hawaiʻi Region Operations Control Center. Kōkeʻe AFS and Kōkeʻe MAS support the HIANG State and Federal missions. The HIANG State mission is to provide organized, trained units to protect Hawaiʻi's citizens and property, preserve peace, and ensure public safety in response to natural or human-caused disasters. The HIANG Federal mission is to provide operationally-ready combat units, combat support units, and qualified personnel for active duty in the Air Force in times of war, national emergency or operational contingency.

Forty-one HIANG and reserve personnel assigned to Kōkeʻe AFS are responsible for the operation of the installation. Normal operations dictate approximately 16 people are on site during duty hours, and 6 at all other times. Occasionally, contractors and material or supply delivery vendors also visit the site, as well as staff from squadrons within the PRSC. The installation also commonly receives maintenance support from the Naval Facilities Engineering Command (NAVFAC) offices based at the Pacific Missile Range Facility, Kauaʻi. There are no on-site personnel at the Kōkeʻe MAS.

Kōkeʻe AFS uses an AN/FPS-117v4 Long Range Radar that operates at a frequency of 1250 to 1400 megahertz and is capable of tracking aircraft 200 to 250 miles away. Because of the critical role of this facility, the radar is in almost continuous operation. Kōkeʻe AFS also uses ultra-high frequency radios for ground-to-air communication. The station distributes collected data to other sites by low-powered microwave links. The AFS is approximately one-fifth of a mile away from the Kalalau Lookout. The Kalalau Lookout is near a cliff, which overlooks the Nā Pali Coast.

The nearby Kōkeʻe MAS contains an 80-foot tall antenna with four guy wires fixed to the ground, which supports communications and mission activities; the site is fully automated. There is one exterior building light, but it is kept off at night in order to reduce the probability of seabird attraction. There are also several red obstruction lights on the tower in order to abide by safety and aviation regulations (FAA 2000, as cited in USAF 2016). The HIANG decommissioned USAF equipment at the site in March 2016. The USAF real estate agents are in the process of releasing management of the Kōkeʻe MAS site to an alternate land manager, however, the real estate transaction has not occurred to date. Kōkeʻe MAS occupies a triangular piece of land 1.25 acres in size, approximately 7.5 miles south on the road from Kōkeʻe AFS. Its grounds (open space, semi-improved) are covered with crushed rock.

Primary purposes of the proposed action are summarized as follows:

- Detect and track all aircraft operating in the area of the Hawaiian Islands
- Provide ground-to-air communication using ultra-high frequency radios
- Distribute collected data to other sites via low-powered microwave links
- Protect Hawaiʻi's citizens and property, preserve peace, and ensure public safety in response to natural or human-caused disasters

Continuing operations at Kōkeʻe AFS and Kōkeʻe MAS include the following activities:

- Security surveillance
- Radar operations
- Digital communication operations
- Continued maintenance of site infrastructure and improved grounds

<u>Conservation Measures to Avoid and Minimize Effects to Listed Species</u>
The USAF proposes measures to reduce and eliminate the effects from proposed actions by including the following:

- Decreasing light pollution
- Effectiveness monitoring of minimization measures
- Control of predators within Kōkeʻe AFS and within seabird colonies
- Implementation of outreach and education
- Funding support to SOS for Kōkeʻe AFS fallout birds

Table 1. Summary of conservation measures and schedule and frequency of implementation.

Conservation Measure	Schedule and Frequency of Implementation
Blackout period	April 1 to December 30; annually
Installation seabird monitoring	April 1 to December 30; annually
Off-site predator control	Colony dependent; annually
Conservation measure reporting	October 31; annually
Construct perimeter walking light path	To be completed in FY17
SOS husbandry support	Annually (contingent on birds discovered per year)
Engineering evaluation	

Decrease Light Pollution

In accordance with the 2011 BO, various lighting infrastructure alterations were conducted in order to eliminate seabird fallout. The installations appearance at night changed significantly after the implementation of the green light conservation measure. A conversion from white and yellow bulbs to green was reported as completed by February of 2013 during biannual reporting (USAF 611 CES 2013, as cited in USAF 2016). As a result of the 2015 fallout event, light monitoring was conducted and infrastructure was inventoried on September 14, 2015, which resulted in a thorough status of inventory and performance for all perimeter and building lights (PRSC 2015a, 2015b, 2015c, as cited in USAF 2016). Identification of operational motion sensors, status of window coverings, and identification of inoperable equipment was also noted within this set of USAF reports. During monitoring efforts of the fall of 2015, various sources identified potential lights which could be further reduced in angle, resulting in a greater reduction of light emittance from the installation (PRSC 2016, as cited in USAF 2016; Raine *et al.* 2015). NAVFAC efforts on September 14, 2015, resulted in re-positioning of problematic perimeter lights. DOFAW confirmed a re-positioning effort was completed, but cited that potential room for further light reduction may still exist. Information collected by DOFAW after the light adjustment from September 14 – 30, 2015, identified no fallout (Kaiakapu Personal Communications 2015, as cited in USAF 2016).

In order to further analyze the installation light system, the USAF worked cooperatively with CSU CEMML in order to update a roster of all lighting conditions and develop a corresponding map (Figure 1), such that the status of each light could be tracked over time. Site visits during 2015, allowed for the update of the master installation lighting inventory. The installation map displays not only current light conditions and bulb color but also depicts the overall infrastructure layout and density of light placement. Further information pertaining to the type and status of each light is found on page two of each report found within Appendix B.

Fallout data collected after issuance of the 2011 BO, suggests that green lights, hooded lights, and re-orientation of installation lighting is not sufficient for the elimination of fallout for the Newell's Shearwater, Hawaiian Petrel, and band-rumped storm-petrel at Kōkeʻe AFS. Rather than to continue the use of green perimeter and building lights currently in place, the USAF proposes to construct a safety walking path outfitted with low level cut off lights as an alternative means to couple mission objectives and minimize impacts to seabird fallout. Prior to the implementation of final design and installation of the walking path lights, PRSC civil engineers and the USAF will share draft drawings and light models (route, ballast, bulb, and post) with the Service for comment and agreement. A similar process for Service involvement will occur for

the perimeter lighting plan. If comments are received with concerns about proposed design, the PRSC will address the concerns as appropriate, and issue a revised design with response to the Service for approval and agreement.

A notional layout for the walking path lights is depicted in Figure 2. According to the Kaua‘i Seabird Habitat Conservation Program (KSHCP) website, light models or designs using bollard type fixtures, such as those proposed by the USAF for usage at Kōke‘e AFS in Figure 3 (and Appendix C), are advised to be outfitted with yellow LED lamps. This design preference advised for usage by the KSHCP is being proposed for the Kōke‘e AFS walking path and associated light system by the 611th CES.

This illuminated walking path will function as the installation’s sole source of outdoor light during the April 1 to December 30 blackout timeframe. This illuminated path will replace the need to use the brighter and taller perimeter and exterior building lights during this period. The USAF anticipates that this conversion of lighting will reduce the attractive nature of the installation for both adult and fledgling Newell’s shearwaters, Hawaiian petrels, and band-rumped storm-petrels flying over en-route to their colony or ocean feeding areas. After the path and lights are completed, any buildings with shiny surfaces that are near the walking path will be painted to reduce potential reflection from bollard lights. The newly constructed path will be monitored annually for protected seabird presence or absence using all or a combination of the following scientific methods: night vision technology, physical observer inspections, deployment of song meters, and avian radar technology. The LED bollard lights and installed shielding are expected to eliminate light trespass in the upward direction, thus reducing the likelihood of fallout due to light attraction. The installation and use of LED bollard lighting is not expected to adversely affect adult and fledgling birds due to injury or mortality.

The seasonal blackout period will be implemented as a new conservation measure at Kōke‘e AFS and Kōke‘e MAS, however, the Federal Aviation Administration’s (FAA) required red sources of light cannot be diminished during the blackout period. FAA requirements for pole and/or radome lighting are exemptions to this blackout conservation measure and are FAA driven requirements for protection of life and safety (FAA 2000, as cited in USAF 2016). Loss of life, safety, and the protection of property may result from removal or dismantling of FAA required red colored lights already in function. Additionally, the USAF proposes in the event of an illegal incursion, emergency on the installation, or security violation occurring during the April 1 to December 30 blackout period to temporarily use existing perimeter and security lighting in order to preserve safety and mission integrity. The usage of perimeter and security lights during the blackout period would be limited to these rare instances and the duration would be minimized to the maximum extent practicable to address the security breach or emergency. Such instances will be reported to the Service within 24 hours of event.

The green bulbs already installed in perimeter and building lighting infrastructure, will continue to be used during the non-blackout period (December 31 to March 31), when birds are not transiting to and from colonies over the installation. These lights are fully shielded and directed downwards. This infrastructure will be evaluated for feasibility of alternative design.

The installations antenna, wire supports, and other installation equipment will also be evaluated for feasibility of alternative design. The feasibility study will identify whether or not new technologies and designs exist, which could replace currently situated infrastructure. During the feasibility study, engineers will identify alternative means of design, and identify those alternatives which are more bird friendly in comparison to current infrastructure. An emphasis during the feasibility study will be placed on those engineering designs and technologies which result in the placement of objects underground or within radome canopies, given that above-ground obstructions have been identified as potentially problematic to transiting seabirds.

The Kōkeʻe MAS includes an 80-foot tall antenna with four guy wires fixed to the ground to support communications and mission activities. There has been no evidence of take at Kōkeʻe MAS. It is located farther from known nesting colonies, does not appear to lie in a flight corridor, and it does not contain white or green lights that attract birds. Impacts from this antenna are not expected to rise to the level of take.

Window coverings inside of Kōkeʻe AFS buildings were also evaluated in 2015. Window coverings are an important component of light emittance reduction. Data collected in 2015 identified specific windows which are in need of repair, update, or adjustment in order to inhibit light from spilling outside the structure (PRSC 2015b, 2015c, as cited in USAF 2016). During future blackout periods the use of effective shading on all windows with connectivity to rooms possessing lights will be required and audited for completion. This conservation measure is expected to minimize effects to adult and fledgling seabirds transiting within the action area. Minimization of inside lights from building windows are not expected to adversely affect adults and fledglings.

Figure 1. Light sources at Kōkeʻe Air Force Station, Kauaʻi, 2015 (PRSC 2015b, 2015c, as cited in USAF 2016).

Legend	
Symbol	Description
▶	Building Flood Light
	Operational Perimeter Lights (A – Q)
	Non-operational Perimeter Lights
— x —	Security Fence
•	Post of Antenna Array
	Bldg. Ext. Light (green or white bulb)
RD	RADAR Dome
WT	Water Tank
DT	Diesel Tanks
GT	Gasoline Tanks and Pump Station
FFV	FASFAC Van
RW	Retaining Wall of Former RADAR
NV	Navy Van
1	BLDG 1 : Operations Building
2	BLDG 2: Generators Building
3	BLDG 3: Chlorinator Shed
5	BLDG 5: Supply Building
6	BLDG 6: HAZMAT Shed
7	BLDG 7: Gate House
10	BLDG 10: Vehicles Building
12	BLDG 12: Unoccupied Building
14	BLDG 14: Unoccupied Building

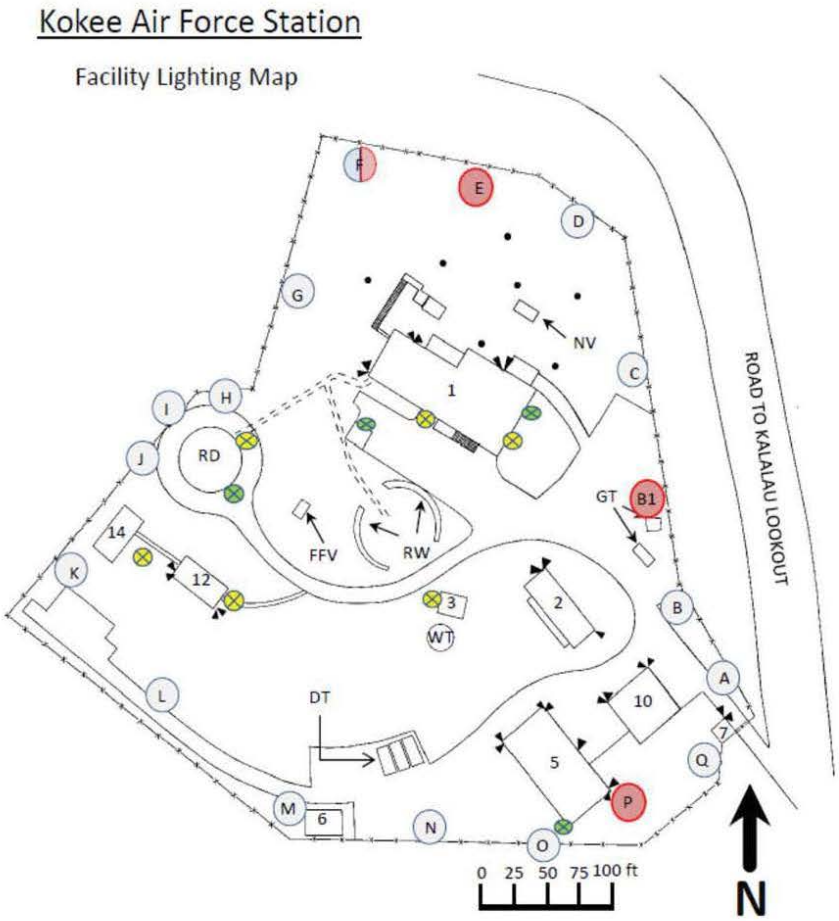


Figure 2. Proposed bollard lighting walking path at Kōkeʻe AFS.

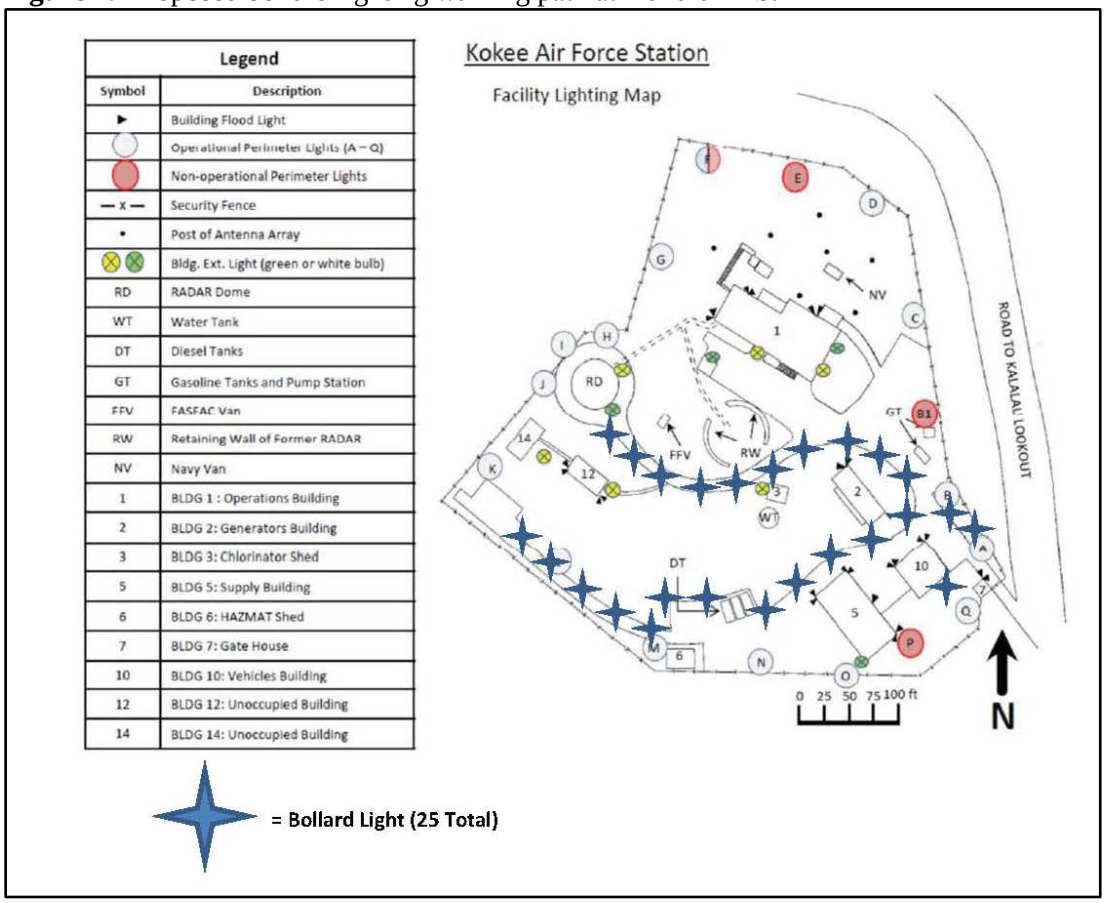
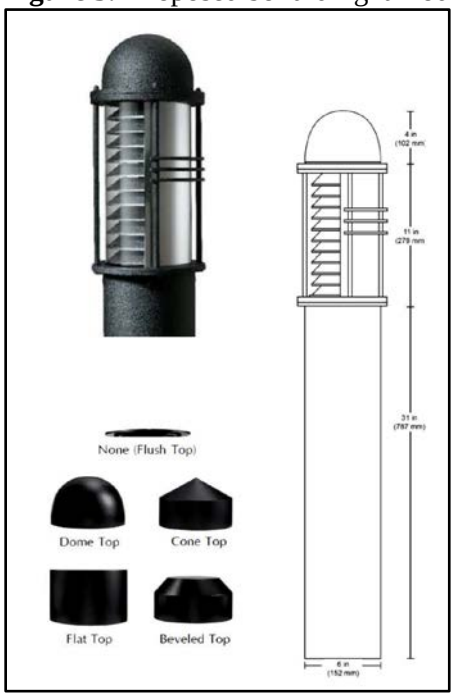


Figure 3. Proposed bollard light model.



Effectiveness Monitoring of Minimization Measures
In an effort to continue monitoring potential seabird fallout, the USAF, with support from the USACE Omaha District, funded the UH and its collaborative network of biologists from the Kauaʻi Endangered Seabird Recovery Project (KESRP) to implement avian monitoring of the site (May – December). This monitoring will allow the USAF to evaluate efficacy of the newly constructed lighting on the safety walking path. Annual monitoring of the site will include presence or absence of Newell's shearwater, Hawaiian petrel, and/or band-rumped storm-petrel, using all or a combination of the following scientific methods: night vision technology, physical observer inspections, deployment of song meters, and avian radar technology. A cooperative agreement was awarded on March 25, 2016; the associated work plan describing the conservation efforts funded by the USAF for implementation can be found within Appendix D. Avian monitoring results will be reported to the Service on an annual basis no later than October 31, of each calendar year.

Control of Predators Within Kōkeʻe AFS and Within Seabird Colonies
The USAF, with support from the USACE Omaha District, has funded the UH and its collaborative network of biologists from the KESRP to implement barn owl predator control (December 2016 to February 2017) on off-site colonies known to provide nesting habitat for the Newell's shearwater, Hawaiian petrel, and the band-rumped storm-petrel transiting over Kōkeʻe AFS. Given there is no documented nesting of Newell's shearwater, Hawaiian petrel, or band-rumped storm-petrel within Kōkeʻe AFS and Kōkeʻe MAS, the ability to improve nesting conditions, fledgling rates, or avian productivity on-site is limited (PRSC 2015d, as cited in USAF 2016) and will most effectively be implemented in off-site colony locations (e.g. Nuʻalolo ʻĀina, Nuʻalolo Kai, Honopū, Kalāheo/Kāhili, Lehua Islet; and the back of Hanalei Valley) where listed seabirds are currently benefiting from barn owl control.

These six off-site colony locations hold significant potential for seabird conservation through barn owl-specific predator control actions. Predation by non-native mammals is a constant threat to endangered seabird populations on Kauaʻi. Feral cats (*Felis cattus*), rats (both black (*Rattus rattus*) and Polynesian (*Rattus exulans*) species), cattle egret (*Bubulcus ibis*), barn owls (*Tyto alba*) and feral pigs (*Sus scrofa*) are all non-native predators that are potentially limiting the breeding success of birds within these colonies. Management for barn owls at these colony locations is expected to increase the survival rates of both adult birds and fledglings. Actions under this work plan would begin in December 2016 and extend to February 2017. Barn owl control has been previously funded by other sources, however, at the present time the only funding source for this predator control comes from the USAF's cooperative agreement (awarded on March 25, 2016); the associated work plan describing the conservation efforts funded for implementation can be found within Appendix D. This barn owl control work will be funded annually and results of the proposed barn owl predator control will be reported to the Service on an annual basis no later than October 31 of each calendar year.

Monitoring for the presence of other introduced predators around breeding sites through the recording of indirect sign (prints, scat) and seabird predation events will also be undertaken. If signs of other predators (cats, rats and cattle egret) are recorded, the control team may target these other species for control actions if time and logistics allow.

Additionally, the USAF proposes to continue predator control (primarily targeting cats, dogs, pigs, and rodents) at off-site seabird colonies. With fewer predators on the installation, grounded seabirds have an increased chance of being rescued. A combination of air and ground based predator control will be implemented.

As of February 2011, garbage cans have been secured from feral cats and rats. Securing the station's garbage cans will provide less incentive for predators to come onto station property. The previous perimeter fence was repaired after the previous consultation was completed, making it more difficult for animals to pass underneath; however, spaces under some areas along the perimeter still have the likelihood to provide access by feral cats and rats. The USAF has established a policy for not feeding feral cats, and of regularly trapping and removing them from the Kōkeʻe AFS.

Implementation of Outreach and Education
The USAF currently has an outreach and education program, in the form of briefings and posters. Implementation began on August 7, 2010, to help on-site personnel understand the importance of keeping windows and doors closed at night, of turning off lights when they are not needed, and of not feeding feral cats. Information is currently posted at Kōkeʻe AFS regarding procedures to be followed should personnel see a downed bird.

Funding Support to SOS for Kōkeʻe AFS Fallout Birds
The SOS program serves to retrieve, evaluate, rehabilitate (when needed), and release back into the wild any seabirds that become disoriented or injured in response to artificial lights, and collisions with power lines, or other man-made structures on Kauaʻi. The SOS program began in 1978 with annual records beginning in 1979.

The SOS program relies solely on members of the public to pick-up and place grounded birds into SOS aid stations, located throughout the island and monitored regularly by SOS staff. The public is encouraged to turn in all live, dead or injured seabirds directly to Kauaʻi Humane Society facilities at any time. The SOS program also accepts and handles other avian species in need. In the last five years, there has been an increase in the number of native waterfowl requiring rehabilitation and care in the SOS program.

Biologically, it is unclear if fledglings released by the SOS program have equal levels of fitness compared to fledglings that naturally leave from montane forest areas. Over the 37-year history of the program, a total of 30,552 fledgling Newell's shearwaters have been turned in to the SOS program for documentation or care. While earlier years of the program did not always include bird banding prior to release, since 1979 a total of 24 Newell's shearwaters previously banded in the SOS program as fledglings have been recovered or re-sighted as adults (Anderson 2016a, in litt.). Regardless of these low re-sight numbers, the SOS program reduces impacts to the Newell's shearwater, Hawaiian petrel, and band-rumped storm-petrel by providing care, rehabilitation, and release after their injury.

The USAF proposes to provide additional measures to recover any birds discovered injured or dazed should there be a fallout event. The USAF will fund rehabilitation efforts for those birds, which are discovered on Kōkeʻe AFS or Kōkeʻe MAS on annual basis in collaboration with the

SOS. During years where fallout is detected on Kōkeʻe AFS or Kōkeʻe MAS, the USAF will issue funds for cages, food, equipment, medicines, logistical movements of birds, and other veterinarian costs associated with the husbandry and recovery of each injured or dazed bird.

Monitoring during the seabird breeding period for each species, will be used to guide whether or not each future year's fallout data will dictate the need for implementation of this conservation measure, which will only be implemented if fallout occurs. Costs accrued for the husbandry of grounded birds discovered after the issuance of the 2011 USFWS BO will be addressed by the USAF in FY17.

Action Area

The action area of a project is defined by regulation as all areas to be affected directly or indirectly by the Federal action and not merely the immediate area involved in the action (50 CFR §402.02). The action area (Figure 4) for this formal consultation includes Kōkeʻe AFS and the western region of the island, from Waimea Canyon through the Nā Pali coast, Hanalei, and Lehua Islet due to indirect effects of the proposed actions on Newell's shearwater, Hawaiian petrel, and band-rumped-storm-petrel nesting colonies.

Kōkeʻe AFS occupies 10.6 acres of mountaintop habitat within Kōkeʻe State Park, about 3,500 feet above sea level. The station is on the Kahuamaʻa Flat of the Alakaʻi Plateau, a gently eastward-sloping plain. It is on a knoll that rises 40 feet above lower portions of the installation. About half the station is fenced, and land is used for light industry and limited landscaping. Outside the fence, the station is surrounded by native koa forest that has suffered relatively little disturbance and is part of the island's montane mesic ecosystem. The station is adjacent to (but does not include) recently designated critical habitat for montane mesic ecosystem species, including nine plant species, the Kauaʻi ʻākepa (*Loxops caeruleirostris*), and the picture-wing fly *Drosophila attigua*.

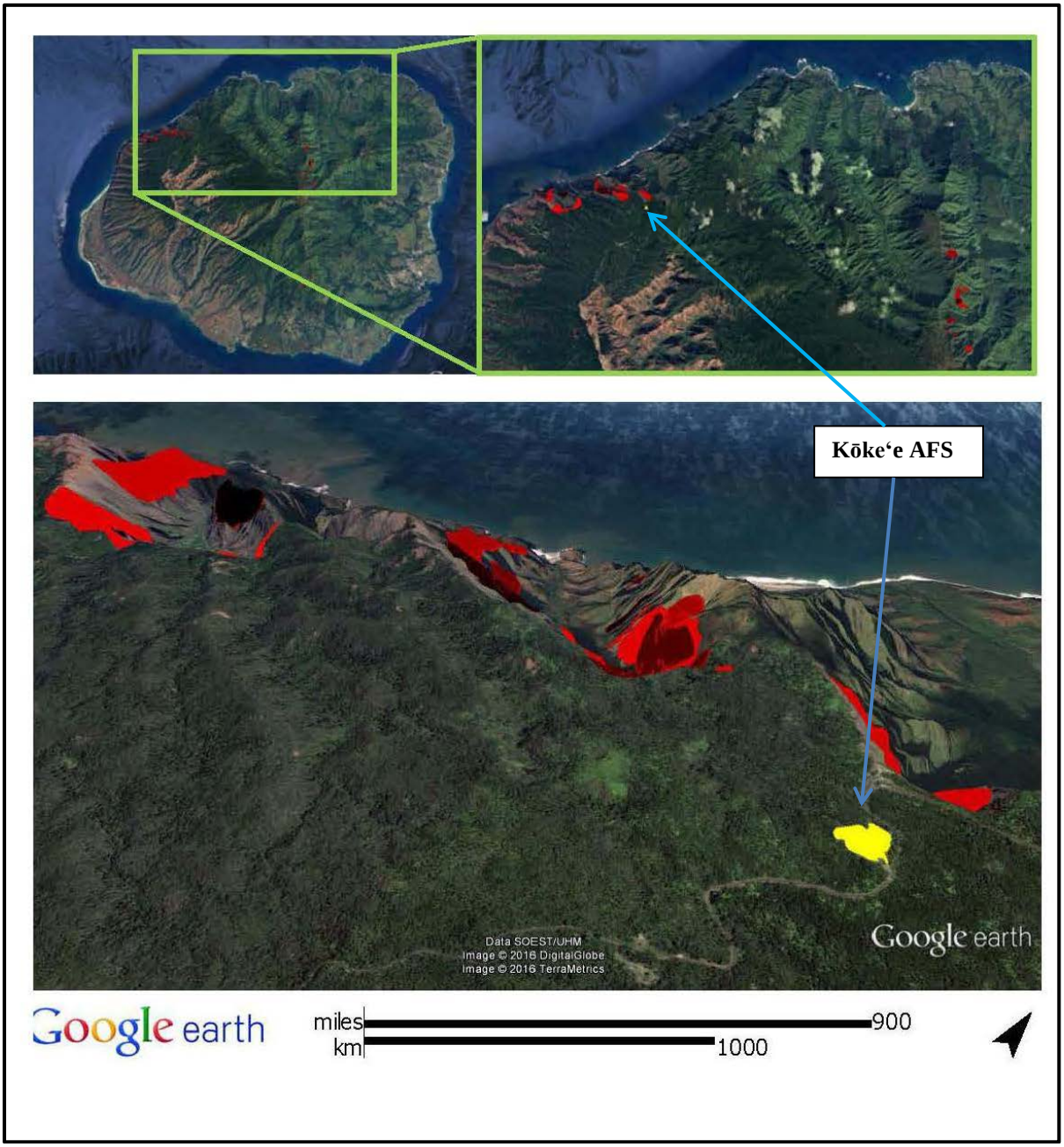
Nuʻalolo ʻĀina, Nuʻalolo Kai, and Honopū are located on the Nā Pali Coast in northwestern Kauaʻi. The Nā Pali Coast extends from Haʻena to Polihale State Park. The elevation along the coast ranges from sea level to 3,700 feet in Kōkeʻe. The Nā Pali region is characterized as a coastal cliff formation with numerous upland finger ridges, precipitous cliffs, and deeply incised valleys. The elevation in the rim areas ranges from approximately 2,700 to 3,600 feet.

Waimea Canyon is located in the western region of Kauaʻi and is bordered by Puʻu Ka Pele uplands and Nā Pali Coast to the west, Makaweli uplands to the south, and the Alakaʻi High Plateau to the north. The elevation in Waimea Canyon ranges from approximately 100 feet up to 3,700 feet at the canyon rim. The Waimea Canyon is characterized by near vertical cliffs and dramatic valleys. Several streams flow into the Waimea River in the Waimea Canyon, including Poʻomau, Waiahulu, Koaiʻe, and Waiʻalae streams. Kāhili is located in Kalāheo in the Waimea district.

Hanalei Valley is located on the North shore of Kauaʻi where cliffs range from greater than 300 meters high on the coast and the topography climbs rapidly to greater than 1,000 meters.

Lehua Islet is approximately 290 acres in size, with a maximum elevation of 710 feet, and the largest offshore islet in the main Hawaiian Islands. Lehua is part of Kaua‘i County and is located ¾ mile north of Ni‘ihau and roughly 20 miles west of Kaua‘i. Lehua is federal property administered by the U.S. Coast Guard and managed by the DOFAW as a seabird sanctuary.

Figure 4. Map of Action Area showing Kōke‘e AFS (yellow) and Newell’s shearwater breeding distribution in the Action Area.



Analytical Framework for the Jeopardy/Adverse Modification Analyses

In accordance with policy and regulation, the jeopardy analysis of this Biological Opinion relies on four components: (1) the *Status of the Species*, which evaluates the range-wide condition of the Newell's shearwater, Hawaiian petrel, and band-rumped storm-petrel, the factors responsible for that condition, and the survival and recovery needs of the Newell's shearwater, Hawaiian petrel, and band-rumped storm-petrel; (2) the *Environmental Baseline*, which evaluates the current condition of the Newell's shearwater, Hawaiian petrel, and band-rumped storm-petrel in the action area, the factors responsible for that condition, and the relationship of the action area to the survival and recovery of the Newell's shearwater, Hawaiian petrel, and band-rumped storm-petrel; (3) the *Effects of the Action*, which determines the direct and indirect impacts of the proposed Federal action and the effects of any interrelated or interdependent activities on the Newell's shearwater, Hawaiian petrel, and band-rumped storm-petrel; and (4) *Cumulative Effects*; which evaluates the effects of future, non-Federal activities in the action area on the Newell's shearwater, Hawaiian petrel, and band-rumped storm-petrel.

In accordance with the policy and regulation, the jeopardy determination is made by evaluating the effects of the proposed Federal action in the context of the current status of the Newell's shearwater, Hawaiian petrel, and band-rumped storm-petrel, taking into account any cumulative effects, to determine if implementation of the proposed action is likely to cause an appreciable reduction in the likelihood of both the survival and recovery of the Newell's shearwater, Hawaiian petrel, and band-rumped storm-petrel in the wild.

The jeopardy analysis in this Biological Opinion places an emphasis on consideration of the range-wide survival and recovery needs of the Newell's shearwater, Hawaiian petrel, and band-rumped storm-petrel and the role of the action area in the survival and recovery of these species as the context for evaluating the significance of the effects of the proposed Federal action, taken together with cumulative effects, for purposes of making the jeopardy determination.

Status of the Species

Status of the Newell's Shearwater

Listing Status, Taxonomy, and Species Description
The Newell's shearwater was listed as a threatened species in 1975 (USFWS 1983), pursuant to the Endangered Species Preservation Act of 1966. *The Hawaiian Dark-rumped Petrel and Newell's Manx Shearwater Recovery Plan* was published in 1983 (USFWS 1983). A species five-year review was completed in 2011. The review recommended up-listing the Newell's shearwater to endangered status due to precipitous declines in the global population over the last two decades. Critical habitat has not been designated for the Newell's shearwater (USFWS 1983).

The Newell's shearwater taxonomically belongs to the *Puffinus* genus, in the *Procellariidae* family and *Procellariiformes* order, along with 20 other extant shearwaters ranging throughout the Indian, Atlantic, and Pacific oceans (Gill and Donsker 2016). Shearwaters are characterized by exhibiting a "shearing" flight pattern, dipping from side to side on stiff, straight wings with

few wing beats. Genetic analyses conducted by Martínez-Gómez *et al.* (2015) confirmed the taxonomic status of Newell's shearwaters (*P. auricularis newelli*) as a subspecies alongside the Townsend's shearwater (*P. auricularis auricularis*). These two subspecies comprise *P. auricularis*. The two subspecies exhibit minor differences in plumage patterns and breeding chronology (Martínez-Gómez *et al.* 2015, p. 1026). The Townsend's shearwater is endemic to the Revillagigedo Archipelago located off the coast of Mexico and south of Baja California Peninsula. The Townsend's shearwater's range and distribution has been significantly contracted to a single island with less than 100 breeding pairs remaining (Martínez-Gómez *et al.* 2015, p. 1032; BirdLife International 2016a).

The Newell's shearwater is approximately 12 to 14 inches long, with a wingspan of 30 to 35 inches (Berger 1972, p. 46), and weighs approximately 14 ounces (Ainley *et al.* 1997b, p. 15). Its plumage is glossy black above, and white below (Ainley *et al.* 1997b, p. 15). Newell's shearwaters have low maneuverability characterized by a fast, directional, and low to water flight pattern, due to high wing-loading. A Newell's shearwater wing-loading averages about 60 N [newtons]/m2 (± 5.3 SD) with a low aspect ratio (10.3 ± 0.45 SD); significantly different from other shearwaters or petrels (Spear *et al.* 1995; Warham 1977). Observations of Newell's shearwaters transiting over land show a distinct flight pattern characterized by an almost frantic flapping style with the wings held straight (KESRP 2017b). It has a dark gray to brown bill that is sharply hooked at the tip (Ainley *et al.* 1997b, p. 15). Its claws are well adapted for burrow excavation and climbing.

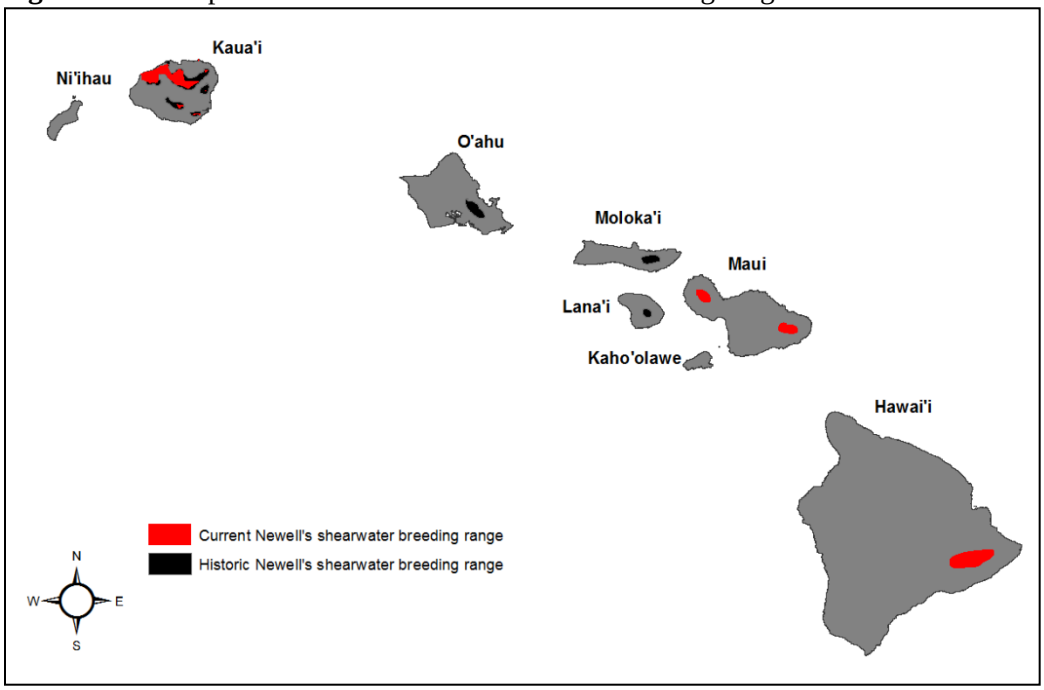
Historic and Current Distribution

The Newell's shearwater is believed to have colonized, historically, many of the southeastern Hawaiian Islands, including Hawai‘i, Maui, Moloka‘i, O‘ahu, and Kaua‘i (USFWS 1983, p. 2; Pyle and Pyle 2009, p.3). Newell's shearwaters were thought to be extinct after 1908, due largely to habitat loss and predation, but in 1954 a specimen was collected on the island of O‘ahu (King and Gould 1967) and in 1967 a breeding colony was found on Kaua‘i (Sincock and Swedberg 1969). Although no Newell's shearwater breeding colonies have been identified on the island of O‘ahu, downed Newell's shearwaters have been recovered throughout the island since the 1950s (Pyle and Pyle 2009, p.3). Three fragmented breeding areas were identified in the Puna District on Hawai‘i Island in 1993, based on nocturnal calling, visual detections of birds in flight, and two Newell's shearwater carcasses found along the highway; however no active burrows were found (Reynolds and Ritchotte 1997, p. 31). Currently, research staff at Haleakalā National Park on Maui Island consistently report Newell's shearwater ground calling within Kīpahulu Valley and along the northern slope of Mount Haleakalā near Ko‘olau Gap, indicating a breeding site (NPS 2012, p. 18). However, due to sensitive resources in the area and the difficult terrain, no ground surveys have been conducted in these locations (NPS 2012, p. 19). In 2015, acoustic song meters were placed at 41 sites in remote areas of Haleakalā National Park to detect potential new seabird breeding colonies (McKown and Savage 2015, p. 1). Song meters detected Newell's shearwater ground calls in low numbers (averaging 2 ground calls per survey night) at five of the 41 sites, with only one site recording regular activity during the 30-day study period (McKown and Savage 2015, p. 15). The song meters in this study were programmed to record 1 out of every 5 minutes, for 5 hours starting at sunset, then record 1 out of every 10 minutes for the 5 hours preceding sunrise (McKown and Savage 2015, p. 3). This schedule amounted to an hour and a half of data each night. Additional longer-term acoustic and ground

surveys are needed to evaluate the extent, distribution, and viability of Newell's shearwater on Maui and Hawai'i islands.

While some knowledge gaps remain concerning its distribution, the Newell's shearwater has experienced a significant breeding range contraction and currently, all known extant breeding colonies with documented burrows are located on the island of Kaua'i (Figure 5). Estimates indicate 90 percent of the global population resides on Kaua'i (Ainley *et al.* 1997b; Griesemer and Holmes 2011).

Figure 5. A comparison of the historic and current breeding range for the Newell's shearwater.



Map shows current breeding range contraction from the historic breeding range for the Newell's shearwater within the Hawaiian Archipelago. While the Newell's shearwater may breed on Hawai'i and Maui islands, the only known breeding colonies of Newell's are located on the island of Kaua'i.

Of the Newell's shearwater breeding on the island of Kaua'i, 104 breeding pairs are being monitored and an additional 64 burrows in Upper Limahuli Preserve were monitored in 2015 but could not be identified to species (i.e., burrows were either Newell's or petrels) (Raine *et al.* 2016a; Raine *et al.* 2016c). The majority of the monitored shearwaters (82 breeding pairs) are concentrated within the Upper Limahuli Preserve (ULP), enclosed by an ungulate exclusion fence. Auditory surveys documented several additional areas of concentrated shearwater ground-calls indicating breeding activity within Lumahai Valley and Lā'au Mountain in montane habitat and within Honopū Valley along the Nā Pali coast (Banfield *et al.* 2013). However, due to inaccessible and difficult terrain, no numbers or estimates exist for shearwaters breeding in these locations.

Based on historic and current distribution of breeding sites, Newell's shearwaters prefer breeding habitat in montane wet (e.g., Hono o Nā Pali colony) to lowland wet and wet cliff (e.g., Upper Limahuli colony) habitat of 200m to 1,000m in elevation, steep to moderate slopes with thick

native understory of uluhe fern (*Dicranopteris linearis*) and open canopy of dispersed ʻōhiʻa trees (*Metrosideros polymorpha*) (Troy *et al.* 2014, p. 325). The preference for montane forested habitat beneath dense uluhe fern helps to conceal shearwater burrows from predators while dispersed ʻōhiʻa trees may provide a take-off point for shearwaters to regain flight (Troy *et al.* 2014, p. 318). The Newell's substrate preference includes rocky volcanic soils with a moderate amount of fine soil particles and suitable drainage to prevent burrow flooding (Troy *et al.* 2014, p. 324). Recent seabird surveys have resulted in the first confirmed Newell's shearwater burrows (n=3) along the Nā Pali coast, in dry cliff habitat (Raine and Banfield 2015a, p. 11).

Life History

Newell's shearwaters have a long lifespan (up to 36 years), do not reproduce until 6 years of age, lay one egg per year, and offspring require significant parental investment (Ainley *et al.* 2001). As with other k-selected species, these traits of long lifespans and low reproduction at high energetic cost define the life strategy of a species that has evolved in a stable environment (i.e., more predictable); the succession of ecosystems in the Hawaiian Islands following a period of volcanic eruptions.

Newell's shearwater breeding season begins in late March/early April when adults and sub-adults arrive to inland breeding colonies, followed by a 2-4 week exodus when breeding adults forage to build-up reserves (Raine and McFarland 2013, p. 2; Raine and McFarland 2014, p.2; Raine and Banfield 2015a, p.2). The incubation period begins in May and continues through July, and the chick provisioning stage occurs in late July through September (Raine and McFarland 2013, p. 2). Both sexes equally incubate the egg (Ainley *et al.* 1997b, p. 10). The fledging or late chick rearing stage, when young leave the nest for the first time occurs in September through December (DOFAW 2016; Raine and McFarland 2013, p. 2). Adults travel from breeding to feeding areas and return to feed their chicks irregularly every one to three nights (Ainley *et al.* 1997b). Newell's shearwaters, similar to other birds in the Order Procellariiformes, exhibit strong natal philopatry, with breeding pairs returning to the same burrow to breed each year (Bried *et al.* 2003, p. 242).

Ainley *et al.* (2001, p. 117) documented higher than expected numbers of active shearwater burrows with no egg or nestling signs present (11%-22%), indicating no breeding attempt was made. Monitoring data of shearwater colonies indicate at least 10% or more of activity within breeding colonies is comprised of non-breeding birds or sub-adults (<6 years old) prospecting for mates or excavating burrows during the breeding season (Raine *et al.* 2016a, 2016c). Ainley *et al.* (1997a, p. 11) suggested shearwaters on Kauaʻi begin returning to their breeding habitat as sub-adults at 2-3 years of age. The full shearwater breeding season is treated as March 1 to January 1 to cover the entire period when shearwaters may transit to and from the ocean and inland breeding sites (Travers *et al.* 2016, p. 5). All transit over land occurs in darkness, with a peak over land passage during the year coinciding with the late incubation and chick rearing stages (Travers *et al*. 2013, p. 35). Fledglings leaving the nest for the first time exhibit strong phototropic behavior and rely on ambient light from the moon to navigate to open ocean (Telfer *et al.* 1987, p. 410).

Newell's shearwaters are pelagic, spending much of their time foraging over deep waters where 96 percent of their diet consists of cephalopods, primarily the Ommastrephidae family of flying

squid with the remaining 4 percent consisting of flying fish (*Exocoetus* sp.) (Ainley *et al.* 2014, p. 70). Newell's shearwaters likely specialize in feeding over yellowfin tuna (*Thunnus albacares*), as both flying squid and flying fish are important in the diet of yellowfin tuna.

Current Population Demographics

At-sea surveys conducted in the central and eastern tropical Pacific between 1980 and 1994 (Spear *et al.* 1995) estimated the total Newell's shearwater population at 84,000 (95% CI = 57,000-115,000) including juveniles and sub-adults. An updated assessment based on survey data collected by the National Oceanic and Atmospheric Administration, National Marine Fisheries Service (NOAA-NMFS) Southwest and Pacific Islands Fisheries Science Centers from 1998 to 2011, estimated the total Newell's shearwater population at 27,011 (95% CI = 18,254-37,125) including juveniles and sub-adults (Joyce 2013). Given 90 percent of the global population resides on Kaua'i (Ainley *et al.* 1997b; Griesemer and Holmes 2011), the estimated population of Kaua'i is 24,310 individuals (USFWS 2017, p. 113). The percentage of the population that is breeding age (6 years of age or older) is estimated at 0.637 (Ainley *et al.* 2001, p.115), equaling an adult population size of 15,485 (approximately 7,500 pairs).

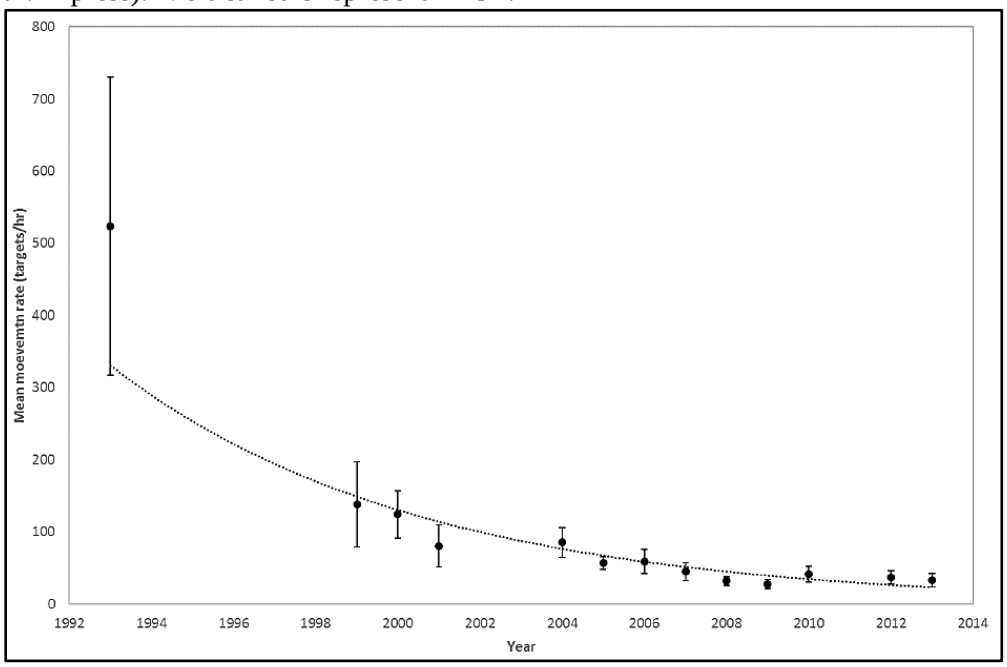
Annual survivorship and juvenile/sub-adult survivorship of the Newell's shearwater has not been studied in the field (i.e., estimated from banding efforts and recapture). Population viability modeling efforts estimate Newell's shearwater adult survivorship at 0.905 (Ainley *et al.* 2001, p. 116) to 0.920 (Griesemer and Holmes 2011, p. 20; USFWS 2017) and juvenile/sub-adult survivorship at 0.333 (Ainley *et al.* 2001, p. 116) based on long-term survivorship data of related species. The likelihood of Newell's shearwater adults (≥ 6 years of age) to breed in any one year was estimated to vary between 0.60 and 0.50 (Ainley *et al.* 2001, p. 118), which is markedly lower than the breeding probability (0.82) of other Procellariidae species. Based on a five-year monitoring study of a single Newell's shearwater colony on Kaua'i the annual reproductive success of shearwaters was estimated at 0.66 fledglings per breeding pair (Ainley *et al.* 2001, p. 117). In comparison, the Manx shearwater, a closely related species with an extensive range and a stable global population has a reproductive success of 0.70 (Brooke 1990; and Ainley *et al.* 2001, p. 117).

Based on Newell's shearwater population parameters, SOS data, and carcass searches under power lines, Ainley *et al.* (2001) estimated the global population of Newell's shearwaters are declining at least 5.9 percent per year (λ=0.941). Ainley *et al.* (2001, p. 118) found that the main factor affecting limiting the population growth rate of the Newell's shearwater was the extremely low breeding probability (0.547), which is associated with individual fitness and habitat quality. Ainley *et al.* (2001, p. 118) suggested that the low breeding probability could be the result of high mate loss due to predation or other threats affecting individual fitness. Indeed, adults that lose a mate due to predation cannot obtain a new one quickly and have been observed not to breed the following season (Ainley *et al*. 2001, p. 118; Raine 2016a, in litt.). The purpose of the Ainley *et al*. (2001) population demographic study was to evaluate the status of Newell's on Kaua'i. The study sampled an average of 65 burrows for seven seabird seasons, 1984–1985 and 1993–1994. The colony sampled was in a natural state (i.e., receiving no conservation management actions) and the sample was not constrained to only experienced breeders, but rather sought to maximize the total number of burrows monitored each season (Ainley *et al*. 2001, p. 112).

Ornithological radar data was first used to monitor populations of Newell's shearwaters and Hawaiian petrels (*Pterodroma sandwichensis*) on Kaua'i in 1992-1993 (Day *et al*. 2003, p. 670), based on methods developed to monitor Marbled murrelet (*Brachyramphus marmoratus*) populations in the Pacific Northwest (Cooper *et al*. 2001). Radar has been used to monitor the summer movement patterns of Newell's shearwaters and provide an accurate estimate of birds as they transit through the detection area at 13 sites throughout the island (Day and Cooper 1995; Raine *et al*. in press). Day *et al*. (2003) reported a mean annual rate of 11.2 percent decline in the Newell's shearwater population between 1993 and 2001, based on the analyses of ornithological radar data.

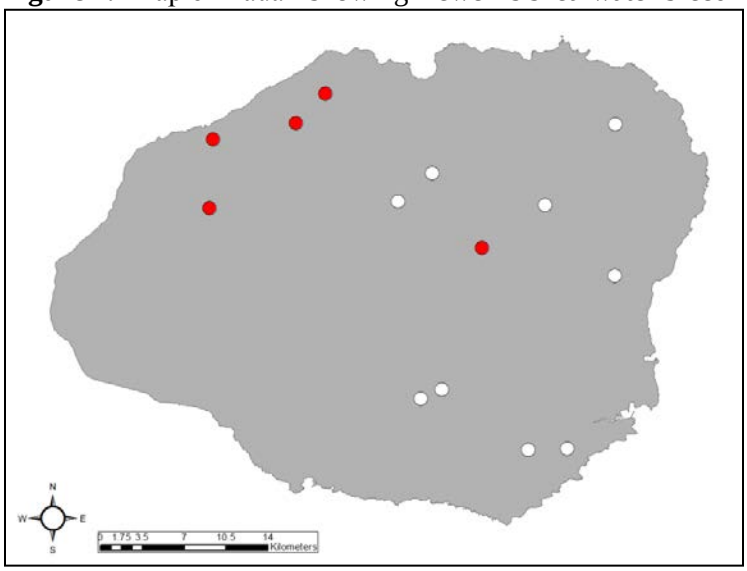
In a subsequent study, based on visual observations and marked differences in the timing of petrel and shearwater movements, radar data analysis (Day and Cooper 1995; Raine *et al*. in press) has shown an appreciable reduction in the number of shearwaters transiting to and from montane breeding colonies from 1993 to 2013 (Figure 6). Radar surveys were conducted in coastal areas of known seabird flyways in May through mid-July, during the incubation and early chick-rearing stage. Therefore, radar data are a conservative index of breeding activity. The overall mean for shearwaters across all 13 radar sites surveyed in 1993 was 523.7 ± 206.5 targets/h and in 2013 was 33.5 ± 9.2 targets/h, representing a mean decrease of 87.5% between the two periods ($t = 2.37$, $df = 24$, $P = 0.026$; Raine *et al*. in press). All of the 13 sites showed a large decrease in movement rates over the entire period, with movement rates at 11 (84.6%) out of 13 sites decreasing by more than 80 percent (Figure 6). (Raine *et al*. in press). Based on the radar data (Raine *et al*. in press) as a proxy for the breeding population, the Newell's shearwater population on the island of Kaua'i declined at a mean annual rate of 12.8 percent over the 20-year period. This updated rate of decline of the Newell's shearwater population is comparable to the mean annual rate of -11.2 percent between 1993 and 2001 reported by Day *et al*. (2003, p. 673).

Figure 6. Regression line showing mean movement rates (targets/hr) of adult Newell's shearwaters during their incubation and early chick-rearing stage for all 13 radar sites surveyed, 1993–2013 (Raine *et al*. in press). Vertical bars represent ±1 SE.



Ainley *et al*. (2001) had documented 14 shearwater breeding colonies distributed across Kaua'i (Figure 7). Currently, several of these formerly large Newell's shearwater colonies in Kalāheo, Kaluahonu, and Makaleha on the island of Kaua'i have declined dramatically in recent decades to near extirpation (Raine *et al*. in press). No population data exists for Newell's breeding on other islands.

Figure 7. Map of Kaua'i showing Newell's shearwater breeding colony locations.



Map showing Newell's shearwater breeding colony locations (n=14); unfilled circles (n=9) represent colonies near extirpation (<5 burrows) (Ainley *et al*. 2001).

In two breeding colonies on Kaua‘i, ULP and Hono o Nā Pali Natural Area Reserve (NAR), efforts are currently underway to curtail the population decline through the removal of predators. The reproduction output of the 104 monitored Newell's shearwater pairs breeding within these areas are measured in terms of their breeding or reproductive success. Since 2011, the breeding success of Newell's shearwater pairs within ULP has increased by 27 percent, from 0.692 to 0.882 in 2011 and 2015, respectively (Raine *et al*. 2016a, p. 16). This increase is a direct result of the ungulate exclusion fence completed in 2010 and intensive predator control that began in 2011. Indeed prior to these conservation efforts surveys at ULP documented a 0.545 reproductive success rate (Table 2). Newell's are less prevalent than petrels within Hono o Nā Pali Natural Area Reserve (NAR) and have not been as successful in reproducing (Table 2) due primarily to predation by cats, rats and feral pigs. In addition to the reproductive success rates from Newell's burrows listed in Table 2, there were an additional 162 burrows at ULP and Hono o Nā Pali NAR monitored in 2015 that could not be identified to species (i.e., burrows were either used by Newell's shearwaters or petrels).

Table 2. Reproductive success rates for Newell's shearwater breeding pairs (*n*).

Year	2010 (*n*)	2011 (*n*)	2012 (*n*)	2013 (*n*)	2014 (*n*)	2015 (*n*)
ULP	0.545 (11)	0.692 (15)	0.682 (34)	0.784 (46)	0.840 (59)	0.882 (82)
HNP NAR-Pōhākea	no data	no data	no data	0.571 (8)	0.375 (20)	0.667 (22)

Pairs were monitored each year (2010–2015) at Upper Limahuli Preserve and Hono o Nā Pali Natural Area Reserve's Pōhākea site. No Newell's shearwaters have been confirmed at the Pihea and North Bog sites of Hono o Nā Pali NAR.

Threats

Primary threats to the Newell's shearwater include artificial nighttime lighting (Reed *et al*. 1985; Cooper and Day 1998), collisions with power lines (Cooper and Day 1998; Podolsky *et al*. 1998), predation by introduced predators (Raine and Banfield 2015b, 2015c), and changes to breeding habitat due to introduced invasive plants (Troy *et al*. 2014). These threats to the Newell's shearwater have been steadily increasing.

Artificial light sources collectively are a significant mortality factor associated with Newell's shearwaters (Ainley *et al*. 2001; Troy *et al*. 2011). Upward projecting nighttime lighting interferes with the shearwaters ability to navigate to and from their breeding sites. Shearwaters, primarily fledglings and sub-adults are disoriented by nighttime lighting and will circle light sources until they become exhausted and fall to the ground, where these birds are vulnerable to being killed by feral cats, dogs, or vehicles (Travers *et al*. 2013, p. 81). They often fly into utility wires, poles, trees, and buildings and fall to the ground; this phenomenon is referred to as "fallout". Once these seabirds fall to the ground, they are unable to regain flight unless they have access to an area with sufficient take-off conditions to allow enough air to move under their wing to provide lift (Ainley *et al*. 2015, p.32). Since 1979, the DOFAW on Kaua‘i has supported the Save our Shearwaters (SOS) program to collect "downed" Newell's shearwaters and Hawaiian petrels (*i.e*., birds that have either collided with structures or fallen out, or have been injured or killed due to exhaustion caused by light attraction). Over a 37-year period (1979-2016), the SOS program documented a total of 30,552 Newell's shearwaters recovered, injured or killed due to artificial nighttime lighting (DOFAW 2016). In the 1980s through 1990s, an

average of 1,247 Newell's shearwaters were processed by the SOS program each year, where carcasses were documented or injured birds were rehabilitated and released (Raine *et al. in press*).

Adults and sub-adults are subject to collisions with power lines while flying between their nesting colonies and at-sea foraging areas (Cooper and Day 1998, p. 18; Podolsky *et al.* 1998, p. 21). Nestlings are indirectly affected as they rely on provisioning from both parents in order to survive, thus the loss of either parent results in nestling fatality. In 1993, in a single breeding season Podolsky *et al*. (1998, p. 30) documented deaths of at least 70 breeding adults and 280 sub-adult shearwaters over the summer months, in addition to 340 fledgling deaths in the autumn months, all as a result of collisions with power lines on Kaua'i. However, this study covered only the eastern and southern portions of the island (Podolsky *et al.* 1998, p. 30).

Based upon recent information collected from passive acoustic song meters (n=51) by the Kaua'i Island Utility Cooperative (KIUC) Underline Monitoring Program, the Service has conducted modeling to extrapolate the amount of documented take (i.e., collisions with power lines) to the entire power line system, encompassing power lines and infrastructure in the central, eastern, northern, southern, and western portions of the island (USFWS 2017). As a result of covered activities under the KIUC Short-Term Habitat Conservation Plan (HCP) and Incidental Take Permit (ITP), the estimated annual take, including direct and indirect mortalities and direct injuries caused by power line collisions are: 3,560 dead and 4,736 injured Newell's shearwaters, across Kaua'i. The estimated number of direct mortalities ranges from 1,664 to 2,960 Newell's shearwaters. These numbers are substantially greater than what was anticipated at the time the ITP was issued. The KIUC Short-Term HCP and Incidental Take Permit authorized the annual take of up to 162 Newell's shearwaters and 2 Hawaiian petrels (adults and sub-adults) from 2011 to 2016.

Introduced predators, particularly cats, rats, feral pigs, mongoose (*Herpestes auropunctatus*), and barn owls, are a severe threat to the continued existence of the Newell's shearwater. Adults, sub-adults, and young are susceptible to predation by these introduced predators (Raine and McFarland 2013a, p. 16; Raine and Banfield 2015a, p. 38). These non-native predators occur throughout the Hawaiian Islands, with the exception of the mongoose, which its establishment is uncertain on the island of Kaua'i (Phillips and Lucey 2016).

Another threat to the Newell's shearwater is habitat loss due to invasive vegetation. Invasive plants alter the three-dimensional structure of Hawaiian forests (Asner *et al.* 2008) as well as disrupt other ecological processes. A vegetation shift in areas of Kaua'i away from native understory to invasive vegetation, including but not limited to strawberry guava (*Psidium cattleianum*) and ginger (*Hedychium gardnerianum*) has been associated with at least one abandoned Newell's shearwater colony on Kaua'i (KESRP, unpublished data). Extreme weather events such as hurricanes 'Iniki (1992) and 'Iwa (1982) have caused significant disruptions in forest habitat and, coupled with colonization of invasive plants, have resulted in permanent habitat loss for forest birds (Pratt 1994). In addition, areas of degraded habitat have facilitated the spread of invasive mammalian predators (Raine *et al.* 2016b, 2016c, 2016d). For example, in a heavily degraded habitat Ainley *et al.* (2001) counted 30 dead Newell's shearwater sub-adults and adults due to predation in one season (Ainley *et al.* 2001, p. 121).

Other threats include climate change and its affects to both seabird adult survivorship and recruitment (Sandvik *et al.* 2012) by generally affecting food availability (Oro 2014). Research by Spear *et al.* (2007) and Ainley *et al.* (2014) also indicate that Newell's shearwaters forage readily with yellowfin tuna and may be vulnerable to fishery interactions.

Survival and Recovery Needs

For purposes of this Opinion, the "survival condition" of the Newell's shearwater in the wild represents the level of reproduction, numbers, and distribution necessary to support a persistent population in the Hawaiian Archipelago that is fully protected by the ESA. For purposes of this Opinion, the "recovery condition" of the Newell's shearwater is that where the threats to the species have been addressed such that the protections of the ESA are no longer necessary to insure the survival condition of the Newell's shearwater in the wild.

The recovery plan (USFWS 1983) for the Newell's shearwater does not contain recovery criteria; rather general goals are listed that require revision due to a substantial amount of new information. For example, the recovery plan (USFWS 1983, p. 22) calls generically for reducing annual SOS collected, lighting related fallout of Newell's shearwaters to less than 100 birds, and for developing efficient predator control methods to protect nesting sites.

In 2015, the Service completed the draft *Newell's Shearwater Recovery Strategy* (USFWS 2015). The Draft Newell's Shearwater Recovery Strategy (USFWS 2015) focuses on managing and enhancing extant colonies in areas with minimal light impacts, mitigating threats at the colony, and those encountered while in transit to the colony, and creating new colonies through social attraction and translocation (USFWS 2015).

This recovery strategy relies on actions completed by Kaua‘i Island Utility Cooperative under their Short Term Habitat Conservation Plan (STHCP), including a predator-exclusion fencing feasibility study (Young and VanderWerf 2014) and the 2013–2014 Kaua‘i island-wide auditory survey reports to locate new shearwater and petrel colonies (Banfield *et al*. 2013; Raine and Banfield 2015b). The draft strategy describes general tools (i.e., manual predator control, ungulate and predator-exclusion fences) as well as translocation and social attraction activities to protect, augment, or create new breeding colonies. Removing terrestrial predators (e.g. feral cats) that depress adult and pre-breeder survival and establishing predator-free breeding habitat is required to successfully restore seabird colonies (Buxton *et al*. 2014; Jones and Kress 2012). On Kaua‘i, repeated access into the colony to conduct intensive predator control in open systems can degrade sensitive vegetation, while predator ingress and predation remains constant. In montane habitat, manual predator control should be conducted as an incremental step towards the goal of constructing a predator exclusion fence culminating with predator removal or eradication.

Predator fencing is the most effective tool against mammalian depredation at the colony, particularly for indigenous species that are highly sensitive to predation (Young *et al*. 2013; Norbury *et al*. 2014). Within the current range of Newell's shearwater, topography, streams, and remoteness limit the number of sites and size of areas that can be protected with predator exclusion fences. Preliminary surveys of eight sites known to have Newell's shearwater populations identified three as suitable for predator fencing; the other five were eliminated because of topography or streams (Young and VanderWerf 2014). Suitability for fencing at

these sites should be verified. The KESRP continues to survey areas for Newell's shearwater activity so active sites suitable for predator fencing, in addition to those identified in our USFWS 2015, could be identified in the coming years. At a minimum, the two sites recommended by Young and VanderWerf (2014) with identified Newell's shearwater burrows should be fenced. The third site identified in this study was found to have only Hawaiian petrel burrows. Other sites located independently by KESRP and verified as occupied and suitable for fencing should be fenced. These sites should be protected using manual predator control until the fences are complete. To increase recruitment once fences are complete, social attraction should be a component of the project (see below).

The draft strategy prioritizes management efforts to occur in colonies already receiving conservation management actions under the existing KIUC Short Term HCP, by relying on the concept of a 'no light conservation zone' or NLCZ to define an area which contains very little artificial nighttime lighting or light impingement. The NLCZ is based on the belief that artificial nighttime lighting is the sole factor constraining the distribution of Newell's shearwater breeding colonies and therefore colonies located in the NLCZ are more viable and should receive conservation actions. The NLCZ encompasses the northwest corner of Kaua'i and includes coastal areas as well as mountainous steep terrain with a relatively small human population, resulting in minimal artificial nighttime lighting in the area. The NLCZ contains very little nighttime lighting currently, unfortunately there are no county ordinances or other mechanisms to support or require the continued existence of an NLCZ into the future. The draft recovery strategy also calls for generally minimizing the effects from artificial nighttime lights and power lines.

In addition to this isolated area there is a need to generally address light attraction. Many sources of lights have already been modified to minimize attraction of fledging Newell's shearwater, but a standard island-wide study is needed at regular intervals to identify new locations of concern for light attraction and those that might be out of compliance. A study is needed to test the various types of LED bulbs available against the existing low pressure sodium bulbs to assess which is most suitable for seabirds. Once the Service determines what configuration has the least impact on Newell's shearwater, lights should be outfitted with these bulbs, targeting the highest impact lights first. In the interim, problematic lights should be removed, turned off during the fledging season, reduced in intensity, or fitted with shields to direct the light toward the ground to minimize impacts.

The draft strategy does not comment on any elements (e.g., habitat requirements, genetic representation, and population resiliency) that would contribute to and define the long-term health needs of the Newell's shearwater population.

Population viability modeling efforts conducted by the Service defined Newell's shearwater adult survivorship at 0.92, based on a boxplot assessment and linear regression of adult survivorship data from proxy Procellariformes (USFWS 2017, p. 122). Because the Newell's reproductive strategy has evolved to have a high adult survivorship, adult mortality is particularly harmful to the population. Left unchecked low adult survivorship (or conversely high adult mortality) will serve to depress the colony population to unsustainable numbers thereby increasing the vulnerability of these populations to invasive predators and other

stochastic events (e.g., hurricanes damaging breeding habitat or climate shifts altering food availability).

The survival and recovery needs of the Newell's shearwater are described in the succeeding paragraphs based on components from recovery documents highlighted above, as well as best currently available scientific information. The survival condition of the Newell's shearwater is the biological factors necessary for a persistent population. The survival condition of the Newell's shearwater will need to include over a generation time (i.e., 7-8 years), an annual and stable breeding probability of 0.80 and consistently high reproductive success levels of at least 0.85 fledglings per breeding pair, per season. In order to achieve these biological factors, immediate actions need to be taken to protect occupied breeding habitat from invasive predators by constructing predator-exclusion fences and concurrently increasing predator removal efforts around the two extant and accessible breeding colonies on Kaua'i (within Hono o Nā Pali and Upper Limahuli). Once a predator exclusion fence is constructed and predators are reduced or eliminated within the fence, management efforts should incorporate social attraction techniques using acoustic and visual/olfactory cues (Buxton and Jones 2012) to lure prospecting non-breeders and sub-adults into the protected breeding habitat. Current telemetry data shows that the Hono o Nā Pali and Limahuli-Mānoa colonies are minimally affected by power line collisions and artificial nighttime lighting based on actual flight paths (n = 9) to and from foraging areas and breeding habitat (Raine *et al*. 2016f, p. 24). The main land-based threats to the Hono o Nā Pali and Upper Limahuli colonies are introduced predators and invasive vegetation.

Maintaining the ecological life-support systems (i.e., habitat requirements) for the two largest Newell's shearwater breeding colonies is critical to the long-term survival. Management of breeding habitat within predator exclusion fences should include invasive vegetation control during the non-breeding season to support a native understory and canopy and biosecurity measures to prevent introductions of invasive flora and fauna. The size of the predator exclusion fences will be dictated to some extent by the terrain, however each exclusion fence should contain the extant colony, anticipate and minimize erosion, and be large enough (≥10 ha) to encompass enough breeding habitat to sustain at least 1,500 active breeding pairs and small enough to be adequately maintained in perpetuity.

Survival of the Newell's shearwater cannot be predicated solely on the existence of two neighboring breeding colonies on a single island. The survival needs of the Newell's shearwater include reducing adult mortality occurring range wide due to the attraction to artificial lights and collisions with power lines. The data gathered from Travers *et al*. (2014) and Travers *et al*. (2015) have vastly improved our knowledge of the scope of the impact of power line collisions and have identified the power line segments, of those surveyed, that have the greatest impact on seabirds. Lines along Power Line Trail in the north central region of the island were responsible for 75 percent of the documented strikes in 2014 (Travers *et al*. 2015). This stretch of lines should be prioritized to be buried, lowered in height, modified such that the top lines are removed, re-directed after appropriate studies to assess minimization effectiveness, or made visible in some manner (e.g., through the use of lasers or bird diverters, both of which are being tested by KESRP). As additional stretches of lines are monitored each year, other high-impact zones will be identified and appropriate avoidance or minimization methods should be

implemented. Reducing the impact of power lines is critically important to ensuring the continued existence of Newell's shearwater on Kaua'i.

The SOS program on Kaua'i is designed to reduce mortality of fledglings and adults that have been grounded (i.e., unable to regain flight) due to the attraction to artificial lights or collisions with power lines. The continuation of the SOS program is a clear step to reduce adult mortality.

In summary, the recovery condition of the Newell's shearwater is the necessary survival condition plus specific measures to adequately address the specific threats contributing to the species range-wide endangerment. Specific measures needed to achieve a recovery condition include the elimination or minimization of all three high collision-risk power lines (the Power Line Trail, Kīlauea, and the Central Region segments) on the island of Kaua'i. The recovery condition will need to include the creation or active management of at least two additional healthy shearwater colonies on Kaua'i and two healthy shearwater colonies on Maui. For example, the two additional colonies on Kaua'i could be any of those identified by Young and VanderWerf (2014), or other colonies located independently by KESRP. For the purposes of this Biological Opinion, a healthy Newell's shearwater breeding colony is defined as containing a: (1) minimum of 1,500 breeding pairs or active burrows, based on long-term monitoring data on the Manx shearwater (Fraser *et al*. 2013; Brooke 1990; BirdLife International 2016b); (2) suitable breeding habitat, including predator-free or low levels of predator presence adequate to sustain in perpetuity a minimum of 1,500 breeding pairs; and (3) a colony-population growth rate, λ equal to or greater than one, sustained over at least a generation time. Protecting and augmenting any existing Newell's shearwater colonies on Maui will ensure genetic representation and redundancy, allowing the Newell's shearwater to maintain an adaptability and evolutionary capacity over time.

New management actions that have occurred in the last five years include:

- Completion of the 3-hectare predator exclusion fence in 2015, at the Nihoku conservation unit within Kīlauea Point National Wildlife Refuge. Newell's shearwater nestling translocations began in 2016 and will continue over the next four years with the goal of establishing a new Newell's shearwater breeding colony within a fully protected predator-free area on Kaua'i.
- Predator control efforts to benefit Newell's shearwaters that began in June 2016 and expected to continue for the next 2-4 years, within a discrete area ($\leq$ 1 hectare) in Hono o Nā Pali Natural Area Reserve, funded by the American Bird Conservancy.
- Construction of two 1.8-hectare predator-exclusion fences (one each for Newell's shearwater and Hawaiian petrels) in West Maui to protect unoccupied Newell's shearwater breeding habitat. Upon completion of the fence in 2013, social attraction techniques including installation of artificial burrows, decoys, and auditory broadcasts calls have been implemented at the site, along with native vegetation restoration efforts. In June 2016, two prospecting Newell's shearwater adults were recorded on remote cameras (Craig 2016, p. 28).

Recommendations for Future Actions:

- Maintain support and oversight of the two 1.8-hectare Makamaka‘ole Seabird Predator-Proof Fences in West Maui, constructed by First Wind, Inc. and maintained by Kaheawa Wind Power LLC, specifically to create a new Newell’s shearwater breeding colony within a predator-free area on Maui. Efforts at this site should be focused on restoring native montane habitat, since this site was previously used for agricultural purposes.
- Conduct additional acoustic surveys within remote areas of Haleakalā National Park in southeast Maui, to identify the areas of Newell’s breeding habitat and the relative colony population size.
- Construct predator exclusion fences to fully enclose and protect colonies within the Hono o Nā Pali NAR and the entirety of Upper Limahuli colony.
- Construct an ungulate exclusion fence to protect the Honopū seabird colony to manage depredation by pigs and habitat damage from pigs and goats. The area of Honopū where the ungulate fence would be installed is located within DLNR State Parks in northwestern Kaua‘i.
- Construct a cat-exclusion fence located in the State’s Hono o Nā Pali Natural Area Reserve, enclosing the colony.
- Implement erosion control measures, best management practices (e.g., area closures) and native vegetation restoration to prevent damage to sensitive montane habitat, caused by continual access into seabird colonies.

Status of the Hawaiian Petrel

Listing Status, Taxonomy, and Species Description
The Hawaiian petrel (*Pterodroma sandwichensis*) was listed as an endangered subspecies (Hawaiian dark-rumped petrel, *Pterodroma phaeopygia sandwichensis*) in 1967 (32 FR 4001; March 11, 1967). The *Hawaiian Dark-rumped Petrel and Newell’s Manx Shearwater Recovery Plan* was published in 1983 (USFWS 1983). No revisions to this plan have been made. A species five-year review was completed in 2011. The review recommended no change to the listing status.

The Hawaiian petrel is a medium-sized seabird in the Pterodromini clade known as “gadfly” petrels because of their agile and erratic flight behavior (Judge *et al*. 2014, p. 1). The *Pterodroma* genus consists of 33 distinct species of seabirds, of which 23 are extant ranging throughout the Indian, Atlantic, and Pacific oceans. The Hawaiian petrel and Galapagos petrel (*Pterodroma phaeopygia*; formerly referred to as *Pterodroma phaeopygia phaeopygia*) were commonly known as two subspecies of the dark-rumped petrel (*Pterodroma phaeopygia*) (USFWS 1983, p. 1). Based on differences in vocalizations, morphology, behavior (Tomkins and Milne 1991, p. 33; Banks *et al*. 2002, p. 898), and genetics (Browne *et al*. 1997, p. 814) *P. sandvicensis* and *P. phaeopygia* were recognized as distinct and elevated to species rank by the American Ornithologists’ Union in 2002 (Banks *et al*. 2002, p. 898). Force *et al*. (2007, pp. 242-247) suggested several characters may be used to visually distinguish the birds at sea, including plumage, size, shape and manner of flight, and distribution and habitat at sea. The Hawaiian petrel, on average, has a smaller wingspan, tarsus, and bill compared to the Galapagos petrel (Brooke 2004). The black markings of the forehead are variable among Galapagos birds and are

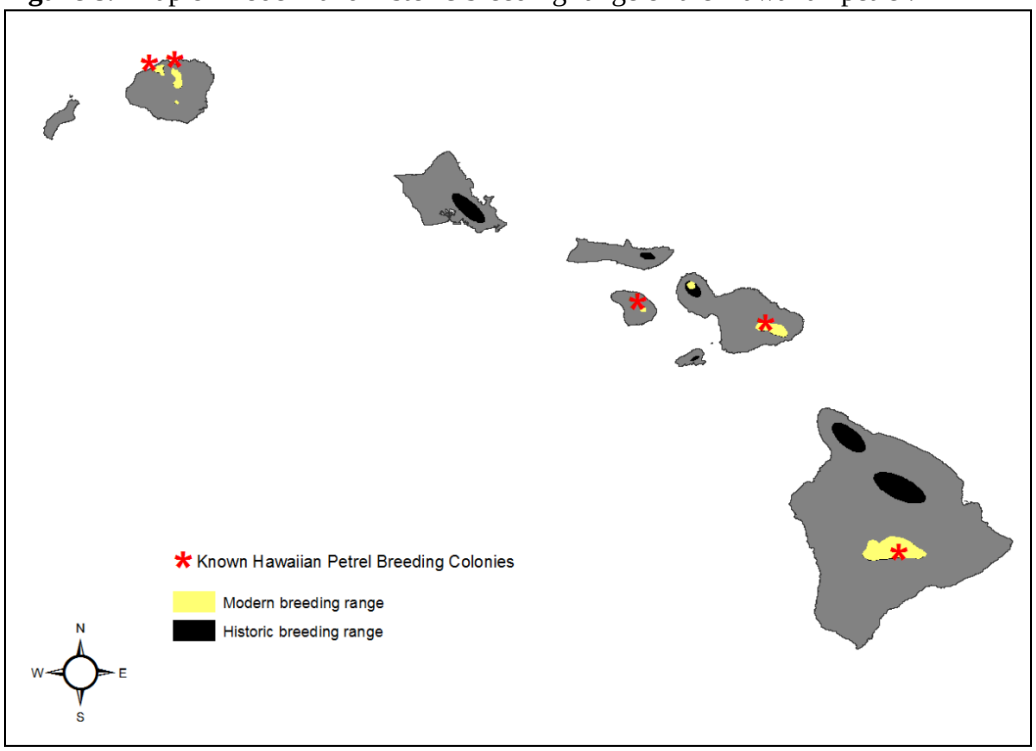
lacking in Hawaiian birds (Tomkins and Milne 1991, p. 33). Moreover, Hawaiian and Galapagos petrels are geographically separated, and do not share at-sea foraging areas (Spear *et al*. 1995, p. 633; Adams *et al*. 2009).

The Hawaiian petrel is approximately 16 inches long (40 cm) and has a wing span of about 3 ft (90 cm). It has a dark gray head, wings, and tail, and a white forehead and belly. The Hawaiian petrel has a stout grayish-black bill that is hooked at the tip, and feet that are pink and black.

Historic and Current Distribution

The Hawaiian petrel was once abundant on all southern islands of the Hawaiian Archipelago including Hawai‘i, Maui, Lāna‘i, Kaho‘olawe, Moloka‘i, O‘ahu, and Kaua‘i (USFWS 1983, p. 3; Ainley *et al*. 1997a, p. 24; KIRC 2015, p. 19). By the 1980s, the Hawaiian petrel population had experienced a significant range contraction and today breeding colonies are found only in remote or high elevation areas on the islands of Hawai‘i, Maui, Lāna‘i, and Kaua‘i (Figure 8). The known breeding habitat varies by location: on East Maui (Haleakalā) and Hawai‘i Island (Mauna Loa), petrels breed in subalpine habitat at high elevation, while on Kaua‘i and Lāna‘i they breed in lowland wet or in wet cliff habitat with dense ferns (VanZandt *et al*. 2014). The current distribution of the Hawaiian petrel is believed to be an artifact of range contraction resulting from predation and habitat destruction rather than preference (Hu *et al*. 2001). Hawaiian petrel breeding colonies are known to exist at five locations on four different islands (Figure 8), although fragmented Hawaiian petrel breeding occurrences (<10 burrows) have been reported in other areas (Simons and Hodges 1998; Spencer 2010).

Figure 8. Map of modern and historic breeding range of the Hawaiian petrel.



Map of the modern and historic breeding range of the Hawaiian petrel showing the southern islands in the Hawaiian Archipelago. Historic (black) and modern (yellow) breeding ranges are illustrated. Historic accounts from islands

outside of Maui are limited and thus the historic breeding range is likely conservative. Currently Hawaiian petrel breeding colonies exist at five locations on four different islands.

Life History

Hawaiian petrels are a *K*-selected species with a reproductive strategy most suited to a stable environment (Stearns 1977). Hawaiian petrels have a long lifespan (up to 35 years), do not reproduce until 6 years of age, lay one egg per year, and require significant parental investment for offspring (Simons and Hodges 1998). Hawaiian petrel breeding season is typically characterized into four consecutive periods: (1) prospecting or pre-laying stage begins in late February, followed by a 2-4 week exodus when breeding adults forage to build-up reserves; (2) the egg laying stage begins at the end of April with incubation through early July; (3) the nestling and chick-provisioning stage continues through early October; and (4) fledging occurs in October through mid-November (NPS 2012, p. 80; Adams 2013). This breeding chronology begins approximately 2-3 weeks later for Hawaiian petrel colonies on Kauaʻi (Judge *et al*. 2014, p. 83; KESRP 2017a). Petrel offspring require up to five months of care from both parents in order to survive. Hawaiian petrels, similar to other birds in the Order Procellariiformes, exhibit strong natal philopatry, with breeding pairs returning to the same burrow to breed each year (Bried *et al*. 2003, p. 242).

Hawaiian petrels are exclusively pelagic, spending much of their time at-sea resting or foraging for squid, small fish, and crustaceans displaced to the surface by schools of tuna (Simons 1985). Satellite telemetry studies in 2006-2008 indicate the majority of Hawaiian petrels (n=20) forage in the North Pacific with few reported south of 10°N (USGS unpublished). During the chick-provisioning stage, each adult foraged an average distance of up to 11,000 km during a 2-3 week period before returning to the nesting site (n=9; Adams *et al*. 2009). Non-breeding adults were documented traveling an average distance of 23,000 km over a six month period (n=3; Adams *et al*. 2009). All transit over land occurs in darkness, with a peak over land passage during the year coinciding with the late incubation and chick rearing stages (Travers *et al*. 2015, p. 18). Fledglings leaving the nest for the first time exhibit strong phototropic behavior and rely on ambient light from the moon and stars to navigate to open ocean (Telfer *et al*. 1987, p. 410).

Current Population Demographics

Pelagic surveys estimate the total Hawaiian petrel population at 19,000 (95% CI = 11,000-34,000) including juveniles and subadults, and an estimate of 4,500-5,000 breeding pairs (Ainley *et al*. 1997a; Spear *et al*. 1995). Croxall *et al*. (2012) estimated a global population of the Hawaiian petrel to be 9,000 to 16,000 mature individuals. Simons (1984, p. 1067) found an 89% breeding frequency of adult Hawaiian petrels (percentage of adults that attempt to breed each year) in a study of 15 accessible, undisturbed, unpredated burrows of established breeding adults. Average breeding probability for Procellariformes is estimated at 0.82 (Griesemer and Holmes 2011, p. 17). Demographic studies of long-lived seabirds have shown that breeding probability increases with age (Ainley and DeMaster 1980) and is a function of individual fitness and habitat quality (Lescroël *et al*. 2009).

Colonial breeding populations of long-lived seabird species rely on a high rate of adult survivorship. Simons (1984, p. 1067) estimated Hawaiian petrel adult survivorship to be 0.93 in the absence of predation and dropped to 0.80 or lower in years of high predation events.

Average sub-adult or juvenile survivorship for Procellariformes is 0.65 to 0.93 (Simons 1984, p. 1067).

The majority of the Hawaiian petrel global population breeds on the island of Maui within Haleakalā National Park, a location that has had the longest consistent and intensive predator control in place since the 1970s. A status of all known extant Hawaiian petrel breeding colonies and the type of active management (i.e., predator control, invasive vegetation control) if any, conducted at each location are shown in Table 3. While fledgling success in the last few years has improved for the Kauaʻi colonies, overall current trend for the Kauaʻi colonies is decreasing.

Due largely to natal and breeding philopatry as well as foraging segregation, limited gene flow occurs within seabird species populations (Friesen *et al*. 2007). Welch *et al*. (2012, p. 23) examined nuclear sequences from 164 Hawaiian petrels representing all extant island colonies and estimated the average migration rate was 0.467 to 10 migrants per generation for petrel populations breeding on different islands. Wiley *et al*. (2012, p. 124) sampled 80 Hawaiian petrels from contemporary Hawaiʻi and Kauaʻi subpopulations and found high levels of genetic differentiation between petrels nesting on Kauaʻi and Hawaiʻi islands (F_{ST}=0.50). Research conducted by Stiebens *et al*. (2013) highlights the conservation value of the Kauaʻi petrel population by demonstrating that philopatry is an evolutionary strategy to conserve a high adaptive potential at the margins of a species' distribution, while asymmetric gene flow maintains genetic connectivity with the rest of the population.

Table 3. Status of all known extant Hawaiian petrel breeding colonies.

Colony	Island	Type of active management	Population size (minimum no. known burrows)	Direction of current trend
Mauna Loa	Hawaiʻi	Predator control	Approx. 100	decreasing
Haleakalā	Maui	Predator control	2,547	increasing
Hono o Nā Pali	Kauaʻi	Predator control	240	decreasing
Limahuli-Mānoa	Kauaʻi	Predator control, invasive vegetation control	26	decreasing
Lānaʻihale	Lānaʻi	None	87	decreasing

Status is based on data from HAVO (2015), NPS (unpublished data), Raine *et al*. (2016a, 2016b, 2016c, 2016d), and VanZandt *et al*. (2014).

Threats

Primary threats to the Hawaiian petrel include predation by introduced predators (Hodges and Nagata 2001; Raine and Banfield 2015a, 2015b) particularly cats, rats, mongoose, feral pigs, and barn owls; as well as collisions with power lines (Cooper and Day 1998; Podolsky *et al*. 1998); light attraction, although at a lower rate than Newell's shearwaters (Reed *et al*. 1985; Cooper and Day 1998); and changes to breeding habitat due to introduced invasive plants (Troy *et al*. 2014). Fifty-four percent of all known Hawaiian petrel deaths at Haleakalā National Park, from 1991 to 2011 (n=532) have been due to introduced predators (NPS 2012). Other studies suggest another threat to seabirds is climate change and its affects to both seabird adult survivorship and

recruitment (Sandvik *et al*. 2012) by generally affecting food availability (Oro 2014). However, other anthropogenic impacts such as oil-spills and interactions with fisheries, as well as previously described land-based threats may confound the association between climate and seabird demography.

Survival and Recovery Needs

For purposes of this BO, the "survival condition" of the Hawaiian petrel in the wild represents the level of reproduction, numbers, and distribution necessary to support a persistent population in the Hawaiian Archipelago that is fully protected by the Act. For purposes of this BO, the "recovery condition" of the petrel is the condition where the threats to the species have been addressed such that the protections under the Act are no longer necessary to insure the survival condition of the petrel in the wild.

The recovery plan (USFWS 1983) for the petrel does not contain recovery criteria; rather general interim objectives are listed that require updating due to a substantial amount of new information. For example, the recovery plan (USFWS 1983) calls for long-term protections of the Haleakalā breeding colony the only known breeding colony at the time, and for a reduction of annual Hawaiian petrel fallout to near 0; however light attraction has not been determined to be a significant threat factor for petrels (Reed *et al*. 1985; Cooper and Day 1998).

The survival and recovery condition of the Hawaiian petrel will need to include representation across Hawai‘i, Maui, Kaua‘i, and Lāna‘i islands to ensure adequate genetic diversity to sustain the evolutionary adaptive potential for the species (Willi *et al*. 2006). Three similar petrel species endemic to their respective archipelago or island group (the Westland petrel, *Procellaria westlandica;* the Stejneger's petrel, *Pterodroma longirostris*; and De Filippi's petrel, *Pterodroma defilippiana*) share identical life histories and philopatric behaviors with the Hawaiian petrel and all exhibit a stable global population (Croxall *et al*. 2012) that includes healthy breeding colonies located on at least 50 percent or more of all islands within their respective archipelago or island group (Wood and Otley 2013; BirdLife International 2016a).

The survival condition of the Hawaiian petrel will rely on the resiliency or health of the five extant individual breeding populations to withstand stochastic events (e.g., tropical hurricanes, changes in food availability). Currently the limiting factor, and indeed the cause of poor health among the extant breeding populations is the lack of suitable breeding habitat free of invasive introduced predators. Furthermore, data from Haleakalā National Park has shown that while predators remain present at low levels due to intensive predator control, other land-based threats (e.g. power lines and artificial nighttime lighting) are highly reduced or non-existent and thus likely are contributing factors in explaining the increasing population trend in the Haleakalā breeding colony.

The recovery condition of the Hawaiian petrel will need to include redundancy in the number and distribution of breeding colony locations on each island, particularly the largest islands with extant breeding populations, including Hawai‘i, Maui, and Kaua‘i. To ensure the viability of each island representational unit and genetic connectivity of populations, the recovery condition should include a minimum of two healthy breeding colonies distributed each on Hawai‘i, Maui, and Kaua‘i islands, in addition to one healthy breeding colony on Lāna‘i. For the purposes of

this Opinion, a healthy Hawaiian petrel breeding colony is defined as (1) containing a minimum of 1,000 breeding pairs or active burrows, based on long-term monitoring data from similar petrel species; (2) suitable breeding habitat, including predator-free or low levels of predator presence adequate to sustain in perpetuity a minimum of 1,000 breeding pairs; and (3) a population growth rate, λ equal to or greater than one, sustained over at least a generation time (i.e., 7 years).

New management actions that have occurred in the last five years include:

- Construction of 5.5 miles of cat-proof fencing to protect the Mauna Loa Hawaiian petrel colony within Hawai‘i Volcanoes National Park. The project was initiated in 2013 and completed in 2016. The cat-proof fence protects 243 hectares of occupied Hawaiian petrel breeding habitat.
- Construction of two 1.8-hectare predator-exclusion fences in West Maui to protect unoccupied Hawaiian petrel breeding habitat. Upon completion of the fence in 2013, social attraction techniques including installation of artificial burrows, decoys, and auditory broadcasts calls have been conducted at the site, along with native vegetation restoration efforts. In 2015, the first prospecting Hawaiian petrel adult was recorded on remote cameras (Craig 2016, p. 26).
- Completion of a 3-hectare predator exclusion fence and successful translocation and fledging of nine Hawaiian petrel nestlings in 2015, at the Nihoku conservation unit within Kīlauea Point National Wildlife Refuge. Hawaiian petrel nestling translocations will continue over the next four years with the goal of establishing a new Hawaiian petrel breeding colony within a fully protected predator-free area on Kaua‘i.
- Predator control efforts to benefit Hawaiian petrel that began in June 2016 and expected to continue for the next 2-4 years, within a discrete area ($\leq$ 1 hectare) in Hono O Nā Pali NAR, funded by the American Bird Conservancy.
- Construction of ungulate exclusion fencing in 2017, to enclose 856 hectares at Haleakalā National Park within the new Nu‘u unit, added to the park in 2008.

Recommendations for Future Actions:

- Maintain consistent, intensive predator control within and surrounding the Mauna Loa Hawaiian petrel colony.
- Conduct strategic and low impact surveys for occupied Hawaiian petrel breeding habitat within the extensive Nu‘u unit of Haleakalā National Park in conjunction with ungulate fence construction, in order to prioritize predator control efforts in this area.
- Construct a predator exclusion fence to protect the largest extant Hawaiian petrel colony at Hono o Nā Pali, Kaua‘i while limiting the impact and restoring where possible the montane wet ecosystem of this area.
- Conduct predator control at the Lāna‘ihale Hawaiian petrel colony, in conjunction with and prior to any additional ground surveys in order to limit vegetation trampling and predator ingress.

- Conduct colony monitoring once the Mauna Loa Hawaiian petrel fence is complete and colony monitoring at the Haleakalā colony to obtain updated population demographic information and life history parameters.
- Maintain support and oversight of the 1.8-hectare Makamakaʻole Seabird Predator-Proof Fence in West Maui, constructed by First Wind, Inc. and maintained by Kaheawa Wind Power LLC, specifically to create a new Hawaiian petrel breeding colony within a protected predator-free area on Maui.

Status of the Band-Rumped Storm-Petrel

Listing Status, Taxonomy, and Species Description
The Hawaiʻi distinct population segment of the band-rumped storm-petrel (*Oceanodroma castro*) (band-rumped storm-petrel) was listed as endangered effective on October 31, 2016 (81 FR 67786). For a population to be listed under the Act as a distinct vertebrate population segment, three elements are considered: (1) the discreteness of the population segment in relation to the remainder of the species to which it belongs; (2) the significance of the population segment to the species to which it belongs; and (3) the population segment's conservation status in relation to the Act's standards for listing (61 FR 4722). The Hawaiʻi population of the band-rumped storm-petrel may be distinct based on geographic and distributional isolation from other band-rumped storm-petrel populations elsewhere in the Pacific and Atlantic oceans. A population also can be considered "discrete" if it is delimited by international boundaries across which exist differences in management control of the species. The Hawaiian Islands population of the band-rumped storm-petrel is the only population within U.S. borders or under U.S. jurisdiction.

The band-rumped storm-petrel is a seabird in the family Hydrobatidae (order Procellariiformes) and a member of the Northern Hemisphere subfamily Hydrobatinae (Slotterback 2002, p. 2), with some taxonomic questions unresolved. Prior to 1900, this species had been described as an unnamed petrel in the genus *Thalassidroma* (Dole 1869, 1879 *in* Stejneger 1887, p. 78), as *Cymochorea cryptoleucura* (Ridgeway 1882, pp. 337– 338), and as *Oceanodroma cryptoleucura* (Stejneger 1887, p. 78). After Henshaw's 1902 publication, the Hawaiian population was known as *O. castro cryptoleucura*, the Hawaiian storm-petrel (Harrison *et al*. 1990, p. 47). Austin (1952, pp. 395-396) examined eleven museum skins from the Hawaiʻi population and studied the taxonomy of the band-rumped storm-petrel and concluded that, although the various populations exhibited minor size differences, these differences were not significant and the populations were best considered as belonging to a single species with no separable subspecies. Since then taxonomists have typically combined the Pacific populations (Galapagos Islands, Japan, and Hawaiʻi) of the band-rumped storm-petrel into a single taxon, and currently the American Ornithologist's Union (AOU) regards the species as monotypic with no recognized subspecies (Slotterback 2002). However, some authors designate *Oceanodroma castro* as referring solely to the Madeiran storm-petrel, breeding in the Azores Archipelago and which may belong to two distinct, albeit sympatric, populations with separate breeding seasons, as well as distinctive morphologies, vocalizations and moult cycles (Monteiro and Furness 1998; Bolton *et al*. 2008). As such, del Hoyo and Collar (2014) have re-classified the band-rumped storm petrel as *Hydrobates castro*, with breeding populations in the eastern Atlantic from the Berlengas Islands and the Azores (Portugal), down to Ascension Island and Saint Helena (St. Helena to UK), and in the Pacific Ocean off eastern Japan, on Kauaʻi, Hawaiʻi (USA) and in the Galapagos Islands

(Ecuador) (del Hoyo *et al*. 1992). Moreover, Pyle *et al*. (2016, p. 59) has reported regular sightings of the Leach's storm-petrel (*Hydrobates leucorhous*) and the band-rumped storm-petrel (*Hydrobates castro*) overlapping in range and plumage coloration around Hawaiian waters, further questioning the taxonomic status of the species.

The band-rumped storm-petrel is a small seabird about 8 inches long with a wingspan of about 19 in (47 cm), and about 2 ounces (50 grams) in weight. The tail is only slightly notched and may appear almost square. Plumage is an overall blackish-brown with a white band across the "rump" (above the tail). This species typically flies with a relatively shallow wing-beat, and glides on slightly bowed wings as a regular part of flight (Slotterback 2002, p. 2). Sexes are alike in size and appearance. Vocalizations at breeding colonies can be used to further distinguish this species from other Procellariiformes seabirds (Allan 1962, p. 279; James and Robertson 1985, pp. 391–392).

Historic and Current Distribution

The band-rumped storm-petrel probably was common on all of the main Hawaiian Islands prior to Polynesians arrival about 1,600 years ago (Berger 1972, pp. 25-26; Harrison *et al*. 1990, p. 47). As evidenced by abundant storm-petrel bones found in middens on the island of Hawai‘i (Harrison *et al*. 1990, p. 47) and in excavation sites on O‘ahu and Moloka‘i (Olson and James 1982b, p. 33), band-rumped storm-petrels once were numerous and nested in sufficiently accessible sites, including coastal areas, to be used as a source of food and possibly feathers (Harrison *et a1*. 1990, p. 48). They were also known from French Frigate Shoals in the Northwestern Hawaiian Islands (Henshaw 1902, p. 118).

The band-rumped storm-petrel is found in several areas of the subtropical Pacific and Atlantic oceans (Slotterback 2002, p. 1). In the Pacific, there are three widely separated breeding populations: one in Japan, one in Hawai‘i, and one in the Galapagos (Slotterback 2002, p. 1). In Hawai‘i, band-rumped storm-petrel habitat preference is primarily wet cliff and dry cliff ecosystems. Storm petrels currently nest in remote cliff locations on Kaua‘i and Lehua Islet, and in high-elevation lava fields on Hawai‘i island (Wood *et al*. 2002, p. 17–18; VanderWerf *et al*. 2007, pp. 1, 5; Joyce and Holmes 2010, p. 3; Banko 2015, in litt.; Raine 2015, in litt.). Due to the remote and vertical nature of their nesting habitat, an active nest has yet to be discovered and only a few inactive nests have been found in the Hawaiian Islands: one on a sheer cliff in remote Pōhakuao Valley on the Nā Pali coast of Kaua‘i (Wood *et a1*. 2002), one in a small cave on Lehua Islet (VanderWerf *et a1*. 2007, p. 47), located 0.6 mi. north of Ni‘ihau, and within two known Hawaiian petrel nesting areas on Mauna Loa volcano (both in the Kīlauea region (8,000-10,000 feet) and at Kahuku (5,000-6,000 feet)) on Hawai‘i Island (Orlando 2015, in litt.). All nests were located in small caves or crevices, and were confirmed to be nests of this species by skeletal remains found in the nest. No other nests have been found (Slotterback 2002).

The at sea distribution of band-rumped storm-petrels in the Pacific Ocean is largely unknown, but birds have been seen 600 miles north of Hawai‘i, 1,000 miles south of Hawai‘i, and between Japan and Hawai‘i. The Pacific populations of the band-rumped storm petrels are not known to range near the waters of the U.S. West Coast (Howell *et al*. 2010, p. 198). Band-rumped storm-petrels in the Atlantic are known to travel immense distances (Howell *et al*. 2010, p. 198), so it is

possible that any of the Pacific records could include the Hawai‘i population of band-rumped storm petrels (KESRP 2017c).

Life History
The band-rumped storm-petrel is long-lived (15 to 20 years) and probably does not breed until its third year (Harrison *et al*. 1990, p. 48). When not at nesting sites, adults spend their time foraging on the open ocean for small fish, squid, and crustaceans. They have been observed feeding during the day, but it is likely that they also feed at night (KESRP 2017c). The band-rumped storm-petrel breeding biology in Hawai‘i is poorly known. Like most seabirds a single egg is laid per season. In Hawai‘i, eggs are laid between May and June, and nestlings fledge in October (DOFAW 2005).

Current Population Demographics
Brooke (2004) estimated the global population of band-rumped storm-petrels to number around 150,000 individuals. However, due to unresolved taxonomic questions and similarity in plumage coloration with other species, population estimates may be widely challenged. Wood *et al*. (2002) estimated 171–221 breeding pairs of band-rumped storm-petrels on Kaua‘i, based on surveys conducted in 2002 and recordings of storm-petrel ground calls. The SOS program has also documented the retrieval of fledglings. Kaua‘i likely has the largest population of band-rumped storm-petrels in the Hawaiian Islands (Harrison *et al*. 1990). During the breeding season, band-rumped storm-petrels have been heard calling in flight over the broad slopes of Mauna Loa on Hawai‘i, the summit of Haleakalā on Maui, and have been heard ground calling from very steep, rocky cliffs along the Nā Pali coast and Waimea Canyon on the island of Kaua‘i (Banfield *et al*. 2013; Raine and Banfield 2015b). Concentrated calling activity on Kaua‘i, Maui, and the Hawai‘i Island suggests breeding occurs on these islands and there is a small possibility that a remnant colony may exist on Lehua Islet (KESRP 2017c). No data exists on the population demographics of band-rumped storm-petrels in the Hawaiian Archipelago.

Threats
Introduced predators are believed to be the most serious terrestrial threats facing the band-rumped storm-petrel in Hawai‘i. Rats, cats, and barn owls are likely culprits. The band-rumped storm-petrel, like the other seabirds discussed above, lack effective predator defenses, and have a lengthy incubation and fledgling period, making adults, eggs, and young highly vulnerable to predation by introduced vertebrates. Wood *et al*. (2002) observed introduced barn owls flying along basalt cliff faces where the band-rumped storm-petrels nest in Pōhakuao, Kaua‘i.

Another impact to the band-rumped storm-petrel results from the effects of artificial lights on fledgling young and, to a lesser degree, adults. Artificial lighting along roadways, resorts, ballparks, residences, and other developed areas both attracts and confuses night-flying band-rumped storm-petrel fledglings, resulting in fallout (Harrison *et al*. 1990) and collisions with buildings and other objects (Banko *et al*. 1991). Since 1979, a total of 40 band-rumped storm petrels have been processed by the SOS program (Anderson 2015, p. 4-13), where carcasses have been documented or live birds rehabilitated and released. The majority of these birds landed on cruise ships enroute and these ships subsequently docked at Nāwiliwili Harbor, Kaua‘i and submitted injured birds to the SOS for care (Anderson 2015, p. 4-13). In 2014, a record number of three band-rumped storm petrel individuals were processed by the SOS program. The

first was a subadult After Hatch Year (AHY) bird picked up in September from Kapaʻa. The second band-rumped storm-petrel was a Hatch-Year (HY) bird attracted to the lights from a research boat offshore from the Nā Pali coast and was subsequently unable to regain flight. The third band-rumped storm-petrel was also a HY bird found at the Kauaʻi Sheraton Hotel in Kōloa, Kauaʻi in November 2014. All three band-rumped storm-petrel individuals were successfully released after rehabilitation by the SOS program.

Survival and Recovery Needs

Recovery goals have not been established for the band-rumped storm-petrel, but the Service's Regional Seabird Conservation Plan (USFWS 2005a, p. 200) contains recommended actions for the species that include controlling predators in nesting areas, assessing status of the population, locating and describing nesting areas, identifying limiting factors and developing a recovery strategy. As described above, the efforts to recover and release downed seabirds through the SOS program are expected to support the survival and recovery needs of the species. Increased surveys for band-rumped storm petrels throughout the Hawaiian Archipelago would serve to obtain needed population demographic information in order to effectively identify survival needs of the species. Based on the locations of known breeding sites along cliff faces of the shoreline and multiple occurrences of band-rump storm petrels interacting with vessels at sea, additional recovery needs would include minimization of artificial nighttime lighting while vessels are at sea near band-rumped storm petrel breeding colonies.

Environmental Baseline of the Newell's Shearwater, Hawaiian Petrel, and the Band-Rumped Storm-Petrel

Adult Newell's shearwaters, Hawaiian petrels, and band-rumped storm-petrels do not nest at Kōkeʻe AFS and MAS, but do use the area to commute to and from the ocean to their high elevation nest sites in the mountains. Fledgling Newell's shearwaters, Hawaiian petrels, and band-rumped storm-petrels also fly through the area on their first trip to the sea. Seabird monitoring at Kōkeʻe AFS has documented very few birds, flying high overhead, at Kōkeʻe AFS (Raine 2016b, in litt.).

Lighting from artificial lights has had a negative impact on these species, in particular during the fledgling period. Nighttime lighting interferes with the birds' ability to navigate. The Newell's shearwater, Hawaiian petrel, and band-rumped storm-petrel become attracted to artificial lighting and will circle light sources until exhausted, fall to the ground or collide with structures. It was previously believed that only fledgling birds were affected by artificial lighting sources, however, as documented at Kōkeʻe AFS in 2015, adult Newell's shearwaters and Hawaiian petrels are also attracted to brightly lit areas and become disoriented by them.

Grounded shearwaters were reported and turned over to the Hawaiʻi Department of Land and Natural Resources in 1996, which was responsible for the SOS during that time period (EA 1996, as cited in USAF 2016). Observations from staff (Table 4) at the station were used to assess the presence of Newell's shearwater and Hawaiian petrel within Kōkeʻe AFS. Observations included in the table below were gathered through e-mails and interviews with staff working on base (VanderWerf and Young 2010, p. 9). In addition to specific events documented below, staff report hearing or observing seabirds flying by the base about twice a month. Several

staff reported that up to six birds at a time had been observed circling lights and ultimately grounded approximately two weeks before surveys conducted by Pacific Rim Conservation in October 2009. There has been no evidence of take at Kōkeʻe MAS. This installation may pose less of a hazard to seabirds because it is located farther from known nesting colonies, does not appear to lie in a flight corridor, and does not contain white lights that attract birds. However, no full-time personnel are present at this site and survey efforts at Kōkeʻe MAS have been much lower.

In 2010, The USAF contracted Pacific Rim Conservation to conduct surveys at Kōkeʻe AFS and MAS in order to help assess potential impacts of USAF actions on the listed seabird species. Auditory and visual surveys for Newell's shearwaters and Hawaiian petrels were conducted at Kōkeʻe AFS and Kōkeʻe MAS for four nights and four mornings during the fledging season in October in 2009 and three nights and mornings during the adult arrival period in May 2010, for a total of seven survey nights and seven survey mornings. Four live seabirds were detected; a Newell's shearwater was heard calling at Kōkeʻe AFS on October 27, 2009, and a Hawaiian petrel and two unidentified seabirds were seen at Kōkeʻe AFS on May 25, 2010 (Table 4). Additionally, the wing of a dead Newell's shearwater was found at Kōkeʻe AFS on October 27, 2009. Staff at Kōkeʻe AFS also reported seeing birds circling lights and finding dead birds on the ground twice in 2009. The Service issued the 2011 BO to address the USAF's actions and effects on the Newell's shearwater and Hawaiian petrel and since issuance of the 2011 BO, the USAF has made efforts to avoid and minimize their take of listed species. Modifications included minimizing light attraction by angling floodlights to a downward position and replacing them with green lights; replacing unshielded outdoor building lights with shielded models or retrofitting them with shields; limiting inside building lights to be seen from the outside; conducting a seabird awareness and rescue training to staff on site at Kōkeʻe AFS; and minimizing predation on grounded seabirds by trapping predators and properly storing rubbish to avoid attracting predators.

Table 4. Known take of federally listed seabirds at Kōkeʻe AFS, prior to issuance of 2011 BO (information taken from VanderWerf and Young 2010, p. 9).

Date	Newell's shearwater*	Hawaiian petrel	Unidentified Seabird	Total
Aug 2006	1			1
July 2008	1			1
Feb 2009	1			1
April 2009	1			1
Oct 2009	7			7

* staff have only reported Newell's shearwaters, but it is possible that some of these birds were Hawaiian Petrels because it was unclear whether staff were aware of the differences between the two species.

However, in 2015, a total of 130 birds (122 Newell's shearwaters, 6 Hawaiian petrels, and 2 unidentified) were documented on the ground at Kōkeʻe AFS from August 7 through September 14 (Table 5). Seabird surveys were conducted within this time period; the main areas of fallout were all associated with very bright perimeter lights, which were orientated outwards or slightly upwards, creating a very bright glow (Raine *et al*. 2015). In some cases, the lights were also pointing at reflective surfaces, further exacerbating the problem. Weather conditions alternated

between dense fog and light rain. In the foggy conditions of the night, these combined issues created very large glows which were apparently highly attractive to the birds. Even in clear conditions, this outward and upward lighting setup would likely be attractive to birds although perhaps to a lesser degree.

Fallout was constant throughout the evening, and centered predominantly on the perimeter lights in four main areas of Kōkeʻe AFS. Many birds were found along the fence line, having landed outside the boundary of the base. All birds were adults. These lights, while being green, were very bright, not well-shielded and orientated outwards and in some cases partially upwards. The effect of turning off lights is apparent in limiting the number of Newell's shearwater and Hawaiian petrel that would be attracted when flying near Kōkeʻe AFS (Figure 9).

An additional Newell's shearwater fledgling was found at Kōkeʻe AFS during the night of November 16, 2015. The USAF had been conducting a trial since October 27, 2015, to test the green perimeter lights which had all been re-oriented in a downward facing direction.

Table 5. Known take of seabirds at Kōkeʻe AFS, after issuance of 2011 BO (data taken from information provided from the USAF downed bird log sheet and Raine 2015)

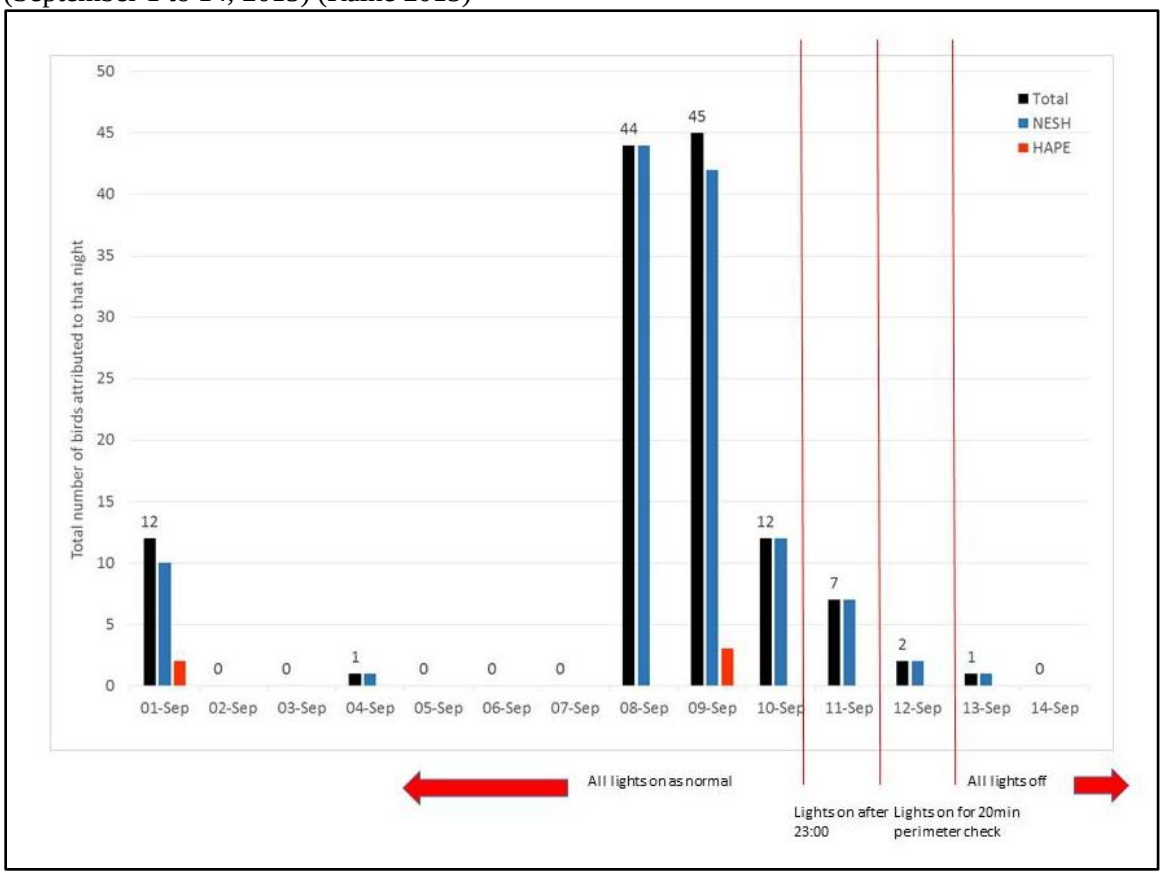
Date	Newell's shearwater	Hawaiian petrel	Unidentified Seabird[^]	Total
Nov 6, 2013	1			1
Nov 25, 2013		1		1
May 26, 2014	1			1
Nov 8, 2014		1		1
Nov 18, 2014		1		1
Nov 28, 2014	1			1
Aug 7, 2015	1			1
Aug 15, 2015[#]	1	1		2
Sept 1, 2015[#]	10	2		12
Sept 4, 2015[#]	1			1
Sept 8, 2015[#]	22			22
Sept 9, 2015[#]	43	1		44
Sept 10, 2015[#]	29	2		31
Sept 11, 2015[#]	7			7
Sept 12, 2015[#]	5		1	6
Sept 13, 2015[#]	2		1	3
Sept 14, 2015[#]	1			1
Nov 18, 2015	1			
May 8, 2016	1			
May 9, 2016	1			

[^] birds listed as 'unidentified seabird' are either Newell's shearwater or Hawaiian petrel, but due to the degraded nature of the carcass they could not be identified to species.

[#] Note data taken from Raine (2015) includes Aug 15, 2015 and afterward; and is presented as day each bird was found and not the day it was handed to the SOS program (which was predominantly the following day).

Since the 2015 fallout events, more Newell's shearwaters were documented at Kōkeʻe AFS on the nights of May 8, 2016 (one Newell's shearwater), and May 9, 2016 (one Newell's shearwater); perimeter security lights were off, but exterior building lights were on. Full blackout conditions were implemented from May 10 to December 31, 2016 and no additional birds were detected after all exterior lights were shut off. Without bright lights, very few birds were documented flying over the AFS; and those observed were high overhead (Raine 2016b, in litt.). This demonstrates that when the lights are turned off at Kōkeʻe AFS there is very little seabird activity in the immediate area (Raine 2016b, in litt.).

Figure 9. All recorded fallout on Kōkeʻe AFS, attributed to each night, since first bird reported (September 1 to 14, 2015) (Raine 2015)



Note the totals shown are both species combined, but 94.4% (n=119) were Newell's shearwater. Also, this does not include the 2 birds (1 Newell's shearwater and 1 Hawaiian petrel) found on the premises in August nor carcasses (n=3) for which date of grounding could not be determined.

There is a likelihood that without minimization of light sources during the adult prospecting and fledgling season, Newell's shearwaters, Hawaiian petrel, and band-rumped storm-petrels will continue to be drawn in from neighboring nesting colonies.

Due to the small size of the band-rumped storm-petrel, it is likely that there are missed events of observed fallout due to the removal of birds by scavengers (e.g., mice, rats, cats, etc.). However, over a 37-year period the SOS program documented a total of 32,462 individuals of the Newell's shearwater, Hawaiian petrel, and band-rumped storm-petrel recovered, injured or killed due to artificial nighttime lighting (Anderson 2016b, in litt.). In 2000–2015, SOS recoveries by species

varied considerably, with 96%, 3%, and 1% of the total consisting of Newell's shearwater, Hawaiian petrel, and band-rumped storm petrel, respectively (DOFAW 2016).

The predation threats described in the Status of the Species section (above) for the Newell's shearwater, Hawaiian petrel, and band-rumped storm-petrel are the same within the action area. Predation by feral cats, rats, barn owls, and feral pigs are all a constant threat that are limiting the breeding success of endangered seabird populations in Hawai'i. In some areas of Kaua'i, seabird populations are mostly protected from terrestrial mammalian predators by geographic barriers such as the steep cliffs of the Nā Pali coast and off-shore islets such as Lehua that preclude easy access to colony locations. In these colony locations, aerial predators are the primary threat.

Previous Consultations in the Action Area

In September of 2014, the Service issued a non-jeopardy BO (Service File 2014-F-0066) addressing the Pacific Missile Range Facility (PMRF) Base-wide Infrastructure, Operations, and Maintenance Activities and their effects on the endangered Hawaiian stilt (*Himantopus mexicanus knudseni*); Hawaiian moorhen (*Gallinula chloropus sandvicensis*); Hawaiian coot (*Fulica alai*); Hawaiian duck (*Anas wyvilliana*); Hawaiian goose; Hawaiian hoary bat; Hawaiian petrel; the threatened Newell's shearwater; and at the time of consultation, a candidate species, the band-rumped storm-petrel. The incidental take statement accompanying the BO authorized the take of up to an average of three Newell's shearwater per year through the foreseeable future. The no-jeopardy conclusion for the Newell's shearwater relied on provisions in the proposed action for lighting minimization and predator control measures at seabird breeding colonies to offset the impacts of incidental take and to provide a net conservation benefit to the species as a whole.

In March of 2011, the Service issued a non-jeopardy BO (Service File 01EPIF00-2010-F-0430 and 01EPIF00-2010-F-0460) for the PMRF Intercept Test Support action, which addressed the effects of Aegis Ashore Intercept Test Support construction and operation activities at Barking Sands on the Newell's shearwater, Hawaiian petrel, and the band-rumped storm petrel for a period of three years; that opinion was amended in October of 2011. The incidental take statement accompanying the amended opinion authorized the take of up to ten Newell's shearwaters, one Hawaiian petrel, and one band-rumped storm-petrel over the 3-year term of the action as a result of collision with the boresight towers or due to attraction and fallout from lighting associated with the project. The incidental take statement accompanying the amended opinion also authorized the take of up to five Newell's shearwaters eggs and/or chicks, one Hawaiian petrel egg and/or chick, and one band-rumped storm-petrel egg and/or chick over the 3-year term of the action as a result of predator control activities at shearwater breeding sites. The Service's non-jeopardy conclusion relied on provisions in the proposed action for minimization and mitigation of take impacts, including predator control within existing seabird breeding colonies and radar surveys to help assess seabird population trends on Kaua'i.

In March of 2011, the Service issued a non-jeopardy BO for the KIUC Short-term Seabird HCP and Incidental Take Permit (Service File 01EPIF00-2011-F-0113, Permit No. TE234201-0), that addressed effects from the operation of existing and new electrical utility facilities on the Newell's shearwater and Hawaiian petrel, until 2016 for the entire island of Kaua'i. The Incidental Take Permit authorized the take of up to 162 adult, sub-adult, or fledgling Newell's

shearwaters annually over the 5-year permit term as a result of attraction to, or collision with, KIUC facilities, as well as the take of up to 18 eggs and/or chicks as a result of the mortality of breeding adults. The annual take of up to two adult, sub-adult, or fledgling Hawaiian petrels was also authorized. Because of the minimization and mitigation measures implemented through the Habitat Conservation Plan, anticipated reduction in ongoing take from these measures, and implementation of conservation projects to offset unavoidable take (i.e. predator control within existing seabird breeding colonies), the Service concluded that the issuance of the Incidental Take Permit was not likely to jeopardize the continued existence of the Newell's shearwater and the Hawaiian petrel in the wild.

In October of 2011, the Service issued a non-jeopardy BO for the PMRF Advanced Hypersonic Weapons System (Service File 01EPIF00-2011-F-0385), which addressed the effects from one-time operation of existing launch facilities at the Kaua'i Test Facility on the Newell's shearwater and the Hawaiian petrel from October through mid-November of 2011. The Incidental Take Statement accompanying the BO authorized the take of up to four Newell's shearwaters and one Hawaiian petrel over the two-month term of the action caused by seabird attraction and fallout from lighting associated with the project. Because of the minimization and mitigation measures implemented under the proposed action, an anticipated reduction in ongoing seabird take as a result of these measures, and implementation of conservation projects to offset unavoidable take, the Service concluded that the proposed action was not likely to jeopardize the continued existence of the Newell's shearwater and the Hawaiian petrel in the wild.

Effects of the Action

Exposure Analysis Approach

The Service has developed an analysis framework for section 7 consultations that incorporates the general structure, primary concepts, and nomenclature of the U.S. Environmental Protection Agency's (EPA) ecological risk assessment framework (USFWS 2005b). Factors causing adverse effects are called "stressors" and beneficial effects are called benefits. In this approach, the Service determines the resources that will be exposed to the proposed action's stressors and benefits by evaluating the location, timing, duration, frequency, and intensity of potential exposure to each stressor and benefit, and identifying the physical, chemical, and biotic features that will be directly and indirectly exposed. Then the causal relationships between sources of stressors and benefits and the response of listed resources are analyzed. The exposure analysis also estimates future changes in the abundance or distribution of listed species expected to result from exposure to stressors and benefits.

The proposed action's stressors and benefits may include the following actions within the action area:

- Kōke'e AFS structures
- Kōke'e AFS installation lighting
- Implementation of outreach and education
- Control of predators within Kōke'e AFS and within seabird colonies

Each stressor and benefit is expected to have direct or indirect effects to the species. Direct effects are effects that are caused by the action affecting species at the time and location of exposure. Indirect effects are effects that are caused by the action but occur later in time or at a different location. The effects of each are explained in relation to the Newell's shearwater, Hawaiian petrel, and band-rumped storm-petrel below.

Effects to Newell's shearwater, Hawaiian petrel, and band-rumped storm-petrel

Kōkeʻe AFS structures
Kōkeʻe AFS contains a large number of structures expected to have direct effects on Newell's shearwater, Hawaiian petrel, and band-rumped storm-petrel by posing a collision risk. The facilities at Kōkeʻe AFS include the AN/FPS-117v4 Long Range Radar, operated out of the radome on the highest point of the installation. The installation maintains ground-to-air communications through antennas; each pole is 80 feet high and connected by guy wires. The installation also contains poles that support flood lights, numerous utility lines, and several buildings. All towers are co-located and adjacent to the main building which contours to the natural topography at the lowest point within the installation. The overall orientation of structures minimizes what actually protrudes above the vegetation layer and into the air space making the collision risk less likely in the absence of the light attraction. We expect by minimizing artificial light the collision risk with structures may be reduced.

Kōkeʻe AFS installation lighting
The proposed action is expected to have direct effects on the Newell's shearwater, Hawaiian petrel, and band-rumped storm-petrel caused by the AFS green perimeter and building installation lighting which will be used December 31 to March 31. The proposed timing for green perimeter and building lights to be on at night is not likely to coincide with the adult prospecting and breeding period, or the fledgling fallout periods, thus minimizing the likelihood of large fallout events that were experienced in 2015. However, there has been documentation of fallout during this time when lights were angled upwards and not completely shielded even when birds are thought to be at their oceanic habitats. We anticipate fallout of adult and fledgling birds due to attraction to green perimeter and building lighting during the December 31 to March 31 timeframe. Additionally, eggs and chicks are indirectly affected as they rely on provisioning from both parents in order to survive, thus the loss of either parent results in nestling fatality. Therefore, we also expect adverse effects to eggs or chicks at the nest due to the loss of an adult bird no longer incubating and providing care for the egg or chick.

The proposed action is expected to have direct effects on the Newell's shearwater, Hawaiian petrel, and band-rumped storm-petrel due to fallout expected from the use of temporary perimeter and security lighting which would be used in an event of an illegal incursion, emergency on the installation, or security violation occurring during April 1 to December 30 blackout period. However, limited usage of light will be used in these rare instances and the duration will be minimized to the maximum extent practicable. We anticipate fallout of adult and fledgling birds due to attraction to installation lighting from such emergency situations during the December 31 to March 31 timeframe. Additionally, eggs and chicks are indirectly affected as they rely on provisioning from both parents in order to survive, thus the loss of either parent results in nestling fatality. Therefore, we also expect adverse effects to eggs or chicks at

the nest due to the loss of an adult bird no longer incubating and providing care for the egg or chick.

Implementation of outreach and education
The proposed action is expected to have an indirect effect on the Newell's shearwater, Hawaiian petrel, and band-rumped storm-petrel due to the USAF's current outreach and education program that will continue to inform and educate on-site staff to understand the importance and of the following actions: keeping windows and doors closed at night, turning off lights when they are not needed, and not feeding feral cats. We expect this to be an important benefit to birds by reducing lights emitted to the outside of buildings. Also, we expect the education of not feeding feral cats to on-site personnel to be an important benefit to reduce potential predation on birds should they suffer fallout.

Control of predators within Kōkeʻe AFS and within seabird colonies
The proposed action is expected to have direct effects on the Newell's shearwater, Hawaiian petrel, and band-rumped storm-petrel due to predation by feral cats, rats, barn owls, and feral pigs which are all a constant threat limiting the breeding success of endangered seabird populations within their colonies in the Hawaiian Islands.

We expect the proposed control and monitoring of predators on the station will decrease the likelihood of the affected species being killed by predators if a fallout event were to happen within fenced areas of Kōkeʻe AFS. Additionally, we expect the proposed barn owl control within seabird colonies will provide a benefit for the reproduction and survivorship of birds at their colonies, which will help to protect and enhance the productivity and reproductive success. We expect this will provide a benefit to adult and fledgling birds, as well as their eggs and chicks. Additionally, we expect the benefits of barn owl control to apply to all three species discussed in this BO.

Quantifying effects of the action
We are not using the number of birds lost from Kōkeʻe AFS actions before 2011 to estimate the likelihood of birds attracted to installation lighting in our analysis. Conservation measures were not in place prior to 2011 and it is likely that the change of actions implemented at that time most resembles the actions proposed for this BO. We are also not using the number of birds lost in the 2015 light entrapment event, due to lights directed upwards coupled with environmental conditions that created an unusually high number of fallout. We expect this is not a likely event that will be repeated due to implementation of conservation measures proposed in this BO. Therefore, the number of birds estimated in our analysis as a result of the USAF proposed actions are based on data taken from 2013, 2014, one fallout event in 2015 (November 28), and data from 2016 which is used as the baseline data set for this analysis.

The highest known observed level of take of the Newell's shearwater at Kōkeʻe AFS within the baseline data set was two birds in 2014 and two birds in 2016. We anticipate up to 2 Newell's shearwaters adults or fledglings per year will likely be taken in the form of injury or death.

Based on a model developed by the Service to assess the predation effects on Newell's shearwater, we estimated that the probability of any two adults mating is approximately 88

percent. We also estimated that the combination of that probability and the survivorship from age 0 to 1 is approximately 47 percent (Vorsino 2016). By multiplying the probability that any two adults will mate (88 percent) and the survivorship of their offspring (47 percent) we estimate that a breeding pair will likely produce 0.41 chicks that survive to fledgling. We applied this number to our 2 anticipated adults lost and calculated that 0.82 eggs or chicks would be lost per year. Therefore, we estimate that up to 1 egg or chick per year would be taken in the form of death due to the injury or death of any 2 adult Newell's shearwater adults likely to be breeding and successfully producing a chick.

The highest known observed level of take of the Hawaiian petrel within the baseline data set was also 2 birds in 2014. Although, the number is the same for Newell's petrel that same year, Hawaiian petrels are impacted by the threat of light attraction at a lower rate than Newell's shearwaters (Reed *et al*. 1985; Cooper and Day 1998). Data from the baseline data set documented 6 Newell's shearwaters and 3 Hawaiian petrels downed at Kōkeʻe AFS. We used this ratio to estimate that for every 1 Newell's sheawater is 0.5 Hawaiian petrel (3/6 = 0.5). We expect 2 adult Newell's shearwaters taken every year, therefore, we can expect 1 adult Hawaiian petrel would be taken every year (2 Newell's per year = (0.5)(2)). Therefore, we estimate that up to 1 Hawaiian petrel adult or fledgling per year would be taken in the form of injury or death due to the proposed action.

The Service has not yet developed a model to assess the predation effects of the barn owl on the Hawaiian petrel, therefore, we used the juvenile survivorship of Procellariforms (0.65 to 0.93) and averaged that number ((0.65 + 0.93)/2 = .79) to estimate the likelihood of eggs or chicks to survive to juvenile age. Multiplying that number by the breeding frequency (89 percent) of adult Hawaiian petrels allowed us to estimate the probability of adults to be breeding and produce an egg or chick to the juvenile age class to be approximately 70 percent ((0.89)(0.79) = 0.70). Therefore, we estimate the mortality of 1 adult Hawaiian petrel is likely to result in the loss of up to 1 egg or chick every per year due to the proposed action.

The environmental baseline of the band-rumped storm-petrel within the action area is poorly understood, however, effects of artificial lighting cannot be discounted. SOS recoveries of the band-rumped storm-petrel from 2000 – 2015 accounted for only one percent of all downed and retrieved seabirds (96 percent and 3 percent for Newell's shearwater and Hawaiian petrel, respectively; DOFAW 2016). This is likely an underestimate of total fallout events for the band-rumped storm-petrel due to fallout not observed or documented as well as the delay in bird carcass retrieval prior to the removal by scavengers. Therefore, we used data from auditory detections to proportion the population estimate of band-rumped storm-petrels to Newell's shearwaters for our analysis of effects. Based on that information we estimate that the band-rumped storm-petrel population is equivalent to approximately 5 percent of the total Newell's shearwater population estimate. We multiplied the 5 percent to the estimated number of 2 adult Newell's shearwaters to be taken by the action to calculate an estimated take of approximately 0.1 band-rumped storm petrel per year ((0.05)(2) = 0.1). Using this estimate we anticipate that up to 1 adult band-rumped storm-petrel will likely be taken in the form of injury or death every 10 years as a result of the proposed action ((0.1)(10) = 1).

We do not have sufficient information to estimate the breeding frequency of adult band-rumped storm-petrels, however, we can assume that the loss of one adult will likely lead to the indirect mortality of a nest within that 10 year period that an adult would have reached breeding age. Therefore, we can expect the take in the form of death of up to 1 band-rumped storm-petrel egg or chick every 10 years due to the proposed action.

Using the number of barn owls sited versus those actually removed in a predator control application conducted by RCUH (RCUH 2015, as cited in Vorsino 2016) efficacy of current barn owl control techniques was determined to be ~50% in the areas outlined on Kaua‘i (Vorsino 2016). We did not factor in the possible benefit scenario from barn owl control to populations on Lehua due to insufficient information regarding population size estimates for the Newell's shearwater, Hawaiian petrel, and band-rumped storm-petrel on Lehua. Additionally, Newell's shearwaters and Hawaiian petrels were not documented when conducting auditory surveys in 2015 on Lehua (Raine *et al*. 2016e).

We created a model (Vorsino 2016) to analyze and approximate the beneficial effects of the proposed barn owl control on the Newell's shearwater, Hawaiian petrel, and band-rumped storm-petrel. Populations were projected for areas known to be occupied by the Newell's shearwater using the methodology outlined in Vorsino (2016) which partitions the most current Newell's shearwater population projection (Joyce 2013) between all known Newell's shearwater colonies. These colonies were then subset by locations on Kaua‘i identified previously to be amenable to barn owl control (Raine 2016), specifically: Nualolo, Honopū, Kalāheo/Kāhili, and Hanalei. Sub-setting the meta-population by these colonies allowed the projection of an initial population size affected by the proposed Barn Owl control work (Raine 2016).

The estimated impact of barn owl control on the individuals this conservation measure would impact, for each predation scenario applied, is estimated in Table 6. Predation offset was estimated using the difference between the population of individuals with all predators present, and a population with Barn Owl Mitigation with 50% efficacy of control. Offset is here used to describe the net gain of the applied Barn Owl mitigation given the current population size at the sites to be mitigated. Adults were defined as those birds age 6 and up and chicks are age 0 to fledglings.

Table 6: Estimated predation offset.

Predation Scenario	Chick Offset	Adult Offset
Predation Estimate Low	5.7	4.3
Predation Estimate Medium	7.4	5.6
Predation Estimate High	9.1	6.9

Predation offset was estimated using the difference between a population of individuals with all predators present, and one in which a subset of predators have been mitigated for. For this assessment Barn Owl control was applied at an efficacy level of 50% per scenario (Vorsino 2016).

This model is based on the current projected population size and does not take into consideration that every year the population will continue to decrease until effective recovery actions are implemented. This estimate is likely the net benefit for the next couple of years and will be used for our analysis to determine the beneficial effects of the proposed action. We anticipate beneficial effects to adults and chicks due to the implementation of proposed barn owl control.

As shown in the table 6 above, we estimate that 4 adult seabirds (this includes all seabirds within the three species discussed in this BO) and 5 chicks (of the three species discussed in this BO) per year would be offset from barn owl control.

Therefore, in summary, we anticipate take in the form of injury or death of up to 2 adult or fledgling Newell's shearwaters every year; up to 1 adult or fledgling Hawaiian petrel every year; and up to 1 band-rumped storm-petrel every 10 years as a result of the proposed action. We anticipate take in the form of death of up to 1 Newell's shearwater egg or chick every year; up to 1 Hawaiian petrel egg or chick every year; and up to 1 band-rumped storm-petrel egg or chick every 10 years that would likely not survive as a result of its parent being taken as a result of the proposed action. We anticipate beneficial effects that would likely produce 4 adults and 5 chicks of the Newell's shearwater, Hawaiian petrel, and band-rumped storm-petrel (combined) every year.

Cumulative Effects

Cumulative effects include the effects of future non-Federal actions that are reasonably certain to occur within the action area subject to consultation. Future federal actions will be subject to the consultation requirements established in section 7 of the Act and, therefore, are not considered cumulative for the proposed action. The Service is unaware of any foreseeable actions within the action area.

Conclusion

After reviewing the current status, the Environmental Baseline, the Effects of the Action, and the Cumulative Effects, it is the Service's Biological Opinion that the proposed continuing operations at Kōkeʻe AFS and MAS discussed herein is not likely to jeopardize the continued existence of the Newell's shearwater, Hawaiian petrel, or band-rumped storm-petrel. As stated in the Effects section above, the adverse effects result in take in the form of injury and death for up to 2 Newell's shearwater adults or fledglings per year; 1 Newell's shearwater egg or chick per year; 1 Hawaiian petrel adult or fledgling per year; 1 Hawaiian petrel egg or chick per year; 1 band-rumped storm-petrel adult or fledgling every 10 years; and 1 band-rumped storm-petrel egg or chick every 10 years as a result of the proposed action. And the beneficial effects of barn owl control within seabird colonies will offset the loss of 4 adult seabirds and 5 chicks every year. Overall, taken all these effects together, there will not be a significant change in the reproduction, numbers, or distribution of the Newell's shearwater, Hawaiian petrel, and band-rumped storm-petrel that will reduce appreciably the likelihood of both the survival and recovery of these species in the wild.

INCIDENTAL TAKE STATEMENT

Section 9 of the Act and Federal regulations promulgated pursuant to section 4(d) of the Act prohibit the take of endangered or threatened species, respectively, without special exemption. Take is defined as to harass, harm, pursue, hunt, shoot, wound, kill, trap, capture, or collect, or attempt to engage in any such conduct. Harm is further defined by the Service to include significant habitat modification or degradation that results in death or injury to listed species by

significantly impairing behavior patterns which include, but are not limited to, breeding, feeding, or sheltering. Harass is defined by the Service as intentional or negligent actions that create the likelihood of injury to listed species to such an extent as to significantly disrupt normal behavior patterns which include, hut arc not limited to, breeding, feeding or sheltering. Incidental take is defined as take that is incidental to, and not the purpose of, carrying out an otherwise lawful activity. Under the terms of section 7(b)(4) and section 7(o)(2) of the Act, taking that is incidental to and not intended as part of the agency action is not considered a prohibited taking under the Act provided that such taking is in compliance with the terms and conditions of this Incidental Take Statement.

The measures described below are non-discretionary, and must be undertaken by the USAF so that they become binding conditions for the exemption in section 7(o)(2) to apply. If the USAF (1) fails to assume and implement the terms and conditions or (2) fails to adhere to the terms and conditions of the incidental take statement through enforceable terms that are added to the permit or grant document, the protective coverage of section 7(o)(2) may lapse. In order to monitor the impact of incidental take, the USAF must report the progress of the action and its impact on the species to the Service as specified in this incidental take statement and reporting requirements below [50 CFR §402.14(i)(3)].

AMOUNT OR EXTENT OF TAKE

Based on our analysis presented in this Biological Opinion, the Service anticipates the following take may occur for as long as the Kōkeʻe AFS and Kōkeʻe MAS are operating and in place:

1) Up to 2 Newell's shearwater adults or fledglings and 1 associated egg or chick every year over the life of the project due to mortality as a result of the proposed action.
2) Up to 1 Hawaiian petrel adult or fledgling and 1 associated egg or chick every year over the life of the project due to mortality as a result of the proposed action.
3) Up to 1 band-rumped storm-petrel adult or fledgling and 1 associated egg or chick every 10 years over the life of the project due to mortality as a result of the proposed action.

Effect of the Take
In this Biological Opinion, the Service determined that this level of anticipated take is not likely to jeopardize the continued existence of the Newell's shearwater, Hawaiian petrel, and band-rumped storm-petrel based on the information provided in this document.

Reasonable and Prudent Measures
The reasonable and prudent measures given below, with their implementing term and conditions, are designed to minimize the impacts of incidental take that might otherwise result from the proposed actions. If, during the course of the action, the level of incidental take is exceeded, such incidental take represents new information requiring reinitiation of consultation and review of the reasonable and prudent measures provided. In addition, the action that caused the taking must cease; the action agency must immediately provide an explanation of the causes of the taking; and must review with the Service the need for possible modification of the reasonable and prudent measures. The following reasonable and prudent measures are necessary and

appropriate to minimize the effect of take on the Newell's shearwater, Hawaiian petrel, and band-rumped storm-petrel.

1. The USAF shall minimize the loss of the Newell's shearwater, Hawaiian petrel, and band-rumped storm-petrel.

Terms and Conditions
In order to be exempt from the prohibitions of section 9 of the Act, the USAF must comply with the following terms and conditions, which implement the reasonable and prudent measures described above and outline required reporting and monitoring requirements. These terms and conditions are non-discretionary.

In order to implement the reasonable and prudent measure #1 above, the following terms and conditions apply:

1. The USAF shall investigate and consider ways to turn off all perimeter and exterior building lights year round on the installation.
2. The USAF shall monitor and report on the levels of take that occur on an annual basis.
    a. The annual reports will document the effectiveness of all avoidance and minimization measures. The written reports will summarize annual minimization measures implemented and success of those measures. The methods and results of the monitoring efforts will also be included in annual reports.
    b. The reports will be submitted by February each calendar year to the Service's Pacific Islands Fish and Wildlife Office (300 Ala Moana Blvd., Room 3-122, Honolulu, Hawai‘i 96850).
    c. The Service will be notified by telephone and email within 24 hours upon the discovery of an injured or dead bird. A written summary of the incident should be provided to the Service within 72 hours of incident.
    d. Should there be a mortality, the depository designated to receive specimens of any Newell's shearwaters, Hawaiian petrels, or band-rumped storm-petrels that are found is the B.P. Bishop Museum, 1525 Bernice Street, Honolulu, Hawai‘i, 96817 (telephone: 808/847-3511). If the B.P. Bishop Museum does not wish to accession the specimens, contact the Service's Division of Law Enforcement in Honolulu, Hawai‘i (telephone: 808/861-8525; fax: 808/861-8515) for instructions on disposition.

CONSERVATION RECOMMENDATIONS

Section 7(a)(1) of the Act directs all Federal agencies to use their authority to further the purposes of the Act by carrying out conservation programs for the benefit of endangered and threatened species. The term "conservation recommendations" has been defined as suggestions from the Service regarding discretionary measures to minimize or avoid adverse effects of a proposed action on listed species or critical habitat or regarding the development of information. The recommendations provided here relate only to the proposed action and do not necessarily represent complete fulfillment of the agency's 7(a)(1) responsibility for the species.

1. The USAF should hire or fund a trained seabird biologist, familiar with doing Newell's shearwater, Hawaiian petrel, and band-rumped storm-petrel surveys, to provide nightly monitoring at Kōke'e AFS as well as outside the perimeter of the installation during the non-blackout period (December 31 to March 31) to evaluate the effectiveness of shielded perimeter and security lights.
2. The USAF should hire or fund a trained seabird biologist, familiar with doing Newell's shearwater, Hawaiian petrel, and band-rumped storm-petrel surveys, to provide opportunistic monitoring at Kōke'e MAS to document any unobserved or undocumented seabirds attracted to red lights associated with the communication tower.
3. The USAF should fund the construction of predator exclusion fences to fully enclose and protect Newell's shearwater colonies within the Hono o Nā Pali NAR and the entirety of Upper Limahuli colony.
4. The USAF should fund the construction of a predator exclusion fence to protect the largest extant Hawaiian petrel colony at Hono o Nā Pali, Kaua'i, while limiting the impact and restoring where possible the montane wet ecosystem of this area.
5. The USAF should fund the construction of an ungulate exclusion fence to protect the Honopū seabird colony to manage depredation by pigs and habitat damage from pigs and goats. The area of Honopū where the ungulate fence should be installed is located within DLNR State Parks in northwestern Kaua'i.

REINITIATION-CLOSING STATEMENT

This concludes formal consultation on this action. As required in 50 CFR §402.16, reinitiation of consultation is required where discretionary Federal agency involvement or control over the action has been retained (or is authorized by law) and if: (1) the amount or extent of incidental take is exceeded; (2) new information reveals effects of the agency action that may affect listed species or critical habitat in a manner or to an extent not considered in this opinion; (3) the agency action is subsequently modified in a manner that causes an effect to the listed species or critical habitat not considered in this opinion; or (4) a new species is listed or critical habitat designated that may be affected by the action. In instances where the amount or extent of incidental take is exceeded, any operation causing such take must cease pending reinitiation.

We appreciate your efforts to conserve protected species. If you have any questions concerning this biological opinion, please contact Jiny Kim of the USFWS Pacific Islands Fish and Wildlife Office at (808) 792-9400.

Sincerely,

Mary M. Abrams, Ph.D.
Field Supervisor

LITERATURE CITED

Adams, J. 2013. At-sea distribution of satellite tagged Hawaiian petrel (*Pterodroma sandwichensis*) nesting on Haleakalā and Lanaʻi and attendance patterns measured using RF-ID to calibrate ornithological radar surveys (Draft Interim Summary Report for E-145562-3). U.S. Geological Survey, Western Ecological Research Center, Moss Landing, California.

Adams, J., D. G. Ainley, J. F. Penniman, and H. B. Freifeld. 2009. Summer movements of ʻUaʻu (Hawaiian Petrel; *Pterodroma sandwichensis*) nesting on Haleakalā, Maui and Lānaʻi: can we use satellite tracking to gain new information and advise conservation management? (Draft Interim Summary Report for TE-145562-2). U.S. Geological Survey, Western Ecological Research Center, Moss Landing, California.

Ainley, D. G., and D. P. DeMaster. 1980. Survival and Mortality in a Population of Adélie Penguins. Ecology 61(3): 522–530.

Ainley, D. G., R. Podolsky, L. DeForest, and G. Spencer. 1997a. New insights into the status of the Hawaiian petrel on Kauaʻi. Colonial Waterbirds 20(1): 24-30.

Ainley, D. G., T. C. Telfer, and M. H. Reynolds. 1997b. Townsend's and Newell's shearwater *Puffinus auricularis*. *In* The Birds of North America, No. 297. (A. Poole and F. Gill, eds.). The Birds of North America, Inc., Philadelphia, PA.

Ainley, D. G., R. Podolsky, L. DeForest, G. Spencer, and N. Nur. 2001. The status and population trends of the Newell's shearwater on Kauaʻi: insights from modeling. Studies in Avian Biology 22: 108-123.

Ainley, D. G., Walker, W. A., Spencer, G. C., and N. D. Holmes. 2014. The prey of Newell's shearwater *Puffinus newelli* in Hawaiian waters. Marine Ornithology 44: 69-72.

Ainley, D. G., E. Porzig, D. Zajanc, and L. B. Spear. 2015. Seabird flight behavior and height in response to altered wind strength and direction. Marine Ornithology 43: 25-36.

Allan, R. G. 1962. The Madeiran storm petrel *Oceanodroma castro*. Ibis 103b: 274–295.

Anderson, T. 2015. Save Our Shearwaters Program, 2014 Annual Report. Kauaʻi Humane Society prepared for Kauaʻi Island Utility Cooperative. 52 pp.

Asner, G. P., R. F. Hughs, P. M. Vitousek, D. E. Knapp, T. Kennedy-Bowdoin, J. Boardman, R. E. Martin, M. Eastwood, and R. O. Green. 2008. Invasive plants transform the three-dimensional structure of rain forests. Proceedings of the National Academy of Sciences 105: 4519-4523.

Austin, O. L. 1952. Notes on some petrels of the North Pacific. *In* Bulletin of the Museum of Comparative Zoology at Harvard College, vol. 107, no. 7, Cambridge. Pp. 391–407.

Banfield, N. K., A. F. Raine, and B. McFarland. 2013. Auditory surveys for endangered seabirds on Kaua‘i. Kaua‘i Endangered Seabird Recovery Project. Hawai‘i Division of Forestry and Wildlife. Unpublished report.

Banko, W. E., P. C. Banko, and R. E. David. 1991. Specimens and probably breeding activity of the band-rumped storm-petrel on Hawai‘i. Wilson Bulletin 103: 650–655.

Banks, R. C., C. Cicero, J. L. Dunn, A. W. Kratter, P. C. Rasmussen, J. V. Remsen, JR., J. D. Rising, and D. F. Stotz. 2002. Forty-third supplement to the American ornithologists' union check-list of North American birds. The Auk 119: 897-906.

Berger, A. 1972. *Hawaiian birdlife.* University of Hawai‘i Press, Honolulu, Hawai‘i.

BirdLife International. 2016a. Species factsheet: *Puffinus auricularis*. Downloaded from http://www.birdlife.org on 08/19/2016, accessed 1 August 2016.

BirdLife International. 2016b. Species factsheet: *Puffinus puffinus*. Downloaded from http://www.birdlife.org on 08/19/2016, accessed 1 August 2016.

Bolton, M., A. L. Smith, E. Gómez-Diaz, V. L. Friesen, R. Medeiros, J. Bried, J. L. Roscales, and R. W. Furness. 2008. Monteiro's Storm-petrel *Oceanodroma monteiroi*: a new species from the Azores. Ibis 150: 717-727.

Bried, J., D. Pontier, and P. Jouventin. 2003. Mate fidelity in monogamous birds: a re-examination of the Procellariiformes. Animal Behaviour 65: 235-246.

Brooke, M. 1990. *The Manx shearwater*. London: A & C Black Publishers Ltd. 264 pp.

Brooke, M. de L. 2004. *Albatrosses and petrels across the world*. Oxford: Oxford University Press. 499 pp.

Browne, R. A., D. J. Anderson, and J. N. Houser. 1997. Genetic diversity and divergence of endangered Galapagos and Hawaiian petrel populations. The Condor 99: 812-815.

Buxton, R. T., and I. L. Jones. 2012. An experimental study of social attraction in two species of storm-petrel by acoustic and olfactory cues. The Condor 114: 733-743.

Buxton, R. T., C. Jones, H. Moller, and D. R. Towns. 2014. Drivers of seabird population recovery on New Zealand islands after predator eradication. Conservation Biology 28: 333-344.

Cooper, B. A., and R. H. Day. 1998. Summer behavior and mortality of dark-rumped petrels and Newell's shearwaters at power lines on Kaua‘i. Colonial Waterbirds 21(1): 11-19.

Cooper, B. A., M. G. Raphael, and D. E. Mack. 2001. Radar-based monitoring of marbled murrelets. The Condor 103(2): 219-229.

Craig, M. 2016. Kaheawa Wind Power I Habitat Conservation Plan, Annual Report: FY 2016. Kaheawa Wind Power I, LLC. Wailuku, Hawai‘i. 50 pp.

Croxall, J. P., S. H. M. Butchart, B. Lascelles, A. J. Stattersfield, B. Sullivan, A. Symes, and P. Taylor. 2012. Seabird conservation status, threats and priority actions: a global assessment. Bird Conservation International 22: 1-34.

Day, R. H. and B. A. Cooper. 1995. Patterns of movement of dark-rumped petrels and Newell's shearwaters on Kaua‘i. Condor 97: 1011-1027.

Day, R. H., B. A. Cooper, and R. J. Blaha. 2003. Movement patterns of Hawaiian petrels and Newell's shearwaters on the island of Hawai‘i. Pacific Science 57: 147-159.

del Hoyo, J., A. Elliot, and J. Sargatal. 1992. *Handbook of the birds of the world, vol. 1: ostrich to ducks*. Lynx Edicions, Barcelona, Spain.

del Hoyo, J., N. J. Collar, D. A. Christie, A. Elliott, and L. D. C. Fishpool. 2014. *HBW and BirdLife International Illustrated checklist of the birds of the world*. Lynx Edicions BirdLife International.

[DOFAW] Hawai‘i Department of Land and Natural Resources, Division of Forestry and Wildlife. 2005. Hawai‘i's comprehensive wildlife conservation strategy. 734 pp.

[DOFAW] Hawai‘i Department of Land and Natural Resources, Division of Forestry and Wildlife. 2016. Kaua‘i Save Our Shearwater data 1979-2016. Summarized by the Service Pacific Islands Fish and Wildlife Office, Honolulu, Hawai‘i.

Force, M. P., S. W. Webb, and S. N. G. Howell. 2007. Identification at sea of Hawaiian and Galapagos petrels. Western Birds 38(3): 242-249.

Fraser, G. S., J. Russell, G. J. Robertson, R. Bryant, and D. A. Fifield. 2013. Prospects for the Manx shearwater colony on Middle Lawn Island, Newfoundland, Canada. Marine Ornithology 41: 137-140.

Friesen, V. L., T. M. Burg, and K. D. McCoy. 2007. Mechanisms of population differentiation in seabirds. Molecular Ecology 16: 1765–1785.

Gill, F. and D. Donsker (eds.). 2016. *Loons, penguins, petrels* at World Bird List Version 6.3. International Ornithologists' Union. http://www.worldbirdnames.org/bow/loons/, accessed 1 August 2016.

Griesemer, A. M. and N. D. Holmes. 2011. Newell's shearwater population modeling for Habitat Conservation Plan and Recovery Planning. Technical Report No. 176. The Hawai‘i-Pacific Islands Cooperative Ecosystem Studies Unit & Pacific Cooperative Studies Unit, University of Hawai‘i, Honolulu, Hawai‘i. 68 pp.

Harrison, C. S., T. C. Telfer, and J. L. Sincock. 1990. The status of Harcourt's storm-petrel (*Oceanodroma castro*) in Hawai'i. Elepaio 50: 47-51.

Henshaw, H. W. 1902. *Oceanodroma castro* (Harcourt). Ake-ake. Hawaiian stormy petrel. *In* Birds of the Hawaiian Islands being a complete list of the birds of the Hawaiian possessions with notes on their habits, published by Thos. G. Thrum Honolulu. Pp. 118-119.

Hodges, C. S. N., and R. J. Nagata. 2001. Effects of predator control on the survival and breeding success of the endangered Hawaiian dark-rumped petrel. *In* Evolution, Ecology, Conservation, and Management of Hawaiian Birds: A vanishing avifauna. (J. M. Scott, S. Conant, and C. Van Riper, III, eds.) Studies in Avian Biology No. 22. Cooper Ornithological Society, Camarillo, California. Pp. 308-318.

Howell, S. N. G., J. B. Patteson, K. Sutherland, and D. T. Shoch. 2010. Occurrence and identification of the band-rumped storm-petrel (*Oceanodroma castro*) complex off North Carolina. North American Birds 64(2): 196-207.

Hu, D., C. Glidden, J. S. Lippert, L. Schnell, J. S. MacIvor, and J. Meisler. 2001. Habitat use and limiting factors in a population of Hawaiian dark-rumped petrels on Mauna Loa, Hawai'i. *In* Evolution, Ecology, Conservation, and Management of Hawaiian Birds: A vanishing avifauna. (J. M. Scott, S. Conant, and C. Van Riper, III, eds.) Studies in Avian Biology No. 22. Cooper Ornithological Society, Camarillo, California. Pp. 234-242

James, P. C. and H. A. Robertson. 1985. The calls of male and female Madeiran storm-petrels (*Oceanodroma castro*). The Auk 102: 391-393.

Jones, H. P. and S. W. Kress. 2012. A review of the World's active seabird restoration projects. The Journal of Wildlife Management 76: 2-9.

Joyce, T. W. 2013. Abundance estimates of the Hawaiian petrel (*Pterodroma sanwichensis*) and Newell's shearwater (*Puffinus newelli*) based on data collected at sea, 1998 – 2011. Scripps Institution of Oceanography, La Jolla, California.

Joyce, T. and N. Holmes. 2010. Band-rumped storm-petrel *Oceanodroma castro* on Kaua'i: submission to Fish and Wildlife Service for 2010 species assessment and endangered species listing priority. 3 pp.

Judge, S. W., D. Hu, and C. N. Bailey. 2014. Comparative analysis of Hawaiian petrel *Pterodroma sandwichensis* morphometrics. Marine Ornithology 42: 81-84.

[KIRC] Kaho'olawe Island Reserve Commission. 2015. A business plan for the restoration of Hawaiian bird life & native ecosystems on Kaho'olawe, Kaho'olawe Island Seabird Restoration Project. 125 pp.

[KESRP] Kaua‘i Endangered Seabird Recovery Project. 2017a. Hawaiian petrel factsheet. Retrieved from http://kauaiseabirdproject.org/index.php/the-birds/hape-fact-sheet/, accessed 1 August 2016.

[KESRP] Kaua‘i Endangered Seabird Recovery Project. 2017b. Newell’s shearwater factsheet. Retrieved from http://kauaiseabirdproject.org/index.php/the-birds/nesh-fact-sheet/, accessed 1 August 2016.

[KESRP] Kaua‘i Endangered Seabird Recovery Project. 2017c. Band-rumped storm-petrel factsheet. Retrieved from http://kauaiseabirdproject.org/index.php/the-birds/banp-fact-sheet/, accessed 1 August 2016.

King, W. B., and P. J. Gould. 1967. The status of Newell’s race of the Manx shearwater. The Living Bird 6: 163-186

Lescroël, A., K. M. Dugger, G. Ballard, and D. G. Ainley. 2009. Effects of individual quality, reproductive success and environmental variability on survival of a long-lived seabird. Journal of Animal Ecology 78: 798–806.

Martínez-Gómez, J. E., N. Matías-Ferrer, R. N. M. Sehgal, and P. Escalante. 2015. Phylogenetic placement of the critically endangered Townsend’s Shearwater (*Puffinus auricularis auricularis*): evidence for its conspecific status with Newell’s Shearwater (*Puffinus a. newelli*) and a mismatch between genetic and phenotypic differentiation. Journal of Ornithology 156: 1025-1034.

McKown, M., and D. Savage. 2015. Exploratory acoustic surveys for Hawaiian petrel, Newell’s shearwater, and barn owl in East Maui, Hawai‘i. Conservation Metrics Inc. Prepared for Maui Nui Seabird Recovery Project. 25 pp.

Monteiro, L. R., and R. W. Furness. 1998. Speciation through temporal segregation of Madeiran storm petrel (*Oceanodroma castro*) populations in the Azores? Philosophical Transactions of the Royal Society of London B 353: 945-953.

[NPS] National Park Service. 2012. Information for programmatic Section 7 consultation, Haleakalā National Park. Makawao, Maui, Hawai‘i. 171 pp.

Norbury, G., A. Hutcheon, J. Reardon, and A. Daigneault. 2014. Pest fencing or pest trapping: A bio-economic analysis of cost-effectiveness. Austral Ecology 39: 795-807.

Olson, S. L. and H. F. James. 1982. Prodromus of the fossil avifauna of the Hawaiian Islands. Smithsonian Contributions to Zoology 365: 1-59.

Oro, D. 2014. Seabirds and climate: knowledge, pitfalls, and opportunities. Frontiers in Ecology and Evolution 2(79): 1-12.

Phillips, R. and B. Lucey. 2016. Kauaʻi mongoose standard operating procedures to conduct and island-wide status assessment and early detection rapid response. U.S. Fish and Wildlife Service and Kauaʻi Invasive Species Committee. 25 pp.

Podolsky, R., D. G. Ainley, G. Spencer, L. Deforest, and N. Nur. 1998. Mortality of Newell's shearwaters caused by collisions with urban structures on Kauaʻi. Colonial Waterbirds 21(1): 20-34.

Pratt, H. D. 1994. *Avifaunal change in the Hawaiian Islands, 1983-1993.* Studies in Avian Biology No. 15: 103-118. Cooper Ornithological Society, Camarillo, California.

Pyle, R. L. and P. Pyle. 2009. *The birds of the Hawaiian Islands: occurrence, history, distribution, and status.* B. P. Bishop Museum, Honolulu, Hawaiʻi.

Pyle, P., D. L. Webster, and R. W. Baird. 2016. White-rumped dark storm-petrels in Hawaiian island waters: the quandary of Leach's vs. band-rumped storm-petrels throughout the world. Birding 47(1): 58-73.

Raine, A. F. 2015. Site visits to Kōkeʻe Air Force Base – 11th – 13th September 2015. Kauaʻi Endangered Seabird Recovery Project (KESRP), Pacific Cooperative Studies Unit, University of Hawaiʻi and Division of Forestry and Wildlife (DOFAW), State of Hawaiʻi Department of Land and Natural Resources, Hawaiʻi, USA. 7 pp.

Raine, A. and B. McFarland. 2013. Monitoring of endangered seabirds in Upper Limahuli Preserve, annual report 2012. Kauaʻi Endangered Seabird Recovery Project. Pacific Cooperative Studies Unit, University of Hawaiʻi, and Division of Forestry and Wildlife, State of Hawaiʻi, Department of Land and Natural Resources, Hawaiʻi, USA.

Raine, A. and B. McFarland. 2014. Monitoring of endangered seabirds in Upper Limahuli Preserve, annual report 2013. Kauaʻi Endangered Seabird Recovery Project. Pacific Cooperative Studies Unit, University of Hawaiʻi, and Division of Forestry and Wildlife, State of Hawaiʻi, Department of Land and Natural Resources, Hawaiʻi, USA.

Raine, A. and N. Banfield. 2015a. Monitoring of endangered seabirds in Upper Limahuli Preserve, annual report 2014. Kauaʻi Endangered Seabird Recovery Project. Pacific Cooperative Studies Unit, University of Hawaiʻi, and Division of Forestry and Wildlife, State of Hawaiʻi, Department of Land and Natural Resources, Hawaiʻi, USA. 52 pp.

Raine, A. F., and N. Banfield. 2015b. Auditory surveys for endangered seabirds on Kauaʻi, annual report 2014. Kauaʻi Endangered Seabird Recovery Project. Pacific Cooperative Studies Unit, University of Hawaiʻi, and Division of Forestry and Wildlife, State of Hawaiʻi, Department of Land and Natural Resources, Hawaiʻi, USA. 46 pp.

Raine, A. F., and N. Banfield. 2015c. Monitoring of endangered seabirds in Hono o Nā Pali Natural Area Reserve II : Pōhākea, annual report 2014. Kauaʻi Endangered Seabird Recovery Project. 54 pp.

Raine, R. F., M. Travers, A. Griesemer. 2015. Site visit to Kōkeʻe Air Force Base – 9th September 2015. 10 September 2015. Unpublished report. 12 pp.

Raine, A., Vynne, M., McFarlin, M., and M. Massie. 2016a. Monitoring of endangered seabirds in Upper Limahuli Preserve, annual report 2015. Kauaʻi Endangered Seabird Recovery Project. Pacific Cooperative Studies Unit, University of Hawaiʻi, and Division of Forestry and Wildlife, State of Hawaiʻi, Department of Land and Natural Resources, Hawaiʻi, USA. 47 pp.

Raine, A. F., M. Vynne, M. McFarlin, and M. Massie. 2016b. Monitoring of endangered seabirds in Hono o Nā Pali Natural Area Reserve (Part I): Pihea, annual report 2015. Kauaʻi Endangered Seabird Recovery Project. Pacific Cooperative Studies Unit, University of Hawaiʻi, and Division of Forestry and Wildlife, State of Hawaiʻi, Department of Land and Natural Resources, Hawaiʻi, USA. 46 pp.

Raine, A. F., M. Vynne, M. McFarlin, and M. Massie. 2016c. Monitoring of endangered seabirds in Hono o Nā Pali Natural Area Reserve (Part II): Pōhākea, annual report 2015. Kauaʻi Endangered Seabird Recovery Project. Pacific Cooperative Studies Unit, University of Hawaiʻi, and Division of Forestry and Wildlife, State of Hawaiʻi, Department of Land and Natural Resources, Hawaiʻi, USA. 50 pp.

Raine, A. F., M. Vynne, M. McFarlin, and M. Massie. 2016d. Monitoring of endangered seabirds in Hono o Nā Pali Natural Area Reserve (Part III): North Bog, annual report 2015. Kauaʻi Endangered Seabird Recovery Project. Kauaʻi Endangered Seabird Recovery Project. Pacific Cooperative Studies Unit, University of Hawaiʻi, and Division of Forestry and Wildlife, State of Hawaiʻi, Department of Land and Natural Resources, Hawaiʻi, USA. 41 pp.

Raine, A. F., M. Vynne, M. McFarlin, M. McKown, and D. Savage. 2016e. Monitoring of endangered seabird colonies on Kauaʻi: implementation of Kahuku Wind Power and Kawailoa Wind Power Habitat Conservation Plan Seabird Mitigation Actions. Annual Report 2015. 36 pp.

Raine A. F., J. Adams, M. Boone, M. Vynne, M. McFarlin, and M. Travers. 2016f. Study of daily movement patterns of NESH and HAPE in relation to power line collisions (Draft Report). Kauaʻi Endangered Seabird Recovery Project, Hanapepe, Hawaiʻi. 33 pp.

Raine, A. F., N. Holmes, M. Travers, B. A. Cooper. *In Press*. Twenty-year population trends for Hawaiian petrel and Newell's shearwater on Kauaʻi Island, Hawaiian Islands.

Reed, J. R., J. L. Sincock, and J. P. Hailman. 1985. Light attraction in endangered Procellariiform birds: reduction by shielding upward radiation. The Auk 102: 377-383.

[RCUH] Research Corporation of the University of Hawaiʻi. 2015. Predator control of Newell's shearwater on Kauaʻi; Kahuku Wind Power Habitat Conservation Plan. Progress Report.

Kauaʻi, Hawaiʻi: University of Hawaiʻi at Mānoa Pacific Cooperative Studies Unit, Division of Forestry and Wildlife State of Hawaiʻi.

Reynolds, M. H., and G. L. Ritchotte. 1997. Evidence of Newell's shearwater breeding in Puna district, Hawaiʻi. Journal of Field Ornithology 68(1): 26-32.

Ridgeway, R. 1882. Description of a new flycatcher and a supposed new petrel from the Sandwich Islands. Proceedings of the United States National Museum 337-338.

Sandvik, H., K. E. Erikstad, and B. Saether. 2012. Climate affects seabird population dynamics both via reproduction and adult survival. Marine Ecology Progress Series 454: 273-284.

Simons, T. R. 1984. Population model of the endangered Hawaiian dark-rumped petrel. The Journal of Wildlife Management 48(4): 1065-1076.

Simons, T. R. 1985. Biology and behavior of the endangered Hawaiian dark-rumped petrel. The Condor 87: 229-245.

Simons, T. R. and C. N. Hodges. 1998. Dark-rumped petrel (*Pterodroma phaeopygia*). *In* Birds of North America, No. 345 (A. Poole and F. Gill, eds.). The Birds of North America, Inc., Philadelphia, Pennsylvannia.

Sincock, J. L., and G. E. Swedberg. 1969. Rediscovery of the nesting grounds of the Newell's Manx shearwater (*Puffinus puffinus newelli*) with initial observations. Condor 7: 69-71.

Slotterback, J. W. 2002. Band-rumped storm-petrel, *Oceanodroma castro*. *In* The Birds of North America, No. 673, A. Poole and F. Gill (eds.), Philadelphia. Pp. 1-28.

Spear, L. B., D. G. Ainely, and W. A. Walker. 2007. Foraging dynamics of seabirds in the Eastern Tropical Pacific Ocean. Studies in Avian Biology 35: 1-99.

Spear, L. B., D. G. Ainley, N. Nur, and S. N. G. Howell. 1995. Population size and factors affecting at-sea distributions of four endangered Procellariids in the tropical Pacific. Condor 97: 613-638.

Spencer, G. 2010. 2009 Makamakaʻole seabird mitigation activities, final report under Kaheawa Wind Power Habitat Conservation Plan. Kaheawa Wind Power, LLC. 8 pp.

Stearns, S.C. 1977. The evolution of life history traits: a critique of the theory and a review of the data. Annual Review of Ecology and Systematics 8: 145-171.

Stejneger, L. 1887. Birds of Kauaʻi Island, Hawaiian archipelago, collected by Mr. Valdemar Knudsen, with descriptions of new species. Proceedings of the United States National Museum. Pp. 75-102.

Stiebens, V. A., S. E. Merino, C. Roder, F. J. J. Chain, P. L. M. Lee, and C. Eizaguirre. 2013. Living on the edge: how philopatry maintains adaptive potential. Proceedings of the Royal Society B 280: 20130305.

Telfer, T. C., J. L. Sincock, G. V. Byrd, and J. R. Reed. 1987. Attraction of Hawaiian seabirds to lights: conservation efforts and effects of moon phase. Wildlife Society Bulletin 15: 406-413.

Tompkins, R. J. and B. J. Milne. 1991. Differences among dark-rumped petrel (*Pterodroma phaeopygia*) populations within the Galapagos archipelago. Notornis 38:1-35.

Travers, M., S. Theis, and A. F. Raine. 2013. Underline monitoring project annual report 2012. Kaua‘i Endangered Seabird Recovery Project. Pacific Cooperative Studies Unit, University of Hawai‘i, and Division of Forestry and Wildlife, State of Hawai‘i, Department of Land and Natural Resources, Hawai‘i, USA.

Travers, M., A. Shipley, M. Dusch, and A. F. Raine. 2014. Underline monitoring project annual report – 2013 field season. Kaua‘i Endangered Seabird Recovery Project. Pacific Cooperative Studies Unit, University of Hawai‘i, and Division of Forestry and Wildlife, State of Hawai‘i, Department of Land and Natural Resources, Hawai‘i, USA.

Travers, M., D. Golden, A. Stemen, and A. F. Raine. 2016. Underline monitoring project annual report – 2015 field season. Kaua‘i Endangered Seabird Recovery Project. Pacific Cooperative Studies Unit, University of Hawai‘i, and Division of Forestry and Wildlife, State of Hawai‘i, Department of Land and Natural Resources, Hawai‘i, USA. 48 pp.

Troy, J. R., N. D. Holmes, J. A.Veech, A. F. Raine, and M. C. Green. 2014. Habitat suitability modeling for the Newell’s shearwater on Kaua‘i. Journal of Fish and Wildlife Management 5(2): 315-329.

Travers, M., A. Shipley, M. Harris, D. Golden, N. Galase, and A. F. Raine. 2015. Underline monitoring project annual report – 2014 field season. Kaua‘i Endangered Seabird Recovery Project. Pacific Cooperative Studies Unit, University of Hawai‘i, and Division of Forestry and Wildlife, State of Hawai‘i, Department of Land and Natural Resources, Hawai‘i, USA.

Troy, J. R., N. D. Holmes, and M. C. Green. 2011. Modeling artificial light viewed by fledgling seabirds. Ecosphere 2(10): 109.

[USAF] U.S. Air Force, Pacific Air Forces Regional Support Center, 611 Civil Engineer Squadron. 2016. Biological Assessment for the Continuing Operations at Kōke‘e Air Force Station and Microwave Antenna Site, Kaua‘i. 11 August 2016. 104 pp.

[USFWS] U.S. Fish and Wildlife Service. 1983. Hawaiian dark-rumped petrel and Newell's Manx shearwater recovery plan. Portland, Oregon. 57 pp.

[USFWS] U.S. Fish and Wildlife Service. 2005a. Regional Seabird Conservation Plan, Pacific Region. U.S. Fish and Wildlife Service, Migratory Birds and Habitat Programs, Pacific Region, Portland, Oregon. 264 pp.

[USFWS] U.S. Fish and Wildlife Service. 2005b. Study guide for the analytical framework, Section 6: in Advanced Interagency Consultation for Endangered Species, unpublished course notebook, National Conservation Training Center, Shepherdstown, West Virginia.

[USFWS] U.S. Fish and Wildlife Service. 2015. Draft Newell's shearwater (NESH) recovery strategy. Portland, Oregon. 25 pp.

[USFWS] U.S. Fish and Wildlife Service. 2017. Appendix II. Modelling methods and results used to inform the Newell's shearwater landscape strategy. Draft Newell's shearwater (NESH) recovery strategy. Portland, Oregon.

VanderWerf, E. and L. Young. 2010. Surveys of endangered Procellariformes and recommendations to minimize potential take, effects of radar transmission on Hawaiian hoary bat activity, and invasive weed control at Kōkeʻe Air Force Station and Microwave Antenna Site. Final report prepared for the U.S. Air Force and Air National Guard. 34 pp.

VanderWerf, E. A., K. R. Wood, C. Swenson, and M. LeGrande. 2007. Avifauna of Lehua Islet, Hawaiʻi: conservation value and management needs. 14 pp.

VanZandt, M., D. Delparte, P. Hart, F. Duvall, and J. Penniman. 2014. Nesting characteristics and habitat use of the endangered Hawaiian petrel (*Pterodroma sandwichensis*) on the island of Lānaʻi. Waterbirds 37(1): 43-51.

Vorsino, A. 2016. Description of analysis performed to inform the Biological Opinion concerning proposed seabird mitigation to offset minimized take from Kōkeʻe Air Force Station. Unpublished report. 4 pp.

Warham, J. 1977. Wing loadings, wing shapes, and flight capabilities of Procellariiformes. New Zealand Journal of Zoology 4: 73-83.

Welch, A. J., R. C. Fleischer, H. F. James, A. E. Wiley, P. H. Ostrom, J. Adams, F. Duvall, N. Holmes, D. Hu, J. Penniman, and K. A. Swindle. 2012. Population divergence and gene flow in an endangered and highly mobile seabird. Heredity 109: 19-28.

Wiley, A. E., A. J. Welch, P. H. Ostrom, H. F. James, C. A. Stricker, R. C. Fleischer, H. Gandhi, J. Adams, D. G. Ainley, F. Duvall, N. Holmes, D. Hu, S. Judge, J. Penniman, and K. A. Swindle. 2012. Foraging segregation and genetic divergence between geographically proximate colonies of a highly mobile seabird. Oecologia 168: 119-130.

Willi, Y., J. V. Buskirk, and A. A. Hoffmann. 2006. Limits to the adaptive potential of small populations. Annual Review of Ecology, Evolution, and Systematics 37: 433-458.

Wood, G. C., and H. M. Otley. 2013. An assessment of the breeding range, colony sizes and population of the Westland petrel (*Procellaria westlandica*). New Zealand Journal of Zoology 40: 186-195.

Wood, K. R., D. Boynton, E. VanderWerf, L. Arnold, M. LeGrande, J. W. Slotterback, and D. Kuhn. 2002. The distribution and abundance of the band-rumped storm-petrel (*Oceanodroma castro*): a preliminary survey on Kauaʻi, Hawaiʻi. Final report prepared for the Pacific Islands Fish and Wildlife Office, Honolulu, Hawaiʻi.

Young, L. and E. VanderWerf. 2014. Feasibility assessment of predator exclusion fencing to protect Newell's shearwater and Hawaiian petrel nesting locations on Kauaʻi. Pacific Rim Conservation. Honolulu, Hawaiʻi. 38 pp.

Young, L. C, E. A. VanderWerf, M. T. Lohr, C. J. Miller, A. J. Titmus, D. Peters, and L. Wilson. 2013. Multi-species predator eradication within a predator-proof fence at Kaʻena Point, Hawaiʻi. Biological Invasions 15: 2627-2638.

Personal Communications and in Litt.

Anderson, T. 2016a, in litt. Email regarding recapture NESH, July 27, 2016.

Anderson, T. 2016b, in litt. Email regarding question on total no. of listed seabird fallout, August 19, 2016.

Banko, P. 2015, in litt., Comments on proposed endangered status for the band-rumped storm-petrel, November 4, 2015.

Orlando, C. 2015, in litt., National Park Service comments on plant species proposed for listing that occur in Hawaiʻi Volcanoes National Park. November 9, 2015.

Raine, A. 2015, in litt., Project manager for the Kauaʻi Endangered Seabird Recovery Project's comments on the band-rumped storm-petrel, proposed for listing. November 2015.

Raine, A. 2016a, in litt. Telephone call regarding KIUC implementation and the issue of predation and mate loss, May 26, 2016.

Raine, A. 2016b, in litt., Email regarding results of seabird monitoring at Kōkeʻe AFS, December 11, 2016.

THIS PAGE IS INTENTIONALLY BLANK

Appendix A.

Informal Consultation for the Hawaiian hoary bat and Hawaiian goose

Not Likely to Adversely Affect Determination for the Hawaiian Hoary Bat and Hawaiian Goose

This Appendix is in response to your request for our concurrence with your determination that the proposed continuing operations at Kōkeʻe Air Force Station (AFS) and Microwave Antenna Site (MAS) as described above, may affect, but are not likely to adversely affect the federally endangered Hawaiian hoary bat (*Lasiurus cinereus semotus*) and endangered Hawaiian goose (*Branta sandvicensis*). The findings and recommendations in this consultation are based on information provided in: (1) the August 11, 2016, Biological Assessment (BA) for your proposed project; (2) email and verbal communication between the USAF staff and our office; (3) survey and reports; and (4) other information available to us. A complete administrative record is on file in our office. This response is in accordance with section 7 of the Endangered Species Act of 1973 (Act), as amended (16 U.S.C. 1531 *et seq*.).

Project Description
The project description and action areas are the same as described above for the formal consultation.

Conservation Measures
The following conservation measures identified in your Biological Assessment and other correspondence will be implemented at the project site to avoid and minimize effects to the Hawaiian hoary bat and Hawaiian goose. These conservation measures are considered part of the project description. Any changes to, modifications of, or failure to implement these conservation measures may result in the need to reinitiate this consultation.

- No woody plants over 15 feet tall will be removed, cut, or trimmed during the sensitive bat pup-birthing and rearing season of June 1 to September 15.
- A biological monitor will conduct Hawaiian goose and nest surveys at the project site prior to any project initiation.
- Any documented nests or broods within the project vicinity will be reported to the Service within 48 hours.
- A biological monitor will be present on the project site during all construction or earth moving activities to ensure that the Hawaiian goose and nest are not adversely impacted.
- Any trenching for conduit work will be closed to avoid birds from falling into holes
- Driving within the Kōkeʻe AFS site is limited to a couple hundred feet of asphalted access pavement and parking spaces. All vehicles will drive less than 5 MPH on site.
- Garbage cans on Kōkeʻe AFS will be regularly inspected to ensure they remain secured from feral cats and rats.
- Trapping and removal of feral cats from Kōkeʻe AFS will continue.
- Outreach and education will be conducted so that base personnel understand that the Hawaiian goose should not be harassed or harmed and that they should not feed the geese or feral cats.

Hawaiian bats

The Hawaiian hoary bat has been documented foraging within the proposed project area. Additionally, bats may utilize the existing forest habitat located within and immediately surrounding the Kōkeʻe AFS site. The proposed project may impact the Hawaiian hoary bat if juvenile bats not capable of flying are roosting in a tree that is cut or trimmed. By incorporating the above conservation measures juvenile bats being injured or killed due to tree cutting or trimming is not probable and, therefore, discountable. Because effects from the action are discountable, the proposed project is not likely to adversely affect the Hawaiian hoary bat.

The Kōkeʻe AFS perimeter fence is approximately 0.3297 miles in length with 3 strands of barbed wire and surrounded by forest habitat. The proposed project may impact the Hawaiian hoary bat if, while foraging, a bat becomes entangled on barbed wire fencing. However, habitat features surrounding the project are important in evaluating take of Hawaiian hoary bats.

We analyzed the probable impacts of the Kōkeʻe AFS perimeter fence to the Hawaiian hoary bat using the Service's formula for barb wire fence incidental take (shown below).

An estimated 0.013 Hawaiian hoary bats are killed per mile of fence per year, where habitat is mostly pasture grasses (Data from Haleakala National Park).

[Miles of fence] x [Number of strands of barbed wire] = Total barb wire assessed

[0.3297] x [3] = 0.9891

[Total barb wire] x [0.013 Bats killed per mile of fence per year] x [Anticipated life of fence] = Estimated bat take

[0.9891] x [0.013] x [30] = 0.385749

We estimate the Kōkeʻe AFS perimeter fence is likely to take 0.39 Hawaiian hoary bats within 30 years (the estimated life of a high quality fence). The Service has determined that any amount less than one, over the life of a project, is not considered take of the bat. The Service has determined that effects to the Hawaiian hoary bat as a result of the use of barbed wire for the Kōkeʻe AFS fence over the life of the project is considered discountable. Based on the formula results, it is unlikely that take of at least one Hawaiian hoary bat will occur over the life of the project. Therefore, the Service concurs with your determination that the proposed project at Kōkeʻe AFS may affect, but is not likely to adversely affect the Hawaiian hoary bat. Additionally, because the site is situated within forested habitat, we expect that Hawaiian hoary bats are less vulnerable to the barbed wire fences at Kōkeʻe AFS.

Hawaiian goose

The Hawaiian goose has been known to forage and utilize the habitat within the Kōkeʻe AFS site. The proposed project may impact the Hawaiian goose if nests are present and the parents are flushed from the nest for extended periods of time causing the nest to fail (e.g., exposed to

predation) or eggs or goslings are crushed by humans or equipment during construction. By incorporating the above conservation measures for the Hawaiian goose, crushed eggs or goslings, and adults leaving nests for extended periods or nests failing are not probable, and therefore discountable. Because effects from the action are discountable, the proposed project is not likely to adversely affect the Hawaiian goose.

Summary

Based upon the above, the Service concurs that the proposed project may affect, but is not likely to adversely affect, the Hawaiian hoary bat and Hawaiian goose. Unless the project description changes, or new information reveals that the proposed project may affect listed species in a manner or to an extent not considered, or a new species or critical habitat is designated that may be affected by the proposed action, no further action pursuant to section 7 of the Act is necessary.

Appendix B.

Building Exterior and Perimeter Lighting Inventory at Kōkeʻe AFS, 2015

Kokee Air Force Station, Kauai

Building Exterior Lighting Inventory

13 Nov 2015 – Final

Prepared by

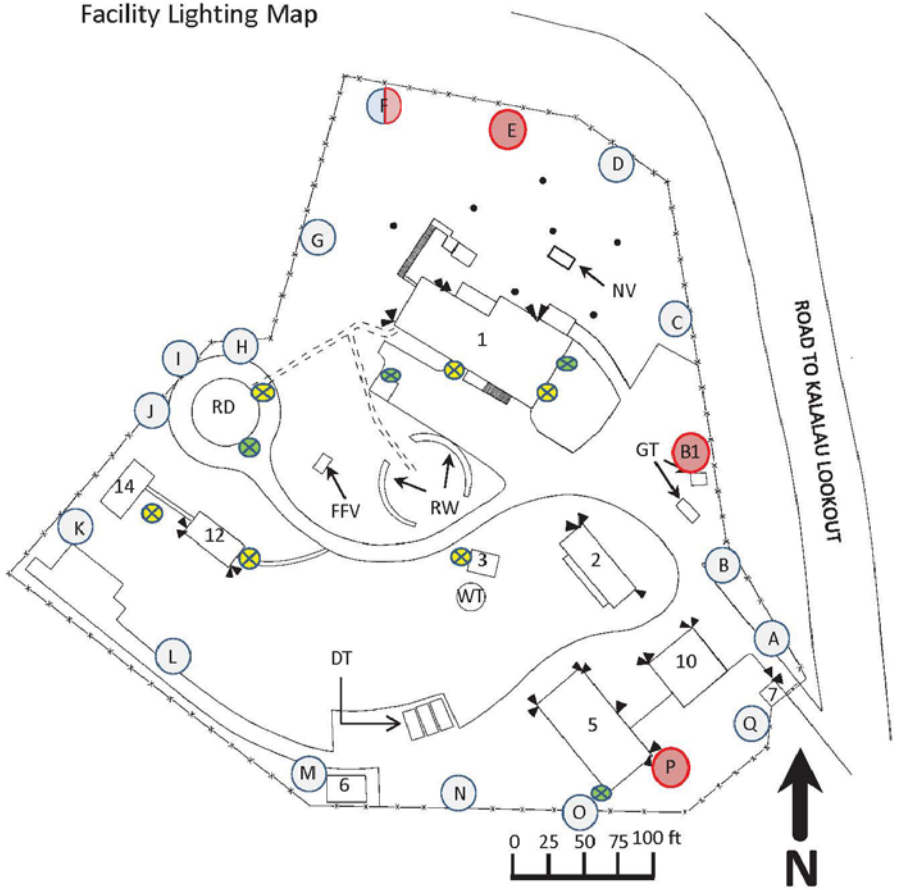
Center for Environmental Management
MILITARY LANDS
Colorado State University

Legend	
Symbol	**Description**
▶	Building Flood Light
○	Operational Perimeter Lights (A – Q)
●	Non-operational Perimeter Lights
— x —	Security Fence
•	Post of Antenna Array
⊗ ⊗	Bldg. Ext. Light (green or white bulb)
RD	RADAR Dome
WT	Water Tank
DT	Diesel Tanks
GT	Gasoline Tanks and Pump Station
FFV	FASFAC Van
RW	Retaining Wall of Former RADAR
NV	Navy Van
1	BLDG 1 : Operations Building
2	BLDG 2: Generators Building
3	BLDG 3: Chlorinator Shed
5	BLDG 5: Supply Building
6	BLDG 6: HAZMAT Shed
7	BLDG 7: Gate House
10	BLDG 10: Vehicles Building
12	BLDG 12: Unoccupied Building
14	BLDG 14: Unoccupied Building

611 CES/CEIE_13 Nov 2015

Kokee Air Force Station

Facility Lighting Map



Kokee Air Force Station - Building Exterior Lights

Building	Location	Type of Light	No. Lights	Comment	Photo No
BLDG 1	North corner	Flood Light	2	Green bulbs with motion detection	Bldg1_FL1, Bldg1_FL1a
BLDG 1	Northwest corner	Flood Light	2	Green bulbs with motion detection	Bldg1_FL2, Bldg1_FL2a
BLDG 1	Northwest side	Flood Light	2	Green bulbs with motion detection	Bldg1_FL3
BLDG 1	Southwest-facing side	Entryway Light	1	2nd floor, entryway over door, no green bulb, no shielding and no motion detection	Bldg1_EL1, Bldg1_EL1a
BLDG 1	Southeast-facing side	Entryway Light	1	1st floor, entryway over door, no green bulb, no shielding and no motion detection	Bldg1_EL2, Bldg1_EL2a
BLDG 1	Southeast-facing side	Entryway Light	1	1st floor, entryway over door, one green bulb, no shielding or motion detection	Bldg1_EL3
RADAR Twr	Southeast-facing side	Entryway Light	1	One green bulb in entryway, doorway is well blocked by three wall	RdrTwr_EL1
RADAR Twr	Northeast-facing side	Entryway Light	1	One white bulb in entryway, no shielding and no motion detection	RdrTwr_EL2
BLDG 2	Southeast corner	Flood Light	1	Green bulb with no shielding or motion detection	Bldg2_FL1
BLDG 2	North-facing side	Flood Light	2	Two green bulbs, with shielding and motion detection over the doorway	Bldg2_FL2, Bldg2_FL2a
BLDG 3	North-facing side	Building Exterior Light	1	One white bulb, with no shielding or motion detection	Bldg3_BEL1
BLDG 5	N/E corner	Flood Light	2	Two green bulbs, with shielding and motion detection	Bldg5_FL1
BLDG 5	N/W corner	Flood Light	2	Two green bulbs, with shielding and motion detection	Bldg5_FL2
BLDG 5	S/E corner	Flood Light	2	Two green bulbs, with shielding and motion detection	Bldg5_FL3
BLDG 5	Northeast-facing side	Flood Light	1	One green bulb, with no shielding and no motion detection	Bldg5_FL4
BLDG 5	S/W corner	Flood Light	1	One green bulb, with no shielding and no motion detection	Bldg5_BEL1
BLDG 7	North corner	Flood Light	2	Two green bulbs, with shielding and motion detection	Bldg7_FL1
BLDG 10	N/W corner	Flood Light	2	Two green bulbs, with shielding and motion detection	Bldg10_FL1&2

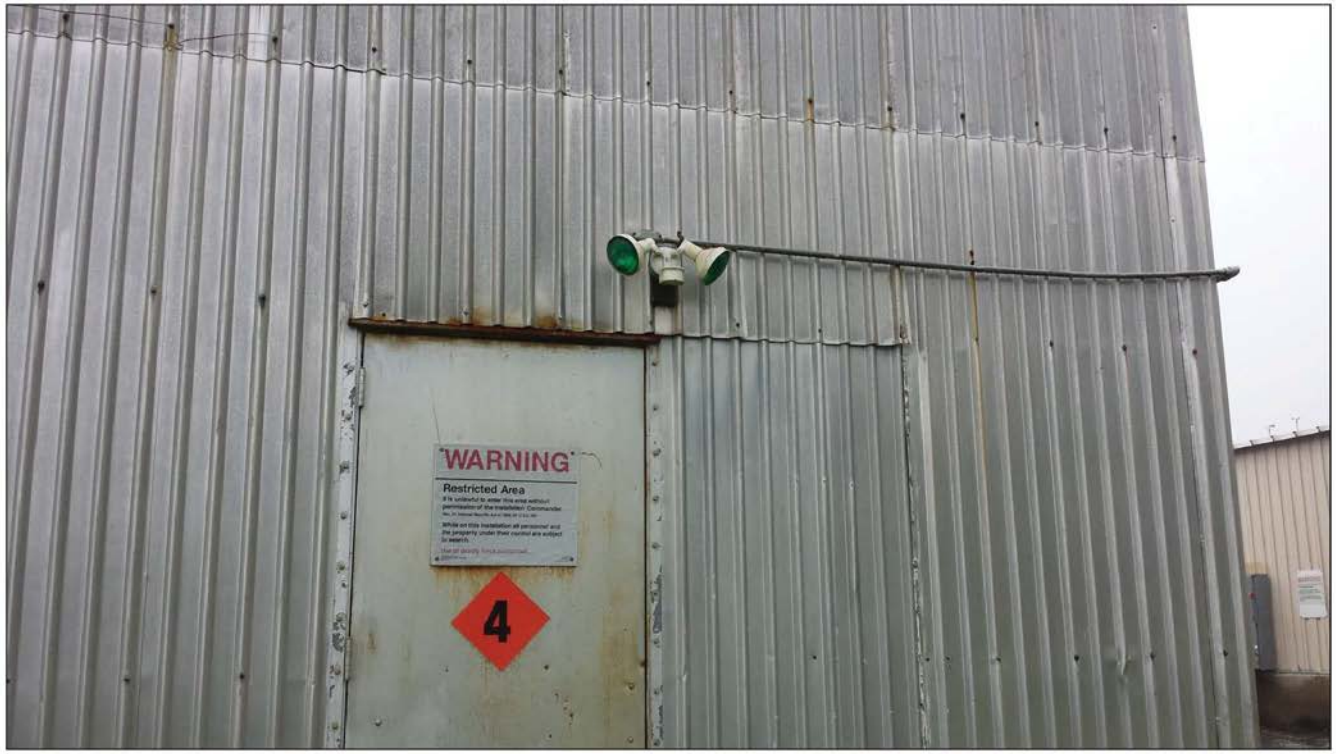
Kokee Air Force Station - Building Exterior Lights

BLDG 10	N/E corner	Flood Light	2	Two green bulbs, with shielding and motion detection	Bldg10_FL1&2
BLDG 12	N/W corner	Flood Light	2	Two white bulbs with shielding and no motion detection (BLDG appears not in use, light appears non functional)	Bldg12_FL1
BLDG 12	Southeast-facing side	Flood Light and Entryway Light	3	Three white bulbs, all with shielding and no motion detection	Bldg12_FL2&EL1
BLDG 14	South-facing side	Entryway Light	1	One white bulb, with minor shielding and no motion detection	Bldg14_EL1
PwrShed	Northeast-facing side	Entry Light	1	One green bulb, with no shielding and no motion detection	PwrShed_EL1
		Total	**36**		

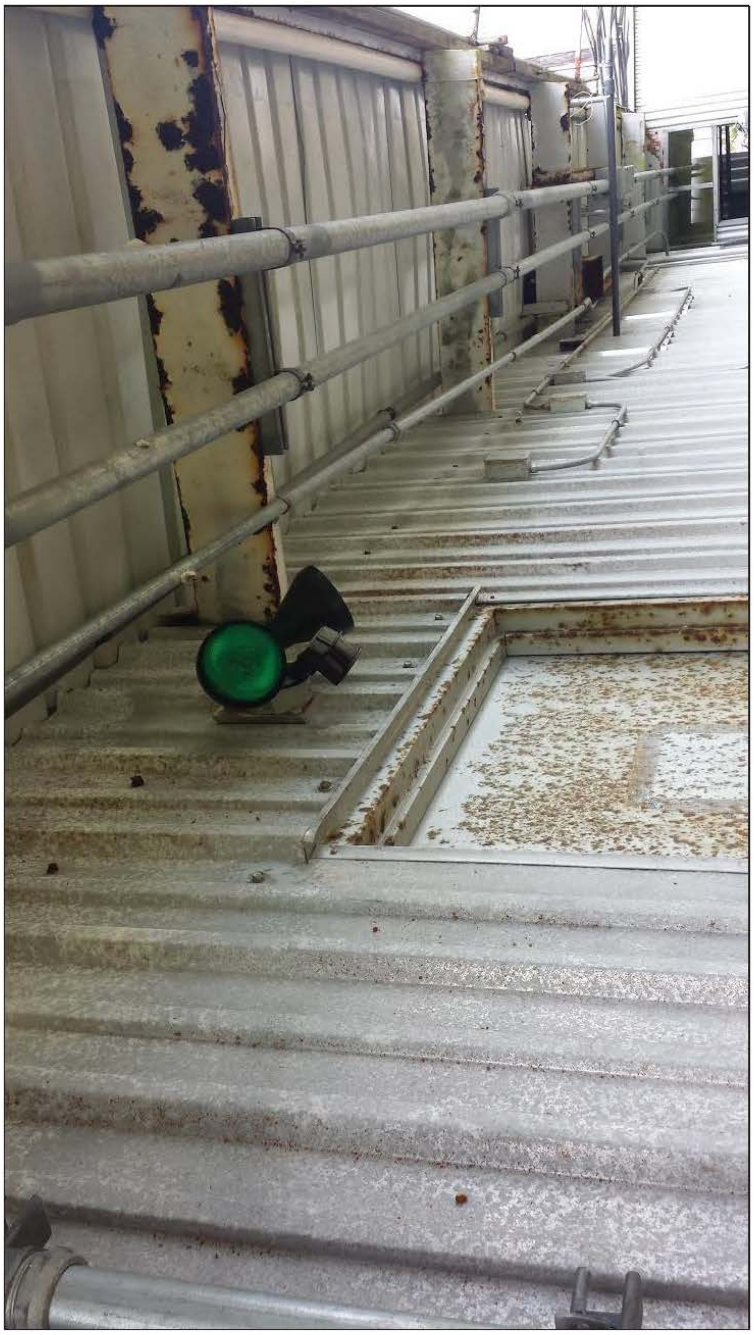
Building 1_Flood Light 1: Two green bulbs with motion detection (close up).

Building 1_Flood Light 1: Two green bulbs with motion detection.

Building 1_Flood Light 2: Two green bulbs with motion detection located on the northside of the building.



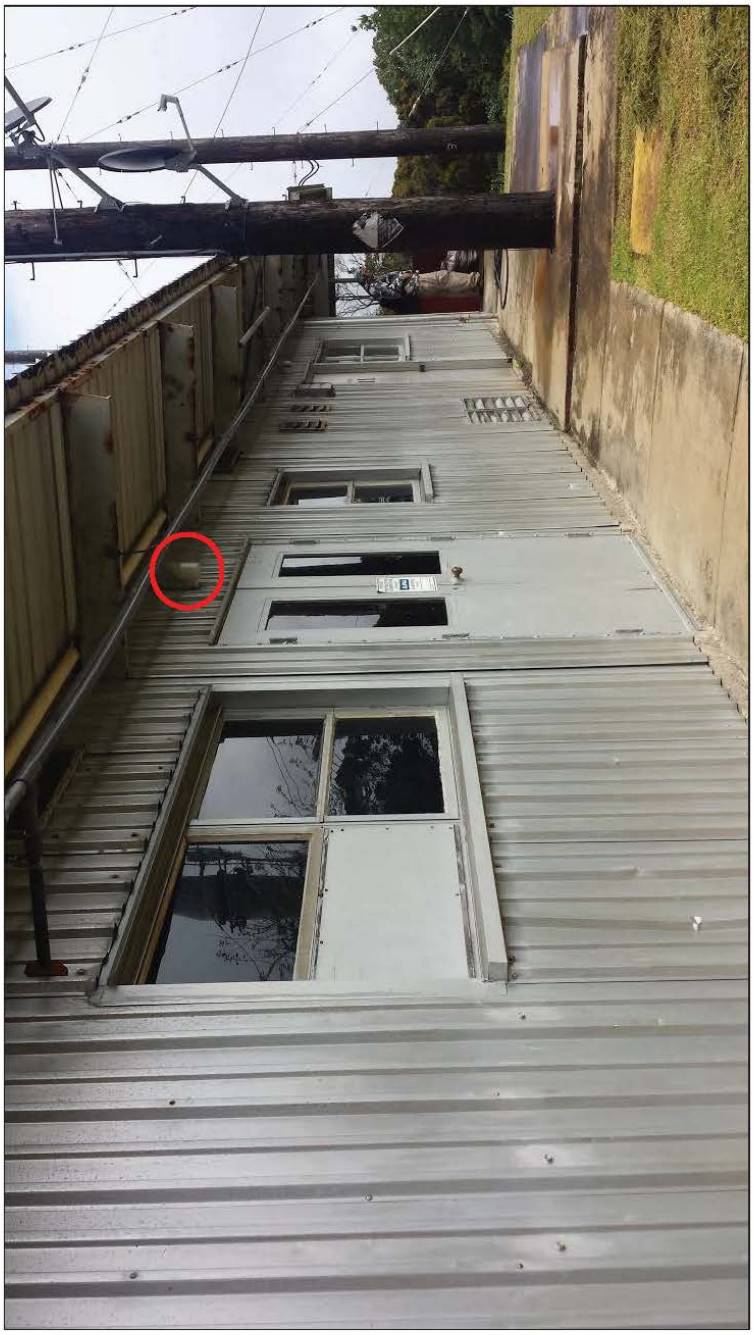
Building 1_Flood Light 2: Two green bulbs with motion detection (close-up).



Building 1_Flood Light 3: Two green bulbs with motion detection (close-up)

Building 1_Entryway Light 1: One white bulb, no shielding and no motion detection, 2nd floor.

Building 1_Entryway Light 1: One white bulb, with no shielding and no motion detection (close-up), 2nd floor.



Building 1_Entryway Light 2: One white bulb, with no shielding and or motion detection, 1st floor southeast-facing.

Building 1_Entryway Light 2: One white bulb, no shielding and no motion detection (close-up), 1st floor, southeast – facing.

Building 1_Entryway Light 3: One green bulb with no shielding or motion detection, 1st floor, southeast facing.

RadarTower_Entryway Light 1: One green bulb with no shielding or motion detection (however the doorway is well blocked by three walls).

RadarTwr_Entryway Light 2: One white bulb with no shielding and no motion detection.

Building 2_Flood Light 1: One green bulb with no shielding or motion detection.

Building 2_Flood Light 2: Two green bulbs, both with shielding and motion detection, facing north.

Building 2_Flood Light 2: Two green bulbs, both with shielding and motion detection, facing north (close up).

Building 3_Building Exterior Light 1: One white bulb with no shielding and no motion detection, facing northwest.

Building 5_Flood Light 1: Two green bulbs both with shielding and motion detection.

Building 5_Flood Light 2: Two green bulbs, both with shielding and motion detection.

Building 5_Flood Light 3: Two green bulbs, both with shielding and motion detection.

Building 5_Flood Light 4: One green bulb with no shielding and no motion detection, bulb is facing northeast and mounted onto of the top of the building.

Building 5_Building Exterior Light 1: One green bulb with no shielding and no motion detection .

Building 7_Flood Light 1: Two green bulbs, both with shielding and motion detection.

Building 10_Flood lights 1 and 2: Two green bulbs each, both with shielding and motion detection.

Building 12_Flood Light 1: Two white bulbs each with shielding and no motion detection (building appears to no longer be in use).

Building 12_Flood Light 2 and Entryway Light 1: Three white bulbs each with shielding and no motion detection (building appears to no longer be in use).

Building 14_Entryway Light 1: One white bulb with no shielding and no motion detection, southeast facing.

Power Shed (no building number)_Entryway Light 1: One green bulb with no shielding and no motion detection.

Kokee Air Force Station, Kauai

Facility Perimeter Lighting Inventory

13 Nov 2015 – Final

Prepared by

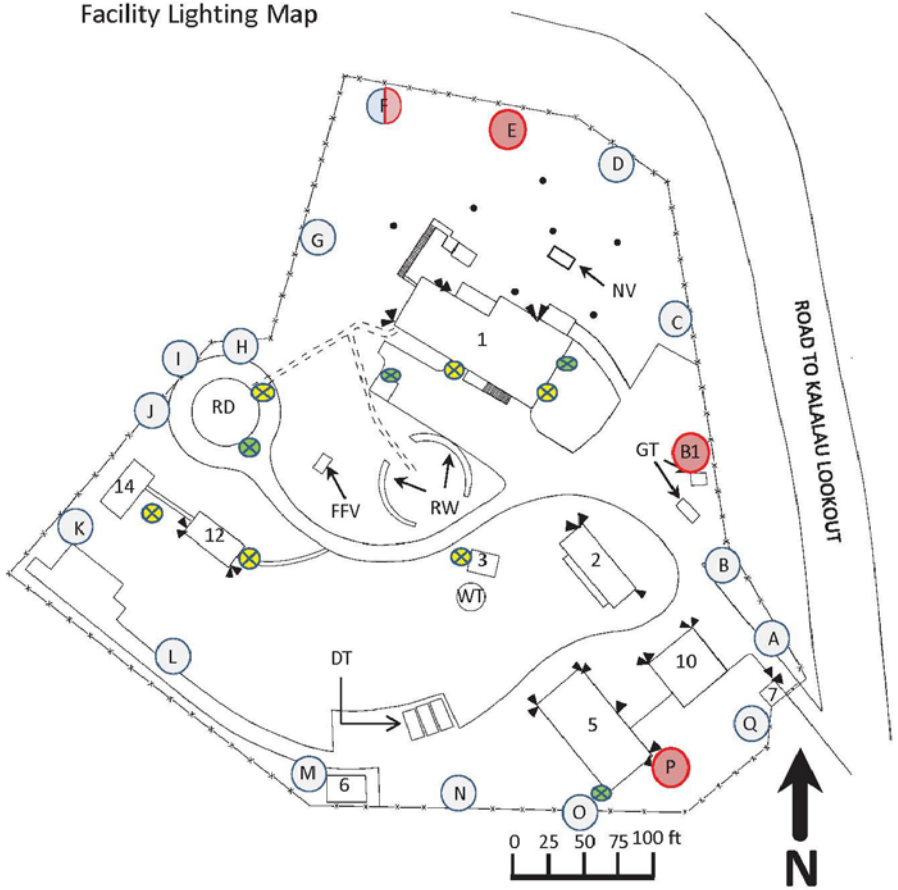
Center for Environmental Management
MILITARY LANDS
Colorado State University

Legend	
Symbol	Description
▶	Building Flood Light
○	Operational Perimeter Lights (A – Q)
●	Non-operational Perimeter Lights
— x —	Security Fence
•	Post of Antenna Array
⊗ ⊗	Bldg. Ext. Light (green or white bulb)
RD	RADAR Dome
WT	Water Tank
DT	Diesel Tanks
GT	Gasoline Tanks and Pump Station
FFV	FASFAC Van
RW	Retaining Wall of Former RADAR
NV	Navy Van
1	BLDG 1 : Operations Building
2	BLDG 2: Generators Building
3	BLDG 3: Chlorinator Shed
5	BLDG 5: Supply Building
6	BLDG 6: HAZMAT Shed
7	BLDG 7: Gate House
10	BLDG 10: Vehicles Building
12	BLDG 12: Unoccupied Building
14	BLDG 14: Unoccupied Building

611 CES/CEIE_13 Nov 2015

Kokee Air Force Station

Facility Lighting Map



Kokee Air Force Station - Perimeter Lighting Inventory

Light Location ID	No. Lights	No. of Lights Operable	Comments	Photo No
A	2	2	Two green bulbs, located across from guard shack (bldg. 7), both lights are tilted downward toward the ground (both with full shielding)	PL_A1, PL_A2 and PL_A3
B	1	1	Single green bulb, along east fenceline (with full shielding)	PL_B, PL_B2, and PL_B3
B1	1	0	One green bulb, along east fenceline, immediately next to gas tanks (light is inoperable)	PL_B1 and PL_B1 (wide view)
C	1	1	One green bulb, immediately north of the Coast Guard monopole (with full shielding)	PL_C (before lighting realignment) and PL_C (after lighting realignment)
D	1	1	One green bulb, along the north fenceline	PL_D
E	1	0	One green bulb (with full shielding)	PL_E, PL_E (close up), and PL_E (side view)
F	2	1	Two green bulbs (both with full shielding), located in the most northern corner of the installation	PL_E & F and PL_F
G	2	2	Two green bulbs (both with full shileding), located north of buidling 1	PL_G
H	1	1	One green bulb, with full shielding mounted to the northeast side of the Radar Tower	PL_H
I	1	1	One green bulb, with full shielding mounted to the north side of the Radar Tower	PL_I & J
J	1	1	One green bulb, with full shielding mounted to the north side of the Radar Tower	PL_I & J
K	2	2	Two green bulbs, with full shileding, located in the northwest corner of the installation	PL_K and PL_K & L
L	1	1	One green bulbs with full shielding located along the western fenceline	PL_K & L
M	2	2	Two green bulbs with full shielding, located immediately west of building 6	PL_M

Kokee Air Force Station - Perimeter Lighting Inventory

N	2	2	Two green bulbs, with full shielding	PL_N
O	1	0	One green bulbs with full shielding located on the southwest corner of bldg. 5	PL_O
P	1	0	One green bulbs with full shielding located on the southeast corner of bldg. 5	PL_P
Q	2	2	Two green bulbs with full shielding, located immediately to the southwest of the guard shack	PL_Q
	25	**20**		

Perimeter Lights_A and B: All green bulbs, with full shielding.

Perimeter Light_A: Two green bulbs, with full shielding, northeast of guard shack.

Perimeter Light_A: Two green bulbs, with full shielding (green lights on), northeast of guard shack.

Perimeter Light_A: Two green bulbs, with full shielding (close up).

Perimeter Light_B: One green bulb, with full shielding, along the eastern fenceline.

Perimeter Light_B: One green bulb, with full shielding (close up).

Perimeter Light_B: One green bulb, with full shielding and green light illuminated.

Perimeter Light_B1: One green bulb, with full shielding (light is currently not functioning).

Perimeter Light_B1 (broad view): One green bulb, with full shielding (light is currently nonfunctional).

Perimeter Light_C: One green bulb, with full shielding (photo taken before the light was realigned in a downward position).

Perimeter Light_C: One green bulb, with full shielding (photo taken after the light was realigned in a downward position).

Perimeter Light_D: One green bulb, with full shielding (moon is visible in the background).

Perimeter Light_E (broad view): One green bulb, with full shielding.

Perimeter Light_E (close up): One green bulb, with full shielding, light is currently not functioning.

Perimeter Light_E : One green bulb, with full shielding.

Perimeter Light_E : One green bulb, with full shielding (circle on the right)

Perimeter Light_F: Two green bulbs, with full shielding (circle on the left)

Perimeter Light_F: Two green bulbs, with full shielding.

Perimeter Light_G: Two green bulbs, with full shielding, north of building 1.

Perimeter Light_H: One green bulb, with full shielding, mounted to the Radar Tower building.

Perimeter Light_I: One green bulb, with full shielding (circle on the left)

Perimeter Light_J: One green bulb, with full shielding (circle on the right)

Perimeter Light_K: Two green bulbs, with full shielding, located in the most western corner of the installation.

Perimeter Light_K: Two green bulbs, with full shielding (circle on the left).

Perimeter Light_L: One green bulb, with full shielding (circle on the right).

Perimeter Light _M: Two green bulbs, with full shielding, immediately west of building 6.

Perimeter Light_N: Two green bulbs, with full shielding, along the south fenceline.

Perimeter Light_O: One green bulb, with full shielding, mounted on the southwest corner of building 5.

Perimeter Light_P: One green bulb, with full shielding, light is mounted to the southeast corner of building 5.

Perimeter Light _Q: Two green bulbs, with full shielding, located immediately southwest of the guard shack.

Appendix C.

Walking Path Bollard Light Model Design proposed by the USAF for usage at Kōkeʻe AFS

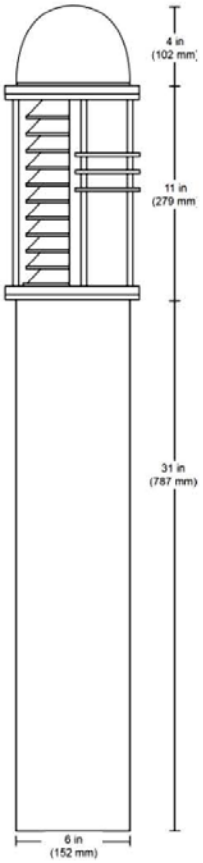
Type: _____ Model: _____

Project: _____

intrigue lighting LED

TURTLE

Amber (590nm) LED Bollard



None (Flush Top)

Dome Top

Cone Top

Flat Top

Beveled Top

General Description: LED bollard utilizing 270° shielding (external to lens) provides pedestrian safety while eliminating light trespass. High-impact look includes extreme durability and corrosion-resistant construction.

Construction: Low-copper content, marine grade, cast aluminum top and mounting gear. Housing is extruded aluminum. Stainless steel external hardware protects against corrosion.

Lens: Cylindrical lens shall be clear acrylic. Acrylic lens shall be UL recognized.

Internal Louvers: Aluminum interior reflector louvers shall have bead blasted top surface and acid etched inside surface.

House-side Shield: Corrosion resistant, high purity aluminum standard with 270° house-side shield.

LED Light Engine: LED module located in lower portion of bollard head offering 33 nominal input watts. Amber LED board providing color wavelength of 590nm.

Driver: Constant current LED driver; input voltage of 120v to 277v, mounted internal to fixture.

Heat Sink: Supplied with 6" cylindrical heat sink; powder coat finish; providing an overall heat-sinking surface area of 384 square inches.

Decorative Top: Five (5) top styles available: Beveled, Cone, Dome, Flat, and None (flush).

Mounting: Base is secured to concrete footing (by others) using provided mounting template and 1/2" anchor bolt kit (4 bolts). A 2.0" (51mm) diameter conduit opening is provided in the base for wiring.

Finish: Textured polyester powder coat finish available in Black, Bronze, Gray, White, Silver, and Verde Green. Contact factory for custom color/woodgrain options.

Gaskets: EPDM and silicone gaskets are standard.

c UL us LISTED

Listings: UL Listed 1598 for Wet Locations. Indoor/Outdoor listed for use in Canada.

Made in USA

www.intrigueled.com N60 W14592 Kaul Avenue Menomonee Falls, WI 53051
P: (877) 965 0005 F: (262) 436 1745

Type: _____ Model: _____

Project: _____

intrigue lighting LED

SERIES	DIAMETER	MOUNTING	SOURCE	LED COLOR	TOP STYLE	LENS	SHIELD	OPTIONS	HEIGHT	FINISH
TB	6	B	33LED	AML		CA	270HSS			

FIXTURE DETAIL

SERIES ☐ **TB** Turtle Series

DIAMETER ☐ **6** 6" Diameter

MOUNTING ☐ **B** Bollard Mount

WATTS ☐ **33LED** 33 Watts

Nominal Watts	Nominal Lumens	Lumens/Watt (LPW)	Nanometers	Rated Life (L85)	Drive Current (mA)	Output Voltage
33	2,000	61	590	50,000 hrs	700mA	48V

LED COLOR ☐ **AML** Amber LED (590nm)

TOP STYLE
- ☐ **B** Beveled
- ☐ **C** Cone
- ☐ **D** Dome
- ☐ **F** Flat
- ☐ **N** None (Flush)

LENS ☐ **CA** Clear Acrylic Lens

SHIELD ☐ **270HSS** 270° House Side Shield *(external to lens)*

OPTIONS
- ☐ **GFI** Cast outlet box with cover for GFI receptacle (by others)
- ☐ **MS** PIR Motion Sensors (3)
- ☐ **NR** No Rings
- ☐ **TRH** Tamper Resistant Hardware

HEIGHT
- ☐ **35** 35" overall height
- ☐ **46** 46" overall height

FINISH

☐ **BLK**	Black	☐ **VGN**	Verde Green
☐ **BRZ**	Bronze	☐ **WHT**	White
☐ **GRY**	Grey	☐ **WGF**	Woodgrain finish – consult factory
☐ **SIL**	Silver	☐ **CC**	Custom Color – consult factory

Made in USA

Content of specification sheets is subject to change. Please consult website for current product detail.

www.intrigueled.com N60 W14592 Kaul Avenue Menomonee Falls, WI 53051
P: (877) 965 0005 F: (262) 436 1745

Type: _____ Model: _____

Project: _____

intrigue lighting LED

BOLLARD DETAILS

RECEPTACLE BOX

☐ **GFI**

Outlet box mounted 16" on center from bottom of bollard tube. Cast aluminum outlet box internally welded and sealed with gasketed spring-loaded hinge cover.

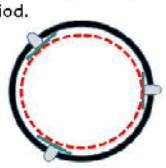
Cover shall be die cast metal construction with finish to match bollard. Typical cover will be lockable, single-gang weatherproof receptacle cover (Bell #MX1050S or similar). *(for wet and damp locations when cover is closed)*

Electrical receptacle not supplied due to variations in municipal electrical codes.

MOTION SENSOR

☐ **MS**

Motion Sensor option includes (3) passive infrared (PIR) sensors to detect motion. When motion is not detected for a 3-1/2 minute period, luminaire will automatically dim to 20% power and light. Once motion is again detected, luminaire immediately ramps up to 100% power and light output until motion is not detected for another 3-1/2 minute period.



Top View

Appendix D.

Seabird Monitoring and Predator Control Work Plan

Monitoring of seabirds on Kokee Air Force Station (KAFS) & off-site Predator Control

USAF Project: YGFZOS167778

Work Plan 2016

Dr. André F. Raine

April 2016

Kaua'i Endangered Seabird Recovery Project (KESRP), Pacific Cooperative Studies Unit (PCSU), University of Hawai'i and Division of Forestry and Wildlife (DOFAW), State of Hawai'i Department of Land and Natural Resources, Hawai'i, USA

In collaboration with : USAF Pacific Regional Support Center, 611 Civil Engineer Squadron

1.0 Introduction

In September 2015, Kauai Endangered Seabird Recovery Project (KESRP) staff were asked to visit the Kokee Air Force Station to consider a recent fall-out incident at the station. A large number of Newell's Shearwaters (as well as Hawaiian Petrels) were found to have been attracted to the lights at the station and become grounded. These were all adults, the majority of which were breeding adults.

Over the next few weeks KESRP staff, along with staff from KSHCP (Kauai Seabird Habitat Conservation Plan), DOFAW (Division of Forestry & Wildlife) and US Fish & Wildlife (USFWS), assisted the USAF in monitoring the site on a nightly basis. KESRP staff provided advice on how to prevent further fall-out and over the next few days the USAF put these measures in place. After the first few nights of fall-out and following new lighting protocols at the station, the presence of grounded birds significantly deceased to near-zero. A total of 129 seabirds (of which 121 were Newell's Shearwater, 6 were Hawaiian Petrel and 2 unidentified) were located within or associated with Kokee Air Force Station between 1st and 14th September of 2015.

KESRP will again monitor seabird activity, fallout and collision incidents at Kokee Air Force Station in 2016, although this time monitoring will be undertaken throughout the seabird season.

A second component of this project in 2016 will be off-site predator control, with a special focus paid to non-native avian species, in particular introduced owls. Non-native invasive species control is a known method for reducing predation of seabirds, in particular for burrow and crevice nesting species. Predation by non-native mammals is a constant threat to endangered seabird populations on Kaua'i. Feral cats (*Felis cattus*), rats (both Black (*Rattus rattus)* and Polynesian (*Rattus exulans*) species), Cattle Egret (*Bubulcus ibis*), Barn Owls (*Tyto alba*) and feral pigs (*Sus scrofa*) are all non-native predators that are potentially limiting the breeding success of birds within these colonies. The above predators have been identified as preying on or likely to prey on Newell's Shearwater (*Puffinus newelli*) and Hawaiian Petrel (*Pterodroma sandwichensis*). Arguably one of the most serious introduced predators of threatened seabirds within certain areas on Kaua'i is the Barn Owl. This is particularly true for those colonies where breeding birds are protected from mammalian predators due to topography (i.e., steep cliffs).

As part of this project, funds will be allocated to the Non-native Avian Predator Control team which has been actively working to reduce the number of non-native avian predators impacting Kauai's endangered seabirds since March 2015. The team is run by the Division of Forestry & Wildlife (DOFAW) with the two staff members hired through the Pacific Studies Co-operative Unit. Funding will be used to pay for three months of time for this team, using methodologies also detailed in this work plan.

2.0 Methodologies

2.1 On-site seabird monitoring

The main issue of seabird fallout at KAFS in 2015 revolved around the fall-out of adult birds. This is a relatively unique scenario, as seabird fallout on Kauai predominantly involves fledglings. It is

presumed that the location of the Air Force Station, in very close proximity to large seabird colonies in the Kalalau Valley, Na Pali coast (particularly Honopu and Nualolo Aina) and Hono o Na Pali NAR is the main reason for this. Due to the fact that fallout appears to be mainly adults, monitoring will therefore need to commence at the site as soon as possible – the first breeding birds return in late April, and following an exodus in May, begin egg-laying and incubation in June. Monitoring will therefore commence no later than June.

2.1.1 Outside observations

From June to end of November, a team of two seabird biologists will conduct auditory surveys and nocturnal observations at the station facilities. Surveys will be conducted for four consecutive nights once a month over this period and follow standardised KESRP auditory survey methodology as outlined below.

Surveys will be conducted during weeks when there is no full moon, which is when the fall-out phenomenon is most pronounced. Surveys will consist of a team of two KESRP seabird biologists stationed at two static points within the AFS with the best field of view of the overall area. Static observation points will be selected prior to the start of the season after a field visit by the KESRP Co-ordinator and will also be based on fallout hotspots identified in 2015. Surveys will commence at sunset, and run for 3 hours, with a further two hours of observations before sunrise.

Prior to the start of each survey, field staff will conduct a thorough search of the AFS grounds to look for downed seabirds from the night before. Searches will cover the entirety of the AFS, with specific attention paid to areas adjacent to the fenceline and any areas where there are crawl spaces which downed birds could hide under. A number of these were identified in 2015.

After the search has been completed they will then set up at their stations to begin surveying. Evening surveys will start at sunset (sunset/sunrise times taken from USNO website - http://www.usno.navy.mil/USNO) and last for four hours. Field staff will use night vision to watch for all seabirds. All seabirds will be recorded to species (wherever possible), with data also collected on bats and any other bird species of interest.

Surveys are split into 30-minute sessions, with 5 minutes allotted for the collection of weather data, 25 minutes for auditory surveying, and 5-10 minutes for concurrent night vision. Surveyors record all seabird calls (classified as a single unbroken note or series of notes) heard during the survey period and any bird actually seen during each period (either by eye or through night-vision equipment). For each record, data will be collected on time of observation, species, direction from observer, distance to observer, height of bird, behaviour of bird (with particular attention paid to circling behaviour), direction of flight path (if possible) and elevation, along with any additional comments that the observer feels are relevant. The final fate of the bird will also be recorded. Data will be recorded on standardized data sheets in the field and digitized after surveys have been completed.

If any bird is grounded, it will be immediately collected and put in a carrier box until the end of the survey. At the end of the survey period, the two field staff will conduct another thorough search of the AFS grounds to look for downed seabirds that may have come down during the survey period. The

exact location of all downed seabirds will be marked on a standard map, and they will be aged using standard ageing techniques for the two species. All uninjured seabirds will be banded and released at the Kalalau lookout after the survey has ended (if a licensed bander is present within the team). All injured seabirds will be passed over to the Save Our Shearwaters program for rehabilitation and release. Whenever a downed bird is found by KESRP, KESRP will notify USAF, who will in turn follow BO stipulations regarding notification of downed ESA species.

2.1.2 Ground searches

As well as the nightly searches detailed above, KESRP staff will also thoroughly search the ground immediately outside the station once a month to look for additional signs of grounded seabirds. Particular attention will be paid to areas identified in 2015 as fallout hotspots. Staff will carefully and thoroughly search surrounding uluhe beds and forested areas for seabird sign (either fresh or old). Any seabirds located will be photographed, and removed. Live birds will be taken to SOS. Dead birds will be bagged and taken to the KESRP office for further examination.

2.1.3 Perimeter searches when KESRP staff are not present

When KESRP field staff are not conducting surveys, AFS staff will conduct a search of AFS grounds twice each day – once 2hrs after sunset and once first thing in the morning. As above all downed seabirds will be collected, their location marked on a standard map, and they will be passed over to SOS for rehabilitation. When on-site USAF staff identify down seabirds they will notify their proper chain of command, collect the bird's location on a standard map, and birds will be placed in a box until KESRP staff can get the animal to SOS for rehabilitation. At the beginning of the season (early June), the USAF 611 CES and KESRP staff will conduct an identification and protocol training session with all AFS staff on site.

2.1.4 Acoustic Monitoring

KESRP monitors endangered seabird collisions with powerlines around Kauai using acoustic recording devices (Song Meter 2+ and Song Meter 4 from Wildlife Acoustics). The units record during the night at peak movement periods and identify collisions from the sound of the birds striking the wires. It seems probable that seabirds flying around the Kokee Air Force Station – especially those attracted to lights at the facilities – may come into contact with guy wires located on the station, particularly on the east side of the area. A song meter will be placed in the middle of this area, and will be set to record throughout the night (12 hrs a night).

A second song meter will be set up on the fence line to the west of the radar site where fence collisions were noted with regularity during monitoring in 2015. Tests will be undertaken at the beginning of the season to confirm whether or not birds hitting the lines and fence will make an audible sound that can be picked up by the song meters. This will be carried out by tapping the lines with a stick to simulate a bird collision.

Data will be recorded on SD cards in the units, and will then be sent to Conservation Metrics for analysis. Conservation Metrics, based in California, currently analyse all acoustic data for KESRP. They

do this by running it through computer software that uses a Deep Neural Network (DNN) to identify signature sounds of seabirds or collisions. All identified sounds are then listened to by staff members at CM to verify that they are seabirds or collisions.

Data from the song meter will be used to assess collision rates, as well as the presence of Hawaiian Petrel, Newell's Shearwater and Band-rumped Storm-petrel via their calls. Final outputs of the analysis will include (i) new collision model and total collision sounds (if any), (ii) nightly patterns of seabird activity and (iii) seasonal patterns of seabird activity.

2.1.5 Camera monitoring

10 Reconyx Hyperfire PC900 cameras will be purchased and deployed at the station. *These are not wirelessly transmitting cameras and are not capable of real-time monitoring.* Cameras will be placed at key fallout hotspots around the station, as identified in 2015. They will be used to record grounded seabirds moving along the fenceline, and under the fence, as well as the presence of introduced predators (cats, dogs, pigs) that may be present and which are known to predate on endangered seabirds.

SD cards will be removed each time a monitoring team visits the site, and data digitised back at the KESRP office. Staff will review photos for signs of seabirds and predators, with data entered into the KESRP Access database.

2.2 Off-site predator control

This portion of the work plan addresses the need to reduce overall predation rates within a number of identified seabird colonies, specifically related to Barn Owls and secondarily to cats, rats and Cattle Egret. Management for Barn Owls at these sites is expected to increase the survival rates of both adult birds and fledglings.

Six sites are currently benefiting from Barn Owl control: (1) Nualolo Aina; (2) Nualolo Kai; (3) Honopu; (4) Kalaheo/Kahili; (5) Lehua Islet; and (6) the back of Hanalei Valley. It is expected that these six areas hold significant potential for seabird conservation through Barn Owl-specific predator control actions. Actions under this work plan would continue these control activities for a further **three months** from the current date that funding for the team expires (December 2016 to February 2017).

2.2.1 Barn Owl control

During the three month period of funding identified under the Scope of Work, the Non-native Avian Predator Control team will utlilise the following methods for Barn Owl control. Targeted Barn Owl hunts will be undertaken at all six sites identified in the preceding paragraph. Access to these sites will be either by helicopter, on foot or – in the case of Lehua – by boat. Targeted hunts will occur at each site over a week period, at least once every other month. Barn Owls are lured into the area using tape lures broadcasting calls of seabirds, Barn Owls or distressed mice. Once within range, Barn Owls are then spot-lighted and shot by licenced and trained hunters. All visual sightings of Barn Owls as well as sign of Barn Owls are also noted during trips. Monitoring for the presence of other introduced

predators around breeding sites through the recording of indirect sign (prints, scat) and seabird predation events is also undertaken. If other predator sign is recorded, the control team may target these other species if time and logistics allow.

All control work is undertaken primarily using targeted hunts and complies with Institutional Animal Care and Use Committee (IACUC) as required by the University of Hawaii. Care will be taken to ensure that the owl is a Barn Owl and not the endemic Pueo (*Asio flammeus sandwichensis*), before any control action is undertaken. Protocols and methodologies may be adapted during the field season, as agreed to by all parties, to best meet project goals, logistical considerations or to address unexpected circumstances.

3.0 Reporting Requirements

Email updates will be sent out monthly between KESRP, the Non-native Avian Predator Control Project and the USAF to keep all parties updated on progress within both facets of this project. In the case of downed seabirds at the radar station, all downed seabirds recovered by the project will be reported to USAF, DOFAW and USFWS the following day, regardless of the scale of the event.

In accordance with the dates as outlined in the initial Scope of Work, a final report will be produced, covering the results of both the seabird monitoring and three months of predator control funded by this project. For seabird monitoring, the report shall provide all necessary information as requested by the Biological Opinion. A draft version of the seabird monitoring report will be provided within four weeks of the end of the field season (**due on January 23rd 2017**). The end of the field season will be considered to be the end of the third week of December, when a final check of the AFS grounds will be conducted by KESRP staff to look for downed Hawaiian Petrels (which fledge later than Newell's Shearwaters, with the last birds fledging in the final weeks of December). The final report will then be provided within two weeks of receiving comments from USAF. The seabird monitoring report will also display how current operations (post green-light implementation) are impacting listed seabirds at the Installation and shall include a list of new potential innovative prevention measures to be implemented at the Installation.

Furthermore a draft Annual Report (including both the seabird monitoring and off-site predator control work) shall be submitted within four weeks of completing the off-site predator control work. The government will provide KESRP and DOFAW with comments on the draft document, which will then be revised as necessary based on government comments. Once comments have been addressed completely, the contractor shall submit a Final Annual Report, in addition to separate responses to each comment on a separate comment matrix independent of the final report.

The data belong to both parties jointly, as this is a cooperative agreement. UH agrees to seek approval from the USAF 611 CES before releasing data, making any media statements, or communication with regulators, as both parties recognize that the data and features of the installation captured in the data could be sensitive if taken out of context. USAF 611 CES will utilize 11 AF Public Affairs for media communication and 611th CES/CEIE will manage communication with state and federal regulators. In the event of a FOIA, 673 CS/SCXK will be responsible for handling FOIA requests, in the event they result during the project or after its completion. UH may wish to publish the results

in peer-reviewed scientific literature and would give USAF an opportunity to comment on the draft manuscript prior to submission to the journal review body. The USAF supports academic publications, but 11 AF Public Affairs office reserves the right to approve the contents of the draft manuscript prior to release outside UH project team, the ACOE, and USAF.

4.0 Breakdown of Cost & Field Supplies and Materials List

This section covers the budget for this project, and is presented in the same way as it was initially presented in the submitted Scope of Work agreed upon by all parties. Note no seabird materials will be purchased for Air Guard Staff. Boxes will be provided to Air Guard Staff by the Save Our Shearwaters project to allow for the safe transport of downed seabirds located when KESRP staff are not present on site.

TASK 1 & 2

Category	Item	Unit	Cost	Total
Salaries	1 x co-ordinator - co-ordination and set-up	0.25	$ 5,067.00	$ 1,266.75
	1 x co-ordinator - report writing	0.25	$ 5,067.00	$ 1,266.75
	1 x Crew Leader	0.5	$ 3,400.00	$ 1,700.00
	2 x Field technicians	16	$ 540.00	$ 8,640.00
Fringe	1 x co-ordinator - co-ordination and set-up			$ 506.70
	1 x co-ordinator - report writing			$ 506.70
	1 x Crew Leader			$ 510.00
	2 x Field technicians			$ 2,592.00
Services - Fee	Analysis of song meter data by Conservation Metrics			$ 5,783.00
Materials & Supplies	Vehicle - Fuel (unit = approx fuel cost for one trip to Kokee)	24	$ 40.00	$ 960.00
	Song meters - SM4	2	$ 849.00	$ 1,698.00
	Microphone for SM4 (4 per unit, replacements)	8	$ 50.00	$ 400.00
	32GB SD cards for SM2 (4 per unit)	8	$ 20.00	$ 160.00
	Song Meter - D batteries (1unit*4*7)	28	$ 0.92	$ 25.85
	Reconyx PC900 Hyperfire Camera	10	$ 649.99	$ 6,499.90
	Thunderbolt mounting block	10	$ 29.99	$ 299.90
	Lithium AA batteries (3 sets per camera)	30	$ 34.99	$ 1,049.70
	SanDisk 8GB SDHC Memory Card (2 per cam)	20	$ 8.11	$ 162.20
	LaCie d2 Quadra v3 4TB External Hard Drive	2	$ 297.62	$ 595.24
	Night Vision - 3 pair	3	$ 3,795.00	$ 11,385.00
Other	Shipping			$ 288.21
	Contingency Costs			$ 3,460.10
Direct Costs Total				**$ 49,756.00**
UH Indirect Costs	CESU 17.5% rate			$ 8,707.00
TOTAL				**$ 58,463.00**

TASK 3

Category	Justification	Monthly Cost	Units (month)	Total Cost
Salaries		$ 5,685.00	3	$17,055.00
Fringe		$ 1,705.00	3	$ 5,115.00
Travel (domestic)	Intra-Island	$ 528.00	3	$ 1,584.00
	Boat Travel	$ 140.00	3	$ 420.00
Services - Fee	Helicopter	$ 2,200.00	3	$ 6,600.00
Materials & Supplies	Field Equipment Maintenance/ Purchase	$ 125.00	3	$ 375.00
	Trapping Equipment Maintenance/ Purchase (ammunition, batteries, etc)	$ 200.00	3	$ 600.00
	Vehicle fuel	$ 45.00	3	$ 135.00
	Office supplies	$ 50.00	3	$ 150.00
Utilities & Communications	Cell phone plan	$ 99.00	3	$ 297.00
	Sat phone plan	$ 62.00	3	$ 186.00
Repairs	Vehicle maintenance	$ 125.00	3	$ 375.00
Other	Contingency Costs			$ 2,459.00
Direct Cost Total				**$35,351.00**
UH Indirect Costs				$ 6,186.00
Total				**$41,537.00**

Appendix 1. Proposed Fieldwork Schedule for seabird monitoring (subject to change based on weather and logistical considerations)

Month	Week	Notes
Jan	1	
Jan	2	
Jan	3	
Jan	4	
Feb	1	
Feb	2	
Feb	3	
Feb	4	
Mar	1	
Mar	2	
Mar	3	
Mar	4	
Apr	1	
Apr	2	
Apr	3	
Apr	4	
May	1	Conduct song meter test at Kokee AFS
May	2	
May	3	
May	4	
June	1	Auditory Surveys
June	2	
June	3	
June	4	
July	1	Seabird monitoring at Kokee AFS, Reconyx cameras and song meters
July	2	
July	3	
July	4	
Aug	1	Seabird monitoring at Kokee AFS, Reconyx cameras and song meters
Aug	2	
Aug	3	
Aug	4	
Sept	1	Seabird monitoring at Kokee AFS, Reconyx cameras and song meters
Sept	2	
Sept	3	
Sept	4	
Oct	1	Seabird monitoring at Kokee AFS, Reconyx cameras and song meters
Oct	2	
Oct	3	
Oct	4	
Nov	1	Seabird monitoring at Kokee AFS, Reconyx cameras and song meters
Nov	2	
Nov	3	
Nov	4	
Dec	1	Remove all equipment
Dec	2	
Dec	3	Conduct final search at Kokee AFS for downed birds, to coincide with end of HAPE breeding season
Dec	4	

Appendix 2. Proposed Fieldwork Schedule for off-site predator control (subject to change based on weather and logistical considerations)

Month	Week	Notes
Jan	1	
Jan	2	
Jan	3	
Jan	4	
Feb	1	
Feb	2	
Feb	3	
Feb	4	
Mar	1	
Mar	2	
Mar	3	
Mar	4	
Apr	1	
Apr	2	
Apr	3	
Apr	4	
May	1	
May	2	
May	3	
May	4	
June	1	
June	2	
June	3	
June	4	
July	1	
July	2	
July	3	
July	4	
Aug	1	
Aug	2	
Aug	3	
Aug	4	
Sept	1	
Sept	2	
Sept	3	
Sept	4	
Oct	1	
Oct	2	
Oct	3	
Oct	4	
Nov	1	
Nov	2	
Nov	3	
Nov	4	
Dec	1	Targeted Barn Owl hunt & incidental predator control
Dec	2	Targeted Barn Owl hunt & incidental predator control
Dec	3	Targeted Barn Owl hunt & incidental predator control
Dec	4	
Jan	1	Targeted Barn Owl hunt & incidental predator control
Jan	2	Targeted Barn Owl hunt & incidental predator control
Jan	3	Targeted Barn Owl hunt & incidental predator control
Jan	4	
Feb	1	Targeted Barn Owl hunt & incidental predator control
Feb	2	Targeted Barn Owl hunt & incidental predator control
Feb	3	Targeted Barn Owl hunt & incidental predator control
Feb	4	

APPENDIX J
UNITED STATES ARMY CORPS OF ENGINEERS - APPROVED JURISDICTIONAL DETERMINATION – NO PERMIT REQUIRED

DEPARTMENT OF THE ARMY
U.S. ARMY CORPS OF ENGINEERS, HONOLULU DISTRICT
FORT SHAFTER, HAWAII 96858-5440

REPLY TO
ATTENTION OF:

March 23, 2012

Regulatory Branch

File Number POH-2012-00086

AFCEE Hawaii
Attention: Kristen Warren
25 E Street B-211
Hickam AFB, HI. 96853

APPROVED JURISDICTIONAL DETERMINATION
NO PERMIT REQUIRED

Dear Ms. Warren:

This letter is in response to your email dated January 19, 2012 requesting Department of the Army (DA) jurisdictional determination for the detention pond abutting the runway at 19.282°N, 166.649°E, Wake Island Airfield, Wake Atoll. We have assigned this project the reference number **POH-2012-00086**. Please cite this reference number in any future correspondence concerning this project.

We have completed our review of the submitted document pursuant to Section 10 of the Rivers and Harbors Act of 1899 (Section 10). For your information, Section 10 requires that a DA permit be obtained from the U.S. Army Corps of Engineers (Corps) prior to undertaking any construction, dredging, or other activity occurring in, over, or under or affecting navigable waters of the U.S. For tidal waters, the shoreward limit of the Corps' jurisdiction extends to the Mean High Water Mark.

Per your meeting with Ms. Jessie Paahana, of this office, on March 13, 2012, the Corps was informed that the detention basin was constructed by the Navy, along with the landing strip, some time ago, as a means to deter surface runoff from ponding on the runway and that the outfall structure conveying accumulated runoff out to the ocean has not drained properly since its construction thus, deterring tidal influxes. You informed Ms. Paahana that the source of the fill material will be concrete rubble resulting from the demolition of existing, dilapidated buildings located on Wake Atoll. We recommend you test the rubble material to assure it is free of lead-based paints, metallics and other pollutants that have the potential to leach into and adversely affect the surrounding environment.

Based on the information you submitted, the Corps has determined that the **detention pond is a non-tidal, man-made feature that lacks a surface connection to a navigable water therefore, it is <u>not a water of the U.S</u> and is not subject to Corps regulatory jurisdiction**. This determination does not relieve you of the responsibility to obtain any other permits, licenses, or approvals that may be required under Federal law for your proposed work.

This letter contains an approved JD for the property in question and is valid for a period of five (5) years unless new information warrants revision of the determination before the expiration date. If you object to this determination, you may request an Administrative Appeal under Corps regulations at 33

Code of Federal Regulations (CFR) Part 331. Should you object to this determination, please notify this office and we will provide you with the informational materials required for an appeal and provide suspense dates based upon the date the appeal information is supplied to you

Thank you for contacting us regarding this project and providing us with the opportunity to comment. Should you have any questions, please contact Ms. Jessie Pa'ahana via e-mail at *Jessie.K.Paahana@usace.army.mil*. You are encouraged to provide comments on your experience with the Honolulu District Regulatory Branch by accessing our web-based customer survey form at *http://per2.nwp.usace.army.mil/survey.html*.

Sincerely,

George P. Young, P.E.
Chief, Regulatory Branch

APPENDIX K
EXAMPLE UNITED STATES FISH AND WILDLIFE SERVICE DECLARATION FOR IMPORTATION OR EXPORTATION OF FISH OR WILDLIFE AND UNITED STATES FISH AND WILDLIFE SERVICE REQUEST FOR INFORMATION FOR FISH SAMPLE EXPORT APPROVAL AND LETTER OF AUTHORIZATION

USFWS Form 3-177
(Revised 03/10)
O.M.B. No. 1018-0012
Expiration Date: 03/31/2013

U.S. FISH AND WILDLIFE SERVICE
DECLARATION FOR IMPORTATION OR EXPORTATION OF FISH OR WILDLIFE

1. Date of Import/Export: (mm/dd/yyyy) 10/04/2013

2. Import/Export License Number:

3. Indicate One: ☑ Import ☐ Export

4. Port of Clearance: HA

5. Purpose Code: S

6. Customs Document Number (s)

7. Name of Carrier: Military Transport

8. Air Waybill or Bill of Lading Number:
Master:
House:

9. Transportation Code: P
License # State or Province

10. Bonded Location for Inspection:

11. Number of Cartons Containing Wildlife:

12. Markings on Cartons Containing Wildlife:

13a. (Indicate One) (Complete name/U.S. address/telephone number/e-mail address)
☑ U.S. Importer
☐ U.S. Exporter
Dan Savercool or Scott Moncrief
EA Engineering, Science, and Technology Inc.
615 Piikoi St. Suite 515
Honolulu, HI 96814

13b. Identifier Number: _____ ID Type: _____

14a. (Indicate One) (Complete name/foreign address/telephone number/e-mail address)
☐ Foreign Importer
☑ Foreign Exporter
Dan Savercool or Scott Moncrief
EA Engineering, Science, and Technology Inc.
615 Piikoi St. Suite 515
Honolulu, HI 96814

14b. Country Code US

14c. Identifier Number: _____ ID Type: _____

15a. Customs Broker, Shipping Agent or Freight Forwarder:
(Complete business name/address/telephone and fax number/e-mail address)

15b. Identifier Number: _____ ID Type: _____

15c. Contact Name: _____

Species Code (Official Use Only)	16a. Scientific Name / 16b. Common Name	17a. Foreign CITES Permit Number / 17b. U.S. CITES Permit Number	18a. Description Code / 18b. Source Code	19a. Quantity/Unit / 19b. Total Monetary Value	20. Country of Species Origin Code (ISO Code)	21. Venomous Live Wildlife Indicator ☑ (Check if yes)
	Echidna nebulosa Whole fish (snowflake moray eel) sample	N.A.		8 $0	US	☐
						☐
						☐
						☐

Knowingly making a false statement in a Declaration for Importation or Exportation of Fish or Wildlife may subject the declarant to the penalty provided by 18 U.S.C. 1001 and 16 U.S.C. 3372(d)

22. I certify under penalty of perjury that the information furnished is true and correct:

Daniel M. Savercool — Signature
08/15/2013 — Date
Daniel M. Savercool — Type or Print Name

For Official Use Only
Action/Comments: No fee required
CLEARED 10/03/13
Wildlife Declared: Yes / No
Wildlife Inspected: None / Partial / Full

See Reverse Side of this Form for Privacy Act Notice

USFWS Form 3-177, Declaration for
Importation or Exportation of Fish or Wildlife.
FWS Fish Sampling Permit for Import

Thanks for the notification and the declaration form. For the description codes in 18a, 18b please use BOD [Dead animal whole] and W [Specimens taken from the wild] for future reference. Additionally, provide the following supplemental documents to my office:

* any permits acquired from the DOD, DOI, or FWS that authorizes your research and the collection of marine specimens, example - a letter of authorization or formal permit from the commander or other ranking official.

* an invoice or invoice like document stating the number of specimens, how they are preserved, location of collection, etc.

We will contact CBP to inform them that Scott Moncrief will be returning from Wake Atoll with fish specimens and to consider the shipment 'Cleared' for Fish and Wildlife purposes.

Mahalo. Let me know if you have any questions, comments or difficulties.

Tony

anthony_palermo@fws.gov

Michael_Oshiro@fws.gov

beth_flint@fws.gov

DEPARTMENT OF THE AIR FORCE
PACIFIC AIR FORCES

4 Oct 13

MEMORANDUM FOR RECORD

FROM: DETACHMENT 1, PACIFIC AIR FORCES REGIONAL SUPPORT CENTER (PRSC)
P.O. Box 68
Wake Island HI 96898

SUBJECT: Letter of Authorization for Government Contractor

1. In accordance with the terms and conditions for task order FA8903-08-D-8791-0034, Post Remedial Sampling at Peacock Point (OT10) Wake Island, EA Engineering is authorized to collect fish tissue and sediment samples for analysis at Wake Island.

2. EA Engineering's Scott Monicrief is the lead scientist who will be returning from Wake Island on or about 4 Oct 2013 to Joint Base Pearl Harbor Hickam (JBPHH) with the subject samples.

3. All samples will be properly labled per the direction of the US Fish and Wildlife Service (USFWS). The Contractor will hand carry a hard copy of the approved permit received from the USFWS for the collection of these samples.

4. Please direct any questions to MSgt Michael Demers via e-mail at michael.demers.1@us.af.mil or via telephone at (808) 424-2276.

C J. Taylor

CHARLIE J. TAYLOR, Captain, USAF
Commander

APPENDIX L
UNITED STATES FISH AND WILDLIFE SERVICE MIGRATORY BIRD TREATY ACT PERMIT FOR BIRD DEPREDATION AT WAKE ISLAND AIRFIELD

DEPARTMENT OF THE INTERIOR
U.S. FISH AND WILDLIFE SERVICE

FEDERAL FISH AND WILDLIFE PERMIT

2 AUTHORITY-STATUTES
16 USD 703-712

REGULATIONS
50 CFR Part 13
50 CFR 21.41

1 PERMITTEE

WAKE ISLAND AIRFIELD
dba U.S. AIR FORCE, 611TH PRSC
116 WAKE AVE
WAKE ISLAND, HI 96898
U.S.A.

3 NUMBER
MB077566-0

4. RENEWABLE ☒ YES ☐ NO

5. MAY COPY ☒ YES ☐ NO

6 EFFECTIVE
02/01/2014

7 EXPIRES
01/31/2015

8. NAME AND TITLE OF PRINCIPAL OFFICER *(If #1 is a business)*
KYLE B KIMBER
ENVIRONMENTAL TECHNICIAN

9. TYPE OF PERMIT
DEPREDATION AT AIRPORTS

10. LOCATION WHERE AUTHORIZED ACTIVITY MAY BE CONDUCTED
Physical Location and Records Kept at:
Address in Block 1
WAKE ISLAND

11 CONDITIONS AND AUTHORIZATIONS

A. GENERAL CONDITIONS SET OUT IN SUBPART D OF 50 CFR 13, AND SPECIFIC CONDITIONS CONTAINED IN FEDERAL REGULATIONS CITED IN BLOCK #2 ABOVE, ARE HEREBY MADE A PART OF THIS PERMIT. ALL ACTIVITIES AUTHORIZED HEREIN MUST BE CARRIED OUT IN ACCORD WITH AND FOR THE PURPOSES DESCRIBED IN THE APPLICATION SUBMITTED. CONTINUED VALIDITY, OR RENEWAL, OF THIS PERMIT IS SUBJECT TO COMPLETE AND TIMELY COMPLIANCE WITH ALL APPLICABLE CONDITIONS, INCLUDING THE FILING OF ALL REQUIRED INFORMATION AND REPORTS.

B. THE VALIDITY OF THIS PERMIT IS ALSO CONDITIONED UPON STRICT OBSERVANCE OF ALL APPLICABLE FOREIGN, STATE, LOCAL, TRIBAL, OR OTHER FEDERAL LAW.

C. VALID FOR USE BY PERMITTEE NAMED ABOVE

D. You are authorized to take, temporarily possess, and transport the migratory birds specified below to relieve or prevent injurious situations impacting public safety. All take must be done as part of an integrated wildlife damage management program that emphasizes nonlethal management techniques. You may not use this authority for situations in which migratory birds are merely causing a nuisance.

(1) The following may be lethally taken:

Up to 100 migratory birds (primarily species not native to Wake Island)

(2) The following active nests (including eggs) may be relocated or destroyed:

Up to 100 migratory bird nests (including sooty tern, grey-backed tern, brown noody, red-tailed tropic bird)

E. You are authorized in emergency situations only to take, trap, or relocate any migratory birds, nests and eggs, including species that are not listed in Condition D (except bald eagles, golden eagles, or endangered or threatened species) when the migratory birds, nests, or eggs are posing a direct threat to human safety. A direct threat to human safety is one which involves a threat of serious bodily injury or a risk to human life.

You must report any emergency take activity to your migratory bird permit issuing office *PermitsR1MB@fws.gov* within 72 hours after the emergency take action. Your report must include the species and number of birds taken, method, and a complete description of the circumstances warranting the emergency action.

F. You are authorized to salvage and temporarily possess migratory birds found dead or taken under this permit for (1) disposal, (2) transfer to the U.S. Department of Agriculture, (3) diagnostic purposes, (4) purposes of training airport personnel, (5) donation to a public scientific or educational institution as defined in 50 CFR 10.12, (6) donation to persons authorized by permit or regulation to possess them, or (7) donation of migratory game birds only to a

☒ ADDITIONAL CONDITIONS AND AUTHORIZATIONS ALSO APPLY

12 REPORTING REQUIREMENTS
ANNUAL REPORT DUE: 01/31
Report Take Jan 1 - Dec 31

ISSUED BY

TITLE
CHIEF, MIGRATORY BIRD PERMIT OFFICE - REGION 1

DATE
03/17/2014

Standard Conditions
Migratory Bird Depredation Permits
50 CFR 21.41

All of the provisions and conditions of the governing regulations at 50 CFR part 13 and 50 CFR part 21.41 are conditions of your permit. Failure to comply with the conditions of your permit could be cause for suspension of the permit. The standard conditions below are a continuation of your permit conditions and must remain with your permit. If you have questions regarding these conditions, refer to the regulations or, if necessary, contact your migratory bird permit issuing office. For copies of the regulations and forms, or to obtain contact information for your issuing office, visit: http://www.fws.gov/migratorybirds/mbpermits.html.

1. To minimize the lethal take of migratory birds, you are required to continually apply non-lethal methods of harassment in conjunction with lethal control.
   [*Note: Explosive Pest Control Devices (EPCDs) are regulated by the Bureau of Alcohol, Tobacco, Firearms, and Explosives (ATF). If you plan to use EPCDs, you require a Federal explosives permit, unless you are exempt under 27 CFR 555.141. Information and contacts may be found at http://www.atf.gov/explosives/how-to/become-an-fel.htm.*]

2. Shotguns used to take migratory birds can be no larger than 10-gauge and must be fired from the shoulder. You must use nontoxic shot listed in 50 CFR 20.21(j).

3. You may not use blinds, pits, or other means of concealment, decoys, duck calls, or other devices to lure or entice migratory birds into gun range.

4. You are not authorized to take, capture, harass, or disturb bald eagles or golden eagles, or species listed as threatened or endangered under the Endangered Species Act found in 50 CFR 17, without additional authorization.

   For a list of threatened and endangered species in your state, visit the U.S. Fish and Wildlife Service's Threatened and Endangered Species System (TESS) at: http://www.fws.gov/endangered.

5. If you encounter a migratory bird with a Federal band issued by the U.S. Geological Survey Bird Banding Laboratory, Laurel, MD, report the band number to 1-800-327-BAND or http://www.reportband.gov.

6. This permit does not authorize take or release of any migratory birds, nests, or eggs on Federal lands without additional prior written authorization from the applicable Federal agency, or on State lands or other public or private property without prior written permission or permits from the landowner or custodian.

7. Unless otherwise specified on the face of the permit, migratory birds, nests, or eggs taken under this permit must be:
   (a) turned over to the U.S. Department of Agriculture for official purposes, or
   (b) donated to a public educational or scientific institution as defined by 50 CFR 10, or
   (c) completely destroyed by burial or incineration, or
   (d) with prior approval from the permit issuing office, donated to persons authorized by permit or regulation to possess them.

APPENDIX M
WAKE ISLAND AIRFIELD SPILL PREVENTION, CONTROL, AND COUNTERMEASURE PLAN

Wake Island Airfield

Spill Prevention, Control, and Countermeasure Plan

Prepared for:

U.S. Department of Defense, U.S. Air Force
Pacific Regional Support Center
9480 Pease Avenue
JBER, AK 99506

Prepared by:

Weston Solutions, Inc.
1435 Garrison Street, Suite 100
Lakewood, CO 80215

August 2015

MEMORANDUM OF TRANSMITTAL
FROM: PRSC CC

SUBJECT: Wake Island Airfield Spill Prevention, Control, and Countermeasure (SPCC) Plan

1.0 Attached is the Wake Island Airfield (WIA) SPCC that becomes effective immediately. This Plan contains instructions for the prevention of oil and hazardous substance spills at WIA. This Plan ensures conformance with Air Force and federal policies.

2.0 This Plan is developed to identify methods for the prevention of oil and hazardous substance spills. Additionally, the SPCC provides guidance to Base personnel on local procedures, conditions and policies unique to WIA. This plan is a rewrite and supersedes all previous SPCC plans.

3.0 PRSC OPR for this plan is the 611th Civil Engineer Squadron Installation Management Flight (611 CES/CEI) at (907) 552-7948.

FRANK A. FLORES, Colonel, USAF

Commander, PACAF Regional Support Center

Attachment:

WIA SPCC

This Page Intentionally Left Blank

WAKE ISLAND AIRFIELD SPCC PLAN

SECURITY INSTRUCTIONS AND RECORD OF CHANGES

1.0 The long title of this plan is Wake Island Airfield Spill Prevention, Control and Countermeasure Plan. The short title is SPCC.

2.0 This document is unclassified but its contents are FOR OFFICIAL USE ONLY.

3.0 Reproduction of this document in whole or in part is allowed.

4.0 The SPCC is to be reviewed on an annual basis - each year during the month of publication. Use the "Record of Review" area. Send a copy of the "Record of Review" to the Installation Management Flight's Natural Resources Element (611 CES/CEI) for review.

5.0 A change number will be assigned by 611 CES/CEI if change is adopted into the SPCC.

6.0 Any changes will be an attachment and will be sent to users.

Record of Changes			
Date Entered	**Posted By**	**Change Number**	**Copy Number**

Record of Annual Review		
Date Reviewed	**Reviewed By**	**Remarks**

This Page Intentionally Left Blank

WAKE ISLAND AIRFIELD SPCC PLAN

PLAN SUMMARY

1.0 The EPA's Oil Pollution Prevention regulations were originally published in the Federal Register on December 11, 1973 and addressed non-transportation-related facilities. Subsequent amendments and final regulations were published in October 1991, 1993, 2002, 2008, and 2009.

2.0 Information presented in this document is based on field investigations and interviews with personnel from the PACAF Regional Support Center, 611th Civil Engineer Squadron, Installation Management Flight (611 CES/CEI), Wake Island Environmental personnel, and on-base organizations that manage tanks and bulk fuel facilities. Regulatory deficiencies and observations, made in 2009, and related to code compliance, were prepared and provided to Wake Island Airfield in a written Executive Briefing under separate cover.

3.0 Regulated materials that fall under purview of this plan include miscellaneous types of petroleum products commonly found on military installations. These materials include, but are not limited to: JP-5, automotive gasoline (MOGAS), and various engine/mechanical lubrication oils that are necessary to ensure proper working order of airbase support equipment.

4.0 This Plan does not address containers that are exempt or excluded from SPCC regulations. This includes motive power containers, and permanently closed in-place tanks. There are no underground storage tanks (USTs) located at Wake Island Airfield. Lastly, petroleum storage containers that are wholly owned and operated by contractor personnel and / or non-Air Force organizations are not included in this Plan

5.0 Per 40 CFR 112 regulations, a facility's SPCC Plan is required to be reviewed and evaluated once every five years. Additionally, the SPCC Plan must be amended when there is a change in facility design, construction, operation, or maintenance that materially affects its potential for a discharge. This Plan is being updated to satisfy the regulatory requirements to incorporate facility changes into the SPCC Plan and also to satisfy the five-year update and re-certification by a licensed professional engineer.

This Page Intentionally Left Blank

WAKE ISLAND AIRFIELD SPCC PLAN

TABLE OF CONTENTS

List of Tables

List of Annexes

WAKE ISLAND AIRFIELD SPCC PLAN

MANAGEMENT APPROVAL

1.0 This Spill Prevention, Control and Countermeasure (SPCC) Plan has been prepared in accordance with good engineering practices, and has the full approval of PACAF Regional Support Center leadership. Leadership will use personnel, equipment, and materials necessary to control and mitigate releases at Wake Island Airfield, and are fully committed to the implementation of the requirements set forth in this plan. The priorities of response team members are based upon protection of human life, mitigating environmental harm, and protection of property, respectively. This SPCC Plan will be implemented as described herein, and will be reviewed and evaluated at least once every five years.

2.0 I have reviewed the recommendations for regulatory compliance as presented in this SPCC Plan. By virtue of my office, I have authority to approve this document on behalf of the facility and to commit the necessary resources to implement the required improvements to comply with existing applicable federal and state laws. Corrective action will be taken to address the regulatory deficiencies noted herein as soon as possible. Should funding or other reasons prevent this from occurring, an extension will be requested from the Regional Administrator in accordance with 40 CFR 112.3(f). Best engineering practice recommendations noted herein (refer to Annex D) will be considered and may or may not be implemented depending on the priority of funding available.

Signature	24 Jan 16 Date Signed
Frank A. Flores Printed Name	Commander, PACAF Regional Support Center Title

This Page Intentionally Left Blank

WAKE ISLAND AIRFIELD SPCC PLAN

RECORD OF OWNER/OPERATOR PLAN REVIEWS AND AMENDMENTS

1.0 In accordance with 40 CFR 112.3 and 112.5 of the Spill Prevention, Control, and Countermeasure Plan (SPCC) regulations, an amendment to the facility SPCC Plan is required under the following conditions:

1.1 At a minimum of every 5 years;

1.2 If National Pollutant Discharge Elimination System (NPDES) permits are issued or amended for Wake Island Airfield;

1.3 If new construction or changes to operations or maintenance materially affects the potential for release of POL products;

1.4 If the SPCC Plan fails or is ineffective in an emergency;

1.5 If there is a change in the spill response organization or spill response equipment list; or

1.6 If there is a change in land use for areas that may be affected by a spill.

2.0. In accordance with 40 CFR 112, a licensed Professional Engineer must review and certify any technical amendments to this SPCC Plan for it to be legally sufficient. Through this certification, the engineer attests to the following statements:

2.1 He or she is familiar with the requirements of the SPCC rule;

2.2 He or she or his or her agent has visited and examined the facility;

2.3 The SPCC Plan has been prepared in accordance with good engineering practices, including consideration of applicable industry standards, and with the requirements of the SPCC rule;

2.4 Procedures for required inspections and testing have been established; and

2.5 The Plan is adequate for the facility.

3.0 To facilitate SPCC reviews and amendments, the following tables are provided.

WAKE ISLAND AIRFIELD SPCC PLAN

OWNER/OPERATOR RECORD OF FIVE-YEAR REVIEWS

I have completed review and evaluation of the SPCC Plan for Wake Island Airfield on the date indicated below, and will (will not) amend the Plan as a result.

Signature of Reviewer	Date of Review	Will Amend the Plan	Will Not Amend the Plan

OWNER/OPERATOR RECORD OF SPCC PLAN AMENDMENTS

If applicable, briefly describe the type of amendment (i.e., administrative or technical). State how amendment was completed (i.e., page change, addendum, etc.). Provide the date of the amendment and the printed name/position of person responsible for the amendment. The SPCC Plan must be amended within six months of the five-year review or any facility changes that affect the facility's potential for a discharge as described in 40 CFR 112.1(b). The revised plan must be implemented no more than six months from the amendment. A licensed Professional Engineer must review and certify any technical amendment of the SPCC Plan.

Description of Change (Administrative or Technical)	Date Entered	Posted By
Administrative and technical update of entire plan	April 30, 2009	Science Applications International Corporation (SAIC)
Update to indicate ownership change from 15 AWG to 611 ASG and update storage tank information	February 4, 2012	611 CES/CEI (W. Gilpin)
Administrative and technical update of entire plan	April 15, 2015	Weston Solutions, Inc.

WAKE ISLAND AIRFIELD SPCC PLAN

PROFESSIONAL ENGINEER'S CERTIFICATION

1.0 In accordance with 40 CFR 112.3(d), I hereby certify that I or my agent has visited and examined the facility, and being familiar with the provisions of 40 CFR 112, *Environmental Protection Agency Regulations on Oil Pollution Prevention*, attest that the Plan has been prepared in accordance with good engineering practice, including consideration of applicable industry standards, and with the requirements of this part; that procedures for required inspections and testing have been established; and that, with the correction of listed deficiencies, the Plan is adequate for the facility.

2.0 I also certify that I have reviewed applicable sections of the Facility Response Plan as it applies to the contingency plan requirements of the SPCC regulations in 40 CFR 112.7(d), discussed in Section 16 of the Plan.

3.0 This SPCC Plan supersedes the previous Wake Island Airfield SPCC Plan dated June 2009.

_____ David A. Goertz

Signature of Certifying Registered Professional Engineer

Name of Certifying Registered Professional Engineer

Colorado

State

30757 exp. 10/31/15

Registration Number and Expiration

August 15, 2015

Certification Date

This Page Intentionally Left Blank

WAKE ISLAND AIRFIELD SPCC PLAN

BASIC PLAN

1.0 Situation.

1.1 The EPA Oil Pollution Prevention Regulation (40 CFR Part 112.1) requires preparation and implementation of a Spill Prevention, Control, and Countermeasure (SPCC) Plan. This SPCC Plan is written and implemented to ensure that proper actions are taken to reduce the chance for oil, hazardous substance, or hazardous waste releases to enter navigable waters of the United States or its adjoining shorelines and the human environment surrounding Wake Island Airfield (WIA or "the Base"). The plan establishes procedures and identifies resources necessary to respond to such releases, address notification requirements, and assign responsibility for carrying out established procedures.

1.2 Assumptions:

1.2.1 The possibility of accidental spills of oil, hazardous substances, and hazardous waste will continue to exist on WIA.

1.2.2 The base will continually assess and upgrade all structures used to prevent environmental releases and ensure they comply with EPA regulations and Air Force and DoD standards.

1.2.3 The base shall have sufficient resources in manpower, equipment, vehicles, and ready contracts to clean up any spills occurring on the installation or caused by its actions.

1.2.4 The base shall identify resources that can be brought to bear in the event of a discharge beyond the on-island spill response capabilities. These resources are addressed in detail in the WIA Facility Response Plan.

1.2.5 Hazards will continue to be managed for necessary industrial operations to support national security objectives.

1.2.6 Military or contractor personnel working in the involved area will readily recognize the danger, evacuate people, call 911 (WIA Base Ops), and inform supervisors.

1.2.7 The Fire Department will perform rescue operations, give first aid, secure ambulance/hospital services and notify security forces.

1.2.8 Chemicals involved will be identified by the using organization, if possible.

2.0 Mission.

2.1 The plan will have a title of "Spill Prevention, Control, and Countermeasure Plan (SPCC Plan)." This plan is intended to be used in conjunction with the WIA Facility Response Plan, by developing appropriate measures to prevent accidental pollution incidents; eliminating sources of potential pollution spills; instituting an effective system for discovering and reporting the existence of pollution spills.

3.0 Execution:

3.1 In the event of a discharge of oil or hazardous substances on or near WIA, all personnel are to follow the immediate response actions documented in THE RED PLAN section of the

WIA Facility Response Plan. The first priority in any emergency situation is the protection of the health and safety of all personnel on WIA.

3.1.1 Concept of Operations: WIA is responsible for minimizing the occurrence of spills and releases of oil or hazardous materials into the environment. WIA is also responsible for developing the capability for prompt response to spill incidents from facilities operated or supervised by WIA.

3.1.2 WIA is responsible for spill cleanup of oil or other hazardous substances occurring on the installation, for restoring the environment to background concentrations. If cleanup and restoration cannot be accomplished by WIA, or is not accomplished in accordance with applicable criteria, the work will be accomplished under direction of cognizant regulatory agencies.

3.1.2.1 Spill prevention should be a primary concern of all base personnel. The following aspects of spill prevention will be executed on an ongoing basis by all organizations storing hazardous substances, hazardous waste and petroleum products.

3.1.2.1.1 Secondary Containment: Secondary containment is the physical containment or capture of a spill, thus preventing or limiting its release to the environment. Examples include: dikes, curbs, oil/water separators, drip pans, and collection systems. Additional examples may include remote secondary containment such as floating booms. All permanently installed storage tanks will have a secondary containment equal to or greater than 110% of the capacity of the tank(s). Secondary containment drain valves shall be kept in the closed position unless releasing rainwater (without sheen).

3.1.2.1.2 Inspections: Visual inspections consist of inspecting potential spill sites to identify spills, evidence of spills based on deterioration of piping and connections and corrosion or weeping from the tank system, and condition of containment devices or other conditions that could result in a spill. In general, the inspections are as follows:

3.1.2.1.3 Preventive Maintenance: Preventive maintenance, as a part of the spill prevention program, involves the periodic lubrication, adjustment and replacement of worn parts in all equipment where failure could result in a spill of oils or hazardous substances or impede response efforts.

3.1.2.1.4 Housekeeping: Good housekeeping is the practice of maintaining a clean, orderly work environment, thereby reducing the possibility of accidental spills caused by mishandling of equipment and materials, and facilitating the detection of spills and leaks.

3.1.2.1.5 Material Compatibility: Oils and hazardous substances must be compatible with the materials used to store or transport them and compatible with storage and/or transfer devices.

3.1.2.1.6 Security: All oils and hazardous substances will be secured. Security involves the deterrence of unauthorized, unknowing or accidental entry of personnel, animals or vehicles into potential spill areas when such entry could result in the damage or misuse of equipment containing or conveying oils or

hazardous substances. Each building and container shall be clearly marked with identification numbers, product contents, warning statement and any other pertinent markings.

4.0 Administration and Logistics.

4.1 Administration. Normal administrative procedures shall apply when this plan is implemented. The PACAF Regional Support Center Commander (PRSC/CC) must approve this plan before it becomes effective.

4.1.2 Logistics.

4.1.2.1 611 CES/CEI and the WIA Environmental Manager are responsible for reviewing this plan prior to its promulgation and prior to finalizing any modifications occurring during the annual review and update of the plan.

4.1.2.2 Organization Commanders. It is the responsibility of all organization commanders to publish such procedures necessary for implementation of this plan, insure personnel under their responsibility receive adequate training and insure that environmental protection/pollution abatement procedures are implemented in their areas of responsibility. This includes initiating projects to correct deficiencies in oil, hazardous substance and hazardous waste spill prevention and containment. The IC: The IC is the individual assigned the responsibility for directing and coordinating all spill response actions for Air Force spills.

4.1.2.3 Primary Incident Commander. The Incident Commander (IC) for response to all oil and hazardous substance spills on WIA is the Fire Chief (SFO).

4.1.2.4 Base Personnel. Each individual assigned to or working at WIA is tasked to report any spill of oil or hazardous substance to the fire department and to take every reasonable precaution to prevent the spillage of oil or hazardous substances. In addition, all contractors performing services on base shall be notified prior to the initiation of the contract of their responsibilities to take every reasonable precaution to prevent the spillage of oil or hazardous substances and to immediately report any spills of this nature to the fire department. Since there are limited U.S. Air Force personnel on Wake Island, the Base Operating Support (BOS) Contractor has primary responsibility of day-to-day spill prevention and control.

4.2 Personnel. Implementing this plan may cause increased personnel requirements.

4.3 Communications Security. COMSEC consideration has been afforded to this plan.

4.4 Operations Security. OPSEC consideration has been afforded to this plan.

5.0 Command and Control. Existing command structure of all military and nonmilitary agencies shall remain in effect, except as specifically stipulated in this plan. Command and Control for response to oil or hazardous substance spills shall follow the procedures, structure and terminology defined by the National Incident Management System (NIMS).

This Page Intentionally Left Blank

1.0 Introduction

1.1 Description of Regulation: The Federal Water Pollution Control Act Amendments of 1972 and the Clean Water Act of 1977 authorize the EPA to "develop, promulgate, and revise ...regulations pertaining to oil..." and to publish regulations classifying toxic pollutants to control plant site runoff, spillage and leaks, sludge, waste disposal, and drainage from raw material storage. Because oils are stored and transferred at WIA, the facility falls under the federal regulation for Oil Pollution Prevention, 40 CFR 112. This regulation requires that a Spill Prevention, Control, and Countermeasure (SPCC) Plan be implemented to establish procedures, methods, equipment, and other criteria to prevent the discharge of oil into or upon navigable waters. This SPCC Plan was updated in October 2008 as a result of the required 5-year review cycle, and updated in February 2012 to reflect changes of facility ownership. This plan version supersedes the SPCC Plan dated 30 April 2009. The next 5 year review will be conducted in 2019.

1.2 Plan Update and Amendment: This SPCC Plan will be reviewed by the owner or operator every five years as outlined in the SPCC Inspection Plan Review Page (pages ix-x). Furthermore, the SPCC Plan must be amended within six months of the five-year review or any facility changes that affect the facility's potential for a discharge as described in 40 CFR 112.1(b). The revised plan must be implemented no more than six months from the amendment. Corrective actions, which arise from regulatory deficiencies identified as a result of plan update or amendment, will be made as soon as practicable. Any technical amendments to the SPCC Plan must be reviewed and certified by a licensed Professional Engineer.

1.3 Plan Purpose: At a minimum, the SPCC Plan will address the following:

1.3.1 Spill Prevention – System components and characteristics, and operating procedures to prevent oil spills.

1.3.2 Spill Control – Control measures to prevent a spill from entering navigable waters.

1.3.3 Spill Countermeasures – Countermeasures to contain a spill and mitigate its impact on navigable water.

1.4 Plan Focus: This SPCC Plan is designed to address all bulk storage oil containers at WIA, except for any container with capacity less than 55 gallons. However, the major or high-risk oil storage and handling areas will receive special attention to expedite and simplify SPCC Plan development, implementation, and amendment. Low-risk oil containers such as drums are addressed as well, but not at the level of detail as the aboveground storage tank (AST) and fueling operations. The level of detail is intended to be commensurate with the level of risk (i.e., potential for oil release and subsequent harm/damage to navigable waterways).

1.5 Plan Organization and Regulatory References: In general, this plan follows the sequence of the regulatory requirements outlined in 40 CFR 112.7 and 112.8, and discusses the facility's conformance to the applicable regulatory requirements of that section. For sections with regulatory references, the federal SPCC regulatory requirements are summarized.

Regulatory Cross-Reference

For Details on 112.4	Refer to Section:
Written Spill Report Guidelines, 112.4	17.0.
Amendment of SPCC Plan by Regional Administrator	17.2.
Internal Spill Report	17.3.
For Details on 112.7	**Refer to Section:**
40 CFR 112.7(a)(3)	
Physical Layout of the Facility/ Facility Diagram	3.1., Annex A
Oil Storage Inventory	3.2.
Discharge Prevention Measures	5.0., 14.2.
Discharge or Drainage Controls	13.0.
Countermeasures for Discharge Recovery	16.0.
Methods of Disposal for Recovered Materials	16.4.
Contact List and Phone Numbers	2.2., 8.5., FRP
For Details on 112.7	**Refer to Section:**
Discharge Reporting Responsibilities, 40 CFR 112.7(a)(4)	16.0.
Discharge Emergency Response Procedures, 40 CFR 112.7(a)(5)	16.0.
Potential Spill Predictions, Volumes, Rates, and Control, 40 CFR 112.7(b)	4.0.
Drainage Prevention Diversionary Structures and Containment, 40 CFR 112.7(c)	5.0.
Impracticality of Secondary Containment, 40 CFR 112.7(d)	6.0.
Inspection/Record Keeping, 40 CFR 112.7(e)	7.0.
Personnel Training on Spill Prevention Procedures, 40 CFR 112.7(f)(1-3)	8.0.
Personnel Instructions, (f)(1)	8.1.
Designated Person Accountable for Spill Prevention, (f)(2)	8.3.
Spill Prevention Briefings, (f)(3)	8.7.
Site Security, 40 CFR 112.7(g)(1-5)	9.0.
Fencing and Gates, (g)(1)	9.3.
Flow and Drain Valves Secured, (g)(2)	9.4.
Starter Controls Secured, (g)(3)	9.5.
Pipeline Loading/Unloading Connections Secured, (g)(4)	9.6.
Lighting Adequate to Detect and Deter Spills, (g)(5)	9.7.
Loading/Unloading Operations, 40 CFR 112.7(h)(1-3)	10.0.
Adequate Secondary Containment for Vehicles, (h)(1)	10.6.
Warning or Barrier System for Vehicles, (h)(2)	10.7.
Vehicles Examined for Lowermost Drainage Outlets before Leaving, (h)(3)	10.8.
Brittle Fracture or Other Catastrophe of Field-Constructed Tanks, 40 CFR 112.7(i)	11.0.
Conformance with Other Applicable Requirements, 40 CFR 112.7(j)	12.0.
For Details on 112.8	**Refer to Section:**
Drainage Control, 40 CFR 112.8(b)(1-5)	13.0.
Drainage from Diked Storage Areas, (b)(1)	13.1.
Valves Used on Diked Storage Areas, (b)(2)	13.2.1.
Facility Drainage Systems from Undiked Areas, (b)(3)	13.3.
Final Discharge of Drainage, (b)(4)	13.4.
Facility Drainage Systems and Equipment, (b)(5)	13.5.
Bulk Storage Tanks/Secondary Containment, 40 CFR 112.8(c)(1-11)	14.0.

This Page Intentionally Left Blank

2.0 Facility Information

2.1 Facility Owner/Operator, Address, and Telephone:

2.1.1 Facility Name: Wake Island Airfield

2.1.2 Facility Owner: U.S. Department of Defense, US Air Force
PACAF Regional Support Center
9480 Pease Avenue
JBER, AK 99506
(907) 552-3442

2.1.3 Facility Operator: Commander
Det 1, PACAF Regional Support Center
1502 Wake Avenue
Wake Island, HI 96898
(808) 424-2468

2.1.4 Latitude (Degrees: North): 6° 23′ 27″

2.1.5 Longitude (Degrees: East): 162° 20′ 31″

2.2 Facility Contact(s):

112.7(a)(3)(vi): You must also address in your plan contact list and phone numbers for the facility response coordinator, National Response Center, cleanup contractors with whom you have an agreement for response, and all appropriate Federal, State, and local agencies who must be contacted in case of a discharge as described in 112.1(b).

2.2.1 Primary contacts for the SPCC Plan:

Title, Name	Telephone
Commander, Detachment 1, PACAF Regional Support Center	(808) 424-2468
	(808) 424-2222 – 24-Hour
	(808) 424-2415 – Home
WIA Environmental Manager	(808) 424-2234 – Home

2.2.2. Incident Commanders (ICs): The ICs' primary responsibilities are responding to a spill, notifying appropriate Base personnel and off-site emergency response agencies, and directing the spill response under the WIA incident command system. Additional responsibilities are included throughout the Facility Response Plan.

Title	Telephone
Fire Chief	(808) 424-2232
Station Captain	(808) 424-2232

2.2.3 Agencies to contact when a discharge of hazardous material & oil occurs:

Primary

JBER Command Post	(907) 552-3000
611 CES/CEI	(907) 552-7948

Secondary

611 CES, located on Joint Base Elmendorf-Richardson (JBER) will normally be responsible for contacting the following agencies:

National Response Center (NRC)	(800) 424-8802
US Coast Guard, Marine Safety Office	(808) 522-8260
Environmental Protection Agency Region IX	(415) 972-3671
PACAF A7 Environmental	(808) 448-6953
JBER Command Post	(907) 552-3000

2.3 Facility Descriptions: Wake Island Airfield (WIA) is under the command of the PACAF Regional Support Center. Presently, WIA is comprised of the PACAF Regional Support Center Detachment 1 and the Missile Defense Agency. Oil storage was originally implemented at the facility in the 1930s with the initiation of trans-Pacific air service by Pan-Am Airways. WIA consists of Wilkes Island, Wake Island, and Peale Island. To avoid confusion, 'WIA' will be used when referring to the facility as a whole, and 'Wake Island' will be used when referring to the individual islet.

2.3.1 Bulk Storage Area (1800 Area): The 1800 Area is located on Wilkes Island and is the receiving area for JP-5 fuel via ocean vessel. The area consists of two active 100,000-barrel JP-5 storage tanks (Tanks 31 and 32). From here, fuel is dispersed to the 1500 Area. Fuel is transported to/from this area via pipeline, primarily below-ground.

2.3.2 Operational Storage Area (1500 Area): The 1500 Area and all other operational areas are located on Wake Island. This area consists of two active 10,000 barrel JP-5 storage tanks (Tanks 28 and 29). JP-5 is piped to these tanks from the 1800 Area. From here, JP-5 is delivered to the airfield hydrant system via piping, and is loaded into mobile refuelers via a fill stand. This area also serves as the Low Sulfur Diesel storage and fill station. Low Sulfur Diesel is stored in 6,500 gallon intermodal shipment containers (or ISO containers); seven containers are always connected to a nearby fill station tank via hose/piping.

2.3.3 Airfield: WIA has a single 9,850 foot runway. Aircraft are re-fueled via a hydrant system from the 1500 Area tanks or via refueling trucks. No aircraft maintenance is conducted at WIA.

2.3.4 Other Areas at WIA include the following:

2.3.4.1 Housing and dining area at the west end of Wake Island.

2.3.4.2 Power Plant, at the north end of Wake Island. The principal oil-containing equipment/ oil storage is JP-5 for the power plant generators.

2.3.4.3 Shop areas including welding, maintenance, environmental, and other areas are located in buildings near the 1500 Area. There are a number of drum storage locations in these areas, including hazardous material storage and hazardous waste storage. Hazardous materials and hazardous waste are stored separately.

2.3.4.4 1400 Area where MOGAS is dispensed. MOGAS bulk storage is in a 6,500 gallon intermodal shipment container (or ISO container) in Area 1500.

2.3.5 Mobile and Portable Oil Storage Containers: There are a number of mobile and portable oil storage containers at the facility, including a bowser, one C-300 tanker truck, three R-11 tanker trucks, two R-12 tanker trucks, and 55-gallon drums. The primary function of the tanker trucks is to refuel aircraft, and to transfer fuel from the 1500 Area to smaller oil tanks and equipment throughout WIA. The primary function of the bowsers is to provide a mobile collection point for recovered fuel generated by routine Liquid Fuels Management (LFM) activities for re-introduction to the fuel system. Drums are used for storage of new, in-use, and used oil.

2.3.6 Fuel Tanks Associated with Engines and Generators: There are several emergency generators located on WIA, to supply electricity during electrical emergencies. Fire water pumps are of a similar design and similarly operate on an "as needed" basis. JP-5 fuel for these engines is stored either in nearby ASTs or in "belly tanks" located within the generator units. Ground power units (GPUs) contain fuel in a belly tank similar to a generator.

2.3.7 Oil-Containing Operating Equipment: There are various pad-mounted oil-filled transformers located on WIA.

2.3.7.1 There is very little other equipment with capacities of oil equal to or greater than 55 gallons. In all cases the capacities are not precisely known and may in fact be less than 55 gallons, but are nonetheless addressed in the SPCC Plan:

2.3.7.1.1 In-line filters and pumps for JP-5 in the 1500 Area and 1800 Area; may have greater than 55 gallons of JP-5.

2.3.7.1.2 Arresting Gears on the runway.

2.3.8 Animal Fats and Vegetable Oil (AFVO) Containers: Animal Fats and Vegetable Oil (AFVO) generated at the kitchen is piped to two in-ground concrete grease pits/grease traps located outdoors and covered by tightly fitting wood planks. The capacity of each pit is approximately 300 gallons although it is unlikely or impractical for the entire contents to be filled (the 'working' capacity is not known). To maintain satisfactory operation, the grease is scooped out monthly into small containers and transferred to the incinerator area; this is conducted by maintenance staff. The AFVO concrete grease traps at WIA meet the definition of an "oil water separator" and therefore are not subject to the SPCC regulations. Based on EPA's 2005 SPCC Guidance for Regional Inspectors (Chapter 5), grease traps are listed as an example of oil/water separators which are eligible for the exemption from SPCC requirements.

2.4 Environmental Setting

2.4.1 Location: Wake Island Airfield (WIA) is located in the Pacific Ocean 2,010 miles West of Honolulu, and 1,225 miles East of Guam. WIA is a tropical Pacific atoll, consisting of three islets totaling 1,826 acres surface area: Wilkes Island (206 acres), Wake Island (1,350 acres), and Peale Island (270 acres). It is approximately 4.5 miles long and 2.0 miles wide. The islands form a V-shape connected by a causeway, and is about 9 miles from tip to tip. WIA is 12 feet above sea level. Wake Island includes the airfield, bulk fuel storage, housing, outdoor recreation, medical facilities, community areas, maintenance ships, a marina, a fire department, a water plant, a sewage treatment area, a supply area, the Power Plant, and the Missile Defense Agency. Wilkes Island includes bulk fuel storage. There are no facilities located on Peale Island. Refer to Figure 1, Annex A for a layout of WIA.

2.4.1.1 Navigable Waters: In the event of a facility discharge of oil or other hazardous substance(s) the closest navigable water to WIA is the Pacific Ocean.

2.4.2 Highways: There are no highways in the vicinity of WIA.

2.4.3 Population: Approximately four military and 120-150 contractor personnel work on WIA. Due to the limited presence of U.S. military personnel, contractors are responsible for day-to-day spill prevention and control.

2.4.4 Utilities

2.4.4.1 Stormwater System: There are several stormwater drains in the vicinity of the kitchen and residence area, and approximately three others scattered in other parts of WIA. Stormwater collected in these drains will flow through pipes to the lagoon or ocean. In all other areas, stormwater runoff from roads and other developed areas will flow to the ocean, lagoon, or, more likely, seep into the porous sandy ground. Details on stormwater and dike drainage in are included in Section 13 of this Plan. There are no surface water impoundments at WIA. Locations of outfalls and drainage ditches are shown on Figure 1 in Annex A. There are localized areas where runoff is collected and conveyed, as follows:

2.4.4.1.1 Containment drainage from 1800 Area.

2.4.4.1.2 Containment drainage from 1500 Area.

2.4.4.2 Sanitary Sewer: WIA maintains separate storm and sanitary sewer systems. Sewage is ultimately discharged in a septic field located at the southern end of Wake Island.

2.4.4.3 Electricity: Electrical power is supplied to WIA by an onsite power plant located at the west end of Wake Island. The power plant was rebuilt in 2009 and consists of four generators fueled by JP-5 stored in one large storage tank and four day tanks.

2.4.4.4 Drinking Water Supply: Drinking water is generated on the island through a reverse osmosis unit. Brackish water is collected from a well located north of the 1300 Area. The potable water is stored in several large tanks and piped throughout the island.

2.5 Relationship to Other Plans: This Plan implements the Clean Water Act requirements of 40 CFR Part 112 to establish "procedures, methods and equipment, and other requirements for equipment to prevent the discharge of oil from non-transportation-related onshore and offshore facilities into or upon the navigable waters of the United States or adjoining shorelines." The WIA SPCC Plan closely relates to several other base plans, including:

2.5.1 WIA Facility Response Plan (FRP): The FRP implements the Oil Pollution Act requirements of 40 Code of Federal Regulations (CFR) 112.20.

2.5.2 WIA Hazardous Waste Management Plan (HWMP). The HWMP provides base personnel with essential information for effective management of hazardous waste. This plan can be used for hazardous waste release prevention and planning, but should not be used for incident response operations.

2.5.3 WIA Solid Waste Management Action Plan (SWMP). The SWMP defines the various elements of the waste stream, documents current solid waste disposal and management practices, and identifies alternative disposal methods.

2.5.4 WIA Stormwater Pollution Prevention Plan (SWPPP). The SWPPP documents stormwater management practices used on base to ensure that stormwater contamination is prevented and best management practices are implemented to prevent and/or minimize the risk of potential spills.

.

This Page Intentionally Left Blank

3.0. Petroleum Storage Information

3.1 Facility Diagram:

112.7(a)(3): Describe in your Plan the physical layout of the Facility and include a Facility diagram, which must mark the location and contents of each container. The Facility diagram must include completely buried tanks that are otherwise exempted from the requirements of this part under §112.1(d)(4). The Facility diagram must also include all transfer stations and connecting pipes.

Figure 1, Annex A shows the location and contents of all oil storage containers with capacities 55 gallons and over, and the locations of the base's main liquid fuels piping system and transfer stations.

3.2 Oil Storage: You must also address in your Plan:

112.7(a)(3)(i) The type of oil in each container and its storage capacity.

112.7(a)(3)(ii) Discharge prevention measures including procedures for routine handling of products (loading/unloading, and facility transfers, etc.)

112.7(a)(3)(iii) Discharge or drainage controls such as secondary containment around containers and other structures, equipment and procedures for the control of a discharge.

112.8(c)(8): Engineer or update each container installation in accordance with good engineering practice to avoid discharges. You must provide a liquid level sensing device.

3.2.1 Table 3-1 summarizes the oil storage containers at WIA that are subject to SPCC requirements. These containers include ASTs, emergency generators with external and/or internal tanks, engines for fire water pumps, mobile tanks, drums and pad-mounted transformers. Information provided in Table 3-1 includes: location, tank capacity, substance stored, tank type, secondary containment, and the year the tank was installed or upgraded, and specific information regarding leak detection and high level alarms where available.

3.2.2 Total *capacity* (not average volume maintained) of the various oil containers (where capacity is 55 gallons or more) is summarized below:

3.2.2.1 Field-erected ASTs – 8,836,854 gallons.

3.2.2.2 External ASTs (except belly tank generators and day tanks) – 9,790 gallons.

3.2.2.3 Internal (Belly) Tanks for Generators – 1,921 gallons.

3.2.2.4 External Day Tanks for Generators – 955 gallons.

3.2.2.5 Mobile/Portable Tanks – 32,400 gallons.

3.2.2.6 Drums – 2,750 gallons (average).

3.2.2.7 Pad-mounted Transformers – 11,000 gallons (52 transformers sized 55 gallons and over; varying in capacity from 60 to 250 gallons).

3.2.3 Bulk Storage Area (1800 Area): The Petroleum, Oils, and Lubricants (POL) Group is responsible for receiving, storing, and issuing the majority of the fuel at WIA. JP-5 fuel is received by fuel barge approximately twice a year. Fuel is pumped from the barge to the two storage tanks (capacity of approximately 4,000,000 gallons each) in the 1800 Area using transfer hose, above-ground piping, and below-grade piping. Tanks 31 and 32 are active. Barge transfer operations are detailed in the facility's Standard

Operating Procedure (SOP) for Offshore Fuel Transfer and Receipt, discussed in Section 15 of this Plan. Additional operations in the 1800 Area includes in-line filtering of JP-5, pumps, and reclaimed fuel collection and processing; these operations are similar to those described for the 1500 Area.

3.2.4 Operational Storage Area (1500 Area): JP-5 fuel is pumped from the 1800 Area to two storage tanks in the 1500 Area (capacity of approximately 400,000 gallons each) via above-ground piping and below-ground piping. Tanks 28 and 29 are active.

3.2.4.1 Transfer operations from the 1800 Area to the 1500 Area are monitored at all times by POL staff. Transfer operations require close attention and operation of equipment, including valves, pumps, filters, and the monitoring of tank liquid levels. During this process, staff in the field and in the office are in continuous radio communication. Additional operations in the 1500 Area include: dispensing of JP-5 into mobile refuelers; in-line filtering of JP-5, collection and processing of reclaimed JP-5 fuel, and the storage and dispensing Low Sulfur Diesel.

3.2.4.2 Fuel is dispensed into 1) C-300, (2) R-12, and (3) R-11, mobile refuelers using flexible hose at the JP-5 dispensing area. A pump control at the rack controls and meters the quantity of fuel dispensed. One personnel is present during dispensing operations since the fillstand is equipped with a deadman. During transfer operations (e.g., between tanks or when dispensing to the refuelers), JP-5 is filtered through in-line filters.

3.2.4.3 MOGAS is stored in the 1500 Area and dispensed in the 1400 Area. MOGAS is stored in a 25,000-Liter (6,600-gallon) intermodal shipment container (or ISO container) in this area and transferred as needed to a smaller above-ground storage tank located at the gasoline dispensing pump via flexible hose/ piping. In the past, MOGAS was brought to WIA by fuel barge and piped to the 1500 Area from the marina area via underground piping (currently out of service) and stored in a large tank in the 1500 Area. The MOGAS pipeline is blank-flanged, and proper closure of the line was completed.

3.2.4.4 Reclaimed fuel is collected and reintroduced to the system in the 1500 Area via a small tank on the filter pad. The fuel is collected from routine maintenance operations throughout the site by Liquid Fuel Maintenance (LFM), collected in a mobile bowser. In addition, oily water is collected from tank draws and stored in 55-gallon drums in the 1500 Area, prior to transfer to WIA Environmental Management.

3.2.4.5 Low Sulfur Diesel is stored in 25,000-Liter (6,600-gallon) intermodal shipment containers (or ISO containers) in this area. It is dispensed from a 2,500 gallon tank in area 1400.

3.2.5 Airfield Operations and Aircraft Refueling: Aircraft are refueled in one of two ways: via the hydrant system or an R-11 or R-12 refueler. From the 1500 Area, the fuel is issued to the hydrant system through underground pipeline or via the loading area to R-11 fuel transport trucks. Fueling is normally conducted at one of eight locations (corresponding to the hydrant locations), or less frequently at Taxiway B based on the number and type of aircraft present. A hydrant hose truck allows transfer of fuel from the hydrant day tanks to the aircraft. The hose truck meters and filters the fuel from the

hydrant to the aircraft. This system involves attaching hoses with D-1 nozzles from the hose truck to the hydrant and aircraft. The nozzle connection to the hydrant activates pumps at the 1500 Area to initiate the flow of fuel. A minimum of two and typically three personnel are present during the fueling operation and monitor the quantity of fuel entering the aircraft. After fueling is complete, the hoses are disconnected from the aircraft and hydrant, and the hose truck is driven away. Alternatively, an R-11 refueler is loaded with fuel at the 1500 Area and driven to the aircraft. Hoses are attached to the refueler and aircraft using D-1 nozzle. The refueler pumps and meters the fuel delivery.

3.2.6 Marine Operations: WIA receives all fuel by a fuel barge, and receives bulk cargo by barge. Due to the reef surrounding WIA, the fuel barge is anchored at sea and a transfer hose is extended from the dock area to the barge. Once initiated, the transfer operation is continuous and for a large shipment can extend several days. Fuel is off-loaded approximately twice a year. The cargo barge enters the marine harbor, where the barge is docked and cargo unloaded. WIA identifies maximum draft limits on the cargo barge to allow it to enter the harbor. The unloading and re-loading procedure takes approximately one week. Procedures for fuel transfers and for supply barge operations are written in two Standard Operating Procedures, discussed in Section 15 of this Plan.

3.2.7 Central Shop Area: Activities and administrative areas for WIA functions such as automobile repair, AGE servicing and storage, POL, and LFM are located in the central shop area. Various oils are stored in drums in these areas. In addition, an above ground JP-5 dispensing tank is present, for dispensing fuel to heavy equipment. There is no piping of significance in this area.

3.2.8 Electrical Power Supply and Electrical Equipment: The power plant is located at the western end of Wake Island. The power plant consists of electrical generators fueled by JP-5. The present power plant consists of four generators and four day-tanks, Tankage consists of a 25,000 gallon JP-5 AST. Oil-filled electrical equipment is located throughout WIA. The only pieces of electrical equipment having an oil-storage capacity of 55 gallons or greater are ground level transformers on concrete pads. None of the transformers at WIA have PCB-containing oil.

3.2.9 Other Areas: Fuel and oil storage/ use at other areas of the site have characteristics similar to the storage and equipment discussed above. For example, other areas of the site have above-ground tank storage and drum storage. Additional areas of WIA where oil is present include: (a) downtown area; (b) solid waste disposal area (SWDA); and (c) Missile Defense Area (MDA).

3.2.10 Emergency Electrical Generators and AGE Equipment: Approximately 15 emergency electrical generators are located throughout WIA. These consist of JP-5 powered engines with fuel stored in belly tanks and/ or an external fuel tank. AGE is responsible for all the ground power units (GPUs) that provide electricity to aircraft while in the refueling area. GPUs are similar to the emergency electrical generators, in that fuel is stored in a belly tank on the generator. AGE has approximately five units that operate using JP-5 fuel. When not in use, the GPUs are stored in the AGE building in the central shop area. The maximum tank capacity of each GPU is approximately 60 gallons.

3.2.11 Anticipated Changes in Oil Storage and Transfer: Planning and/or construction are underway for a number of improvements which will affect how oil and fuel is stored and transferred at WIA. As these facility changes are implemented, technical amendments will be made to this Plan and certified by a Professional Engineer. While there is uncertainty in the timing, it is anticipated that the following activities will occur:

3.2.11.1 Upgrade and replacement of POL equipment, including the commissioning of two hydrant service vehicles (HSV) and at three R-11 and two R-12 refuelers replaced the aircraft hose cart(s), the R-9 refuelers. The results of these actions: (a) increased hydrant operations due to improved efficiency; (b) all refuelers will be equipped with automatic shut-offs; the current visual method when filling the C-300 refueler will no longer be needed; (c) the new R-11/ R-12 refuelers will be equipped with both D-1 and open port nozzles, providing flexibility for use in both aircraft and non-airfield applications; and (d) eliminated of the R-9 refueler as a temporary tank for the power plant (see below).

3.2.11.2 Replace an old incinerator located west of the 1400 Area with an oxidation system.

Table 3-1: Facility Oil Storage Inventory											
Equipment Number	**Building Number**	**Facility**	**Tank Purpose**	**Capacity (gallons)**	**Contents**	**Date Installed**	**Tank Type**	**Piping**	**Secondary Containment**	**Spill Prevention**	**Notes**
Aboveground Storage Tanks											
1104-1	1104	Dining	Fuel for Boiler	3,000	JP-5	Unk	DW, steel, HC	Steel	Integral	Interstitial monitor	Inside building
1104-2	1104	Dining	Belly Tank for Emer. Gen.	140	JP-5	Unk	SW, steel, R	Steel	None	None	Inside building
1110	1110	Fire Pump	Belly Tank for Fire Pump	74	JP-5	Unk	SW, steel, R	Steel	None	None	Inside building
	1190	Power Plant	Day Tank	500	JP-5	Unk	SW, steel, R	Steel	None	None	Inside building
	1190	Power Plant	Day Tank	500	JP-5	Unk	SW, steel, R	Steel	None	None	Inside building
	1190	Power Plant	Day Tank	500	JP-5	Unk	SW, steel, R	Steel	None	None	Inside building
	1190	Power Plant	Day Tank	500	JP-5	Unk	SW, steel, R	Steel	None	None	Inside building
1401	1401	Central Shop	Fuel for Emer. Gen.	180	JP-5	Unk	SW, steel, R	Steel	None	None	
1406	1406	Central Shop	Refueling	2,500	MOGAS	Unk	DW, steel, HC	Steel	Integral	Sight gauge, interstitial monitor	
1503-1	1503	Airfield	Fuel for Emer. Gen. for runway	500	JP-5	Unk	SW, steel, R	Steel	None	Clock gauge	Inside building
1506	1506	Central Shop	Fuel for Emer. Gen.	62	JP-5	Unk	SW, steel, R	Steel	None	None	Inside building
1602	1602	MDA	Fuel for Emer. Gen. for runway	1,000	JP-5	Unk	DW, steel, R	Steel	Integral	Sight gauge, interstitial monitor	
1608	1608	MDA	Fuel for Emer. Gen.	210	JP-5	Unk	SW, steel, R	Steel	None	Sight gauge	Inside building
1610	1610	MDA	Fuel for Emer. Gen.	55	JP-5	Unk	SW, steel, R	Steel	None	Sight gauge	Spare tank, empty
1649	1649	MDA	Fuel for Emer. Gen.	510	JP-5	Unk	SW, steel, R	Steel	None	Sight gauge	Inside building
1651	1651	MDA	Fuel for Emer. Gen.	510	JP-5	Unk	SW, steel, R	Steel	None	Sight gauge	Inside building
1703-1	1703	VORTAC	Fuel for Emer. Gen.	245	JP-5	Unk	SW, steel, R	Steel	None	Sight gauge	Inside building
1703-2	1703	VORTAC	Day Tank for Emer. Gen	80	JP-5	Unk	SW, steel, R	Steel	Concrete dike	Sight gauge	Inside building
1703-3	1703	VORTAC	Fuel storage	550	JP-5	Unk	DW, steel, HC	Steel	Integral	Sight gauge, interstitial monitor	
1706-1	1706	Marina	Emer. Response	600	Empty/Used JP-5	Unk	SW, steel, R	Steel	None	None	Skid-mounted, SW tank; maintained empty; used for fuel recovery during emergency response
1706-2	1706	Marina	Emer. Response	600	Empty/Used JP-5	Unk	SW, steel, R	Steel	None	None	Skid-mounted, SW tank; maintained empty; used for fuel recovery during emergency response
1812	1812	Bulk Storage	Product Recovery	650	JP-5	Unk	SW, steel, HC	Steel	Concrete dike	Clock gauge	
3860	1190	Power Plant	Storage	25,000	JP-5	1999	DW, steel, HC	Steel	Integral	None	

Table 3-1: Facility Oil Storage Inventory

Equipment Number	Building Number	Facility	Tank Purpose	Capacity (gallons)	Contents	Date Installed	Tank Type	Piping	Secondary Containment	Spill Prevention	Notes
41128	1504	Operational Storage	Storage	400,000	JP-5	1967	SW, steel, VC	Steel	Concrete dike	High-Level Alarm	
41129	1504	Operational Storage	Storage	400,000	JP-5	1967	SW, steel, VC	Steel	Concrete dike	High-Level Alarm	
41131	1800 Area	Bulk Storage	Bulk storage	3,997,000	JP-5	1984	SW, steel, VC	Steel	Concrete dike	High-Level Alarm	Automatic Tank Gauging is out-of-service
41132	1800 Area	Bulk Storage	Bulk storage	4,039,854	JP-5	1984	SW, steel, VC	Steel	Concrete dike	High-Level Alarm	Automatic Tank Gauging is out-of-service
SDWA1	SWDA	SWDA	Fuel for incinerator	550	JP-5	1992	SW, steel, R	Steel	None	None	Solid waste disposal area; incinerator being replaced with oxidation system; may remove tank in future
	1500 Area	Operational Storage	Product Recovery	200	Reclaimed JP-5	Unk	SW, steel, R	Steel	Concrete dike	Clock gauge	
	1500 Area	Operational Storage	Fuel for Emer. Gen.	800	JP-5	Unk	SW, steel, R	Steel	None	Sight gauge	Inside building
	1500 Area	Operational Storage	MOGAS	6,600	MOGAS	Unk	SW, steel, R	N/A	Concrete dike	None	
	1500 Area	Operational Storage	Low Sulfur Diesel	6,600	Low Sulfur Diesel	Unk	SW, steel, R	N/A	Concrete dike	None	
	1500 Area	Operational Storage	Low Sulfur Diesel	6,600	Low Sulfur Diesel	Unk	SW, steel, R	N/A	Concrete dike	None	
	1500 Area	Operational Storage	Low Sulfur Diesel	6,600	Low Sulfur Diesel	Unk	SW, steel, R	N/A	Concrete dike	None	
	1500 Area	Operational Storage	Low Sulfur Diesel	6,600	Low Sulfur Diesel	Unk	SW, steel, R	N/A	Concrete dike	None	
	1500 Area	Operational Storage	Low Sulfur Diesel	6,600	Low Sulfur Diesel	Unk	SW, steel, R	N/A	Concrete dike	None	
	1500 Area	Operational Storage	Low Sulfur Diesel	6,600	Low Sulfur Diesel	Unk	SW, steel, R	N/A	Concrete dike	None	
	1500 Area	Operational Storage	Fire pump	165	JP-5	Unk	SW, steel, R	Steel	None	Float gauge	
	1500 Area	Operational Storage	Inactive Tanks in Storage	(7) 6,600	N/A	Unk	SW, steel, R	N/A	None	None	Unused tanks stored at previous site of AST 41130
Loading/Unloading Racks											
	1500 Area	Operational Storage	Truck Loading Rack	N/A	JP-5	Unk	N/A	N/A	Steel Tray	N/A	
		Marina	Fuel/ Barge unloading area	N/A	JP-5	Unk	N/A	N/A	None	N/A	
Mobile Refuelers											

Table 3-1: Facility Oil Storage Inventory											
Equipment Number	**Building Number**	**Facility**	**Tank Purpose**	**Capacity (gallons)**	**Contents**	**Date Installed**	**Tank Type**	**Piping**	**Secondary Containment**	**Spill Prevention**	**Notes**
		Central Shop	R-11	6,000	JP-5	N/A	N/A	N/A	N/A	N/A	
		Central Shop	R-11	6,000	JP-5	N/A	N/A	N/A	N/A	N/A	
		Central Shop	R-11	6,000	JP-5	N/A	N/A	N/A	N/A	N/A	
		Central Shop	R-12	6,000	JP-5	N/A	N/A	N/A	N/A	N/A	
		Central Shop	R-12	6,000	JP-5	N/A	N/A	N/A	N/A	N/A	
		Central Shop	C-300	1,200	JP-5	N/A	N/A	N/A	N/A	N/A	
Drums and Bowsers											
	1190	Power Plant	Drum	55	Lube oil	N/A	N/A	N/A	Concrete dike	N/A	
	1190	Power Plant	Drum	55	Lube oil	N/A	N/A	N/A	Concrete dike	N/A	
	1190	Power Plant	Drum	55	Lube oil	N/A	N/A	N/A	Concrete dike	N/A	
	400	Central Shop	Drum	55	Reclaimed fuel	N/A	N/A	N/A	Spill pallets	N/A	
	1509	Central Shop	Drum	55	New oil	N/A	N/A	N/A	Spill pallets	N/A	
	MAP	Central Shop	Drum	55	Used oil	N/A	N/A	N/A	Spill pallets	N/A	
	1519	Central Shop	Drum	55	Used oil	N/A	N/A	N/A	Spill pallets	N/A	
	1403	Central Shop	Drum	55	New oil	N/A	N/A	N/A	Spill pallets	N/A	
	1407	Central Shop	Drum	55	New oil	N/A	N/A	N/A	Spill pallets	N/A	
	1411	Central Shop	Drum	55	New oil	N/A	N/A	N/A	Spill pallets	N/A	
	1511	Central Shop	Drum	55	Used oil	N/A	N/A	N/A	Spill pallets	N/A	
	1513	Central Shop	Drum	55	Used oil	N/A	N/A	N/A	Spill pallets	N/A	
	1500 Area	Operational Storage	Drum	55	Water/JP-5	N/A	N/A	N/A	Spill pallets	N/A	
	1500 Area	Operational Storage	Drum	55	Water/JP-5	N/A	N/A	N/A	Spill pallets	N/A	
	1800 Area	Bulk Storage	Drum	55	Water/JP-5	N/A	N/A	N/A	Spill pallets	N/A	
	1800 Area	Bulk Storage	Drum	55	Water/JP-5	N/A	N/A	N/A	Spill pallets	N/A	
	1800 Area	Bulk Storage	Drum	55	Water/JP-5	N/A	N/A	N/A	Spill pallets	N/A	
	1800 Area	Bulk Storage	Bowser	400	Water/JP-5	N/A	N/A	N/A	None	Sight gauge	
	SWDA	SWDA	Drum	55	Water/JP-5	N/A	N/A	N/A	Steel dike	N/A	
	1706	Marina	Drum	55	New oil	N/A	N/A	N/A	Spill pallets	N/A	
	1500 Area	Operational Storage	Bowser	(2) 400	JP-5	N/A	N/A	N/A	None	Sight gauge	
	1519	Central Shop	GPU	60	JP-5	N/A	N/A	N/A	None	N/A	
Oil-Filled Operating Equipment (Other than transformers)**											
	1800 Area	Pumps	Fuel in pumps	55	JP-5	Unk	N/A	N/A	N/A	N/A	
	1800 Area	Pumps	Fuel in pumps	55	JP-5	Unk	N/A	N/A	N/A	N/A	
	Airfield	Arresting Gears	Gear oil	55	JP-5	Unk	N/A	N/A	N/A	N/A	
	Airfield	Arresting Gears	Gear oil	55	JP-5	Unk	N/A	N/A	N/A	N/A	

Table 3-1: Facility Oil Storage Inventory											
Equipment Number	**Building Number**	**Facility**	**Tank Purpose**	**Capacity (gallons)**	**Contents**	**Date Installed**	**Tank Type**	**Piping**	**Secondary Containment**	**Spill Prevention**	**Notes**
TOTAL				**9,002,995**							

*Refer to attachment for explanation of Deficiency and Observation codes

** Transformers are presented on a separate spreadsheet

Notes:
GPU - Ground Power Unit
MDA - Missile Defense Area
VORTAC - VHF Omni-directional Radio Range Tactical Air Navigation
SWDA - Solid Waste Disposal Area
Unk - Unknown
N/A - Not applicable

SW - Single-walled
VC - Vertical cylindrical
DW - Double-walled
HC - Horizontal cylindrical
R - Rectangular

4.0. Potential Spill Predictions, Volumes, Rates, and Control

112.7(b): Where experience indicates a reasonable potential for equipment failure (such as loading or unloading equipment, tank overflow, rupture, or leakage, or any other equipment known to be a source of a discharge), include in your Plan a prediction of the direction, rate of flow, and total quantity of oil which could be discharged from the facility as a result of each type of major equipment failure.

4.1 Table 3-1 lists the oil storage structure and the maximum volume that could be released if a failure occurred. The worst-case spill rate is assumed to be an instantaneous release of the entire structure (i.e., rupture for bulk ASTs and rapid leakage for transformers and drums). For secondary containments that are open to precipitation, field measurements were obtained, and containment volumes and freeboard depths were calculated. For each double-walled tank, the containment is greater than its container capacity and the freeboard determination is not applicable (N/A). In the vast majority of cases, a spill will either be contained in a permanent secondary containment structure (e.g., concrete dike, double-wall tank, drum containment pallet) or discharge onto surrounding ground surface where it would most likely adsorb in the soil with a potential (but unlikely) flow path to the ocean or lagoon. In the remaining cases, a spill can potentially enter storm drains (which are in the vicinity of the downtown area and the airfield area); in these cases the stormwater outfall discharges onto rocky areas near, but not directly into, the ocean or lagoon. In cases where permanent secondary containment is not present, there is potential for oil or fuel to enter a waterway; the distance from the source (or outfall) to water, and the porous ground surface, will mitigate direct impact of a spill to water. The topography of WIA is flat except in regions very close to the lagoon and ocean, where there is a sharp downward slope followed by gentle sloping to the water. Facility layout and drainage are shown on figures in Annex A. While Table 3-1 includes all equipment, the principal oil storage areas are discussed in detail below.

4.1.1 Bulk Storage Area (1800 Area): The most significant potential for a spill or discharge is from the bulk JP-5 storage tanks and from transfer operations. Spill prevention and protection measures, and spill predictions, volumes, and rates, from the two active 4,000,000 gallon fuel storage tanks (Tanks 31 and 32) include the following:

4.1.1.1 The potential for a discharge due to an overfill is minimized due to manual gauging of tanks prior to transfer, visual monitoring of tank sight gauges during transfer, and high-level alarms on each tank.

4.1.1.2 A concrete secondary containment dike is sufficient to hold the entire contents of each tank, plus sufficient freeboard for precipitation.

4.1.1.3 During transfer operations where fuel is transferred into the 1800 Area (i.e., from the fuel barge), an operator is present at all times to monitor the tank gauges, monitor fuel filters, and/or control the pipeline valves.

4.1.1.4 Spill prevention and protection measures and spill predictions, volumes, and rates, from the filters and pumphouse near Building 1812, as well as piping leading to/ from/ within the 1800 Area, include the following:

4.1.1.4.1 During transfer operations, an operator is present at all times to monitor the line pressure, tank gauges, monitor fuel filters, and/or control the pipeline valves.

4.1.1.4.2 When transfer operations are not underway, the pipeline is depressurized and low spots are periodically drained to reduce the quantity of fuel in the line. Valves which allow flow in or out of the tanks are kept locked.

4.1.1.4.3 A concrete secondary containment dike is available in the immediate vicinity of the fuel filters and 650 gallon JP-5 fuel product recovery tank near Building 1812, providing 2400 gallons of containment (no allowance for precipitation is needed because it is under roof). Pumps in Building 1812 are in a structure which provides minimal containment. These containment systems provide protection against small leaks in the equipment, but could not contain a catastrophic release of 36,000 gallons, assuming a maximum transfer rate of 2400 gallons per minute and a 15 minute response time. This secondary containment is sufficient to hold the contents of the 650 gallon JP-5 fuel product recovery tank.

4.1.1.4.4 Some piping is within the permanent secondary containment of the concrete dikes surrounding the tanks and the filters. For other areas, there is no permanent secondary containment. A spill or overflow would pool and percolate through the soil with potential runoff to the lagoon.

4.1.1.5 Other relevant spill predictions, volumes, rates, and control measures in this area include the following:

4.1.1.5.1 Several drums of fuel/water mixture are in covered containment drums which provide 100% secondary containment.

4.1.1.5.2 There is no secondary containment for the old fire pumps in Buildings 1800/1801 and the two 350 gallon JP-5 fuel tanks outside these buildings. The tanks are empty and the pumps do not work. A spill or overflow would pool and percolate through the soil with potential runoff to the lagoon. A leak rate equal to the contents of one tank (350 gallons) over one hour is assumed.

4.1.1.6 Operational Storage Area (1500 Area): The most significant potential for a spill or discharge is from the bulk JP-5, low sulfur diesel, and MOGAS storage tanks, and from transfer operations. Spill prevention and protection measures, and spill predictions, volumes, and rates, from the two large 400,000 fuel storage tanks (Tanks 28 and 29) include the following:

4.1.1.6.1 The potential for a discharge due to an overfill is minimized due to manual gauging of tanks prior to transfer, visual monitoring of tank sight gauges during transfer, and high-level alarms on each tank.

4.1.1.6.2 A concrete secondary containment dike is sufficient to hold the entire contents of each tank, plus sufficient freeboard for precipitation.

4.1.1.6.3 During transfer operations from the 1800 to the 1500 Areas, an operator is present at all times to monitor the tank gauges, monitor fuel filters, and/or control the pipeline valves.

4.1.1.6.4 Spill prevention and protection measures and spill predictions, volumes, and rates for the Low Sulfur Diesel and MOGAS storage and transfer operations include the following:

4.1.1.6.4.1 The 6,600-gallon ISO tanks are single-walled and located in a lined containment area. The containment drain valve is closed and locked to prevent discharge into the lagoon. This area also holds the ISO tanks. A leak rate equal to the contents of one tank (6,600 gallons) over one hour is assumed.

4.1.1.6.4.2 During transfer operations (including the transfer of Low Sulfur Diesel between tanks or the dispensing of Low Sulfur Diesel into vehicles), at least two personnel are present. Visual monitoring of the tank level is conducted when transferring fuel between tanks.

4.1.1.6.4.3 When transfer operations are not underway, the hose connecting the ISO tank to the dispensing tank is depressurized and the valve leading out of the ISO tank is kept closed.

4.1.1.6.4.4 MOGAS and Low Sulfur Diesel dispensing is only available several hours each week, staffed by an operator, with the nozzle kept locked at all other times. A spill in this vicinity would be onto a concrete pad and could overflow to the surrounding gravel. An emergency shutoff is in the vicinity. A spill would be immediately noticed and boom/ absorbents deployed for cleanup.

4.1.1.6.4.5 The 2,500 gallon MOGAS dispensing tank is double-walled.

4.1.1.6.5 Spill prevention and protection measures and spill predictions, volumes, and rates for the JP-5 refueler loading area include the following:

4.1.1.6.5.1 Releases could result from an accident involving a tank truck, where a puncture of a tank truck could release up to 1,200 gallons from a C-300 truck, 6,000 gallons from an R-11 or approximately 6000 gallons from a R-12 truck (a leak rate over one hour is assumed).

4.1.1.6.5.2 A spill could occur during the issuing of JP-5 if a tank truck hose is accidentally disconnected. Should operating practices and system control devices fail, the spill volume for JP-5 at the fill stand could potentially be 600 gallons (based upon a 600 gpm pumping rate and approximately 1 minute response time). During refueling, trucks are parked on a concrete pad. A spill in this vicinity would be onto a concrete pad. There is a possibility of lateral flow off the pad to surrounding gravel and a small potential for runoff to the lagoon.

4.1.1.6.5.3 Emergency shutdown switches for the pumps and numerous valves to isolate fuel flow are located in the immediate vicinity; therefore, the spill would be rapidly isolated.

4.1.1.6.5.4 During transfer operations, at least two personnel are present.

4.1.1.6.5.5 The R-11 and R-12 refuelers are equipped with an automatic shutoff. Filling of the C-300 refueler is monitored visually.

4.1.1.6.5.6 Filling is conducted from the bottom of the refueler storage compartment using D-1 hose connectors. Spill pans are used for collecting small drips from connecting or disconnecting the hose.

4.1.1.6.6 Spill prevention and protection measures and spill predictions, volumes, and rates, from the pumps and filters, as well as transfer piping, include the following:

4.1.1.6.6.1 Transfer operations from the 1800 Area to the 1500 Area are monitored at all times by POL staff. Transfer operations require close attention and operation of equipment, including valves, pumps, and filters, and the monitoring of tank liquid levels. During this process, staff personnel in the field and in the office are in continuous radio communication.

4.1.1.6.6.2 When transfer operations are not underway, the pipeline is depressurized to reduce the potential for a leak and reduce the wear and tear on equipment. Valves which allow flow in/ out of the tanks are kept locked.

4.1.1.6.6.3 A concrete secondary containment dike is available in the immediate vicinity of an area of three fuel filters and one 200 gallon JP-5 fuel product recovery tank, providing 4,700 gallons of containment. The containment system provides protection against small leaks in the equipment, but could not contain a catastrophic failure of 27,000 gallons, assuming a maximum transfer rate of 1,800 gallons per minute and a 15 minute response/ correction time. This secondary containment is sufficient to hold the contents of the 200 gallon JP-5 fuel product recovery tank.

4.1.1.6.6.4 Some piping is within the permanent secondary containment of the concrete dikes surrounding the tanks and the filters. For other areas, there is no permanent secondary containment. A spill or overflow would pool and percolate through the soil with potential runoff to the lagoon.

4.1.1.6.7 Other relevant spill predictions, volumes, rates, and control measures in this area include the following:

4.1.1.6.7.1 Several drums of fuel/water mixture are in covered containment drums which provide 100% secondary containment.

4.1.1.6.7.2 There are several old, empty, disconnected tanks (with capacities up to 500 gallons) in this area which lack permanent secondary containment. If used, a potential spill or leak would overflow onto the surrounding gravel area.

4.1.1.6.7.3 The usual parking area for the LFM bowser (a 400 gallon mobile tank) does not have secondary containment. A potential spill or leak would overflow onto the surrounding gravel area (at an estimated rate of 400 gallons per hour).

4.1.1.6.7.4 In the 1500 Area, a building provides sufficient secondary containment for a fuel storage tank for a fire pump. The capacity of the tank is 165 gallons and the building provides 175 gallons of secondary

containment (no allowance for precipitation is needed because it is under roof).

4.1.1.7 Airfield Operations and Aircraft Refueling: The most significant potential for a spill or discharge is from aircraft refueling operations, either through the hydrant system or the mobile R-11 refuelers. Spill prevention and protection measures and spill predictions, volumes, and rates for the transfer operations include the following:

4.1.1.7.1 A minimum of two and typically three personnel are present at all times during the refueling operation.

4.1.1.7.2 The hydrant system is pressurized only on an 'as needed' basis. The hydrants/refueling areas used are rotated periodically. When fueling is complete, the pipeline is depressurized to reduce the potential for a leak and reduce the wear and tear on equipment.

4.1.1.7.3 There is no diversionary containment in the vicinity of the airfield. Spills would spread laterally on the taxiway/refueling area, or overflow to the parking areas or grassy areas surrounding the airfield. The closest storm drain is at the southern end of the terminal (the location of the outfall leading from this drain is not known).

4.1.1.7.4 The maximum spill volume is estimated as 1,800 gallons, assuming a maximum transfer rate of 1,800 gallons per minute and a one minute response time. A release could also result from an accident of an R-11 refueling truck (6,000 gallons); a release from a hose leak from R-11 refueling would be less than that from the hydrant system due to a lower transfer rate.

4.1.1.7.5 Other relevant spill predictions, volumes, rates, and control measures in this area include the following:

4.1.1.7.5.1 A 550 gallon JP-5 tank at the VORTAC area is double-walled.

4.1.1.8 Marine Operations: The most significant potential for a spill or discharge is from transfer operations from the fuel barge, and transfer of MOGAS and Low Sulfur Diesel ISO containers (or 55-gallon oil drums) from the supply barge. These operations are at or near the marine channel so the potential for a spill is directly into the marine channel leading to the ocean. Spill prevention and protection measures and spill predictions, volumes, and rates for the transfer operations include the following:

4.1.1.8.1 Procedures for both the fuel barge transfers and for supply barge operations are written in two Standard Operating Procedures.

4.1.1.8.2 During fuel barge transfers, boom is deployed to surround the barge. Other protection and prevention measures during fuel barge transfers are discussed above with regard to the 1800 Area.

4.1.1.8.3 A worst case discharge spill volume from a catastrophic failure from fuel transfer is assumed to be 26,964 gallons, based on a maximum transfer rate of 1,700 gallons per minute and a 15 minute response time. The spill has the potential to directly enter the harbor channel.

4.1.1.8.4 Protective measures during cargo barge unloading include: (a) daily safety briefings; (b) off-loading occurs during daylight hours only; (c) many working and emergency personnel are in the dock vicinity.

4.1.1.8.5 During the offloading of MOGAS and Low Sulfur Diesel ISO containers, there is a potential for a catastrophic failure of a container; a maximum spill volume of 6,600 gallons is assumed. The spill has the potential to be directly into the harbor channel.

4.1.1.9 Central Shop Area: The most significant potential for a spill or discharge is from the numerous fuel and oil storage locations throughout this area. Spill prevention and protection measures and spill predictions, volumes, and rates for the JP-5 dispensing operations and other area operations include the following:

4.1.1.9.1 The 2,500 gallon JP-5 dispensing tank is double-walled.

4.1.1.9.2 When not in use, the JP-5 dispensing tank is kept locked.

4.1.1.9.3 Visual monitoring of the tank level is conducted when transferring fuel to the tank from a POL refueler. A spill in this vicinity during transfer or dispensing operations would be onto a concrete pad and could overflow to the surrounding gravel. An emergency shutoff is in the vicinity. A spill would be immediately noticed and boom/ absorbents deployed for cleanup.

4.1.1.9.4 The POL refuelers are parked outdoors on containment pads, and typically contain fuel. A leak or failure would spread laterally on the concrete and overflow to gravel areas. The maximum spill volume is estimated as 6,000 gallons, based on the capacity of the R-11 or R-12.

4.1.1.9.5 All drums in the shop areas, whether indoors or outdoors, are stored on containment pallets which hold 100% of the contents.

4.1.1.10 Electrical Power Supply and Electrical Equipment: The most significant potential for a spill or discharge is from the power plant area. Additional potential for spills exist from the numerous transformers throughout WIA, often located at infrequently visited locations.

4.1.1.10.1 Tank overfills could occur at the power plant ASTs since the tanks do not have over-fill protection alarms or automatic high level shut-off devices. The 25,000 gallon JP-5 tank is double-walled. Ruptures could result in releases from the remaining tanks because they are single-wall tanks. Releases from a spill, leak, or overflow would pool in the surrounding gravel area. The largest tank is the empty 6,000 gallon lube oil tank; a leak rate of 6,000 gallons per hour is assumed.

4.1.1.10.2 Outdoor drum storage is also present. Containment is provided for all three of the areas so that 100% of the contents of one drum would be contained in each area.

4.1.1.10.3 In the case of transformers located throughout WIA, equipment failure could be caused by normal mechanical wear or from weather-related conditions. The potential discharge quantity for each piece of electrical equipment is noted

under the quantity stored in Table 3-1. It should also be noted that in the event of damage to an active transformer (i.e., not spares or those in storage) a loss of power would occur. This would necessitate the need for immediate inspection and corrective action would be taken to mitigate a release. In the vast majority of cases, transformers are outdoors and oil released would be immediately absorbed into the surrounding soils. In a few cases, the transformers are indoors or under cover which would provide limited protection from oil reaching the surrounding soil.

4.1.1.11 Emergency Electrical Generators and AGE Equipment: Emergency electrical generators are located throughout WIA. Equipment failure could be caused by a tank or line rupture or leak. The potential discharge quantity for each emergency generator is noted under the quantity stored in Table 3-1. All emergency generators are under some type of cover to keep rainfall off of the generator; this protection ranges from the generator cover to a small building. The cover or building will sometimes provide containment in the form of a raised side which could hold any spills or leaks. Depending on the unit design, size of the fuel tank, and capacity of the containment, a discharge would be contained in the structure or would spread laterally in the surrounding soil. When not in use, GPUs are stored indoors. The equipment is stored sufficiently far from the doors, and the capacity of the GPU fuel tanks is sufficiently low, that a spill or leak would remain in the building.

4.1.1.12 Other Areas: In other areas of the site, the use and storage of fuel is similar to that described above and includes fuel storage in above-ground tanks, transfer from a C-300 refueler into the tank, and drum storage. Other areas of WIA where fuel or oil is present in this regard include: (a) downtown area; (b) solid waste disposal area (SWDA); and (c) Missile Defense Area (MDA). Spill prevention and protection measures and spill predictions, volumes, and rates for these areas are identified in Table 3-1.

This Page Intentionally Left Blank

5.0 Drainage Prevention Diversionary Structures and Containment

112.7(c): Provide appropriate containment and/or diversionary structures or equipment to prevent a discharge as described in §112.1(b). The entire containment system, including walls and floor, must be capable of containing oil and must be constructed so that any discharge from a primary containment system, such as a tank or pipe, will not escape the containment system before cleanup occurs. At a minimum, you must use one of the following prevention systems or its equivalent:

(1) For onshore facilities:

(i) Dikes, dikes, or retaining walls sufficiently impervious to contain oil;

(ii) Curbing;

(iii) Culverting, gutters, or other drainage systems;

(iv) Weirs, booms, or other barriers;

(v) Spill diversion ponds;

(vi) Retention ponds; or

(vii) Sorbent materials.

(2) For offshore facilities:

(i) Curbing or drip pans; or

(ii) Sumps and collection systems.

5.1 Table 3-1 lists the containment/diversion structures for each tank, equipment, and oil storage area at the facility. Primary containment is the vessel, such as a tank, housing the oil. For each primary containment, a secondary containment system and/or diversionary structure is necessary. The secondary containment system and/or diversionary structures in place at WIA include: (a) double-walled tanks with intrinsic secondary containment; (b) dikes, or curbing sufficiently impervious to contain oil; (c) temporary boom or similar barriers; and (d) sorbent systems so that a discharge from the primary containment will not escape the containment system before cleanup occurs. Not all primary containment at WIA has a passive secondary containment system and/or passive diversionary structure. Single-walled storage containers that are located inside rooms (e.g., generator tanks) should be surrounded by an impervious barrier large enough to sufficiently contain the entire contents of the tank. If the room acts as secondary containment, the walls and floor should be constructed of impervious materials and have a large enough lip built into doorways and walkways to prevent the spread of spilled product. In some cases, active diversionary containment (such as booms and sorbent systems) are deployed prior to fuel transfer operations or are readily available in the event of a spill.

5.2 In general, secondary containment systems and/or diversionary structures at WIA are designed and implemented according to the quantity of oil present and potential risk. For example, most above ground storage tanks have secondary containment systems consisting of double-walled tanks or a concrete diked area, whereas smaller emergency generator tanks are less likely to be equipped with these measures. As noted in Sections 2.4 and 4.0, the potential for a spill from virtually anywhere at WIA to reach water is mitigated by the following factors: (1) mostly flat, undeveloped, porous soil/coral covering the site; (2) long distances (typically greater than 100 feet) between the primary containment and the surface water; and (3) very few storm drains, which could serve as a conduit between the spill

location and the surface water. These factors should be taken into account when developing priorities for implementing or improving secondary containment systems and/or diversionary structures.

5.3 Due to the small size of WIA, all equipment, transfer operations, fuel loading/unloading areas, and oil storage structures are located within acceptable range of the spill response equipment/personnel should a release occur. WIA spill response training, procedures, equipment and notification procedures are detailed further in the Facility Response Plan, and discussed briefly below in Sections 8, 16, and 17; fuel loading/unloading operations are detailed in Section 10.

5.4 To determine if a given containment structure such as a dike provides adequate volume for the largest single tank plus sufficient freeboard for precipitation, the secondary containment volume was calculated as a percentage of the primary containment volume, with the minimum criteria as 110% (i.e., secondary containment is to be equal to or greater than 110% of the primary containment) if the structure allows rainwater to enter. If precipitation cannot enter the secondary containment (e.g., indoors, covered, double-wall tank), then the secondary containment volume only must be greater than the primary containment volume. Precipitation data from historical storm events are not readily available for WIA and therefore an alternative criteria such as the precipitation volume from a 25-year/24-hour storm event is not used. Discharge control materials are available onsite at multiple locations as described in WIA's Facility Response Plan; locations of significant materials include the marina and airfield.

5.4.1 Bulk Storage Area (1800 Area): Concrete secondary containment structures surround Tanks 31 and 32. The volume of the secondary containment structure is at least 110% of the primary containment volume. No secondary containment is present for Tank 27 (empty) and the two empty tanks outside of Buildings 1800 and 1801 (old fire pump buildings). Recommended corrections of deficiencies for these three tanks are listed in Annex D. All other oil storage meeting the definition of a 'bulk storage container' has sufficient secondary containment to hold 100% of the primary containment (and is designed to exclude precipitation). Spills or leaks may occur from piping, filters, and pumps. A small covered dike area provides containment for small spills, but would not provide containment for a catastrophic failure or pipeline failure outside of diked areas. In these cases, contingency actions contained in the WIA FRP would be implemented. Spill response material is located at the marina which is the closest location to the 1800 Area.

5.4.2 Operational Storage Area (1500 Area): Concrete secondary containment structures surround Tanks 28 and 29. The volume of the secondary containment structure is at least 110% of the primary containment volume. Containment structures for the smaller JP-5 product recovery tank, the Low Sulfur Diesel and MOGAS dispensing tanks, and 55-gallon drums of JP-5 and water mixture, must have the capacity to hold the primary tank volumes plus precipitation. Spill response material at or closest to 1500 Area includes material located at the JP-5 loading/unloading rack, the Environmental shop area, and the north airfield Connex. Spills or leaks may occur from piping, filters, and pumps. A small covered dike area provides containment for small spills, but would not provide containment for a catastrophic failure or for failures in the pipeline outside of

these diked areas. In these cases, contingency actions contained in the WIA FRP would be implemented. Permanent secondary containment is either not present or not sufficiently impervious for the following tanks or containers:

5.4.2.1 Parking area for bowser

5.4.2.2 Section 10 of this Plan discusses the JP-5 loading/unloading rack and the MOGAS dispensing area.

5.4.3 Airfield Operations and Aircraft Refueling: There is no permanent or passive diversionary containment for the fueling area of the airfield nor is it required by regulation. Spill response material is located at the Terminal. The spill response equipment serves as providing containment for small spills, but would not provide containment for a catastrophic failure. In these cases, contingency actions contained in the WIA FRP would be implemented. Section 10 of this Plan discusses fuel transfer operations for aircraft.

5.4.4 Marine Operations: During fuel transfer operations from the fuel barge, boom is deployed prior to transfer to provide diversionary containment and allow containment of a spill prior to cleanup. A spill response trailer, provided by WIA Environmental Management, is parked at the valve area for use in the event of a spill. In the event of a spill, additional contingency actions contained in the WIA FRP would likely be implemented.

5.4.5 Central Shop Areas: As indicated in Table 3-1, permanent secondary containment is present for the parking area used for the POL refuelers. For all other drum storage areas and oil storage containers in the central shop areas, permanent secondary containment is adequate and includes either containment pallets (for drums) or double-wall tank (for the JP-5 dispensing tank).

5.4.6 Electrical Power Supply and Electrical Equipment: Of the tanks and containers at the Power Plant, the following are equipped with adequate secondary containment:

5.4.6.1 25,000 gallon double-wall tank for JP-5 storage

5.4.6.2 Two drum storage areas

5.4.7 Permanent secondary containment is either not present or not sufficiently impervious for the following tanks or containers at the Power Plant:

5.4.7.1 One drum storage area near 25,000 gallon JP-5 tank

5.4.7.4 There are no localized containment or diversionary structures for electrical transformers except at a few locations where transformers are located indoors or otherwise under cover. In the case of a spill or leak from a transformer, contingency actions contained in the WIA FRP would be implemented. Providing secondary containment for all transformers is impractical as discussed in Section 6.

5.4.8 Emergency Electrical Generators and AGE Equipment: As noted in Table 3-1, certain emergency generators are not equipped with permanent secondary containment. Sufficient containment is present for the fuel tanks on the GPUs. When not in use, the GPUs are parked indoors, sufficiently away from the doors so that a spill would not leave the building.

5.4.9 Other Areas: Refer to Table 3-1 for diversionary structures and containment in other areas, such as downtown and MDA. The types of containment or deficiencies are similar to that already discussed above for similar primary containment structures.

5.5 Consideration of Industry Standards: Except for areas noted in Section 10.1 (Adequate Secondary Containment for Vehicles) and 13.3 (Facility Drainage Systems from Undiked Areas), all areas in which oil is stored are equipped with appropriate containment and/or diversionary structures to prevent discharged oil from reaching a navigable watercourse and are in conformance with industry standards. As a reference, the industry standards from NFPA 30 for "Impounding Around Tanks by Diking" and "Secondary Containment Tanks" (National Fire Prevention Association [NFPA] 30 - *Flammable and Combustible Liquids Code*, 2000) are outlined below. Any future secondary containment structures at WIA should conform to these or higher standards.

5.5.1 Impounding Around Tanks by Diking (NFPA 30 Section 22.11.2)

5.5.1.1 A slope of not less than 1 percent away from the tank shall be provided for at least 50 feet or to the dike base, whichever is less.

5.5.1.2 The volumetric capacity of the diked area shall not be less than the greatest amount of liquid that can be released from the largest tank within the diked area, assuming a full tank.

5.5.1.3 The outside base of the of the dike at ground level shall be no closer than 10 feet to any property line, where the property is or can be built upon.

5.5.1.4 Walls of the diked area shall be of earth, steel, concrete, or solid masonry designed to be liquid-tight and to withstand a full hydrostatic head and restricted to a maximum height of 6 feet. (In addition to the minimum NFPA standard, the diked area must be designed to withstand a full hydrostatic head, plus 4 inches freeboard for precipitation).

5.5.1.5 Each diked area containing two or more tanks shall be subdivided, preferably by drainage channels or at least by intermediate dikes to prevent spills from endangering adjacent tanks within the diked area.

5.5.1.6 Draining water from diked areas shall be controlled to prevent liquids from entering natural water resources, public sewers, or public drains.

5.5.2 Secondary Containment Tanks (NFPA 30 Section 22.11.4)

5.5.2.1 Tank capacity should not exceed 12,000 gallons.

5.5.2.2 Piping connections to the tank should be made above the maximum liquid level.

5.5.2.3 Means shall be provided to prevent the release of liquid from the tank by siphon flow.

5.5.2.4 Means shall be provided for determining the liquid level of tank (i.e., stick, gauge, etc.)

5.5.2.5 Means shall be provided to prevent overfilling by sounding an alarm when the liquid level in tank reaches 90% capacity and automatically stopping delivery in the tank when liquid level reaches 95% capacity.

5.5.2.6 Spacing between adjacent tanks shall be not less than 3 feet.

5.5.2.7 Tank shall be capable of resisting the damage from the impact of a motor vehicle or suitable collision barriers shall be provided.

5.5.2.8 Where secondary containments are enclosed, it shall have appropriate emergency venting.

5.5.2.9 Liquid capacity of secondary containment should be designed to withstand hydrostatic head for the maximum capacity of the primary tank. (In addition to the minimum NFPA standard, the secondary containment must be designed to withstand a full hydrostatic head, plus 4 inches freeboard for precipitation).

5.5.2.10 The interstitial space between the primary and secondary containment shall be tested either hydrostatically or with air pressure in accordance with the tank's listing or manufacturer's instructions.

This Page Intentionally Left Blank

6.0 Impracticality of Secondary Containment, 40 CFR 112.7(d)

112.7(d): If you determine that the installation of any of the structures or pieces of equipment listed in 40 CFR 112.7 (c) and (h)(1), and 112.8(c)(2), 112.8(c)(11), to prevent a discharge as described in 112.1(b) from any onshore or offshore facility is not practicable, you must clearly explain in your Plan why such measures are not practicable; for bulk storage containers, conduct both periodic integrity testing of the containers and periodic integrity and leak testing of the valves and piping; and, unless you have submitted a response plan under 112.20, provide in your Plan the following:

(1) An oil spill contingency plan following the provisions of 40 CFR 109.

(2) A written commitment of manpower, equipment, and materials required to expeditiously control and remove any quantity of oil discharged that may be harmful.

6.1 WIA considers secondary containment to be impractical for the following instances:

6.1.1 Aboveground and underground piping; and

6.1.2 Electrical transformers.

6.2 Transfer Piping: Aboveground and underground piping is used for the transfer of JP-5 fuel between the marine area, the 1800 Area, the 1500 Area, and the hydrants. For smaller piping (e.g., shorter transfer lines and smaller diameter piping such as for small tanks), the risk from discharge is much less. Drainage prevention from these smaller lines is discussed in Section 5. These piping systems vary from six inch to twelve inch pipe. Piping is in varying degrees of age, with the newest piping (circa 2005) consisting of the receipt and issue piping between the marina and the 1800 Area; additional sections of pipe outside of this corridor were repaired or replaced as needed. Due to various physical constraints, it is not practicable to provide secondary containment for all aboveground piping on WIA. These constraints included the location of pipe supports, utilities and buildings. In the event of a spill or leak from transfer piping, contingency actions contained in the WIA FRP would be implemented. The FRP includes a written commitment of manpower, equipment and materials to expeditiously control and remove any discharges from aboveground piping. WIA employs the following preventive measures to prevent discharges from the transfer piping:

6.2.1 Cathodic protection. Cathodic protection is used for all buried piping.

6.2.2 Painting. Above-ground piping is inspected regularly and spot-painting is performed by LFM as needed.

6.2.3 Pressure testing. The entire system is pressure tested annually.

6.2.4 Visual inspections. At least daily, LFM staff visually inspects the 1800 and 1500 Areas including the transfer piping.

6.3 Electrical Transformers: WIA considers secondary containment to be impractical for electrical equipment containing mineral oil (i.e., single- and three-phase pad-mounted transformers) due to safety considerations. The Air Force Civil Engineer Support Agency (AFCESA) issued informal guidance on containment for oil-containing electrical equipment. According to AFCESA, secondary containment curbs for transformers do not comply with established Air Force electrical safety requirements. The guidance states that "containment curbs built high enough to hold the anticipated maximum rainfall and contain a worst-case oil leak can impede electrical workers unrestricted egress from the equipment in case of a problem, creating unsafe working conditions." The guidance notes that SPCC regulations

contain a provision for an alternative to secondary containment if the containment is impracticable. The preferred alternative is to have an oil-spill contingency plan in place that outlines the procedures for control and removal of any oil discharges. This SPCC Plan meets the requirements of an "oil-spill contingency plan" as specified in the USEPA SPCC regulatory guidance. According to the USEPA guidance, the contingency plan must include the following: a written commitment of manpower, equipment, and materials; and an inspection or monitoring program to detect equipment failure and/or a discharge. Spill response and absorbent materials will be used as the primary means of containment in these circumstances. Equally important is an extensive preventive maintenance program completed by CE. This program, which includes annual external and/or visual inspections and operational checks, helps ensure that all Air Force-owned transformers are well maintained and monitored. Any identified leaks are reported and corrected promptly, or monitored frequently until they can be replaced. Additional rationale for the facility's ability to rely on spill response to satisfy this requirement is included below:

6.3.1 There is no documented case of oil from these sources reaching navigable waters. If a transformer or other high voltage electrical equipment were to fail causing a leakage of oil, the facility's electrical systems would shut down. Thus, operating personnel would immediately know that a leakage of oil had occurred and would react expeditiously to control and remove any oil in accordance with the countermeasures in the Spill Contingency Plan.

6.3.2 Secondary containment is not provided for outdoor high voltage electrical equipment because it would represent a potential serious safety hazard for personnel who must enter these areas. Standing water, a common occurrence in diked areas, poses an unreasonable risk to employees and would result in degradation of the foundations of this equipment and significantly increase the rate of corrosion.

6.3.3 There are no PCB-containing transformers at the facility.

6.3.4 The facility is manned 24 hours per day, 365 days per year, and oil-handling personnel are trained to notify the proper personnel if a release is discovered.

7.0 Inspections/Record Keeping

112.7(e): Conduct inspections and tests required by this part in accordance with written procedures that you or the certifying engineer develop for the facility. You must keep these written procedures and a record of the inspections and tests, signed by the appropriate supervisor or inspector, with the SPCC Plan for a period of three years. Records of inspections and tests kept under usual and customary business practices will suffice for purposes of this paragraph.

7.1 Although inspections may be performed more often, periodic inspections must be performed on all oil storage structures at the minimum frequency indicated in Table 7-1. Inspection forms in Annex B are completed and signed by the appropriate supervisor or inspector. Records must be kept for at least *three* years for SPCC records and at least *five* years for FRP records. Table 7-1 provides a summary of all inspections required to satisfy the above requirement. Refer to Sections 14.0 and 15.0 for detailed information pertaining to required and recommended visual inspections of tanks, integrity testing of POL storage containers, pipelines, and liquid level sensing device testing.

7.1.1 WIA personnel are trained to identify, notify, and respond to any instances of equipment malfunction, leaks, and spills during the normal course of their duties. Routine daily activity serves as the 'first line of defense' in identifying and responding to spills and abnormal situations which may lead to spills. The inspection procedures described in this section supplement this routine activity to ensure all oil use areas are inspected at a frequency corresponding to their risk.

7.1.2 Responsibility for inspections at WIA is typically divided among different departments based on the type of equipment or oil storage area. Inspections occur in two ways: (1) inspecting specific pieces of equipment throughout WIA, such as all emergency generators; and (2) inspecting all components in a single area, such as all tanks, piping, etc. in the 1800 Area. Both types of inspections complement each other and are part of the WIA spill prevention program.

7.1.3 WIA uses the IMAINT system to identify and record work tasks. Periodic inspections are most often identified in the system as Recurring Work Procedures (RWPs). At a minimum, the RWP will identify the responsible group, identify when the inspection must next be performed, and record dates and personnel who conducted the inspection in the past. The RWP will sometimes, but not always, identify the procedures or inspection criteria to be used. Some procedures will incorporate by reference other USAF forms or documents such as the United Facilities Criteria 'Operation and Maintenance: Maintenance of Petroleum Systems' (UFC 3-460-03); the procedures used or referenced for each area are noted below. The IMAINT system serves as one of the ways that WIA fulfills inspection recordkeeping requirements. In many cases, individual departments maintain more detailed records (e.g., original inspection logs) in their office space. Inspections are not required for containers which do not contain oil and are labeled as 'Out of Service;' these items are identified in Annex A.

7.2 Routine Visual Inspections: The following procedures cover all oil-storage container and oil-containing operational equipment identified in Table 3-1. The intent of these inspections is to provide a minimum level of inspection for proper operation, using primarily visual means.

7.2.1 Daily Inspections of Bulk and Operational Storage Areas: LFM personnel conduct a visual inspection of all bulk/operational fuel storage and related pumps, filters, and pipeline equipment at the 1500 and 1800 Areas at least once per day to ensure proper operation and to identify any maintenance needs. The criteria and results of these daily inspections are recorded as part of the Recurring Work Program (RWP). POL tracks the transactions of fuel through WIA and gauges the fuel in the aboveground bulk storage tanks. These are used to provide a record for summarizing fuel transactions and computing gains and losses. Refer to Annex B for sample inspection forms.

7.2.2 Weekly Inspections of Certain Used Oil Storage Areas: WIA Environmental Management inspects Accumulation Points (APs) on a weekly basis. These areas include all locations used for storing drums of used oil. The inspection criteria, and the results of the inspections, are recorded on an AFTO Form 39 in Annex B for an example .

7.2.3 Weekly Inspections of Emergency Generators and Arresting Gear Building: Power Department personnel inspect emergency generator equipment and associated fuel tanks on a monthly basis, in conjunction with existing testing requirements. The inspection criteria, and the results of the inspections, are recorded on an "Equipment Operating Log" for Emergency Generator" or similar form (refer to AFTO Form 39 in Annex B for an example).

7.2.4 Monthly Housekeeping Check of Central Shop Areas: WIA Environmental Management inspects all central shop areas; this includes checking for general housekeeping and spill containment practices associated with new, in-use, and used oil drums. Results of the inspections are recorded on an "ENV Monthly Inspection Form" or similar form (refer to AFTO Form 39 in Annex B for an example). At a minimum cover the following areas related to SPCC planning:

7.2.4.1 Ensure there are no leaks or spills from oil-filled drums or equipment; and

7.2.4.2 Ensure that secondary containment (pallets) is used for drum storage.

7.2.5 Monthly Check of 1500 and 1800 Areas and Fuel Delivery: LFM and/or POL personnel inspect all components of the 1800 Area, 1500 Area, and hydrants. These are recorded in the following series of RWPs in the IMAINT system:

7.2.5.1 LFM inspection of field-erected tanks, including exterior tank surface, roof drains, internal floating pan, and dike areas; specific sections of UFC 3-460-03 are incorporated by reference into the RWP for task CE-LF-Dikes-M.

7.2.5.2 LFM inspection of fuel system including 1500 and 1800 Area valves and the flightline hydrants. Specific actions are identified in the RWP for task CE-LF-FuelSystems-M.

7.2.5.3 POL inspection of hose trucks and refuelers using form AFTO Form 39 (refer to Annex B for a copy of this form).

7.2.5.4 POL inspection of harbor and channel using AFTO Form 39 (refer to Annex B for a copy of this form).

7.2.5.5 POL inspection of 1800 Area using AFTO Form 39 (refer to Annex B for a copy of this form).

7.2.6 Monthly Check of Fire Water Pumps: Each month, the fire department inspects and checks the pumps for fire water and foam, located at 1800 Area, 1500 Area, and Downtown.

7.2.7 Monthly and Annual Inspection of Aboveground Storage Tanks: LFM Department personnel conduct monthly and annual inspections of the following above-ground storage tanks:

7.2.7.1 JP-5 Dispensing tank in central shop area

7.2.7.2 MOGAS Dispensing tank in 1500 Area

7.2.7.3 Airfield emergency lighting Building 1602 (JP-5)

7.2.7.4 VORTAC building (JP-5)

7.2.7.5 Dining Hall (JP-5)

7.2.7.6 SWDA incinerator (JP-5)

7.2.7.7 25,000 gallon JP-5 tank at Power Plant

7.2.8 Section 10.3.3.1.1 of UFC 3-460-03 is incorporated by reference into the RWP for each tank.

7.2.9 Annual Inspection of Transformers: CE/Electrical Department personnel inspect all transformers on an annual basis via SWO. Inspection criteria are identified in the RWP for task CE-EL-Transformer-A.

7.2.10 Routine Inspections of Other Areas: A minimum monthly inspection will be conducted at the following areas (these inspections may not be presently performed):

7.2.10.1 Inspection of drum storage and fuel storage in Power area by Power

7.2.10.2 Inspection of GPUs by AGE

7.2.10.3 Inspection of drum storage area at SWDA

7.2.10.4 Inspection of drum storage area (for new oil) at marina Building 1706.

7.2.11 Inspection items include the evidence of any leaks or spills, the presence of accumulated rainwater (to determine if the containment needs to be drained), and whether the drainage devices are functioning properly.

7.2.12 POL inspects hoses and valves on the mobile refuelers and hose trucks daily or prior to each use. Discrepancies are noted on Form AFTO Form 39 (refer to Annex B) or equivalent.

7.3 Annual Plan Review: In addition to inspection of physical controls, the following SPCC compliance elements shall also be inspected annually.

7.3.1 Plan Content;

7.3.2 Records Check (including compliance with weekly and monthly inspections);

7.3.3 Pollutant Source Inspections;

7.3.4 Facility Evaluation; and

7.3.5 Determination of Plan Modification.

7.4 Integrity Testing: Integrity testing is conducted for certain storage containers and equipment listed in Table 3-1. Integrity testing requirements for tanks and storage containers are presented in Section 14.6. Integrity testing requirements for piping is presented in Section 15.4.

7.4.1 Integrity testing for piping is limited to the fuel delivery system between the 1800 Area through the hydrants, and the transfer hose for fuel barge delivery. This piping is the largest diameter and carries the bulk of the fuel used at the site. All other piping at WIA is smaller, has low flow or intermittent service (such as emergency generators), and is therefore considered to have lower risk. For these areas of piping, visual inspection associated with the areas and equipment identified above in Section 7.1 will suffice.

Table 7-1 Inspection And Testing Schedule				
Inspection/Test	**Frequency**	**Personnel**	**Standard**	**Recordkeeping**
Storage Tank / Container Inspection and Maintenance				
Shop Fabricated Tanks				
Visually inspect tank surfaces / equipment for corrosion at bulk storage facilities. Assess paint condition for deterioration	Daily	Tank Manger	40 CFR 112.8(c)(6)	3 years
External visual inspection of AST, gauges, secondary containment, etc.	Monthly		40 CFR 112.8(c)(6)	3 years
Regularly test liquid level sensing devices			40 CFR 112.8(c)(8)(v) NFPA 30, Section 2.6.1.3 API 653	
Inspect piping, valves, and appurtenances			40 CFR 112.8(d)(4)	
Presence of water in primary tank			STI SP001 (4.2)	
Presence of water or fuel in interstice (double-walled ASTs)			STI SP001 (4.3)	
Proper operation of leak detection system (double-walled ASTs)			STI SP001 (4.3)	
Inspect pipe connections for evidence of leakage			STI SP001 (4.4)	
Operation / cleanliness of operating and emergency vents	Quarterly		STI SP001 (4.6)	
Inspect emergency vent gasket	Yearly		STI SP001 (4.8)	
Tank supports and foundation damage	Yearly		STI SP001 (4.9 and 4.10)	

Table 7-1 Inspection And Testing Schedule				
Inspection/Test	**Frequency**	**Personnel**	**Standard**	**Recordkeeping**
Field Erected Tanks				
External Visual (r); include floating roof pan seals and roof drains	Monthly[1]	POL Personnel	40 CFR 112.8(c)(6)	Indefinite
External Visual (nr)	IAW API 653 4.3.2.1	API 653 Authorized Inspector		
External Ultrasonic[2] (nr)	IAW API 653 4.3.3.2			
Internal (nr)	IAW API 653 4.4.2 or 4.4.3			
Pipeline, Pump and Manifold Inspection[1]				
Pressure testing	Yearly	CE / Contractor	UFC 3-460-03 (2.3.3.1)	3 years
Hydrostatic testing	5 years		UFC 3-460-03 (2.3.3.2)	5 years
Visual integrity inspection, check valves and appurtenances for ease of operation	Daily or prior to use	LGRF Personnel	40 CFR 112.8(d)(4)	5 years
Belowground External Visual (r)	Semiannually	CE	IAW API 570	3 years
Belowground External Visual, Line Thickness, Leak Testing (r)	5 years	Qualified Inspector	IAW API 570 (section 9) ASME B31.4 (Section 461.3g)	3 years
OWS Inspection and Maintenance				
Operation of OWS pumps, valves, skimmers	At least Monthly	CE or Using Organization, as assigned	40 CFR 60.692-3	3 years
Check solids level with dipstick	At least Monthly		40 CFR 60.692-3	
Check oil level with dipstick	Monthly (if there is no scrap tank associated w/the OWS), otherwise semiannually		40 CFR 60.692-3	

Table 7-1 Inspection And Testing Schedule					
Inspection/Test	**Frequency**	**Personnel**	**Standard**	**Recordkeeping**	
Inspection and cleaning of internal chambers	Annually and more frequently, as needed		40 CFR 60.692-3		
Fuel Loading/Unloading Racks (POL Areas)					
External visual	Monthly	POL Personnel	40 CFR 112	3 years	
Drum and Portable Containers					
Routine visual inspection for leaks	Monthly	Tank Manager	40 CFR 112.8	3 years	
Fuel Trailers and Fuel Trucks					
Routine visual inspection for leaks	Varies; See Regulation	Truck owner/operator	49 CFR 180.407(c)	Per owner / operator	Varies; See Regulation
General Cathodic Protection System					
Cathodic Protection System (r)	Annually[3]	NACE qualified CP Specialist	NACE RP 0169 (sections 6 and 10)	Indefinite	

Notes:

Routine	Inspection can be performed by qualified facility personnel.
Non-routine	Inspection is performed by qualified personnel in accordance with regulatory requirements and/or industry accepted standards
API	American Petroleum Institute
ASME	American Society of Mechanical Engineers
CFR	Code of Federal Regulations
IAW	In accordance with
NACE	National Association of Corrosion Engineers
OWS	Oil/Water Separator
POL	Petroleum, Oils and Lubricants
STI	Steel Tank Institute
UFC	Unified Facilities Criteria

1 Monthly, yet no later than 35 days from the previous inspection

2 Internal (non-routine) inspection may substitute for external ultrasonic inspection **IF** API 653 4.3.3.3 is met

3 The effectiveness of the cathodic protection system should be monitored annually as outlined in Section 10 of NACE 0169 by an inspector knowledgeable about cathodic protection systems and sacrificial anodes. Evidence of adequate level of cathodic protection shall be one or more of the criteria listed in Section 6 of NACE 0169 which includes visual observation, measurements of pipe wall thickness, or internal inspection devices. Typical documentation that should be maintained for the system includes potential measurements, effectiveness of isolating devices, and rectifier operation. Sources of impressed current should be inspected at 2 month intervals.

This Page Intentionally Left Blank

8.0 Personnel Training on Spill Prevention Procedures

112.7(f)(1): At a minimum, train your oil-handling personnel in the operation and maintenance of equipment to prevent discharges; discharge procedure protocols; applicable pollution control laws, rules, and regulations; general facility operations; and, the contents of the facility SPCC Plan.

8.1 WIA must provide prevention, awareness, and spill response training to all new employees involved with oil equipment operation, maintenance, or oversight. Annual refresher training and exercises/drills are to be completed as well. Intermediate training sessions must be conducted for appropriate personnel when a process or procedure changes, and for new employees who are responsible for the implementation of any portion of the SPCC Plan.

8.1.2 Required Training Topics

8.1.2.1 Discussion of federal, state, and Air Force rules and regulations

8.1.2.2 Operation and maintenance of equipment to prevent oil discharges

8.1.2.3 Discharge procedure protocols

8.1.2.4 Purpose and overview of SPCC Plan

8.1.2.5 General facility operations

8.1.3 Other Training Topics

8.1.3.1 Review of potential spill areas and drainage routes

8.1.3.2 Review of emergency response procedures

8.1.3.3 Review of spill cleanup equipment locations and the use of the equipment

8.1.3.4 Recent spill events, subsequent response and corrective action.

8.1.4 Specific individuals, who are designated as SPCC inspection personnel must also be trained on the inspection procedures to be used, the frequency of inspections, record-keeping requirements, and procedures for reporting and correcting detected problems. The required training programs are discussed in greater detail in the Facility Response Plan.

8.2 Logistics Fuels Management (LGRF): each member's training records must be kept in the immediate work area. Details that must be included in the records are the names of personnel, status of most recent training, refresher due date, and remarks. A Qualifications and Personnel Roster is must be kept on site at the LGRF main office, as well as the Fuels Distribution Training and Continuity Book. In accordance with AFI 23-204 Section 13, Tank Custodians must receive training on gauging procedures for fuel and water, facility inspection and maintenance requirements, emergency/spill response, and hazardous waste management.

8.3 Designated Person Accountable for Spill Prevention

112.7(f)(2): Designate a person at each applicable facility who is accountable for discharge prevention and who reports to facility management.

8.4 Each assigned tank custodian is responsible for POL spill prevention and reporting to the WIA Environmental Manager. The WIA Environmental Manager is the designated person accountable for spill prevention at WIA. He/she reports directly to the BOS Contract Program Manager. The BOS Contract Program Manager also reports to the Government, who shares in the responsibility for discharge prevention.

8.5 The following WIA person is the primary contact for the SPCC Plan.

WIA Environmental Manager	(808) 424-2234

8.6 Spill Prevention Briefings

112.7(f)(3): Schedule and conduct discharge prevention briefings for your oil-handling personnel at least once a year to assure adequate understanding of the SPCC Plan for that facility. Such briefings must highlight and describe known discharges as described in §112.1(b) or failures, malfunctioning components, and any recently developed precautionary measures.

8.7 WIA must schedule and conduct spill prevention briefings as part of its annual SPCC/HAZMAT training. The purpose of the briefings is to discuss: (1) recent spill events, (2) causes of the spill, and (3) corrective action to prevent recurrence of similar spills. Personnel responsible for the oil storage areas/inspections must be included in the SPCC briefings.

9.0 Site Security

9.1 Fuels Storage Area and Hydrant Systems: the principal fuel delivery components are kept secured at all times when not in use, using locks with keys kept in the POL shop. POL staff is responsible for the check in/ check out of keys. The following components are kept secured:

9.1.1 All valves leading to or from the bulk or operational storage tanks in the 1500 and 1800 Areas.

9.1.2 All dike drainage in the 1500 and 1800 Areas.

9.1.3 Pump dispensing nozzles for the Low Sulfur Diesel tank, MOGAS tank and JP-5 tank.

9.2 AFI 23-204 Section 5.1 requires that the following organizational tank components be secured: Pump dispensing nozzles and electrical power sources for all issue tanks, gauge hatches and other access points on all storage tanks, bulk fuel off-loading systems and low point drains. Components will be secured using number-controlled padlocks, seals or plugging valves, or anti-siphoning devices.

9.2.1 Security supervisors ensure at least one security check is performed (Monday-Friday) on all facilities during their shift. On weekends and holidays, all supervisors will ensure a security check is performed on facilities that are not manned 24 hours per day.

9.2.2 Organizational Fuel Tank custodians follow the basic measures outlined in AFI 31-209, Air Force Resource Protection Program. To protect fuel in above-ground organizational tanks, commanders check organizational tanks for access, dispensing points, and the overall security.

9.3 Fencing and Gates

112.7(g)(1): Fully fence each facility handling, processing, or storing oil, and lock and/or guard entrance gates when the facility is not in production or is unattended.

9.3.1 WIA is a remote, access-controlled island. Access to aircraft destined for WIA is strictly controlled by the originating airfield such as Hickam AFB. Facility access is reserved for military personnel and approved government contractors. Only authorized vessels are allowed to approach the island by sea. This secure access serves the equivalent of the requirement to fully fence the facility.

9.3.2 Other than the general site security, there are very few individual oil storage or oil use areas at WIA which are fenced with controlled access.

9.4 Flow and Drain Valves Secured

112.7(g)(2): Ensure that the master flow and drain valves and any other valves permitting direct outward flow of the container's contents to the surface have adequate security measures so that they remain in the closed position when in non-operating or non-standby status.

9.4.1 This requirement relates to the security of oil systems from discharges due to use of system components in an unauthorized manner. On larger systems, valves are controlled through good engineering systems. On smaller systems, master flow and drain plugs are maintained in a closed position, except to drain water from tank bottoms.

9.4.2 Bulk Storage Area: in accordance with Unified Facilities Criteria (UFC) 3-460-03, secondary containment drainage valves must be closed and locked when not in use.

9.5 Starter Controls Secured

112.7(g)(3): Lock the starter control on each oil pump in the "off" position and locate it at a site accessible only to authorized personnel when the pump is in a non-operating or non-standby status.

9.5.1 The starter controls for oil pumps must be maintained in an "off" position and locked. Access to starter controls is limited to authorized personnel only. Each starter control is located in a secure area of a building adjacent to the applicable AST. Only authorized personnel have access to keys to the buildings and starter controls.

9.5.2 Bulk Fuels Storage Areas: access to the pump houses is secured when pump houses are not manned by LGRF personnel. Pumps are kept in the "off" position and the pump house is secured when the pumps are not in use.

9.6 Pipeline Loading/Unloading Connections Secured

112.7(g)(4): Securely cap or blank-flange the loading/unloading connections of oil pipelines or facility piping when not in service or when in standby service for an extended time. This security practice also applies to piping that is emptied of liquid content either by draining or by inert gas pressure.

9.6.1 All oil loading/unloading connections are securely capped or blank-flanged when not in service or standby service. Capping or blank-flanging a pipeline connection should be recorded by designated personnel on an AFTO Form 39 (refer to Annex B). These forms are maintained by LGRF for at least three years. Reinstatement of an out-of-service pipeline should also be recorded.

9.7 Lighting Adequate to Detect and Deter Spills

112.7(g)(5): Provide facility lighting commensurate with the type and location of the facility that will assist in the:
(i) Discovery of discharges occurring during hours of darkness, both by operating personnel, if present, and by non-operating personnel (the general public, local police, etc.); and
(ii) Prevention of discharges occurring through acts of vandalism.

9.7.1 Lighting is critical for oil system security and spill prevention and is provided for loading and unloading racks, truck parking, tank farm areas, and fueling areas. Overhead lighting at night is provided along roadways, thoroughfares, and many of the parking areas for security and inspections.

9.7.2 In large volume bulk fuel storage areas, lighting conforms to the industry standard (API 2610 Section 11.2.2), which recommends the following:

9.7.3 Industry Standard Consideration:

9.7.3.1 Use high intensity discharge lamps such as mercury vapor or high pressure sodium lighting

9.7.3.2 Intersperse incandescent lighting fixtures in areas that require immediate return of lighting after power dips or outages.

9.7.3.3 Consider photoelectric cell control where automatic switching of yard and rack lighting is required.

9.7.3.4 Install explosion proof lighting in areas containing Class I liquids (those with a flash point below 100° F and having a vapor pressure not exceeding 40 pounds per square inch) conforming with NFPA 70 and maintained in good condition.

9.7.4 The facility is manned 24 hours per day, 7 days per week, and security is provided at all times, thereby greatly reducing the likelihood of spills occurring through acts of vandalism. In the Bulk Storage Areas, security lighting is provided for security and inspections at night. Night lighting is provided along the runway for landing aircraft, for flight line security, and for operating the fuel hydrant system.

This Page Intentionally Left Blank

10.0 Loading/Unloading Operations

10.1 Tank truck loading/unloading at WIA meets operational requirements and regulations established by the Department of Transportation.

10.1.1 POL personnel are responsible for receiving, storing, and issuing the majority of the fuel at WIA. The primary areas under POL supervision include the Bulk Fuel Area (1800 Area), the Operational Area (1500 Area), a Type II hydrant system, and Re-Supply. Fueling of aircraft is conducted by refueler pump trucks or from the Type II Hydrant Systems. See Figure A-1 for fuel storage locations. See section 10.2 for truck loading/unloading instructions for POL personnel.

10.1.2 Spills may occur during fuel loading and unloading operations. Spill response kits are located near the loading areas which contain absorbent booms, pigs, pads, shovels, and storm drain covers for immediate response. In addition, portable spill response kits are located on each refueler truck, and drip pans are used beneath each hose connection.

10.2 Bulk Fuel Area (1800 Area): the Bulk Fuel Area is located on Wilkes Island. Re-supply is via an ocean-going vessel. Two ASTs that have a total capacity of approximately 8.04 million gallons are located at the Bulk Fuel Area.

10.3 Operational Area (1500 Area): the JP-5 tanker-truck loading facility is located at the 1500 Area. The loading facility is fueled by the Type II hydrant system, which obtain fuel from tanks 41128 and 41129. The tanker trucks are used throughout WIA to fuel smaller JP-5-containing ASTs, such as emergency generator tanks.

10.4 Type II Hydrant System: the Type II Hydrant System is located along the flight line, fronting Base Operations. The Type II Hydrant System is the primary fuel delivery system for the WIA flight line hydrants, of which there are four control pits each with two hydrant outlets. The storage tanks for the Type II system consist of the JP-5 ASTs listed above in the 1500 Area. Tanks 41128 and 41129 deliver fuel via pipeline to the hydrants. JP-5 is then delivered under pressure to the flight line hydrants and is pumped into aircraft through refueling hose carts. 10.5 RE-Supply: JP-5 is delivered to WIA by tanker or barge that are moored to offshore monobuoys where a fuel offloading hose is towed out to them by contractor personnel. Pumps aboard these vessels offload JP-5 at up to 2,400 gallons per minute through the hose and into an 8-inch receipt pipeline at the fuel offload pier, located on the southwestern end of WIA. The buried receipt pipeline runs across the causeway connecting Wake Island to Wilkes Island, to the Bulk Storage Area (1800 Area). Total length of the pipeline is approximately 1 mile. JP-5 is also received by the 1500 Area from the 1800 Area via pipeline.

10.5.1 Industry Standard Consideration:

10.5.1.1 An industry standard (Section 5.6 of NFPA 30) outlines the following loading/unloading operational guidelines that are applicable to WIA.

10.5.1.2 Tank vehicle loading/unloading facilities should be separated from ASTs, buildings, and nearest property lines by a distance of 25 feet for Class I and Class II liquids and 15 feet for Class III liquids.

10.5.1.3 Loading/unloading facilities shall be provided with drainage systems or other means to contain spills.

10.5.1.4 Loading/unloading facilities that are used to load liquids into tank vehicles through open domes shall be provided with a means of electrically bonding to protect against static electricity hazards.

10.5.1.5 Equipment used for the transfer of Class I liquids between tanks shall not be used for Class II or Class III liquids.

10.5.1.6 Liquids shall be loaded only into tanks whose material of construction is compatible with the chemical characteristics of the liquid (see Section 5.6.10 of NFPA for detailed loading/unloading guidelines).

10.5.1.7 To prevent hazards due to a change in flash point of liquids, no tank car (rail) or tank vehicle that has previously contained a Class I liquid shall be loaded with a Class II or Class III liquid unless proper precautions are taken.

10.5.2 Further, Section 9.3.1 of API 2610 specifies that "spill containment for truck loading rack is provided by a steel tray.. The raised edge *is* sloped to facilitate truck access.

10.6 Adequate Secondary Containment for Vehicles

112.7(h)(1): Where loading/unloading area drainage does not flow into a catchment basin or treatment facility designed to handle spills, use a quick drainage system for tank car or tank truck loading and unloading areas. You must design any containment system to hold at least the maximum capacity of any single compartment of a tank car or tank truck loaded or unloaded at the facility.

10.6.1 Table 10-1 summarizes the active jet fuel loading/unloading rack at WIA. For the purpose of this section of the SPCC Plan, a tank truck fuel loading/unloading rack is defined as including a platform, gangway or loading/unloading arm and any combination of the following: piping assemblages, valves, pumps, shut-off devices, overfill sensors or personnel safety devices. This section does not apply to intra-facility transfer of fuel by government vehicles or transfer of fuel to ancillary (i.e., end-use containers such as generators or small ASTs). There is one fuel loading/unloading rack at WIA (1500 Area JP-5 Loading Rack). There are no rail car tank fuel loading/unloading racks at WIA. The 1500 Area JP-5 Loading Rack consists of a meter, pump, and a concrete slab. Secondary containment is provided at the 1500 Area JP-5 Loading Rack.

10.6.2 Designated facility personnel must observe each loading event in its entirety. Facility personnel must ensure that the proper procedures are employed, that correct material is being loaded and that the appropriate personnel are notified immediately if a release occurs (as previously described). Because this facility operates 24 hours per day,

7 days per week, emergency response personnel are available onsite. An emergency contact number must be posted at the loading/unloading rack, and the designated facility personnel have access to a radio or other device to notify emergency response personnel if a release occurs. The designated employee who observes the loading event is trained in the SPCC Plan training discussed in Section 8. Should a release occur during a product transfer event, the designated employee who observed the release will notify the appropriate personnel to recover the spilled material.

Table 10-1 Tank Truck Loading Racks

Location	Potential Spill Volume / Containment (Gallons)	Potential Release Discharge Point
1500 Area JP-5 Fuel Loading Rack	< 6,000[1] / 7,000	Drainage flows north and enters the lagoon several feet from the loading rack

[1] Potential spill volume is based on maximum capacity of any single container in the tank truck, in accordance with, 40 CFR 112.7(h)(1). At WIA, the largest mobile refueler (i.e., R-11) has a single tank with a maximum capacity of 6,000 gallons.

10.6.3 Industry Standard Consideration:

10.6.3.1 The fuel loading operations are in general conformance with industry standards. Section 5.6 of NFPA 30 specifies that "loading and unloading facilities shall be provided with drainage systems or other means to contain spills" and Section 9.3.1 of API 2610 specifies that "spill containment for truck loading rack areas *should* include concrete pavement with a raised edge (curbing) or other spill containment method provided around the loading rack perimeter. The raised edge should be sloped or rounded to facilitate truck access. Concrete joints should be sealed with petroleum resistant sealants to prevent leaks to sub-grade. Pavement should be sloped toward catch basins and drains that are piped to containment or treatment facilities."

10.6.3.2 For tank systems throughout the installation, drivers of intra-facility transfer trucks are equipped with quick-response equipment and trained in notification and response procedures to ensure that a spill will be contained or controlled as quickly as possible.

10.7 Warning or Barrier System for Vehicles

112.7(h)(2): Provide an interlocked warning light or physical barrier system, warning signs, wheel chocks, or vehicle break interlock system in loading/unloading areas to prevent vehicles from departing before complete disconnection of flexible or fixed oil transfer lines.

10.7.1 Usually two personnel are present throughout fuel loading and unloading to verify that all lines have been properly disconnected, and all valves properly closed before the vehicle departs. The fuel truck driver sets wheel chocks prior to connecting the fuel transfer lines to the quick-connect coupling and disconnects fuel transfer lines prior to removing wheel chocks.

10.7.2 Prior to unloading, the truck wheels are chocked and the transfer lines and connection seals are inspected for evidence of leaks. The valves and lowermost drains of the tank trucks are examined prior to filling, during filling, and prior to departure.

10.8 Vehicles Examined at Lowermost Drainage Outlets Before Leaving

112.7(h)(3): Prior to filling and departure of any tank car or tank truck, closely inspect for discharges the lowermost drain and all outlets of such vehicles, and if necessary, ensure that they are tightened, adjusted, or replaced to prevent liquid discharge while in transit.

10.9 At all loading and unloading areas, designated personnel must be present during transfer operations. Following each delivery, the area and tank truck connections must be examined for leakage. Before tank truck departure, the tank custodian performs a walk-around inspection of the tanker to examine and verify that all transfer lines have been disconnected and properly stowed and drains and valves are closed. The Tank Custodian monitors the operations to ensure that all connections are made properly. In addition, there are shut-off valves located on each truck. Spill response materials are available on the trucks for immediate response to spills, and drip pans are used beneath each hose connection.

11.0 Brittle Fracture or Other Catastrophe of Field-Constructed Tanks

112.7(i): If a field-constructed aboveground container undergoes a repair, alteration, reconstruction, or a change in service that might affect the risk of a discharge or failure due to brittle fracture or other catastrophe, or has discharged oil or failed due to brittle fracture failure or other catastrophe, evaluate the container for risk of discharge or failure due to brittle fracture or other catastrophe, and as necessary, take appropriate action.

11.1 API 653–Inspection Program for Field Constructed Tanks: for new construction, the scheduling and contracting of API inspections must be performed by the Civil Engineering Design Flight (CECE). For maintenance of existing tanks, the scheduling and contracting of API certified inspectors must be done by Liquid Fuels Management (LFM).

11.2 WIA will implement an inspection and maintenance program consistent with the standards and protocols established with API 653 – Tank Inspection, Repair, Alteration, and Reconstruction. The program will address all aspects associated with maintenance inspections, repair, alteration, relocation, and reconstruction of tanks, as applicable. Beginning in fall 2012 and in accordance with AFI 32-7044 (once the draft is approved), WIA began an inspection and maintenance program consistent with the Steel Tank Institute standard SP-001 for all non-capitalized fuel tanks that can be inspected under that standard.

11.3 The program will assess and confirm suitability for continued service in instances where tank inspections indicate a change of service from original physical condition has occurred.

11.4 The inspection program must incorporate procedures for the assessment of field erected tanks for suitability for continued operation or change of service with respect to brittle fracture. Brittle Fracture Assessment considerations employ decision tree logic as outlined within API 653, Figure 5-1, *Brittle Fracture Consideration*.

11.5 WIA will employ the services of a certified API inspector to establish an inspection frequency schedule for each tank that includes routine in-service external inspections and also addresses non-destructive testing options and protocols outlined in API 653. Inspection frequencies will be established by the certified API inspector based on historical inspection records and known or projected tank wall corrosion rates. After each tank subject to API 653 has been evaluated, the certified API inspector will identify suitability for service actions and determine when the next API inspection is required for the respective tank. Inspection frequencies typically vary between 5 and 10 years. Refer to Table 7-1 for a listing of required inspections that should be conducted for all field-erected bulk storage tanks in accordance with API 653.

11.6 WIA will maintain construction, inspection, repair/alteration history records and reports consistent with API 653 for the life of the tank. Only authorized API-certified inspectors will support these non-routine inspection and maintenance actions. The records will be maintained at the POL office.

11.7 There are two areas on WIA containing field-erected bulk fuel storage tanks that must be inspected as outlined within API 653.

11.7.1 The 1800 Area (Bulk Storage Area) contains two active 100,000 barrel field-erected tanks (31 and 32). Tanks 31 and 32 currently are used to store JP-5.

11.7.2 The 1500 Area (Operational Storage Area) contains two active 10,000 barrel field erected tanks (28 and 29. Tanks 28 and 29 store JP-5 and should undergo regular API 653 inspections.

11.7.3 With the exception of the tanks 28 and 29 at the 1500 area, and the bulk storage tanks at the 1800 area, all other tanks will undergo regular inspections in accordance with STI-SP001 and AFI 32-7044.

12.0 Conformance with Other Applicable Requirements

112.7(j): In addition to the minimal prevention standards listed under this section, include in your Plan a complete discussion of conformance with the applicable requirements and other effective discharge prevention and containment procedures listed in this part or any applicable more stringent State rules, regulations, and guidelines.

12.1 Discussions regarding conformance with the requirements API, NFPA and STI standards, and other industry standards are integrated where applicable throughout this SPCC Plan.

12.1.1 Applicable Air Force procedures include the following:

12.1.1.1 AFI 23-201, Fuels Management

12.1.1.2 AFI 23-204, Organizational Fuel Tanks

12.1.1.3 AFI 31-209, Air Force Resource Protection Program

12.1.1.4 AFI 32-7044, Storage Tank Compliance

12.1.2 WIA complies with all applicable Air Force Instructions pertaining to spill prevention, control, and countermeasures.

This Page Intentionally Left Blank

13.0. Drainage Control

13.1 Drainage from Diked Storage Areas

112.8(b)(1): Restrain drainage from diked storage areas by valves to prevent a discharge into the drainage system or facility effluent treatment system, except where facility systems are designed to control such discharge. You may empty diked areas by pumps or ejectors; however, you must manually activate these pumps or ejectors and must inspect the condition of the accumulation before starting, to ensure no oil will be discharged.

13.1.1 Table 3-1 identifies the ASTs that have open-top steel or concrete secondary containment dikes that are exposed to precipitation. The diked areas associated with these ASTs have manual valves or plugs that may be opened to release water from secondary containment. Following significant rainfall events or successive small rainfall events, these diked storage areas are inspected to determine if they need to be drained of stormwater.

13.1.2 The individual responsible for drainage control must visually observe the contents of the containment structure prior to emptying its contents. If an oily sheen or product is observed, environmental supervisory personnel are notified immediately to determine the source of the sheen (i.e., overfill or leak). Once the source of the sheen is determined, appropriate corrective measures are taken. The contaminants are then removed with absorbent material and bagged for appropriate disposal.

13.1.3 If no sheen is observed, the manual drainage valve is opened and the contents are discharged to the stormwater drainage system. All discharges to the stormwater system must be documented on the Secondary Containment Drainage log, Form 2 of Annex B.

13.1.4 Bulk Fuel Area (1800 Area): tanks 41131 and 41132 rest on concrete pads, with concrete sealed dikes which are considered to be sufficiently impervious. However, the secondary containment for Tank 41132 is 110% of the capacity of the tank. 13.1.5. All drainage from diked areas at the Bulk Fuel Area is restrained by manually-operated valved gravity-fed discharge pipes. The valve of this discharge line is kept locked in the upright and closed position to prevent flow through the line. The dike drainage lines are kept closed and locked until rainwater accumulation within the diked area is determined to be uncontaminated.

13.1.6 Operational Area (1500 Area): all drainage from diked areas at the bulk ASTs are restrained by a drainage sump that is controlled manually. In the event of a release from the AST, the fuel would be contained within the containment dike.

13.2 Surface Releases: this section is designated for records involving surface releases from ASTs to the ground or paved surfaces. In case of a surface release from an AST (fixed or mobile), the "BOS Contractor Hazardous Materials Release Report," (located in Annex B), is completed by the individual reporting the spill. Following contingency measures for an emergency surface release, the "Spill Incident Report to Environmental Management" (Form 1 in Annex B) is completed by the responding manager and inserted into Annex B. These forms are kept for at least three years.

13.2.1 Valves Used on Diked Storage Areas

112.8(b)(2): Use valves of manual, open-and-closed design, for the drainage of diked areas. You may not use flapper-type drain valves to drain diked areas. If your facility drainage drains directly into a watercourse and not into an on-site wastewater treatment plant, you must inspect and may drain uncontaminated retained stormwater, as provided in 112.8(c)(3)(ii), (iii), and (iv).

13.2.1.1 All drainage valves on secondary containment structures are manual gate or ball valves that are required to be maintained in the "closed" position except during secondary containment draining events.

13.2.1.2 Flapper type drain valves are not used for secondary containment structures at WIA. All accumulated rainwater must be inspected per Section 13.1 prior to discharge. All secondary containment drain valves must be maintained and inspected per Forms AFTO Form 39, . in Annex B. This inspection form complies with STI SP001 industry standard (Steel Tank Institute SP001 — S*tandard for Inspection of In-Service Shop-Fabricated Aboveground Tanks for Storage of Combustible and Flammable Liquids*), which establishes the minimum criteria and frequency for container inspections.

13.3 Facility Drainage Systems from Undiked Areas

112.8(b)(3): Design facility drainage systems from undiked areas with a potential for a discharge (such as where piping is located outside containment walls or where tank truck discharges may occur outside the loading area) to flow into ponds, lagoons, or catchment basins designed to retain oil or return it to the facility. You must not locate catchment basins in areas subject to periodic flooding.

13.3.1 All primary oil storage structures within the facility must be contained in diked or otherwise contained areas, except pad-mounted transformers. For smaller risk containers (i.e., pad-mounted transformers), WIA's routine operation and maintenance procedures together with their contingency plan are the appropriate oil pollution prevention measures for these sources.

13.3.2 The referenced transformers are considered low risk based on their operational use and preventative maintenance. In addition, there are a number of locations where piping is located outside containment walls or where tank truck discharges may occur outside the loading area. Tank trucks delivering fuel around the facility have capacities of 1200 to 6,000 gallons. The facility's Facility Response Plan details the facility's preparedness for responding to releases from tank trucks.

13.3.3 Bulk Storage Area (1800 Area): active storage containers are located in sufficiently sized containment areas. Inactive and out-of-service containers may be located in undiked areas. The potential for release from these containers is low as they do not store product; however, a discharge would ultimately terminate in the surface. Drainage in the 1800 Area generally flows over the surface to the lagoon.

13.3.4 Operational Area (1500 Area): releases from areas not provided with secondary containment would ultimately discharge to the surface. All drainage in the Operational Area would flow over the surface to the lagoon. The topography of the Operational Area is flat.

13.3.5 Transformers: there are no diked areas associated with the transformers on base. Drainage at each transformer varies, but the majority of releases from transformers would spread radially on the ground and be absorbed into the soil or pavement. No redesign of transformer areas is necessary due to the low likelihood of a release as well as the operation and maintenance procedures in place.

13.4 Final Discharge of Drainage

112.8(b)(4): If facility drainage is not engineered as in 112.8(b)(3), equip the final discharge of all ditches inside the facility with a diversion system that would, in the event of an uncontrolled discharge, retain oil in the facility.

13.4.1 In the vast majority of cases, a spill will either be contained in a permanent secondary containment structure (e.g., concrete dike, double-wall tank, drum containment pallet) or discharged onto surrounding ground where it would most likely percolate into in the soil with a potential (but unlikely) flow path to the ocean or lagoon. In the remaining cases, a spill can potentially enter storm drains (which are in the vicinity of the downtown area and the airfield area); in these cases the stormwater outfall discharges onto rocky areas near, but not directly into, the ocean or lagoon. In cases where permanent secondary containment is not present, there is potential for oil to enter a waterway; the distance from the source (or outfall) to water, and the landscape of porous substrate, will mitigate direct impact of a spill to water. The topography of WIA is flat except in regions very close to the lagoon and ocean, where there is a sharp downward slope followed by gentle sloping to the water. There are no diversion systems at WIA.

13.5 Facility Drainage Systems and Equipment

112.8(b)(5): Where drainage waters are treated in more than one treatment unit and such treatment is continuous, and pump transfer is needed, provide two "lift" pumps and permanently install at least one of the pumps. Whatever techniques you use, you must engineer facility drainage systems to prevent a discharge as described in §112.1(b) in case there is an equipment failure or human error at the facility.

13.5.1 The first sentence of this rule is not applicable to WIA. For the second sentence, multiple levels of control are implemented to prevent a discharge from the base. Facility drainage from undiked areas is described in Section 13.3. Stormwater and facility drainage outfalls must be monitored quarterly for indications of oil to ensure that discharges do not reach navigable waters.

13.6 Continuous Treatment: Not applicable to WIA.

This Page Intentionally Left Blank

14.0 Bulk Storage Containers/Secondary Containment

14.1 Container Compatibility with Its Contents

112.8(c)(1): You must not use a container for the storage of oil unless its material and construction are compatible with the material stored and conditions of storage such as pressure and temperature.

14.1.1 All bulk storage containers are made of material (i.e., steel) that is compatible with its contents (i.e., vehicular diesel, unleaded gasoline, heating fuel oil, waste oil, lubrication oil) and therefore conform with the relevant industry standard (NFPA 30 Flammable and Combustible Liquids Code Section 5.6.10.1). All electrical transformer oil tanks are also built of materials (i.e., steel) that are compatible with its contents (i.e., mineral oil). Reference Table 3-1 for container content/capacity, container and pipe material, year installed and good engineering (i.e., overfill and leak alarms, etc.). The two bulk storage areas are discussed below.

14.1.2 Bulk Storage Area (1800 Area): the Bulk Storage Area ASTs (41131, and 41132) are constructed of ASTM A-283-46, Grade C OH steel, which is compatible with the fuel stored in the tanks. The ASTs are cylindrical and have a fixed roof, floating pan type roof. The ASTs operate under atmospheric pressure and temperature. During the most recent field inspection, the tanks in operation were found to be free of excessive corrosion and visible defects. All of the ASTs rest on concrete pads.

14.1.3 Operational Storage Area (1500 Area): the ASTs are constructed of ASTM A-283-46, Grade C OH steel, which is compatible with fuel stored in the tanks. The ASTs are cylindrical and are "fixed-roof, floating pan" type tanks. The ASTs operate under atmospheric pressure and temperature. During the most recent field inspection, the tanks in operation were found to be free of excessive corrosion and visible defects.

14.2 Diked Area Construction and Containment Volume for Storage Containers

112.8(c)(2): You must construct all bulk storage container installations so that you provide a secondary means of containment for the entire capacity of the largest single container and sufficient freeboard to contain precipitation. You must ensure that diked areas are sufficiently impervious to contain discharged oil. Dikes, containment curbs, and pits are commonly employed for this purpose. You may also use an alternative system consisting of a drainage trench enclosure that must be arranged so that any discharge will terminate and be safely confined in a facility catchment basin or holding pond.

14.2.1 Under the SPCC Rule, the *de minimus* bulk storage container is 55 gallons. Therefore this rule applies to drums, totes, bowsers, and mobile tanks (discussed further in Section 14.11), in addition to tanks. In addition, the rules are based on nominal capacity rather than the amount of oil maintained in the container. All 55-gallon drums must have at least one of the following: 1) containment in the form of containment pallets, 2) a designated curbed area for more than four drums, or 3) control measures in the form of local spill response equipment with absorbent/adsorbent socks and flexible dikes. Drums are discussed further in Section 14.12.

14.2.1.1 Where diked containment areas are employed for bulk oil storage tanks, they must be sufficiently impervious to contain spilled oil and conform with the NFPA industry standards listed in Section 5 for "Impoundment Around Tanks by Diking." Secondary containment calculations are located in Table 3-1 and indicate the total secondary containment volume (including freeboard depth incorporated into

the containment capacity of each tank) for each individual tank. Since EPA, as discussed in the SPCC Rule preamble, considered and rejected using 110% of primary tank capacity as sufficient freeboard for precipitation, freeboard depths will be considered as regulatory deficient if less than the greater of 1) 4 inches, or 2) 110% of the primary container capacity.

14.2.1.2 All containment and diked areas for bulk oil storage tanks are sufficiently impervious to contain spilled oil.

14.2.2 Bulk Storage Area (1800 Area): the two active 4,000,000-gallon fuel storage tanks (Tanks 31 and 32) have a sufficient concrete secondary containment dike to hold the entire contents of each tank, plus sufficient freeboard for precipitation. A concrete secondary containment dike is available in the immediate vicinity of the filter separators and 650 gallon JP-5 fuel product recovery tank near Building 1812, providing 2,400 gallons of containment (no allowance for precipitation is needed because it is under roof). Pumps in Building 1812 are in a building which provides minimal containment. These containment systems provide protection against small leaks in the equipment, but could not contain a catastrophic failure of 36,000 gallons, assuming a maximum transfer rate of 2,400 gallons per minute and a 15 minute response time. This secondary containment is sufficient to hold the contents of the 650 gallon JP-5 fuel product recovery tank. Some piping is within the permanent secondary containment of the concrete dikes surrounding the tanks and the filters. For other areas, there is no permanent secondary containment. A spill or overflow would pool and percolate through the soil with potential runoff to the lagoon.

14.2.2.1 Several drums of fuel/ water mixture are in covered containment drums which provide 100% secondary containment.

14.2.3 Operational Storage Area (1500 Area): the two large 400,000-gallon fuel storage ASTs (Tanks 28 and 29) have sufficient secondary containment, plus sufficient freeboard for precipitation and expansion of product.

14.2.3.1 Some of the 6,600-gallon ISO tanks are located in a walled area with an impervious bottom. However, not all of the tanks are located within this containment area. A spill, leak, or overflow can potentially: (a) percolate into the ground or (b) reach a drain which discharges as an outfall very close to a wetland area leading to the lagoon. The 2,500-gallon MOGAS dispensing tank is double-walled.

14.2.3.2 A concrete secondary containment dike is available in the immediate vicinity of an area of three filter separators and one 20-gallon JP-5 fuel product recovery tank, providing 4,700 gallons of containment. The containment system provides protection against small leaks in the equipment, but could not contain a catastrophic failure of 27,000 gallons, assuming a maximum transfer rate of 1,800 gallons per minute and a 15 minute response time. This secondary containment is sufficient to hold the contents of the 200-gallon JP-5 fuel product recovery tank.

14.2.3.3 Some piping is within the permanent secondary containment of the concrete dikes surrounding the tanks and the filters. For other areas, there is no permanent

secondary containment. A spill or overflow would pool and percolate through the soil with potential runoff to the lagoon. Several drums of fuel/ water mixture are in covered containment drums which provide 100% secondary containment. There are several old, empty, disconnected tanks (with capacities up to 500 gallons) in this area which lack permanent secondary containment. If used, a potential spill or leak would overflow onto the surrounding gravel area.

14.2.3.4 The usual parking area for the LFM bowser (a 400-gallon mobile tank) does not have secondary containment. A potential spill or leak would overflow onto the surrounding gravel area (at an assumed rate of 400 gallons per hour). In the 1500 Area, a building provides sufficient secondary containment for a fuel storage tank for a fire pump. The capacity of the tank is 165 gallons and the building provides 175 gallons of secondary containment (no allowance for precipitation is needed because it is under roof).

14.2.4 Central Shop Area: the most significant potential for a spill or discharge is from the numerous fuel and oil storage locations throughout this area.

14.2.4.1 The POL refuelers are parked outdoors on metal secondary containment, and typically contain fuel. A leak or failure would be contained in the secondary containment and overflow to gravel areas. The maximum spill volume is estimated as 6,000 gallons, based on the capacity of the R-11.

14.2.4.2 All drums in the shop areas, whether indoors or outdoors, are stored on containment pallets which hold 100% of the contents of the single largest container on the pallet. Outdoor drum storage is also present. Containment is provided for all three areas so that 100% of the contents of one drum would be contained in each area.

14.2.5 SWDA has one 550-gallon tank which stores JP-5 to power the incinerator. The area is enclosed by a ring of concrete blocks. These blocks do not provide secondary containment. The tank is of single-walled construction, and has no secondary construction associated with it. A spill or discharge would collect and penetrate the soil and / or discharge through spaces in the vehicle barrier. Runoff would be in the direction of the Pacific Ocean.

14.3 Diked Area, Inspection and Drainage of Rainwater

112.8(c)(3): You must not allow drainage of uncontaminated rainwater from the diked area into a storm drain or discharge of an effluent into an open watercourse, lake, or pond, bypassing the facility treatment system unless you:

(i) Normally keep the bypass valve sealed closed.

(ii) Inspect the retained rainwater to ensure that its presence will not cause a discharge as described in §112.1(b).

(iii) Open the bypass valve and reseal it following drainage under responsible supervision; and

(iv) Keep adequate records of such events, for example, any records required under permits issued in accordance with 40 CFR 122.41(j)(2) and 40 CFR 122.41(m)(3).

14.3.1 Following each major rainfall event or a series of minor rainfall events, designated facility personnel trained in SPCC procedures must inspect diked areas to determine if the rainwater needs to be removed from the structure, and to assess whether oil sheen is present. When no free product or sheen is observed, the valve is opened and

rainwater drained onto the surface. Section 13.1 of this Plan presents the procedures in place for responding to the presence of free product or sheen on impounded rain water during inspection of the diked area. The drainage events must be continually monitored. All dike drain valves are maintained in the "closed" position, except during these drainage events.

14.3.2 The date, time, location, and name of the individual who performed the operation must be logged on the Secondary Containment Drainage Log (Form 2 in Annex B). The diked areas must also be inspected in accordance with Form AFTO 39. 14.3.3 Secondary containment areas for bulk storage tanks and associated containment basins are inspected daily for potential JP-8 releases and rainwater accumulation. Rainwater is considered contaminated if it exhibits a visible sheen on the surface. If oil sheen is observed, it is noted, on AFTO Form 39, as a discrepancy. The discrepancy is reported to maintenance and action is taken in accordance with Air Force Instruction (AFI) 23-201 and Technical Order (TO) 37-1-1 to remove JP-5 prior to discharging the accumulated rainwater. Drainage from the diked areas is controlled by a manually operated ball valve that is normally locked in the "closed" position. The Bulk Storage Dike Drain Log must be annotated each time the dike drain is opened to remove water. These logs are maintained by LFM personnel. The two bulk storage areas are discussed below.

14.3.3.1 Bulk Storage Area (1800 Area) and Operational Storage Area (1500 Area).

14.3.3.2 Rainwater accumulation from the diked areas drains to vaulted sumps that are equipped with manually-operated gravity-feed discharge pipes. These discharge lines must be kept locked in the upright and "closed" position to prevent flow through the line. In the event of a release from the ASTs, the fuel would be contained within the diked areas.

14.3.3.3 The dike drainage lines must be kept closed and locked until rainwater accumulation within the diked area is determined to be uncontaminated. This determination is based upon visual inspection to note if there is a sheen on the surface of the water. If a sheen is not observed, the water is deemed uncontaminated and the dike is drained by system operator. Exterior dike drain valves must be inspected weekly to ensure they are locked in the closed position. Secondary containment areas must be visually inspected daily for potential discharges and contaminated rainwater accumulation using the Fuel System Inspection and Discrepancy Report Form (AFTO Form 39, Annex B).

14.3.3.4 In accordance with AFI 23-201, Attachment 10, Environmental Guidelines, WIA will not discharge contaminated drainage water containing residual petroleum products directly to the environment. The POL Manager coordinates with WIA Environmental Management to properly dispose of contaminated fuel tank dike drainage and tank bottom water. Tank bottom water logs must be maintained in the functional areas.

14.4 Corrosion Protection and leak testing of Buried Metallic Storage Tanks

112.8(c)(4): You must protect any completely buried metallic storage tank installed on or after January 10, 1974 from corrosion by coatings or cathodic protection compatible with local soil conditions. You must regularly leak test such completely buried metallic storage tanks.

14.4.1 There are no USTs located at WIA, therefore, this section is not applicable.

14.5 Corrosion Protection of Partially Buried Metallic Tanks

112.8(c)(5): You must not use partially buried or bunkered metallic tanks for the storage of oil, unless you protect the buried section of the tank from corrosion. You must protect partially buried and bunkered tanks from corrosion by coatings or cathodic protection compatible with local soil conditions.

14.5.1 No partially buried metallic tanks are present at WIA; therefore, this section is not applicable.

14.6 Aboveground container Periodic Integrity Testing

112.8(c)(6): You must test each aboveground container for integrity on a regular schedule, and whenever you make material repairs. The frequency of and type of testing must take into account container size and design such as floating roof, skid-mounted, elevated, or partially buried. You must combine visual inspection with another testing technique such as hydrostatic testing, radiographic testing, ultrasonic testing, acoustic emissions testing, or another system of non-destructive shell testing. You must keep comparison records and you must also inspect the container's supports and foundations. In addition, you must frequently inspect the outside of the container for signs of deterioration, discharges, or accumulation of oil inside diked areas. Records of inspections and tests kept under usual and customary business practices will suffice for purposes of this paragraph.

14.6.1 In general, the intent of 112.8(c)(6), as described further in the preamble (67 FR 47120), "requires visual testing in conjunction with another method of testing, because visual testing alone is normally insufficient to measure the integrity of a container." The preamble further states, however, that:

14.6.1.1 "For certain smaller shop-built containers in which internal corrosion poses minimal risk of failure; which are inspected at least monthly; and, for which all sides are visible (i.e., the container has no contact with the ground), visual inspection alone might suffice, subject to good engineering practice. In such case the owner or operator must explain in the Plan why visual integrity testing alone is sufficient, and provide equivalent environmental protection."

14.6.2 Based on this citation from the SPCC preamble, deviations to the integrity testing requirements of Rule 112.8(c)(6) exist based on the container size and design and whether good engineering practices are applied for the alternative. For example, integrity testing of 55-gallon drums is not practicable, however, visual inspection of all sides on monthly inspections, maintaining free contact from ground, and secondary containment are practicable and similarly meet the intent of the rule. This is also consistent with the industry standard for shop-built containers (Section 5 of Steel Tank Institute SP001) that similarly specifies visual inspections alone are adequate for tanks that meet certain criteria, which are discussed further below.

14.6.3 Records of all inspections must be maintained by the respective Tank Custodians for a period of 5 years.

14.6.4 Shop-Fabricated Tanks (Visual Inspection Only): tanks that meet the following criteria do not require non-destructive integrity testing. Visual inspections alone, as outlined in the inspection Form AFTO 39 (Annex B), is adequate for meeting the rule:

14.6.4.1 Double-wall tanks with interstitial monitoring

14.6.4.2 Single-wall tanks constructed with a double bottom that includes a vacuum on the interstitial space

14.6.4.3 Single-wall tanks and other containers that are supported on legs, pedestals, or pallets such that the bottom of the container is visible, the contained substances are not corrosive to the tank, and the containers are located within adequate containment structures

14.6.5 Tanks at WIA that are covered by the above criteria for visual inspections are as follows:

14.6.5.1 ConVault Tanks

14.6.5.2 Double-wall Tanks

14.6.5.3 Single-wall tanks, including totes and 55-gallon drums, with support and secondary containment

14.6.6 Sample inspection Form AFTO 39 presented in Annex B for inspections of a single tank and multiple tanks, respectively. As discussed in Section 7, tanks covered by this SPCC Plan are subject to routine visual inspections at least once a month. POL personnel perform maintenance inspections by visually inspecting all tanks within the 1800 Area and 1500 Area daily, weekly, monthly, quarterly, and semiannually. Owning personnel visually inspect the remaining tanks throughout the Base as indicated in Table 7-1. As long as the monthly visual inspections of these tanks reveal no indications of defects, visual inspections are sufficient to verify the integrity of the shop fabricated tanks listed above. Facility personnel are instructed to notify the individuals listed in Section 2 any time leaks, overfills, or signs of deterioration of any oil containers are observed.

14.6.7 Elements to be addressed during the periodic visual inspections include the following:

14.6.7.1 Presence of water present in the primary tank, secondary tank, interstice, or spill container;

14.6.7.2 Whether or not there is debris or a fire hazard present in the secondary containment;

14.6.7.3 Drain valves are operable and in a closed position;

14.6.7.4 Containment egress pathways are clear and any gates or doors are operable;

14.6.7.5 Visible signs of leakage around the tank, concrete pad, containment, ringwall, or the ground;

14.6.7.6 Ladder or platform structure is secure with no signs of severe corrosion or damage;

14.6.7.7 Tank liquid level gauge is readable and in good condition; and

14.6.7.8 All tank openings are properly sealed.

14.6.8 Shop-Fabricated Tanks (Visual Inspection and Non-Destructive Integrity Testing): in addition to the visual inspection requirements, tanks that meet the criteria

outlined below require the minimum integrity testing every 10 years as outlined in Section 5 of STI SP001:

14.6.8.1 Single-wall tanks with ground contact without interior access / manways (pressure testing required).

14.6.8.2 Single-wall tanks with ground contact with interior access / manways (ultrasonic testing and/or pressure testing).

14.6.8.3 Single-wall tanks not in contact with the ground without secondary containment and without interior access / manways (visually examine tank interior or conduct ultrasonic testing).

14.6.8.4 Single-wall tanks not in contact with the ground without secondary containment and with interior access / manways (visually examine tank interior or conduct ultrasonic testing).

14.6.9 Field-Erected Tanks (Visual Inspection and Non-Destructive Testing): in addition to the visual inspection requirements, minimum integrity testing requirements must also be met for field-erected tanks which have tank bottoms that cannot be visually inspected. More information about inspections for field-erected tanks, and which tanks this requirement is applicable to, is described in Section 11.0

14.6.9.1 The industry standard for field-erected tanks (API 653-Tank Inspection, Repair, Alteration, and Reconstruction) specifies that in addition to monthly visual inspection, external inspections by an authorized inspector must be conducted at least every 5 years or based on a shell thickness/corrosion rate measurements outlined in Section 6.3.2 and 6.3.3 of API 653.

14.6.9.2 Internal tank inspections are also required to: (1) ensure tank bottoms are not severely corroded / leaking (2) to determine whether bottom and shell thickness meet the minimum requirements, and (3) identify and evaluate whether tank bottoms are settling. Formal inspections by a qualified inspector using ultrasonic inspections shall be used to determine the thickness, corrosion rate, and integrity of the tank bottom. With this information, an internal inspection interval should be established utilizing the methods included in API 653. The inspection interval shall be set to ensure that the bottom plate minimum thickness at the next inspection is not less than the criteria listed as follows.

14.6.9.3 Minimum Bottom Plate Thickness (inch) Foundation Design

0.10 Foundation design with no means for detection and containment of a bottom leak.

0.05 Foundation design with means to provide detection and containment of a bottom leak.

0.05 Applied tank bottom reinforced lining, >0.05 inch thick, in accordance with API RP 652.

14.6.9.4 In cases where external access to the tank bottom is allowed, external inspections in lieu of internal inspections can be used to meet the data requirements above. If corrosion rates and tank bottom thickness are not known, these must be

determined within **10 years** of tank operation. All records, reports, and non-destructive examinations shall be maintained/ performed as outlined in Section 6.8 through 6.10 of API 653.

14.6.9.5 For any new tanks that it might install in the future, WIA must obtain certification of integrity testing from the manufacturer or installer prior to placing the tank into service. Likewise, if there is a material (significant) repair of the shell of any tank, the integrity of the tank must be tested by an appropriate method before the tank is returned to service. In addition to these inspections, installation personnel and building managers are instructed to notify the individuals listed in Section 2.2 any time leaks, overfills, or signs of deterioration of the oil structure are observed.

14.6.9.6 Inspections are documented and records maintained for at least three years by the respective office performing the inspections. Table 7-1, Visual Inspection Schedule, summarizes required inspection and testing requirements for primary oil-containing structures at WIA. The table also includes fuel-transfer piping systems, generators with internal day tanks, drum storage sites, and vehicle storage areas.

14.6.10 Bulk Storage Area (1800 Area): leak detection tests must be conducted annually on all tank systems and piping. These tests must comply with the requirements of UFC 3-460-03 and AFI 32-7044, *Storage Tank Compliance*. Daily inspections of the exterior of the ASTs must be conducted, in accordance with TO 37-1-1. Any discrepancies must be noted on AFTO Form 39 and a maintenance work request order is submitted to LFM.

14.6.10.1 LFM conducts weekly, monthly, quarterly, and annual inspections. Maintenance Action Sheets (MAS) are used to track and record maintenance activities on all LGRF tanks. These inspections include visual observation of the exterior of the tanks and tank coatings for signs of deterioration or corrosion with special attention to seams for rust, foundation settlement, leaks, accumulation of oil inside diked areas, and inspection of ground connections around the periphery of the base. LFM also conducts tank cleaning, valve replacement, meter/gauge calibration and corrosion control which is covered in UFC 3-460-03, Chapters 2 and 9.

14.7 Control of Leakage through Internal Heating Coils

112.8(c)(7): You must control leakage through defective internal heating coils by monitoring the steam return and exhaust lines for contamination from internal heating coils that discharge into an open watercourse, or pass the steam return or exhaust lines through a settling tank, skimmer, or other separation or retention system.

14.7.1 No tanks at this facility are equipped with internal heating coils; therefore*, this section is not applicable*.

14.8 Liquid Level Sensing Devices

112.8(c)(8): You must engineer or update each container installation in accordance with good engineering practice to avoid discharges. You must provide at least one of the following devices:

(i) High liquid level alarms with an audible or visual signal at a constantly attended operation or surveillance station. In smaller facilities an audible air vent may suffice.

(ii) High liquid level pump cutoff devices set to stop flow at a predetermined container content level.

(iii) Direct audible or code signal communication between the container gauger and the pumping station.

(iv) A fast response system for determining the liquid level of each bulk storage container such as digital computers, telepulse, or direct vision gauges. If you use this alternative, a person must be present to monitor gauges and the overall filling of bulk storage containers.

(v) You must regularly test liquid level sensing devices to ensure proper operation.

14.8.1 Protection against tank overfill is best achieved by (1) awareness of available tank capacity and inventory and (2) careful monitoring (either manually or automatically) and control of product movement. Good engineering practices at WIA include either liquid level sensing devices and high level liquid alarms or a combination of manual gauging and verbal communication. No fuel loading/unloading is performed through remote monitoring or at unattended facilities.

14.8.2 Bulk Storage Area (1800 Area): tanks 31 and 32 are equipped with high-level automatic alarms, which must be tested annually by LFM in accordance with manufacturer's specifications. Tanks 31 and 32 are equipped with automatic tank gauging that is currently out of service. Pipelines associated with the ASTs enter the tanks near the bottom of the liquid level. Each transfer line is equipped with an emergency shutoff valve at the tank, in the event of line rupture.

14.8.3 Operational Storage Area (1500 Area): tanks 28 and 29 are equipped with audible high liquid level alarms and automatic shut-off valves. High level alarms are regularly tested in accordance with manufacturer's specifications. These tests are documented in order to help facilitate compliance during an inspection. Annex B contains Form AFTO 39 to be used to document these inspections. Each transfer pipeline is equipped with an emergency shut-off valve at the tank, in the event of line rupture.

14.8.4 Electrical Equipment: according to the "bulk storage container" definition under rule 112.2, oil-filled electrical equipment is not a bulk storage container. Therefore, rule 112.8(c) does not apply to oil-filled electrical equipment, and liquid level sensing devices are not required.

14.8.5 Industry Standard Consideration: in addition to the general fuel loading guidelines outlined in Section 10, WIA personnel must be cognizant of the following overfill protection guidelines outlined in API 2350 Section 2.2.2:

14.8.5.1 If an electrical or mechanical failure occurs that affects the level detectors, product receipt shall stop and not recommence until (a) the detectors are functioning properly or (b) manual operations and procedures are implemented (as outlined in Section 10).

14.8.5.2 When only one detector is used, this high-high level detector shall be located at or above the safe fill levels and shall alarm/signal to provide sufficient time to shut off or divert product flow before the overfill is reached.

14.8.5.3 When used for overfill protection, the high-high level detector shall be independent of the automatic tank gauge system to provide greater reliability and to comply with the requirements of NFPA 30 (Section 2-10).

14.8.5.4 If a tank is to be filled above its normal fill level (normal capacity) up to its safe fill level (tank rated capacity), a trained and qualified person shall be assigned by

the operator to be present at the tank. API does not recommend routinely filling a tank above the safe fill level due to the increase in overfill risk.

14.8.5.5 Any shutdown or diversion procedures should be compatible with the transporter's operations to prevent consequential damage such as hydraulic shock or over-pressuring the piping system.

14.8.6 All gauging equipment, detector instrumentation, and related systems must be inspected and tested annually as outlined in NFPA 30, Section 2.6.1.3, API 653, and in accordance with the manufacturers' instructions. Refer to Form AFTO 39 in Annex B for guidance on what systems need to be inspected.

14.9 Observation of Disposal Facilities for Effluent Discharge

112.8(c)(9): You must observe effluent treatment facilities frequently enough to detect possible system upsets that could cause a discharge as described in §112.1(b).

14.9.1 There are no effluent treatment facilities at WIA.

14.10 Visible Oil Leak Corrections from Tank Seams and Gaskets

112.8(c)(10): You must promptly correct visible discharges which result in a loss of oil from the container, including but not limited to seams, gaskets, piping, pumps, valves, rivets, and bolts. You must promptly remove any accumulations of oil in diked areas.

14.10.1 Visible oil leaks from tank systems are identified during the inspections that are completed in accordance with Table 7-1 and Annex B, Form 3A, and AFTO Form 39. Operational personnel are trained and instructed to notify the individuals listed in Section 2.2 if these conditions are observed. WIA will remove any discharged oil from the secondary containment area, if needed, and ensure that tank seams, gaskets, pumps, valves, rivets and bolts are repaired promptly.

14.10.2 Bulk Storage Area (1800 Area): visible oil leaks from tank seams, gaskets, rivets, and bolts, causing an accumulation of oil in the diked areas of the tanks, are immediately reported by POL Operations to LFM and are promptly corrected by LFM through established procedures found in UFC 3-460-03. LFM is responsible for remediating any oil leaks and correcting the deficiency or damage responsible for causing the leakage. POL Operations is responsible for recording any deficiencies observed and tracking remedial actions taken on AFTO Form 39. LFM personnel maintain inventories of the tank contents as an additional method of monitoring for leaks.

14.10.3 Operational Storage Area (1500 Area): visible oil leaks from tank seams, gaskets, rivets, and bolts, causing an accumulation of oil in the diked areas of the tanks, are promptly reported by POL Operations to LFM and are promptly corrected by LFM through established procedures found in in UFC 3-460-03. See Section 5.3.8 for AF protocol followed by POL Operations and LFM personnel.

14.11 Appropriate Position of Mobile or Portable Oil Storage Containers

112.8(c)(11): You must position or locate mobile or portable oil storage containers to prevent a discharge as described in §112.1(b). You must furnish a secondary means of containment, such as a dike or catchment basin, sufficient to contain the capacity of the largest single compartment or container with sufficient freeboard to contain precipitation.

14.11.1 Table 3-1 summarizes the mobile or portable oil storage containers at the facility. Mobile or portable containers consist of tank trucks and bowsers. Also included on Table 3-1 are 55-gallon or large size drums and AFVO ASTs. There are a number of mobile and portable oil storage containers at the facility, including bowsers, one C-300 tanker truck, three R-11 tanker trucks, two R-12 tanker truck, and 55-gallon drums. The primary function of the tanker trucks is to refuel aircraft, and to transfer fuel from the 1500 Area to smaller oil tanks/ equipment throughout WIA. The primary function of the bowsers is to provide a mobile collection point for recovered fuel generated by routine LFM activities for re-introduction to the fuel system. Drums are used for storage of new, in-use, and used oil. The POL refuelers are parked outdoors on a metal secondary containment pad, and typically contain fuel. A leak or failure would be contained in the secondary containment and overflow to gravel areas. A spill response kit should be kept in the cab of the refuelers or other accessible location. See section 14.2 for more information regarding secondary containment for mobile containers.

14.11.2 Industry Standard Consideration: relevant industry standards (BOCA F-3210) related to portable tanks/tank vehicles include the following:

14.11.2.1 All tank vehicles be designed and constructed in accordance with NFPA 385 listed in Chapter 44. These standards offer detailed information regarding thickness of material for tank construction versus tank capacities, etc.

14.11.2.2 Tank vehicles shall not be parked or left unattended on any street, highway, avenue, or alley except for necessary stops. Tank vehicles shall not be parked out-of-doors at any one point for longer than 1 hour, except at flammable liquid bulk terminals, bulk plants, and other approved locations.

14.11.2.3 Tank vehicles shall not be parked or garaged in any structure, except structures specifically approved for such purpose.

14.11.2.4 Each tank vehicle shall be provided with at least one portable multi-use fire extinguisher with a minimum 2A, 20B, C rating. The "A" indicates suitability for ordinary combustibles (wood, trash, etc.), "B" indicates suitability for flammable liquids, and "C" indicates suitability for electrical fires.

14.11.2.5 The driver, operator or attendant of any tank vehicle shall not remain in the vehicle cab and shall not leave the vehicle while being filled or discharged. If loading/unloading is performed without a power pump, the tank truck motor shall be shut down throughout such operations

This Page Intentionally Left Blank

15.0 Facility Transfer Operations, Piping and Pumping

15.1 Bulk Storage Areas: pipelines are used for the transfer of fuel from the 1800 Area ASTs to the 1500 Area ASTs to the tank truck loading/unloading area in the 1500 Area, and from the 1800 Area to the Type II hydrant system.

15.2 Buried Piping Installation Protection and Examination

112.8(d)(1): Provide buried piping that is installed or replaced on or after August 16, 2002, with a protective wrapping and coating. You must also cathodically protect such buried piping installations or otherwise satisfy the corrosion protection standards for piping in 40 CFR 280 or a State program approved under 40 CFR 281. If a section of buried line is exposed for any reason, you must carefully inspect it for deterioration. If you find corrosion damage, you must undertake additional examination and corrective action as indicated by the magnitude of the damage.

15.2.1 Buried piping installed prior to August 16, 2002 is not required to comply with this requirement. Buried piping installed after August 16, 2002, namely piping between the Marine Area and 1800 Area, is wrapped and cathodically protected and therefore complies with this requirement.

15.2.2 Table 7-1 presents the inspection schedule for aboveground and underground piping. Once per year, cathodic protection systems are inspected by a cathodic protection specialist certified through the National Association of Corrosion Engineers. Semiannual visual inspections for underground piping consist of an evaluation of possible leaks by noting any changes in the surface contour of the ground, discoloration of the soil, softening of paving asphalt, pool formation, bubbling water puddles, or noticeable odor. The annual inspection of the cathodic protection for aboveground piping consists of an external visual inspection, leak testing, or line thickness testing as outlined in Sections 9.2.6 and 9.2.7 of API 570 – Piping Inspection Code. If corrosion damage is detected, appropriate corrective action is taken.

15.2.3 Bulk Storage Areas 1800 and 1500:

15.2.3.1 All bulk storage underground transfer pipelines on-base are cathodically protected, including piping connected to the ASTs and to the tank truck loading/unloading facility. Aboveground piping is constructed of painted steel pipe. It is not known as to whether all the underground piping has protective wrapping or coating. If a portion of the buried pipeline is exposed for any reason, it is carefully examined for deterioration and corrective action taken as indicated by the magnitude of the damage. Pipeline terminal connections are capped or blank-flanged and marked as to their origin when they are removed from service.

15.3 Not-In-Service and Standby Service Terminal Connections

112.8(d)(2): Cap or blank-flange the terminal connection at the transfer point and mark it as to origin when piping is not in service or is in standby service for an extended time.

15.3.1 Written procedures for capping and blank-flanging of pipe must be followed when maintenance is performed on the tanks, piping, or dispensing systems.

15.3.2 Bulk Fuel Storage Areas and Hydrant System: written procedures for capping and blank-flanging pipes as contained in UFC 3-460-03 are followed when maintenance is performed on the hydrant system or bulk fuel storage systems. Transfer pipe terminal

connections were observed at each pump house. Pipeline terminal connections are capped or blank flanged and marked as to their origin when they are removed from service.

15.3.3 Other Tank Systems: written procedures for capping and blank flanging of pipe contained in UFC 3-460-03 are followed when maintenance is performed on the tanks, piping, or dispensing systems.

15.4 Pipe Supports Design

112.8(d)(3): Properly design pipe supports to minimize abrasion and corrosion and allow for expansion and contraction.

15.4.1 Piping supports have been designed and constructed in accordance with good engineering practice to minimize the potential for abrasion and corrosion and to allow for expansion and contraction.

15.4.2 Bulk Storage Area (1800 Area): pipe supports within the 1800 Area are constructed of steel braces set in concrete. The pipes sit on steel cradles which are attached to the steel braces. The construction minimizes abrasion and corrosion, but allows for expansion and contraction of the pipeline.

15.4.3 Operational Storage Area (1500 Area): pipe supports within the Type II Hydrant area are constructed of steel braces set in concrete and the pipes are sitting on the steel cradles. The pipes sit on steel cradles which are attached to the steel braces. The construction minimizes abrasion and corrosion, but allows for expansion and contraction of the pipeline. The supports are noted to be in good condition, free of corrosion.

15.5 Aboveground Valve and Pipeline Examination

112.8(d)(4): Regularly inspect all aboveground valves, piping, and appurtenances. During the inspection you must assess the general condition of items, such as flange joints, expansion joints, valve glands and bodies, catch pans, pipeline supports, locking of valves, and metal surfaces. You must also conduct integrity and leak testing of buried piping at the time of installation, modification, construction, relocation, or replacement.

15.5.1 All aboveground piping must be visually inspected annually as outlined in Table 7-1 to satisfy this regulation. An example aboveground piping inspection checklist is provided as Form AFTO 39 in Annex B. This inspection includes observations for leaks, misalignment, vibration, supports, corrosion, and miscellaneous items. Additionally, operational personnel are trained and instructed to notify the individuals listed in Section 2.2 any time leaks or signs of deterioration are observed. WIA will conduct integrity and leak testing of buried piping at the time of installation, modification, construction, relocation, or replacement.

15.5.2 Bulk Fuel Storage Areas: LGRF operations personnel must conduct daily and weekly operational inspections in accordance with Air Force TO 37-1-1. All valves, piping, and other appurtenances must be visually inspected to identify deficiencies or maintenance needs. Ensure that secondary containment valves are in the "locked" position unless when filling. Pipe integrity testing must be performed in accordance with UFC 3-460-03.

15.5.3 Operational Storage Area: All aboveground fuel piping must be pressure-tested annually and hydrostatically tested every five years. Records of these integrity tests are

maintained by LFM and Environmental Flight personnel. AFTO Form 39 is used for recording daily and weekly equipment inspections, including the general condition of items such as flange joints, expansion joints, valve glands and bodies, catch pans, piping supports, locking valves and metal surfaces.

15.6 Aboveground Piping Protection from Vehicular Traffic

112.8(d)(5): Warn all vehicles entering the facility to be sure that no vehicle will endanger aboveground piping or other oil transfer operations.

15.6.1 Though primarily used to protect aboveground piping, bollards and other similar equipment are also used to protect aboveground tanks and shallow underground lines. These structures are used properly at WIA and are painted yellow to ensure that drivers of vehicles are aware of the hazards.

15.6.2 Bulk Storage Area (1800 Area): procedures are in place to control vehicular traffic into the 1800 Area, as there is little traffic other than LFM and driveways are clearly delineated. Aboveground piping is not within the traffic areas. LFM ensures all pipelines, tanks, and fill stands are properly marked in accordance with Mil-Std-161.

15.6.3 Operational Storage Area (1500 Area): procedures are in place to control vehicular traffic into the 1500 Area, as the area is not fenced and driveways are clearly delineated. Aboveground piping is minimal and not within the traffic areas. LFM ensures all pipelines, tanks, and fill stands are properly marked in accordance with Mil-Std-161.

This Page Intentionally Left Blank

16.0 Countermeasures, Cleanup, and Disposal Procedures

112.7(a)(3): You must also address in your Plan: (iv) Countermeasures for discharge discovery, response, and cleanup… (v) Methods of disposal of recovered materials in accordance with applicable legal requirements.

16.1. Discharge Control Equipment and Materials

16.1.1 WIA has discharge response capability, equipment, and personnel to handle any small and medium discharge or discharge to on-site facilities. In addition, WIA will retain an outside spill response contractor if there is a discharge to the Pacific Ocean.

16.1.2 The WIA Staff and its spill response contractors are responsible for inspecting, maintaining, and replenishing discharge response equipment. Discharge identification and response/recovery exercises and drills must be conducted during the annual SWPP/SPCC training.

Spill Response Equipment and Materials Available at WIA

- Containment Booms
- Backhoe
- Materials to construct weirs in ditches
- Forklift trucks
- Tanks, totes, barrels
- Pumps
- Booms, absorbent pads, stay dry
- Personal protection equipment
- Communication equipment

16.2 Discharge Notifications

16.2.1 Discharge-related emergency contacts must be made on many levels, primarily local and regional. However, the National Response Center is the first organization contacted in the event of a discharge to the environment. Spill reporting forms to be used in the event of a spill are located in Annex B.

16.2.2 Notification will include at a minimum the following information: amount and type of oil discharged, the source of the discharge, and the time the event occurred.

16.2.3 Additional information on discharge notifications can be found in the WIA FRP.

Definitions

Release is any spilling, leaking, pumping, pouring, escaping, leaching, or disposing into the environment.

Environment is the navigable waters of the U.S., and any other surface water, groundwater, drinking water supply, land surface or subsurface strata, or ambient air within the U.S.

Harmful quantity of oil is a quantity that violates applicable water quality standards, causes a film or sheen upon or discoloration of the surface of the water or adjoining shorelines or a sludge or emulsion to be deposited beneath the surface of the water or upon adjoining shorelines, or exceeds 25 U.S. gallons on land.

16.3 Discharge Response Procedures

16.3.1 This section addresses the emergency procedures to be followed by WIA personnel if a discharge, release, or intermittent discharge of oil occurs at the facility. Discharge response procedures are addressed in the facility's Facility Response Plan. Refer to these manuals for additional response and safety information.

16.4 Disposal Plans

16.4.1 Small quantities of contaminated materials and waste product should be handled according to the WIA Hazardous Material and Waste Management Plan (HMWMP). Materials determined to exhibit hazardous waste characteristics will be prepared for

disposal according to procedures outlined in the HMWMP. Disposal should be undertaken according to appropriate federal requirements.

16.4.2 Any HW generated will be managed in accordance with the WIA HMWMP, maintained by the BOS Contractor. Recovered product, excluding MOGAS and Low Sulfur Diesel, shall be tested by LFM to determine if it can be reclaimed. If it meets the criteria, it will be shipped off-island for recycling; recovered MOGAS and unsuitable recovered product is shipped off-site as hazardous waste. Disposal of diesel fuel contaminated PPE, absorbents and soil will be sent to the SWDA and incinerated. MOGAS contaminated PPE and response materials will be shipped off-island as hazardous waste and will be performed in compliance with applicable federal regulations.

16.4.3 Disposal of items not described above will be conducted in accordance with procedures described in the WIA HMWMP. Non-hazardous used or spent response materials, contaminated soil, PPE, decontamination solution, adsorbents and spent chemicals should be containerized in compatible DOT approved containers. WIA Environmental Management should verify that transport and final disposal are performed in compliance with applicable regulations.

16.4.4 For medium and large quantity discharges, contaminated soil, PPE, decontamination solution, adsorbents and spent chemicals should be containerized in storage containers (bulk storage/roll-offs, as necessary) compatible with the material being stored. As stated previously, all waste material will be disposed of by approved methods described in the WIA HMWMP.

16.4.5 Discharges requiring assistance from contractors will be initiated by the IC and coordinated through 611 CES/CEI through the base contracting officer. Once the contractor arrives on base, cleanup is facilitated through 611 CES/CEI. The WIA Environmental Manager will coordinate, schedule, and oversee all contractor activities including response, record keeping, and reporting, as well as discharge monitoring and assessment of completed decontamination of the incident area. For waste that are deemed regulated and greater than 55 gallons in quantity must be removed to a 90-day site (once 55 gallons has been reached, generator has three calendar days to remove waste to a 90-day facility), thereafter waste will be shipped off the island for proper disposal and/or treatment. Likewise, all waste containers should be secured, labeled, marked, stored with compatible waste, stored in compatible containers and stored in secondary containment (applicable to liquid or semi-liquid waste).

16.5 Safety Precautions

16.5.1 Discharged oil products, due to inherent physical characteristics, must be assumed to be hazardous. As such, personnel must take appropriate measures to prevent accidental ignition of any waste materials during discharge remedial activities. The most prominent threat is from external ignition sources, such as open flames, smoking materials, sparks, etc. The following safety guidelines are to be strictly enforced to ensure that accidental ignition does not result:

16.5.1.1 Smoking will be prohibited within 100 feet of the discharge-impacted area. NO SMOKING signs shall be posted at the discharge area.

16.5.1.2 Ignition sources shall be prohibited in the discharge area.

16.5.1.3 Spark-producing equipment and tools shall be prohibited from use near discharged materials or oil-contaminated materials, unless specifically authorized by the Incident Commander.

16.5.1.4 The Incident Commander shall ensure that hand tools and mechanical devices are inspected to ensure they have not become unsafe for designated uses.

16.5.1.5 Motor vehicles used to transport any waste fuels, oil-contaminated materials, or any other potentially hazardous material at the discharge site, shall meet all applicable U.S. Department of Transportation safety standards.

16.5.1.6 No operations shall be conducted during electrical storms.

16.6 Free Product (Oil, JP-5, and Gasoline)

16.6.1 Free product is to be collected by experienced or trained personnel.

16.6.2 Dispersing materials or methods must never be used unless specifically authorized by the regulatory personnel.

16.6.3 Free product shall be collected using absorbent materials. The absorbent shall be applied until all free liquids are retained.

16.6.4 Free product may be stored in waste collection containers (tank or drums) until pickup for removal from the site. Storage time onsite should be kept to a minimum.

16.6.5 Collected materials shall be transferred within areas equipped with secondary containment or in areas where temporary containment can prevent leaks or discharges from escaping.

16.6.6 Used absorbent shall be collected with non-spark-producing tools and placed in drums or pails, which shall be sealed when full. All containers shall be labeled as directed by the WIA Environmental Manager.

16.6.7 All containerized waste products shall be classified within the provisions of 40 CFR 261 and transported offsite within regulatory time constraints for reclamation/disposal at a state-licensed treatment, storage, and disposal facility (TSDF).

16.6.8 Appropriate manifests, disposal documentation, and written reports shall be maintained onsite within the provisions of 40 CFR 262.

16.6.9 The Incident Commander will supervise removal and disposal of discharged and related materials.

16.7 Preventing Recurrence or Spread of Fires, Explosions, or Releases

16.7.1 Shut off all electrical power to the affected area and cease normal operations ceased to allow full access by incident teams. Notify local authorities when appropriate (FRP).

16.7.2 Isolate the incident area, determine the effect upon adjacent operations, and evaluate factors such as heat buildup on adjacent walls/containers and the potential for discharged material to react with other nearby materials or building surfaces, etc.

16.7.3 WIA response personnel should continue to monitor the area following incident response and cleanup.

16.7.4 Dispose of oily wastes and associated disposable material generated as a result of discharge cleanup, fire-fighting efforts, etc. in appropriate containers for subsequent disposal in accordance with federal laws. Oil shall be recycled or reclaimed whenever possible prior to the decision to dispose.

16.7.5 Handle recovered materials as a hazardous waste unless analyses from approved analytical procedures or generator knowledge indicate otherwise.

16.7.6 The emergency response procedures addressed here shall be reviewed annually and amended as needed to address changes or additions to any of the following: (1) facility processes and operations, (2) petroleum substances present onsite, or (3) key discharge response personnel. In addition, after any reportable discharge event, information in this section should be reviewed and updated as necessary with any amendments certified in a timely fashion.

17.0 Written Spill Report Guidelines:

17.1 This section addresses written spill reporting requirements for government agencies and for internal record keeping requirements.

17.2 Amendment of SPCC Plans by Regional Administrator

17.2.1 According to 40 CFR 112.4*, WIA is required to report a spill event to the Regional Administrator of the Environmental Protection Agency if it meets either of the criteria shown at right:

1. Greater than 1,000 gallons of oil into or upon the navigable water of the United States or adjoining shorelines in a single spill event;
   OR
2. More than 42 U.S. gallons of oil in each of two discharges occurring within any 12-month period.

17.2.2 The owner or operator of the facility shall submit a written report within 60 days of the date of the spill. The following information must be provided in the report:

17.2.2.1 Name of the facility

17.2.2.2 Your name

17.2.2.3 Location of the facility

17.2.2.4 Maximum storage or handling capacity of the facility and normal daily throughput

17.2.2.5 Corrective action and countermeasures you have taken, including a description of equipment repairs and replacements

17.2.2.6 An adequate description of the facility, including maps, flow diagrams, and topographical maps, as necessary

17.2.2.7 The cause of such discharge as described in §112.1(b), including a failure analysis of the system or subsystem in which the failure occurred

17.2.2.8 Additional preventive measures you have taken or contemplated to minimize the possibility of recurrence

17.2.2.9 Such other information as the Regional Administrator may reasonably require pertinent to the Plan or discharge

17.3 Internal Spill Report

17.3.1 Significant spills† must be logged for internal record keeping. The report should be completed by the facility representative who led the emergency response. Spill reports should be kept in the plan for at least three years following the event.

* Amendment of SPCC Plans by the EPA Regional Administrator

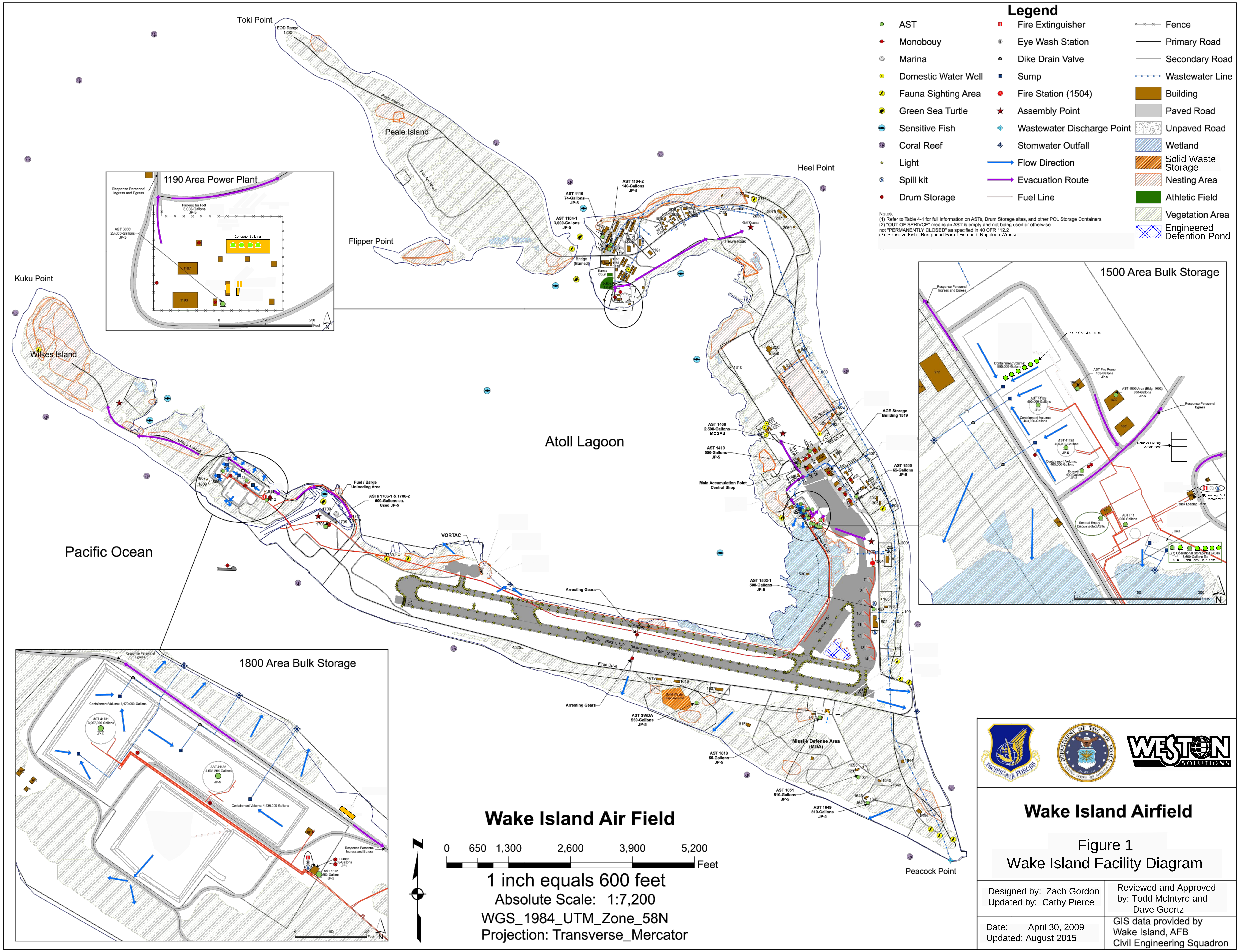
† Spills to the environment that exceed 25 gallons or spills to a waterway that cause a sheen

This Page Intentionally Left Blank

Annex A

Figures

This Page Intentionally Left Blank



Legend
AST
Monobouy
Marina
Domestic Water Well
Fauna Sighting Area
Green Sea Turtle
Sensitive Fish
Coral Reef
Light
Spill kit
Drum Storage
Fire Extinguisher
Eye Wash Station
Dike Drain Valve
Sump
Fire Station (1504)
Assembly Point
Wastewater Discharge Point
Stomwater Outfall
Flow Direction
Evacuation Route
Fuel Line
Fence
Primary Road
Secondary Road
Wastewater Line
Building
Paved Road
Unpaved Road
Wetland
Solid Waste Storage
Nesting Area
Athletic Field
Vegetation Area
Engineered Detention Pond
Notes:
(1) Refer to Table 4-1 for full information on ASTs, Drum Storage sites, and other POL Storage Containers
(2) "OUT OF SERIVCE" means an AST is empty and not being used or otherwise not "PERMANENTLY CLOSED" as specified in 40 CFR 112.2
(3) Sensitive Fish - Bumphead Parrot Fish and Napoleon Wrasse
Toki Point
EOD Range 1200
Peale Avenue
Peale Island
Pan Am Road
Flipper Point
Kuku Point
Wilkes Island
Wilkes Avenue
Heel Point
Wake Avenue
Heiwa Road
Golf Course
Bridge (Burned)
Tennis Court
Softball Field
AST 1110 74-Gallons JP-5
AST 1104-2 140-Gallons JP-5
AST 1104-1 3,000-Gallons JP-5
1190 Area Power Plant
Response Personnel Ingress and Egress
Parking for R-9 5,000-Gallons JP-5
AST 3860 25,000-Gallons JP-5
Generator Building
1197
1198
Atoll Lagoon
Pacific Ocean
Fuel / Barge Unloading Area
ASTs 1706-1 & 1706-2 600-Gallons ea. Used JP-5
VORTAC
Arresting Gears
Runway 9843' x 150' (Instrument) N 68° 15' 08" W
Taxiway "B"
Elrod Drive
Lagoon Road
7th Street
6th Street
5th Street
AST 1406 2,500-Gallons MOGAS
AST 1410 500-Gallons JP-5
Main Accumulation Point Central Shop
AGE Storage Building 1519
AST 1506 62-Gallons JP-5
AST 1503-1 500-Gallons JP-5
AST SWDA 550-Gallons JP-5
Solid Waste Disposal Area
AST 1610 55-Gallons JP-5
Missile Defense Area (MDA)
AST 1651 510-Gallons JP-5
AST 1649 510-Gallons JP-5
Peacock Point
1500 Area Bulk Storage
Out Of Service Tanks
Containment Volume: 995,000-Gallons
AST Fire Pump 165-Gallons JP-5
AST 1500 Area (Bldg. 1602) 800-Gallons JP-5
AST 41129 400,000-Gallons JP-5
Containment Volume: 460,000-Gallons
AST 41128 400,000-Gallons JP-5
Bowser 400-Gallons JP-5
Response Personnel Egress
Refueler Parking Containment
Loading Rack Containment
Truck Loading Rack
Several Empty Disconnected ASTs
AST PR 200-Gallons
Dike
(7) Operational Storage ISO ASTs 6,600-Gallons Ea. MOGAS and Low Sulfur Diesel
1800 Area Bulk Storage
Response Personnel Egress
Containment Volume: 4,470,000-Gallons
AST 41131 3,997,000-Gallons JP-5
AST 41132 4,039,854-Gallons JP-5
Containment Volume: 4,430,000-Gallons
Pumps 55-Gallons JP-5
AST 1812 650-Gallons JP-5
Wake Island Air Field
0 650 1,300 2,600 3,900 5,200 Feet
1 inch equals 600 feet
Absolute Scale: 1:7,200
WGS_1984_UTM_Zone_58N
Projection: Transverse_Mercator
PACIFIC AIR FORCES
DEPARTMENT OF THE AIR FORCE UNITED STATES OF AMERICA
WESTON SOLUTIONS
Wake Island Airfield
Figure 1
Wake Island Facility Diagram
Designed by: Zach Gordon
Updated by: Cathy Pierce
Reviewed and Approved by: Todd McIntyre and Dave Goertz
Date: April 30, 2009
Updated: August 2015
GIS data provided by Wake Island, AFB Civil Engineering Squadron

This Page Intentionally Left Blank

Annex B

Facility Inspection and Spill Reporting Forms

This Page Intentionally Left Blank

BASE OPERATING SUPPORT CONTRACTOR
WAKE ISLAND AIRFIELD
Contract #FA5000-13-C-0005
ENVIRONMENTAL RELEASE REPORT

1. Facility name, location, and mailing address:

Commanding Officer
Wake Island Airfield
Wake Island, HI 96898

Military Installation
NAICS Code 928110
19° 16' 54.46" North Latitude
166° 38' 27.19" East Longitude

2. Qualified Individual name and phone number (contact for more information):

Commander PRSC, Det.1 (808) 424-2468

3. Reporter's name, organization and phone #:
4. Date and time of release:
5. Location of release:
6. Notification of Fire Dept? Yes No by: _____ time: _____
7. Equipment/Facility Involved (include aircraft type & tail number or equipment model number)
8. Root cause of release:
9. Type of material released:
10. Estimated quantity of release:

Spills on hard surfaces: 2 ft dia = 0.25 gal 4 ft dia = 1 gal 6 ft dia. = 2 gal 8 ft dia. = 4 gal 10 ft dia = 6 gal

11. Corrective action taken:

		Est. Quantity (gal)
12. Was the release contained on a hard surface? (concrete, asphalt)	Yes No	_____
Did the release enter the storm drain or surface water?	Yes No	_____
Did the release enter the sanitary sewer?	Yes No	_____
Did the process owner have sufficient clean-up capabilities?	Yes No N/A	
Did the spill reach and soak into the soil?	Yes No <1	
Was the spill cleaned within 24 hours?	Yes No N/A	

13. Name and telephone number for the spill cleanup point of contact:
14. Requirement for DLA spill cleanup support and/or funding:

To be completed by the CFSI Environmental Manager: _____

Is the spill reportable? Yes No

Any continuing threat to the environment? Yes No

FORM 1
SPILL INCIDENT REPORT TO ENVIRONMENTAL MANAGER
(To be completed by responding manager)

INCIDENT DATE:_____ TIME: _____
REPORT DATE: _____ TIME: _____
LOCATION: _____
PERSON REPORTING: _____ PHONE: _____
MANAGER IN CHARGE: ___ PHONE: _____

SPILLED PRODUCT INFORMATION:

Product	Jet Fuel	MOGAS	Diesel	Oil (new)	Oil (used)	Solvent	Deicing Fluid	AFFF	Other
Storage Capacity									
Spill Volume (in gallons)									

STOPPED DATE:_____ TIME: _____

	Yes	No
Spill from or suspected from a leaking underground storage tank or piping?	☐	☐
Spill contained on premises?	☐	☐
If not, did the spill enter sewers, pipes, or ditches?	☐	☐
If not, did the spill enter a body of water?	☐	☐
Will spill cleanup be accomplished within 24 hours?	☐	☐
Were there any injuries?	☐	☐

Nearest body of water or body of water spill entered? _____ Distance_____

CONTRACTORS CONTACTED / AGENCIES AWARE OF INCIDENT:

CONTRACTOR / AGENCY	REPRESENTATIVE	PHONE

DESCRIPTION: (Check one.)

☐ leaking UST or piping
☐ overfill, during fuel drop
☐ drive off, hose in vehicle
☐ overfill, vehicle unattended
☐ overfill, aircraft
☐ venting, aircraft
☐ equipment failure
☐ other human error
☐ other than UST, human error, or equipment failure

(Describe incident on opposite side.)

ADDITIONAL INCIDENT INFORMATION. Include all facts relating to how the incident was discovered, stopped, contained, and cleaned up, and details on any and contacts/conversations with outside agencies.

FORM 2: SECONDARY CONTAINMENT DRAINAGE LOG

Instructions: This log must be completed each time storm water is discharged from secondary containment. The storm water shall not be discharged without treatment if it has a visible sheen. Furthermore, any product in the secondary containment structure must be removed.

Notify WIA Environmental Office immediately if any significant problems are identified.

Site/Date	Oil Present[1] (Y/N)	Treatment Employed (Y/N)	Drain Valve Opened (time)	Drain Valve Closed (time)	Name	Comments

Note:
1 –product or sheen

WEEKLY						
NO.	ITEMS TO BE INSPECTED	1ST	2ND	3RD	4TH	5TH
1	VALVES					
2	ELECTRICAL EQUIPMENT					
3	STRAINERS					
4	GAUGES					
5	DIKES					
6	SAFETY EQUIPMENT					
7	HYDRANT SYSTEM STATIC PRESSURE TEST					
8	CNG SERVICE STATION					

MONTHLY		
NO.	ITEMS TO BE INSPECTED	DATE *(YYYYMMDD*
1	STRAINERS	
2	EMERGENCY SWITCHES	
3	FILLSTAND	
4	WARNING SIGNS	
5	ID MARKINGS	
6	PIPELINES	
7	SAMPLING CONNECTIONS	
8	CNG SERVICE STATION	
9	LOW POINT WATER DRAINS	
10	HYDRANT SYSTEM FLUSH	

SEMI ANNUAL		
NO.	ITEMS TO BE INSPECTED	DATE *(YYYYMMDD*
1	STRAINERS	
2	METERS	
3	GROUNDING/BONDING RECEPTACLES	
4	CNG SERVICE STATION	

FUEL SYSTEM INSPECTION AND DISCREPANCY REPORT

FACILITY NUMBER AND TYPE	DATE *(YYYYMMDD*	SUPERVISOR

GROUND PHASE		FLIGHT PHASE	
NO.	ITEMS TO BE INSPECTED	SIGNATURE	DAY
1	HOSES, NOZZLES, COUPLERS		1
2	BONDING HARDWARE		2
3	PUMPS AND MOTORS		3
4	LEAKS		4
5	FILTERS/FILTER SEPARATORS		5
6	VALVES		6
7	PITS AND OUTLETS		7
8	TANKS		8
9	METERS		9
10	UNLOADING HEADERS		10
11	PRESSURE AND FLOW RECORDER		11
12	PRODUCT RECOVERY SYSTEM		12
13	SYSTEM AREA		13
14	STRAINERS		14
15	PANTOGRAPH ARM		15
16	PNEUMATIC SYSTEMS		16
17	ATG SYSTEMS		17
18	ADDITIVE INJECTOR SYSTEM		18
19	FUEL LEVEL ALARMS		19
20	CNG SERVICE STATION		20
			21
			22
			23
			24
			25
			26
LFM/FUELS SUPERVISOR INSPECTION			27
SIGNATURE	DATE *(YYYYMMDD*		28
			29
			30
			31
			32
			33

OPERATOR		REPORTED TO MAINTENANCE				MAINTENANCE STATUS			
DISCREPANCY	DATE DISC *(YYYYMMDD)*	DATE *(YYYYMMDD)*	TIME	INITIAL	WORK ORDER NUMBER	DATE *(YYYYMMDD)*	STATUS CODE 1	FOLLOW-UP DATE	INITIAL

REMARKS

SIGNATURE OF FUELS MANAGER/SUPERINDENT	DATE
SIGNATURE OF FUELS MANAGEMENT FLIGHT COMMANDER	DATE

STATUS CODE: C - CORRECTED DP - DEFERRED FOR PARTS DM - DEFERRED FOR MAINTENANCE

Annex C

List of Acronyms

This Page Intentionally Left Blank

AFB	Air Force Base
AFCESA	Air Force Civil Engineer Support Agency
AFTO	Air Force Technical Order
AGE	Aerospace Ground Equipment
API	American Petroleum Institute
ASME	American Society of Mechanical Engineers
AST	Aboveground Storage Tank
ATG	Automatic Tank Gauge
ASTM	American Society for Testing and Materials
BBL	Barrels (42 gallons)
CAR	Corrective Action Required
CC	Commander
CE	Civil Engineer
CEI	Installation Management Flight
CES	Civil Engineer Squadron
CEAN	Natural Resource Element
CFR	Code of Federal Regulations
COMSEC	Communications Security
CV	Vice Commander
DESC	Defense Energy Support Center
DLA	Defense Logistics Agency
DOD	U.S. Department of Defense
DOT	U.S. Department of Transportation
DW	Double-walled
EPA	U.S. Environmental Protection Agency
FR	Federal Register
FRP	Facility Response Plan
FY	Fiscal year
GPU	Ground Power Unit
HAZMAT	Hazardous Material
HC	Horizontal Cylindrical
HMWMP	Hazardous Materials and Waste Management Plan
HSV	Hydrant Service Vehicle
HW	Hazardous Waste
IAW	in accordance with
IC	Incident Commander
LFM	Liquid Fuels Maintenance
MDA	Missile Defense Area
MOGAS	Motor Gasoline
NA	not applicable
NACE	National Association of Corrosion Engineers
NFPA	National Fire Protection Association
NIMS	National Incident Management System
NRC	National Response Center (USCG)
OPSEC	Operations Security
OSRO	Oil Spill Removal Organization (classified by NSFCC)
PACAF	Pacific Air Forces
POC	Point of contact
POL	Petroleum, Oil, and Lubricant
PPE	Personal protective equipment

PRSC	PACAF Regional Support Center
R	Rectangular
RA	Regional Administrator (EPA)
S	Satisfactory (also SAT)
SFO	Senior Fire Official
SOP	Standard Operating Procedure
SPCC	Spill Prevention, Control, and Countermeasure (plan)
STI	Steel Tank Institute
SW	Single-walled
SWDA	Solid Waste Disposal Area
U	Unsatisfactory (also UNSAT)
UK	Unknown
USAF	U.S. Air Force
USCG	U.S. Coast Guard
USEPA	U.S. Environmental Protection Agency
UST	Underground Storage Tank
VC	Vertical Cylindrical
VORTAC	VHF Omni-Directional Radio Range Tactical Air Navigation
WIA	Wake Island Airfield

APPENDIX N
STORMWATER POLLUTION PREVENTION PLAN FOR WAKE ISLAND AIRFIELD

Stormwater Pollution Prevention Plan

for:

Wake Island Airfield
1502 Wake Ave.
Wake Island, HI 96898
808-424-2222

SWPPP Contact(s):

Chugach Federal Solutions, Inc.
Kyle Kimber
1401 Wake Ave.
Wake Island, HI 96898
808-424-2234
Kyle.Kimber@wakeisland.net

SWPPP Preparation Date:

28 Jan 2016

Contents

Table of Contents

SECTION 1: FACILITY DESCRIPTION AND CONTACT INFORMATION.

1.1 Facility Information.

Facility Information

Name of Facility: Wake Island Airfield

Street: 1502 Wake Ave

City: Wake Island State: HI ZIP Code: 96898

County or Similar Subdivision: N/A

NPDES ID (i.e., permit tracking number): N/A (if covered under a previous perm

Primary Industrial Activity SIC code, and Sector and Subsector (2015 MSGP, Appendix D and Part 8):

9711; 5171; 4493; 4581

P, P1; Q, Q1; S, S1

Co-located Industrial Activity(s) SIC code(s), Sector(s) and Subsector(s) (2015 MSGP, Appendix D):

Latitude/Longitude

Latitude: 19 º 17' 24" N (decimal degrees)

Longitude: 166 º 37' 18" W (decimal degrees)

Method for determining latitude/longitude (check one):

☐USGS topographic map (specify scale:_____) ☐GPS

☒Other (please specify): Provided by USAF

Horizontal Reference Datum (check one):

☐NAD 27 ☐NAD 83 ☐WGS 84

Is the facility located in Indian country? ☐Yes ☒No

If yes, name of Reservation, or if not part of a Reservation, indicate "not applicable."

Are you considered a "federal operator" of the facility?

Federal Operator – an entity that meets the definition of "operator" in this permit and is either any department, agency or instrumentality of the executive, legislative and judicial branches of the Federal government of the United States, or another entity, such as a private contractor, operating for any such department, agency, or instrumentality.

☒Yes ☐No

Estimated area of industrial activity at site exposed to stormwater: <500 (acres)

Discharge Information

Does this facility discharge stormwater into a municipal separate storm sewer system

(MS4)? ☐Yes ☒No

If yes, name of MS4 operator: _____

Name(s) of surface water(s) that receive stormwater from your facility: Pacific Ocean

Does this facility discharge industrial stormwater directly into any segment of an "impaired water" (see definition in 2015 MSGP, Appendix A)? ☐Yes ☒No

If Yes, identify name of the impaired water(s) (and segment(s), if applicable): _____

Identify the pollutant(s) causing the impairment(s): _____

Which of the identified pollutants may be present in industrial stormwater discharges from this facility?

Has a Total Maximum Daily Load (TMDL) been completed for any of the identified pollutants? If yes, please list the TMDL pollutants: _____

Does this facility discharge industrial stormwater into a receiving water designated as a Tier 2, Tier 2.5 or Tier 3 water (see definitions in 2015 MSGP, Appendix A)? ☐Yes ☒No

Are any of your stormwater discharges subject to effluent limitation guidelines (ELGs) (2015 MSGP Table 1-1)? ☐Yes ☒No

If Yes, which guidelines apply? _____

1.2 Contact Information/Responsible Parties.

Facility Operator(s): US Air Force
- Name: Ronald Dion, Major, USAF
  - Address: 1502 Wake Ave.
  - City, State, Zip Code: Wake Island, HI 96898
  - Telephone Number: 808-424-2468
  - Email address: Ronald.dion@us.af.mil

Facility Owner(s): US Air Force
- Name: Frank Flores, Colonel, USAF
  - Address: 9480 Pease Ave., Ste. 123
  - City, State, Zip Code: JBER, AK 99506-2201
  - Telephone Number: 907-552-3442

SWPPP Contact(s):
- SWPPP Contact Name (Primary): Kyle Kimber
  - Telephone number: 808-424-2234
  - Email address: kyle.kimber@wakeisland.net

1.3 Stormwater Pollution Prevention Team.

Table 1 – Stormwater Pollution Prevention Team

Staff Names	Individual Responsibilities
Kyle Kimber	Environmental Technician
Rick Noggle	CE Manager
Johnathan Seifert	POL Manager
Rick Scates	Logistics Manager
Chris Ballew	QC/Safety Manager

1.4 Site Description.

Pacific Air Force currently maintains Wake Atoll for the benefit of other Department of Defense (DOD) services and various government agencies and other tenants. All operational needs from an airfield perspective are in place (e.g. runway in excellent condition, lighting operative, petroleum, oil and lubricant (POL) systems fully functional). Wake Atoll and the surrounding navigable waters are possessions of the U.S. Federal Government. The U.S. Air Force (Air Force) operates Wake Island Airfield (WIA). The Air Force representative commanding officer is permanently assigned and stationed on Wake Atoll and monitors the Base Operating Support (BOS) contractor Chugach Federal Services Inc. The Air Force furnishes all personnel, financial, and logistical support for WIA. The island community currently consists of approximately 95 BOS contractor personnel comprised of Americans and Thailand Nationals. Present tenants include the US Geological Survey, Missile Defense Agency, National Oceanic and Atmospheric Administration, Air Force Technical Application Center, and the National Weather Service. These tenants have facilities on Wake Atoll that are contracted to the BOS contractor to maintain. Under a change in operational status, these tenants, and other Federal agencies, would be allowed to continue to use the island as long as they pay their share of the operating costs.

WIA has two distinct areas of activity; the airport and "downtown." The airport consists of a 9,850-foot runway, supporting taxiways, tarmacs, various navigational aids, and vacant areas between active and non-active facilities. The airport terminal, fire and rescue, aircraft fueling support facilities, and other airfield operational support facilities make up the airport operations and maintenance areas. Other industrial facilities in the area include maintenance shops, supply and warehouse buildings, and water collection and distribution structures.

The "downtown" area supports a library, dining hall, medical facility, laundry facility and laundromat, fire station, gym, morale, welfare and recreation buildings, single-family housing, and billeting.

1.5 General Location Map.

Wake Island Airfield is located on Wake Atoll in the Pacific Ocean at latitude 19 degrees 17 minutes North and longitude 166 degrees 38 minutes East (19º 17' N, 166º 38' E) . It is situated 2,460 miles west of Honolulu, and 1,590 miles east of Guam.

The general location map for this facility can be found in Attachment A.

1.6 Site Map.

Wake Atoll is a tropical Pacific atoll, consisting of three islets totaling approximately 1,800 acres surface area: Wilkes Island (206 acres), Wake Island (1,350 acres), and Peale Island (270 acres). It is approximately 4.5 miles long and 2.0 miles wide. The islands form a V-shape with a length of about 9 miles from tip to tip. WIA is 12 feet above sea level. Wake Island includes the airfield, bulk fuel storage, housing, outdoor recreation, medical facilities, and community areas. Wilkes Island includes bulk fuel storage. There are no facilities located on Peale Island.

The site map for this facility can be found in Attachment B.

SECTION 2: POTENTIAL POLLUTANT SOURCES.

WIA has the types of pollutant sources typically found on airfields. Because of the low operational tempo there are no ongoing aircraft support operations other than those necessary to receive and refuel aircraft. There are no de-icing chemicals managed at WIA because of its tropical location. In addition to the JP-5 fuel stored at WIA, there is also motor gasoline (MOGAS) and various solvents and pesticides associated with ongoing operations on the island.

2.1 Potential Pollutants Associated with Industrial Activity.

Table 2 below identifies the industrial activities and associated pollutants at WIA that are exposed to stormwater.

Table 2 – Industrial Activities and Associated Pollutants

Industrial Activity	Associated Pollutants
Land Transportation & Warehousing	Petroleum, oil, lubricants and solvents
Aircraft Refueling and Maintenance	Petroleum, oil, lubricants and solvents
Fuel Transfer at Marina	Petroleum, oil and lubricants
MOGAS Storage and Fueling	Petroleum, oil and lubricants
Pesticide Mixing at Pesticide Storage	Pesticides

2.2 Spills and Leaks.

Table 3 - Areas of Site Where Potential Spills/Leaks Could Occur

Location	Outfalls
Bulk Fuel Storage (1800 Area)	Outfalls No. 1, 2, & 3 on Wilkes Island are associated with bulk fuel storage containment areas. Each of these outfalls has a valve that is always kept closed and locked when not in use.
Aircraft Refueling Operations at Airfield	There are no stormwater inlets or outfalls in the refueling area. Any spills or leaks of sufficient magnitude could discharge to surface waters as sheet flow. Outfall No. 4 is at the west end of the runway and is not in a location where refueling occurs.
MOGAS Storage and	Outfall No. 5 to wetland/lagoon in 1500 Area.

Location	Outfalls
Transfer	
JP-5 Bulk Fuel Storage (1500 Area)	Outfall No. 6 is associated with the bulk fuel storage containment areas. The conveyances to the outfall have valves that remain in the closed/locked position.
Downtown	Outfall No. 7 is associated with discharge from the downtown area. Though there are no industrial activities in this region, a spill of sufficient magnitude could enter a storm drain in the area.
Marina	There are no stormwater inlets or outfalls in this area. A spill of sufficient magnitude outside the designated fuel transfer area, which is surrounded by a concrete berm, would enter the harbor water.
Vehicle Maintenance (Building 1403)	There are no stormwater inlets or outfalls in this area. Maintenance is conducted in a covered area.
Operational Area (1500 Area)	There are no stormwater inlets or outfalls in this area. Any spills or leaks of sufficient magnitude could discharge to surface waters as sheet flow.
Pesticide Mixing Area (near Building 1422)	There are no stormwater inlets or outfalls in this area. Any spills or leaks of sufficient magnitude could discharge to surface waters as sheet flow.
Disinfection at Reverse Osmosis Purification Unit	There are no stormwater inlets or outfalls in this area. Any spills or leaks of sufficient magnitude could discharge to surface waters as sheet flow.
Fuel Transfer between 1800 and 1500 Areas	There are no stormwater inlets or outfalls in this area. Any spills or leaks of sufficient magnitude could discharge to surface waters as sheet flow.

Table 4 - Description of Past Spills/Leaks

Date	Description	Volume (Gal)	Outfall No.
14-Feb-13	JP-5 – Truck fill stand – Faulty high level shut off valve	4	NA; There are no stormwater inlets or outfalls in this area.
5-Feb-14	JP-5 – 1800 Area - Pipeline leak	25	NA; There are no stormwater inlets or outfalls in this area.
7-Feb-14	JP-5 – Flightline – Aircraft overfill	2.5	NA; There are no stormwater inlets or outfalls in this area.
11-Mar-14	JP-5 – Flightline – Aircraft overfill	1	NA; There are no stormwater inlets or outfalls in this area.

Date	Description	Volume (Gal)	Outfall No.
12-Mar-14	JP-5 – Taxiway Bravo - Aircraft overfill	2.5	NA; There are no stormwater inlets or outfalls in this area.
12-Mar-14	JP-5 – Flightline – Aircraft overfill	1	NA; There are no stormwater inlets or outfalls in this area.
19-Mar-14	JP-5 – 1800 Area - Pipeline leak	1	NA; There are no stormwater inlets or outfalls in this area.
26-Sep-14	Hydraulic Fluid – Between Bldg. 115 & 1117 - Hydraulic line break on bucket truck	<.25	NA; There are no stormwater inlets or outfalls in this area.
21-Feb-15	Hydraulic Fluid – Marina Causeway - Hydraulic line pin hole leak	<.25	NA; There are no stormwater inlets or outfalls in this area.
27-Feb-15	JP-5 – Flightline – Aircraft overfill	5	NA; There are no stormwater inlets or outfalls in this area.
13-Mar-15	JP-5 – Flightline – Aircraft overfill	2.5	NA; There are no stormwater inlets or outfalls in this area.
21-Apr-15	JP-5 – 1800 Area - Pipeline leak	<1	NA; There are no stormwater inlets or outfalls in this area.

2.3 Unauthorized Non-stormwater Discharges Documentation.

Date of evaluation: June 04, 2015.

Description of the evaluation criteria used: Visual inspection of Reverse Osmosis Purification Unit (ROPU) and surroundings in 1300 Area. The ROPU discharges into the lagoon.

List of the outfalls or onsite drainage points that were directly observed during the evaluation: RO Outfall into lagoon.

Different types of non-stormwater discharge(s) and source locations: High salt concentration in effluent from RO.

A Form 2C Application to discharge effluent from the Reverse Osmosis Purification Unit was submitted to Region 9 EPA on January 15, 2009.

2.4 Salt Storage.

Due to its tropical climate and location, WIA maintains no salt stockpiles.

2.5 Sampling Data Summary.

There currently are no analytical data available for stormwater runoff from WIA because of logistical problems associated with sample holding times. The Air Force is working with their contractor to remedy this situation and will provide data as soon as it becomes available.

SECTION 3: STORMWATER CONTROL MEASURES.

This section of the SWPPP contains subsections that outline requirements and best management practices for stormwater control and pollution prevention. Management of runoff by stormwater outfalls and other stormwater controls also is described. Table 5 below is a summary table of activities, potential pollutants, affected outfalls, and references to applicable stormwater control measures found in this SWPPP.

Table 5 – Applicable Stormwater Control Measures

Activities	Sector (If Applicable)	Potential Pollutants	Affected Outfalls	Applicable Control Measures (SWPPP Section Reference)
JP-5 Fuel Storage and Fueling	P – Land Transportation and Warehousing	Petroleum, oil, lubricants and solvents	1, 2, 3, 6	3.1 Minimize Exposure 3.2 Good Housekeeping 3.3 Maintenance 3.4 Spill Prevention & Response 3.8.1 Non-Numeric Effluent Limits
MOGAS Fuel Storage and Fueling		Petroleum, oil, lubricants and solvents	N/A	
Fuel Transfer at Marina	Q – Water Transportation	Petroleum, oil and lubricants	Non-point discharge	3.1 Minimize Exposure 3.2 Good Housekeeping 3.3 Maintenance 3.4 Spill Prevention & Response 3.8.2 Non-Numeric Effluent Limits
Aircraft Refueling	S – Air Transportation	Petroleum, oil, lubricants, and solvents	4	3.1 Minimize Exposure 3.2 Good Housekeeping 3.3 Maintenance 3.4 Spill Prevention & Response 3.8.3 Non-Numeric Effluent Limits
Pesticide Storage and Mixing	N/A	Pesticides	N/A	3.1 Minimize Exposure 3.2 Good Housekeeping 3.3 Maintenance 3.4 Spill Prevention & Response
Downtown Area	N/A	Debris, petroleum, oil and lubricants	7	3.1 Minimize Exposure 3.2 Good Housekeeping 3.3 Maintenance 3.4 Spill Prevention & Response

3.1 Non-numeric Technology-based Effluent Limits (BPT/BAT/BCT)

3.1.1 Minimize Exposure.

In order to minimize the exposure of manufacturing, processing, and material storage areas (including loading and unloading, storage, disposal, cleaning, maintenance, and fueling operations) to rain and runoff, materials and activities should to be located inside or protected with storm resistant covering.

The storm collection areas at WIA are located in areas protected from industrial contaminants, including the fueling of aircraft. Gravel and debris are removed from the streets by a sweeper/vacuum truck. In the event of a spill, the island has a fire department with spill kits readily available at various locations on the island. Additional personnel are HAZWOPER trained. Please see the WIA Spill Prevention, Control, and Countermeasures (SPCC) Plan for more details.

Exposure can be minimized by paying particular attention to the following:

- Use grading, berming, or curbing to prevent runoff of contaminated flows and divert run-on away from these areas;
- Locate materials, equipment, and activities so that leaks are contained in existing containment and diversion systems (confine the storage of leaky or leak-prone vehicles and equipment awaiting maintenance to protected areas);
- Clean up spills and leaks promptly using dry methods (e.g., absorbents) to prevent the discharge of pollutants;
- In the event that vehicles cannot be repaired, use drip pans and absorbents under or around leaky vehicles and equipment or store indoors where feasible;
- Use spill/overflow protection equipment for aircraft fueling as prescribed in the appropriate U.S. Air Force regulations;
- Drain fluids from equipment and vehicles prior to on-site storage or disposal;
- Perform all cleaning operations indoors, under cover, or in bermed areas that prevent runoff and run-on and also that capture any overspray; and
- Ensure that all wash water drains to a proper collection system (i.e., not the stormwater drainage system).

Note: Industrial materials do not need to be enclosed or covered if stormwater runoff from affected areas will not be discharged to receiving waters or if discharges are authorized under another NPDES permit.

3.1.2 Good Housekeeping.

Good housekeeping practices are designed to maintain a clean and orderly work environment and require the maintenance of areas that may contribute pollutants to storm water discharges. Good housekeeping is met by implementation of the following procedures:

- As part of all ongoing operations and maintenance activities routinely inspect for leaks or conditions that could lead to discharges of chemicals to storm water;
- Properly store hazardous and non-hazardous materials (i.e., store materials in appropriate containers);

- Maintain well organized work areas;
- Routinely pickup and dispose of garbage and waste materials and maintain regular cleanup schedules;
- Use absorbent materials and spot cleaning for small spills; and
- Conduct training programs (see Section 3.1.9) for employees about these practices.

3.1.3 Maintenance.

Preventive maintenance involves the regular inspection and maintenance of storm water controls. Preventive maintenance is met by implementation of the following procedures:

- Inspect and maintain storm water management devices (e.g., catch basins, outfalls) on an at least quarterly basis or after any significant storm event;
- Inspect, test and maintain facility equipment and systems to uncover conditions that could cause breakdowns or failures resulting in discharges of pollutants to surface waters at least quarterly;
- Diligently maintain non-structural control measures (e.g., spill response supplies available, personnel appropriately trained); and
- Expeditiously make the necessary modifications for any control measure that requires replacement or repair.

Section 4 of this SWPPP provides more detail on the inspection procedures for WIA.

3.1.4 Spill Prevention and Response.

The potential for a spill from virtually anywhere at WIA to reach water is mitigated by the following factors: (1) WIA is mostly flat, undeveloped, porous soil/ coral covering the site; (2) there are long distances (typically greater than 100 feet) between the primary containment and the surface water; and (3) there are very few storm drains on the island which could serve as a conduit between the spill location and the surface water.

The potential for leaks, spills and other releases at WIA to be exposed to stormwater is further minimized by implementation of the following:

- Procedures for plainly labeling containers (e.g., “Used Oil,” “Spent Solvents,” “Fertilizers and Pesticides,” etc.) that could be susceptible to spillage or leakage to encourage proper handling and facilitate rapid response if spills or leaks occur;
- Preventative measures such as barriers between material storage and traffic areas, secondary containment provisions, and procedures for material storage and handling;
- Procedures for expeditiously stopping, containing, and cleaning up leaks, spills, and other releases. Employees who may cause, detect, or respond to a spill or leak must be trained in these procedures and have necessary spill response equipment available. If possible, one of these individuals should be a member of the stormwater pollution prevention team; and
- Procedures for notification of appropriate facility personnel, emergency response agencies, and regulatory agencies. Where a leak, spill, or other release containing a hazardous substance or oil in an amount equal to or in excess of a reportable quantity established under either 40 CFR Part 110, 40 CFR Part 117, or 40 CFR Part 302, occurs during a 24-hour period, WIA must notify the

National Response Center (NRC) at (800) 424-8802 as soon as WIA has knowledge of the discharge. Contact information must be in locations that are readily accessible and available.

Developing a site-specific Spill Prevention, Control, and Countermeasure (SPCC) Plan is the major BMP for spill prevention and response. A SPCC provides for the following procedures:

- Inspections and maintenance of lines, valves, and connections used to transfer chemicals, fuel, oil, and sludge;
- Maintain a sufficient inventory of spill cleanup equipment such as booms, absorbents, containers, and drain covers, which shall be strategically placed to minimize the time necessary to respond to a spill;
- Provide spill prevention, containment and response training for all employees that my handle, move, store, use, or clean up any chemicals or fuel. The training program is to be carried out annually by staff authorized by the BOS Environmental Manager. Section 3.1.9 discusses training in more detail;
- Report spills to the direct manager or supervisor;
- Notify the proper authorities and response team immediately, as outlined in the SPCC plan;
- Document spills; and
- If a spill occurs near a catch basin, place rubber mats or suitable covers over the catch basins to prevent spills from entering the storm drain system.

WIA maintains a current SPCC plan, which the BOS Environmental Manager is charged with maintaining. A copy of the SPCC plan must be kept with the SWPPP. All environmental and other selected BOS staff are required to be trained in spill response on assignment to WIA; training is to be updated annually by the Environmental Manager or their designee. Finally, activity specific, spill prevention and response procedures are available for certain activities such as aircraft fueling and barge-tank fuel transfer operations.

3.1.5 Erosion and Sediment Controls.

No major signs of erosion or potential erosion were reported in the survey of January 2000 or observed during the evaluation for this SWPPP in June 2015. Existing controls, including vegetative swales, wetlands, infiltration basins, trees, and aboveground vegetation adequately control sediment runoff. As a result of these controls, the fact that storm drains are built into the pavement structure, the isolated location of the outfalls, and the limited rainfall at Wake Atoll, erosion does not appear to present a problem.

3.1.6 Management of Runoff.

3.1.6.1 Stormwater Outfalls

Currently there are seven (7) stormwater outfalls in use at WIA. Each of the outfalls and their associated drainage areas and inlets are described in the following sections.

Please note that the effluent from Outfalls No. 1, No. 2, and No. 3 is considered substantially identical for the purposes of benchmark monitoring (see Section 4) and quarterly visual inspections (see Section 5.2). WIA is making the claim that Outfalls No. 1, No. 2, and No. 3 are substantially identical in order to minimize the quarterly visual inspection and benchmark monitoring requirements. These three outfalls are located near the Bulk Fuel Storage Area on Wilkes Island. While each outfall services a separate containment area for an individual tank, the control systems and pollutant managed (JP-5) are identical for all three outfalls. All outlet valves are mechanically controlled and kept in the closed position until after a rainfall event. At that time the surface of the collected rainfall is visually inspected for sheen and in the event no sheen is detected the valves are opened and the water discharged. The coefficient of drainage is assessed as low based on the engineered concrete containment area. Section 3.1.6.1 provides a more detailed discussion of each individual outfall.

Outfall No. 1

Outfall No. 1 is the western most outfall located on Wilkes Island (please refer to *Appendix B – Bulk Fuel Storage I Area* for the site map that includes Outfall No. 1). The outfall discharges stormwater collected by two inlet drains within the concrete containment area for JP-5 fuel storage Tank 41131, which has a drainage area of approximately 2.5 acres. The 16 inch diameter pipe discharges directly into the lagoon. The valve for this outfall remains closed and locked. The valve is opened only after major storm events that result in standing water within the containment area and only if no sheen is observed.

Outfall No. 1

These photographs of Outfall No. 1 were taken the day after a major storm surge hit Wake Atoll during a time period when the valve was opened to drain the containment area for Tank 41131. The storm altered the shoreline and deposited sand, rocks, and coral in front of the outfall. The outfall area has since been cleared such that the outfall flap is free to open and discharge water.

Inlets for Outfall No. 1

These photographs show the two (2) drains within the concrete containment area for Tank 41131.

Outfall No. 2

Outfall No. 2 is the middle outfall located on Wilkes Island (please refer to *Appendix B – Bulk Fuel Storage I Area* for the site map that includes Outfall No. 2). The outfall discharges stormwater collected by an inlet drain within the concrete containment area on the northwest side of JP-5 fuel storage Tank 41132, which has a drainage area of approximately 1.5 acres. The 16 inch diameter pipe discharges directly into the lagoon. The valve for this outfall remains closed and locked. The valve is opened only after major storm events that result in standing water within the containment area and only if no sheen is observed.

Outfall No. 2

These photographs of Outfall No. 2 were taken the day after a major storm surge hit Wake. The storm altered the shoreline and deposited sand, rocks, and coral in front of the outfall. The outfall area has since been cleared such that the outfall flap is free to open and discharge water.

Inlet for Outfall No. 2

This photograph shows the drain within the concrete containment area on the northwest side of Tank 41132.

Outfall No. 3

Outfall No. 3 is the east most outfall located on Wilkes Island (please refer to *Appendix B – Bulk Fuel Storage I Area* for the site map that includes Outfall No. 3). The outfall discharges stormwater collected by an inlet drain within the concrete containment area on the southeast side of JP-5 fuel storage Tank 41132, which has a drainage area of approximately 1.5 acres. The 16 inch diameter pipe discharges directly into the lagoon. The valve for this outfall remains closed and locked. The valve is opened only after major storm events that result in standing water within the containment area and only if no sheen is observed.

Outfall No. 3

These photographs show Outfall No. 3 during a time period when the valve was opened to drain the containment area for Tank 41132.

Inlet for Outfall No. 3

This photograph shows the drain within the concrete containment area on the southeast side of Tank 41132.

Outfall No. 4

Outfall No. 4 is located on the lagoon side of the western end of the runway (please refer to *Appendix B – Airfield Area* for the site map that includes Outfall No. 4). There are no industrial activities that occur in this area. The outfall discharges stormwater collected by a drain in the grassy area on the western end of the runway. This grassy area has a total area of approximately 8.5 acres. The pipe discharges directly into the lagoon. There is no valve for this outfall.

Outfall No. 4

These photographs of Outfall No. 4 were taken two days after a major storm surge hit Wake Atoll. The storm significantly altered the shoreline and deposited sand, rocks, and coral in front of the outfall. The outfall area has since been cleared such that the outfall can discharge water.

Inlet for Outfall No. 4

These photographs show the inlet for Outfall No. 4.

Outfall No. 5

Outfall No. 5 is located south of the DS-2 storage area (please refer to *Appendix B – Bulk Fuel Storage II Area* for the site map that includes Outfall No. 5). This area stores mobile, 6,000 gallon, double walled, aboveground storage tanks (ASTs). The outfall discharges stormwater collected by two (2) drains in the DS-2 storage area. The 6 inch diameter pipe discharges into a wetland area.

Outfall No. 5

These photographs show Outfall No. 5 into the wetland area near DS-2 Storage.

Inlets to Outfall No. 5

This photograph shows the inlets for Outfall No. 5.

Outfall No. 6

Outfall No. 6 is located west of the JP-5 bulk fuel storage tank area (please refer to *Appendix B – Bulk Fuel Storage II Area* for the site map that includes Outfall No. 6). The outfall discharges stormwater collected by 3 drains in the bulk fuel storage containment area, which has a drainage area of approximately 1 acre. The 6 inch diameter pipe discharges into a ditch in the wooded area to the west of the fuel storage area. The valves for this outfall remain closed and locked. The valves are opened only after major storm events that result in standing water within the containment area and only if no sheen is observed.

Outfall No. 6

These photographs show Outfall No. 6 which discharges into a ditch in the wooded area west of the bulk fuel storage area. The water in the ditch was apparently entrained as a result of the recent storm.

Inlets to Outfall No. 6

These photographs show the inlets (north, middle, south) for Outfall No. 6.

Outfall No. 7

Outfall No. 7 is located in the downtown area (please refer to *Appendix B – Downtown Area* for the site map that includes Outfall No. 7). The outfall discharges stormwater collected by 5 drains in the downtown area, which has a drainage area of approximately 1 acre. There are no industrial activities that occur in this area. The outfall pipe discharges into the channel between Peale Island and Wake Island.

Outfall No. 7

This photograph shows the approximate location of Outfall No. 7. The photograph was taken a few days after a storm surge hit Wake Atoll. The storm significantly altered the shoreline in this area and completely buried the outfall with sand, rock, and coral. The area has since been cleared of debris.

Inlets for Outfall No. 7

These photographs show the inlets east of Building 1104 (Dining Hall) that drain to Outfall No. 7.

These photographs show the inlets on the southwest and southeast corners of Building 1116 (Medical Clinic).

This photograph shows the inlet on the southwest corner of Building 1115 (Billeting) that drains to Outfall No. 7.

3.1.6.2 Other Stormwater Controls

Drainage Swale

There is a visible swale along the lower east end of the runway (please refer to *Appendix B – Airfield Area* for the site map including this detail). However, no pipe or outfall could be located in the area.

These photographs show the drainage swale along the southern edge of the east end of the runway. The photograph on the left looks north while the photograph on the right looks east.

Stormwater Drain at Building 1502 (Base Operations)

There is a storm drain located near the southeast corner of Building 1502 (Base Operations). Though no outfall could be located for this drain, there is a pond about 1,000 feet southwest of the inlet, at approximate latitude 19º 17' 50" N, longitude 166º 39' 00" E, which is the presumed discharge location.

This photograph shows the drain near the southeast corner of Building 1502.

3.1.7 Salt Storage Piles or Piles Containing Salt.

Wake Island Airfield does not manage salt storage piles because of its tropical climate and location.

3.1.8 Dust Generation and Vehicle Tracking of Industrial Materials.

Dust is not typically generated as a result of operations at WIA. Dust associated with construction activities is minimized by contractors, typically by wetting work areas or erecting barriers to minimize wind.

The major industrial material at WIA is fuel. Non-service vehicles are kept away from aircraft during re-fueling activities and do not enter tank management areas. This minimizes the possibility of fuel being picked up in tire treads.

3.1.9 Employee Training

Employee training programs must inform personnel at all levels of responsibility of the components and goals of the SWPPP. As such, preparing training materials that follow the overall organization of this document would meet the training requirements. All employees stationed at WIA are required to take the SWPPP training on assignment. An annual refresher re-emphasizing and updating the original training also is required. Training is provided by the BOS Environmental Manager or designee. Training is provided in both English and Thai. A record of all employee SWPPP training must be maintained with this document (see Attachment D).

The SWPPP training coordinator is responsible for:

- Providing staff with an initial and annual refresher on both the SWPPP and the SPCC; and
- Maintaining training records.

Training will address each component of the SWPPP, including description of the facility and industrial activities performed at WIA, potential pollutant sources resulting from industrial activities, stormwater control measures, and schedules and procedures for monitoring and inspections. In addition, BMPs should be addressed regarding spill prevention and response, good housekeeping, and material management practices.

Spill Prevention and Response Training will include:

- Identifying potential spill areas and drainage routes, including information on past spills and causes;
- Reporting spills to the appropriate individuals (i.e., Environmental Manager), without penalty;
- Specifying material handling procedures and storage requirements; and
- Implementing spill response procedures and contact list with phone numbers (see SPCC Plan).

Good Housekeeping Training will include:

- Regular housekeeping (i.e., weekly clean up, vacuuming and/or sweeping);
- Prompt cleanup of spilled materials to prevent polluted runoff;
- Identify where spill response equipment is located (see SPCC Plan); and
- Display signs in both English and Thai reminding employees of the importance and procedures of good housekeeping.

Materials Management Practices Training and will include:

- Initial training of all new personnel will occur on an as-soon-as possible basis, in both English and Thai;
- New employees will be trained within the first month of being hired;
- If significant changes occur on island, employees will be trained immediately; and
- If a BMP is determined to be ineffective or a BMP is not implemented properly, additional training will occur to correct the situation.

3.1.10 Non-Stormwater Discharges

Non-stormwater discharges are described in Section 2.3 of this SWPPP.

3.1.11 Waste, Garbage and Floatable Debris

WIA staff must ensure that waste, garbage, and floatable debris are not discharged to receiving waters by keeping exposed areas free of such materials or by intercepting them before they are discharged. WIA personnel dispose of all waste, resulting from either personal or work-related activities, in appropriate containers and keep exposed areas free of waste, garbage, and floatable debris to prevent these items from being discharged to receiving waters.

3.2 Sector-Specific Non-Numeric Effluent Limits.

In addition to the requirements listed in Section 3.1.2 and Section 3.1.9 of this SWPPP, the following effluent management measures have been instituted at WIA for the applicable non-numeric effluent limits for Sector P – Land Transportation and Warehousing, Sector Q – Water Transportation, and Sector S – Air Transportation.

3.2.1 Sector P – Land Transportation and Warehousing (Bulk Fuel Storage)

Minimize contamination of stormwater runoff from fueling areas:

- Diked containment areas at the Bulk Fuel Areas are restrained by manually-operated, valved gravity-fed discharge pipes. The valves for these discharge lines remain locked in the upright and closed position to prevent flow through the line until rainwater accumulation within the diked area is determined to be uncontaminated; and
- Routine visual inspections are conducted, e.g. daily/weekly inspections of bulk fuel transfer and operational storage areas; monthly check of 1500 and 1800 Areas for fuel delivery; monthly and annual inspections of aboveground storage tanks.

Maintain all material storage vessels to prevent contamination of stormwater:

- Storage vessels are plainly labeled (e.g., "Used Oil");
- When possible materials are stored inside; and
- Spill kits (as specified by the WIA SPCC) are readily available throughout WIA should a spill occur.

Minimize contamination of stormwater runoff from all areas used for vehicle/equipment maintenance:

- Vehicle maintenance is conducted in Building 1403, which is a covered structure, and there are no stormwater inlets or outfalls in the area to transport contaminated water.

3.2.2 Sector Q – Water Transportation (Marina)

Minimize the contamination of precipitation or surface runoff from material handling operations and areas:

- There are no storm drains in the Marina vicinity. The fuel port has a concrete containment berm around it and spill kits are readily available should a larger spill occur.

3.2.3 Sector S – Air Transportation

Minimize the contamination of stormwater runoff from areas used for vehicle and equipment maintenance, cleaning, storage:

- No aircraft maintenance or washing occurs at WIA, nor are any aircraft stored. If a repair is absolutely necessary, dry cleanup methods are implemented.

Minimize discharge of fuel to the storm sewer/surface waters resulting from fuel servicing activities:

- There are no stormwater inlets in the immediate area of the aircraft refueling pads.
- Spill and overflow procedures are in place at WIA. These procedures are under the control of the organization managing aircraft refueling at WIA and meet all applicable U.S. Air Force regulations.

SECTION 4: SCHEDULES AND PROCEDURES.

All required monitoring must be performed on a storm event that results in an actual discharge from the site, or "measurable storm event," that follows the preceding measurable storm event by at least 72 hours (3 days). The 72-hour (3-day) storm interval does not apply if WIA is able to document that less than a 72-hour (3-day) interval is representative for local storm events during the sampling period. For each monitoring event WIA must identify the date and duration (in hours) of the rainfall event, rainfall total (in inches) for that rainfall event, and time (in days) since the previous measurable storm event.

WIA must take a minimum of one grab sample from a discharge resulting from a measurable storm event. Samples must be collected within the first 30 minutes of a measurable storm event. If it is not possible to

collect the sample within the first 30 minutes of a measurable storm event, the sample must be collected as soon as practicable after the first 30 minutes and documentation must be kept with the SWPPP explaining why it was not possible to take samples within the first 30 minutes. All samples must be taken in accordance with the sampling methodologies identified in Table 6 below. The laboratory identified (to be determined) as performing the analytical work should provide all required glassware, blanks, and reagents.

When adverse weather conditions prevent the collection of samples according to the relevant monitoring schedule, WIA must take a substitute sample during the next qualifying storm event. Adverse weather does not exempt WIA from having to file a benchmark monitoring report in accordance with the sampling schedule. WIA must report any failure to monitor indicating the basis for not sampling during the usual reporting period.

Since Wake Atoll is located where limited rainfall occurs during parts of the year, required monitoring events may be distributed during seasons when precipitation occurs. WIA must still collect the required number of samples.

Monitoring requirements begin in the first full quarter following either April 1, 2009 or the date of discharge authorization, whichever date comes later. WIA must monitor at least once in each of the following 3-month intervals:

- January 1 – March 31;
- April 1 – June 30;
- July 1 – September 30; and
- October 1 – December 31.

4.1 Benchmark Monitoring

Wake Island Airfield's remote location presents a significant challenge in meeting the holding times for the analytical tests required for the SWPPP. In the most recent quarter for which there is data WIA serviced a total of approximately 250 flights. Multiple flights may land/depart in a single day and be followed by one or more days with no flights whatsoever. Any sampling schedule must be organized around the departure time for a particular flight. At this time it is impossible to assume a significant storm event (permitting acceptable sampling conditions) would coincide with a flight departing from WIA that would allow for standard sampling holding times and procedures.

As an alternative to this approach, the Air Force evaluated the possibility of requesting a variance allowing the use of Hach Kits to analyze the parameters identified. Unfortunately, not all of the parameters can be measured using this technological solution. As a result, variances were requested as follows:

- A single annual sample taken in August (the highest rainfall period of the year);
- An increase of the current holding time requirement for all parameters by a factor of two;

- Since WIA stores no de-icing chemicals, a request that none of the analytical requirements associated with management of such chemicals be required; and
- Since the marina at WIA is small, manages no large metal vessels, and has no work on-going that would cause the release of aluminum, iron, or zinc, a variance on sampling for those chemicals.

The Air Force rationale for this request revolves around several facts regarding WIA. First, the facility is staffed by a very small complement of personnel and operates at a very low tempo. There are typically fewer than 150 staff and visitors on WIA at any time. Other than refueling, there is no routine servicing of aircraft at WIA and no active industrial facilities to support such service operations. The rationale for selecting these parameters was that all of the outfalls are subject to the same basic threats with regard to stormwater pollution; those associated with the operation or servicing (including fueling, repairs, oil changes and battery maintenance) of automobiles and trucks and the fueling of aircraft. Given this low operational tempo, combined with extreme isolation and difficulty in transporting samples the Air Force believes that these variances are warranted.

Table 6 identifies the sample locations, parameters and their limits, and the proposed schedule and procedures.

Table 6 – Outfall Locations, Sampling Parameters, Schedule, and Procedures

Outfall No.[1]	Location	Pollutant Parameters & Numerical Limits (mg/l)	Monitoring Schedule	Procedures[2]
1	West most outfall on Wilkes (bulk fuel storage)	Flow (GPD) Suspended Solids Oil & Grease (15) Lead (0.0081) Toluene Benzene (0.071) Ethyl-benzene Xylene pH (6.5-8.5)	August	Up to three grab samples taken over the course of the first hour of rainfall. • Sample 1: 15 minutes after rain start. • Sample 2: 30 minutes after rain start. • Sample 3: 60 minutes after rain start. EPA METHOD [3] Suspended Solids 160.2 Oil & Grease 1664 Lead 6010C Benzene 5030B pH 9040C
2	Middle outfall on Wilkes (bulk fuel storage)			
3	East most outfall on Wilkes (bulk fuel storage)			
4	West end of runway/taxiway			
5	DS-2			
6	1500 Area JP-5 fuel storage			
7	Downtown			

Note 1. Outfalls No. 1, No. 2, and No. 3 are considered substantially identical for the purposes of monitoring, provided that monitoring is performed on a rotating basis of each substantially identical outfall throughout the period of coverage under the NPDES permit.

Note 2. The parameters listed for air transport operations are not included here because WIA does not manage any de-icing chemicals.

Note 3. All proposed methods are from SW-846. In addition, there currently are no limits for Toluene, Xylene, and Ethyl-benzene and methods for these chemicals are not included in the procedures section of the table.

4.2 Inspections

4.2.1 Routine Facility Inspections

The Environmental Manager, or person(s) designated by the Environmental Manager, is responsible for conducting routine facility inspections along with at least one other member of the stormwater pollution prevention team on a quarterly basis. The following areas will be inspected in the months of January, April, July, and October:

- Outfall No. 1 – Western-most outfall on Wilkes (bulk fuel storage)
- Outfall No. 2 – Middle outfall on Wilkes (bulk fuel storage)
- Outfall No. 3 – Eastern-most outfall on Wilkes (bulk fuel storage)
- Outfall No. 4 – Western end of runway/taxiway
- Outfall No. 5 – DS-2
- Outfall No. 6 – 1500 Area JP-5 fuel storage
- Outfall No. 7 – Downtown

In addition to the outfalls, all areas of the facility where industrial materials or activities are exposed to stormwater also will be inspected. The July inspection will coincided with the Comprehensive Site Inspection for the year and must take place when stormwater discharge is occurring. See Section 4.2.3 below for a discussion of the Comprehensive Site Inspection.

Findings from each routine facility inspection performed must be documented and maintained onsite with this SWPPP. Unless specifically asked to do so, it is not necessary to submit routine facility inspection findings to EPA. Please see Attachment E for WIA's Routine Facility Inspection Log, which is to be completed during each inspection. Any corrective action required as a result of a routine facility inspection, or any other inspection, must be documented in accordance with Part 3 of EPA's Multi-Sector General Permit, which is included as Section 4.2.4 of this SWPPP.

4.2.2 Quarterly Visual Assessments

The Environmental Manager, or person(s) designated by the Environmental Manager, is responsible for conducting visual inspections of stormwater outfalls on a quarterly basis. These assessments will be carried out in the months of February, May, August, and November. Specific inspection areas for assessment are:

- Outfall No. 1, Outfall No. 2, or Outfall No. 3 – Wilkes (bulk fuel storage);
- Outfall No. 4 – Western end of runway/taxiway
- Outfall No. 5 – DS-2
- Outfall No. 6 – 1500 Area JP-5 fuel storage
- Outfall No. 7 – Downtown

Outfalls No. 1, No. 2, and No. 3 are considered substantially identical for the purposes of visual assessments, provided that assessments are performed on a rotating basis of each substantially identical outfall throughout the period of coverage under the NPDES permit. Section 3.6 provides a more detailed discussion of the individual outfalls.

These assessments will be performed within 30 minutes of the start of a storm event in the month in which the assessment is scheduled. When adverse weather conditions prevent the collection of samples during the quarter, WIA must take a substitute sample during the next qualifying storm event. Documentation of the rationale for no visual assessment for the quarter must be included with the SWPPP records.

Visual assessments must be made:

- Of a sample in a clean, clear glass, or plastic container, and examined in a well-lit area;
- On samples collected within the first 30 minutes of an actual discharge from a storm event. If it is not possible to collect the sample within the first 30 minutes of discharge, the sample must be collected as soon as practicable after the first 30 minutes and WIA must document why it was not possible to take samples within the first 30 minutes; and
- For storm events, on discharges that occur at least 72 hours (3 days) from the previous discharge. The 72-hour (3-day) storm interval does not apply if WIA documents that less than a 72-hour (3-day) interval is representative for local storm events during the sampling period.

WIA must visually inspect the sample for the following water quality characteristics:

- Color;
- Odor;
- Clarity;
- Floating solids;
- Settled solids;
- Suspended solids;
- Foam;
- Oil sheen; and
- Other obvious indicators of stormwater pollution.

The results of the visual assessment must be documented and maintained onsite with this SWPPP. Unless specifically asked to do so, it is not necessary to submit quarterly visual inspection findings to EPA. Please see Attachment F for WIA's Visual Inspection Log, which is to be completed for each sampling event. Any corrective action required as a result of a visual inspection, or any other inspection, must be documented in accordance with Part 3 of EPA's Multi-Sector General Permit, which is included as Section 4.2.4 of this SWPPP.

4.2.3 Comprehensive Site Inspections

Comprehensive site inspections will take place yearly during the month of July and at a time when stormwater is flowing. The inspection will be performed by the BOS Environmental Manager and at least one other stormwater pollution prevention team member. In addition to the seven outfalls, the inspection will cover all areas of the facility identified as potentially contributing to stormwater pollution. Any area where a spill or leak has occurred in the past three years also will be evaluated to determine if any potential

pollutants remain. Finally, all available monitoring data must be reviewed. During the inspection staff must examine the following situations:

- Industrial materials, residue, or trash that may have or could come into contact with stormwater;
- Leaks or spills from industrial equipment, drums, tanks, and other containers;
- Offsite tracking of industrial or waste materials, or sediment where vehicles enter or exit the site;
- Tracking or blowing of raw, final, or waste materials from areas of no exposure to exposed areas; and
- Control measures needing replacement, maintenance, or repair.

The results of the comprehensive site inspection must be documented, using the Annual Report Form, which is attached as Attachment G of this SWPPP, and maintained onsite with this SWPPP. This Annual Report must be submitted to EPA within 45 days (postmark date) after conducting the comprehensive site inspection. Any corrective action identified as a result of this comprehensive site inspection, or any other inspection, must be carried out in accordance with Part 3 of EPA's Multi-Sector General Permit, which is included as Section 4.2.4 of this SWPPP.

4.2.4 Corrective Actions

4.2.4.1 Conditions Requiring Review and Revision to Eliminate Problem

If any of the following conditions occur, WIA must review and revise the selection, design, installation, and implementation of control measures to ensure that the condition is eliminated and will not be repeated in the future:

- An unauthorized release or discharge (e.g., spill, leak, or discharge of non-stormwater not authorized by a NPDES permit) occurs at the facility;
- A discharge violates a numeric effluent limit;
- WIA becomes aware, or EPA determines, that control measures are not stringent enough for the discharge to meet applicable water quality standards;
- An inspection or evaluation of WIA by an EPA official, determines that modifications to the control measures are necessary to meet the non-numeric effluent limits in the NPDES permit; or
- WIA finds, in a routine facility inspection, quarterly visual assessment, or comprehensive site inspection, that control measures are not being properly operated and maintained.

4.2.4.2 Conditions Requiring Review to Determine if Modifications Are Necessary

If any of the following conditions occur, WIA must review the selection, design, installation, and implementation of control measures to determine if modifications are necessary to meet the effluent limits in this permit:

- Construction or a change in design, operation, or maintenance at WIA significantly changes the nature of pollutants discharged in stormwater from the facility, or significantly increases the quantity of pollutants discharged; or
- The average of 4 quarterly sampling results exceeds an applicable benchmark. If less than 4 benchmark samples have been taken, but the results are such that an exceedance of the 4 quarter average is mathematically certain (i.e., if the sum of quarterly sample results to date is more than 4 times the benchmark level) this is considered a benchmark exceedance, triggering this review.

4.2.4.3 Corrective Action Deadlines

WIA must document the discovery of any of the conditions listed in Sections 4.2.4.1 and 4.2.4.2 within 24 hours of making such discovery. Subsequently, within 14 days of such discovery, WIA must document any corrective action(s) to be taken to eliminate or further investigate the deficiency, or if no corrective action is needed, the basis for that determination. Specific documentation required within 24 hours and 14 days is detailed in Section 4.2.4.4. If WIA determines that changes are necessary following the review, any modifications to control measures must be made before the next storm event if possible, or as soon as practicable following that storm event. These time intervals are not grace periods, but are schedules considered reasonable for documenting findings and for making repairs and improvements. They are included to ensure that the conditions prompting the need for repairs and improvements are not allowed to persist indefinitely.

4.2.4.4 Corrective Action Report

Within 24 hours of discovery of any condition listed in Sections 4.2.4.1 and 4.2.4.2, WIA must document the following information (i.e., questions 3-5 of the Corrective Actions section in the Annual Reporting Form, found in Appendix G of this SWPPP):

- Identification of the condition triggering the need for corrective action review;
- Description of the problem identified; and
- Date the problem was identified.

Within 14 days of discovery of any condition listed in Sections 4.2.4.1 and 4.2.4.2, WIA must document the following information (i.e., questions 7-11 of the Corrective Actions section in the Annual Reporting Form, found in Appendix G of this SWPPP):

- Summary of corrective action taken or to be taken (or, for triggering events identified in Section 5.4.2 where WIA determines that corrective action is not necessary, the basis for this determination);
- Notice of whether SWPPP modifications are required as a result of this discovery or corrective action;
- Date corrective action initiated; and
- Date corrective action completed or expected to be completed.

WIA must submit this documentation in an annual report and retain a copy onsite with the SWPPP.

4.2.4.5 Effect of Corrective Action

If the event triggering the review is a permit violation (e.g., non-compliance with an effluent limit), correcting it does not remove the original violation. Additionally, failing to take corrective action in accordance with this section is an additional permit violation. EPA will consider the appropriateness and promptness of corrective action in determining enforcement responses to permit violations.

4.2.4.6 Substantially Identical Outfalls

If the event triggering corrective action is linked to an outfall that represents other substantially identical outfalls, the review must assess the need for corrective action for each outfall represented by the outfall that triggered the review. Any necessary changes to control measures that affect these other outfalls must also be made before the next storm event if possible, or as soon as practicable following that storm event.

SECTION 5: DOCUMENTATION TO SUPPORT ELIGIBILITY CONSIDERATIONS UNDER OTHER FEDERAL LAWS.

5.1 Documentation Regarding Endangered Species.

As part of earlier planning to convert WIA to "Long-term Caretaker Status", the U.S. Air Force prepared a draft environmental assessment (EA) in support of a finding of no significant impact (FONSI). An evaluation of the atoll for the presence of endangered species and critical habitat was performed as part of a natural resources management plan developed to support this activity. No endangered or threatened species were identified at the atoll. However, the channel between Wake Island and Peale Island is considered a sensitive habitat, since the threatened green sea turtle (*Chelonia mydas*) has been observed using the channel to access the lagoon and (unsuccessful) nesting attempts by the Black-footed Albatross (*Diomedea nigripes*), which is a candidate for listing, have been observed at several locations.

An outfall that manages stormwater from the downtown area does discharge to the channel. There are no industrial activities in this area. The total area managed by this outfall (Outfall No. 7) is on the order of 1.5 acres. Given the small volume of stormwater discharge in all but typhoon conditions, the daily tidal exchange through the channel along with its relatively large volume, and the relatively low toxicity of the pollutants potentially managed by the outfall, the overall impact on the habitat is judged to be low.

To date, Albatrosses have not nested in an area where an outfall is present. Since the Albatross' will nest above the high tide line it is unlikely that the nests will be impacted by the outfalls.

5.2 Documentation Regarding Historic Properties.

Wake Island was accorded National Registry for Historic Preservation status in 1985 in recognition of its importance during World War II. An evaluation of the historic properties at Wake Island also was performed as part of the EA which included a Cultural Resource Management Plan. The current stormwater system and its outfalls do not appear to impact any of the historically significant areas. Should additional construction be required to modify or extend the stormwater system, especially on the Pacific side of the island it would be necessary to carefully investigate the areas where construction would be required in order to properly manage any historical remains.

SECTION 7: SWPPP CERTIFICATION.

Instructions (see 2015 MSGP Part 5.2.7):

The following certification statement must be signed and dated by a person who meets the requirements of Appendix B, Subsection 11.A, of the 2015 MSGP.

Note: this certification must be re-signed in the event of a SWPPP modification in response to a Part 4.1 trigger for corrective action.

I certify under penalty of law that this document and all attachments were prepared under my direction or supervision in accordance with a system designed to assure that qualified personnel properly gathered and evaluated the information submitted. Based on my inquiry of the person or persons who manage the system, or those persons directly responsible for gathering the information, the information submitted is, to the best of my knowledge and belief, true, accurate and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fine and imprisonment for knowing violations.

Name: Ronald Dion, Major Title: Commander, Det 1, PRSC

Signature: _____ Date: _____

SECTION 8: SWPPP MODIFICATIONS.

Table 7 – Record of Review and Amendments

Date	Section Amended (If Any)	Regulatory Agencies Notified	Signature

APPENDIX O
WAKE ISLAND OPERATING GUIDANCE
ENVIRONMENTAL COMPLIANCE AND PROTECTION OF NATURAL RESOURCES

13 APRIL 2017

WAKE ISLAND OPERATING GUIDANCE

ENVIRONMENTAL COMPLIANCE AND PROTECTION OF NATURAL RESOURCES

13 APRIL 2017

COMPLIANCE WITH THIS ENVIRONMENTAL GUIDANCE IS MANDATORY

Supersedes: OI 32-7001, 30 November 2016 **Pages: 10**

This guidance provides protection for natural resources at Wake Island. The following policies, codes, and public laws serve as references for this guidance document:

References

- Air Force Instruction (AFI) 32-1053; Integrated Pest Management Program, as amended on November 20, 2014
- AFI 32-7064; Integrated Natural Resource Management Plan
- Internal Security Act of 1950, *Public Law (P.L.) 81-831, 64 Statute 1005*, 50 United States Code (USC) *783, et seq.*
- Endangered Species Act (ESA) of 1973*, P.L. 93-205, 87 Statute 884*, 16 USC *1531*
- Migratory Bird Treaty Act (MBTA) of 1918, 16 USC *703-712, Chapter 128, 40 Statute 755*
- Lacey Act Amendments of 1981, *P.L. 97-79, 95 Statute 1073*, 16 USC *3371-3378 as amended by P.L. 98-327, 98 Statute 271*.
- Code of Federal Regulations (CFR) 50 CFR Part 17, Endangered and Threatened Wildlife and Plants
- Sikes Act of 1960, *P.L. 113-291, 74 Statute 1052, 16 USC 670a-670o*
- Convention for the International Trade of Endangered Species (CITES)
- Executive Order (E.O.) 13089, June 11, 1998; *Coral Reef Protection*
- E.O. 13112, February 3, 1999; Invasive Species
- Uniform Code of Military Justice (UCMJ), Article 134
- Marine Mammal Protection Act of 1972 (amended 1994), (CFR) 50 CFR *216*
- Fish and Wildlife Conservation Act of 1980, 16 U.S.C. 2901-2911, as amended.
- Fish and Wildlife Coordination Act of 1934, 16 U.S.C. 661-666c, as amended.
- National Wildlife Refuge System Improvement Act of 1997, Public Law 105-57

APPLICABILITY: This operating guidance applies to all personnel (both resident, and transient) involved in the daily use of Wake Island Airfield (AWK). All personnel must implement their recreational practices in alignment with this guidance.

1. POLICY: It is the policy of the Department of Defense (DoD) and the United States Air Force (USAF) to apply all laws, restrictions and regulation to its properties within the confines of the military mission.

2. REGULATION: All US regulation regarding Natural Resources will be adhered to on Wake Island within the constraints of the military mission. All personnel at Wake Island are subject to these applicable Codes, Regulations, Public Laws, Acts, and Statutes.

3. PENALTY: The commander and their designated representatives will set and enforce all policy within the confines of the Wake Island Airfield mission. All personnel are required to follow this guidance immediately. Violators may be subject to civil or criminal penalties under the laws and regulations of the United States, including the Uniform Code of Military Justice where applicable. Violations committed by non-DOD contract personnel will result in contract review to determine whether appropriate adjustments are necessary under the default provisions of the contract.

3.a. GENERAL RESTRICTIONS FOR WAKE ISLAND:

3.a.1. Birds: It is prohibited for any person to harass, willfully disturb, hunt, trap, capture, possess or kill any bird, or take any eggs of any bird, except as specifically authorized by the installation commander, Bird Aircraft Strike Hazard (BASH) Committee, or the environmental office at Wake.

3.a.2. Threatened and Endangered Species: It is prohibited for any person to harass, willfully disturb, hunt, trap, possess or kill any individual of any species that has been designated as threatened or endangered pursuant to the Endangered Species Act. All sea turtle species (e.g., green, hawksbill, leatherback etc.) shall not be handled by anyone at Wake Atoll, unless otherwise authorized by the U.S. Fish and Wildlife Service.

3.a.3. Marine Mammals: It is prohibited for any person to harass, willfully disturb, hunt, trap, possess or kill any marine mammal except under the authorization of a federal permit. Monk seals, which may be encountered in the lagoon or on beaches of Wake, are also protected under the ESA.

3.a.4. Possession of Marine Species: It is prohibited for anyone at Wake to possess any marine species, unless otherwise authorized by the U.S. Fish and Wildlife Service. The importation of any species of marine fish, mollusk, crustacean is prohibited.

3.a.5. Shrubs within the Clear Zones: The Bird Hazard Working Group (BHWG) is the determining authority for cutting or removal of shrubs within the Clear Zones.

3.a.6. Approved Trash / Refuge Containers: Residents and visitors to Wake Island will discard all trash, fishing line, and etc. into approved trash / refuge containers. All materials taken to Wilkes and Peale Islands will be returned to Wake Island proper for appropriate removal.

3.b. RESTRICTIONS FOR SPECIFIC AREAS ON AND SURROUNDING WAKE ISLAND:

3.b.1. Wilkes Island Seabird Sanctuary: It is prohibited to enter the Wilkes Island Seabird Sanctuary without written permission of the commander or designated representative (currently Base Operations and the Environmental Office).

3.b.2. Entry Authorization Form: Obtain form from the Environmental Office.

3.c. RESTRICTIONS ON TAKING MARINE LIFE FROM WAKE ISLAND:

3.c.1. Collection of Coral: It is prohibited for anyone to possess any coral species from the waters surrounding Wake, living or dead, unless otherwise authorized by the U.S. Fish and Wildlife Service.

3.c.2. Marine Molluscs: It is prohibited for anyone to possess any living marine molluscs from the waters surrounding Wake, unless otherwise authorized by the U.S. Fish and Wildlife Service. Furthermore, it is prohibited for anyone to disturb, harass or harm species of molluscs that belong to the family TRIDACNIDAE (Giant Clams). The possession or transport of living shells from Wake Island is prohibited. A live shell is considered any shell with a living organism inside of it, including a mollusk or hermit crab. Harvesting of live shells for personal use or collection on island is also prohibited. This includes, but is not limited to:

3.c.2.a. CLAM SHELLS: Removal of live giant clam shells, in the family TRIDACNIDAE, from the water is prohibited.

4.c.2.b CONCH SHELLS: Removal of live conch shells, in the family STROMBIDAE, from the water is prohibited.

4.c.2.c. COWRY SHELLS: Removal of live cowry shells, from the family CYPRAEIDAE, is prohibited

3.c.3. Marine Mollusc Shell Transport: Collection of empty shells (with no living organisms inside) from the beach is allowed. Transport off of Wake Island is limited to personal use by permit (see Section 5)

3.c.4. Commercial Fishing: Commercial fishing, (fishing for monetary gain of any kind) is not allowed. It is prohibited for anyone to harvest and sell fish at Wake Island. It is prohibited for anyone to transport fish from Wake Island, unless otherwise authorized by the U.S. Fish and Wildlife Service.

3.c.5. Live Reef Fish: It is prohibited for anyone to possess reef fish, live or dead, for any purpose, unless otherwise authorized by the U.S. Fish and Wildlife Service.

3.c.6. Lobsters: It is prohibited for anyone to possess lobsters, live or dead, for any purpose, unless otherwise authorized by the U.S. Fish and Wildlife Service.

3.c.7. Octopus: It is prohibited for anyone to possess Octopus, live or dead, for any purpose, unless otherwise authorized by the U.S. Fish and Wildlife Service.

3.c.8. Shark Fishing: No sharks or rays may be taken from waters surrounding Wake. It is prohibited for anyone to possess sharks, live or dead, for any purpose, unless otherwise authorized by the U.S. Fish and Wildlife Service. Shark species accidentally hooked during fishing activities will be released by cutting the line as close to the shark as possible and the hook will not be removed. Shark teeth found on beaches may be removed from the island for personal use by permit (see Section 5).

4.c.9. Fishing from the Shore: A limited level of recreational fishing from shore for "catch and release" or on-island consumption will be permitted in conjunction with a fisherman data sheet. Areas closed to lagoon fishing are identified within Map 1 of this guidance document. Anyone fishing at Wake is required to record their fishing activities on a "USAF / PRSC – Wake Atoll Fishing Log" sheet and return it to the terminal front desk; residents shall submit on a monthly basis, while visitors shall submit on a two week basis. This system of data collection will track numbers of fishers, gear types used, level of effort, and harvest information. This information will also be provided to the USFWS and NOAA. Fishing from the shore is limited to rod-and-reel and Hawaiian sling spear fishing only. One rod per person is allowed and it must be attended when the hook is in the water. Automated spear gun fishing is not authorized at any time. It is prohibited to use gill, lay, drag, or seine nets from shore. Hand-thrown nets may be used from shore to catch bait fish only. The capture of fish, shellfish, and other marine species through the use of stationary traps is prohibited. Use of barbless, bite-shortened hooks is recommended. Hooks must be galvanized or bronzed; stainless steel hooks are prohibited.

Shoreline fishing is allowed on the exterior shorelines of the atoll (e.g. beaches, jetties, piers, or docks), however lagoon fishing shall be restricted as depicted in Map 1, with select areas closed to all forms of fishing.

When fishing from shore, an upper limit of three fish per week per person may be kept for immediate consumption. Freezing of fish is not allowed. Bumphead parrotfish (*Bolbometopon muricatum*) and Napoleon wrasse (*Cheilinus undulatus*) may not be taken (see Fig. 1 and 2 below). If either of these fish are unintentionally hooked while fishing from shore, the hook should be removed or the line should be cut as close to the fish as possible.

Figure 1. Bumphead Parrotfish

Figure 2. Napolean Wrasse

4.c.10: **Fishing from a Vessel for Pelagic Species.** Fishing from any vessel at Wake is limited to pelagic species only. No fishing from a vessel is allowed within the areas shaded green on Map 2 of this guidance document. According to NOAA charts these areas are known to harbor many species of coral, therefore trolling shall not take place so as to avoid anchor and vessel contact with corals. Fishing may commence when vessels are beyond the green shaded area on Map 2. Anyone fishing at Wake is required to record their fishing activities on a "USAF / PRSC – Wake Atoll Fishing Log" and return it to the base operating support contractor environmental office.

The following is a list of acceptable pelagic species that may harvested, landed and consumed on Wake. It is prohibited for any pelagic species to be transported from Wake, unless otherwise authorized by the U.S. Fish and Wildlife Service. Fishers are limited to harvest 2 pelagic fish per fishing trip.

List of Acceptable Pelagic Species to Harvest

Tunas and Mackerels

Acanthocybium solandri, Wahoo (Ono)
Euthynnus affinis, Kawakawa
Katsuwonus pelamis, Skipjack Tuna (Aku)
Thunnus alalunga, Albacore
Thunnus albacares, Yellowfin (Ahi)

Billfish

Makaira nigricans, Pacific Blue Marlin
Tetrapteus audax, Striped Marlin
Istiophorus platyterus, Sailfish

Swordfish

Xiphias gladius, Broadbill Swordfish

Mahimahi

Coryphaena hippurus, Dophinfish (Mahimahi)

Flyingfishes

Cheilopogon spilonotopterus, Stained Flyingfish
Exocoetus volitans, Tropical two-winged Flyingfish
Parexocoetus brachypterus, Sailfin Flyingfish

4.c.11 Fishing Permits. The PRSC applied for a Special Use Fishing Permit from the USFWS on 25 June 2015 in alignment with monument provisions. This guidance document identifies required guidelines provided by the USFWS for

recreational fishing and shall be followed at all times. Fishers should carry current "USAF / PRSC – Wake Atoll Fishing Log" upon their person when fishing. Non-residents of the island shall submit populated sheets every two weeks at the Terminal prior to island departure. Residents shall submit their respective "USAF / PRSC – Wake Atoll Fishing Log" sheets on a monthly basis at the terminal. Residents and visitors are not authorized to remove any fish from Wake.

5. PERMITS: Permits for removal of seashells or shark teeth from Wake Island are available from the Environmental Office. The original permit and as many copies as necessary will be affixed to shipments containing such items leaving Wake Island. Hand-carried permits must accompany items transported in person and must be submitted to military, customs and/or US Fish and Wildlife Service authorities at port of entry if requested. Copies of the permits will be kept at the Environmental Office for internal records.

6. POSTING OF REGULATIONS: This guidance document shall be posted in a highly conspicuous manner at the air terminal bulletin board, boathouse, dining facility bulletin board, the office of the peace officer and all managers. It is the responsibility of the managers to disseminate this information immediately to the personnel under their purview. General regulations must be briefed to incoming personnel upon arrival to Wake Island, and the specific regulations on marine resource use/harvest must be briefed prior to sanctioned diving and pelagic fishing excursions.

7. PENALTIES FOR VIOLATION: Persons violating the provisions of this guidance document will be subject to the applicable civil and criminal penalties prescribed by Public Law listed in the references for this guidance document.

Wake Island Natural Resource Permit

For natural resource items transported off Wake

Name (Last, First, M.I.), Address Wake and U.S.	Telephone Number Wake and U.S.

Itemized List: (e.g. 3pc.)	Be as specific as possible in the description(e.g. Tiger Cowry shell, 3 inch)
Other	

I acknowledge that the information recorded above is complete and accurate, and that intentional falsification of these claims may subject me to civil or criminal penalties under the laws and regulations of the United States, including the Uniform Code of Military Justice where applicable.

Date	Applicant Signature
Date	Environmental Office Signature
Date	Commander Signature

In accordance with the Lacey Act (16 U.S.C. §§ 3371-3378, this permit must be affixed to any shipment containing above items. For hand-carried items, this permit (original or copy) must be ready to be shown to military, customs, and/or US Fish and Wildlife Service authorities at the port of entry.

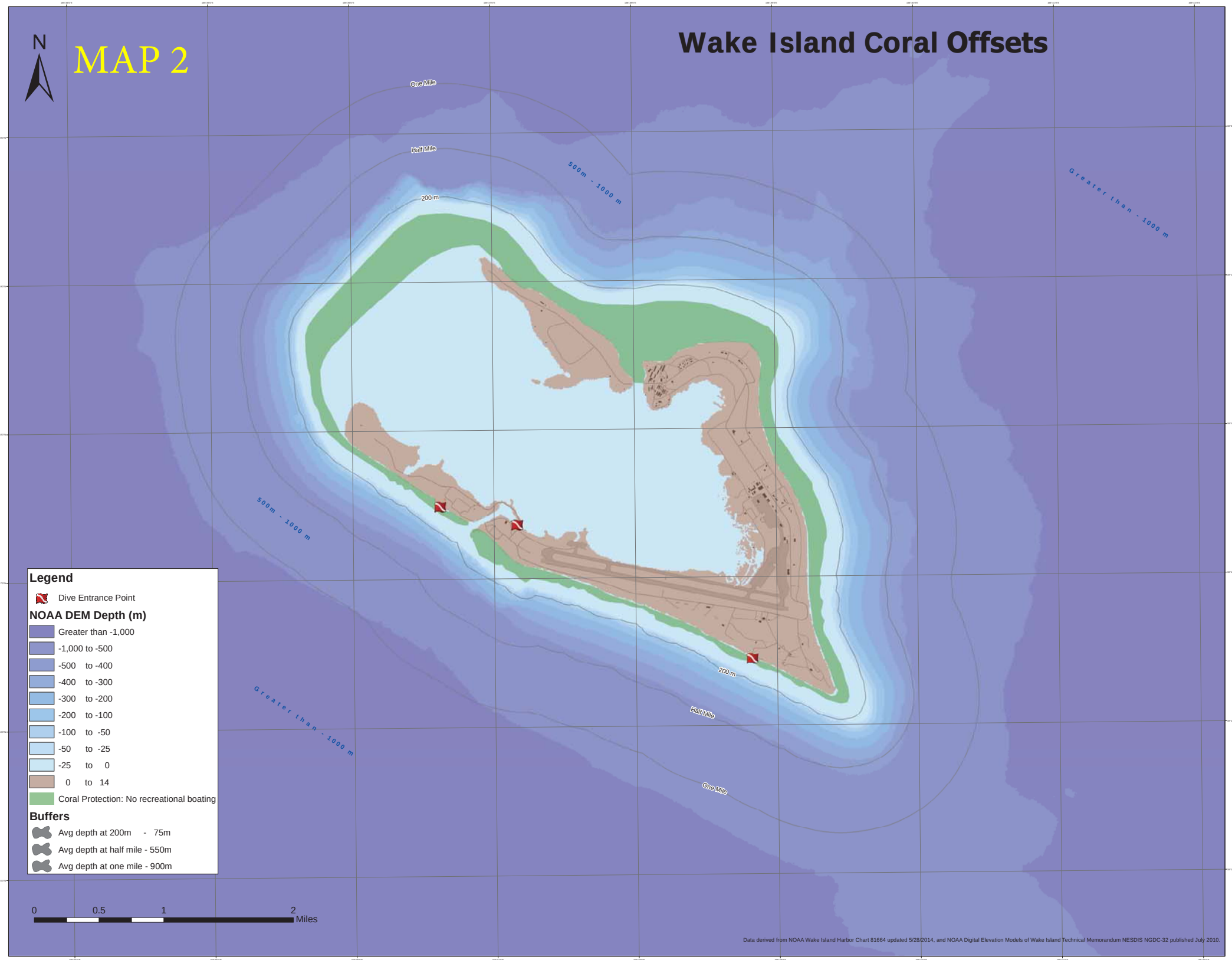
All other versions are obsolete 13 April 2017

MAP 1


Toki Point
Peale Island
Flipper Point
Kuku Point
Wilkes Island
Zone 1
Zone 2
Atoll Lagoon
Zone 4
Zone 3
Pacific Ocean
AREAS IN RED ARE CONSIDERED "NO FISHING ZONES"

MAP 2

Wake Island Coral Offsets



Legend

Dive Entrance Point

NOAA DEM Depth (m)

- Greater than -1,000
- -1,000 to -500
- -500 to -400
- -400 to -300
- -300 to -200
- -200 to -100
- -100 to -50
- -50 to -25
- -25 to 0
- 0 to 14
- Coral Protection: No recreational boating

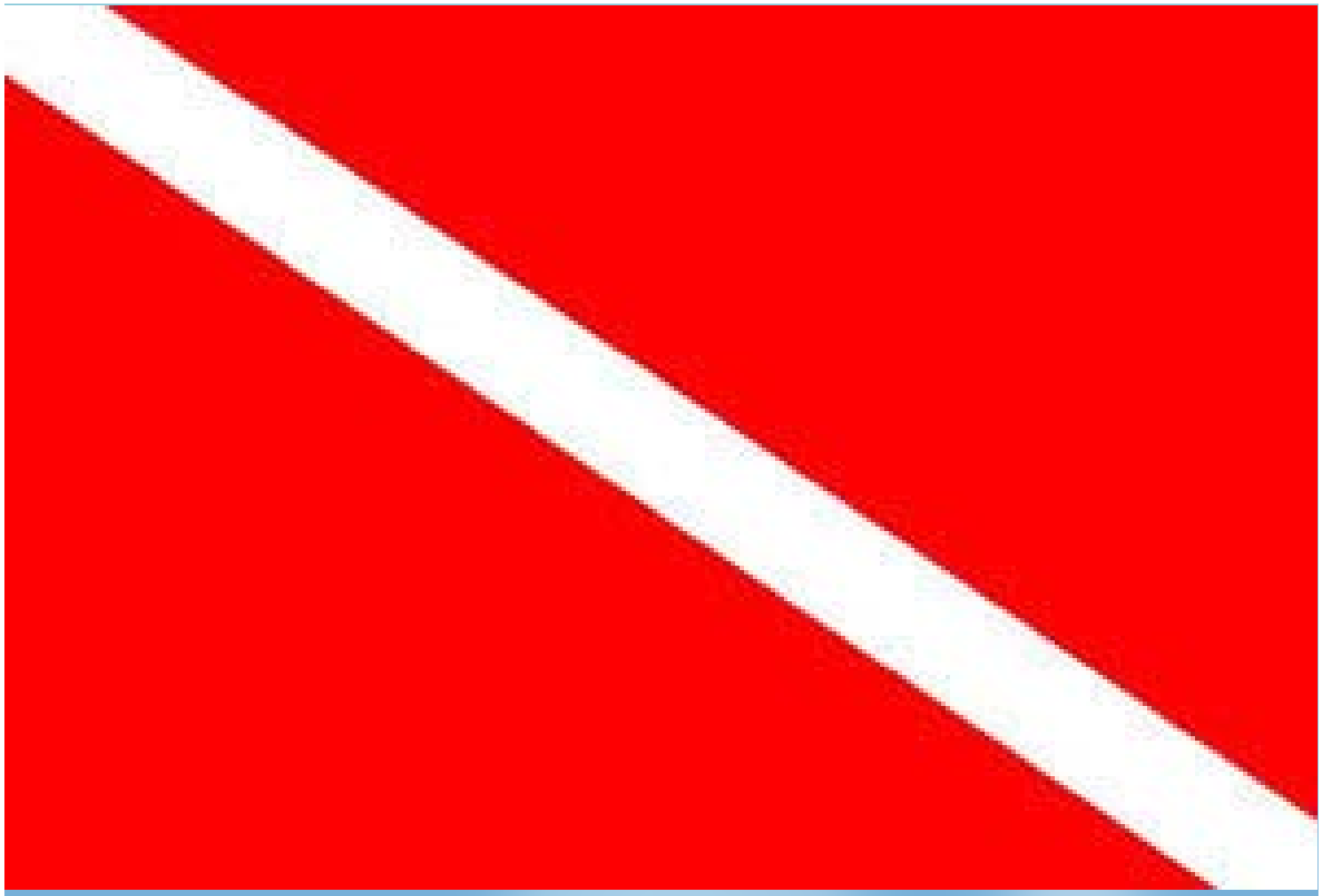
Buffers

- Avg depth at 200m - 75m
- Avg depth at half mile - 550m
- Avg depth at one mile - 900m

0 0.5 1 2 Miles

Data derived from NOAA Wake Island Harbor Chart 81664 updated 5/28/2014, and NOAA Digital Elevation Models of Wake Island Technical Memorandum NESDIS NGDC-32 published July 2010.

APPENDIX P
WAKE ISLAND DIVE CLUB CHARTER



Wake Island Dive Club Charter

Revised June 2016

The Wake Island Dive Club is a subsidiary Committee

Of The

Wake Island RCA (MWR Activity) Advisory Council

ARTICLE I – NAME, MISSION, VISION, GOALS AND OBJECTIVES

A. Name

The organization name is: “Wake Island Dive Club” and is referred herein as the “Dive Club”.

B. Mission

Safe Recreational Diving.

C. Vision

Fun and Safe Recreation that builds morale, improves retention and promotes recruiting

D. Goals

The Goals of the Wake Island Dive Club are:

1. To promote safe SCUBA diving as a means of recreation and sport
2. To have Fun
3. To establish basic requirements for safe accomplishment of recreational SCUBA diving for Wake Island residents and visitors.
4. To responsibly care and account for all assets of the Dive Club

E. Objectives

1. Safety
    a. Metric 1. No Reportable Injuries per Calendar Year
    b. Metric 2. 100% Reporting, Investigation and Follow-up Re-Training following all Near Misses within 2 Months of each Near Miss Occurrence
2. Fun
    a. Metric 3. Monthly Member Feedback of Four or Better on 5 point scale
3. Diver Certification
    a. Metric 4. Monthly Hands-On and/or Classroom/Presentation Training
    b. Metric 5. Provide a Yearly Initial Certification and Upgrade Training Opportunity
    c. Metric 6. 80% Member Certification Retention without Lapse
    d. Metric 7. Bi-Yearly Equipment Operations and Maintenance Training
4. Accountability
    a. Metric 8. 100% Compliance with Dive Club Training and Certification Requirements

b. Metric 9. 100% Accountability of Dive Club Assets; Equipment, Supplies, Records and Funds

ARTICLE II – OVERSIGHT

A. Operations

The Wake Island Dive Club (Dive Club) operates as a subsidiary committee of the Wake Island RCA (MWR Activity) Advisory Council, and as such will abide by the charter of the RCA and be accountable to it for all aspects of the Dive Club Operations, Safety, Finances, and Equipment Accountability.

B. Finances

There shall be tree layers of Fiscal Oversight of funds received, held and expensed on behalf of the Dive Club.

1. The Dive Club shall keep books of all funds received, held as Cash, and Expensed on behalf of the Dive Club in accordance with Article IV Paragraph C. The Dive Club will submit on a Monthly basis to the RCA Treasurer an accounting of all funds and a budget execution summary. The Dive Club will submit to the RCA for approval an annual budget and Fee Structure to include Operations, Maintenance and Repair, Investment, Recapitalization, Training and Certification.
2. RCA (MWR Activity) Advisory Council Treasurer will validate the Dive Club Financial Statement and include such in Monthly Accounts and Budget Execution summary for approval of the RCA Advisory Council.
3. The RCA Treasurer shall submit all MWR Activities accounts including the Dive Club for Project Level review through the Wake Island Site Manager who will then forward them for audit by the ISS GSL Project Financial Manager at PHQ in Anchorage, AK.

C. Accountability

1. Equipment and Supplies. The Dive Club Members are accountable to the RCA (MWR Activity) Advisory Council for all Assigned Acquired and borrowed equipment and supplies.
2. Funds. The Dive Club Members are accountable to the RCA (MWR Activity) Advisory Council for all funds collected, held and expensed by the Dive Club. The Dive Club Budget must be approved first by the Membership and then by RCA (MWR Activity) Advisory Council, and as such the Dive Club and RCA Advisory Committee have a responsibility to their members to maintain fiscal solvency from Calendar Year to Calendar Year.
3. Facility. The Dive Club members are responsible to the Site Manager for the Building Custodianship Duties, Cleanliness and Security of any facilities provided to them for their operations.

4. Borrowed and Co-Used Equipment. The Dive Club Members are responsible to the owning organization for the safe operation, cleanliness and access control to any borrowed or co-used equipment while in their care, such as Fire Department's Breathing Air Compressor, et al.

ARTICLE II – OPERATIONS FUNCTIONS AND ACTIVITIES

A. Functions

Conduct safe SCUBA diving for Wake Island residents and visitors by:

1. Promoting safe diving through education in regularly scheduled meetings, on-site certified training, guest speakers, and shared experiences
2. Providing safe breathing air and cylinders
3. Investigating unsafe dive practices, incidents, and accidents
4. Conducting dive orientations for certified divers

B. Activities

1. Conduct Wake Island orientation dives
2. Provide Club dive trips
3. Conduct community dive events
4. Conduct tank house and scuba locker maintenance and operations
5. Provide Safe Diving Orientation Presentations as requested to Wake Island Staff and Visitors
6. Orientation Dives. All Divers in Training and any transient divers must be accompanied by an experienced, qualified Wake Island dive lead on any dive.

C. 24 Hour Limit

There must be at least 24 hours surface interval before flying. Therefore, aircrew/pax on Island for less than 24 hours shall not be extended diving privileges. NOTE: Compliance with this rule is the responsibility of the diving transient, NOT the Dive Club, its membership, or management. ANY military member who questions or disputes this policy will be referred to the Det. 1 Commander for resolution.

ARTICLE III - MEMBERSHIP

A. Diver Status

There are five levels of Diver Status relevant to the Wake Island Dive Club:

1. Transient/Non-Member Diver: Any non-resident certified diver assigned, TDY, or visiting Wake Island for less than 90 consecutive days.

2. Resident/Member Diver: Any certified diver residing, assigned, TDY, or contracted to Wake Island for more than 90 consecutive days, and who meets all eligibility requirements set forth herein.
3. Dive Lead:
    a. The Dive Lead is a guide and the responsible Dive Club authority for escorting non-members, Divers in Training, and other newcomers on Dives of the waters in and around Wake Island.
    b. The Dive Lead performs the leadership role for Dives so that they are safe and fun, and to assure that Dive Club equipment is accounted for and Divers are held responsible for the equipment that they check-out form the Dive Club.
    c. A Dive Lead must be so designated by the Dive Club Committee. The Qualifications of a Dive Lead are:
        (1) An experienced Wake Island Resident/Member Diver who has completed at least 20 logged dives of the waters immediately surrounding Wake Island,
        (2) Demonstrated desire to be a Dive Lead by requesting to become a Dive Lead to the Dive Club Committee.
        (3) Must be deemed qualified by a current Dive Club Dive Lead.
        (4) Dive Leads do not need advanced certifications or emergency training.
4. Resident/Committee Member Diver: Experienced, knowledgeable resident diver who has shown the willingness and ability to serve the Dive Club as a Committee Member, and who meets all eligibility requirements set forth herein.
5. Diver in Training: A person who is seeking dive Certification through participation in Dive Club Training.

B. Membership Eligibility

Any Resident/Member diver holding a nationally sanctioned recreational SCUBA Open Water certification (i.e. PADI, NAUI, NASDS, SSI, WUF, & YMCA), or military/commercial dive credentials is eligible for membership.

C. Membership Suspension

The Dive Club has the right to suspend the Membership of any member who fails to maintain the established safety and accountability standards of the Dive Club, and/or who is in fiscal arrears to the Dive Club. Suspended Members have a right to provide rebuttal of their suspension for reconsideration to the Dive Club Membership and to appeal their suspension to the RCA (MWR Activity) Advisory Council. To overturn a Suspension decision of the Dive Club Membership, the RCA (MWR Activity) Advisory Council must achieve a unanimous vote of members present. In order for the Suspension rebuttal to be heard, 75% of all RCA (MWR Activity) Advisory Council Members must be present. If a Member is suspended, the Dive Club shall return to that member the prorated portion of

their Dues (if collected) calculated as of the last day of the month in which the member was suspended. After thorough inventory, the Dive Club shall also return to the Suspended Member any personal equipment that may have been stored or left in Dive Club facility(s). Suspension from the Dive Club does not alleviate the member from being subject to disciplinary action(s) that the Company may decide to take for violating company code of conduct or other corporate policy.

D. Membership Requirements

Only members in good standing may use Dive Club equipment, supplies and/or have access to and use the Breathing Air Compressor. To be considered in good standing members must:

1. Be willing to attend all scheduled Dive Club Meetings held while they are on Island.
2. Have the following documents on file with the Dive Club Treasurer/Secretary:
    a. An executed and current (< 1 year) Wake Island Diver's/Snorkeler's Liability Release Form
    b. An executed and current (latest revision) Wake Island Dive Club Charter Acknowledgement Form
    c. A photo copy of a recreational, military, or commercial dive certification.
3. Receive a Wake Island safety and UXO brief acknowledged by the WI CFSI Safety Manager.
4. Be in good standing fiscally with the Dive Club having paid any dues and dive fees as may be required under Attachment 1. To this Charter.

ARTICLE IV – CLUB COMMITTEE

A. Committee Members

1. The Dive Club Committee shall be made up of 3 or more members of the Wake Island Dive Club including a Secretary. Any non-transient, permanent island Resident Dive Club Member who currently holds an official SCUBA certification may be a member of the Dive Club Committee.
2. Any permanent resident of good standing who wishes to attend ALL Dive Club meetings with the intention of becoming certified is welcome to attend and contribute to Dive Club and Committee meetings, but cannot be a committee member until receiving an Open Water SCUBA certification.
3. All Committee members will work together to ensure the safety of all divers. All Committee members will work together to ensure that equipment is maintained, serviced and tested. All decisions regarding the Wake Island Dive Club shall be a majority vote. No unilateral decision affecting Dive Club operations and/or administration shall be made by any individual member.

4. The Dive Club Committee is responsible for situational awareness of general status of equipment inventory and condition, and coordination/approval of new equipment expenditures through RCA (MWR Activity) Advisory Committee.

B. Dive Club Meetings

Dive Club meetings should be held monthly, regardless of number of members able to attend. However, 4 or more members must be present to constitute a quorum for voting on any Dive Club decisions including approval of minutes and any financial commitments. New acquisitions for Dive Club exceeding $250.00 must first be approved by majority vote of Dive Club members at open Dive Club membership meetings. Any tie of such a vote will be broken by the Secretary.

C. Dive Club Duties of Dive Club Committee

The Dive Club Committee shall constitute no less than 3 Dive Club Members including the Treasurer Secretary. The Dive Club Committee shall:

1. Be selected from amongst Dive Club Members by popular vote in open session of the Dive Club.
2. Ensure Dive Club viability through promotion, activities, and general welfare.
3. Ensure compressed air tanks are tested quarterly by WI Fire Department's Breathing Air Specialist.
4. Ensure regulators and gauges are certified and serviced annually.
5. Ensure tanks are serviceable within hydrostatic test dates.
6. Ensure tanks are VIP tested annually.
7. Review Tankhouse, SCUBA Locker inventory, and dive logs.
8. Request and coordinate Dive Club-sponsored boat operations.
9. Administer dive boat sign-up sheets.
10. To review each Member's Certification and to call into question the attitude or actions of any other member when those actions and attitudes may pose a safety risk or are in disregard for the rights of other members under this charter including for the lack of accountability of Dive Club assets.
11. Report to the general Membership, no less than quarterly, the progress toward achieving each of the Dive Club Goals by presenting to the Membership each Metric stipulated in Article I, Paragraph E. Objectives.

D. Treasurer/Secretary (via designated proxy if not present) shall:

1. The position of Secretary will be approved by a majority vote of the Dive Club general Membership. Secretary will keep track of dive certifications, committee

hours, monies collected, receipts, and non-member documents/forms. Secretary Duties are further ruminated in Article IV Paragraph D.

2. Maintain a cash based record/ledger of accounts for all Dive Club monies received, held and expensed and to report those accounts in open forum to the Dive Club Membership.
3. Prepare, Coordinate and present for the approval of the Dive Club Membership an Annual Budget and Usage Fee Schedule.
4. Present for the Approval by the RCA Advisory Council the Dive Club Approved Annual Budget and reconcile as necessary with Dive Club any objections or provisions as stipulated by the RCA Advisory Council.
5. Collect all required fees PRIOR TO dive trips/excursions. NO EXCEPTIONS.
6. Transfer all funds collected to RCA Treasurer/designated representative. The Treasurer shall obtain receipt for such funds and file these receipts and record transfers in the Dive Club Accounting Record.
7. Coordinate purchase/reimbursement for all approved Dive Club purchases.
8. Provide to the RCA Treasurer with a monthly financial statement of accounts and budget execution. As necessary, represent the Dive Club budget and accounts to the RCA Advisory Council, advocate for resources and coordinate activities.
9. Maintain current roster of Dive Club membership and Member files to include: executed and current (< 1 year) Wake Island Diver's/Snorkeler's Liability Release Form, an executed and current (latest revision) Wake Island Dive Club Charter Acknowledgement Form, and photo copy of a recreational, military, or commercial dive certification(s).
10. Maintain a current and accurate equipment inventory and shall assure an audit of all Dive Club equipment is conducted no less than annually and conducted prior to changing of Treasurer/Secretary personnel as a ritual of office transition protocol.
11. Report to the RCA (MWR Activity) Advisory Council the status of equipment on a quarterly basis and shall report immediately any damaged, lost or stolen equipment as well as any equipment that is determined to be permanently unserviceable. Unserviceable equipment shall be turned into supply for recording of disposition and disposal processing.

ARTICLE V - TANKHOUSE & SCUBA LOCKER OPERATIONS

Violating this Article shall subject members to disciplinary action up to and including suspension of Wake Island diving privileges.

A. Dive Log. Members of the Dive Club are responsible for logging their dives on the log each time a dive is made.

B. Equipment Maintenance. All equipment of the Dive Club shall be thoroughly rinsed with fresh water, inspected for serviceability, and hung back up in scuba locker at the end of each dive.

C. Tank Filling. Depleted SCUBA tanks taken to the Firehouse immediately after use, refilled with Breathing Air in accordance with Dive Club instructions and immediately returned to the Tank Storage Facility ("Tankhouse") to be checked in by the Dive Lead..

D. Equipment Inventory and Accountability. The Dive Lead shall check out all equipment and gain signature from the Diver checking it out to establish clear accountability and chain of custody. The Dive Lead shall inventory all equipment returns and identify any and all discrepancies in quantity and condition. The Dive Lead shall hold all Divers responsible for the gear they have checked out will report to the Dive Committee and General Membership any discrepancies left unresolved following their Dive. The Dive Lead shall accomplish reports as directed by the Dive Club Committee in reconciling lost or Damaged Equipment. The Dive Lead shall assure any equipment found to be in question as to its serviceability or safety is immediately taken out of service and clearly marked "OUT OF SERVICE". The Equipment, as well as the equipment inventory, shall be marked as to why, by whom and on what date the equipment was taken out of service. To re-establish an equipment item's serviceability requires the verification of no less than two Dive Leads and shall be noted in the Equipment Inventory and reported to the Dive Club Members in Open Meeting.

E. Tankhouse Security and Cleanliness. Dive Club Members shall keep the Tankhouse clean, neatly organized, safe and secure. The Dive Club Committee shall assign a Tankhouse Facility Custodian to oversee Security and Condition of the Tankhouse and to generate work orders and perform follow-up on those work orders with Civil Engineering.

ARTICLE VI – DIVE BOAT OPERATIONS, MAINTENANCE, AND SECURITY

A. Members of the Club are all responsible for helping to ensure dive boat is maintained, in good operation, and secured properly. The designated/qualified dive lead is responsible for proper mooring and unmooring of boat, post-dive cleaning, and general organization during each outing. Violating this Article may subject members to disciplinary action up to and including suspension of Wake Island diving privileges.

B. The Dive Boat shall always have at least one qualified operator remaining onboard during boat dive activities, regardless whether it is moored to a buoy or unmoored. The Dive Leader shall always perform a complete inspection of the integrity of a buoy prior to its use. While in open water, the Dive Boat Pilot/Captain shall never shut off the motor(s) until and unless the boat is securely moored to a serviceable buoy. Props shall be idled while the Dive Leader performs the Buoy security check

C. Any members of the Dive Club who notice a problem with the boat will inform the RCA Manager, Transportation section, and Dive Club Committee and Secretary, to ensure that issues are corrected/repaired in a timely manner. If there are malfunctions to the

dive boat, a work order must be submitted to the transportation supervisor by the Dive Lead. Keeping up with the maintenance and performance of the dive boat has been determined by the Project Manager to be a function of the Transportation section, as it must be maintained for contingency use in other Wake island operations.

ARTICLE VII – FEES AND RULES

A. Membership Dues/Fees and Rules

1. The Dive Club is authorized to set Membership Dues and Usage Fees in order to sustain and nurture its operation as well as to assure long term solvency. If employed, Membership Dues and/or Usage Fees Schedules shall be at Attachment 1. to this Charter. The Fact that the Dive Club may establish Dues and Fees Schedules does not mean it must establish them.
2. The Dive Club is authorized to establish graduated or differential Dues and Fee Schedules based upon category of CFSI employment (SCA, Union, Exempt Supervisor, Exempt Manager), and/or by the Diver Status as described in Article III Paragraph A.
3. Fees and fee structure must be submitted along with the Dive Club Budget for the approval of the RCA (MWR Activity) Advisory Council. Approval of the Budget and Fee proposal must be by majority vote of those attending the Dive Club meeting, as long as there is a quorum present. Subsequent to the approval of a revision to the Dive Club Fees and/or Fee Structure, the Dive Club Committee must issue to each member and to the RCA (MWR Activity) Committee, Site Manager and ISS GSL Project Financial Manager a revised Attachment 1. to the Wake Island Dive Club Charter.

ARTICLE VII – DISSOLUTIONMENT OF THE WAKE ISLAND DIVE CLUB

In the event of the dissolution of the Wake Island Dive Club, all funds collected on behalf of the Dive Club will be used to meet any outstanding obligations, and any remaining funds will be turned over to Wake Island RCA (MWR Activity) Advisory Council.

AUTHORIZED BY: DATE:

DAVID T PETERS, CFSI ISS GSL

Project Manager

Installation Support Services (ISS) Geographically Separate Locations (GSL) Project

Chugach Federal Solutions, Inc.

ATTACHMENTS

1. Member Ship Dues and Dive Fees
2. Incident Reporting Procedure
3. Dive Club Member Acknowledgement

Attachment 1. Member Ship Dues and Dive Fees

A. Transient Divers / Non-Member Divers.

1. This section applies to all persons not assigned to or who are just visiting Wake Island for less than 90 consecutive days or those who do not have membership in the club.

2. All fees collected for transient divers must be collected by the designated/qualified Dive Lead (or the Dive Club Secretary, if present) PRIOR TO the dive.

3. The Resident Dive Lead shall oversee and assure proper pre and post-dive equipment inspections, and assure that post dive cleaning and care of equipment and boat is accomplished.

4. Fees.

a. Shore Dives: Shore dives are authorized only at known and pre-designated shore dive locations. Transient and non-member shore dives are charged a flat fee of $40.00 per dive, regardless of whether Dive Club-owned or personal equipment is used.

b. Boat Dives: Transient and non-member divers are each charged a flat fee of $60.00 per dive, regardless of whether Dive Club-owned or personal equipment is used.

B. Resident Divers - residing, assigned, or TDY to Wake Island for more than 90 consecutive days who are Dive Club members in good standing. Dive Club members must attend Dive Club Meetings.

1. Resident divers must log at least 20 verified dives on Wake Island, with a lead-qualified Wake Island diver, before requesting to be designated as a Dive Lead to escort/lead any group of non-lead-qualified divers.

2. Fees.

a. Dive Equipment rental for Resident Members: No charge

b. SCUBA air tank rental for Resident Members: No charge

c. Dive Boat rental for Resident Members: Current Boat Usage Rules/Fees apply (see R/CA representative).

d. Shore Dive fee rental for Resident Members: No charge

e. Dive Club dues for Resident Members: No charge

ATTACHMENT 2. - Incident Reporting Procedure

A. Applicability.

All Dive Club members will report violations of this Charter and/or relevant other policies to the Committee. Failure to do so may result in suspension or revocation of diving privileges.

B. Reporting. Any reports or documentation provided to the accused member shall have the reporting member's name removed.

C. Process. When a report is received by a Dive Club Secretary, the following actions will be taken:

1. Any individual may make complaint of violation of this Charter to any member of the Dive Club Committee, Member of the RCA (MWR Activity) Advisory Council, WI Safety Manager, Fire Chief or Site Manager.
2. Upon being notified the notified party will contact the Dive Club Treasurer/Secretary, or if the complaint is against the Dive Club Treasurer Secretary, to another member of the Dive Club Committee.
3. The Dive Club Secretary or Committee Member will immediately contact the individual reporting the incident to verify and further discuss the incident.
4. The Dive Club Secretary or Committee Member shall investigate the complaint and conduct an inquiry to attempt to verify or refute the allegation.
5. The Dive Club Committee will advise the accused of the accusation immediately.
6. At the Committee's discretion, based on the seriousness of the accusation, the accused will be required to respond to the accusation(s) not later than seven days after receiving the report or seven days after returning to Wake Island if on travel.
    a. If a response is not received within seven days, the individual will be suspended from all diving activities until the issue is resolved.
    b. If the individual continues to dive, he/she will be automatically expelled from the Dive Club, and the Wake Island Site Manager will be notified.
7. Upon receipt of the accused member's response and the written result of the investigation, the Secretary or Committee Member will notify the RCA (MWR Activity) Advisory Council only that there is complaint that is being forwarded to the Wake Island Site Manager for disposition.

D. Failure to Comply.

1. Any diver who continues to dive while on suspension will be permanently expelled from the Dive Club.
2. Any diver found to be knowingly diving with an expelled diver will also be expelled from the Dive Club.

3. If a member is found to file a false accusation with intent to harm the credibility of another member, that member will be suspended for a period of time to be determined by the Committee.

E. All reports will be made available, upon request, to members after the name of the reporting individual is removed from the report.

F. Safe Diving Complaints, Near Misses and Accidents.

1. Accidents.

a. All accidents will be reported immediately using the Wake Island Standard procedures for Accident Reporting by using radio Channel 6 or 8 or by phone to 911 to Fire Dispatch.

b. Any emergency response will be promptly accomplished and made secure.

c. Witnesses shall provide Statements and writing to the WI CFSI Safety Manager. All accidents shall be reported to the CFSI Safety Manager.

2. Near Misses.

a. All Near Misses will be reported to a Dive Lead, or Dive Club Committee, and shall be reported to the WI CFSI Safety Manager.

b. Dive Club Members shall use the Near Miss reporting procedures as dictated by the WI CFSI Safety Manager.

3. Safe Diving Complaints.

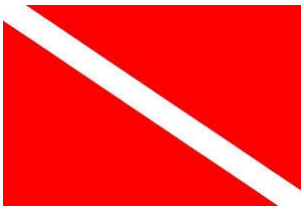
a. Complaints of Unsafe Practices shall be acted upon immediately by the observer who will call the issue to the attention of the person or persons whose action(s) or failure to act are in question. Immediate assessment and review is the appropriate response of all parties with correction/risk mitigation as appropriate.

b. Failure to immediately address a complaint of Unsafe Diving Practices shall be made and processed as a violation of the Wake Island Dive Club Charter pursuant to Paragraph A. Applicability and Paragraph B. Process.

c. Validated complaints of Unsafe Diving Practice shall be addressed formally as a “Near Miss” and be addressed under Paragraph 2 above, Near Misses.

ATTACHMENT 3. Dive Club Member Acknowledgement

As Revised June 2016



The Undersigned Dive Club Member acknowledges receipt, understanding of, and compliance with the Wake Island Dive Club Charter, and agrees to be bound by the rules and procedures contained therein. Furthermore, the Dive Club Member acknowledges that failure to comply with the Dive Club rules set forth may result in disciplinary action up to and including revocation of all SCUBA privileges on Wake Island.

Every Dive Club Member Must Complete the Following.

A. Print Name, Sign, and Date, below.

B. After signature copy this page and submit it to the Dive Club Secretary.

C. Retain the Original for Personal Record.

I certify that I have read the Wake Island Dive Club Charter and agree to be bound by it. I will faithfully carry out my duties as a Dive Club Member and to Practice Safe Diving at all times.

NAME (PRINT)	DATE:
SIGN:	

APPENDIX Q
KŌKE`E AIR FORCE STATION AND KŌKE`E MICROWAVE ANTENNA SITE DOWNED BIRD LOG

KOKE`E DOWNED BIRD LOG

DATE	TIME	LOCATION FOUND	SPECIES	STATUS WHEN FOUND	ACTION TAKEN	IF DECEASED, CAUSE OF DEATH

* If a dead bird is found, please bag it, label it with the date, time, and location and freeze it.

APPENDIX R
UNITED STATES SPECIFIC COMMAND DEFENSE TRANSPORTATION REGULATION PART V – CHAPTER 511

CHAPTER 511

UNITED STATES PACIFIC COMMAND (USPACOM)

A. GENERAL USPACOM GUIDANCE

This chapter identifies regulations or directives and establishes Customs/Border Clearance requirements and procedures and organizational POCs responsible for the entry/exit of material and personnel from the various countries listed. There is presently no electronic foreign Customs interface for military shipments going through Japanese Customs.

B. CUSTOMS CLEARANCE PROCESSES

This section provides the most up-to-date overseas customs process information that has been obtained for the following countries:

C. AUSTRALIA

1. Passengers. See the DOD Foreign Clearance Guide available at https://www.fcg.pentagon.mil/fcg.cfm. From the left column select Pacific and South Asia and then Australia.
2. Cargo:
   a. Government. When military equipment is shipped into Australia for combined exercises or training or other activities approved by the Australian Government, Australian Customs and the Australian Quarantine Inspection Service must be advised at least four weeks in advance of the arrival at the First Port of Entry (FPE) and four weeks before departure at the Last Port of Departure (LPD).
   b. Military weapons destined for exercises approved by the Australian Government are exempted from normal import and export restrictions (Australian Regulation 3A Customs Regulations 1956 – Prohibited Import), but other goods subject to controls, such as drugs and pharmaceuticals, are not exempt. These require a permit issued by the authority. All weapons and equipment must be clearly manifested. At the time of importation, the US Defense Force must be the owner of the goods or a member/employee of that defense force must have been issued those goods.
   c. The export of goods from Australia is controlled by laws and Government policies to:
      (1) Prohibit the export of certain goods either absolutely or conditionally
      (2) Record Australia's international trade.

Total prohibition applies to the export of protected wildlife, some heritage items, and other dangerous goods. Goods that are conditionally prohibited from export may not be exported unless all export permits are obtained from the permit-issuing agency. Further, goods may not be exported or loaded on a ship or aircraft for export (some exemptions apply) until Customs has given approval to export by means of a "cleared" Export Clearance Number.

d. All export consignments greater than Australian Dollars (AUD) $2000 in value will require an export entry. Ships or aircraft may not depart from Australia unless Customs has issued a Certificate of Clearance. A certificate will not be issued unless all Commonwealth requirements concerning the ship or aircraft and its cargo have been met.

3. Personal Property and POVs. Customs is responsible for the clearance of all unaccompanied effects from overseas. The member/employee can clear unaccompanied effects. The member/employee can appoint a nominee to clear the effects or use a customs broker. In order to clear goods, the following steps need to be taken:

   a. Complete a Form B534, Unaccompanied Personal Effects Statement, Figure 511-1

   b. Provide passport

   c. Provide detailed packing list.

4. Duty free concessions applying to alcohol, tobacco, and other articles that arrive accompanied through Customs do not apply when the same goods arrive as unaccompanied effects. Additionally, Customs duty and taxes are payable on goods acquired as gifts.

   a. Any motor vehicle imported into Australia must have a vehicle Import Approval issued by the Department of Infrastructure, Transport, Regional Development and local government.

   b. Duty free concessions for personal effects, HHG and motor vehicles arriving in Australia for SOFA personnel are controlled by Customs By-Law 9940005.

   c. Cargo not related to military exercises must go through the formal entry process, when the value exceeds AUD $250.

   d. Information may be obtained at http://www.dotars.gov.au/ **(*) Non-DOD website** or by e-mail at Vimports@dotars.gov.au.

5. Firearms/Weapons – Australian Regulation 3A Customs (Prohibited Import) 1956 for import and Regulation 13E (2) Customs (Prohibited Exports) control the import and export of firearms in Australia.

   a. Firearms and weapons owned and imported by the US Military for participation in combined exercises or other activities approved by the Australian Government are exempt all permit requirements for both import and export. These goods must be manifested and cleared through Customs. At the time of importation, the US military must be the owner of the equipment.

   b. Personal equipment including military souvenirs, firearms or dangerous weapons, including trophies/displays or military souvenirs not owned by the US military is subject to normal customs requirements.

6. Modes of Shipment:

   a. Military Air or Sea. Cargo arriving or exiting by military airlift or sealift is to be reported at FPE on an uncoded and legible manifest. The manifest must show the intended port of destination.

      (1) Cargo moved to a subsequent port for clearance is moved under Customs control and must be reported at the destination port for clearance. Customs entries are not required for foreign Defense Forces participating in military exercises approved by the Australian Government.

      (2) At the time of importation, the US defense force must be the owner of the goods or a member/employee of that defense force must have been issued those goods. All weapons and equipment must be clearly manifested.

      (3) Customs Prohibited Imports and Prohibited Export Regulations exempt specified visiting foreign Defense Forces from import and export permits for certain defense goods when such forces arrive in Australia to participate in activities approved by the Government (such as combined exercises and training) and when they depart from Australia.

      (4) Permits for all other goods subject to controls (e.g., drugs and pharmaceuticals) will be required from the authority. A manifest is to be produced at the LPD to confirm export of the cargo. The Australian Customs Service may examine the cargo on importation and/or exportation.

      (5) Personnel. Upon arrival at all airports, a passenger list must be provided to Customs. The list must include full name, date of birth, gender, and passport/visa number/confirmation that the passenger holds an Electronic Travel Authority. Duty passengers covered by SOFA can enter Australia on a military ID and movement orders (individual or collective).

      (6) Spouses and/or dependants of US armed forces member/employee covered by SOFA must present a valid passport and either movement orders or a certificate stating that the person is a spouse or dependant and is accompanying or joining that member/employee. Spouses and/or dependants who comply with these requirements are cleared to hold a Special Purpose visa under the Migration Regulations.

      (7) Upon departure, outgoing military aircraft must produce one copy of the cargo manifest and a copy of passenger list. Normal immigration processing applies to passengers (e.g., Outgoing Passenger Card and passport). A military ID is an acceptable travel document for passengers on orders.

   b. Commercial Air. Advanced passenger information must be provided to Customs for expected flight movements at least 48 hours prior to arrival and 24 hours prior to departure. All passengers must have the following:

      (1) Passport or military ID

      (2) Completed Incoming Passenger Card.

c. Documents are returned after processing.

(1) Goods imported into Australia by commercial airline will be reported electronically to Customs by the handling agent or freight forwarder.

(2) For Customs reporting purposes, the airline company or local handling agent requires the following information: full details of the consignor, consignee, and description of the goods, value, and origin.

(3) For Customs clearance purposes, the minimum documentation required to be submitted with customs import entries or Informal Clearance Documents includes an AWB, invoices, and any other papers (including packing lists, insurance documents) relating to the shipment.

7. The Customs Act of 1901 requires importers to retain commercial documents relating to a transaction for five years from the date of entry. These documents may be required for Customs audit purposes. The goods will remain in a Customs licensed depot until Customs and Quarantine clearance has been completed and the goods have been released.

8. There are severe penalties for not declaring prohibited or restricted items and goods on which duty or taxes are due.

9. Refer to the Customs website http://www.customs.gov.au/ for further information on items which must be declared on arrival.

10. Commercial Ocean Vessel Shipments. Goods imported into Australia and exported from Australia by ship are treated in the same manner as air cargo in Paragraph 6.b.

D. BANGLADESH

1. Passengers. See the DOD Foreign Clearance Guide available at https://www.fcg.pentagon.mil/fcg.cfm. From the left column select Pacific and South Asia and then Bangladesh.

2. Cargo. No country specific details.

3. Personal Property. See the PPCIG at https://tops.ppcigweb.sddc.army.mil/ppcig/menu/home/warning.do. Select Query CG tab, select County Instructions tab, at the Country drop down box under Custom Selection, select Bangladesh, submit. Click on the detail icon on the upper right hand side to review shipping requirements.

E. BURMA

1. Passengers. See the DOD Foreign Clearance Guide available at https://www.fcg.pentagon.mil/fcg.cfm. From the left column select Pacific and South Asia and then Burma.

2. Cargo. No country specific details.

3. Personal Property. See the PPCIG at https://tops.ppcigweb.sddc.army.mil/ppcig/menu/home/warning.do. Select Query CG tab, select County Instructions tab, at the Country drop down box under Custom Selection, select Burma, submit. Click on the detail icon on the upper right hand side to review shipping requirements.

F. CAMBODIA

1. Passengers. See the DOD Foreign Clearance Guide available at https://www.fcg.pentagon.mil/fcg.cfm. From the left column select Pacific and South Asia and then Cambodia.
2. Cargo. No country specific details.
3. Personal Property. See the PPCIG at https://tops.ppcigweb.sddc.army.mil/ppcig/menu/home/warning.do. Select Query CG tab, select County Instructions tab, at the Country drop down box under Custom Selection, select Cambodia, submit. Click on the detail icon on the upper right hand side to review shipping requirements.

G. CHINA

1. Passengers. See the DOD Foreign Clearance Guide available at https://www.fcg.pentagon.mil/fcg.cfm. From the left column select Pacific and South Asia and then China.
2. Cargo. Per 22 CFR 126.1, ITAR controlled cargo cannot be imported into or transit through mainland China
3. Personal Property. See the PPCIG at https://tops.ppcigweb.sddc.army.mil/ppcig/menu/home/warning.do. Select Query CG tab, select County Instructions tab, at the Country drop down box under Custom Selection, select China, submit. Click on the detail icon on the upper right hand side to review shipping requirements.

H. FIJI

1. Passengers. See the DOD Foreign Clearance Guide available at https://www.fcg.pentagon.mil/fcg.cfm. From the left column select Pacific and South Asia and then Fiji.
2. Cargo. No country specific details.
3. Personal Property. See the PPCIG at https://tops.ppcigweb.sddc.army.mil/ppcig/menu/home/warning.do. Select Query CG tab, select County Instructions tab, at the Country drop down box under Custom Selection, select Fiji, submit. Click on the detail icon on the upper right hand side to review shipping requirements.

I. GUAM

1. Passengers. See the DOD Foreign Clearance Guide available at https://www.fcg.pentagon.mil/fcg.cfm. From the left column select Pacific and South Asia and then Guam.
2. Cargo. All cargo entering Guam, regardless of origin, is subject to inspection by Guam Customs (http://www.cqa.guam.gov **(*)**).
3. The Commander, US Naval Forces Marianas is the lead military agency on the island for issues with Guam Customs.
4. Guam Customs requires a container packing list for all containers. Guam Customs will also conduct a physical inspection of selected containers which are sealed with a Customs Seal and delivered to the consignee but must not be opened until a Guam Customs inspector is present.

5. Military shippers will ensure:
   a. Cargo descriptions are complete and accurate.
   b. Container packing lists are in each container and a separate advance copy forwarded (e-mail) to destination.
6. The Customs Authority for Guam will not accept the following types of descriptions for container clearance on the manifests generated in GATES Surface.
   a. Descriptions such as "General Cargo", "Freight All Kinds" (FAK), or "Said to Contain" (SAC).
   b. Cargo N.O.S.
   c. Furniture - must specify the type of furniture (e.g., chairs, desks, sofas).
   d. Bakery products - specify specific bakery product (e.g., bread, pie crusts).
   e. Canned goods - must specify type of canned good (e.g., canned meat, canned vegetables, canned fruits).
   f. Appliances - must specify type of appliance (e.g., stove, refrigerator).
7. Military consignees on Guam will ensure the container packing lists are promptly provided to Guam Customs when requested.
8. Failure to comply with these requirements may result in the delayed delivery of cargo.

   NOTE: Military shipping activities on Guam must take measures to prevent the spread of the Brown Tree Snake (BTS) to other countries.

   Activities must inspect all shipments departing Guam to ensure they are free of the BTS.
9. Personal Property. See the PPCIG at https://tops.ppcigweb.sddc.army.mil/ppcig/menu/home/warning.do. Select Query CG tab, select County Instructions tab, at the Country drop down box under Custom Selection, select Guam, submit. Click on the detail icon on the upper right hand side to review shipping requirements.

J. INDIA

1. Passengers. See the DOD Foreign Clearance Guide available at https://www.fcg.pentagon.mil/fcg.cfm. From the left column select Pacific and South Asia and then India.
2. Cargo:
   a. Government. Depending on whether the cargo is for use in the Embassy or for a combined exercise, it is handled differently. For cargo going to the Embassy, import permission for goods is required from the Ministry of External Affairs. The Ministry of External Affairs requires complete details of the contents of the shipment, along with their approximate value and use. For cargo meant for a combined defense exercise, import permissions are required from the Ministry of Defense, Ministry of Finance, or Ministry of External Affairs.
   b. For incoming cargo consigned to the Embassy, the Embassy recommends at least ten days advance notice. This enables the Embassy to obtain the necessary prior approval from the Government of India before the shipment reaches Indian ports. For cargo shipped overland, the duty exemption certificate must be obtained from the Ministry of External Affairs detailing the content of the shipment. The US Embassy shipping expediter goes to the border to complete the customs clearance formalities. The US Embassy does not have direct control

over cargo booked on a door-to-door basis. The Embassy provides the duty exemption certificate for the shipment to the destination agent.

3. Personal Property. Personnel assigned to the US Embassy require duty free permission from the Ministry of External Affairs for the importation of HHG and UB. POVs must meet pollution emission standards as mandated by the Government of India. The member/employee must have a EURO II certificate from the manufacturer or a certificate from the US EPA authorities.

4. Firearms/Weapons. Importation of firearms/weapons into India is prohibited without special permission from the Government of India. Weapons are subject to physical verification by the customs authority at the time of their import.

5. Pets. A member/employee must obtain an import sanitary permit from the Ministry of Agriculture or an import license from the Director General of Foreign Trade, Ministry of Commerce. The member/employee will be in possession of a valid health certificate at the time of importing the animal. The Department of State recommends the member/employee hire a private pet expediter, because the General Services Office does not handle pets. Local pet expediters can be referred to a member/employee upon request.

6. Modes of Shipment:

   a. Military Air. Currently no provisions are in place for the US to import cargo via military vessels/aircraft into India. If military cargo is consigned to the US Embassy, then it is treated as any other cargo. If military cargo is consigned to the India Ministry of Defense, it is the responsibility of the Government of India to make the necessary arrangements for its customs clearance.

   b. Commercial Air. As stated above in Paragraph J.2, shipments coming in under a commercial contracted carrier must be consigned to the US Embassy, New Delhi. The General Services Office receives the AWB and packing list or invoice, prepares the exemption certificate, and sends it to the Ministry of External Affairs for duty-free import.

   c. Ocean Vessel. Shipments coming in under a commercial contracted carrier must be consigned to the US Embassy in New Delhi, India. As soon as the General Services Office receives the BL and the packing list or invoice, the office prepares the exemption certificate and sends it to the Ministry of External Affairs for duty-free import.

7. Personal Property. See the PPCIG at https://tops.ppcigweb.sddc.army.mil/ppcig/menu/home/warning.do. Select Query CG tab, select County Instructions tab, at the Country drop down box under Custom Selection, select India, submit. Click on the detail icon on the upper right hand side to review shipping requirements.

K. INDONESIA

1. Passengers. See the DOD Foreign Clearance Guide available at https://www.fcg.pentagon.mil/fcg.cfm. From the left column select Pacific and South Asia and then Indonesia.

2. Cargo.

   a. Government. The Government of Indonesia extends duty-free privileges only to holders of diplomatic or consular titles and a member/employee whose agencies have special agreements with the Government of Indonesia. A general declaration and packing list, along with the cargo manifest and any other shipping documents, will accompany all cargo. Each item must be listed on the cargo manifest. The US Embassy Jakarta does not recommend consolidating shipments through a freight forwarder company. Consign the shipment directly to the US Embassy and indicate the agency's name. To expedite the shipment, notify the

Post of shipping details prior to the shipment's arrival. This prior notification enables the Post to prepare import permits required by the Government of Indonesia and Customs.

b. Personal Property. HHG and UB, not to include POVs or motorcycles, may be shipped directly to Jakarta and may arrive prior to the member's/employee's arrival on Post. Designate the consignee on the BL as:

American Embassy
Jakarta, Indonesia
For (Name of Member/Employee)

c. To obtain import permits from the Government of Indonesia Foreign Ministry, FAX a copy of the Ocean Bill of Lading (OBL) and Packing list/HHG descriptive inventory to the General Service Office (GSO)/Transportation, telephone number 62-21-34359923. Send the original BL via air courier or, if time permits, US Express Mail.

d. POVs. Do not ship a POV, motorcycle, or any other motorized vehicle in a HHG shipment. The Government of Indonesia grants preliminary permission to import a POV duty free only after the member/employee arrives at Post and has been accredited by the Government of Indonesia Ministry of Foreign Affairs (MOFA). The OBL for a POV must contain the vehicle year/make/model/type/color and VIN or chassis number and engine number. Incomplete or missing data on the OBL will delay the clearance and vehicle registration process. Provide the following vehicle information to GSO/Transportation:

(1) Name, diplomatic title, and estimate arrival date at Post

(2) Vehicle year/make/model/type

(3) Price of cost, insurance, freight in US dollars

(4) Engine displacement (CC)

(5) Country of origin

(6) Name of address of car dealer (for new car)

(7) Estimated date of importation

(8) VIN or chassis number

(9) Engine number.

The original BL covering a POV shipment will be forwarded immediately to the Embassy GSO/Transportation via air courier.

e. Firearms/Weapons. The import of firearms is prohibited.

f. Pets. The member/employee must have import permit from the Ministry of Agriculture. The pet must have a health certificate issued within five days prior to the shipment stating that the animal is free from any disease and has not been in a yellow-fever-infected area for at least five days prior to shipment.

g. Security and Law Enforcement Items. The Government of Indonesia strictly prohibits the importation of firearms, drugs and narcotics, and indecent or obscene publications. The importation of alcohol is limited.

3. Modes of Shipment

   a. Military Air. A BL, cargo manifest, general declaration and packing list, along with any other shipping documents, will accompany all cargo. Each item must be listed on the cargo manifest. On the BL, designate the consignee as:

      American Embassy
      Jakarta, Indonesia
      For (Name of agency)

   b. Commercial Air. A BL, cargo manifest, general declaration and packing list, along with any other shipping documents, will accompany all cargo. Each item must be listed on the cargo manifest. Designate the consignee on the BL as provided in Paragraph 3.a.

   c. Ocean Vessel. A BL, cargo manifest, general declaration and packing list, along with any other shipping documents, will accompany all cargo. Each item must be listed on the cargo manifest. Designate the consignee on the BL as provided Paragraph 3.a.

4. Personal Property. See the PPCIG at https://tops.ppcigweb.sddc.army.mil/ppcig/menu/home/warning.do. Select Query CG tab, select County Instructions tab, at the Country drop down box under Custom Selection, select Indonesia, submit. Click on the detail icon on the upper right hand side to review shipping requirements.

L. JAPAN

1. Passengers. See the DOD Foreign Clearance Guide available at https://www.fcg.pentagon.mil/fcg.cfm. From the left column select Pacific and South Asia and then Japan.

2. Cargo. The following Paragraphs describe the customs clearance and inspection process for government and personal property shipped into Japan. The SOFA between the US and the Government of Japan (GOJ) establishes the guidelines by which government cargo and personal property can be shipped into Japan. Generally, property bound for the US Armed Forces in Japan enters duty-free.

   a. United States Forces-Japan (USFJ) Regulations, Figure 511-2. The regulations implement those portions of the SOFA that deal with customs clearance of, access to, use, and resale of duty-free goods.

   b. Government Property. The US-GOJ SOFA Article XI states “all materials, supplies, and equipment imported by the United States Armed Forces, for official use of the United States Armed Forces or for use of the member/employee of the United States Armed Forces, will be free from customs duties and other such charges. Appropriate certification will be made that such materials, supplies, and equipment are being imported to be used exclusively by the United States Armed Forces or ultimately to be incorporated into articles or facilities used by such forces.”

c. Personal Property. The US-GOJ SOFA Article XI also allows military personnel, civilian employees of the Armed Forces, invited contractors, technical representatives, and their families assigned to USFJ to ship reasonable quantities of personal property into Japan without paying duty or customs taxes for a period of six months after arrival. Personal property includes any item shipped in HHG or UB or hand-carried to the port of entry (normally Narita, Kansai, Haneda, Fukuoka, or Naha International Airports or Misawa, Yokota, and Kadena ABs and Marine Corps Air Station [MCAS] Iwakuni). USFJ personnel governed by the SOFA are not authorized to:

(1) Use their duty-free privileges to import goods into or from Japan for the purpose of realizing personal gain or profit, or for providing a gain or profit for any other individual.

(2) Use their duty-free privileges to import property when the property is not intended for the personal use of the individual or the individual's SOFA family member. Importing commercial goods for resale or gifts is prohibited.

(3) Deliberately importing goods into Japan in quantities exceeding personal needs or the needs of their bona fide family member.

(4) Personal property shipments to Japan using a reengineering initiative must be coordinated with USFJ. Rationale is that local TOs and Military Common User Port Operators must still process proper documentation to clear shipments through GOJ customs. A Government Bill of Lading (GBL) will still be used to move personal property to Japan. Procedures have not been coordinated with GOJ to use commercial documentation to customs clear shipments. The USG must abide by the SOFA.

(a) Customs clearance of personal property is subject to the six-month rule. If a member/employee ships property into Japan via commercial means after six months, the SOFA member/employee is responsible for accomplishing the proper paperwork with GOJ Customs officials. Personnel who ship property into Japan after six months must pay the customs duties, ship or hand-carry the items back out of Japan, or abandon them. When the member/employee makes a PCS move from Japan, there will be no customs duties upon export of these goods from Japan.

(b) Items shipped into Japan through the APO are not subject to the six-month rule. Import restrictions on types of items and the prohibition on items in excess of personal need apply. Vehicles and vehicle parts are not subject to the six-month rule; however, vehicles are subject to import restrictions.

d. Restricted Items. Under GOJ law and USFJ directives, the following are restricted or prohibited from importation into Japan (the list is not all encompassing and will only be used as a guide:

(1) Fresh fruits and vegetables

(2) Plants, seeds, bulbs, and straw goods

(3) Animal products such as unprocessed meats

(4) Endangered species or products made from endangered species

(5) Counterfeit, altered or imitation coins, paper money, bank notes, or securities

(6) Any books, pamphlets, paper, writings, advertisements, circulars, prints, pictures, drawings, motion picture films, phonograph or tape or wire recording, containing any matter advocating or urging treason or insurrection against the GOJ or the US.

(7) Obscene books, drawings, carvings, films, videos, and other articles of a pornographic nature

(8) Any narcotic drug or utensil used therefore (this includes marijuana, amphetamines, and hallucinogenic drugs as well as instruments for their administration

(9) Ammunition, gunpowder, and explosives

(10) Importation of items in excess of personal needs.

e. Firearms/Weapons. GOJ Custom's officials strictly control the importation of firearms/weapons of all types. USFJ Custom's officials suggest personnel coming for assignment in Japan leave all types of privately owned firearms/weapons in the US. However, if a member/employee desires to ship authorized firearm(s), the firearms will be shipped as outlined in the PPCIG (available at https://tops.ppcigweb.sddc.army.mil/ppcig/menu/home/warning.do)

(1) Privately owned firearms may not be hand carried to Japan.

(2) USFJ members/employees are not authorized to import or possess handguns.

(3) Personnel will not ship any firearm or ammunition in HHG, accompanied baggage, or UB.

(4) Firearms that are authorized by the PPCIG must be mailed by the member/employee through the US Postal System, consigned to the CDR for the unit of assignment of the gaining command and marked for the member/employee.

(5) Component and installation CDRs are authorized to impose more stringent requirements; therefore, it is important to follow the instructions in the PPCIG. Also, the member/employee will communicate with his/her gaining unit and/or sponsor.

(6) Firearms that are authorized and mailed must be registered with the local Provost Marshal or Security Forces Squadron immediately upon the weapon arriving in Japan. Personnel must have a bill of sale or a registration from the last duty assignment for the weapon to complete the registration process.

(7) Other weapons defined as dangerous instruments are instruments manufactured for or designed to inflict physical harm to other persons. Installation CDRs will determine possession, transfer, and storage requirements for dangerous instruments through installation regulations/instructions. Prior to shipping these items, the member/employee will contact his/her gaining unit or sponsor. Dangerous instruments may include but are not limited to the following:

(a) Swords, stilettos, sabers, ice pick, daggers, machetes, spears, or other similar instruments (Official military ceremonial swords may be shipped in member/employee HHG, but must be clearly marked on the carrier's inventory as "Official Military Ceremonial Sword")

(b) Spring release, switchblade, "bolo" and "butterfly" knives and metal ("brass") knuckles

(c) Trench knives or bayonets

(d) Blackjacks or objects that may be used as clubs that inflict bodily harm

(e) Explosives of any type

(f) Straight razors, razor blades, or any weapon made from either device

(g) Any other objects determined by Service components

f. Pets. The GOJ is enforcing a quarantine program for import and export of pets. These procedures listed in the PPCIG and the Public Health Command District-Japan (PHCD-J) website (www.usarj.army.mil/organization/vet/index.htm) must be strictly followed. If the pet is traveling via commercial air, the GOJ requires advance notification as soon as transportation is scheduled. GOJ will return a notification approval; it must be used when checking the animal in with the airline. A quarantine period may apply after the animal arrives in Japan. Proof of microchipping, rabies vaccinations paperwork, blood test results, a health certificate, and other documents are required. Personnel who choose to bring pets may bring them into Japan via commercial air or AMC's Patriot Express flights. The only authorized AMC military ports for importing/exporting pets are Yokota, Kadena, and Misawa AB (Misawa is for export only). Whether arriving at a commercial or AMC port, MDJ Form 270, Pet Quarantine and Examination Certificate, Figure 511-4, is required. An MDJ Form 270 can be downloaded from the PHCD-J website (http://www.usarj.army.mil/organization/vet/doc/MDJ%20270.pdf). If a pet is shipped separately as freight, it will be customs-cleared using USFJ Form 380EJ, Customs Free Import or Export of Cargo or Customs Declaration of Personal Property. This form is available at the Customs check point at the point of entry or at the Camp Zama Veterinary Treatment Facility. The member/employee may also contact a local veterinarian about detailed medical requirements for shipment of pets into Japan. It is extremely important to consult the PPCIG and/or PHCD-J (http://www.usarj.army.mil/organization/vet/) website as soon as possible after receiving an assignment to Japan.

g. Contractor Items. Article XIV, SOFA, provides that US contractors present in Japan solely for the purpose of executing contracts with the US Armed Forces may be designated US Official Contractors if they qualify under certain specified criteria. With the influx in contracting initiatives, some contractor cargo and/or personal effects may not be entitled to customs free import and export privileges. It is important to obtain a copy of the contract to determine entitlements or contact the local contracting office.

h. Security/Enforcement. In order to prevent offenses against laws and regulations administered by the Customs authorities of the GOJ, the Japanese authorities and the US Armed Forces will assist each other in the conduct of inquires and the collection of evidence. Each agency, unit, and member/employee involved with importing/exporting cargo, personal effects, and the movement of passengers has an inherent responsibility to ensure compliance with directives and the SOFA. When there are violations, proper reporting must be accomplished, thereby preserving the privileges outlined in the SOFA. Use Figure 511-3 as a guide for selecting organizations to notify.

i. Air Shipments.

(1) MILAIR. Cargo arriving in Japan by AMC is cleared by using the aircraft cargo manifest and/or DOD shipping documents attached to a USFJ Form 380EJ. The documents are presented to the GOJ Customs officials. Customs clearance is done immediately and property is released to the local agent for pick up. After the local agent picks up HHG or UB, they notify the TO for delivery instructions.

(2) Commercial Air Shipments Door-To-Door. Cargo shipments moving by commercial air express and freight forwarder carriers (door-to-door) are cleared at Narita or Kansai International Airports for both mainland Japan and Okinawa. The express carrier receives advance electronic notification alerting them of incoming shipments. The express carrier notifies the destination TO of shipping data (CBL, AWB, and/or invoice) by FAX. The TO will determine whether the shipments are official DOD cargo. After

verifying the shipments are official cargo, the TO issues a USFJ Form 380EJ or authorizes the express air carrier by FAX to create a partially completed USFJ Form 380EJ. TOs have provided contract express air carriers with pre-signed and serial-numbered USFJ Forms 380EJ. After customs clearance actions are completed, carriers must return a copy of the original USFJ Form 380EJ to the TO. After clearance, the express air carrier will make delivery to the final destination.

(3) UB Moving by Commercial Air (Code 8). The processing of USFJ Form 380EJ is the same as for HHG and UB by commercial surface not under the USC. However, the exception is that the local agent clears the UB at the IAP airport. Notification and delivery procedures are the same as HHG.

3. Ocean Vessel Shipments:

a. DOD Shipments on Commercial Contracted Carriers or MSC Vessels. DOD cargo, personal property, and POVs shipped on commercial carriers under the USC on commercial OBLs or via MSC vessels require additional certification by the MCUPOs and/or other USFJ representative. The MCUPOs are the 836th and 835th Transportation Battalions (Terminals) at Yokohama and Naha ports respectively. The carrier submits a load list/manifest by EDI and hard copy to SDDC seven to 14 days before the vessel arrives. The MCUPO pulls the military manifest from the GATES Surface, verifies and compares it with the commercial carrier's manifest for accuracy, and ensures all cargo shipped has been documented. A USFJ Form 380EJ is prepared and copies of the GATES Surface manifest, vessel papers, and/or DOD shipping documents are attached to it and forwarded to GOJ customs for clearance action. After GOJ clearance action is complete, the container/cargo is delivered to the consignee.

b. DOD Shipments on Commercial Vessels. Military cargo shipped on commercial vessels by CBL arriving Yokohama, Kobe, Hakata, or water ports used for supporting military exercises requires a USFJ Form 380EJ. The vessel representative or vessel's agent submits an arrival notice, a copy of the CBL, and any other DOD cargo documentation to the MCUPO. The MCUPO prepares and certifies/authenticates the USFJ Form 380EJ and presents it to the GOJ for customs clearance action. At Naha, the carrier agent provides a copy of the arrival notice to the consignee identified on the arrival notice. The consignee coordinates with his/her TO who prepares and certifies/authenticates the USFJ Form 380EJ and presents to the GOJ for customs clearance action. The 835th MCUPO provides assistance when requested by the consignee.

c. HHG and UB moving under the USC are cleared as government property as outlined in Paragraphs 3.a. and b.

d. HHG and UB Commercial Surface Not Under the USC. The carrier's local agent delivers inventories and customs clearance documents (USFJ Form 380EJ) to the MCUPO. A MCUPO official reviews the documentation and certifies/authenticates the USFJ Form 380EJ. After signature, the documents are returned to the local agent who files them with GOJ Customs to clear property. GOJ Customs clears shipments by ocean container loads (e.g., APL, SEALAND) that normally take seven to 10 days. After the property clears customs, the local agent picks up the container from the port and unstuffs the container at their warehouse. After unstuffing the container, the local agent contacts the TO for delivery instructions. Exception: At Naha (Okinawa), the carrier's local agent will notify the local receiving agent by providing a copy of the arrival notice. The local receiving agent will prepare USFJ Form 380EJ and clear customs.

e. HHG (Code T) and UB (Code J) Moving by Military Air. The cargo manifest is attached to a USFJ Form 380EJ and presented to GOJ Customs officials. Customs clearance is done immediately and the property is released to the local agent for pick up. After the local agent picks up HHG or UB, he/she notifies the TO and requests delivery instructions.

f. POVs. POVs shipped to Japan as a part of a PCS move are customs cleared by the MCUPOs. The MCUPO prepares, certifies/authenticates, and submits the USFJ Form 380EJ to GOJ Customs officials. Shipping POVs to Japan is a complicated process because of the DOD embargo and waiver requirements. It is important the PPCIG be referred to for specific guidance.

4. Overland Carrier Shipments. Customs processes are not required for this mode of shipment in Japan.

5. Personal Property. See the PPCIG at https://tops.ppcigweb.sddc.army.mil/ppcig/menu/home/warning.do. Select Query CG tab, select County Instructions tab, at the Country drop down box under Custom Selection, select Japan, submit. Click on the detail icon on the upper right hand side to review shipping requirements.

M. KOREA, NORTH

1. Passengers. See the DOD Foreign Clearance Guide available at https://www.fcg.pentagon.mil/fcg.cfm. From the left column select Pacific and South Asia and then Korea, Democratic People's Republic of (North).

2. Cargo. No country specific details.

3. Personal Property. See the PPCIG at https://tops.ppcigweb.sddc.army.mil/ppcig/menu/home/warning.do. Select Query CG tab, select County Instructions tab, at the Country drop down box under Custom Selection, select Korea, Democratic People's Republic of, submit. Click on the detail icon on the upper right hand side to review shipping requirements.

N. KOREA, REPUBLIC OF (SOUTH)

1. Passengers. See the DOD Foreign Clearance Guide available at https://www.fcg.pentagon.mil/fcg.cfm. From the left column select Pacific and South Asia and then Korea, Republic of (South).

2. Cargo. The following Paragraphs describe the customs clearance and inspection process for government and personal property shipped into Korea from the US. The SOFA between the US and the Republic of Korea (ROK) establishes the guidelines by which government and personal property can be shipped into the ROK. Generally, property bound for the US Armed Forces in Korea enters duty-free.

a. United States Forces Korea (USFK) and United Nations Command Implementing Regulations (Figure 511-5). These regulations implement those portions of the SOFA that deal with customs clearance of, access to, use, and resale of duty-free goods.

b. Government Property. In Article IX, the US-ROK SOFA states, “All materials, supplies and equipment imported by the United States Armed Forces, for the official use of the United States Armed Force will be permitted entry into the Republic of Korea; such entry will be free from customs duties and other such charges. Appropriate certification will be made that such materials, supplies, and equipment are being imported by the United States Armed Forces [for exclusive use] by the United States Armed Forces.” During the 5th Joint Committee Meeting in 1967, the US and ROK governments agreed that “it is expressly

understood that USFK imports which enter the ROK on MSC, AMC, or USG BL shipments require no additional certification since these shipments are, by nature of their shipment, expressly for the use of USFK."

(1) Cargo arriving in Korea on GBL, MSC vessels, and AMC aircraft requires no additional certification, stamps, or signatures from USFK Customs Clearance Officers (CCOs). This includes cargo sent to Korea via commercial carriers using the GBL for payment. The major commercial carriers routinely process these shipments through customs and deliver them to their destination IAW the terms of the contract.

(2) Cargo arriving in Korea via commercial carrier using a CBL for payment requires additional certification IAW Article IX of the US-ROK SOFA and USFK/UNC Regulation 55-72. In general, additional certification means that a USFK CCO appointed by the USFK Combined Joint Provost Marshal (CJPM) has checked the validity of the paperwork supporting each CBL shipment, verified the identity of the consignee/declarant, and affixed his/her signature on the USFK Form 95EK, Import Declaration. In some cases, the CCO will direct an inspection of the shipment because of irregularities on the import documents or to comply with the Random Inspection Program (RIP). See Figure 511-8 for a list of CCO office information.

(3) Security in the customs clearance system is a great concern. Since USG cargo is afforded duty-free status, the system is highly susceptible to abuse once the signature of a USFK CCO is affixed, with stamps, to the Form 95EK. As a result, local CCOs have various security measures in place. Measures include requiring customers to hand-carry the forms to the carrier or establishing authorized agents with the carriers themselves. The CCO reserves the right to inspect suspect shipments arriving in the ROK. These inspections consist of verification of the actual contents against the paperwork, insuring that no prohibited or restricted items are present, and checking that the shipment contains no personal property.

c. Air Shipments. Cargo arriving in Korea by commercial air normally arrives at Incheon (Inchon) IAP. Occasionally, cargo will arrive at other ports of entry such as Kimhae IAP. Refer to the list in Figure 511-8 to determine whom to call. The USFK CJPM, in cooperation with Korea Customs Service, established an air cargo customs clearance and inspection section at Incheon (Inchon), to provide better customer service, more rapid customs clearance, and on-the-spot inspection of suspect cargo.

(1) To obtain a customs clearance for air freight, customers need to have a USFK Form 95EK, signed by a declarant; an AWB; an invoice; and other documents that the carrier may provide such as power of attorney. These documents can be faxed or hand-carried to the CCO nearest to where the cargo is arriving (see Figure 511-8).

(2) For the CCO to process the paperwork, customers will use the Department of the Army (DA) Form 1687, Notice of Delegation of Authority - Receipt for Supplies, Figure 511-11, or a signature card or equivalent memorandum as proof of eligibility for the customer to act as "declarant" (consignee) on the USFK Form 95EK. The declarant files the signature card with the local CCO. If the declarant is performing a one-time transaction, a letter from the unit CDR stating the property is for the exclusive use of the USG will suffice. Korean nationals appointed on DA Form 1687 as "authorized agents" are only allowed to pickup and transfer paperwork. Once the paperwork is presented, the CCO checks the identity of the declarant, verifies that the paperwork is in order, determines whether further inspection is warranted, and affixes an original signature to the USFK Form 95EK. Korean Customs will not process the clearance without an original signature. After the USFK Form 95EK is signed by a CCO, the declarant has

overall responsibility for taking it to the carrier. At Incheon (Inchon), the carriers pickup the USFK Form 95EK for their own companies. The carrier then presents the USFK Form 95EK to Korean Customs for duty-free clearance. (See Figure 511-6.)

d. Ocean Vessel Shipments.

(1) Military Cargo Shipped on Commercial Contracted Carriers. DOD cargo shipped on commercial carriers under the USC requires additional certification by a CCO but the process is different than for air freight. Between seven and 14 days before the vessel arrives, the carrier submits a load list/manifest by EDI and hard copy to the Military Terminal, Pier 8, Busan (Pusan), Korea. The CCO handles the commercial carrier's arrival notice in the same manner as a USFK Form 95EK. The CCO pulls the military manifest from the GATES Surface, verifies and compares it with the commercial carrier's manifest for accuracy, and ensures all cargo shipped has been documented. He/she signs, stamps, and returns the copy with an original signature to the carrier's authorized agent. At least 24 hours before the vessel arrives, the carrier submits a copy of the commercial load list/manifest by EDI directly into the Korea Customs House. The carrier then delivers the copy with the original CCO signature and stamp to the Main Busan (Pusan) Customs House. A RIP will be conducted if the CCO detects irregularities on the import documents, if seals are broken on containers, or when HN Korean Customs Service requests to conduct a joint inspection. The shipment is then customs cleared for duty free entry.

(2) Military Cargo Shipped on Commercial Vessels by CBL. DOD cargo arriving on a CBL requires additional certification utilizing a USFK Form 95EK in a similar manner as for the clearance of air freight. The vessel's agent submits an arrival notice, a copy of the CBL, the packing list, and other procurement documentation to the TO of the consignee. The TO prepares and signs the USFK Form 95EK and presents the form to the CCO for review and certification. Security procedures and the requirement for the signature card are the same as with air freight. The TO or his/her authorized representative delivers the certification and documentation packet to the Korea Customs House to receive a license for duty free entry. Figure 511-7 illustrates the customs clearance process for military container cargo shipped via sealift using a CBL into the ROK.

e. Overland Carrier Shipments. This mode of shipment does not exist in USFK.

f. Personal Property. Article IX, of the US-ROK SOFA also allows military personnel, civilian employees of the Armed Forces, invited contractors, and technical representatives, assigned to USFK and their families to ship reasonable quantities of personal property into Korea by commercial means without paying duty or customs taxes for a period of six months after arrival ("the six month rule", see Paragraph h. below). Personal property includes any item shipped with HHG, shipped in UB, or hand-carried to the port of entry (normally Incheon [Inchon] IAP). USFK personnel governed by the SOFA are not authorized to:

(1) Use their duty-free privileges to import goods into or from Korea for the purpose of realizing personal gain or profit, or for providing a gain or profit for any other individual.

(2) Use their duty-free privileges to import duty-free property when the property is not intended for the personal use of the individual or the individual's SOFA family member. Importing commercial goods for resale or gifts is prohibited.

(3) Import goods into Korea in quantities exceeding personal needs, the needs of their bona fide family member, or reasonable quantities for bona fide maintenance or welfare gifts as defined in USFK Regulation 643-2, Transfers of Duty-Free Items. Final decisions on

reasonable quantities of personal property will be made by the Chief, Customs Division, USFK CJPM, DSN 738-5101.

g. Vehicles, vehicle parts, and items shipped into Korea through the APO are not subject to the six-month rule. Import restrictions on types of items and the prohibition on items in excess of personal need still apply in these cases.

h. Customs Clearance. Customs clearance of personal property is subject to the six-month rule. If a member/employee ships property into Korea via commercial means, the method of customs clearance is similar to that for government property. The chief exception is that personal property is cleared using Korea Customs forms but the paperwork is still signed by a USFK CCO. Most personal property clearance takes place in Seoul, at the SOFA Customs Division (CJPM-CD). The SOFA member/employee is responsible for taking the paperwork to the carrier for clearance through Korea Customs. Personnel who ship property into Korea after six months must pay the customs duties, ship or hand-carry the items back out of Korea, or abandon them.

i. HHG and UB. Carriers deliver inventories and customs clearance documents to CJPM-CD for all HHG and UB shipments arriving in Korea. A USFK CCO reviews each inventory for prohibited or restricted items and places his/her stamp and original signature on the clearance document. The carrier is then responsible for secure transport of the documents to the Yongdang Customs House, Busan (Pusan), where duty free clearance takes place.

j. POVs. POVs that are shipped to Korea as a part of a PCS move are customs cleared at the Military Terminal, Pier 8, Busan (Pusan) by the CCO. The POV contractor for the DOD is responsible for assembling the necessary paperwork including the clearance documents and obtaining the original signature of the CCO. The contractor then ensures that the clearance documents are transmitted to Korea Customs by EDI and hard-copy. Korea Customs will not issue clearance authority without the original signature of the CCO. Personnel shipping POVs into Korea after they arrive in country must obtain a clearance in person through the CJPM-CD at DSN 738-5110 (located on Yongsan South Post). The Customs Clearance specialist is responsible for assembling the necessary paperwork including the clearance documents and obtaining the original signature of the CCO. This clearance involves certification that the member/employee does not own a second POV and is in SOFA status.

k. Restricted Items. The types of personal property that may be imported are extremely limited by ROK law and USFK regulations. Items restricted or prohibited from importation into Korea are fresh fruits and vegetables, animal products such as unprocessed meats, endangered species or products made from endangered species (e.g., alligator handbag and exotic pets), counterfeit currency, communist propaganda, material that may compromise the security of the ROK, pornography (e.g., material displaying sexual acts including child pornography and homosexuality), aphrodisiacs (e.g., deer horn), narcotics (e.g., hashish and cocaine), flammables, uncut stones, explosives, and weapons. Importation of items in excess of personal needs is also prohibited. In cases of suspected excess personal property, USFK Customs inspectors use the guidelines contained in Figure 511-9.

l. Firearms/Weapons. USFK and Korea Customs inspectors strictly control the importation of weapons of all types. Many weapons commonly available for purchase and use in the US directly violate USFK regulations. USFK Customs officials advise personnel coming for assignment in Korea to leave all types of privately owned weapons in the US. The following procedures have been put in place to reduce inconvenience and ensure rapid processing of authorized weapons. Personnel will not ship any firearm or ammunition in HHG, or accompanied baggage or UB, except as prescribed in DOD regulations and the PPCIG (available at https://tops.ppcigweb.sddc.army.mil/ppcig/menu/home/warning.do). See Figure

511-10 for a list of restricted/prohibited weapons. Observe the following procedures for importation of authorized privately owned firearms.

(1) For firearms shipped in HHG, the firearm model and serial number must be listed on the member's/employee's HHG inventory and PCS orders and packed in the number one external shipping container. Prior to the unpacking of HHG, the customs inspector will ask the member/employee whether the shipment contains any firearms or other weapons. The member/employee will announce the presence of a firearm or weapon prior to unpacking crate number one.

(2) If the firearm is hand-carried at a port of entry, the member/employee must comply with Service and common carrier regulations. Generally, this means declaring the firearms prior to boarding the aircraft, transporting the firearm in a locked container, and ensuring the firearm is unloaded, located in checked baggage, and not available during flight. Additionally, the member/employee will ensure the firearm model and serial number are listed in some way on their PCS/temporary duty orders. Once arriving in Korea, all weapons including firearms will be declared on the USFK Form 96, Customs Declaration.

(3) Weapons not in the prohibited weapons list are authorized for importation. If the weapon is intended for one of the purposes as noted in the exceptions (e.g., knives, swords, or martial arts equipment), the member/employee will point that out to the USFK Customs Inspector during customs declaration and inspection. Even authorized weapons will be seized and stored by custom officials until the gaining CDR certifies proper use and storage.

(4) Firearms (Class "A" weapons) must be registered into the installation identification system with the local Provost Marshal or Security Forces Squadron within 72 hours of the weapon arriving in Korea or prior to arrival of the HHG shipment. Personnel must have a bill of sale, registration from the last duty assignment, or a BL for the weapon to complete the registration process.

m. Pets. Personnel who choose to bring pets must bring them into Korea via commercial means. Currently, USFK Customs has no way to check pets at any military port of entry. Contact your local veterinarian about detailed medical requirements for shipment of pets into Korea or consult the PPCIG (available at https://tops.ppcigweb.sddc.army.mil/ppcig/menu/home/warning.do).

n. Enforcement. USFK Customs Inspectors routinely inspect HHG and UB hard-copy inventories and deliveries at quarters, shipments of commercial cargo, hand-carried luggage, and personal effects at USFK ports of entry to detect violations. Under the US-ROK SOFA, U.S. military investigators and Korea Customs Service routinely conduct joint investigations of customs offenses. Violators are dealt with severely under US and ROK laws. The ROK Government may take jurisdiction in such cases and prosecute violators in their court system. Other punishments include administrative actions and judicial or non-judicial punishment under the Uniform Code of Military Justice. For further information, contact the USFK Customs office at DSN 738-5101/4247/5110.

3. Personal Property. See the PPCIG at https://tops.ppcigweb.sddc.army.mil/ppcig/menu/home/warning.do. Select Query CG tab, select County Instructions tab, at the Country drop down box under Custom Selection, select Korea, Republic of, submit. Click on the detail icon on the upper right hand side to review shipping requirements.

O. LAOS

1. Passengers. See the DOD Foreign Clearance Guide available at https://www.fcg.pentagon.mil/fcg.cfm. From the left column select Pacific and South Asia and then Laos.
2. Cargo.
   a. Government. Notify the US Embassy, Vientiane, of the arrival at least 15 working days before shipping the cargo to enable the Embassy to get customs clearance. Provide clear and detailed information about the shipment to the GSO to include itemized cargo detail in the form of the standardized military commercial invoice (value in US dollars) and commercial packing list, both with booking number(s), carrier, and vessel name. The US Embassy completes and submits Form D-50 (for temporary importation) or D-40 (for permanent importation) along with a diplomatic note to the MOFA to allow original import of the goods. Consign shipments to:

      US Embassy
      Vientiane, Laos
      (name of final recipient)
      Via: Bangkok in Transit

      Commercial air shipments sent door-to-door will be identified as such on the AWB and forwarded to the GSO/Customs/Shipping office. Military cargo shipped on commercial vessels with a CBL will be consigned to the US Embassy, Vientiane, with attention to the GSO officer.

   b. Personal Property. For HHG, provide the number of vans, the gross weight, and a packing list to the GSO at the US Embassy. For UB, provide the number of boxes, the gross weight, and a packing list. For POVs, provide the following information:

      (1) Year, make, model
      (2) Type (e.g., pickup truck, sedan)
      (3) Engine number
      (4) Chassis or VIN number
      (5) Color
      (6) Weight
      (7) Driving system (left- or right-hand drive)
      (8) Cylinder
      (9) Condition
      (10) Value.

      The GSO can recommend a moving company to move goods from the terminal to the final destination.

   c. Firearms/Weapons. Officially, importation of firearms/weapons requires a permit from the Lao police authorities. Sources at the US Embassy state the permit policy has not been tested, but they are doubtful import of firearms would be allowed.

   d. Pets. Pets require a health certificate and a Rabies Vaccination Certificate.

   e. Security and Law Enforcement. Importation of firearms and narcotics is restricted and possibly prohibited.

3. Modes of Shipment:

   a. Military Air. Wattay International Airport serves as both the military and commercial terminal for customs clearance.

   b. Commercial Air. Cargo on commercial carriers, whether military or non-military, must have a CBL as described in Paragraph 2.a above (Cargo).

   c. Ocean Vessel. Thanaleng port in Thailand serves as both the military and commercial terminal for customs clearance. Shipments bound for Laos will go to Bangkok first, then through Thanaleng Port Vientiane, Laos.

4. Personal Property. See the PPCIG at https://tops.ppcigweb.sddc.army.mil/ppcig/menu/home/warning.do. Select Query CG tab, select County Instructions tab, at the Country drop down box under Custom Selection, select Laos, submit. Click on the detail icon on the upper right hand side to review shipping requirements.

P. MALAYSIA

1. Passengers. See the DOD Foreign Clearance Guide available at https://www.fcg.pentagon.mil/fcg.cfm. From the left column select Pacific and South Asia and then Malaysia.

2. Cargo.

   a. Surface

      (1) End-User Certificates are required for all military cargo transiting ports in Malaysia. Malaysian authorities require the End-User Certificate 15 days in advance of cargo arrival. It is recommended Certificate be provided 18 to 20 days in advance of cargo arrival to avoid any delay with onward movement.

      (2) Procedures:

         (a) Carriers must advise shippers if cargo will transit Malaysia immediately after booking is confirmed.

         (b) End-User Certificate must be completed by the shipper as a government representative of the consignee. Certificate must be on official letter head and signed by a consignee representative. A sample Certificate is provided in Figure 511-12.

         (c) Certificate must be provided to the Defense Attache Office at the US Embassy in Kuala Lumpur at the following e-mail address: KLDAO@state.gov or sent to the following fax number +603-2142-1579.

3. Personal Property. See the PPCIG at https://tops.ppcigweb.sddc.army.mil/ppcig/menu/home/warning.do. Select Query CG tab, select County Instructions tab, at the Country drop down box under Custom Selection, select Malaysia, submit. Click on the detail icon on the upper right hand side to review shipping requirements.

Q. MARSHALL ISLANDS

1. Passengers. See the DOD Foreign Clearance Guide available at https://www.fcg.pentagon.mil/fcg.cfm. From the left column select Pacific and South Asia and then Marshall Islands.

2. Cargo. No country specific details.

3. Personal Property. See the PPCIG at https://tops.ppcigweb.sddc.army.mil/ppcig/menu/home/warning.do. Select Query CG tab, select County Instructions tab, at the Country drop down box under Custom Selection, select Marshall Islands, submit. Click on the detail icon on the upper right hand side to review shipping requirements.

R. MONGOLIA

1. Passengers. See the DOD Foreign Clearance Guide available at https://www.fcg.pentagon.mil/fcg.cfm. From the left column select Pacific and South Asia and then Mongolia.

2. Cargo.

   b. Government Property. Based on "The Agreement on Military Visits and Exchanges between the Government of Mongolia and the United States of America" cargo will be declared to customs and application for duty free exemption will be made to the Taxation and Revenue Collection Division. This will be done in advance for shipments that do not include medicine, medical supplies, medical equipment or agricultural products. For these items, the BL/invoice with cost breakdowns will be provided to the US Embassy. The Embassy will submit requests to:

      (1) * The Ministry of Finance for a customs tax release.

      (2) * The Ministry of Health for medicine, medical supplies and medical equipment clearance. For this action, the medicine list needs to be categorized by brand/trade name and internationally recognized name with the expiration date, unit of measure, amount, unit cost and total cost. By Mongolian law and regulation, all medicines and agricultural products that are not internationally recognized will be tested. Samples must be submitted a sufficient time ahead for two week testing.

      (3) * The Customs General Department which processes the paperwork submitted by the freight forwarding company. After the information of declared goods is submitted, the US Embassy will be able to obtain the shipment from the customs storage area. There is a charge of at least nine dollars a kilo for cargo stored beyond 72 hours.

      (4) * The Ministry of Health of Mongolia, which requires used clothing to be hygienically tested in advance with a verification document.

   c. Personal Property (HHG, UB, and POVs). Personal property is exempt from all duties and taxes. Vehicles are not subject to this exemption, except for accredited diplomats. If a diplomatic licensed vehicle is sold to a Mongolian citizen, the purchaser must pay a duty and excise tax to customs.

   d. Firearms. Firearms and ammunition used for joint exercises and training need special clearance from the Customs General Department, Police Department, Ministry of Defense's General Staff Headquarters.

   ***NOTE**: Due to the large amount of requirements, it is necessary to have all the required paperwork submitted at least three weeks prior to the actual shipment arrival at either the airport or railway station.

3. Modes of Shipment.

   a. Military Air. Procedures are the same as in Paragraph 2.a above.

   b. Commercial Air. The airport cargo unit is responsible for the clearance of goods coming as international cargo. The procedures are the same as in Paragraph 2.a above.

c. Military Sea Terminals – not applicable.

d. Commercial Sea Terminals – not applicable.

4. Personal Property. See the PPCIG at https://tops.ppcigweb.sddc.army.mil/ppcig/menu/home/warning.do. Select Query CG tab, select County Instructions tab, at the Country drop down box under Custom Selection, select Mongolia, submit. Click on the detail icon on the upper right hand side to review shipping requirements.

S. NEPAL

1. Passengers. See the DOD Foreign Clearance Guide available at https://www.fcg.pentagon.mil/fcg.cfm. From the left column select Pacific and South Asia and then Nepal.

2. Cargo.

   a. Government Property. A detailed packing list and freight details (aircraft type/flight number and date of arrival) must be provided to the Post (US Embassy) at least 10 working days prior to arrival. For military cargo shipped on commercial vessels by CBLs, the original AWB/OBL and invoice and/or packing list is required to initiate Government of Nepal (GON) custom paper work. At least 10 working days are required to get approval from the MOFA of GON.

   b. Personal Property. The original AWB/OBL and billing invoice and/or packing list are required to initiate GON Custom clearance paper work. At least 10 working days are required to get approval of the MOFA, GON. For ocean vessel shipping, the original OBL must be provided.

   c. Firearms. The import of firearms and ammunition is subject to issuance of an import permit that must be obtained in advance from the MOFA of GON.

3. Mode of Shipment.

   a. Military Air. See 2.a and b above.

   b. Commercial Air. See 2.a and b above.

   c. Military Sea Terminals – not applicable.

   d. Commercial Sea Terminals – not applicable.

4. Personal Property. See the PPCIG at https://tops.ppcigweb.sddc.army.mil/ppcig/menu/home/warning.do. Select Query CG tab, select County Instructions tab, at the Country drop down box under Custom Selection, select Nepal, submit. Click on the detail icon on the upper right hand side to review shipping requirements.

T. NEW ZEALAND

1. Passengers. See the DOD Foreign Clearance Guide available at https://www.fcg.pentagon.mil/fcg.cfm. From the left column select Pacific and South Asia and then New Zealand.

2. Cargo. No country specific details.

3. Personal Property. See the PPCIG at https://tops.ppcigweb.sddc.army.mil/ppcig/menu/home/warning.do. Select Query CG tab, select County Instructions tab, at the Country drop down box under Custom Selection, select New

Zealand, submit. Click on the detail icon on the upper right hand side to review shipping requirements.

U. PAPUA NEW GUINEA

1. Passengers. See the DOD Foreign Clearance Guide available at https://www.fcg.pentagon.mil/fcg.cfm. From the left column select Pacific and South Asia and then Papua New Guinea.

2. Cargo.

   a. Government Property. No inspection is done for cargo arriving on military aircraft or sealift. For military cargo arriving on commercial vessels or aircraft, customs documentation has to be completed. For duty free clearance, a Consular Certificate will be lodged with the Department of Foreign Affairs (DFA) and Customs for documents approval. A Customs agent will be engaged to compile import entry though customs. The required documents for the documentation preclearance process are the OBL and inventory list for sealift and the AWB and inventory list for airlift. These documents have to be faxed to the shipping section of the US Embassy before the cargo arrives at the final destination. Cargo is taken from the wharf or airport after customs and quarantine procedure is cleared. Cargo in containers is kept in a container storage facility. For sensitive shipments, cargo is delivered from the wharf to the proper location as instructed. Less-than-container load and full-container-load cargo are kept in the agent's warehouse awaiting delivery instructions. Transportation can be arranged for delivery through the local Customs and forwarding agent for delivery to a residence, an office, or other specified location within road access. The cargo owner can also make arrangements to pick up the cargo from the container facility or agent warehouse. Cargo is duty free when the Embassy is involved. Handling and delivery charges for the customs agent must be paid. The Embassy will require fiscal data to pay local charges incurred.

   b. Personal Property (HHG, UB, POV). See Paragraph 2.a. The customs procedures for HHG, UB, and POV are the same as general military shipment.

   c. Firearms/Weapons. The import of weapons is restricted unless specific arrangements with government authorities are in place.

3. Personal Property. See the PPCIG at https://tops.ppcigweb.sddc.army.mil/ppcig/menu/home/warning.do. Select Query CG tab, select County Instructions tab, at the Country drop down box under Custom Selection, select Papua New Guinea, submit. Click on the detail icon on the upper right hand side to review shipping requirements.

V. PHILIPPINES

1. Passengers. See the DOD Foreign Clearance Guide available at https://www.fcg.pentagon.mil/fcg.cfm. From the left column select Pacific and South Asia and then Philippines.

2. Cargo.

   a. Government Cargo. The Government of the Philippines (RP) exempts from all kinds of taxes all military personnel assigned to the US Embassy in Manila and accredited with the DFA. Cargo arriving is subject to customs clearance prior to release from the port. The US Embassy in Manila prepares a Certificate of Tax Exemption and a Letter of Guaranty for submission to the DFA, together with a copy of the AWB or BL and an invoice or packing list. The shipment must be consigned to the US Embassy in Manila. The recipient agency or person will be indicated as the secondary recipient. The documents are then forwarded to the

Bureau of Customs and processed by a licensed customs broker to release the shipment. Expect processing to take two or three working days.

b. Shipments in support of the RP-US Balikatan Joint Exercises. The Embassy is also supporting shipments being sent to the Philippines in support of the RP-US Balikatan joint exercises so long as the shipments are endorsed by any military agency at the Embassy (such as Joint United States Military Advisory Group (JUSMAG), Chief Information Officer [CIO] Program Review Panel [CPRP], Defense Attache Office (DAO), Naval Regional Contracting Center [NRCC] and others). It is important that shipping documents address the US Embassy, Manila with a line that says, "For: Balikatan Exercise (Name of person or office)".

c. Cargo Leaving the RP. For cargo exiting the Republic of the Philippines, the US Embassy prepares an exit clearance to declare the shipment tax at the port through the DFA and Customs. The Transportation Unit of the GSO at the US Embassy in Manila can provide additional information on customs laws in the Philippines. The phone number is (63-2) 523-1001 extensions 2813 or 2796 and the FAX number is (63-2) 831-0631.

d. Personal Property. Personal property shipments are subject to customs clearance prior to release from the port. The member/employee will be physically present in the country and accredited with the DFA prior to the preparation of the Certificate of Tax Exemption. The arrival of the HHG or UB will coincide with or follow the member/employee's arrival. Expect processing time to be 10 to 15 working days for HHG and two to three days for UB.

e. Privately Owned Vehicles. POVs are also subject to customs clearance prior to release from the port. As with HHG and UB, the member/employee must be in the country and accredited before the US Embassy prepares the importation request with the DFA. Upon receipt of approval, a Free Entry for Motor Vehicle request is then submitted to the DFA together with the BL. Expect five working days at the DFA, five working days with Customs, and another five days for the broker to release and deliver the shipment to the Embassy. Importation of right-hand-drive cars is prohibited.

f. Firearms/Weapons. Importation of firearms into the country is restricted. Exception is being granted if the Philippine National Police Firearms and Explosives Division and/or Philippine Armed Forces of the Philippines provide an importation permit.

g. Security and Law Enforcement Items. The Republic of the Philippines prohibits the importation of gunpowder, dynamite, ammunition, other explosives, and firearms; marijuana, opium, or other narcotics or synthetic drugs; and right-hand-drive cars.

3. Modes of Shipment.

a. Military Air. Military shipment (air or sea) typically does not require customs clearance because the arrival of the vessel or carrier is usually coordinated between the US Forces and the Armed Forces of the Philippines. These shipments do not pass through the usual commercial terminals or ports where customs offices are located.

b. Commercial Air. As stated in Paragraph V. 2, shipments inbound by commercial air require customs clearance prior to release from the port. The AWB and packing list are needed to complete processing. This applies whether the cargo is civilian or military.

c. Ocean Vessel. As stated in Paragraph V. 2, shipments inbound by ocean vessel require customs clearance prior to release from the port. The BL and packing list are needed to complete processing. This applies whether the cargo is civilian or military.

4. Personal Property. See the PPCIG at https://tops.ppcigweb.sddc.army.mil/ppcig/menu/home/warning.do. Select Query CG tab, select County Instructions tab, at the Country drop down box under Custom Selection, select

Philippines, submit. Click on the detail icon on the upper right hand side to review shipping requirements.

W. SAMOA

1. Passengers. See the DOD Foreign Clearance Guide available at https://www.fcg.pentagon.mil/fcg.cfm. From the left column select Pacific and South Asia and then Samoa.
2. Cargo. No country specific details.
3. Personal Property. See the PPCIG at https://tops.ppcigweb.sddc.army.mil/ppcig/menu/home/warning.do. Select Query CG tab, select County Instructions tab, at the Country drop down box under Custom Selection, select Samoa, submit. Click on the detail icon on the upper right hand side to review shipping requirements.

X. SINGAPORE

1. Passengers. See the DOD Foreign Clearance Guide available at https://www.fcg.pentagon.mil/fcg.cfm. From the left column select Pacific and South Asia and then Singapore.
2. Cargo. No country specific details.
3. Personal Property. See the PPCIG at https://tops.ppcigweb.sddc.army.mil/ppcig/menu/home/warning.do. Select Query CG tab, select County Instructions tab, at the Country drop down box under Custom Selection, select Singapore, submit. Click on the detail icon on the upper right hand side to review shipping requirements.

Y. SRI LANKA, REPUBLIC OF

1. Passengers. See the DOD Foreign Clearance Guide available at https://www.fcg.pentagon.mil/fcg.cfm. From the left column select Pacific and South Asia and then Sri Lanka, Republic of.
2. Cargo.
   a. Government Property. For cargo arriving in country, the US Embassy DAO coordinates with the Ministry of Defense (MOD). The MOD will advise the Department of Customs and other authorities in the US military removing cargo through Customs. For cargo exiting the country (same as above) the GSO Shipping Unit (SU), on receipt of the cargo details, will obtain the MOFA export approval. The documents and cargo will be handed over to the agent to process customs and export formalities.
   b. Personal Property (HHG and UB) and POVs. The US DAO requests the duty-free privileges from the MOFA for military personnel. This will enable the SU to obtain duty-free clearance approval for HHG and UB shipments. The SU expediter will clear the cargo.
3. Modes of Shipment.
   a. Military Air. Not available in Sri Lanka.
   b. Commercial Air. The DAO coordinates with the MOD to obtain customs clearance for inbound cargo.
   c. Military Sea. Not available in Sri Lanka.
   d. Commercial Sea. The DAO will coordinate with the MOD to obtain customs clearance for inbound cargo. The US Embassy contractor will clear the cargo.

4. Personal Property. See the PPCIG at https://tops.ppcigweb.sddc.army.mil/ppcig/menu/home/warning.do. Select Query CG tab, select County Instructions tab, at the Country drop down box under Custom Selection, select Sri Lanka, submit. Click on the detail icon on the upper right hand side to review shipping requirements.

Z. TAIWAN

1. Passengers. See the DOD Foreign Clearance Guide available at https://www.fcg.pentagon.mil/fcg.cfm. From the left column select Pacific and South Asia and then Taiwan.
2. Cargo.
   a. Government Property. There are two different channels for the importation of military shipments into Taiwan. For shipment consigned to the American Institute in Taiwan (AIT), duty-free paperwork must be submitted to the MOFA through the Taipei Economic and Cultural Representative Office for approval. If the item is restricted for importation, a special import permit may be required. If the shipment is not assigned to AIT, the receiving organization also needs to request a special import permit. For military cargo shipped on commercial vessels by CBLs, a special import permit may also have to be requested from the Taiwan authorities.
   b. Personal Property. Taiwan authorities have no restrictions for the importation of HHG, UB, and POV. The AIT can assist with the application for duty-free importation, customs clearance and delivery.
3. Mode of Shipment.
   a. Military Air. There are no military bases in Taiwan.
   b. Commercial Air. The US Embassy can apply for a duty-free document from MOFA. Upon receiving the duty-free approval, the US Embassy can submit the packing list/invoice to Customs for clearance. The shipment can be released when the warehouse charges have been paid. The US Embassy will make all arrangements for transportation and delivery.
   c. Military Sea. There are no military bases in Taiwan.
   d. Commercial Sea. The process for shipping via commercial sea vessel is the same as is for commercial air (Paragraph 3.b).
4. Personal Property. See the PPCIG at https://tops.ppcigweb.sddc.army.mil/ppcig/menu/home/warning.do. Select Query CG tab, select County Instructions tab, at the Country drop down box under Custom Selection, select Taiwan, submit. Click on the detail icon on the upper right hand side to review shipping requirements.

AA. THAILAND

1. Passengers. See the DOD Foreign Clearance Guide available at https://www.fcg.pentagon.mil/fcg.cfm. From the left column select Pacific and South Asia and then Thailand.
2. Cargo. No country specific details.
3. Personal Property. See the PPCIG at https://tops.ppcigweb.sddc.army.mil/ppcig/menu/home/warning.do. Select Query CG tab, select County Instructions tab, at the Country drop down box under Custom Selection, select Thailand, submit. Click on the detail icon on the upper right hand side to review shipping requirements.

BB. VIETNAM

1. Passengers. See the DOD Foreign Clearance Guide available at https://www.fcg.pentagon.mil/fcg.cfm. From the left column select Pacific and South Asia and then Vietnam.
2. Cargo. No country specific details.
3. Personal Property. See the PPCIG at https://tops.ppcigweb.sddc.army.mil/ppcig/menu/home/warning.do. Select Query CG tab, select County Instructions tab, at the Country drop down box under Custom Selection, select Vietnam, submit. Click on the detail icon on the upper right hand side to review shipping requirements.

CC. WAKE ISLAND

1. Passengers. See the DOD Foreign Clearance Guide available at https://www.fcg.pentagon.mil/. From the left column select Pacific, South Asia, then Wake Island.
2. Cargo.
   a. All cargo entering Wake Island, regardless of origin, is subject to inspection by a US Air Force (USAF)-appointed inspector at point of departure as well as upon arrival. A rodent eradication was accomplished in May 2012 and a heightened level of bio-security to inhibit rodent reinvasion was implemented. The 611th Civil Engineer Squadron (CES) is the lead military POC for issues associated with invasive species and inspection issues. Inquiries associated with invasive species issues particular to Wake Island and shipment requirements to prevent transport of invasive species to the island will be directed towards the Wake Island installation CDR via Base Operations at BaseOperations2@wakeisland.net. All incoming cargo will meet the requirements of the United States Department of Agriculture, Natural Resources Conservation Service- Hawaii Invasive Species List. This list can be located at (http://plants.usda.gov/java/noxious?rptType=State&statefips=15).
   b. Military shippers will ensure that:
      (1) Cargo descriptions are complete and accurate.
      (2) Container packing lists will be in or attached to each container. The USAF requires a container packaging list for all containers. USAF inspectors may also conduct a physical inspection of the selected containers which are sealed with a Customs Seal and delivered to the consignee. These containers are not to be opened until they reach their final destination or unless a USAF inspector is present.
      (3) Advanced copies of the container packing list and the USAF Wake Island Vessel/Aircraft Rodent Pre-departure Inspection Forms are sent to the Wake Island Base Operations at BaseOperations2@wakeisland.net. A copy of the USAF Wake Island Vessel/Aircraft Rodent Pre-departure Inspection Form can be obtained from the Wake Base Operations, the 611th Natural Resources Program Manager, and/or the vessel government contracting officer.
      (4) All vessels destined for Wake will have rat guards on board for immediate deployment upon docking at Wake.
   c. All cargo staging areas where equipment and supplies destined for Wake are held will show documented proof that the facilities have rodent control operations in place throughout the facility. Facilities will be maintained rodent free by continually deploying a network of the following tools: glue boards, snap traps, and anticoagulant baits in tamper proof stations (baits that fluoresce under UV light are recommended - see URL:

http://www.belllabs.com/product_details/united-states-pest-control-contrac-with-lumitrack). The spacing of traps and stations will encompass the entire facility. These measures are required at each facility storing equipment that is destined for shipment to Wake Island. Facility pest management contracts will include a quarterly report that will be submitted to the 611th CES, Natural Resources Program Manager, in order to ensure the equipment and supplies came from a facility with an ongoing pest control operation. The reports from pest control contracts will display the type of rodent control in place, the frequency of baiting, density of traps and trap results. The Wake Island CDR can prohibit the opening of containers or other cargo, if there is no documentation showing that the origin activity has an ongoing pest control program. Contact the 611th CES, Natural Resources Manager, for further information (907-552-0788) or Wake Island Base Operations (808-424-2222).

d. In the event that cargo destined for Wake is discovered to be contaminated with an invasive species (i.e., rodents, snakes, insects) after departure from point of origin, the pilot or captain will isolate the package or container, and refrain from offloading the item on Wake. The pilot or captain will immediately contact Wake Base Ops (DSN: 315-424-2222 or Commercial: 808-424-2222) and alert them to the presence of an invasive species on the vessel or aircraft. This notification will activate the Wake Island rodent rapid response team.

e. Vessel operators will ensure that during loading operation at the location of origin all mooring lines are protected with rat guards and baited snap traps are deployed at each line exit and tie off point. For areas of high activity, baited snap traps will be placed inside a protected station called a "bait station" to avoid accidental triggers.

f. All containers regardless of size will have one baited glue board and one baited snap trap inside of each container prior to sealing. Contract language will include this requirement. Contract language will also include the purchase of these detection devices and supplies (snap traps, glue boards, rat attractant, and/or bait).

g. Vessels or aircraft originating from Guam destined for Wake will display documented proof of equipment and vessel/aircraft inspection with USDA canine prior to unloading equipment on Wake Island. This inspection is required to ensure Brown Tree Snakes (BTS) are not contained within shipments, aircraft, or vessels. This USDA BTS inspection requires advanced coordination with the Guam USDA, Wildlife Services at (671) 366 -3886 or (671) 635-4400. The Guam USDA inspector will provide the vessel or aircraft operator with a letter of verification, this letter of verification is to be submitted to the Wake Island Base Operations at BaseOperations2@wakeisland.net prior to the vessel or aircraft arrival at Wake.

h. During loading operations at origin, any box, cargo, or container showing signs of infestation (feces, chew marks, urine scent, hair) will be pulled out of the shipment and placed in an isolated area and thoroughly inspected prior to being placed back in the shipment.

3. Personal Property. See the PPCIG at https://tops.ppcigweb.sddc.army.mil/ppcig/menu/home/warning.do. Select Query CG tab, select County Instructions tab, at the Country drop down box under Custom Selection, select Wake Island, submit. Click on the detail icon on the upper right hand side to review shipping requirements.

AUSTRALIAN CUSTOMS SERVICE

UNACCOMPANIED PERSONAL EFFECTS STATEMENT

AQIS
AUSTRALIAN QUARANTINE AND INSPECTION SERVICE

- *This is a legally binding document and may be used as evidence.*
- *This statement must be completed in English (block letters), with all errors and alterations to be initialled.*

WARNING

*Do **not** carry drugs. Penalties for drug offences in Australia are severe. A **false** or **misleading** statement to a Customs Officer is an **offence** and may involve heavy penalties, including forfeiture of any goods concerned.*

NOTICE

The Privacy Act 1988 says we must tell you why we are collecting this information, how we will use it and whether you have to give it to us. This information is required to ensure travellers comply with Australian Customs, Quarantine, Health, Wildlife and Currency laws. We require this information under the Customs Act 1901, the Quarantine Act 1908, the Wildlife Protection (Regulation of Exports and Imports) Act 1982 and the Financial Transaction Reports Act 1988. Customs also need the information to calculate the right amount of duties and taxes. Any questions you do not answer will be asked by a Customs or Quarantine Officer. The Australian Customs and Quarantine Services are not permitted to disclose this information or any supplementary information you give, except when authorised or required by law.

Please complete the following details

Given names	Family name
Address and telephone number of intended or actual Australian residential address	Date of birth

Sex ☐ Male ☐ Female	Passport number	Country of issue
Persons covered by this statement: ☐ Myself ☐ Spouse	Name of spouse	
Spouse passport number	Number of children under 18 years of age	

How I arrived or intend to arrive in Australia

On *(airline flight number or ship name)*	At *(port or airport)*
Date, or estimated date, of arrival	Country of departure

For returning residents only

Other countries visited	Period of absence from Australia

How my personal effects arrived or will arrive

☐ By Mail; or ☐ By Air; or ☐ By Sea *(if by air or sea then complete below)*

The *(number of packages)* consigned to me have arrived or are due to arrive:

On *(airline flight number or ship name)*	At *(port or airport)*	Date, or estimated date, of arrival
Container number	Sea Bill or Air Waybill number	Name of local business handling your personal effects

Clearing your personal effects

You may clear your personal effects or pay a licenced Customs Broker to clear them for you. Alternatively, you may nominate somebody else (eg a family member or friend) to act on your behalf. If you wish to nominate somebody else, you must fill in the details of your nominee in the space provided below.

Family name	Given names
Address	Phone number

Your nominee will need to produce one of the following forms of identification when clearing your goods through Customs.

Driver's licence number	Place of issue	**Or**	Passport number	Country of issue

Declaration

I declare that the above particulars are to the best of my knowledge true and correct.

Signature of owner	Date

B534 (6/00)

Figure 511-1. Form B534, Unaccompanied Personal Effects Statement

USFJ Instruction 31-207, Weapons and Firearms in Japan

Policy Letter 4-3, Entry and Exit of Individuals, Cargo, Aircraft, and Surface Vessels.

Figure 511-2. USFJ Regulations (Japan)

Organization	Location	Phone Numbers	Primary Responsibility
HQ US Forces Japan	Yokota AB	DSN 225-4714 FAX 225-6321	Office of Primary Responsibility Customs Japan
TO	Camp Butler Okinawa	DSN 645-9248 FAX 645-1155	Customs clears commercial air cargo for Okinawa (USMC)
TO	MCAS Iwakuni	DSN 253-4076 FAX 253-6455	Customs clears commercial air cargo for Iwakuni (USMC)
TO	Kadena AB	DSN 634-2430 FAX 634-5181	Customs clears commercial air cargo for Okinawa (USAF)
TO	Yokota AB	DSN 225-9154 FAX 225-5807	Customs clears commercial air cargo for mainland Japan and Okinawa (USAF)
TO	Yokosuka	DSN 243-8731 FAX 243-6998	Customs clears commercial air and surface cargo Japan (at US Navy Ports)
TO	Yokohama Seaport	DSN 269-6334 FAX 269-6679	Customs clears Code 8 UB for all services arriving at Narita and all cargo arriving at Kansai (USA)
TO	Camp Zama	DSN 263-8980 FAX 263-8984	Customs clears commercial air cargo for Japan and Okinawa except for Code 8 UB arriving at Narita and cargo arriving at Kansai (USA)
TO	Torii Station Okinawa	DSN 644-4274 FAX 644-4375	Customs clears commercial air cargo for Okinawa (USA)
TO	DDYJ Det Okinawa	DSN: 637-2104 FAX 637-2107	Customs clears commercial air cargo consigned to the Okinawa Det.
835th Transportation Battalion	Okinawa Seaport	DSN 648-7721 FAX 648-7635	Customs clears surface cargo for Okinawa (USA)
836th Transportation Battalion	Yokohama North Dock	DSN 269-6513 FAX 269-6860	Customs clears surface cargo for mainland Japan (USA)
730 Air Mobility Squadron.	Yokota AB	DSN 225-9616 FAX 225-6091	Customs clears AMC cargo for mainland Japan
733 Air Mobility Squadron.	Kadena AB	DSN 634-3659 FAX 634-2279	Customs clears AMC cargo for Okinawa
TO (PPSO)	Fleet Logistics Center Yokosuka Sasebo	DSN 252-3418 FAX 252-3704	Customs clears commercial air and surface cargo for Sasebo arriving at Southern terminals/ports

Figure 511-3. POCs in Japan

PET QUARANTINE AND EXAMINATION CERTIFICATE (See DD Form 2005 for Privacy Act Statement)	Control #

PART I - CERTIFICATE OF COMPLIANCE

Japanese law requires pets entering Japan to be quarantined up to 180 days. Pets belonging to U.S. Forces personnel may be placed in a "Working Quarantine" in the custody of the owner for on post/base housing, providing all paper work has been properly completed. Quarantine length depends on rabies vaccine history, Fluorescent Antibody Viral Neutralization Test (FAVN) results, date of FAVN testing, proper identification, and appropriately prepared and verified documents. **You must 1)** report to the U.S. Forces veterinary clinic **within 72 hours**, or the first clinic day following arrival of the animal to Japan, **2)** present your animal to the U.S. Forces veterinary clinic **within 72 hours** of completion of the quarantine requirement. Failure to do so is a violation of the quarantine law, resulting in a fine up to 50,000 yen per animal. (USFJ PL 4-3).

In accordance with the above, I request the pet(s) described below be placed in quarantine in my custody. **I agree to present my pet(s) to the nearest U.S. Forces veterinary clinic.** I will immediately notify the U.S. Forces veterinary clinic if my pet exhibits unusual behavior, any sudden symptoms, or should become ill or die. I will keep my pet(s) within my household on U.S. Installations at all times during the quarantine period. I will not allow my pet(s) to come in contact with other animals or people other than the members of my immediate family. I fully understand and will comply with above regulations, **including all quarantine requirements** and understand that any failure to do so will result in forwarding a copy of this report through command channels.

Name and grade of sponsor	Sponsor's SSN
Name and grade of authorized representative (if applicable)	Signature of owner or authorized representative
Complete local military address of owner (or gaining unit address)	Quarters # Telephone #
Gaining Unit Name	Duty #

PART II - DESCRIPTION OF PET(S)

Microchip #	Pet Name	Sex	Age	Color	Species	Breed
(1)		M F				
(2)		M F				
(3)		M F				

Date and Place of Rabies Vaccination		
(1)	(2)	(3)
Arrival date of pet(s)	Country of origin	Name of airline & flight #

PART III - INITIAL QUARANTINE EXAMINATION

I certify the pet(s) described above was/were examined by me and found to be free from symptoms of communicable diseases. According to current regulations, the pet(s) is/are placed in custody of the owner for a period of _____ days.

Remarks:

Final quarantine date:	Final quarantine place:
Typed name and position of animal quarantine officer	Signature

PART IV - FINAL QUARANTINE EXAMINATION

I certify that the pet(s) described above was/were examined by me and found to be free from symptoms of communicable diseases. According to current regulation, the pet(s) is/are released from quarantine.

Remarks: Actual Release Date:

Typed name and grade of veterinarian	Signature

MDJ FORM 270, 1 JUN 2009. Edition of 1 JUN 2005 is obsolete.

Figure 511-4. MDJ Form 270, Pet Quarantine and Examination Certificate

USFK Regulation 27-5, Individual Conduct and Appearance.

USFK/UNC Regulation 190-41, USFK Customs Program.

USFK Regulation 55-73, Customs Inspection.

USFK Regulation 60-1, Access to Duty-Free Goods.

USFK Regulation 643-2, Transfers of Duty-Free Items.

Note: Many of these regulations are currently under revision.

Figure 511-5. USFK and United Nations Command Regulations (Korea)

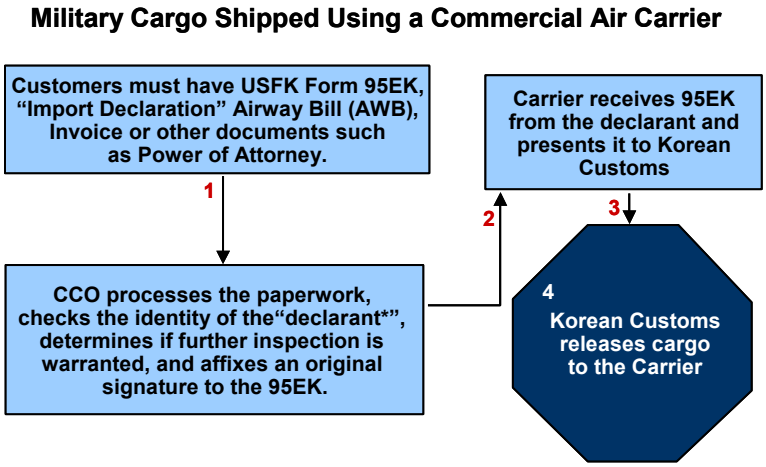


Figure 511-6. Military Cargo Shipped Using a Commercial Air Carrier (Korea)

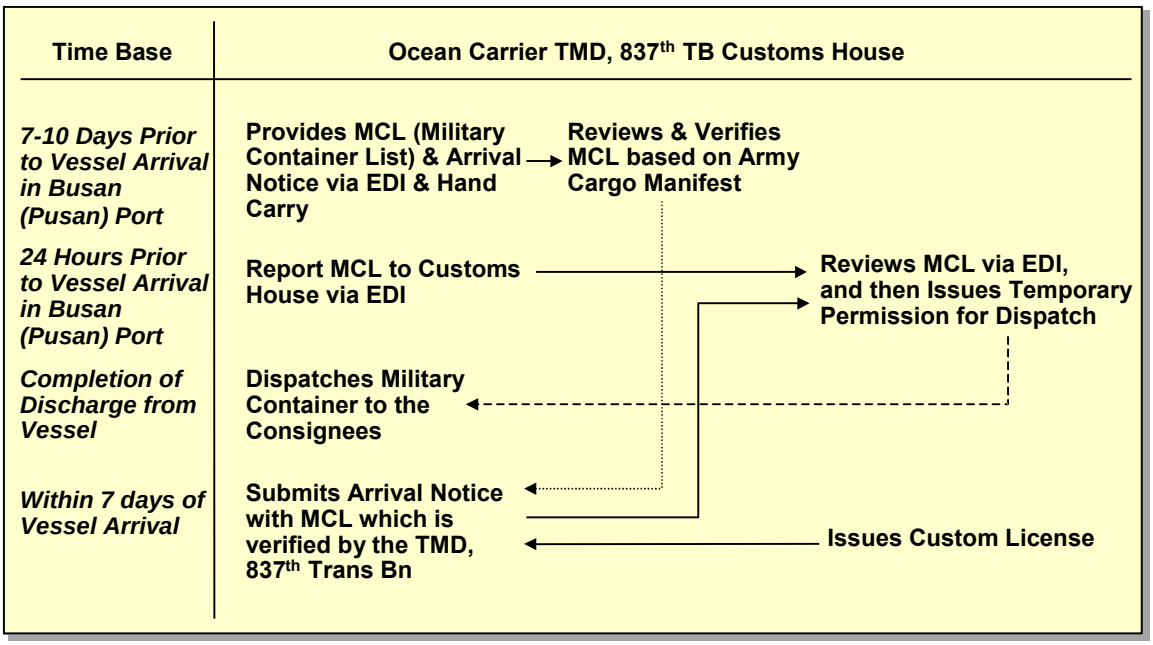


Figure 511-7. Military Container Cargo Shipped Using a Commercial Ocean Vessel (Korea)

Duty Title	Organization	Phone Number	Areas of Interest
Chief, & Deputy Chief Customs Division	USFK Combined Joint Provost Marshal's Office (CJPM-CD)	738-5101/5110/6182 FAX: 736-5105	Lead CCO; oversight of all CCO's in USFK; clearance of personal property, cargo, and household goods
Customs Clearance Officer, Incheon (Inchon) Customs Office	USFK Combined Joint Provost Marshal's Office (CJPM-CD)	723-5481 FAX: 723-7978	Clears air cargo arriving at Incheon (Inchon) International Airport
Chief, Traffic Management Division	837th Transportation Battalion, Military Terminal Pier 8, Busan (Pusan) (MTPC-PU-TM)	763-7163 FAX: 763-7175	Clears sea cargo arriving in Busan (Pusan); sole POC for clearing USC contract cargo
Installation Transportation Officer	20th Support Group (EANC-TP-STD)	763-7640 FAX: 763-7249	Clears POVs arriving in Busan (Pusan) and air shipments at Kimhae
Supply Officer	CNFK Fleet Activity, Chinhae (N4)	762-5479 FAX: 762-5526	Clears US Navy cargo arriving in Chinhae

Figure 511-8. Customs Clearance Officers Appointed IAW USFK Regulation 55-72 (Korea)

Currency	Not more than $10,000 in negotiable currency including traveler's checks.
Tobacco	Not more than 200 cigarettes or an equivalent amount of other tobacco products.
Alcohol	Not more than 1 liter of alcoholic beverage.
Perfume	Not more than 2 ounces of perfume.
Other Personal Property	Decisions on enforcement action are made on a case-by-case basis. Factors include family size, religious background, medical conditions, rank, whether the items are known to be "hot" on the black market, and other factors that may bear on the individual member/employee.

Figure 511-9. Import Restrictions

- Fully automatic firearms.
- A shotgun with the barrel length less than 18 inches in length.
- A weapon made from a shotgun (for example, by modification) having an overall length less than 26 inches or a barrel less than 18 inches in length.
- A rifle having a barrel less than 16 inches in length.
- A weapon made from a rifle (for example, by modification) having an overall length less than 26 inches or a barrel less than 16 inches in length.
- Any type of BB guns, pellet gun, or slingshot.
- Other weapons, except a pistol or revolver, from which a shot is discharged by an explosive if the weapon is capable of being concealed on the person.
- A noise suppresser for any weapon.
- A molotov cocktail or any gasoline or other flammable or combustible substance in a glass container or other breakable container that is configured with a fuse-type device.
- A straight razor, a knife with a razor blade, a switchblade knife, a t-handle push knife, a hooked blade knife (carpet-type knife), a box knife, a "butterfly" knife with hinged handle sections that collapse around the blade, or any knife, sword or dagger with a 4-inch or longer blade. **Exceptions**: (1). A hunting knife, fishing knife, jackknife, sheathed knife or kitchen knife with a 4-inch or longer blade may be acquired, owned, possessed, and transported when used exclusively for hunting, fishing, camping, cooking, and eating activities. (2). A sheathed knife with a 4-inch or longer blade if required to perform military duties and carried or worn immediately to or from work. (3). Ceremonial/decorative knives, swords, and daggers, regardless of size, may be acquired, owned, possessed, and displayed in home, office, or at official functions, but will not be carried or possessed in public places except to transport them to and from home, office, or an official function. (4). A straight razor, when used for shaving only. **Note**: The member/employee is responsible for providing certification from the gaining commander to USFK Customs of intended use and storage for all exceptions.
- A club-type hand weapon (blackjack), brass knuckles and gloves or bracelets studded with hard or sharp metal objects.
- A shooting pen (fountain pen or automatic pencil-style pen capable of discharging tear gas or similar substances) or any weapon capable of discharging any chemical agent. Exception: Weapons that discharge water and blanks, and defensive pepper spray devices.
- A shooting weapon or blade that can collapse, be telescoped, or shortened, or that is stripped beyond the normal extent required for hunting or sporting; or is concealed in other devices (for example, walking sticks, umbrellas, tubes, and others).
- A shooting weapon with mounted searchlights.
- A hollow point cartridge, opened or closed, for any firearm of more than .22 caliber (5.6 mm).
- An explosive, incendiary, or gas bomb, grenade, missile, mine, or similar device or any rocket having a propellant charge of more than four ounces.
- A kung fu or Chinese fighting stick or nunchakus or similarly constructed items. **Exception**: A kung fu or Chinese fighting stick or nunchakus or similarly constructed items are authorized if the item was acquired and is owned, possessed, transported, and used solely in connection with authorized sporting events or regularly scheduled martial arts training or practice. **Note**: The member/employee is responsible for providing certification from the gaining commander to USFK Customs of intended use and storage for all exceptions.
- A metal Chinese throwing star or similarly constructed item having multiple sharpened appendages.

Figure 511-10. Weapons Prohibited for Import to Korea

NOTICE OF DELEGATION OF AUTHORITY - RECEIPT FOR SUPPLIES *For use of this form, see DA PAM 710-2-1. The proponent agency is DCS, G-4.*				DATE
AUTHORIZED REPRESENTATIVE(S)				
ORGANIZATION RECEIVING SUPPLIES			LOCATION	
LAST NAME-FIRST NAME-MIDDLE INITIAL			AUTHORITY REQ / REC	SIGNATURE AND INITIALS
AUTHORIZATION BY RESPONSIBLE SUPPLY OFFICER OR ACCOUNTABLE OFFICER				
THE UNDERSIGNED HEREBY ☐ DELEGATES TO ☐ WITHDRAWS FROM THE PERSON(S) LISTED ABOVE, THE AUTHORITY TO:				
REMARKS				
I ASSUME FULL RESPONSIBILITY				
UNIT IDENTIFICATION CODE			DODAAC/ACCOUNT NUMBER	
LAST NAME-FIRST NAME-MIDDLE INITIAL	GRADE	TELEPHONE NUMBER	EXPIRATION DATE	SIGNATURE

DA FORM 1687, MAY 2009 PREVIOUS EDITIONS ARE OBSOLETE APD PE v1.00ES

Figure 511-11. DA Form 1687, Notice of Delegation of Authority – Receipt for Supplies

FORM 5

[Paragraphs 10(7)*(b)*, 11(7)*(b)*, 12(7)*(b)*, 13(4)*(b)* and subregulation 14(1)]

END-USE STATEMENT

This end-use statement must be issued by the consignee or end-user using the letterhead of the consignee or end-user, which ever is relevant.

Important Notes:

1. "*" indicates delete whichever is not applicable.
2. Tick (✓) the relevant box.
3. This end-use statement must be signed—
   (a) if an individual, by the person directly interested or his employee authorized by him in writing;
   (b) if a partnership, by a partner or an employee of the firm duly authorized in writing by a partner; or
   (c) if a body corporate, by a director, the secretary or an employee duly authorized in writing by a director or the secretary of the body corporate.
4. Pursuant to subsection 40(1) of the Strategic Trade Act 2010, a person who submits false or misleading information in any application, report or other documents for any purpose under this Act or the related laws commits an offence and shall, on conviction, be punished with a fine not exceeding one million ringgit or with imprisonment for a term not exceeding two years or with both, and in the case of a body corporate, be punished with a minimum fine of two million ringgit.

END USE STATEMENT

For presentation in compliance with subsection 14(2) of the Strategic Trade Act 2010 (*Act 708*) Malaysia.

We (I) certify that we have requested (*name, address and contact number of the supplier*) to supply us the following strategic/ unlisted* items:

Description of the items : _____

Category Codes : _____

Quantity : _____

Total Value : _____

Figure 511-12. End Use Statement

which is intended for—

Consumption	☐	in _____ *(country of final destination)*	for _____ *(details of end-use OR industry/business activity involved)*
Production	☐	in _____ *(country of final destination)*	for _____ *(details of end-use OR industry/business activity involved)*
Distribution	☐	in _____ *(country of final destination)*	for _____ *(details of end-use OR industry/business activity involved)*
Repair	☐	in _____ *(country of final destination)*	for _____ *(details of end-use OR industry/business activity involved)*
Others (Please Specify: _____)	☐	in _____ *(country of final destination)*	for _____ *(details of end-use OR industry/business activity involved)*

We (I) certify that the strategic items/unlisted items will not be used for any restricted activity that supports the development, production, handling, usage, maintenance, storage, inventory or proliferation of any weapons of mass destruction and its delivery systems or participation in transaction with persons engaged in such activities.

We (I) also certify that we (I) will not subsequently export or otherwise re-sell the items to any person or country that is subject to any sanction imposed pursuant to a decision of the United Nations Security Council.

_____ Date

_____ Original signature of the end user/government official*

_____ Company stamp/official seal

_____ Name and designation of signer in block letters

Figure 511-12. End Use Statement (Cont'd)

THIS PAGE INTENTIONALLY LEFT BLANK

APPENDIX R

CORAL CONSERVATION ACTIONS AT WAKE ATOLL

Coral Conservation Actions at Wake Atoll

Marine biologists employed by differing institutions and agencies have documented a series of terrestrial and marine based actions which afford benefits to coral reef systems. Such actions are vital to the sustained resilience of coral reef systems and these scientific groups have developed guidance to grant land and marine managers easier access to a host of actions they can implement should they be provided with financial resources to implement such coral protections. Entities such as the International Union for the Conservation of Nature (IUCN), International Society For Reef Studies (ISRS), Department of Defense (DoD), Joint Group of Experts on the Scientific Aspects of Marine Environmental Protection (GESAMP) and other environmental groups have used scientific data to develop guidance documents for resource managers which place focus on those actions which result in the highest return on investment, such that marine conservations funds are not expended on experimental projects with unknown benefits (Green and Bellwood 2009, ISRS 2004, DoD 2000, GESAMP 2001). Resource documents authored by the aforementioned groups have been used to support the development of this appendices list of strategic projects which afford those corals currently listed as threatened and or endangered under the auspice of the Endangered Species Act (ESA). Utilizing legal provisions in the Sikes Act and ESA primarily, the Pacific Air Forces Regional Support Center (PRSC) with support from the Air Force Civil Engineer Center, is capable of funding biological assessments and potential proactive coral protection measures which afford a benefit to ESA listed coral species and their critical habitats. These legal protections not only mandate compliance, but simultaneously supply various federal entities with a legal foundations to request financial support to comply with the very provisions.

The institution of legal protections has greatly contributed to the continued existence of ESA corals in various parts of the world. Executive orders and proclamations have been effective legal instruments to provide protections for ESA corals in the U.S., specifically Executive Order 13089 "Coral Reef Protection". The aforementioned Executive Order required the Departments of Commerce, Defense, Interior, Agriculture, Transportation, in addition to several states and territories, to actively participate in coral reef conservation via their membership to the US Coral Reef Task Force (DoD 2000). In some cases legal statute has taken on a very specific regional focus, such as Proclamation No. 8336, which eliminated commercial fishing in the waters surrounding Pacific Remote Islands Marine National Monument (PRIMNM), and established additional restrictions to afford protections to the resources that exist within the PRIMNM (Proc. No. 8336). This establishment of a "no commercial fishing zone" within the monument provides direct benefit to ESA corals species and has been identified by researchers as one of the most effective management strategy for improving coral reef system resiliency (Green and Bellwood 2009, Lubchenco et al 2003). Other legal statues, such as ESA, have also been effective at affording additional protections to ESA coral species, and in recent years, this act has been used to secure further protections for ESA corals (50 CFR Part 223). The existence of ESA legal protections is paramount to ensuring federal and non-federal entities do not intentionally or unintentionally injure the resource in question or its habitat. Such ESA protections are currently being analyzed by NOAA for a specific group of corals confirmed by USFWS to exist in the waters surrounding Wake Atoll. The discovery of two ESA coral species along the south side of Wake Atoll by USFWS in 2016 was not only monumental because such species had never been discovered in this region before, but more importantly it marked an important period in the life history of military stewardship, given USAF dollars led to the discovery of *Acropora globiceps* and *Acropora retusa* at Wake Atoll (USFWS 2017). This draft information from USFWS arrives at a crucial time, given NOAA is

Acropora globiceps, a federally-listed threatened coral species at Wake Atoll. Photo Credit: K. Foster, Pacific Islands Fish and Wildlife Office, USFWS 2016.

considering the release of a draft proposed rule on establishment of critical habitat for these two species (and others) in 2017. The development of the proposed rule on the establishment of critical habitat for this select group of corals (of which *Acropora globiceps* and *Acropora retusa* are both included) has benefited from the new discovery. As a function of the federal rule making process, NOAA must evaluate the PRSC's INRMP in order to identify if the actions within the INRMP afford these two species sufficient benefit. National security implications posed by the draft rule are also components that are taken into consideration during NOAA's review process. The remaining content of this appendix focuses on those past, present, and future projects within the 2017 INRMP which afford ESA corals such as *Acropora globiceps* and *Acropora retusa* (as well as non-listed corals) true benefits and a greater likelihood of continued survival in the waters surrounding Wake Atoll.

Coral conservation actions (past, present, and future) depicted within Tables 1-4 are segregated using the focus areas of coral protection suggested or commonly used by the IUCN, ISRS, DoD, GESAMP and other institutions engaged in coral reef protection or the development of scientific monitoring guidance. Each action within Tables 1-4 has been identified to either provide a direct, indirect or both to *Acropora globiceps* and *Acropora retusa*, as well as non-listed coral species. All projects and monitoring strategies have been screened against professional guidance documents from groups such as IUCN and ISRS in order to validate scientific approach. Given the USAF PRSC was not selected by President Bush in 2009 to manage the waters surrounding Wake Atoll during his creation of Proclamation 8336, a disproportionate number of the PRSC's coral protection actions take place on land versus in water. Those in water conservation actions which have taken place in the monument waters or are planned to take place in the next 5 years, have been pre-coordinated with regulatory parties via the INRMP review process. This cross agency project coordination was carried out in alignment with Air Force Instruction (AFI) 32-7064 "Integrated Natural Resources Management" and the Sikes Act Tripartite Agreement. In many cases the very projects identified in Tables 1-4 of this appendix have been or will be implemented by NOAA or USFWS given their respective workforce skill set. In the event a specific skill set needed for certain surveys is lacking within state and federal agencies, the utilization of university based experts or private researchers is likely to ensue.

As a partner of the US Coral Reef Task Force, the PRSC is proud of its stewardship actions which have led to the discovery of *Acropora globiceps* and *Acropora retusa* and has created this section of the INRMP to display those actions in the 2017 Wake-Kokee-Kaala INRMP which are either directly beneficial or indirectly beneficial (or both in some cases) to the continued existence of both species. The projects benefiting *Acropora globiceps* and *Acropora retusa* are divided amongst the following categories: Water Quality Improvements, Education and Outreach, Fisheries Management, and Physical DoD Presence on Wake Atoll.

Table 1. Water Quality Improvements

Project or Contract Number(s)	***Project Title***	***Benefits to A. globiceps, A. retusa and other coral species***
FA5000-13-C- 0005-P00005	Wake Stormwater Pollution Prevention Plan	Improved recruitment, increased distribution limits, increased species composition, and increase in biodiversity[1].
Weston Solution 2015	Spill Prevention Control and Countermeasure Plan	Improved recruitment, increased distribution limits, increased species composition, and increase in biodiversity[1].
FA5000-13-C- 0005-P00005	National Pollution Discharge Elimination System-	Improved recruitment, increased distribution limits, increased species composition, and increase in biodiversity[1].

	Reverse Osmosis Permit	
YGFZOS161377 YGFZOS171377 YGFZOS181377 YGFZOS191377 YGFZOS201377	Management, Invasive Species, Ironwood Removal	Improved recruitment, increased distribution limits, increased species composition, and increase in biodiversity[1].
YGFZOS171268 YGFZOS181268 YGFZOS191268 YGFZOS201268	Management, Native Ecosystems	Improved recruitment, increased distribution limits, increased species composition, and increase in biodiversity[1].
YGFZOS161315 YGFZOS171315 YGFZOS181315 YGFZOS191315 YGFZOS201315	Management, Invasive Species, Polynesian Rats	Improved recruitment, increased distribution limits, increased species composition, and increase in biodiversity[1].
YGFZOS175524	Management, Wetland, Floodplain	Improved recruitment, increased distribution limits, increased species composition, and increase in biodiversity[1].

The ISRS identifies known effects of exposure to terrestrial run off on the health of corals and coral reef systems and they include but are not limited to the following: reduced recruitment, shallower depth distribution limits, altered species composition, and loss of biodiversity (ISRS 2004). The result of implementation of the 28 January 2016 SWPPP on Wake Atoll is a reduction of terrestrial runoff (in comparison to the runoff amount, should the SWPPP and its implemented action be eliminated from its existence), thus *Acropora globiceps* and *Acropora retus*a benefit from this INRMP and its inherent actions. The PRSC possess a devoted water quality specialist at the GS-12 level and the SWPPP and SPCC these two documents are review primary duties to update, audit, and amend accordingly (PRSC 2016a, 2016b). In addition to the existence of a SWPPP and SPCC and their associated implementation, the recently discovered ESA corals also benefit from other PRSC funded water quality improvement projects.

Biologist treats invasive ironwood (Casurina angustifolia) with EPA approved herbicide. Photo Credit: J. Gilardi.

Further improvements in water quality are obtained as a result of the PRSC's implementation of native forest restoration actions, which is the focus of the projects entitled "Management, Invasive Species, Ironwood", "Management, Native Ecosystems", and "Management, Invasive Species, Polynesian Rats". Replacing invasive plants such as Ironwood (*Casurina angustifolia*) and Haole Koa (*Leucaena leucocephala*) with native species such as beach helioptrope (*Heliotropium anomalum*), morning glory (*Convolvulaceae sp.*), and kou (*Cordia subcordata*), reduces overall sediment input into the marine environment, due to the ability for native species to better capture runoff, reduce overland flow, and allow for better percolation into the subterranean environment in comparison to their invasive competitors.

In 2016, the PRSC funded the University of Hawaii to implement ironwood eradication services and their efforts have already lead to the removal of ironwood from 12 acres of Wake Atoll (Gilardi 2017). An

additional phase of removal is already underway. Project funds for fiscal year 2017 have been issued and procurement is under way as of February 2, 2017; future site visits shall include additional removal of invasive ironwood, as well as Haole Koa, cactus, and agave. "YGFZOS171268 Management, Native Ecosystems" was funded in 2016 and awarded to Colorado State University and will result in the creation of an operational native plant nursery on Wake Atoll. This project is programmed through FY2020 and subsequent years efforts focus shall be placed on using nursery plants to replace occurrences of invasive trees, shrubs or plants which are less effective at reducing terrestrial runoff. "YGFZOS161377 Management, Invasive Species, Ironwood" focuses purely on the removal component of invasive plants and is the sister project to "Management, Native Ecosystems". These two projects are used in tangent to complete the vegetation restoration cycle. The dual approach of these two married projects results in improved recruitment, increased distribution limits for *Acropora globiceps* and *Acropora retus*a as well as an increase in species composition and biodiversity for other coral species.

The presence of an invasive rodent on a tropical island is not beneficial for the improvement of forest condition, due to seed and seedling predation, as well as adult plant injury. Rodents are well known seed predators and alter the structure of forests, when their digestive tract renders seed unviable, which is the case for many tropical plant species which have not evolved to co-exist with such predatory influence (Shiels 2010). In 2012, the PRSC, USFWS and private contractors worked together to successfully remove the Asian House Rat (*Rattus tanezumi)* from Wake Atoll. In addition Peale Island was confirmed free of both rodent species, thus stands as an important conservation success for not only plants, birds, and other terrestrial organisms, but the marine world benefits from this action as well, given re-forestation is not successful in the presence of an aggressive seed predator. In order to further improve water quality standards for ESA protected corals in the waters surrounding Wake Atoll, the PRSC continues to fund research with groups such as the United States Department of Agriculture National Wildlife Research Center, in order to develop methods to remove remaining Polynesian Rats (*Rattus exulans*) on Wilkes and Peale Island. If successful during a re-attempt at rodent eradication, the water quality improvements resulting from such effort shall further provide additional benefit to ESA corals.

Table 2. Education and Outreach

Project or Contract Number(s)	***Project Title***	***Benefits to A. globiceps, A. retusa and other coral species***
FA5000-13-C-0005-P00005 YGFZOS161317 YGFZOS171317 YGFZOS181317 YGFZOS191317 YGFZOS201317	Outdoor Recreation & Public Access to Natural Resources, Outreach	Reduced likelihood of contact, injury, and mortality.
FA5000-13-C-0005-P00005	Wake Island Dive Club - Memorandum	Reduced likelihood of contact, injury, and mortality

The PRSC has a limited moral, welfare and recreation program on Wake Atoll, however there is a small dive club and cadre of recreational fishers who utilize the marine environment to recreate. In order to ensure such activities do not impact ESA listed corals, the Wake Island Dive Club has created a dive club memorandum or charter, which identifies methods for eliminating contact with corals, such as using pre-existing anchors only for vessel dives, remaining a safe distance from corals when in the water, taking extra precaution not to allow equipment to drag when diving, safe boating rules, and the use of designated shore entry

locations for snorkelers and shore divers. This document is updated by the Base Operations Support contractor on Wake Island during INRMP reviews and is depicted within Appendix P of this INRMP.

Upon arrival to Wake Island, each visitor, regardless of place of employment or origin, must sit through an island in brief. During this in brief rules regarding environmental protection are summarized and include measures to eliminate contact with corals, during in water forms of recreation such as swimming, snorkeling, or scuba diving. Tri folds are present in the terminal which also present prohibitions for certain actions, such as the take of Bumphead parrotfish, any shark species, or any live shell or coral. Funds to update trifolds, develop new in brief materials and scripts, and institute awareness of ESA coral protection is derived from the projects and contract number listed in Table 2. A subset of funds issued to USFWS in 2016 were used to provide supplemental guidance for the pre-existing Dive rule charter, however USFWS has not supplied such deliverable to date. Once received this information will be used to revise the Wake Island Dive Club Memorandum/charter, such that it affords additional protections to ESA corals and other marine organisms.

Table 3. Fisheries Management

Project or Contract Number(s)	***Project Title***	***Benefits to A. globiceps, A. retusa and other coral species***
In house / FA5000-13-C-0005-P00005	Wake Island Operating Guidance – Environmental Compliance and Protection of Nat. Resources	Implementation of instruction results in lower likelihood of recreationalists contact (or their gear) with corals, yielding a higher likelihood of continued survival.
YGFZOS167777 YGFZOS177777 YGFZOS187777	Management, Species, Pacific T&E (coral)	Improved recruitment, increased distribution limits, increased species composition, and increase in biodiversity.
YGFZOS173456 YGFZOS183456 YGFZOS193456	Management, Species, Fish Population Survey	Improved recruitment, increased distribution limits, increased species composition, and increase in biodiversity.
YGFZOS17766	Management, Species, Pacific T&E, Bumphead Parrotfish & Humphead wrasse	Improved recruitment, increased distribution limits, increased species composition, and increase in biodiversity

Wake Island Instruction (WII) 32-7001 was updated in 2017 (and re-titled the "Wake Island Operating Guidance – Environmental Compliance and Protection of Natural Resources") with assistance from NOAA and USFWS via the INRMP review process (PRSC 2017). The revised guidance document does not allow for the casting of nets on the exterior of the atoll, which eliminates the opportunity for structural damage to T&E corals. Furthermore, it prohibits anchoring or trolling in areas depicted on NOAA charts as coral reef habitat, which eliminates the potential for structural damage to ESA corals. This very action has been documented as beneficial to coral reef conservation in other locations such as the Great Barrier Reef (Beeden 2014). The remaining content of the revised guidance assists recreational fishers steer away from sensitive areas possessing corals and also requires lagoon fishers to release all fish. A ban on lobster harvest is included within this guidance document, as are fish catch limits, allowable species (no sharks, Napolean wrasse or Bumphead parrotfish are allowed to be targeted or retained), and permissible equipment. Due to the risks posed to T&E corals by automated spear guns, such equipment is not permitted for use at Wake Atoll. The revised 2017 Wake Island Operating Guidance document for recreational fishers affords both direct and indirect benefits to the newly discovered ESA corals via its implementation.

In 2016, the PRSC funded a team of marine scientists to evaluate the South Shore (inclusive of a small harbor and channel) of Wake Atoll for the presence of ESA corals. Future projects under the heading of "Management, Species, Pacific T&E (coral)" have been programmed into the USAF Automated Engineer System, in order to plan for future surveys of the remaining portions of the atolls reef flats and slopes atoll that were not surveyed in 2016. In addition to programming projects for the remaining un-surveyed portions, the PRSC also anticipates completing parallel fishery studies under a project entitled "Management, Species, Fish Population Survey". The need to document the impacts from a recreational fishing program is imperative to the sustainment of the activity and resource. A segment of this project will focus on those species known to serve as "indicators" of coral reef system resiliency. The IUCN's 2009 Edition of the Manual for "Monitoring for Monitoring Herbivorous Reef Fishes as Indicators of Coral Reef Resilience" identifies scientific rationale for monitoring this segment of marine fishes to understand the status and health of Wake's coral ecosystems, of which both *A. globicep*s and *A. retusa* are identified by USFWS as possessing. Given the ecosystem services provided by various herbivores (such as the ability for scrapers to limit the establishment and growth of microalgae, promoting areas of clean substratum for new coral recruitment) the implementation of a sustained fisheries management program and parallel monitoring program focusing on this niche will afford ESA corals conservation benefits.

Table 4. Physical DoD Presence on Wake Atoll

Project or Contract Number(s)	***Project Title***	***Benefits to A. globiceps, A. retusa and other coral species***
N/A	32 CFR Part 935 Wake Island Code	Domestic and foreign poachers are unable to harvest ESA corals (or rare fish species which provide coral beneficial services), due to DoD presence. Due to restrictions for public access, a minimal human presence in marine environment is also beneficial to the sustained viability of the two coral species. Increase in population of bioeroders, which creates new sites for colonization of ESA corals.
YGFZ330313	Plan Update, INRMP, 5 Year Review	Additional funding avenue for coral reef conservation actions.
YGFZOS18133	Plan Update, INRMP, Annual Review	Additional funding avenue for coral reef conservation actions.

Even though unpopular in some environmental communities, a segment of the biological scientific community, has successfully identified the conservation benefits associated with lands under military management (PRI 2014, Stein et al 2008). The occurrence of ESA and sensitive species on military lands (or within adjacent marine environments) is further evidence that military lands (or waters adjacent to) should not be overlooked for hidden biological value. In the case of Wake Atoll, the military's presence as defined within 32 CFR Part 935, results in the creation of a de facto refuge and network of federal partnerships to "watch" over the uses of the PRIMNM, in a location where surveillance is very difficult to implement within one set agency budget.

This concept of a de facto refuge has been suggested as one of the main reasons Wake Atoll has held a large population of Bumphead parrotfish (DoD 2000). In other locations of the world they are overharvested by night divers, but at Wake, commercial fishing and night diving is not allowed, and recreational fishers are not permitted to target or retain this species. Bumphead parrotfish populations were surveyed at various remote Pacific Islands from 2000-2009 during NOAA Coral Reef Ecosystem Division Marine Surveys. The results during this period are quite startling given Wake population's population density for this species was identified by NOAA as 297 individuals km^{-2}, whereas Palmyra Atoll (a non-active military site) only possessed a population density of five individuals km^{-2} (Kenyon 2011). Marine scientists studying the effects of overfishing on coral communities have identified that bioeroders, such as Bumphead parrotfish, play a major role in the resiliency of a coral reef ecosystem; unlike scrapers and small excavators, the Bumphead parrotfish and other bioeroders, create new sites for colonization opening up new sites for colonization by coralline algae and corals (Green and Bellwood 2009). The existence of such a large community of sensitive species is further scientific evidence that the actions carried out by the PRSC are beneficial to the survival of this species and the corals communities it help augment, of which *A. globiceps*, and *A. retusa* are both members of.

Bumphead Parrotfish (Bolbometopon muricatum) at Wake Atoll. Photo Credit: S. Bogorodsky.

References

Beeden, R. et al. 2014. No-anchoring areas reduce coral damage in an effort to build resilience in Keppel Bay, southern Great Barrier Reef. Australasian Journal of Environmental Management, 21:3, 311-319.

[DoD] Department of Defense. 2000. US Coral Reef Task Force, Coral Reef Protection Implementation Plan. Prepared by ADI Technologies, Inc. under the direction of the Naval Facilities Engineering Command. Publication edited and designed by Lisa Kerr and Dr. Phillip Lobel, Boston University Marine Program.

Department of Defense, U.S. Fish and Wildlife Service, and the Association of Fish and Wildlife Agencies. 2013. Memorandum of Understanding between the U.S. Department of Defense and the United States Fish and Wildlife Service and the Association of Fish and Wildlife Agencies for a Cooperative Integrated Natural Resource Management Program on Military Lands.

GESAMP (IMO/FAO/UNESCO-IOC/WMO/WHO/IAEA/UN/UNEP Joint Group of Experts on the Scientific Aspects of Marine Environmental Protection) and Advisory Committee on Protection of the Sea. 2001. Protecting the oceans from land-based activities - Land-based sources and activities affecting the quality and uses of the marine, coastal and associated freshwater environment. Rep. Stud. GESAMP No. 71, 162 pp.

Gilardi, J. 2017. Wake Atoll Ironwood Removal Project, 7 December 2016 – 7 January 2017 Summary. ACES Project Number YGFZOS161377.

Green, A.L. and Bellwood, D.R. 2009. Monitoring functional groups of herbivorous reef fished as indicators of coral reef resilience – A practical guide for coral reef managers in the Asia Pacific region. The International Union for the Conservation (IUCN) of Nature Working Group on Climate Change and Coral Reefs.

[ISRS] International Society for Reef Studies. 2004. The effects of terrestrial runoff of sediments, nutrients and other pollutants on coral reefs. Briefing Paper3, ISRS, pp: 18.

Kenyon, C.J. et al. 2013. Characterization of Coral Communities at Wake Atoll in the Remote Central Pacific Ocean. Atoll Research Bulletin No. 600. Smithsonian Institution Scholarly Press, 30 December 2013.

Lubchenco, J., Palumbi, S. R., Gaines, S. D., & Andelman, S. 2003. Plugging a hole in the ocean: the emerging science of marine reserves. Ecological applications, 13(1), S3-S7.

[PRI] Public Radio International. 17 November. 2014 https://www.pri.org/stories/2014-11-18/bombs-and-biodiversity-why-military-lands-make-great-conservation-areas

[PRSC] Pacific Air Force Regional Support Center. 2016a. Stormwater Pollution Prevention Plan, Wake Island Airfield, January 2016. Prepared by Chugach Federal Solutions, Inc.

[PRSC] Pacific Air Force Regional Support Center. 2016b. Wake Island Airfield, Spill Prevention, Control, and Countermeasure Plan, August 2015. Prepared by Weston Solutions, Inc.

[PRSC] Pacific Air Force Regional Support Center. 2017. Wake Island Operating Guidance – Environmental Compliance and Protection of Natural Resources. April.

Shiels, A. 2010. Ecology and Impacts of Introduced Rodent (Rattus spp. and Mus musculus) in the Hawaiian Islands. Thesis. University of Hawaii, Manoa, 2010. Print.

Stein, B. A., C. Scott, and N. Benton. 2008. Federal Lands and Endangered Species: The Role of Military and Other Federal Lands in Sustaining Biodiversity. BioScience 2008; 58 (4): 339-347.

[USFWS] United States Fish and Wildlife Service. 2017. Draft Report, Phase I Marine Benthic Habitat Characterization, Wake Atoll Coral Reef Ecosystem Survey. Prepared by Kevin Foster, Anthony Montgomery, Adam Griesemer, and Douglas Fenner. A

APPENDIX T

WAKE ATOLL FISH TISSUE SAMPLING ANALYSIS THREE YEARS AFTER AN ISLAND WIDE RODENTICIDE APPLICATION

NWRC FINAL REPORT

January 27, 2016

PROJECT TITLE:

Wake Atoll fish tissue sampling and analysis three years after an island wide rodenticide application

AUTHORS:

Shane R. Siers
Aaron B. Shiels
David A. Goldade
Steven F. Volker
Thomas W. McAuliffe
Heather L. Coad
William C. Pitt

SPONSOR:

U.S. Air Force

SITE:

Wake Island

LABORATORY PROJECT ID:

QA-2441

Hawaii Field Station
National Wildlife Research Center
Wildlife Services
Animal and Plant Health Inspection Service
United States Department of Agriculture

This report should be cited as follows:
Siers, S.R., Shiels, A.B., Goldade, D.A., Volker, S.F., McAuliffe, T.W., Coad, H.L., and Pitt, W.C. 2015. Wake Atoll fish tissue sampling and analysis three years after an island wide rodenticide application. Final Report QA 2241. USDA, APHIS, WS, NWRC. Hilo, HI. 49 pp. + Appendices.

EXECUTIVE SUMMARY

Between 21 March 2015 and 2 April 2015, we collected 69 whole-body fish tissue samples from Wake Atoll to test for: 1) residues of the anticoagulant rodenticide brodifacoum, potentially resulting from a 2012 rat eradication attempt involving hand- and aerially-broadcast brodifacoum pellets, and 2) the potentially toxic metals beryllium, vanadium, chromium, cobalt, nickel, copper, zinc, arsenic, selenium, cadmium, antimony, barium, thallium, lead, and mercury.

Samples of milkfish, bonefish, goatfish, blacktail snapper, bluefin trevally, soldierfish, and flounder were systematically collected from six sampling sites (Peale Lagoon, Ioke Beach, Waterplant Outfall, Battery Dump Pond, AF Beach House, and Nitro Rock) as well a few sites sampled in a more opportunistic fashion.

Brodifacoum analysis was conducted by the USDA-APHIS-WS-NWRC Analytical Chemistry Unit in Fort Collins, using high-performance liquid chromatography (HPLC). Samples suspected of brodifacoum contamination were tested with a more sensitive HPLC method combined with atmospheric pressure chemical ionization (APCI) and tandem mass spectrometry (HPLC-APCI-MS/MS). Of the 69 samples tested, 20 were suspected of brodifacoum contamination. Of those, only three samples indicated concentrations above the detection limit, but below the quantification limit; care should be taken when evaluating results below the quantification limit as the variability will be significantly greater than the quality control samples. No samples yielded reliably quantifiable concentrations of brodifacoum. All three samples suggesting contamination were from one species, the blacktail snapper (*Lutjanus fulvus*); in a 2012 analysis, four of the five samples suspected of brodifacoum contamination were also from this same species. At this point it is unclear whether the preponderance of contaminations in this species are a result of some physiological or life history characteristic of the species increasing exposure, trace retention, or bioaccumulation, or whether a systematic bias in the methodology has led to erroneous detections in uncontaminated samples. Additional tests with species-specific baseline noise data may be required to clarify the veracity of these detections. No data exist on adverse human health effects associated with chronic oral exposure to trace concentrations of brodifacoum. Few detections of brodifacoum, at unquantifiable levels so low as to be equivocal, suggest minimal to no risk of harmful exposure to brodifacoum through fish consumption by humans.

Comparisons of sample concentrations of arsenic, mercury, lead, and other potentially toxic metals to EPA daily reference doses (RfDs) were made by three methods: 1) estimation of a maximum meal size that may be consumed before ingestion of the RfD; 2) identification of fish samples for which a single 225 gram (8 ounce) serving would exceed the RfD; and 3) comparison of sample concentrations to EPA's risk-based consumption limit tables for arsenic, cadmium, methylmercury, and selenium.

All fish sampled were high in arsenic and exceeded all risk assessment thresholds; by adapted EPA risk-based consumption limits, only very limited consumption of a few species would be considered within limits. These arsenic levels are consistent with a 2002 final risk evaluation of chemical levels in fish tissue that recommended an interim advisory on consumption of whole lagoon-caught fish. While only one fish from the current sample exceeded the 0.3 mg/kg EPA

threshold for mercury consumption, the majority of fish sampled contained mercury concentrations in excess of the RfD (assuming a 225 g meal of whole-body fish); adapted EPA risk-based consumption tables recommended no more than 3 to 16 fish meals per month, depending on the species. Arsenic concentrations from this and the previous 2002 health risk assessment are based on a presumed ratio of inorganic arsenic to non-toxic organic arsenic; actual levels of toxic inorganic arsenic may be higher or lower than reported here.

Beryllium, antimony, and thallium were detected in only a few samples, while all other metals were detected in all samples. Only milkfish from the Battery Dump Pond sampling location exceeded the average daily dietary intake of lead in a 225 g serving; the EPA does not establish a "safe" threshold for intake of lead. Toxic metal residues in fish tissues were generally higher at the Battery Dump Pond site and within milkfish when compared to other species, though these patterns did not extend to the primary toxins of concern, arsenic and mercury.

Despite concentrations of some potentially toxic metals in excess of intake recommendations in the Wake Atoll samples, contaminant values for the two control fish obtained at the Suisan Fish Market in Hilo, Hawaii, tended to be within the same range of values. This suggests that Wake fish may not be significantly more contaminated than fish in consumer markets. A greater sample size of commercially available fish would be required to strengthen such an assertion. The samples collected for this assessment were almost exclusively taken from within the lagoon, and are not intended to represent the contamination status of pelagic fishes.

Contaminant exposure risks are based on the EPA RfD, where applicable, which is an estimate (with uncertainty spanning perhaps an order of magnitude) of a daily oral exposure to the human population (including sensitive subgroups) that is likely to be without appreciable risk of deleterious noncancer effects during a lifetime. It is not a direct estimator of risk, but rather a reference point to gauge the potential effects. At exposures increasingly greater than the RfD, the potential for adverse health effects increases. However, lifetime exposure above the RfD does not imply that an adverse health effect would necessarily occur.

The data described in this report should inform the decisions of occupational health personnel when making determinations of acceptable risk and contemplating issuance of fish consumption advisories.

INTRODUCTION

Wake Island is an unincorporated U.S. territory located between Hawaii and Guam in the Pacific Ocean and managed by the Department of Defense, U.S. Air Force. Wake Island has approximately 12 miles of coastline and is an important breeding area for many species of seabirds. Two species of rats were inadvertently introduced onto Wake Island: Polynesian rats (*Rattus exulans*) and Asian house rats (*Rattus tanezumi*). A rodent eradication effort was conducted on Wake Island in the summer of 2012 (Island Conservation 2013). *R. tanezumi* was successfully extirpated, but *R. exulans* survived the eradication attempt and is now widespread on the island. This eradication effort employed the rodenticide Brodifacoum 25W: Conservation, manufactured by Bell Laboratories.

The use of rodenticides to control or eradicate invasive rats (*Rattus* spp.) for conservation purposes has rapidly grown in the past decade, especially on islands. The non-target consequences and the fate of toxicant residue from such rodent eradication operations have not been well explored (but see Sztukowski and Kesler 2013 and Pitt et al. 2015). A study summarizing rodent eradication attempts between 1971 and 2011 demonstrated that brodifacoum was the chosen toxicant in 396 of 546 cases (72.5%); this is partly due its status as one of the few rodenticides registered for aerial use by the environmental protection agency (Parkes et al., 2011).

Brodifacoum is considered a second generation "superwarfarin" rodenticide that is extremely effective at inhibiting the reconstitution of active vitamin K, yielding a 100-fold decrease in vitamin K-dependent coagulation factors when compared with warfarin at the same molar dose (Lipton and Klass 1984). Due to its increased lipid solubility and increased affinity for hepatic enzymes, brodifacoum has a significantly longer elimination half-life than warfarin- 156 hours versus 6 hours, respectively, in rats, and in classified as "extremely toxic" with an LD50 <0.27 mg/kg in rats and an LD50 <1.00 mg/kg in humans (Bachmann and Sullivan 1983, Rauch et al. 1994). Clinically significant adverse events related to "superwarfarin" exposure are most commonly related to brodifacoum poisoning; in humans, gastrointestinal exposure is the most common route for brodifacoum poisoning. Brodifacoum is available in small, brightly colored red, green or blue cereal based baits resembling nontoxic food or candy which may increase the likelihood for mistaken ingestion (Fang et al. 2012). Gastrointestinal exposure to brodifacoum may also occur when food tainted with rat droppings is consumed (Rauch et al. 1994). Recently, a case of intentional brodifacoum inhalation was presented in the literature, where a young male patient with a medical history of schizophrenia presented to a local emergency department complaining of chest pain and a CT scan of the thorax revealed a mediastinal hematoma. The patient subsequently admitted to intentional large volume snorting/inhalation of brodifacoum in the days leading up to his presentation (Booth and Mody 2015). Inhalation of brodifacoum has also been implicated in poisoning cases where marijuana was laced with the toxicant (La Rosa et al. 1997). Clinically, the most common hemorrhagic features of brodifacoum poisoning are hematuria, gingival bleeding, epistaxis and gastrointestinal bleeding; the hemorrhagic event most closely related to death due to brodifacoum poisoning is intracranial hemorrhage (King and Tran 2015). In an effort to reduce unintentional poisoning to humans, the Environmental Protection Agency (EPA) requires additions of bitterants and indicator dyes to all anticoagulant rodenticides to reduce the palatability of the bait (USEPA 1998). A more thorough listing of case studies of

brodifacoum intoxication, along with a toxicity summary, pharmacokinetics, medical treatments, animal toxicity studies, ecotoxicity excerpts, occupational exposure standards, and more are available through the U.S. National Library of Medicine's TOXNET Toxicology Network (USNLM 2016).

Brodifacoum has a very low solubility in water, and degrades slowly (weeks to months) in water; thus, brodifacoum baits and residues may be available for extended periods in the environment and may enter the marine food web through direct bait consumption or by indirect measures (e.g., invertebrates eating the bait, then fish eating invertebrates).

A review by Fisher (2010) indicated that multiple aerial applications of brodifacoum on New Zealand islands have led to no detectable brodifacoum residues in fresh water, and conclude that factors such as brodifacoum's low water-solubility (especially at acidic and neutral pH), the adsorption of brodifacoum to organic particles, and dilution with water volume and flow rate likely contributed to this result. Primus et al. (2005) reported on the accidental discharge of approximately 20 tons of brodifacoum bait into the near-shore marine environment resulting from a road transport accident. Not all of the bait material entered the ocean, and it was estimated that a maximum of 360 g of the active ingredient entered the marine environment. Water samples were collected for up to 1.5 months, and aquatic biota were sampled for up to 21 months. No dead animals found contained evidence of brodifacoum exposure. Within 36 hours to 9 days of the event, concentrations of brodifacoum in water samples were below the method detection limit (<0.020 parts per million). Sparse sampling of marine life indicated little residual contamination past 9 days, with the exception of sedentary molluscs containing detectable residues at day 353. Detectable residues in limpet (*Cellana ornata*) tissues persisted for 80 days. It was estimated that paua (genus *Haliotis*) and mussels (*Mytilus eduli*s and *Perna canaliculus*) were within New Zealand's acceptable consumption limit (0.001 ppm) within 471 and 796 days, respectively; this prolonged persistence was thought to be due to continued exposure through filter feeding.

Following the 2012 island-wide application of brodifacoum on Wake Island, brodifacoum residue sampling occurred in several environmental compartments of the Wake Island food web, with a focus on invertebrates and vertebrates. Fish were also sampled post-application in 2012, and some fish (one of eight bluefin trevally, *Caranx* sp., and four of four blacktail snapper, *Lutijanus fulvus*), had low but detectable levels of brodifacoum residues (Musashino Keisoku 2012, included as Appendix A). It is unclear how long these residues persist in the environment, and there is particular concern about their persistence in fish that are caught by Wake Island residents for sport and consumption. Additionally, Wake Island has had a long history of equipment (e.g., military and non-military) and additional sources of pollution on the land and in the near shore environment that could be polluting the waters and associated biota with heavy metals.

In 2002, 10 years before the rodent eradication attempt on Wake, a risk evaluation of chemical levels in fish tissue was conducted (URS Group 2002). This study tested target fish species for PCBs, metals, lipid content, and low level mercury. The report indicated that 1) some detectable levels of heavy metals, particularly arsenic, were present in the fish, and 2) because residents

living on Wake Island commonly consume whole fish prepared in stews, including the skin, head, and organs, whole body analyses should be performed in any future sampling.

The objectives of the current study were to re-sample the same near-shore environments in 2015, approximately three years post-rodenticide application, for a suite of fish species commonly caught by island residents on Wake to: determine the levels of brodifacoum residue in fish (Part A); determine concentrations of heavy metals (e.g., mercury and lead) in fish (Part B**)**; and give an assessment of metals concentrations with respect to potential human health threshold values (Part C).

The levels of brodifacoum are compared to the 2012 report. Based on the relatively low incidence of brodifacoum detection approximately 3 months after rodenticide application in 2012 (e.g., 5 out of 48 samples had 'detectable levels', which were >0.001 mg/kg[1]), we expected even lower incidence of detectable brodifacoum in the 2015 samples. Based on the presence of remaining and decaying structures on land and the near-shore environment on Wake, we also expected to find significant levels of mercury, lead, and other heavy metals in some species of fish.

FISH SAMPLING METHODS

Fish samples for whole-body analysis were collected from Wake Island at the same locations that were sampled in 2012 (Musashino Keisoku 2012; Figure 1). These locations were originally chosen because they are representative of where fishing typically occurs and/or where there is a high likelihood that brodifacoum has entered the water. The same species were sampled as in 2012, with the exception of the following: soldierfish and flounder were sampled instead of eel and crab. Thus, the species targeted for this study were: milkfish (*Chanos chanos*); goatfish (*Mulloides flavolineatus*, *Parupeneus barberinus*, or *Upeneus arge*); blacktail snapper (*Lutijanus fulvus*); bluefin trevally (*Caranx* sp., probably *C. melampygus*); bonefish (*Albula glossodonta*); soldierfish (*Myripristis murdjan*); and flounder (*Bothus* sp., probably *B. mancus*). Select characteristics of these species are summarized in Table 1.

Table 1. General characteristics of sampled species.

Species	Trophic Characteristics	Size	Longevity
Milkfish	Juveniles and adults eat cyanobacteria, soft algae, small benthic invertebrates, and pelagic fish eggs and larvae	To 180 cm, commonly 100 cm	To 15 years
Goatfish	Feed on crustaceans, mollusks, worms, heart urchins and foraminiferans	To 60 cm, commonly 30 cm	To 5 years[1]*
Blacktail snapper	Adults feed at night on fishes, shrimps, crabs, holothurians and cephalopods	To 40 cm, commonly 25 cm	To 34 years (Shimose 2014)

[1] The references associated with this report, including lab analyses, use varying units to describe contaminant concentrations. For the sake of clarification, mg/kg = µg/g = ppm. We will standardize on the usage of mg/kg.

Bluefin trevally	Feeds mainly on other fishes, also crustaceans. Often contain ciguatoxins when reaching lengths of more than 50 cm	To 120 cm, commonly 60 cm	To 11 years[1]*
Bonefish	Feeds on invertebrates, benthic species, mollusks and small crustaceans	To 90 cm	To 20 years, usually 5 to 10[2]*
Soldierfish	Feed mainly on plankton such as crab larvae	To 60 cm, commonly 18 cm	To 14 years[3]*
Flounder	Feed on fishes, crabs and shrimps	To 51 cm	No information

Source: FishBase (Froese and Pauly 1994) unless otherwise noted. [1]AnAge 2015; [2]Crabree et al. 1996; [3]Dee and Radtke 1989. *Estimated from information on closely related species.

Our target sample size for 2015 sampling (as was in 2012) was 10 samples per species (total of 70 samples). In most cases, a sample represents an individual; however, in those instances when an individual caught weighed <100 g, multiple individuals were pooled to make a sample (typically up to three individuals). Individuals < 10 g were released. We planned to sample across the locations as evenly as possible for most fish species; however, some species only reside in particular locations so it was expected that all 10 samples for a given species might be collected from a subset of the locations.

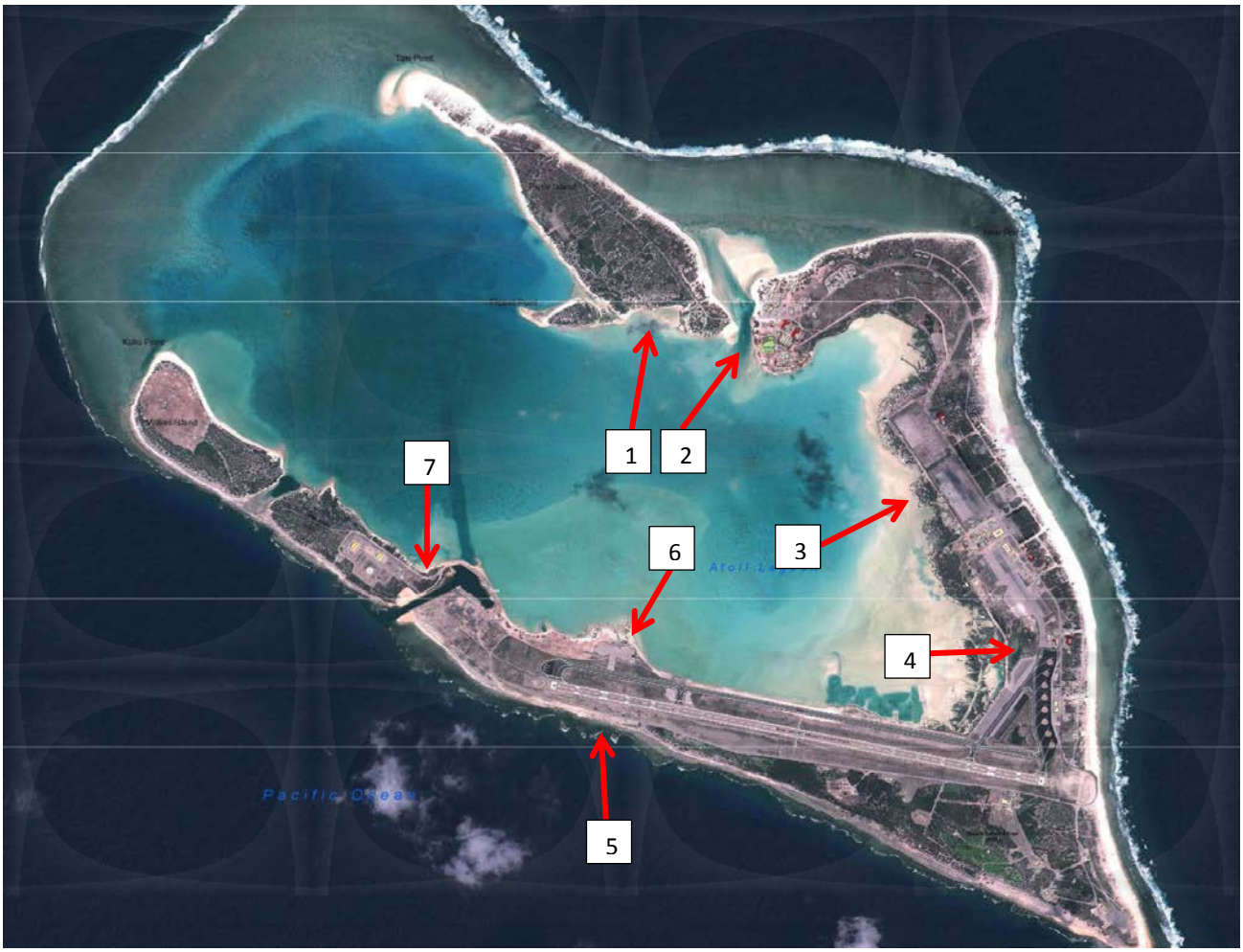


Figure 1. Wake Island with the seven sampling locations marked by arrows. Site names include: 1-Peale Lagoon Side, 2-Ioke Beach House, 3-Waterplant Outfall, 4-Battery Dump Pond, 5-Southern Runway Windsock (not sampled in this study), 6-Old AF Beach House, 7-Nitro Rock.

The primary sampling method was fishing pole (hook and line; Figure 2) or secondarily by cast nets (Figure 3) or spearing. Fish removed from nets or from hooks were stunned and then euthanized by pithing in concordance with AVMA guidelines for euthanasia of fish. Non-target captures were released. Fish were photographed, weighed, and measured (total length) immediately following capture. Individual fish were placed in a plastic bag, then pooled, if necessary (as outlined above), into a larger plastic bag labeled by location and time period. Samples were shipped frozen to the USDA-APHIS-WS-NWRC field station in Hilo, Hawai'i, and then on to the NWRC Analytical Chemistry Unit lab in Fort Collins, Colorado, for brodifacoum analysis, and to the University of Georgia Savannah River Ecology Laboratory (SREL) for heavy metal analysis.

Figure 2. Hook and line fishing was the primary sampling method.

Figure 3. Cast nets were employed as a secondary sampling method.

FISH SAMPLING RESULTS

Between 21 March 2015 and 2 April 2015, 69 fish samples (either individual fish or pooled samples) were collected from Wake Island. The samples are summarized in Table 2 and detailed in Table 3. In the 2012 sampling (Musashinko Keisoku 2012), only land crabs were collected from sampling location 5; for this study, it was determined that no crabs would be collected, and therefore collection of fish from this site would be of no comparative value. Instead, a small number of fish (nine) were collected opportunistically from a small number of other locations:

Heal Point, Marina Channel, North Shore Peale, and North Shore Wake. Figures 4 through 10 depict individual samples of each species.

Table 2. Distribution of sampled fish among species and sampling locations: 1-Peale Lagoon Side, 2-Ioke Beach House, 3-Waterplant Outfall, 4-Battery Dump Pond, 5-Southern Runway Windsock (not sampled), 6-Old AF Beach House, 7-Nitro Rock. These locations are depicted on the map in Figure 1. For the sake of summarization, other sites have been labeled: a-Heal Point; b-Marina Channel; c-North Shore Peale; d-North Shore Wake.

Common name	**Latin name**	**Counts of Samples by Location**								**Total**
		1	**2**	**3**	**4**	**5**	**6**	**7**	**Other**	
Milkfish	*Chanos chanos*			5	6					11
Goatfish	*Mulloides flavolineatus, Parupeneus barberinus* or *Upeneus arge*	4					1	2	1^{b},1^{c}	9
Blacktail Snapper	*Lutjanus fulvus*	2	2		3		4	1		12
Bluefin trevally	*Caranx* sp., probably *C. melampygus*	1						2	2^{a},1^{b},2^{d}	8
Bonefish	*Albula glossodonta*	2			4		4			10
Soldierfish	*Myripristis murdjan*			7					2^{b*}	9
Flounder	*Bothus* sp., probably *B. manthus*	1	2	2			1	4		10
	Total	10	4	14	13	0	10	9	9	**69**

*One soldierfish from this site was *Myripristis chryseres*

Figure 4. Pooled milkfish sample.

Figure 5. Goatfish sample.

Figure 6. Blacktail snapper sample.

Figure 7. Bluefin trevally sample.

Figure 8. Bonefish sample.

Figure 9. Soldierfish sample.

Figure 10. Flounder sample.

Table 3: Details of sampled fish, including sample numbers for analyses.

#	Site	Com. Name	Latin Name	Len (cm)	Wt (g)	Date Caught	Sample #
1	Peale Lagoon Side	Snapper	*Lutjanus fulvus*	105	105.0	3/25/2015	S150413-45
1	Peale Lagoon Side	Snapper	*Lutjanus fulvus*	140	25.5	3/25/2015	S150413-46
1	Peale Lagoon Side	Bonefish	*Albula glossodonta*	635	54.0	3/25/2015	S150413-47
1	Peale Lagoon Side	Bonefish	*Albula glossodonta*	635	54.0	3/25/2015	S150413-50
1	Peale Lagoon Side	Flounder	*Bothus manthus*	450	43.0	3/25/2015	S150413-49
1	Peale Lagoon Side	Goatfish	*Upeneus arge*	225	36.0	3/25/2015	S150413-41
1	Peale Lagoon Side	Goatfish	*Upeneus arge*	280	40.5	3/25/2015	S150413-42
1	Peale Lagoon Side	Goatfish	*Upeneus arge*	120	28.5	3/25/2015	S150413-43
1	Peale Lagoon Side	Goatfish	*Upeneus arge*	250	38.5	3/25/2015	S150413-44
1	Peale Lagoon Side	Trevally	*Caranx* sp.	120	51.5	3/25/2015	S150413-48
2	Ioke Beach	Snapper	*Lutjanus fulvus*	180	28.5	3/25/2015	S150413-39
2	Ioke Beach	Snapper	*Lutjanus fulvus*	190	28.0	3/25/2015	S150413-40
2	Ioke Beach	Flounder	*Bothus manthus*	420	42.0	3/29/2015	S150413-56
2	Ioke Beach	Flounder	*Bothus manthus*	445	43.5	3/29/2015	S150413-57
2	Ioke Beach	Soldierfish	*Myripristis murdjan*	90	31.0	4/1/2015	S150413-61
2	Ioke Beach	Soldierfish	*Myripristis murdjan*	130	24.0	4/1/2015	S150413-62
2	Ioke Beach	Soldierfish	*Myripristis murdjan*	150	24.0	4/1/2015	S150413-63
2	Ioke Beach	Soldierfish	*Myripristis murdjan*	125	24.5	4/1/2015	S150413-64
2	Ioke Beach	Soldierfish	*Myripristis murdjan*	125	25.5	4/1/2015	S150413-65
2	Ioke Beach	Soldierfish	*Myripristis murdjan*	95	21.5	4/1/2015	S150413-66
2	Ioke Beach	Soldierfish	*Myripristis murdjan*	110	23.5	4/1/2015	S150413-67
3	Waterplant Outfall	Flounder	*Bothus manthus*	480	43.0	3/27/2015	S150413-52
3	Waterplant Outfall	Flounder	*Bothus manthus*	130	28.0	3/28/2015	S150413-55
3	Waterplant Outfall	Milkfish	*Chanos chanos*	1361	6.0	3/23/2015	S150413-19
3	Waterplant Outfall	Milkfish	*Chanos chanos*	2177	84.5	3/23/2015	S150413-20
3	Waterplant Outfall	Milkfish	*Chanos chanos*	2381	85.0	3/23/2015	S150413-21

3	Waterplant Outfall	Milkfish	*Chanos chanos*	1700	71.5	3/23/2015	S150413-22
3	Waterplant Outfall	Milkfish	*Chanos chanos*	1247	66.0	3/23/2015	S150413-23
4	Battery Dump Pond	Snapper	*Lutjanus fulvus*	175	28.0	3/24/2015	S150413-35
4	Battery Dump Pond	Snapper	*Lutjanus fulvus*	230	30.0	3/24/2015	S150413-36
4	Battery Dump Pond	Snapper	*Lutjanus fulvus*	182	29.0	3/24/2015	S150413-37
4	Battery Dump Pond	Bonefish	*Albula glossodonta*	630	54.5	3/23/2015	S150413-31
4	Battery Dump Pond	Bonefish	*Albula glossodonta*	700	57.0	3/23/2015	S150413-32
4	Battery Dump Pond	Bonefish	*Albula glossodonta*	500	50.5	3/23/2015	S150413-33
4	Battery Dump Pond	Bonefish	*Albula glossodonta*	710	56.5	3/23/2015	S150413-34
4	Battery Dump Pond	Milkfish	*Chanos chanos*	104	104.0	3/23/2015	S150413-24
4	Battery Dump Pond	Milkfish	*Chanos chanos*	124	124.0	3/23/2015	S150413-25
4	Battery Dump Pond	Milkfish	*Chanos chanos*	100	100.0	3/23/2015	S150413-26
4	Battery Dump Pond	Milkfish	*Chanos chanos*	107	107.0	3/23/2015	S150413-28
4	Battery Dump Pond	Milkfish	*Chanos chanos*	113	113.0	3/23/2015	S150413-29
4	Battery Dump Pond	Milkfish	*Chanos chanos*	240	240.0	3/23/2015	S150413-30
6	AF Beach House	Snapper	*Lutjanus fulvus*	230	29.5	3/21/2015	S150413-01
6	AF Beach House	Snapper	*Lutjanus fulvus*	200	29.5	3/21/2015	S150413-02
6	AF Beach House	Snapper	*Lutjanus fulvus*	180	29.0	3/21/2015	S150413-03
6	AF Beach House	Snapper	*Lutjanus fulvus*	290	32.5	3/21/2015	S150413-04
6	AF Beach House	Bonefish	*Albula glossodonta*	580	54.5	3/21/2015	S150413-05
6	AF Beach House	Bonefish	*Albula glossodonta*	740	56.5	3/22/2015	S150413-15
6	AF Beach House	Bonefish	*Albula glossodonta*	1000	65.0	3/22/2015	S150413-16
6	AF Beach House	Bonefish	*Albula glossodonta*	730	55.0	3/22/2015	S150413-17
6	AF Beach House	Flounder	*Bothus manthus*	400	43.5	3/22/2015	S150413-18
6	AF Beach House	Goatfish	*Mulloides flavolineatus*	400	40.5	3/22/2015	S150413-14
7	Nitro Rock	Snapper	*Lutjanus fulvus*	190	30.0	3/24/2015	S150413-38
7	Nitro Rock	Flounder	*Bothus manthus*	415	43.0	3/22/2015	S150413-06
7	Nitro Rock	Flounder	*Bothus manthus*	280	49.5	3/22/2015	S150413-07
7	Nitro Rock	Flounder	*Bothus manthus*	280	35.5	3/22/2015	S150413-08
7	Nitro Rock	Flounder	*Bothus manthus*	390	39.5	3/22/2015	S150413-09
7	Nitro Rock	Goatfish	*Mulloides flavolineatus*	300	38.5	3/22/2015	S150413-12
7	Nitro Rock	Goatfish	*Mulloides flavolineatus*	390	41.5	3/22/2015	S150413-13
7	Nitro Rock	Trevally	*Caranx* sp.	430	42.0	3/22/2015	S150413-10
7	Nitro Rock	Trevally	*Caranx* sp.	370	39.5	3/22/2015	S150413-11
a	Heal Point	Trevally	*Caranx* sp.	840	54.0	3/28/2015	S150413-53
a	Heal Point	Trevally	*Caranx* sp.	270	35.5	3/28/2015	S150413-54
b	Marina Channel	Goatfish	*Parupeneus* sp.	120	26.5	4/2/2015	S150413-27
b	Marina Channel	Soldierfish	*Myripristis murdjan*	85	21.5	3/26/2015	S150413-51
b	Marina Channel	Soldierfish	*Myripristis chryseres*	275	31.0	4/2/2015	S150413-68
b	Marina Channel	Trevally	*Caranx sp.*	155	31.0	4/2/2015	S150413-69
c	North Shore Peale	Goatfish	*Parupeneus barberinus*	820	52.0	3/31/2015	S150413-58
d	North Shore Wake	Trevally	*Caranx* sp.	240	34.5	4/1/2015	S150413-59
d	North Shore Wake	Trevally	*Caranx* sp.	430	43.0	4/1/2015	S150413-60

The methods, results, and discussions pertaining to brodifacoum analysis, metals analysis, and assessment of health risks associated with metals contamination are all contained within separate parts to this report.

PART A: BRODIFACOUM ANALYSIS

METHODS

All samples were analyzed by high-performance liquid chromatography (HPLC) with fluorescence detection. Sample preparation and extraction and liquid chromatograph conditions are detailed in Appendix B. The detection limit (DL), the concentration of brodifacoum in a sample required to generate a signal equal to 3X the baseline noise (measured peak-to-peak) observed in a control extract, was estimated from the mean chromatographic peak height of brodifacoum in twelve control samples fortified at approximately 0.10 mg/kg and the peak-to-peak noise observed in eight control extracts. The quantitation limit (QL), the concentration of brodifacoum in a sample required to generate a signal equal to l0X the baseline noise, was also determined from twelve fortified control samples and eight control extracts.

Samples with suspected levels of brodifacoum below the quantitation limit were tested using a more sensitive method employing dispersive solid phase extraction (dSPE) and HPLC combined with atmospheric pressure chemical ionization (APCI) and tandem mass spectrometry (HPLC-APCI-MS/MS). More detailed methodological information is contained in Appendix C.

Control samples were obtained from two brodifacoum-free fish purchased at the Suisan Fish Market in Hilo, Hawaii (a bluestripe snapper, *Lutjanus kasmira*, and a soldierfish, *Myripristis* sp.).

Results from the current brodifacoum sampling were quantitatively and qualitatively compared to the previous sampling occurring in 2012 (Musashino Keisoku 2012).

RESULTS

The two non-contaminated control fish (*Lutjanus kasmira*, *Myripristis* sp.) were used to prepare quality control samples and to determine baseline noise, from which the detection limit and quantitation limit values were determined. Mean percent recovery of brodifacoum from quality control samples (tissues dosed to known concentrations of brodifacoum) was 82.0% (range 77.9% to 89.0%). Full QC recovery data are reported in Appendix B. The detection limit was determined to be 0.0035 mg/kg, and the quantitation limit was determined to be 0.0117 mg/kg.

There were no definitive detections of brodifacoum by the preliminary HPLC method. Small responses at the retention time of brodifacoum were observed in 20 of the samples. These samples were suspected of having brodifacoum residues and were submitted to the more sensitive LC/MS/MS testing methodology. Of these 20 samples, 17 indicated no brodifacoum contamination or were below the noise threshold. Three samples (S150413-35, -36, and -40) tested positive for brodifacoum, but at concentrations below the quantitation limit of 0.0117 mg/kg; care should be taken when evaluating results <QL as the variability will be significantly greater than the quality control samples. All three fish with detectable contamination were blacktail snappers, *Lutjanus fulvus*; two from the Battery Dump Pond (Site 4) and one from Ioke Beach (Site 2). These results are detailed in Table 4 and in the original lab report (Appendix C).

Table 4. Results of brodifacoum analyses. HPLC = preliminary analytical methodology; LC/MS/MS = more sensitive follow-up methodology used on samples suspected (S) of containing brodifacoum. *Results reported with an asterisk denote concentrations below the estimated quantitation limit of 0.0117 mg/kg brodifacoum; care should be taken when evaluating results <QL as the variability will be significantly greater than the quality control samples.

#	Site	Com.Name	Sample #	HPLC	LC/MS/MS
1	Peale Lagoon Side	Snapper	S150413-45	ND	—
1	Peale Lagoon Side	Snapper	S150413-46	S*	ND
1	Peale Lagoon Side	Bonefish	S150413-47	ND	—
1	Peale Lagoon Side	Bonefish	S150413-50	ND	—
1	Peale Lagoon Side	Flounder	S150413-49	ND	—
1	Peale Lagoon Side	Goatfish	S150413-41	S*	ND
1	Peale Lagoon Side	Goatfish	S150413-42	ND	—
1	Peale Lagoon Side	Goatfish	S150413-43	ND	—
1	Peale Lagoon Side	Goatfish	S150413-44	ND	—
1	Peale Lagoon Side	Trevally	S150413-48	ND	—
2	Ioke Beach	Snapper	S150413-39	ND	—
2	Ioke Beach	Snapper	S150413-40	S*	0.0031 mg/kg*
2	Ioke Beach	Flounder	S150413-56	ND	—
2	Ioke Beach	Flounder	S150413-57	ND	—
2	Ioke Beach	Soldierfish	S150413-61	ND	—
2	Ioke Beach	Soldierfish	S150413-62	ND	—
2	Ioke Beach	Soldierfish	S150413-63	S*	ND
2	Ioke Beach	Soldierfish	S150413-64	ND	—
2	Ioke Beach	Soldierfish	S150413-65	ND	—
2	Ioke Beach	Soldierfish	S150413-66	ND	—
2	Ioke Beach	Soldierfish	S150413-67	ND	—
3	Waterplant Outfall	Flounder	S150413-52	ND	—
3	Waterplant Outfall	Flounder	S150413-55	ND	—
3	Waterplant Outfall	Milkfish	S150413-19	ND	—
3	Waterplant Outfall	Milkfish	S150413-20	ND	—
3	Waterplant Outfall	Milkfish	S150413-21	ND	—
3	Waterplant Outfall	Milkfish	S150413-22	ND	—
3	Waterplant Outfall	Milkfish	S150413-23	ND	—
4	Battery Dump Pond	Snapper	S150413-35	S*	0.0038 mg/kg *
4	Battery Dump Pond	Snapper	S150413-36	S*	0.0086 mg/kg *
4	Battery Dump Pond	Snapper	S150413-37	S*	ND
4	Battery Dump Pond	Bonefish	S150413-31	ND	—
4	Battery Dump Pond	Bonefish	S150413-32	ND	—
4	Battery Dump Pond	Bonefish	S150413-33	ND	—
4	Battery Dump Pond	Bonefish	S150413-34	ND	—
4	Battery Dump Pond	Milkfish	S150413-24	ND	—
4	Battery Dump Pond	Milkfish	S150413-25	S*	ND
4	Battery Dump Pond	Milkfish	S150413-26	ND	—
4	Battery Dump Pond	Milkfish	S150413-28	S*	ND

4	Battery Dump Pond	Milkfish	S150413-29	S*	ND
4	Battery Dump Pond	Milkfish	S150413-30	ND	—
6	AF Beach House	Snapper	S150413-01	ND	—
6	AF Beach House	Snapper	S150413-02	ND	—
6	AF Beach House	Snapper	S150413-03	S*	ND
6	AF Beach House	Snapper	S150413-04	S*	ND
6	AF Beach House	Bonefish	S150413-05	S*	ND
6	AF Beach House	Bonefish	S150413-15	ND	—
6	AF Beach House	Bonefish	S150413-16	ND	—
6	AF Beach House	Bonefish	S150413-17	ND	—
6	AF Beach House	Flounder	S150413-18	ND	—
6	AF Beach House	Goatfish	S150413-14	ND	—
7	Nitro Rock	Snapper	S150413-38	S*	ND
7	Nitro Rock	Flounder	S150413-06	ND	—
7	Nitro Rock	Flounder	S150413-07	ND	—
7	Nitro Rock	Flounder	S150413-08	ND	—
7	Nitro Rock	Flounder	S150413-09	ND	—
7	Nitro Rock	Goatfish	S150413-12	S*	ND
7	Nitro Rock	Goatfish	S150413-13	ND	—
7	Nitro Rock	Trevally	S150413-10	S*	ND
7	Nitro Rock	Trevally	S150413-11	ND	—
a	Heal Point	Trevally	S150413-53	ND	—
a	Heal Point	Trevally	S150413-54	S*	ND
b	Marina Channel	Goatfish	S150413-27	S*	ND
b	Marina Channel	Soldierfish	S150413-51	ND	—
b	Marina Channel	Soldierfish	S150413-68	ND	—
b	Marina Channel	Trevally	S150413-69	ND	—
c	North Shore Peale	Goatfish	S150413-58	S*	ND
d	North Shore Wake	Trevally	S150413-59	ND	—
d	North Shore Wake	Trevally	S150413-60	S*	ND

The 2012 sample indicated 5 brodifacoum detections from 48 fish, including 4 of 4 blacktail snappers. The current sample indicated 3 brodifacoum detections (though below the quantitation limit) in a sample of 69 fish (3 of 12 blacktail snappers). Qualitatively, the proportion of detections in the 2015 sample (3/69 = 0.0435) appears less than the proportion in the 2012 sample (5/48 = 0.104); however, these proportions cannot be statistically distinguished (Fisher's exact test, one-tailed, $p = 0.206$). Note that if detections below the quantitation limit are ignored (0/69 = 0.0), the difference is significant at $p = 0.0102$. Among blacktail snappers sampled, the 2015 sample contained a lower ratio (3/12 = 0.25) than the 2013 sample (4/4 = 1.0), a difference that is statistically significant (one-sided, $p = 0.00903$).

DISCUSSION

Three years after an island-wide brodifacoum treatment (Island Conservation 2013), there is no reliably quantifiable evidence of brodifacoum residues in fish samples. However, three samples

did indicate levels of brodifacoum above the detection limit but below the quantification limit. Care should be taken when evaluating results below the quantitation limit, as variability in the samples will be significantly greater than in the quality control samples.

There is an apparent decreasing trend in brodifacoum detections since the 2012 sampling occurred, though this trend is not statistically significant when including all fish and treating detections below the quantitation limit as detections. However, caution should be taken when comparing detections between different detection methods and when considering detections below the quantitation limit.

All three fish with values beyond the detection limit for brodifacoum were blacktail snappers, (*Lutjanus fulvus*). This is particularly noteworthy in light of the fact that four of the five fish identified as containing brodifacoum residues in the 2012 sample were also blacktail snappers, and that every snapper in that sample tested positive. On face value, this may indicate that blacktail snappers either had more exposure to brodifacoum (through direct consumption or bioaccumulation), retained brodifacoum in body tissues longer, or exhibited greater site fidelity than other fish. Given the chemical properties of brodifacoum, the potential for bioconcentration in aquatic organisms is high (USNLM 2016); blacktail snappers are predators of fishes, shrimps, crabs, holothurians, and cephalopods, placing them a trophic level with potential for bioaccumulation of brodifacoum. Alternatively, it should also be considered that baseline noise data, used to determine detection and quantitation limits, were derived from other fish species and may not appropriately reflect the baseline noise for this species, which might then result in a large number of positive detections which may be erroneous. If this is indeed the case, some or all of the 2012 detections of brodifacoum may also be suspect. A proper approach to clarifying this apparently anomalous preponderance of brodifacoum detections in this one species might include re-establishing a baseline based on a sample of negative control blacktail snappers obtained from untreated areas.

Brodifacoum has been used on Wake on a limited basis, in bait stations designed to reduce non-target take and environmental contamination, from 2014 to 2015, and in a much more comprehensive rat eradication campaign in 2012 that involved large numbers of bait stations and the aerial and hand broadcast of brodifacoum pellets across the terrestrial expanse of the islands, during which over 18,000 kg of brodifacoum bait was applied (Island Conservation 2013). While great care was taken in treating coastlines, some small amount of pellets were observed to have directly entered the marine environment. While it is not impossible that routine use of brodifacoum in bait stations could lead to the movement of brodifacoum traces into the marine environment, potentially through consumption and dispersal by invertebrates such as crabs, it is far more likely that any marine residues of brodifacoum are a result of landscape-scale application of brodifacoum pellets. Our analytical methods cannot distinguish between potential routes of exposure.

A toxicological profile for brodifacoum is available from the U.S. National Library of Medicine (USNLM 2016) summarizing the human health effects from acute brodifacoum poisoning. The main risks are associated with potentially fatal gastrointestinal and intracerebral hemorrhage. If toxic amounts have been ingested, coagulation will be impaired, with gum bleeding, epistaxis, ecchymosis, hematomata, hematesis, melena and hematuria. Human fatalities from brodifacoum

exposure are exclusively due to deliberate ingestion. A retrospective review of 10,733 cases of single acute unintentional brodifacoum ingestions in children less than 7 years old reported no deaths or major adverse effects.

The average fatal dose for an adult man of 60 kg is estimated to be approximately 15 mg of brodifacoum, or 300 g of 5 mg/kg bait (WHO 1996). Assuming a hypothetical fish sample contaminated at the quantitation limit of 0.0117 mg of brodifacoum per kg of fish tissue, 1,282 kg of fish would have to be consumed to obtain a lethal dose (15 mg) of brodifacoum. All samples obtained during this study were below this quantitation limit.

Case histories of two factory workers exposed to brodifacoum and difenacoum exhibited abnormal vitamin K_1 metabolism for more than 18 months after exposure. Both exhibited prolongation of blood clotting times at the time of exposure, but subsequent tests were normal in both cases (Park et al. 1986). Dosages received and routes of exposure (e.g., inhalation, ingestion, transdermal) were not identified.

To date, there are no known cases of human poisoning from ingestion of brodifacoum-contaminated meats. Sufficient data do not exist to characterize the health effects of chronic exposure to trace levels of brodifacoum in humans or suitable animal models. There is no U.S. standard for acceptable levels of brodifacoum in food products.

Monitoring of brodifacoum residues in the food web before and after a Palmyra Atoll rat eradication campaign has demonstrated contamination of fish in the near-shore environment (Pitt et al. 2015), probably via bait drift directly into coastal waters, making it directly available to a wide variety of marine organisms. Black spot sergeant (*Abudefduf sordidus*) were sampled before the first brodifacoum application (8 samples from 26 fish) and after the second application (10 samples from 30 fish); Brodifacoum was not detected in any of the pre-treatment samples, but after the second treatment, 9 of 10 samples contained detectable residues (mean = 0.143 mg/kg, SE = 0.027 mg/kg). Twenty-four samples of dead mullet (*Moolgarda engeli* or *Liza vaigiensis*, 47 fish) and one dead pufferfish (species ID unknown) were opportunistically collected during and after eradication operations. All dead fish samples tested positive for brodifacoum residues, with concentrations ranging from 0.058 to 1.160 mg/kg (mean = 0.337), with the highest concentrations in the earlier recovered samples and declining over time. The lack of dead organisms before the initial bait broadcast and the concentrations of brodifacoum in carcasses recovered after baiting began suggests that brodifacoum played a role in those mortalities. Mullet are frequently fed upon by predatory fish, demonstrating potential for accumulation of brodifacoum residues at higher trophic levels.

Pitt et al. concluded that any future eradication efforts, such as may occur on Wake, should include monitoring for toxicant residues in fish, insects, crabs, and other organisms for at least 180 days following rodenticide broadcast.

PART B: METAL ANALYSIS

METHODS

Samples were processed for metal analysis following EPA Method 3052 for microwave assisted acid digestion of siliceous and organically based matrices (USEPA 1996). Analysis of beryllium (Be), vanadium (V), chromium (Cr), cobalt (Co), nickel (Ni), copper (Cu), zinc (Zn), arsenic (As), selenium (Se), cadmium (Cd), antimony (Sb), barium (Ba), thallium (Tl), and lead (Pb) was performed by inductively coupled plasma mass spectroscopy (Nexion 300X ICP-MS; Perkin Elmer, Norwalk, CT, USA) on diluted samples following EPA Method 6020A (USEPA 2007a). Certified reference material (TORT 3; National Research Council, Ottawa, ON, Canada), blanks and duplicate samples, were included in the digestion and analysis procedure for quality control purposes.

Total mercury was measured on a Milestone DMA-80 Direct Mercury Analyzer (Milestone, Shelton, CT). This instrument combines the techniques of thermal decomposition, catalytic conversion, amalgamation, and atomic absorption spectrophotometry. Controlled heating stages are implemented to first dry and then thermally decompose a sample introduced into a quartz tube. A continuous flow of oxygen carries the decomposition products through a catalyst bed where interferences are trapped. All mercury species are reduced to elemental Hg and are then carried along to a gold amalgamator where the mercury is selectively trapped. The system is purged and the amalgamator is subsequently heated which releases all mercury vapors to the single beam, fixed wavelength atomic absorption spectrophotometer. Here, absorbance measured at 253.7 nm is proportional to mercury content in the sample. The DMA-80 is fully compliant with US EPA method 7473 (USEPA 2007b). Two certified reference materials (TORT-3 and PACS-2, National Research Council, Ottawa, Ontario, CA), blanks and duplicates were included in the analysis procedure for quality control purposes.

Actual results are reported based on dry weight. Since regulatory limits may refer to wet weight, the results have also been calculated for wet weight. The dry weight results were converted to wet weight values using the water fraction of the wet weight (F_W) determined separately and Equation 1:

$$Wet\ wt. = \frac{Dry\ wt.}{F_W}$$

(Metal analysis methodologies per Angela Lindell, Savannah River Ecology Laboratory; Appendix D)

Linear regressions were performed for each fish species to determine if metal concentrations where influenced by fish size (weight). Scatterplots were viewed to determine if relationships were driven by influential outlier data points. Positive correlations would indicate that size-standardization would be required for site-by-site comparisons.

Observed values for arsenic, lead, and mercury were graphed in comparison to values reported for other commonly-consumed marine fishes in published literature.

RESULTS

The results of metal analyses are reported by dry weight in Tables 5 and 6. Table 7 reports the sample dry and wet weights and wet/dry factor (F_W) used to calculate the wet weights reported in Tables 8 and 9. Fish purchased at the Suisan Fish Market in Hilo, Hawaii, as negative controls for brodifacoum analysis, were also included in these analyses (Samples 150514-01 and 02). Sample concentrations by wet weight are summarized for each analyte, by pooling all fish species from all sites, in Table 10. Figures 11 through 25 graphically depict the distributions of contaminant concentrations across fish species and sampling sites by analyte.

Table 5. Dry weight analyses for beryllium (Be), vanadium(V), chromium (Cr), cobalt (Co), nickel (Ni), copper (Cu), zinc (Zn), arsenic (As). All values are mg/kg dry weight. Boldfaced values below respective element headers are the minimum detection limits (MDL) in mg/kg. †-control fish.

#	Site	Com. Name	Sample #	Be	V	Cr	Co	Ni	Cu	Zn	As
				0.018	**0.016**	**0.027**	**0.011**	**0.009**	**0.017**	**0.016**	**0.020**
1	Peale Lagoon Side	Bonefish	S150413-47	<MDL	4.66	0.704	0.0743	1.26	2.21	93.5	62.7
1	Peale Lagoon Side	Bonefish	S150413-50	<MDL	0.543	0.682	0.0489	0.741	3.25	97.0	146
1	Peale Lagoon Side	Flounder	S150413-49	<MDL	0.262	0.494	0.0868	1.52	0.704	92.3	22.8
1	Peale Lagoon Side	Goatfish	S150413-41	<MDL	1.50	0.732	0.0733	1.17	2.82	43.3	15.6
1	Peale Lagoon Side	Goatfish	S150413-42	<MDL	1.57	1.06	0.0822	1.20	8.42	110	35.2
1	Peale Lagoon Side	Goatfish	S150413-43	<MDL	2.12	0.482	0.0622	0.966	3.15	46.5	31.2
1	Peale Lagoon Side	Goatfish	S150413-44	<MDL	5.67	0.519	0.0953	1.61	3.30	61.7	16.8
1	Peale Lagoon Side	Trevally	S150413-48	<MDL	0.211	0.606	0.0551	0.874	2.99	52.4	18.5
1	Peale Lagoon Side	Snapper	S150413-45	<MDL	9.99	0.899	0.0981	1.63	3.90	65.2	5.98
1	Peale Lagoon Side	Snapper	S150413-46	<MDL	33.1	0.645	0.0624	1.04	2.43	57.9	4.60
2	Ioke Beach	Flounder	S150413-56	<MDL	0.203	0.770	0.112	1.93	0.992	122	26.1
2	Ioke Beach	Flounder	S150413-57	<MDL	0.293	0.710	0.153	1.91	0.861	107	33.4
2	Ioke Beach	Soldierfish	S150413-61	<MDL	0.147	0.536	0.0724	1.25	1.66	47.0	91.2
2	Ioke Beach	Soldierfish	S150413-62	<MDL	0.133	0.575	0.0783	1.25	1.80	46.0	76.7
2	Ioke Beach	Soldierfish	S150413-63	<MDL	0.172	0.648	0.0766	1.23	1.62	53.0	66.3
2	Ioke Beach	Soldierfish	S150413-64	<MDL	0.101	0.461	0.0476	0.762	1.05	30.6	95.4
2	Ioke Beach	Soldierfish	S150413-65	<MDL	0.260	0.487	0.0763	1.24	1.93	49.4	78.9
2	Ioke Beach	Soldierfish	S150413-66	<MDL	0.115	0.418	0.0836	1.33	2.14	40.9	61.2
2	Ioke Beach	Soldierfish	S150413-67	<MDL	0.163	0.459	0.0641	1.11	0.787	33.3	55.8
2	Ioke Beach	Snapper	S150413-39	<MDL	3.79	0.746	0.0844	1.40	3.02	39.9	4.06
2	Ioke Beach	Snapper	S150413-40	<MDL	2.24	0.794	0.0845	2.04	2.73	43.3	3.76
3	Waterplant Outfall	Flounder	S150413-52	<MDL	0.281	0.579	0.0856	1.49	0.836	108	24.7
3	Waterplant Outfall	Flounder	S150413-55	<MDL	0.0938	0.503	0.0704	1.02	1.34	77.8	212
3	Waterplant Outfall	Milkfish	S150413-19	<MDL	0.488	1.43	0.0990	1.90	6.41	41.2	18.4
3	Waterplant Outfall	Milkfish	S150413-20	0.0206	0.634	1.30	0.108	1.76	4.46	50.9	20.3
3	Waterplant Outfall	Milkfish	S150413-21	<MDL	0.376	1.64	0.0760	1.40	3.42	33.7	14.0
3	Waterplant Outfall	Milkfish	S150413-22	<MDL	0.355	2.19	0.0896	1.81	5.34	42.1	26.4
3	Waterplant Outfall	Milkfish	S150413-23	<MDL	0.351	1.32	0.0706	1.36	5.42	38.9	26.2
4	Battery Dump Pond	Bonefish	S150413-31	<MDL	0.857	2.59	0.0778	1.08	2.12	153	56.1
4	Battery Dump Pond	Bonefish	S150413-32	<MDL	0.865	1.62	0.0747	0.915	2.77	76.0	39.5
4	Battery Dump Pond	Bonefish	S150413-33	<MDL	0.642	1.03	0.0807	1.14	2.48	167	37.9
4	Battery Dump Pond	Bonefish	S150413-34	<MDL	0.477	0.605	0.0626	1.03	2.53	66.4	52.3
4	Battery Dump Pond	Milkfish	S150413-24	<MDL	1.71	4.62	0.189	3.02	41.9	197	14.5
4	Battery Dump Pond	Milkfish	S150413-25	<MDL	1.33	3.26	0.143	2.37	14.4	122	8.56
4	Battery Dump Pond	Milkfish	S150413-26	<MDL	0.858	3.69	0.175	2.42	11.8	129	10.3
4	Battery Dump Pond	Milkfish	S150413-28	<MDL	1.35	3.50	0.177	3.01	16.6	119	11.2
4	Battery Dump Pond	Milkfish	S150413-29	0.0219	2.01	3.94	0.213	2.92	39.9	184	10.4
4	Battery Dump Pond	Milkfish	S150413-30	<MDL	0.927	2.15	0.136	2.63	10.6	57.4	24.9

4	Battery Dump Pond	Snapper	S150413-35	<MDL	0.196	0.689	0.0797	1.33	4.62	49.0	6.64
4	Battery Dump Pond	Snapper	S150413-36	<MDL	0.167	0.678	0.0745	1.16	3.23	49.4	6.90
4	Battery Dump Pond	Snapper	S150413-37	<MDL	0.172	0.659	0.0918	1.43	2.93	38.2	6.60
6	AF Beach House	Bonefish	S150413-05	<MDL	0.885	2.51	0.0803	1.30	5.66	95.1	36.0
6	AF Beach House	Bonefish	S150413-15	<MDL	2.39	0.946	0.0676	1.11	4.35	103	50.4
6	AF Beach House	Bonefish	S150413-16	<MDL	1.16	0.773	0.124	1.78	2.67	156	66.0
6	AF Beach House	Bonefish	S150413-17	<MDL	2.19	0.827	0.0586	0.867	6.62	101	74.3
6	AF Beach House	Flounder	S150413-18	<MDL	0.316	0.505	0.0989	1.66	2.06	121	50.5
6	AF Beach House	Goatfish	S150413-14	<MDL	0.283	0.721	0.0740	1.05	3.67	168	42.6
6	AF Beach House	Snapper	S150413-01	<MDL	0.337	0.671	0.0694	1.10	4.09	48.3	14.1
6	AF Beach House	Snapper	S150413-02	<MDL	0.275	0.938	0.0686	1.14	3.33	50.5	12.9
6	AF Beach House	Snapper	S150413-03	<MDL	1.50	1.20	0.158	1.62	4.20	89.7	5.88
6	AF Beach House	Snapper	S150413-04	<MDL	0.246	0.783	0.0519	0.801	2.17	46.4	6.56
7	Nitro Rock	Flounder	S150413-06	<MDL	0.265	0.833	0.106	1.76	1.61	134	29.3
7	Nitro Rock	Flounder	S150413-07	<MDL	0.334	1.00	0.110	1.55	1.19	90.4	24.8
7	Nitro Rock	Flounder	S150413-08	<MDL	0.273	1.18	0.0800	1.07	1.70	98.6	24.6
7	Nitro Rock	Flounder	S150413-09	<MDL	0.291	1.03	0.0494	0.587	1.28	82.7	32.1
7	Nitro Rock	Goatfish	S150413-12	<MDL	0.586	1.84	0.0858	1.37	4.19	107	58.2
7	Nitro Rock	Goatfish	S150413-13	<MDL	0.768	0.964	0.0748	1.31	3.18	141	49.9
7	Nitro Rock	Trevally	S150413-10	<MDL	0.172	0.500	0.0511	0.711	1.41	70.4	3.30
7	Nitro Rock	Trevally	S150413-11	<MDL	0.227	0.769	0.0356	0.447	2.12	48.6	6.94
7	Nitro Rock	Snapper	S150413-38	<MDL	1.45	0.796	0.0833	1.34	4.28	42.2	5.06
a	Heal Point	Trevally	S150413-53	<MDL	0.179	0.795	0.0473	0.719	1.60	94.6	2.86
a	Heal Point	Trevally	S150413-54	<MDL	0.142	0.584	0.0523	0.769	1.91	51.6	4.96
b	Marina Channel	Goatfish	S150413-27	<MDL	0.216	0.521	0.0746	0.842	4.28	66.2	52.3
b	Marina Channel	Soldierfish	S150413-51	<MDL	0.212	0.823	0.0887	1.47	2.46	57.0	48.0
b	Marina Channel	Soldierfish	S150413-68	<MDL	0.328	0.613	0.0955	1.52	3.21	40.1	7.54
b	Marina Channel	Trevally	S150413-69	<MDL	0.0538	0.300	0.0604	0.941	2.95	70.3	9.41
c	North Shore Peale	Goatfish	S150413-58	<MDL	0.196	0.784	0.0560	1.07	1.80	57.3	54.1
d	North Shore Wake	Trevally	S150413-59	<MDL	0.147	0.520	0.0494	0.753	1.89	57.3	3.81
d	North Shore Wake	Trevally	S150413-60	<MDL	0.154	0.719	0.0524	0.835	2.23	74.5	3.70
†	Control (Hilo, HI)	Snapper	S150514-01	<MDL	0.360	0.262	0.0848	1.18	3.66	53.6	30.8
†	Control (Hilo, HI)	Soldierfish	S150514-02	<MDL	0.111	0.198	0.0982	1.68	2.74	41.5	58.6

Table 6. Dry weight analyses for selenium (Se), cadmium (Cd), antimony (Sb), barium (Ba), thallium (Tl), lead (Pb), and total mercury (THg). All values are mg/kg dry weight. Boldfaced values below respective element headers are the minimum detection limits (MDL) in mg/kg. †-control fish.

#	Site	Com. Name	Sample #	Se	Cd	Sb	Ba	Tl	Pb	THg
				0.424	**0.015**	**0.046**	**0.012**	**0.015**	**0.018**	**0.000**
1	Peale Lagoon Side	Bonefish	S150413-47	5.02	0.129	<MDL	1.26	<MDL	0.0928	0.311
1	Peale Lagoon Side	Bonefish	S150413-50	5.99	0.162	<MDL	0.834	<MDL	0.0590	0.144
1	Peale Lagoon Side	Flounder	S150413-49	3.08	0.0312	<MDL	0.605	<MDL	0.0387	0.112
1	Peale Lagoon Side	Goatfish	S150413-41	1.75	0.0387	<MDL	0.711	<MDL	0.913	0.355
1	Peale Lagoon Side	Goatfish	S150413-42	2.75	0.0917	<MDL	0.953	<MDL	0.478	0.367
1	Peale Lagoon Side	Goatfish	S150413-43	3.19	0.0878	<MDL	0.551	<MDL	0.0898	0.157
1	Peale Lagoon Side	Goatfish	S150413-44	3.03	0.0558	<MDL	1.23	<MDL	0.171	0.465
1	Peale Lagoon Side	Trevally	S150413-48	3.54	0.0778	<MDL	0.574	<MDL	0.297	0.176
1	Peale Lagoon Side	Snapper	S150413-45	3.64	0.0889	<MDL	1.91	<MDL	0.165	0.156
1	Peale Lagoon Side	Snapper	S150413-46	2.76	0.0421	<MDL	2.04	<MDL	0.165	0.189
2	Ioke Beach	Flounder	S150413-56	3.05	0.0951	<MDL	1.05	<MDL	0.0911	0.248
2	Ioke Beach	Flounder	S150413-57	3.04	0.0714	<MDL	1.03	<MDL	0.0646	0.167
2	Ioke Beach	Soldierfish	S150413-61	4.89	0.302	<MDL	0.942	<MDL	0.0455	0.0605
2	Ioke Beach	Soldierfish	S150413-62	4.08	0.251	<MDL	0.856	<MDL	0.0404	0.0615
2	Ioke Beach	Soldierfish	S150413-63	6.02	0.530	<MDL	1.26	<MDL	0.119	0.0620
2	Ioke Beach	Soldierfish	S150413-64	4.83	0.0963	<MDL	0.569	<MDL	0.0339	0.0806

2	Ioke Beach	Soldierfish	S150413-65	4.10	0.248	<MDL	1.06	<MDL	0.0439	0.0637
2	Ioke Beach	Soldierfish	S150413-66	5.83	0.247	<MDL	1.02	<MDL	0.0617	0.0514
2	Ioke Beach	Soldierfish	S150413-67	4.77	0.405	<MDL	0.940	<MDL	0.0318	0.0528
2	Ioke Beach	Snapper	S150413-39	2.03	0.0455	<MDL	0.823	<MDL	0.368	0.250
2	Ioke Beach	Snapper	S150413-40	2.27	0.0379	<MDL	0.877	<MDL	0.190	0.213
3	Waterplant Outfall	Flounder	S150413-52	2.27	0.0623	<MDL	0.656	<MDL	0.119	0.140
3	Waterplant Outfall	Flounder	S150413-55	2.47	0.0363	<MDL	0.365	<MDL	0.138	0.0590
3	Waterplant Outfall	Milkfish	S150413-19	2.49	0.0722	0.0587	2.60	<MDL	0.707	0.0525
3	Waterplant Outfall	Milkfish	S150413-20	2.86	0.213	0.0880	2.59	0.032	0.772	0.0698
3	Waterplant Outfall	Milkfish	S150413-21	1.79	0.163	<MDL	2.06	<MDL	0.473	0.0871
3	Waterplant Outfall	Milkfish	S150413-22	2.18	0.0539	<MDL	2.13	<MDL	0.508	0.0471
3	Waterplant Outfall	Milkfish	S150413-23	3.39	0.0399	<MDL	1.90	<MDL	0.590	0.0549
4	Battery Dump Pond	Bonefish	S150413-31	4.00	0.122	<MDL	2.10	<MDL	0.347	0.192
4	Battery Dump Pond	Bonefish	S150413-32	3.08	0.0770	<MDL	1.53	<MDL	0.200	0.0567
4	Battery Dump Pond	Bonefish	S150413-33	3.29	0.145	<MDL	1.75	<MDL	0.471	0.128
4	Battery Dump Pond	Bonefish	S150413-34	2.43	0.0462	<MDL	1.56	<MDL	0.244	0.0496
4	Battery Dump Pond	Milkfish	S150413-24	2.32	0.264	2.069	4.18	<MDL	53.7	0.110
4	Battery Dump Pond	Milkfish	S150413-25	2.20	0.199	0.048	2.80	<MDL	17.6	0.0449
4	Battery Dump Pond	Milkfish	S150413-26	2.58	0.183	0.045	3.05	<MDL	11.4	0.0416
4	Battery Dump Pond	Milkfish	S150413-28	2.50	0.177	0.069	3.34	<MDL	19.0	0.0399
4	Battery Dump Pond	Milkfish	S150413-29	2.26	0.220	1.82	4.56	0.018	57.8	0.0888
4	Battery Dump Pond	Milkfish	S150413-30	2.55	0.0603	<MDL	3.43	<MDL	3.10	0.0301
4	Battery Dump Pond	Snapper	S150413-35	2.23	0.0398	<MDL	0.934	<MDL	0.494	0.313
4	Battery Dump Pond	Snapper	S150413-36	1.94	0.0329	<MDL	1.04	<MDL	0.468	0.203
4	Battery Dump Pond	Snapper	S150413-37	1.93	0.0154	<MDL	0.881	<MDL	0.156	0.214
6	AF Beach House	Bonefish	S150413-05	4.49	0.0316	<MDL	1.48	<MDL	0.203	0.122
6	AF Beach House	Bonefish	S150413-15	5.32	0.0501	<MDL	1.90	<MDL	0.094	0.189
6	AF Beach House	Bonefish	S150413-16	4.43	0.463	<MDL	5.04	<MDL	0.335	0.256
6	AF Beach House	Bonefish	S150413-17	4.31	0.0316	<MDL	1.72	<MDL	0.135	0.168
6	AF Beach House	Flounder	S150413-18	2.98	0.101	<MDL	1.45	<MDL	0.143	0.244
6	AF Beach House	Goatfish	S150413-14	2.55	0.0362	<MDL	1.45	<MDL	0.916	0.118
6	AF Beach House	Snapper	S150413-01	3.12	0.0529	0.0668	0.911	<MDL	0.952	0.197
6	AF Beach House	Snapper	S150413-02	2.74	0.0455	<MDL	1.09	<MDL	0.120	0.133
6	AF Beach House	Snapper	S150413-03	2.58	0.0356	<MDL	24.0	<MDL	0.428	0.204
6	AF Beach House	Snapper	S150413-04	2.08	0.0330	<MDL	0.832	<MDL	0.122	0.263
7	Nitro Rock	Flounder	S150413-06	2.42	0.0667	<MDL	1.10	<MDL	0.271	0.255
7	Nitro Rock	Flounder	S150413-07	3.06	0.0500	<MDL	1.17	<MDL	0.0718	0.091
7	Nitro Rock	Flounder	S150413-08	3.07	0.0579	<MDL	0.780	<MDL	0.0733	0.116
7	Nitro Rock	Flounder	S150413-09	3.08	0.121	<MDL	0.473	<MDL	0.0673	0.155
7	Nitro Rock	Goatfish	S150413-12	3.55	0.0148	<MDL	2.19	<MDL	0.799	0.071
7	Nitro Rock	Goatfish	S150413-13	4.23	0.0563	<MDL	2.47	<MDL	0.233	0.057
7	Nitro Rock	Trevally	S150413-10	2.48	0.0185	<MDL	0.653	<MDL	0.050	0.284
7	Nitro Rock	Trevally	S150413-11	2.82	0.0481	<MDL	0.356	<MDL	0.114	0.361
7	Nitro Rock	Snapper	S150413-38	2.49	0.0411	<MDL	1.12	<MDL	0.126	0.263
a	Heal Point	Trevally	S150413-53	3.55	0.251	<MDL	0.698	<MDL	0.0430	0.997
a	Heal Point	Trevally	S150413-54	3.03	0.0333	<MDL	0.272	<MDL	0.0959	0.128
b	Marina Channel	Goatfish	S150413-27	2.20	0.0341	<MDL	0.906	<MDL	0.472	0.106
b	Marina Channel	Soldierfish	S150413-51	5.14	0.607	<MDL	1.54	<MDL	0.395	0.118
b	Marina Channel	Soldierfish	S150413-68	3.03	0.0169	<MDL	0.969	<MDL	0.363	0.230
b	Marina Channel	Trevally	S150413-69	2.64	0.0408	<MDL	0.440	<MDL	0.137	0.199
c	North Shore Peale	Goatfish	S150413-58	3.93	0.158	<MDL	0.604	<MDL	0.148	0.0653
d	North Shore Wake	Trevally	S150413-59	3.43	0.0371	<MDL	0.330	<MDL	0.0346	0.245
d	North Shore Wake	Trevally	S150413-60	2.65	0.0369	<MDL	0.528	<MDL	0.0380	1.13
†	Control (Hilo, HI)	Snapper	S150514-01	3.68	0.259	<MDL	1.58	<MDL	0.216	0.155
†	Control (Hilo, HI)	Soldierfish	S150514-02	3.95	0.817	<MDL	1.77	<MDL	0.537	0.203

Table 7. Sample wet and dry weights used to calculate the wet/dry factor for converting dry weight values into wet weights reported in Tables 8 and 9. †- control fish.

#	Site	Com. Name	Sample #	Sample Wet Wt. (g)	Sample Dry Wt. (g)	Wet/Dry Factor (Fw)
1	Peale Lagoon Side	Bonefish	S150413-47	37.3349	11.3570	3.2874
1	Peale Lagoon Side	Bonefish	S150413-50	37.0018	9.3743	3.9472
1	Peale Lagoon Side	Flounder	S150413-49	32.2467	10.6964	3.0147
1	Peale Lagoon Side	Goatfish	S150413-41	36.3883	10.8893	3.3417
1	Peale Lagoon Side	Goatfish	S150413-42	33.2557	9.4051	3.5359
1	Peale Lagoon Side	Goatfish	S150413-43	39.1629	11.0710	3.5374
1	Peale Lagoon Side	Goatfish	S150413-44	33.2377	10.2070	3.2564
1	Peale Lagoon Side	Trevally	S150413-48	35.4725	10.4469	3.3955
1	Peale Lagoon Side	Snapper	S150413-45	30.2587	7.8814	3.8393
1	Peale Lagoon Side	Snapper	S150413-46	34.7359	10.8299	3.2074
2	Ioke Beach	Flounder	S150413-56	32.1802	10.3989	3.0946
2	Ioke Beach	Flounder	S150413-57	34.6204	10.5054	3.2955
2	Ioke Beach	Soldierfish	S150413-61	21.5442	7.8504	2.7443
2	Ioke Beach	Soldierfish	S150413-62	34.8770	12.5811	2.7722
2	Ioke Beach	Soldierfish	S150413-63	21.2416	6.9797	3.0433
2	Ioke Beach	Soldierfish	S150413-64	21.1583	7.2551	2.9163
2	Ioke Beach	Soldierfish	S150413-65	29.2059	10.6559	2.7408
2	Ioke Beach	Soldierfish	S150413-66	23.8427	8.9795	2.6552
2	Ioke Beach	Soldierfish	S150413-67	21.0594	8.2520	2.5520
2	Ioke Beach	Snapper	S150413-39	34.3034	10.9065	3.1452
2	Ioke Beach	Snapper	S150413-40	39.2335	12.4976	3.1393
3	Waterplant Outfall	Flounder	S150413-52	33.3462	11.4333	2.9166
3	Waterplant Outfall	Flounder	S150413-55	28.1902	7.6318	3.6938
3	Waterplant Outfall	Milkfish	S150413-19	35.3378	13.3061	2.6558
3	Waterplant Outfall	Milkfish	S150413-20	36.7282	13.4436	2.7320
3	Waterplant Outfall	Milkfish	S150413-21	34.7119	11.9568	2.9031
3	Waterplant Outfall	Milkfish	S150413-22	28.4891	12.7432	2.2356
3	Waterplant Outfall	Milkfish	S150413-23	36.7472	11.8705	3.0957
4	Battery Dump Pond	Bonefish	S150413-31	40.4914	10.9957	3.6825
4	Battery Dump Pond	Bonefish	S150413-32	43.7370	13.3022	3.2880
4	Battery Dump Pond	Bonefish	S150413-33	31.7473	10.5596	3.0065
4	Battery Dump Pond	Bonefish	S150413-34	31.8473	11.3776	2.7991
4	Battery Dump Pond	Milkfish	S150413-24	20.7053	8.5623	2.4182
4	Battery Dump Pond	Milkfish	S150413-25	28.4904	11.1787	2.5486
4	Battery Dump Pond	Milkfish	S150413-26	31.7747	9.6774	3.2834
4	Battery Dump Pond	Milkfish	S150413-28	36.5116	11.6800	3.1260
4	Battery Dump Pond	Milkfish	S150413-29	40.7549	12.7212	3.2037
4	Battery Dump Pond	Milkfish	S150413-30	34.3958	10.8510	3.1698
4	Battery Dump Pond	Snapper	S150413-35	37.3315	11.3333	3.2940
4	Battery Dump Pond	Snapper	S150413-36	34.7748	11.9502	2.9100
4	Battery Dump Pond	Snapper	S150413-37	32.2540	10.7299	3.0060
6	AF Beach House	Bonefish	S150413-05	34.2524	10.4353	3.2824
6	AF Beach House	Bonefish	S150413-15	35.3830	11.9842	2.9525
6	AF Beach House	Bonefish	S150413-16	30.5653	10.8316	2.8219
6	AF Beach House	Bonefish	S150413-17	33.0845	11.3152	2.9239
6	AF Beach House	Flounder	S150413-18	32.9317	9.6686	3.4060
6	AF Beach House	Goatfish	S150413-14	35.3565	11.9074	2.9693
6	AF Beach House	Snapper	S150413-01	35.1721	11.4855	3.0623
6	AF Beach House	Snapper	S150413-02	34.5409	12.0371	2.8695

6	AF Beach House	Snapper	S150413-03	28.0696	11.7693	2.3850
6	AF Beach House	Snapper	S150413-04	36.4599	12.6836	2.8746
7	Nitro Rock	Flounder	S150413-06	31.2909	8.0864	3.8696
7	Nitro Rock	Flounder	S150413-07	33.8906	9.9257	3.4144
7	Nitro Rock	Flounder	S150413-08	31.7019	8.8896	3.5662
7	Nitro Rock	Flounder	S150413-09	33.1489	7.9258	4.1824
7	Nitro Rock	Goatfish	S150413-12	35.6165	12.1177	2.9392
7	Nitro Rock	Goatfish	S150413-13	35.2040	10.7432	3.2769
7	Nitro Rock	Trevally	S150413-10	32.5485	11.6051	2.8047
7	Nitro Rock	Trevally	S150413-11	33.9476	9.8116	3.4599
7	Nitro Rock	Snapper	S150413-38	33.5093	10.9693	3.0548
a	Heal Point	Trevally	S150413-53	41.4880	11.7007	3.5458
a	Heal Point	Trevally	S150413-54	35.2721	10.3151	3.4195
b	Marina Channel	Goatfish	S150413-27	28.4666	11.4872	2.4781
b	Marina Channel	Soldierfish	S150413-51	18.3353	5.5151	3.3246
b	Marina Channel	Soldierfish	S150413-68	32.7351	12.2419	2.6740
b	Marina Channel	Trevally	S150413-69	29.8627	9.5658	3.1218
c	North Shore Peale	Goatfish	S150413-58	24.1990	7.8383	3.0873
d	North Shore Wake	Trevally	S150413-59	37.8090	11.0603	3.4184
d	North Shore Wake	Trevally	S150413-60	33.9128	11.8680	2.8575
†	Control (Hilo, HI)	Snapper	S150514-01	38.3703	10.3764	3.6978
†	Control (Hilo, HI)	Soldierfish	S150514-02	36.7354	11.4445	3.2099

Table 8. Wet weight analyses for beryllium (Be), vanadium(V), chromium (Cr), cobalt (Co), nickel (Ni), copper (Cu), zinc (Zn), arsenic (As). All values are mg/kg wet weight. †- control fish.

#	Site	Com. Name	Sample #	**Be**	**V**	**Cr**	**Co**	**Ni**	**Cu**	**Zn**	**As**
1	Peale Lagoon Side	Bonefish	S150413-47	<MDL	1.42	0.214	0.0226	0.382	0.672	28.4	19.1
1	Peale Lagoon Side	Bonefish	S150413-50	<MDL	0.138	0.173	0.0124	0.188	0.824	24.6	37.0
1	Peale Lagoon Side	Flounder	S150413-49	<MDL	0.0868	0.164	0.0288	0.504	0.233	30.6	7.55
1	Peale Lagoon Side	Goatfish	S150413-41	<MDL	0.449	0.219	0.0219	0.350	0.843	12.9	4.66
1	Peale Lagoon Side	Goatfish	S150413-42	<MDL	0.445	0.300	0.0233	0.340	2.38	31.2	9.96
1	Peale Lagoon Side	Goatfish	S150413-43	<MDL	0.598	0.136	0.0176	0.273	0.889	13.1	8.82
1	Peale Lagoon Side	Goatfish	S150413-44	<MDL	1.74	0.159	0.0293	0.495	1.01	18.9	5.15
1	Peale Lagoon Side	Trevally	S150413-48	<MDL	0.0622	0.178	0.0162	0.257	0.880	15.4	5.46
1	Peale Lagoon Side	Snapper	S150413-45	<MDL	2.60	0.234	0.0256	0.423	1.02	17.0	1.56
1	Peale Lagoon Side	Snapper	S150413-46	<MDL	10.3	0.201	0.0194	0.324	0.758	18.1	1.43
2	Ioke Beach	Flounder	S150413-56	<MDL	0.0657	0.249	0.0363	0.622	0.320	39.3	8.45
2	Ioke Beach	Flounder	S150413-57	<MDL	0.0889	0.215	0.0464	0.580	0.261	32.3	10.1
2	Ioke Beach	Soldierfish	S150413-61	<MDL	0.0537	0.195	0.0264	0.454	0.604	17.1	33.2
2	Ioke Beach	Soldierfish	S150413-62	<MDL	0.0479	0.207	0.0282	0.452	0.648	16.6	27.7
2	Ioke Beach	Soldierfish	S150413-63	<MDL	0.0564	0.213	0.0252	0.405	0.533	17.4	21.8
2	Ioke Beach	Soldierfish	S150413-64	<MDL	0.0347	0.158	0.0163	0.261	0.361	10.5	32.7
2	Ioke Beach	Soldierfish	S150413-65	<MDL	0.0949	0.178	0.0278	0.452	0.703	18.0	28.8
2	Ioke Beach	Soldierfish	S150413-66	<MDL	0.0432	0.158	0.0315	0.499	0.806	15.4	23.0
2	Ioke Beach	Soldierfish	S150413-67	<MDL	0.0639	0.180	0.0251	0.436	0.308	13.0	21.9
2	Ioke Beach	Snapper	S150413-39	<MDL	1.20	0.237	0.0268	0.445	0.961	12.7	1.29
2	Ioke Beach	Snapper	S150413-40	<MDL	0.713	0.253	0.0269	0.650	0.868	13.8	1.20
3	Waterplant Outfall	Flounder	S150413-52	<MDL	0.0964	0.198	0.0293	0.509	0.287	36.9	8.46
3	Waterplant Outfall	Flounder	S150413-55	<MDL	0.0254	0.136	0.0190	0.277	0.362	21.1	57.4
3	Waterplant Outfall	Milkfish	S150413-19	<MDL	0.184	0.539	0.0373	0.716	2.41	15.5	6.92
3	Waterplant Outfall	Milkfish	S150413-20	0.00754	0.232	0.476	0.0395	0.644	1.63	18.6	7.42
3	Waterplant Outfall	Milkfish	S150413-21	<MDL	0.129	0.566	0.0262	0.481	1.18	11.6	4.82
3	Waterplant Outfall	Milkfish	S150413-22	<MDL	0.159	0.979	0.0401	0.808	2.39	18.8	11.8
3	Waterplant Outfall	Milkfish	S150413-23	<MDL	0.113	0.425	0.0228	0.441	1.75	12.6	8.46

4	Battery Dump Pond	Bonefish	S150413-31	<MDL	0.233	0.704	0.0211	0.292	0.575	41.6	15.2
4	Battery Dump Pond	Bonefish	S150413-32	<MDL	0.263	0.491	0.0227	0.278	0.844	23.1	12.0
4	Battery Dump Pond	Bonefish	S150413-33	<MDL	0.214	0.343	0.0269	0.378	0.826	55.5	12.6
4	Battery Dump Pond	Bonefish	S150413-34	<MDL	0.170	0.216	0.0224	0.367	0.904	23.7	18.7
4	Battery Dump Pond	Milkfish	S150413-24	<MDL	0.708	1.91	0.0782	1.25	17.3	81.6	6.00
4	Battery Dump Pond	Milkfish	S150413-25	<MDL	0.520	1.28	0.0562	0.930	5.65	48.0	3.36
4	Battery Dump Pond	Milkfish	S150413-26	<MDL	0.261	1.13	0.0534	0.736	3.58	39.3	3.13
4	Battery Dump Pond	Milkfish	S150413-28	<MDL	0.433	1.12	0.0566	0.964	5.31	38.1	3.59
4	Battery Dump Pond	Milkfish	S150413-29	0.00682	0.628	1.23	0.0666	0.912	12.4	57.6	3.23
4	Battery Dump Pond	Milkfish	S150413-30	<MDL	0.292	0.677	0.0428	0.830	3.35	18.1	7.85
4	Battery Dump Pond	Snapper	S150413-35	<MDL	0.0595	0.209	0.0242	0.405	1.40	14.9	2.02
4	Battery Dump Pond	Snapper	S150413-36	<MDL	0.0575	0.233	0.0256	0.398	1.11	17.0	2.37
4	Battery Dump Pond	Snapper	S150413-37	<MDL	0.0573	0.219	0.0305	0.476	0.974	12.7	2.20
6	AF Beach House	Bonefish	S150413-05	<MDL	0.269	0.763	0.0245	0.397	1.73	29.0	11.0
6	AF Beach House	Bonefish	S150413-15	<MDL	0.810	0.320	0.0229	0.375	1.47	34.8	17.1
6	AF Beach House	Bonefish	S150413-16	<MDL	0.413	0.274	0.0439	0.630	0.946	55.2	23.4
6	AF Beach House	Bonefish	S150413-17	<MDL	0.749	0.283	0.0200	0.297	2.27	34.6	25.4
6	AF Beach House	Flounder	S150413-18	<MDL	0.0928	0.148	0.0290	0.487	0.606	35.6	14.8
6	AF Beach House	Goatfish	S150413-14	<MDL	0.0953	0.243	0.0249	0.354	1.24	56.5	14.3
6	AF Beach House	Snapper	S150413-01	<MDL	0.110	0.219	0.0227	0.359	1.33	15.8	4.60
6	AF Beach House	Snapper	S150413-02	<MDL	0.0959	0.327	0.0239	0.398	1.16	17.6	4.51
6	AF Beach House	Snapper	S150413-03	<MDL	0.627	0.505	0.0664	0.681	1.76	37.6	2.46
6	AF Beach House	Snapper	S150413-04	<MDL	0.0856	0.272	0.0181	0.278	0.755	16.1	2.28
7	Nitro Rock	Flounder	S150413-06	<MDL	0.0685	0.215	0.0274	0.454	0.417	34.6	7.57
7	Nitro Rock	Flounder	S150413-07	<MDL	0.0978	0.294	0.0321	0.455	0.348	26.5	7.27
7	Nitro Rock	Flounder	S150413-08	<MDL	0.0766	0.331	0.0224	0.301	0.476	27.7	6.88
7	Nitro Rock	Flounder	S150413-09	<MDL	0.0696	0.246	0.0118	0.140	0.307	19.8	7.68
7	Nitro Rock	Goatfish	S150413-12	<MDL	0.199	0.626	0.0292	0.466	1.43	36.3	19.8
7	Nitro Rock	Goatfish	S150413-13	<MDL	0.234	0.294	0.0228	0.399	0.971	43.0	15.2
7	Nitro Rock	Trevally	S150413-10	<MDL	0.0614	0.178	0.0182	0.253	0.503	25.1	1.18
7	Nitro Rock	Trevally	S150413-11	<MDL	0.0657	0.222	0.0103	0.129	0.613	14.0	2.01
7	Nitro Rock	Snapper	S150413-38	<MDL	0.474	0.261	0.0273	0.440	1.40	13.8	1.66
a	Heal Point	Trevally	S150413-53	<MDL	0.0504	0.224	0.0133	0.203	0.451	26.7	0.808
a	Heal Point	Trevally	S150413-54	<MDL	0.0417	0.171	0.0153	0.225	0.558	15.1	1.45
b	Marina Channel	Goatfish	S150413-27	<MDL	0.0872	0.210	0.0301	0.340	1.73	26.7	21.1
b	Marina Channel	Soldierfish	S150413-51	<MDL	0.0638	0.247	0.0267	0.443	0.739	17.2	14.5
b	Marina Channel	Soldierfish	S150413-68	<MDL	0.123	0.229	0.0357	0.570	1.20	15.0	2.82
b	Marina Channel	Trevally	S150413-69	<MDL	0.0172	0.0961	0.0193	0.301	0.946	22.5	3.01
c	North Shore Peale	Goatfish	S150413-58	<MDL	0.0635	0.254	0.0181	0.346	0.584	18.6	17.5
d	North Shore Wake	Trevally	S150413-59	<MDL	0.0429	0.152	0.0145	0.220	0.551	16.8	1.11
d	North Shore Wake	Trevally	S150413-60	<MDL	0.0540	0.252	0.0183	0.292	0.782	26.1	1.29
†	Control (Hilo, HI)	Snapper	S150514-01	<MDL	0.0973	0.0708	0.0229	0.319	0.990	14.5	8.32
†	Control (Hilo, HI)	Soldierfish	S150514-02	<MDL	0.0345	0.0617	0.0306	0.524	0.854	12.9	18.3

Table 9. Wet weight analyses for selenium (Se), cadmium (Cd), antimony (Sb), barium (Ba), thallium (Tl), lead (Pb), and total mercury (THg). All values are mg/kg wet weight. †- control fish.

#	Site	Com. Name	Sample #	**Se**	**Cd**	**Sb**	**Ba**	**Tl**	**Pb**	**THg**
1	Peale Lagoon Side	Bonefish	S150413-47	1.53	0.0392	<MDL	0.382	<MDL	0.0282	0.0947
1	Peale Lagoon Side	Bonefish	S150413-50	1.52	0.0410	<MDL	0.211	<MDL	0.0149	0.0365
1	Peale Lagoon Side	Flounder	S150413-49	1.02	0.0103	<MDL	0.201	<MDL	0.0128	0.0370
1	Peale Lagoon Side	Goatfish	S150413-41	0.523	0.0116	<MDL	0.213	<MDL	0.273	0.106
1	Peale Lagoon Side	Goatfish	S150413-42	0.779	0.0259	<MDL	0.270	<MDL	0.135	0.104
1	Peale Lagoon Side	Goatfish	S150413-43	0.901	0.0248	<MDL	0.156	<MDL	0.0254	0.0445
1	Peale Lagoon Side	Goatfish	S150413-44	0.930	0.0171	<MDL	0.379	<MDL	0.0525	0.143
1	Peale Lagoon Side	Trevally	S150413-48	1.04	0.0229	<MDL	0.169	<MDL	0.0874	0.0517

1	Peale Lagoon Side	Snapper	S150413-45	0.948	0.0232	<MDL	0.499	<MDL	0.0429	0.0407
1	Peale Lagoon Side	Snapper	S150413-46	0.859	0.0131	<MDL	0.637	<MDL	0.0514	0.0591
2	Ioke Beach	Flounder	S150413-56	0.987	0.0307	<MDL	0.339	<MDL	0.0294	0.0800
2	Ioke Beach	Flounder	S150413-57	0.924	0.0217	<MDL	0.314	<MDL	0.0196	0.0507
2	Ioke Beach	Soldierfish	S150413-61	1.78	0.1100	<MDL	0.343	<MDL	0.0166	0.0220
2	Ioke Beach	Soldierfish	S150413-62	1.47	0.0904	<MDL	0.309	<MDL	0.0146	0.0222
2	Ioke Beach	Soldierfish	S150413-63	1.98	0.1740	<MDL	0.414	<MDL	0.0391	0.0204
2	Ioke Beach	Soldierfish	S150413-64	1.66	0.0330	<MDL	0.195	<MDL	0.0116	0.0276
2	Ioke Beach	Soldierfish	S150413-65	1.50	0.0906	<MDL	0.388	<MDL	0.0160	0.0233
2	Ioke Beach	Soldierfish	S150413-66	2.20	0.0929	<MDL	0.382	<MDL	0.0233	0.0194
2	Ioke Beach	Soldierfish	S150413-67	1.87	0.1590	<MDL	0.368	<MDL	0.0125	0.0207
2	Ioke Beach	Snapper	S150413-39	0.644	0.0145	<MDL	0.262	<MDL	0.117	0.0796
2	Ioke Beach	Snapper	S150413-40	0.723	0.0121	<MDL	0.279	<MDL	0.0606	0.0678
3	Waterplant Outfall	Flounder	S150413-52	0.778	0.0214	<MDL	0.225	<MDL	0.0409	0.0480
3	Waterplant Outfall	Flounder	S150413-55	0.668	0.0098	<MDL	0.0987	<MDL	0.0373	0.0160
3	Waterplant Outfall	Milkfish	S150413-19	0.938	0.0272	0.0221	0.978	<MDL	0.266	0.0197
3	Waterplant Outfall	Milkfish	S150413-20	1.05	0.0781	0.0322	0.947	0.0118	0.283	0.0255
3	Waterplant Outfall	Milkfish	S150413-21	0.616	0.0562	<MDL	0.709	<MDL	0.163	0.0300
3	Waterplant Outfall	Milkfish	S150413-22	0.976	0.0241	<MDL	0.952	<MDL	0.227	0.0210
3	Waterplant Outfall	Milkfish	S150413-23	1.10	0.0129	<MDL	0.613	<MDL	0.191	0.0177
4	Battery Dump Pond	Bonefish	S150413-31	1.09	0.0332	<MDL	0.571	<MDL	0.0942	0.0522
4	Battery Dump Pond	Bonefish	S150413-32	0.937	0.0234	<MDL	0.464	<MDL	0.0608	0.0172
4	Battery Dump Pond	Bonefish	S150413-33	1.10	0.0483	<MDL	0.583	<MDL	0.157	0.0425
4	Battery Dump Pond	Bonefish	S150413-34	0.868	0.0165	<MDL	0.558	<MDL	0.0873	0.0177
4	Battery Dump Pond	Milkfish	S150413-24	0.958	0.1090	0.855	1.73	<MDL	22.2	0.0456
4	Battery Dump Pond	Milkfish	S150413-25	0.863	0.0782	0.0190	1.10	<MDL	6.92	0.0176
4	Battery Dump Pond	Milkfish	S150413-26	0.785	0.0557	0.0137	0.930	<MDL	3.46	0.0127
4	Battery Dump Pond	Milkfish	S150413-28	0.799	0.0568	0.0222	1.07	<MDL	6.07	0.0128
4	Battery Dump Pond	Milkfish	S150413-29	0.706	0.0686	0.568	1.42	0.00559	18.0	0.0277
4	Battery Dump Pond	Milkfish	S150413-30	0.804	0.0190	<MDL	1.08	<MDL	0.979	0.0095
4	Battery Dump Pond	Snapper	S150413-35	0.677	0.0121	<MDL	0.283	<MDL	0.150	0.0949
4	Battery Dump Pond	Snapper	S150413-36	0.665	0.0113	<MDL	0.358	<MDL	0.161	0.0698
4	Battery Dump Pond	Snapper	S150413-37	0.643	0.0051	<MDL	0.293	<MDL	0.0518	0.0713
6	AF Beach House	Bonefish	S150413-05	1.37	0.0096	<MDL	0.452	<MDL	0.0619	0.0373
6	AF Beach House	Bonefish	S150413-15	1.80	0.0170	<MDL	0.643	<MDL	0.0317	0.0641
6	AF Beach House	Bonefish	S150413-16	1.57	0.1641	<MDL	1.79	<MDL	0.119	0.0907
6	AF Beach House	Bonefish	S150413-17	1.47	0.0108	<MDL	0.587	<MDL	0.0461	0.0575
6	AF Beach House	Flounder	S150413-18	0.873	0.0295	<MDL	0.426	<MDL	0.0421	0.0715
6	AF Beach House	Goatfish	S150413-14	0.859	0.0122	<MDL	0.488	<MDL	0.308	0.0398
6	AF Beach House	Snapper	S150413-01	1.02	0.0173	0.022	0.297	<MDL	0.311	0.0644
6	AF Beach House	Snapper	S150413-02	0.956	0.0158	<MDL	0.379	<MDL	0.0418	0.0462
6	AF Beach House	Snapper	S150413-03	1.08	0.0149	<MDL	10.0	<MDL	0.180	0.0854
6	AF Beach House	Snapper	S150413-04	0.723	0.0115	<MDL	0.289	<MDL	0.0426	0.0913
7	Nitro Rock	Flounder	S150413-06	0.625	0.0172	<MDL	0.284	<MDL	0.0700	0.0659
7	Nitro Rock	Flounder	S150413-07	0.897	0.0146	<MDL	0.343	<MDL	0.0210	0.0267
7	Nitro Rock	Flounder	S150413-08	0.860	0.0162	<MDL	0.219	<MDL	0.0205	0.0326
7	Nitro Rock	Flounder	S150413-09	0.737	0.0289	<MDL	0.113	<MDL	0.0161	0.0372
7	Nitro Rock	Goatfish	S150413-12	1.21	0.0051	<MDL	0.745	<MDL	0.272	0.0243
7	Nitro Rock	Goatfish	S150413-13	1.29	0.0172	<MDL	0.754	<MDL	0.0711	0.0175
7	Nitro Rock	Trevally	S150413-10	0.884	0.0066	<MDL	0.233	<MDL	0.0179	0.101
7	Nitro Rock	Trevally	S150413-11	0.816	0.0139	<MDL	0.103	<MDL	0.0329	0.104
7	Nitro Rock	Snapper	S150413-38	0.817	0.0134	<MDL	0.368	<MDL	0.0413	0.0862
a	Heal Point	Trevally	S150413-53	1.00	0.0709	<MDL	0.197	<MDL	0.0121	0.281
a	Heal Point	Trevally	S150413-54	0.887	0.0098	<MDL	0.0795	<MDL	0.0280	0.0376
b	Marina Channel	Goatfish	S150413-27	0.887	0.0138	<MDL	0.366	<MDL	0.191	0.0426
b	Marina Channel	Soldierfish	S150413-51	1.55	0.1830	<MDL	0.463	<MDL	0.119	0.0355
b	Marina Channel	Soldierfish	S150413-68	1.13	0.0063	<MDL	0.362	<MDL	0.136	0.0860

b	Marina Channel	Trevally	S150413-69	0.845	0.0131	<MDL	0.141	<MDL	0.0438	0.0638
c	North Shore Peale	Goatfish	S150413-58	1.27	0.0511	<MDL	0.196	<MDL	0.0480	0.0212
d	North Shore Wake	Trevally	S150413-59	1.00	0.0109	<MDL	0.0967	<MDL	0.0101	0.0716
d	North Shore Wake	Trevally	S150413-60	0.926	0.0129	<MDL	0.185	<MDL	0.0133	0.394
†	Control (Hilo, HI)	Snapper	S150514-01	0.996	0.0699	<MDL	0.428	<MDL	0.0584	0.0418
†	Control (Hilo, HI)	Soldierfish	S150514-02	1.23	0.254	<MDL	0.550	<MDL	0.167	0.0633

Table 10. Summary statistics for metal and mercury residues in fish tissue samples. All units mg/kg. %<MDL = Percentage of sample below the minimum detection limit; all other values based on samples with detectable respective elements.

Code	Element	%<MDL	Mean	Min	25%	Median	75%	Max
Be	Beryllium	97.1%	0.007	0.007	NA	NA	NA	0.008
V	Vanadium	0%	0.430	0.017	0.063	0.098	0.413	10.309
Cr	Chromium	0%	0.356	0.096	0.195	0.234	0.331	1.909
Co	Cobalt	0%	0.028	0.010	0.021	0.026	0.031	0.078
Ni	Nickel	0%	0.450	0.129	0.301	0.405	0.504	1.250
Cu	Copper	0%	1.540	0.233	0.584	0.880	1.402	17.336
Zn	Zinc	0%	25.474	10.490	15.422	18.933	34.609	81.644
As	Arsenic	0%	11.094	0.808	3.014	7.681	17.074	57.424
Se	Selenium	0%	1.047	0.523	0.816	0.938	1.208	2.198
Cd	Cadmium	0%	0.0381	0.005	0.013	0.019	0.050	0.183
Sb	Antimony	88.7%	0.194	0.014	0.020	0.022	0.434	0.855
Ba	Barium	0%	0.610	0.080	0.233	0.368	0.587	10.050
Tl	Thallium	97.1%	0.009	0.006	NA	NA	NA	0.012
Pb	Lead	0%	0.892	0.010	0.028	0.053	0.163	22.194
THg	Mercury	0%	0.058	0.009	0.023	0.043	0.072	0.394

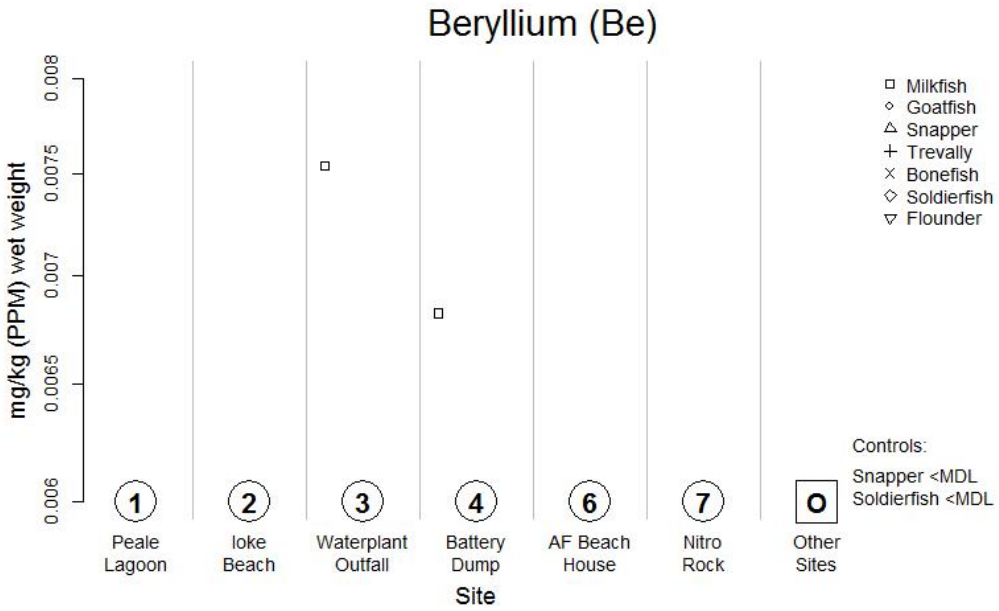


Figure 11. Beryllium concentrations by site and by fish species. 67 sample were below the minimum detection limit. Note that the y-axis is on a logarithmic scale. No samples exceeded the reference dose at a 225 gram fish serving.

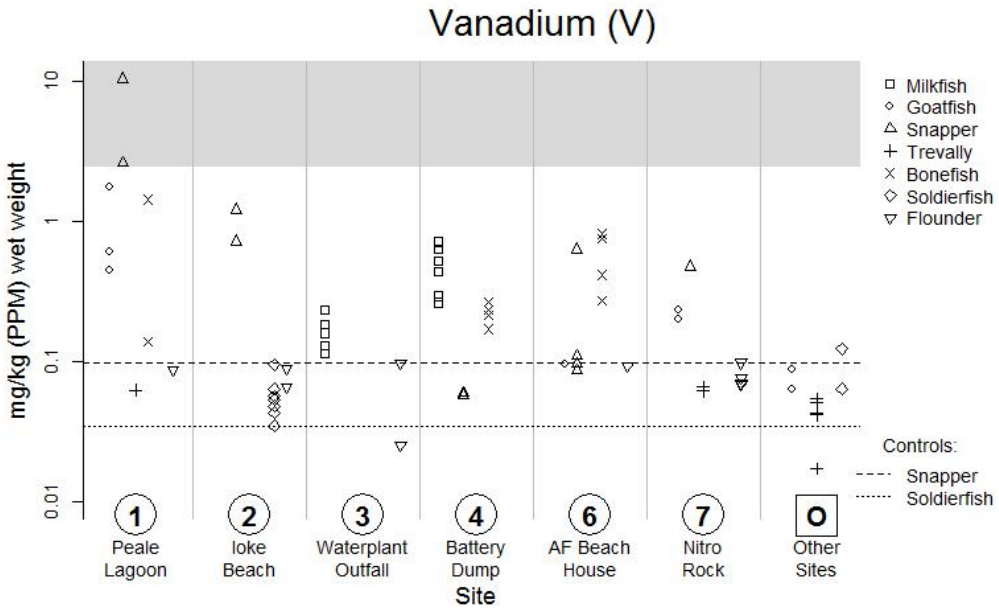


Figure 12. Vanadium concentrations by site and by fish species for 69 samples. Note that the y-axis is on a logarithmic scale. The shaded zone represents samples that would exceed the reference dose at a 225 gram fish serving.

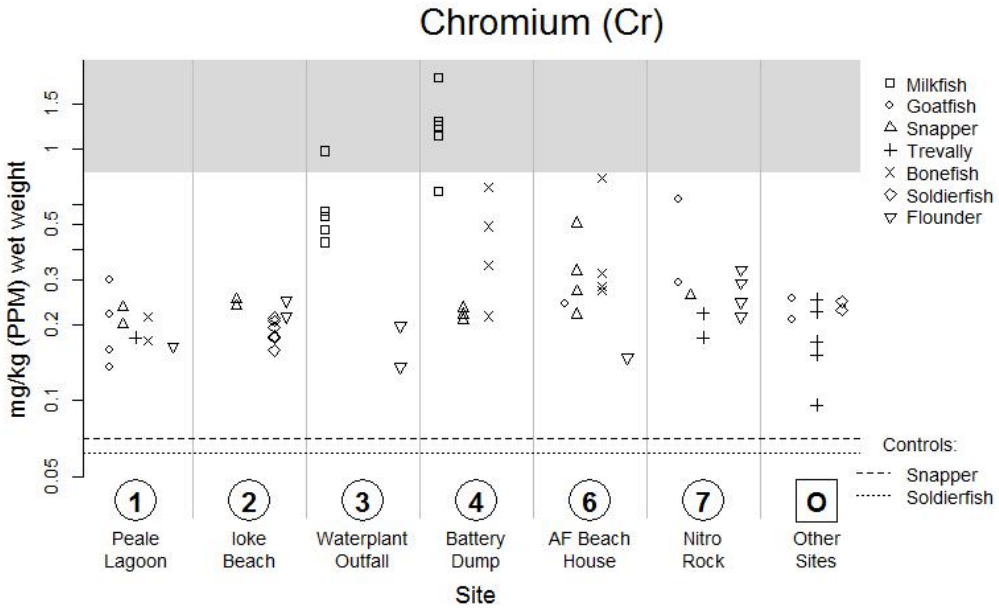


Figure 13. Chromium concentrations by site and by fish species for 69 samples. Note that the y-axis is on a logarithmic scale. The shaded zone represents samples that would exceed the reference dose at a 225 gram fish serving for chromium VI; no samples exceeded the reference dose for chromium III.

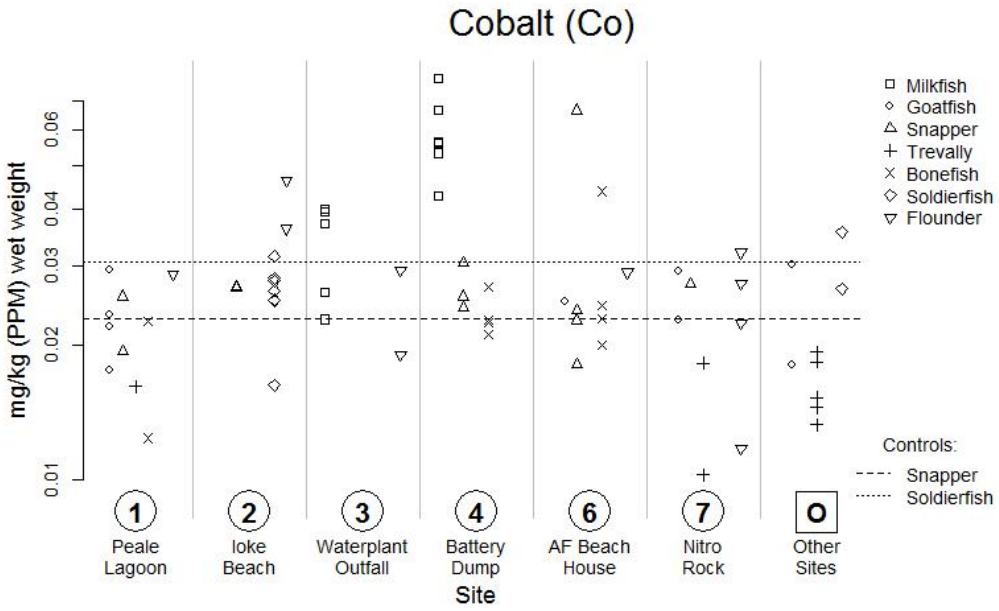


Figure 14. Cobalt concentrations by site and by fish species for 69 samples. Note that the y-axis is on a logarithmic scale. No samples exceeded the reference dose at a 225 gram fish serving.

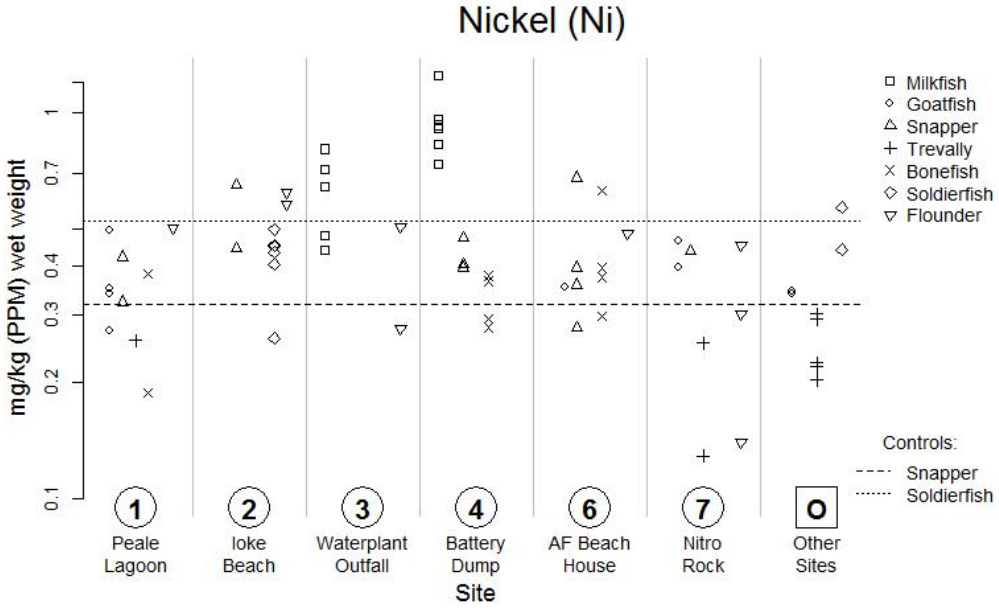


Figure 15. Nickel concentrations by site and by fish species for 69 samples. Note that the y-axis is on a logarithmic scale. No samples exceeded the reference dose at a 225 gram fish serving.

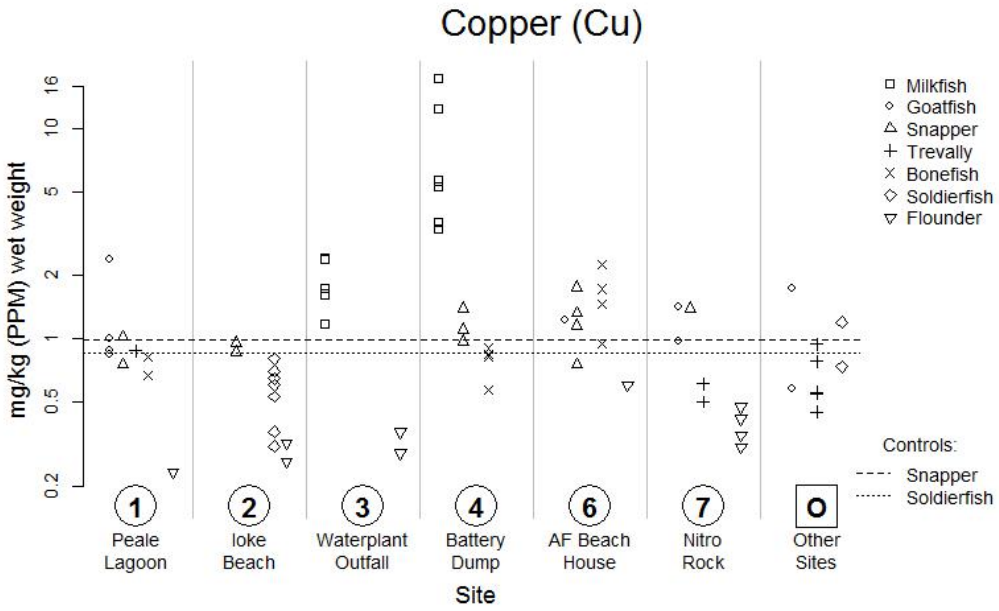


Figure 16. Copper concentrations by site and by fish species for 69 samples. Note that the y-axis is on a logarithmic scale. No samples exceeded the reference dose at a 225 gram fish serving.

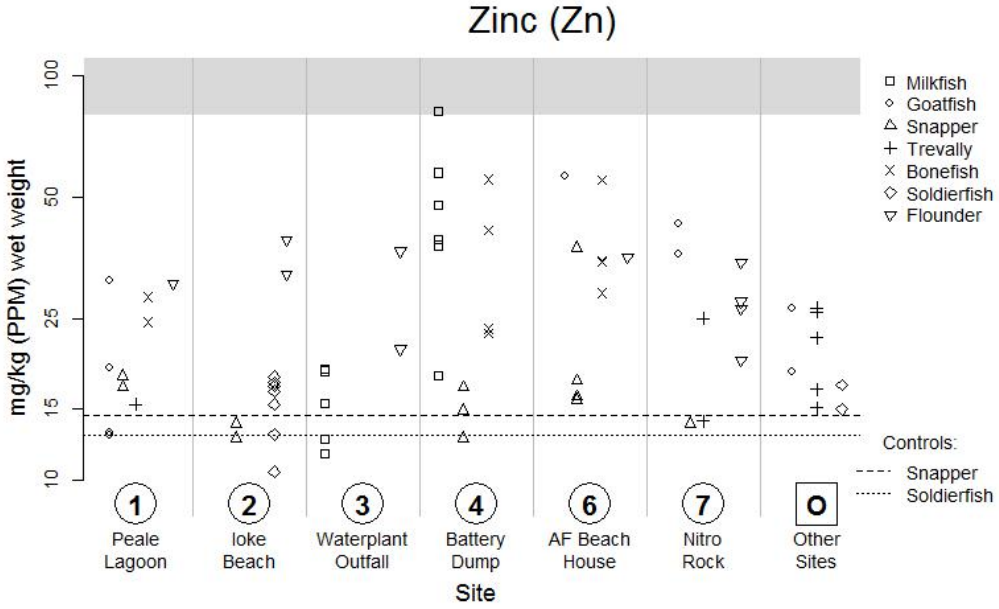


Figure 17. Zinc concentrations by site and by fish species for 69 samples. Note that the y-axis is on a logarithmic scale. The shaded zone represents samples that would exceed the reference dose at a 225 gram fish serving.

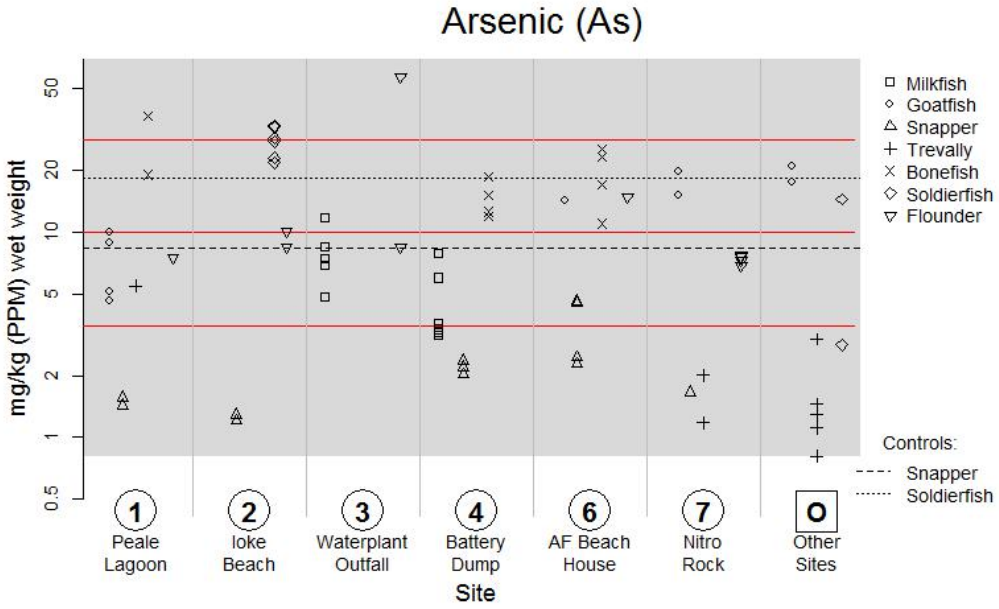


Figure 18. Arsenic concentrations by site and by fish species for 69 samples. Note that the y-axis is on a logarithmic scale. Horizontal lines indicate the minimum (3.47), mean (9.97) and maximum (28.1) arsenic concentrations (mg/kg) observed in a sample of 15 goatfish associated with a 2002 risk assessment (URS Group 2002). The shaded zone represents samples that would exceed the reference dose at a 225 gram fish serving.

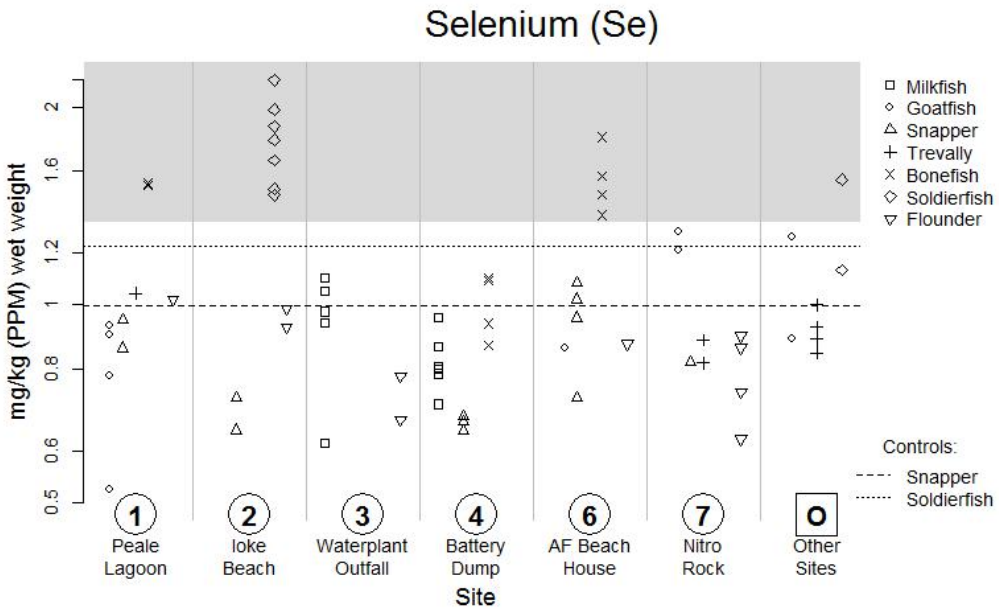


Figure 19. Selenium concentrations by site and by fish species for 69 samples. Note that the y-axis is on a logarithmic scale. The shaded zone represents samples that would exceed the reference dose at a 225 gram fish serving.

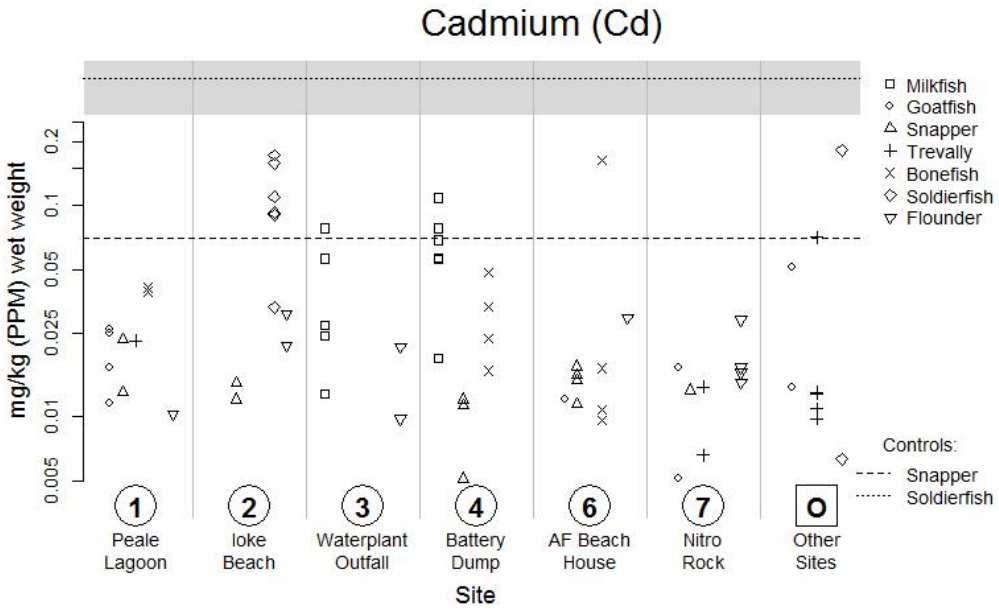


Figure 20. Cadmium concentrations by site and by fish species for 69 samples. Note that the y-axis is on a logarithmic scale. The shaded zone represents samples the concentration that would exceed the reference dose at a 225 gram fish serving; no fish in this sample exceeded this threshold.

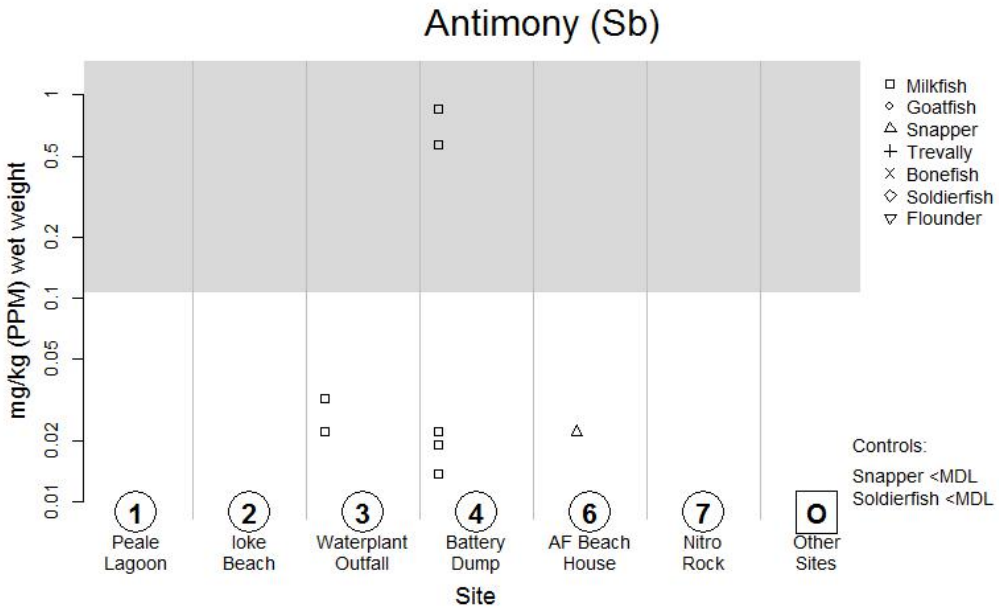


Figure 21. Antimony concentrations by site and by fish species. 61 samples were below the minimum detection limit. Note that the y-axis is on a logarithmic scale. The shaded zone represents samples that would exceed the reference dose at a 225 gram fish serving.

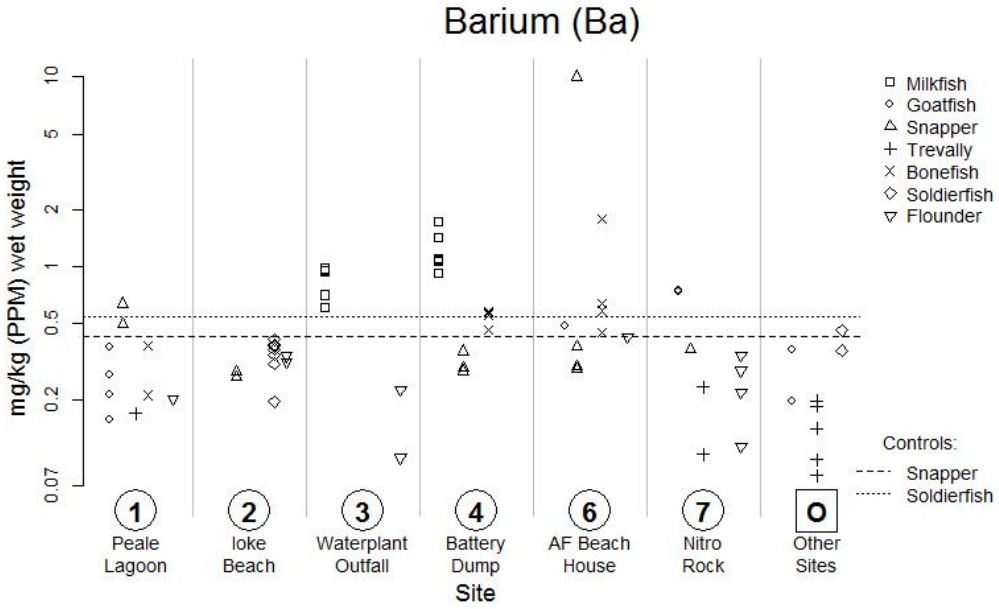


Figure 22. Barium concentrations by site and by fish species for 69 samples. Note that the y-axis is on a logarithmic scale. No samples exceeded the reference dose at a 225 gram fish serving.

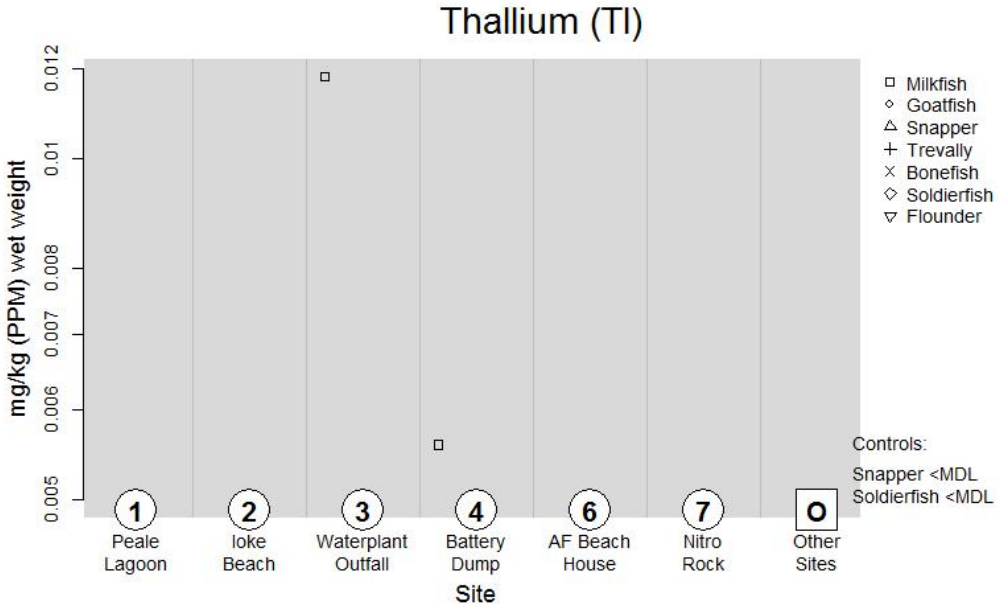


Figure 23. Thallium concentrations by site and by fish species. 67 samples were below the minimum detection limit. Note that the y-axis is on a logarithmic scale. The shaded zone represents samples that would exceed the reference dose at a 225 gram fish serving.

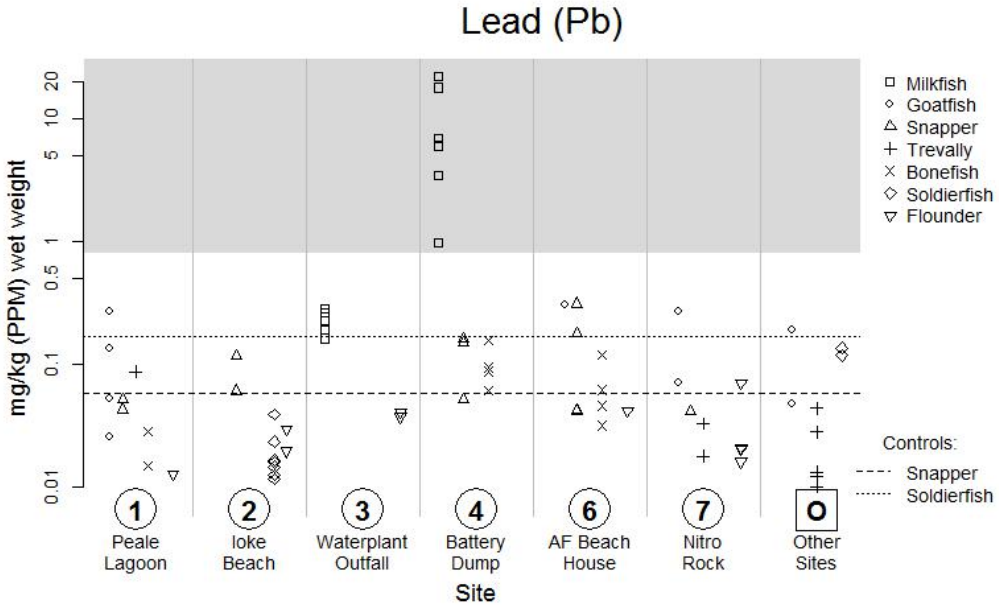


Figure 24. Lead concentrations by site and by fish species for 69 samples. Note that the y-axis is on a logarithmic scale. The shaded zone represents samples that would exceed the average daily dietary intake of lead in a 225 gram fish serving. The EPA does not establish a "safe" level of lead intake.

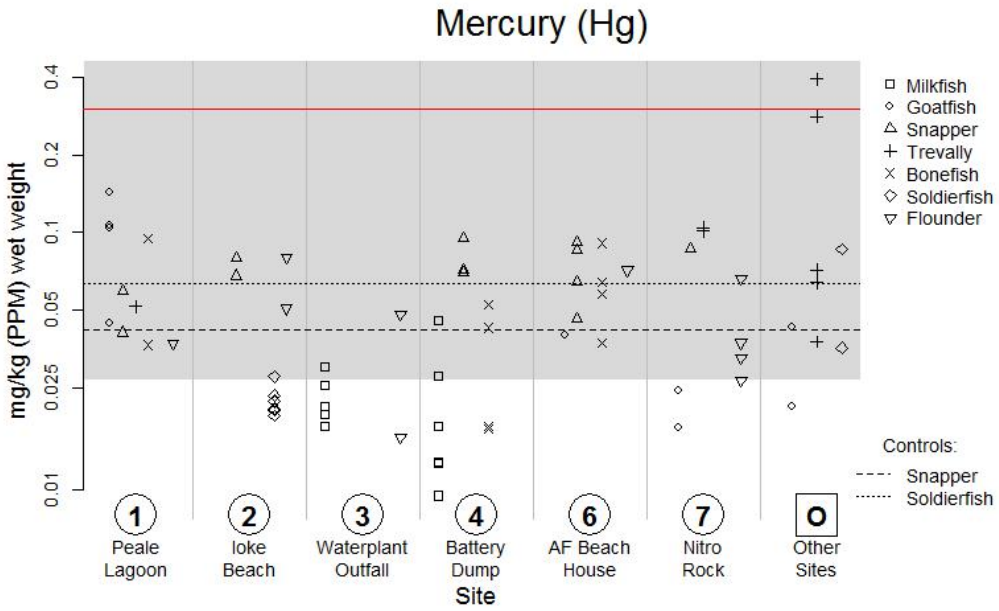


Figure 25. Total mercury concentrations by site and by fish species for 69 samples. The horizontal red line at 0.3 mg/kg indicates the EPA Human Health Threshold for mercury in food items. Note that the y-axis is on a logarithmic scale. The shaded zone represents samples that would exceed the reference dose at a 225 gram fish serving.

Linear regressions of metal concentrations as predicted by fish weight were non-significant, except for a few cases where single influential outliers gave the appearance of a relationship.

Because concentrations were independent of fish size, site comparisons were not based on contaminant concentrations standardized by fish size.

Figures 26 through 30 reflect arsenic, lead, and mercury values observed in the current sample, in comparison to values from other commonly-consumed marine fished from the published literature.

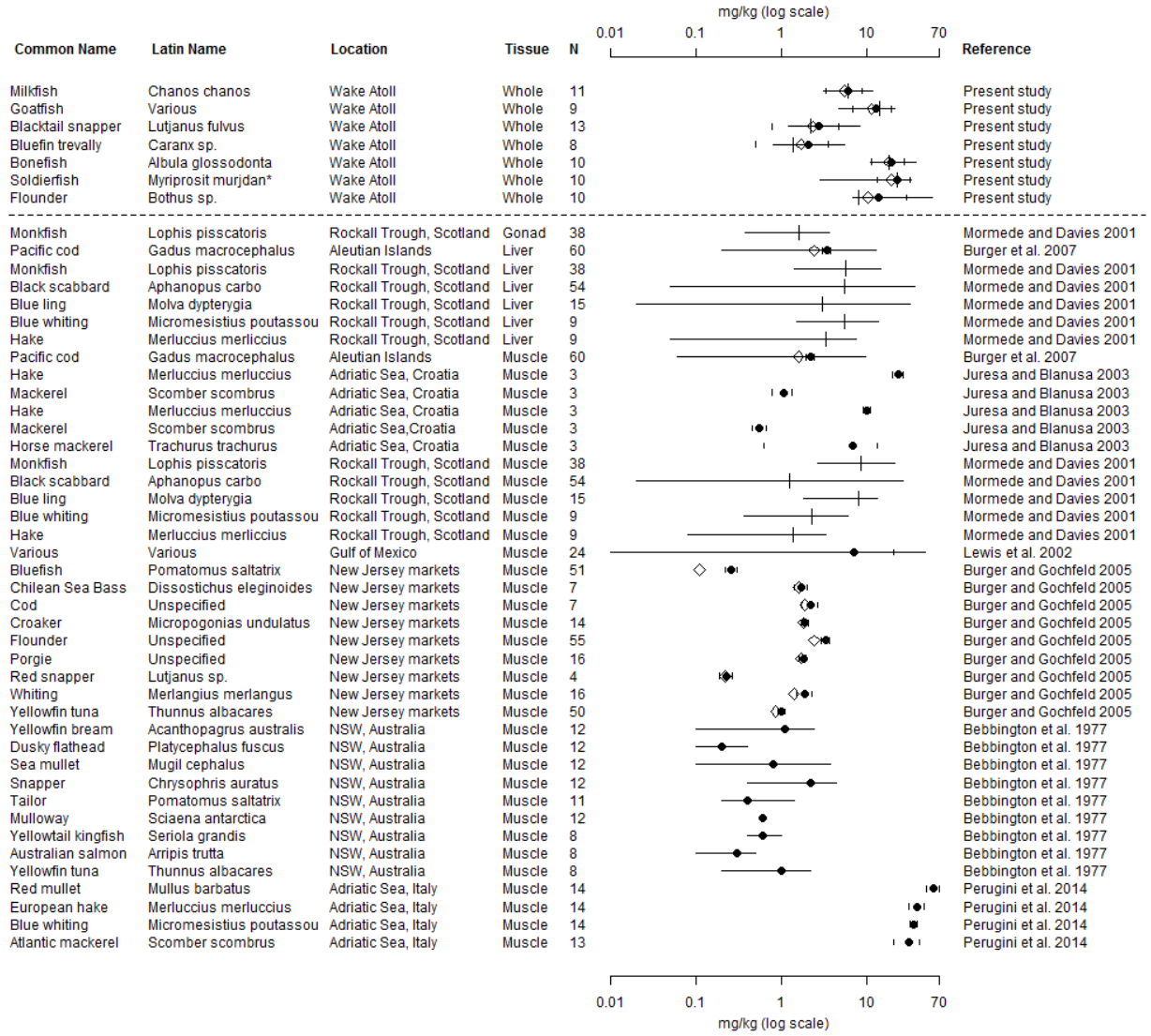


Figure 26. Arsenic (wet weight) values from the present study (above the dashed line) in comparison to values from other published literature (mg/kg). Where reported: horizontal line = range (min – max); solid circle = arithmetic mean (average); open diamond = geometric mean; long vertical tick = median; short vertical tick = one standard deviation.

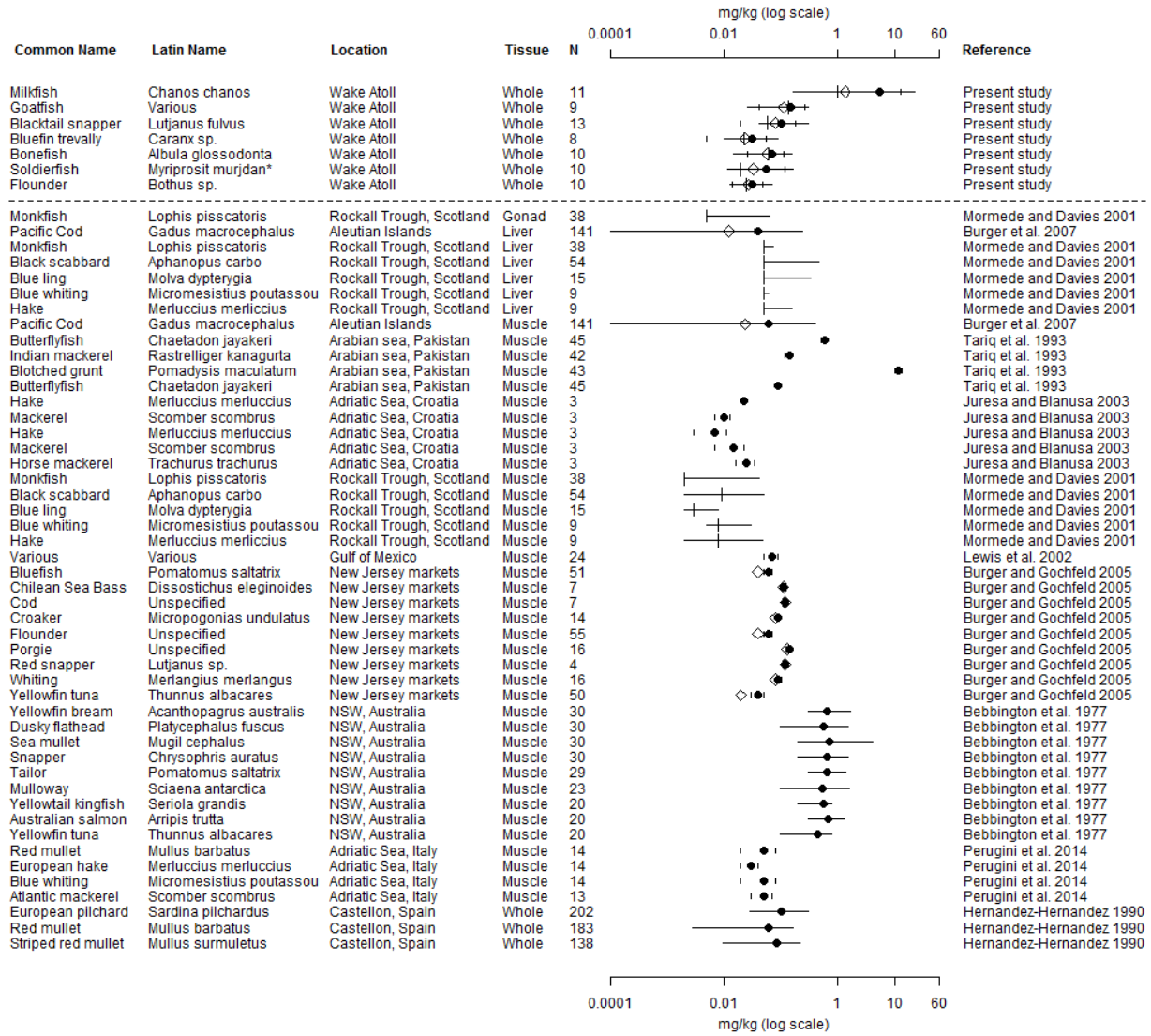


Figure 27. Lead (wet weight) values from the present study (above the dashed line) in comparison to values from other published literature (mg/kg). Where reported: horizontal line = range (min – max); solid circle = arithmetic mean (average); open diamond = geometric mean; long vertical tick = median; short vertical tick = one standard deviation.

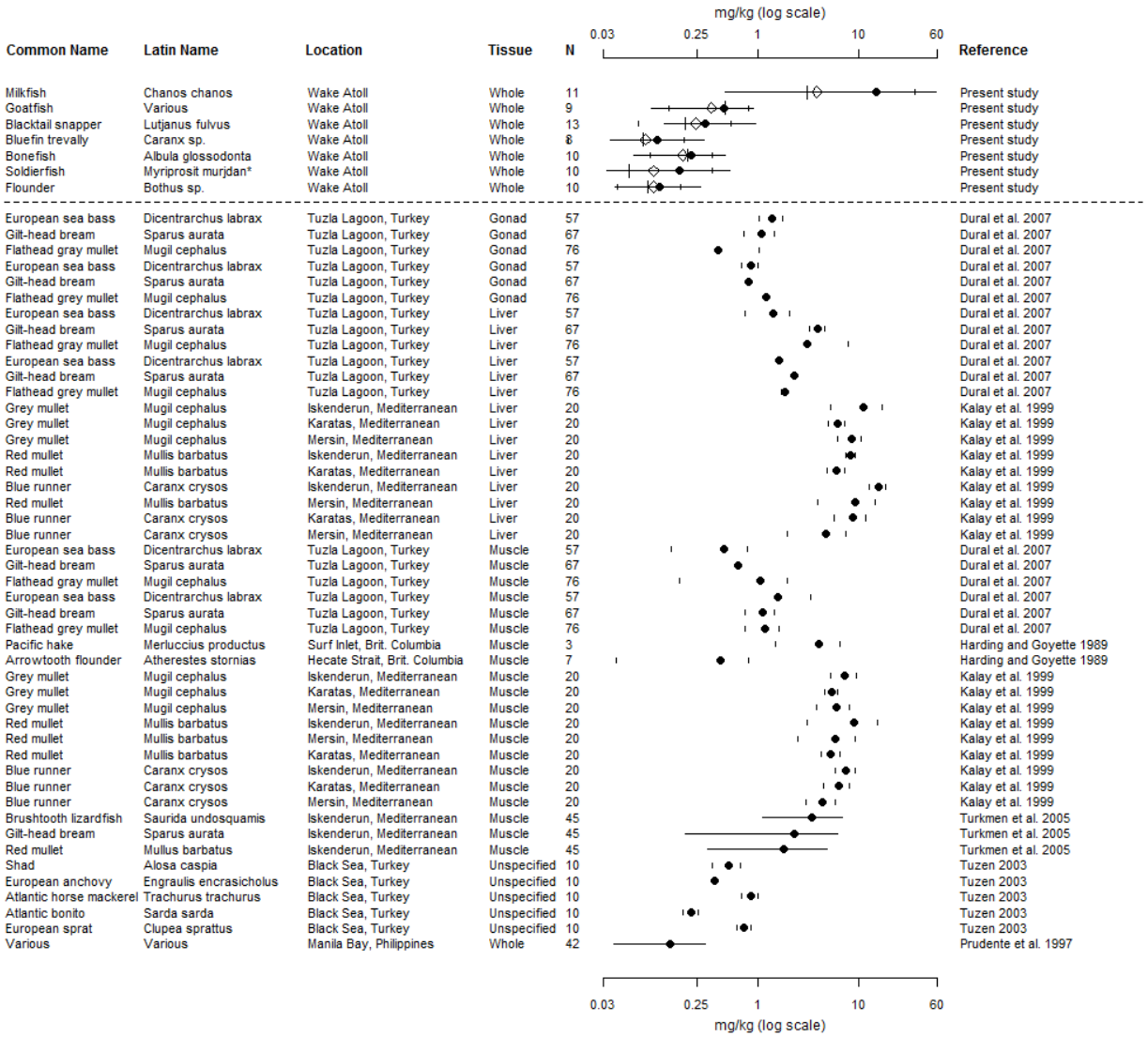


Figure 28. Lead (dry weight) values from the present study (above the dashed line) in comparison to values from other published literature (mg/kg). Where reported: horizontal line = range (min – max); solid circle = arithmetic mean (average); open diamond = geometric mean; long vertical tick = median; short vertical tick = one standard deviation.

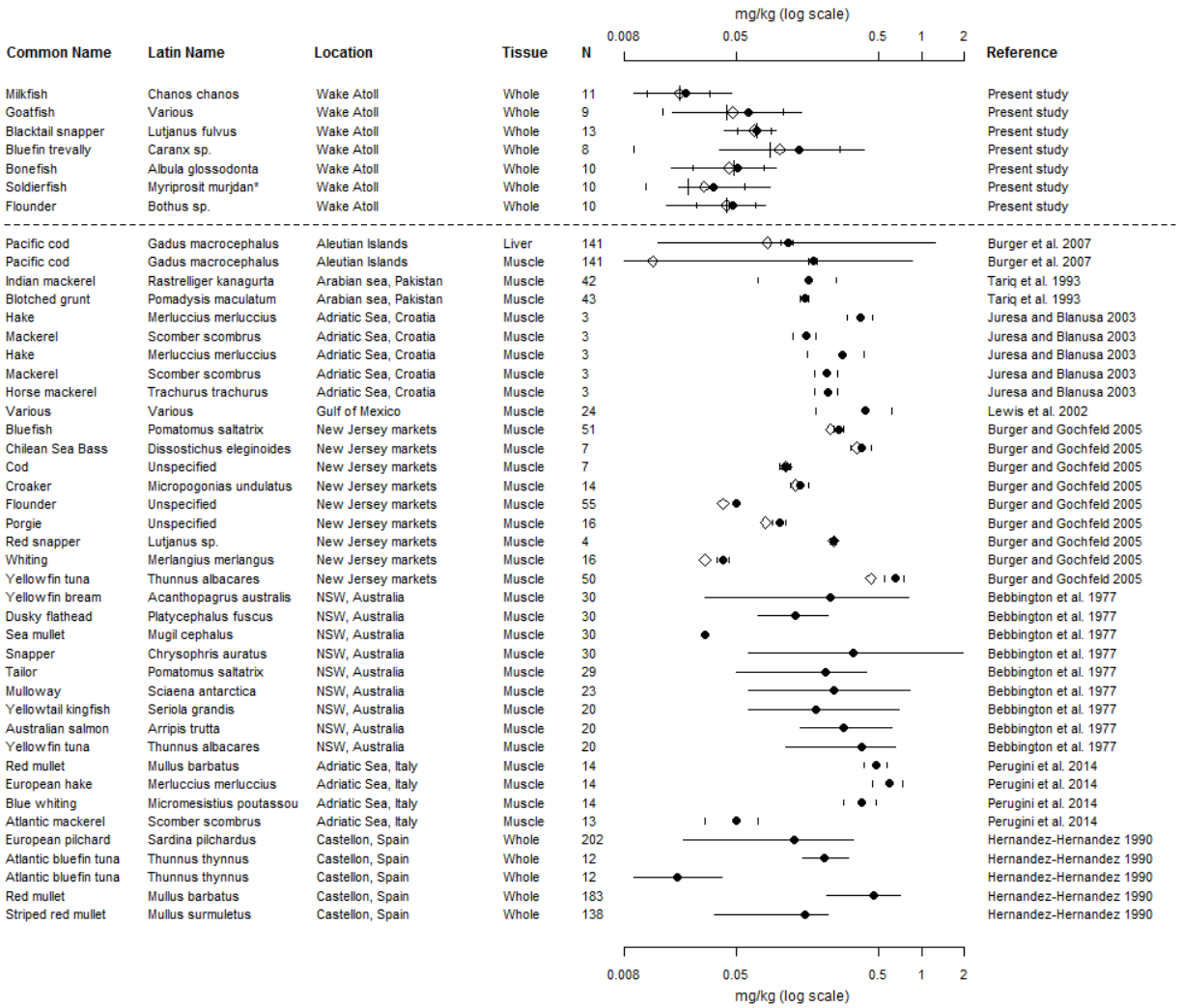


Figure 29. Total mercury (wet weight) values from the present study (above the dashed line) in comparison to values from other published literature (mg/kg). Where reported: horizontal line = range (min – max); solid circle = arithmetic mean (average); open diamond = geometric mean; long vertical tick = median; short vertical tick = one standard deviation.

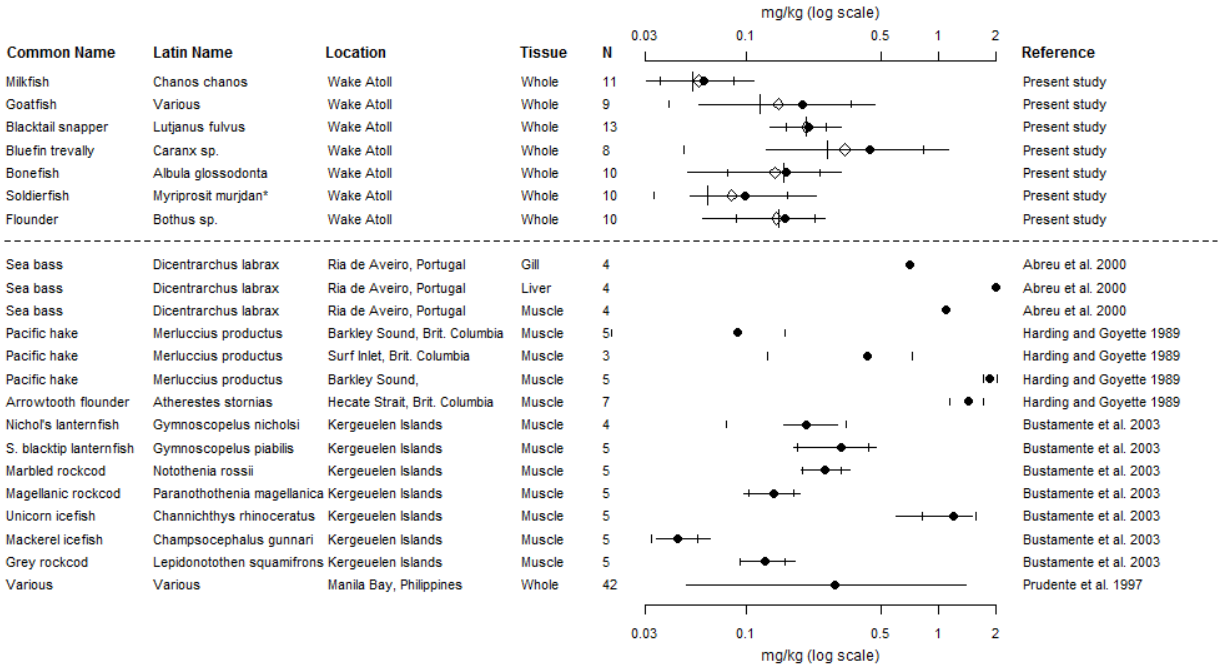


Figure 30. Total mercury (dry weight) values from the present study (above the dashed line) in comparison to values from other published literature (mg/kg). Where reported: horizontal line = range (min – max); solid circle = arithmetic mean (average); open diamond = geometric mean; long vertical tick = median; short vertical tick = one standard deviation.

DISCUSSION

An examination of the metals data as graphically visualized in Figures 11 through 25 indicate three general observations:

Higher concentrations of toxic metals at the Battery Dump site: Concentrations of chromium, cobalt, nickel, copper, zinc, antimony, barium, and lead were particularly high at the Battery Dump site. While beryllium and thallium were not present in detectable levels in 97% of the fish sampled, one of the two detections of each of these analytes was at the battery dump site.

Higher concentrations of toxic metals in milkfish: Milkfish samples yielded particularly high concentrations of chromium, cobalt, vanadium, nickel, copper, zinc, cadmium, antimony, barium, and lead relative to the other fish species sampled. The only detections of beryllium and thallium (two detections each) were in milkfish samples from the Battery Dump and Waterplant Outfall sites. Milkfish are commonly consumed. Often of small size (hence our pooled samples), they may be more likely to be prepared in a whole body manner, potentially increasing exposure of consumers to heavy metal contamination.

Control samples generally within range observed on Wake: Analyte concentrations in the two control fish, purchased at the Suisan Fish Market in Hilo, Hawaii, are generally

within the ranges of values observed in the fish sampled on Wake. Notable exceptions include chromium and zinc, where Wake samples typically exceed the values observed in the small sample of controls. Additionally, as noted above, fish at the Battery Dump site also tended to be higher than control fish in vanadium, cobalt, nickel, copper, and lead. Wake fish were predominantly lower than control fish in cadmium. With respect to the analytes typically below the minimum detection limit in the Wake samples (beryllium, antimony, and thallium), the control sample is too small to indicate whether rare detections, as observed in the Wake samples, would also be encountered in other fish from this same market.

However, concentrations of arsenic and mercury, toxins typically of higher risk to consumers of fish, were not particularly high either at the Battery Dump site or in milkfish.

In comparison to other reported values for arsenic, lead, and total mercury, the sample from the present study does not appear to be atypical. Arsenic values appear to be slightly higher than other samples in comparison (Figure 26), and higher than values from a New Jersey fish market (Burger and Gochfeld 2005), but not as high as the values observed in commercial fisheries in the Adriatic Sea (Perugini et al. 2014). Lead values are low to average (Figures 27 and 28), with the exception of the milkfish sample which is relatively high; not surprisingly, this result is highly influenced by high-lead milkfish captured at the "battery dump" site (Figure 24). Mercury content (Figures 29 and 30) is relatively average to low compared to the values found in the published literature. It is important to note that the values published in scientific journals generally precede any risk analyses, the results of which are not typically published; therefore, these compared values are not known to have been considered safe or unsafe for consumption.

For a more complete discussion of these results with respect to threshold values for human health, see Part C of this report.

PART C: ASSESSMENT OF HEALTH RISKS

METHODS

Potential exposure to toxic levels of trace metals was assessed by comparing the concentrations of the respective analytes found in fish samples to EPA reference doses (RfDs). The RfD is an estimate (with uncertainty spanning perhaps an order of magnitude) of a daily oral exposure to the human population (including sensitive subgroups) that is likely to be without appreciable risk of deleterious noncancer effects during a lifetime. It is not a direct estimator of risk, but rather a reference point to gauge the potential effects. At exposures increasingly greater than the RfD, the potential for adverse health effects increases. Lifetime exposure above the RfD does not imply that an adverse health effect would necessarily occur. The EPA reference dose is more fully explained at: http://www.epa.gov/iris/reference-dose-rfd-description-and-use-health-risk-assessments

Comparisons of sample concentrations to RfDs were made by three methods: 1) estimation of a maximum meal size that may be consumed before ingestion of the RfD; 2) identification of fish samples for which a single 225 gram (8 ounce) serving would exceed the RfD; and 3) comparison of sample concentrations to EPA's risk-based consumption limit tables for arsenic, cadmium, methylmercury, and selenium.

Maximum meal size

For each of the analytes considered, we determined the maximum daily intake of fish from Wake Atoll that could be consumed without exceeding the RfD threshold. Under this method, we did not distinguish between fish species or sampling location.

Maximum meal sizes were calculated as:

Equation 2:

$$MM(g) = \frac{RfD(mg/kg/day) * CW(kg) * 1000}{AC(mg/kg/day)}$$

where MM is the maximum meal size (g) of fish that can be ingested before exceeding the daily reference dose; RfD is the EPA reference dose (mg/kg/day); CW is the consumer weight (estimated at 60kg for an adult male); and AC is the analyte concentration as measured in fish samples. Values are reported for the maximum meal at the mean analyte concentration, and at the upper 75th percentile of concentrations for a more conservative limit. This equation is varied as appropriate to other means of maximum meal size estimation (e.g., mg/day recommendations rather than mg/kg/day). In the case of non-normally distributed data, the mean value may be greater than the 75th percentile. Maximum meal sizes less than a hypothetical 225 gram meal were flagged as being in excess of the RfD.

In order to estimate maximum meal sizes for samples below the minimum detection limit (MDL), these samples were assumed to have concentrations equal to the MDL (adjusted for wet

weight). This provides a conservative, or "worst case" estimate of concentrations. It may be more judicious to consider these values inestimable given the limitations on detectability.

Samples exceeding RfD for one meal

We calculated the concentration threshold (CT) at which one 225 gram meal of a given fish sample would exceed the RfD for the respective contaminant.

Equation 3:

$$CT(mg) = \frac{RfD\ (mg/kg/day) * 0.225}{CW(kg)}$$

where the SC is the sample concentration and CW is the consumer weight, estimated at 60 kg for an adult male. Concentration thresholds are plotted on sample concentration graphs to visually depict which samples, by species and sampling location, would exceed the RfD with one meal. The EPA human health threshold for mercury in food items and the minimum, mean, and maximum arsenic values from the 2002 risk assessment (URS Group 2002) are also plotted on their respective graphs.

Risk-based consumption limit tables

The EPA has established risk-based fish consumption limit tables, indicating the number of fish meals that may be consumed per month at various concentrations of arsenic, cadmium, methylmercury, and selenium (USEPA 2000b; Appendix E). These are the allowable numbers of meals (8 ounces / 225 grams) per month without undue risk of chronic, systemic adverse health effects (non-cancer health endpoints); an alternative consumption limit for cancer health endpoints (with values representing tissue concentrations at a 1 in 100,000 risk level) for arsenic only.

The published tables are based on a body weight assumption of 70 kg; for the sake of consistency with our assumed body weight of 60 kg in the preceding methodologies, we adjusted the consumption rates per section 3.3 of USEPA 200b. Consumer weight-adjusted consumption limits are tabulated, with meal frequencies exceeding the consumption limits flagged.

RESULTS

Maximum meal size

The amounts of fish (in grams) that can be consumed without exceeding the RfD for each respective trace metal are reported in Table 11, along with the RfD value and a description of the effects of chronic oral exposure to the contaminant.

Table 11. Summary of effects of chronic exposure, EPA reference doses (RfD) or proxy thresholds, and maximum daily fish meal sizes (g) that can be consumed before exceeding the daily RfD, reported both at the mean observed concentration and at a more conservative upper

75th percentile of concentrations. Shaded cells indicate values less than an 8 oz./225 g serving size of fish. Electronic references were accessed 30 December 2015. *The majority of samples were below the minimum detection limit; results are based on the assumption that samples "< MDL" were contaminated "= MDL" as a "worst case scenario." †- NA where an EPA RfD is not available; an alternative threshold was substituted based on literature referenced in footnotes.

Metal	**Effects of Chronic Oral Exposure**	**EPA RfD†**	**Max. Meal (g)**	
			Mean	**75%**
*Beryllium[1,2]	Swallowing beryllium has not been reported to cause effects in humans. Ulcers have been seen in dogs ingesting soluble beryllium salts in the diet.	$2x10^{-3}$ mg/kg/d	20,305[j]	18,930[j]
Vanadium[3]	Nausea, mild diarrhea, and stomach cramps	$9x10^{-3}$ mg/kg/d	1,256	1,308
Chromium III[4,5,a]	Low toxicity, does not appear to cause problems	1.5 mg/kg/d	252,809	271,903
Chromium VI[4,6,a]	Effects on the liver, kidney, gastrointestinal and immune systems, and possibly anemia	$3x10^{-3}$ mg/kg/d	505	543
Cobalt[7,8]	Gastrointestinal effects (nausea, vomiting, and diarrhea), effects on the blood, liver injury, and allergic dermatitis	NA; $4x10^{-2}$ mg/d[b]	1,429[b]	1,290[b]
Nickel[9]	Decreased body and organ weights in rats	$2x10^{-2}$ mg/kg/d	2,667	2,381
Copper[10]	Gastrointestinal disturbances in humans	NA; 10 mg/d[c]	6,494	7,133
Zinc[11,12]	Gastrointestinal disturbances, anemia, pancreas damage, and decreased HDL cholesterol	$3x10^{-1}$ mg/kg/d	706	520
Arsenic[13,14]	Gastrointestinal effects, anemia, peripheral neuropathy, skin lesions, hyperpigmentation, and liver or kidney damage in humans	$3x10^{-3}$ ($3x10^{-4}$)[d] mg/kg/d	16	10
Selenium[15,16,e]	Discoloration of the skin, deformation and loss of nails or hair, lack of mental alertness, listlessness, and loss of feeling and control in arms and legs (selenosis)	$5x10^{-3}$ mg/kg/d	286	248
Cadmium[17,18]	Kidney disease, effects on liver, lung, bone, immune system, blood, and nervous system	$1x10^{-3}$ mg/kg/d	1,428	1,071
*Antimony[19,20,f]	Gastrointestinal effects; blood, liver, and central nervous system effects in test animals	$4x10^{-4}$ mg/kg/d	672[k]	1,463[k]

Barium[21,22]	Gastrointestinal effects, difficulties in breathing, increased or decreased blood pressure, numbness around the face, and muscle weakness	$2x10^{-1}$ mg/kg/d	19,672	20,443
*Thallium[23,24]	Nervous system, lung, hear, liver, kidney and gastrointestinal effects, hair loss	$1x10^{-5}$ mg/kg/d[g] $3x10^{-6}$ mg/kg/d	120[l] 72[l]	114[l] 68[l]
Lead[25,26]	Decreased nervous system function, weakness in fingers, wrists, or ankles, increases in blood pressure, anemia, brain and kidney damage, miscarriage.	NA; $1x10^{-3}$ mg/kg/d[h]	67[h]	368[h]
Mercury[27,28]	Central nervous system effects such as excitability, irritability, excessive shyness, tremors	$1x10^{-4}$ mg/kg/d[i]	103	83

1- http://www3.epa.gov/airtoxics/hlthef/berylliu.html
2- http://www.atsdr.cdc.gov/ToxProfiles/tp4-c1-b.pdf
3- http://www.atsdr.cdc.gov/ToxProfiles/tp58-c1-b.pdf
4- http://www.atsdr.cdc.gov/ToxProfiles/tp7-c1-b.pdf
5- http://cfpub.epa.gov/ncea/iris/index.cfm?fuseaction=iris.showQuickView&substance_nmbr=0028
6- http://cfpub.epa.gov/ncea/iris/index.cfm?fuseaction=iris.showQuickView&substance_nmbr=0144
7- http://www3.epa.gov/airtoxics/hlthef/cobalt.html
8- http://www.atsdr.cdc.gov/toxprofiles/tp33-c1-b.pdf
9- http://www3.epa.gov/airtoxics/hlthef/nickel.html
10- http://www.atsdr.cdc.gov/ToxProfiles/tp132-c1-b.pdf
11- http://www.atsdr.cdc.gov/ToxProfiles/tp60-c1-b.pdf
12- http://www.atsdr.cdc.gov/toxprofiles/tp60-c8.pdf
13- http://www.atsdr.cdc.gov/ToxProfiles/tp2-c1-b.pdf
14- http://www3.epa.gov/airtoxics/hlthef/arsenic.html
15- http://www.atsdr.cdc.gov/ToxProfiles/tp92-c1-b.pdf
16- http://www3.epa.gov/airtoxics/hlthef/selenium.html
17- http://www.atsdr.cdc.gov/ToxProfiles/tp5-c1-b.pdf
18- http://www3.epa.gov/airtoxics/hlthef/cadmium.html
19- http://www.atsdr.cdc.gov/ToxProfiles/tp23-c1-b.pdf
20- http://www3.epa.gov/airtoxics/hlthef/antimony.html
21- http://www.atsdr.cdc.gov/ToxProfiles/tp24-c1-b.pdf
22- http://cfpub.epa.gov/ncea/iris/index.cfm?fuseaction=iris.showQuickView&substance_nmbr=0010
23- http://www.atsdr.cdc.gov/ToxProfiles/tp54-c1-b.pdf
24- http://cfpub.epa.gov/ncea/iris/iris_documents/documents/subst/1012_summary.pdf
25- http://www.atsdr.cdc.gov/ToxProfiles/tp13-c1-b.pdf
26- http://www.atsdr.cdc.gov/toxprofiles/tp13-c8.pdf
27- http://www.atsdr.cdc.gov/ToxProfiles/tp46-c1-b.pdf
28- http://www3.epa.gov/airtoxics/hlthef/mercury.html

a- These analyses do not distinguish between chromium compounds; reference doses for both III and VI are used here to cover the extremes of 100% concentration of either compound
b- Most regulatory concern is associated with respiratory effects associated with airborne cobalt; cobalt is not known to bioaccumulate up the food chain; cobalt is an essential element required for good health in humans and animals; 0.04 mg/d is the upper end of the average daily intake from food per the associated references

c- Most regulatory concern is associated with copper in drinking water, there is no EPA Reference Dose established for copper in food; 10 mg/d is the Institute of Occupational Medicine's tolerable upper intake level per the associated reference
d- Only inorganic arsenic is toxic in low concentrations; however, this testing methodology measures only total arsenic; while inorganic arsenic can range from 1% to 27% of total arsenic, FDA recommends estimation of 10% inorganic arsenic; for this reason, the EPA RfD of 0.0003 mg/kg/d will be adjusted to 0.003 for this analysis (URS Group 2002; USFDA 1993)
e- Food is the primary source of exposure to selenium, with an estimated selenium intake for the U.S. population ranging from 0.071 to 0.152 milligrams per day (mg/d).
f- Antimony is primarily of concern as an inhalant; average concentration in seafood are 0.0002 to 0.0011 mg/kg.
g- An EPA oral reference dose is not well resolved; $1x10^{-5}$ mg/kg/d and $3x10^{-6}$ are listed for hair follicle atrophy and clinical observations, respectively.
h- EPA has decided it would be inappropriate to develop a reference dose for inorganic lead because some of the health effects occur at blood levels so low as to be essentially without a threshold. In the most recent studies, the average dietary intake of lead was about 0.001 mg/kg/day; this value will be used to determine the amount of fish that may be consumed to equal the average dietary intake of lead for one day.
i- Mercury exists in three forms: elemental, inorganic, and organic (primarily methyl mercury); EPA has no RfD for elemental mercury; RfDs for inorganic and methyl mercury are 0.0003 and 0.0001 mg/kg/d respectively; the RfD for methyl mercury, which is more common and more conservative, will be employed here.
j- Beryllium was below the detection limit in 97.1% of the samples; these estimates are based on only two detections
k- Antimony was below the minimum detection limit in 88.7% of the samples; these values are based only on the small number of samples that did contain quantifiable amounts of the analyte; actual risk of exceeding the RfD is much lower.
l- 97.1% of thallium samples were below the minimum detection limit; these estimates are based on the only two sample with quantifiable amounts of the analyte; actual risk of reaching the reference dose by eating an average fish is much lower.

The majority of antimony (88.7%) and beryllium and thallium samples (97.1% each) contained concentrations below the minimum detection limit. The meal sizes for these metals comprise a "worst case scenario" where all of the samples below the MDL were assumed to be at the MDL, providing a very conservative benchmark of likely exposure. Despite this conservatism, neither beryllium nor antimony were indicated as being likely to exceed the RfD in a 225 gram meal. Thallium, however, was estimated to exceed the RfD at both of the cited RfD levels. Interpretation of this result should be tempered by the acknowledgement that traces in samples were actually lower than the value used to estimate the maximum meal size. In a sense, the test is not sensitive enough to detect concentrations low enough to determine whether a given sample is below the RfD. It may be more judicious to consider these values inestimable given the limitations on detectability.

An average 225 gram meal of whole-body fish on Wake, irrespective of species or capture location, is expected to exceed the RfD for arsenic and mercury. Selenium approaches this threshold with a maximum meal size of 286 g at the mean sample concentration. The results suggest that an average 225 gram meal would exceed the average daily dietary intake for lead (no EPA RfD); however, this result is strongly influenced by some extreme values in milkfish within the Battery Dump Pond site; the majority of fish sampled did not contain lead concentrations above this threshold (see Figure 24).

Samples exceeding RfD for one meal

The individual fish samples which would exceed the RfD, based on consumption of a 225 g whole-body serving by a 60 kg consumer, are represented within the shaded zones in Figures 11 to 25.

Notable observations include:

- Neither of the two samples of milkfish which tested positive for detectable levels of beryllium exceeded the concentration threshold of 0.533 mg/kg (Figure 11).
- Two samples of snapper from Peale Lagoon exceeded the RfD threshold of 2.4 mg/kg for Vanadium (Figure 12).
- Only milkfish, primarily those from the Battery Dump site, exceeded the 0.0133 mg/kg threshold for chromium VI (Figure 13), while no samples exceeded the 400 mg/kg for chromium III; it is important to note that the sampling methodology does not distinguish between chromium III and VI, so these thresholds should be seen as the extremes of a range of possible ratios of chromium III to VI.
- None of the samples exceeded the RfD thresholds for cobalt (0.800 mg/kg), nickel (5.33 mg/kg), copper (0.0133 mg/kg), cadmium (0.267 mg/kg), or barium (53.3 mg/kg). See Figures 14-16, 20, and 22.
- Only one milkfish, from the Battery Dump site, exceeded the threshold for zinc (80 mg/kg; Figure 17).
- **Every fish in the sample exceeded the arsenic RfD threshold (0.8 mg/kg, min = 0.808; Figure 18).** Compared to the arsenic values observed during the 2002 samples and the two control fish from a commercial fish market in Hilo, Hawaii, the current arsenic concentrations are within the same general range.
- Several fish samples exceeded the RfD threshold for Selenium (1.33 mg/kg), primarily soldierfish from Ioke Beach and bonefish from AF Beach House (Figure 19).
- Two milkfish from the Battery Dump site exceeded the threshold (0.107 mg/kg) for antimony (Figure 21).
- While all other thallium samples tested below the minimum detection limit, two milkfish from Waterplant Outfall and Battery Dump exceeded both thresholds (0.0008 and 0.00267 mg/kg; Figure 23).
- While the preceding maximum meal size analysis indicated that an average fish meal from Wake would exceed the average daily dietary intake of lead (0.8 mg/kg), that result was heavily influenced by extremely high concentrations in milkfish from the Battery Dump site, which were the only fish to exceed this threshold (Figure 24.).
- Only one fish, a trevally from the north shore of Wake Island, exceeded the EPA human health threshold of 0.3 mg/kg for mercury in food items. However, the majority of fish sampled exceeded the RfD threshold of 0.0267 mg/kg, as did the control samples from Hilo, Hawaii (Figure 25).

Risk-based consumption limit tables

Table 12.1 through 12.8 reflect the EPA-recommended restrictions on fish intake, in meals per month, based upon whole-body samples. Results are reported for all fish samples, regardless of species, in Table 12.1, while Tables 12.2 through 12.8 break results down by fish species.

Table 12. Risk-based consumption limits in 8 ounce / 225 gram meals per months based upon whole-body fish tissue metal residues for arsenic, cadmium, methylmercury, and selenium. Adjusted from EPA tables to depict intervals based upon an assumed consumer body weight of 60 kg. Intervals are in mg/kg wet weight. "Mean" reflects the mean analyte concentration for the sample, irrespective of sampling site. Shaded cells represent consumption levels in excess of the recommended intake restrictions.

Table 12.1. All fish (n = 69)

Meals/ Month	Arsenic		Cadmium	Methylmercury	Selenium
	Non-cancer	Cancer	Non-cancer	Non-cancer	Non-cancer
> 16	0 – 0.075	0 – 0.0017	0 – 0.075	0 – 0.025	0 – 1.3
16	>0.075 – 0.15	>0.0017 – 0.0033	>0.075 – 0.15	>0.025 – 0.051	>1.3 – 2.5
12	>0.15 – 0.20	>0.0033 – 0.0045	>0.15 – 0.20	>0.051 – 0.067	>2.5 – 3.3
8	>0.20 – 0.3	>0.0045 – 0.0067	>0.20 – 0.3	>0.067 – 0.1	>3.3 – 5.1
4	>0.3 – 0.6	>0.0067 – 0.014	>0.3 – 0.6	>0.1 – 0.2	>5.1– 10
3	>0.6 – 0.8	>0.014 – 0.018	>0.6 – 0.8	>0.2 – 0.27	>10 – 14
2	>0.8 – 1.2	>0.018 – 0.027	>0.8 – 1.2	>0.27 – 0.4	>14 – 20
1	>1.2 – 2.4	>0.027 – 0.054	>1.2 – 2.4	>0.4 – 0.81	>20 – 40
0.5	>2.4 – 4.8	>0.054 – 0.11	>2.4 – 4.8	>0.81 – 1.6	>40 – 80
< 0.5	>4.8	> 0.11	>4.8	>1.6	>80
Mean	11.094 mg/kg	11.094 mg/kg	0.0381 mg/kg	0.058 mg/kg	1.047 mg/kg

Table 12.2. Milkfish (n = 11)

Meals/ Month	Arsenic		Cadmium	Methylmercury	Selenium
	Non-cancer	Cancer	Non-cancer	Non-cancer	Non-cancer
> 16	0 – 0.075	0 – 0.0017	0 – 0.075	0 – 0.025	0 – 1.3
16	>0.075 – 0.15	>0.0017 – 0.0033	>0.075 – 0.15	>0.025 – 0.051	>1.3 – 2.5
12	>0.15 – 0.20	>0.0033 – 0.0045	>0.15 – 0.20	>0.051 – 0.067	>2.5 – 3.3
8	>0.20 – 0.3	>0.0045 – 0.0067	>0.20 – 0.3	>0.067 – 0.1	>3.3 – 5.1
4	>0.3 – 0.6	>0.0067 – 0.014	>0.3 – 0.6	>0.1 – 0.2	>5.1– 10
3	>0.6 – 0.8	>0.014 – 0.018	>0.6 – 0.8	>0.2 – 0.27	>10 – 14
2	>0.8 – 1.2	>0.018 – 0.027	>0.8 – 1.2	>0.27 – 0.4	>14 – 20
1	>1.2 – 2.4	>0.027 – 0.054	>1.2 – 2.4	>0.4 – 0.81	>20 – 40
0.5	>2.4 – 4.8	>0.054 – 0.11	>2.4 – 4.8	>0.81 – 1.6	>40 – 80
< 0.5	>4.8	> 0.11	>4.8	>1.6	>80
Mean	6.054 mg/kg	6.054 mg/kg	0.053 mg/kg	0.022 mg/kg	0.872 mg/kg

Table 12.3. Goatfish (n = 9)

Meals/ Month	Arsenic		Cadmium	Methylmercury	Selenium
	Non-cancer	Cancer	Non-cancer	Non-cancer	Non-cancer
> 16	0 – 0.075	0 – 0.0017	0 – 0.075	0 – 0.025	0 – 1.3
16	>0.075 – 0.15	>0.0017 – 0.0033	>0.075 – 0.15	>0.025 – 0.051	>1.3 – 2.5
12	>0.15 – 0.20	>0.0033 – 0.0045	>0.15 – 0.20	>0.051 – 0.067	>2.5 – 3.3
8	>0.20 – 0.3	>0.0045 – 0.0067	>0.20 – 0.3	>0.067 – 0.1	>3.3 – 5.1
4	>0.3 – 0.6	>0.0067 – 0.014	>0.3 – 0.6	>0.1 – 0.2	>5.1– 10
3	>0.6 – 0.8	>0.014 – 0.018	>0.6 – 0.8	>0.2 – 0.27	>10 – 14
2	>0.8 – 1.2	>0.018 – 0.027	>0.8 – 1.2	>0.27 – 0.4	>14 – 20
1	>1.2 – 2.4	>0.027 – 0.054	>1.2 – 2.4	>0.4 – 0.81	>20 – 40
0.5	>2.4 – 4.8	>0.054 – 0.11	>2.4 – 4.8	>0.81 – 1.6	>40 – 80
< 0.5	>4.8	> 0.11	>4.8	>1.6	>80
Mean	12.956 mg/kg	12.956 mg/kg	0.020 mg/kg	0.060 mg/kg	0.961 mg/kg

Table 12.4. Blacktail snapper (n = 12)

Meals/ Month	Arsenic		Cadmium	Methylmercury	Selenium
	Non-cancer	Cancer	Non-cancer	Non-cancer	Non-cancer
> 16	0 – 0.075	0 – 0.0017	0 – 0.075	0 – 0.025	0 – 1.3
16	>0.075 – 0.15	>0.0017 – 0.0033	>0.075 – 0.15	>0.025 – 0.051	>1.3 – 2.5
12	>0.15 – 0.20	>0.0033 – 0.0045	>0.15 – 0.20	>0.051 – 0.067	>2.5 – 3.3
8	>0.20 – 0.3	>0.0045 – 0.0067	>0.20 – 0.3	>0.067 – 0.1	>3.3 – 5.1
4	>0.3 – 0.6	>0.0067 – 0.014	>0.3 – 0.6	>0.1 – 0.2	>5.1– 10
3	>0.6 – 0.8	>0.014 – 0.018	>0.6 – 0.8	>0.2 – 0.27	>10 – 14
2	>0.8 – 1.2	>0.018 – 0.027	>0.8 – 1.2	>0.27 – 0.4	>14 – 20
1	>1.2 – 2.4	>0.027 – 0.054	>1.2 – 2.4	>0.4 – 0.81	>20 – 40
0.5	>2.4 – 4.8	>0.054 – 0.11	>2.4 – 4.8	>0.81 – 1.6	>40 – 80
< 0.5	>4.8	> 0.11	>4.8	>1.6	>80
Mean	2.298 mg/kg	2.298 mg/kg	0.014 mg/kg	0.071 mg/kg	0.813 mg/kg

Table 12.5. Bluefin Trevally (n = 8)

Meals/ Month	Arsenic		Cadmium	Methylmercury	Selenium
	Non-cancer	Cancer	Non-cancer	Non-cancer	Non-cancer
> 16	0 – 0.075	0 – 0.0017	0 – 0.075	0 – 0.025	0 – 1.3
16	>0.075 – 0.15	>0.0017 – 0.0033	>0.075 – 0.15	>0.025 – 0.051	>1.3 – 2.5
12	>0.15 – 0.20	>0.0033 – 0.0045	>0.15 – 0.20	>0.051 – 0.067	>2.5 – 3.3
8	>0.20 – 0.3	>0.0045 – 0.0067	>0.20 – 0.3	>0.067 – 0.1	>3.3 – 5.1
4	>0.3 – 0.6	>0.0067 – 0.014	>0.3 – 0.6	>0.1 – 0.2	>5.1– 10
3	>0.6 – 0.8	>0.014 – 0.018	>0.6 – 0.8	>0.2 – 0.27	>10 – 14
2	>0.8 – 1.2	>0.018 – 0.027	>0.8 – 1.2	>0.27 – 0.4	>14 – 20
1	>1.2 – 2.4	>0.027 – 0.054	>1.2 – 2.4	>0.4 – 0.81	>20 – 40
0.5	>2.4 – 4.8	>0.054 – 0.11	>2.4 – 4.8	>0.81 – 1.6	>40 – 80
< 0.5	>4.8	> 0.11	>4.8	>1.6	>80
Mean	2.040 mg/kg	2.040 mg/kg	0.020 mg/kg	0.138 mg/kg	0.926 mg/kg

Table 12.6. Bonefish (n = 10)

Meals/ Month	Arsenic		Cadmium	Methylmercury	Selenium
	Non-cancer	Cancer	Non-cancer	Non-cancer	Non-cancer
> 16	0 – 0.075	0 – 0.0017	0 – 0.075	0 – 0.025	0 – 1.3
16	>0.075 – 0.15	>0.0017 – 0.0033	>0.075 – 0.15	>0.025 – 0.051	>1.3 – 2.5
12	>0.15 – 0.20	>0.0033 – 0.0045	>0.15 – 0.20	>0.051 – 0.067	>2.5 – 3.3
8	>0.20 – 0.3	>0.0045 – 0.0067	>0.20 – 0.3	>0.067 – 0.1	>3.3 – 5.1
4	>0.3 – 0.6	>0.0067 – 0.014	>0.3 – 0.6	>0.1 – 0.2	>5.1– 10
3	>0.6 – 0.8	>0.014 – 0.018	>0.6 – 0.8	>0.2 – 0.27	>10 – 14
2	>0.8 – 1.2	>0.018 – 0.027	>0.8 – 1.2	>0.27 – 0.4	>14 – 20
1	>1.2 – 2.4	>0.027 – 0.054	>1.2 – 2.4	>0.4 – 0.81	>20 – 40
0.5	>2.4 – 4.8	>0.054 – 0.11	>2.4 – 4.8	>0.81 – 1.6	>40 – 80
< 0.5	>4.8	> 0.11	>4.8	>1.6	>80
Mean	19.140 mg/kg	19.140 mg/kg	0.040 mg/kg	0.051 mg/kg	1.325 mg/kg

Table 12.7. Soldierfish (n = 9)

Meals/ Month	Arsenic		Cadmium	Methylmercury	Selenium
	Non-cancer	Cancer	Non-cancer	Non-cancer	Non-cancer
> 16	0 – 0.075	0 – 0.0017	0 – 0.075	0 – 0.025	0 – 1.3
16	>0.075 – 0.15	>0.0017 – 0.0033	>0.075 – 0.15	>0.025 – 0.051	>1.3 – 2.5
12	>0.15 – 0.20	>0.0033 – 0.0045	>0.15 – 0.20	>0.051 – 0.067	>2.5 – 3.3

8	>0.20 – 0.3	>0.0045 – 0.0067	>0.20 – 0.3	>0.067 – 0.1	>3.3 – 5.1
4	>0.3 – 0.6	>0.0067 – 0.014	>0.3 – 0.6	>0.1 – 0.2	>5.1– 10
3	>0.6 – 0.8	>0.014 – 0.018	>0.6 – 0.8	>0.2 – 0.27	>10 – 14
2	>0.8 – 1.2	>0.018 – 0.027	>0.8 – 1.2	>0.27 – 0.4	>14 – 20
1	>1.2 – 2.4	>0.027 – 0.054	>1.2 – 2.4	>0.4 – 0.81	>20 – 40
0.5	>2.4 – 4.8	>0.054 – 0.11	>2.4 – 4.8	>0.81 – 1.6	>40 – 80
< 0.5	>4.8	> 0.11	>4.8	>1.6	>80
Mean	22.925 mg/kg	22.925 mg/kg	0.104 mg/kg	0.031 mg/kg	1.681 mg/kg

Table 12.8. Flounder (n = 10)

Meals/ Month	Arsenic		Cadmium	Methylmercury	Selenium
	Non-cancer	Cancer	Non-cancer	Non-cancer	Non-cancer
> 16	0 – 0.075	0 – 0.0017	0 – 0.075	0 – 0.025	0 – 1.3
16	>0.075 – 0.15	>0.0017 – 0.0033	>0.075 – 0.15	>0.025 – 0.051	>1.3 – 2.5
12	>0.15 – 0.20	>0.0033 – 0.0045	>0.15 – 0.20	>0.051 – 0.067	>2.5 – 3.3
8	>0.20 – 0.3	>0.0045 – 0.0067	>0.20 – 0.3	>0.067 – 0.1	>3.3 – 5.1
4	>0.3 – 0.6	>0.0067 – 0.014	>0.3 – 0.6	>0.1 – 0.2	>5.1– 10
3	>0.6 – 0.8	>0.014 – 0.018	>0.6 – 0.8	>0.2 – 0.27	>10 – 14
2	>0.8 – 1.2	>0.018 – 0.027	>0.8 – 1.2	>0.27 – 0.4	>14 – 20
1	>1.2 – 2.4	>0.027 – 0.054	>1.2 – 2.4	>0.4 – 0.81	>20 – 40
0.5	>2.4 – 4.8	>0.054 – 0.11	>2.4 – 4.8	>0.81 – 1.6	>40 – 80
< 0.5	>4.8	> 0.11	>4.8	>1.6	>80
Mean	13.626 mg/kg	13.626 mg/kg	0.020 mg/kg	0.047 mg/kg	0.837 mg/kg

By these risk-based consumption limit tables, any consumption of fish from Wake Atoll would exceed the recommended number of meals per months for arsenic, with the exception of very low consumption (0.5 meals per month or less) of blacktail snapper or bluefin trevally. Any intake of fish from Wake Atoll would exceed the risk thresholds for cancer health endpoints from arsenic.

Fish meals in excess of 8 to 16 per month exceed the acceptable risk for mercury exposure.

Because some levels of cadmium, mercury, and selenium were found in all samples, by this methodology consumption of more than 16 meals per month of any fish will result in excess exposure; for risk associated with consumption of high levels of fish with low contaminant concentrations, refer to the maximum meal size/daily reference dose methodology employed previously in this section.

DISCUSSION

Many of the analytes considered here occur naturally in foods and may be essential dietary components, with recommended daily allowances (RDAs) or dietary reference intakes (DRIs) that may exceed the daily intake from a fish diet. DRI tables, including RDAs and upper limits of intake for arsenic, chromium, copper, nickel, selenium, vanadium, and zinc from the Food and Nutrition Board, Institute of Medicine, National Academies, are attached as Appendix F (FNB 2016).

The thresholds for the levels of mercury in fish that trigger the issuance of an advisory for women of childbearing age vary among local jurisdictions, but generally range from 0.07 to 1

ppm, with most threshold values in the range of 0.1 to 0.3 mg/kg (USEPA 2010); 0.3 ppm is the typically-cited threshold. All sampled fish were below this threshold with a single exception, a bluefin trevally (*Caranx* sp.) caught on the north shore of Wake Island. Another bluefin trevally from Heal Point approached this threshold at a concentration of 0.281 mg/kg. Ninety percent of the fish sampled were below the 0.1 mg/kg threshold. However, a 60 kg person consuming 225 g of whole-body fish products would likely exceed the EPA reference dose for mercury; more than half of all fish sampled contained concentrations of mercury that would exceed the EPA reference dose with one meal of standard size. By the EPA risk-based consumption limit tables, taken on average, more than 8 fish meals per month should not be consumed to avoid excess risk of chronic mercury ingestion.

In a 2002 "Risk Evaluation of Chemical Levels in Fish Tissue" (URS Group 2002) on Wake, the only inorganic compound screened for was arsenic. This risk assessment only applied to consumption of goatfish; bonefish were also sampled, but since samples were whole-body while consumers typically eat muscle tissue only, the risk assessment methodology was not considered valid for bonefish. Based on measured arsenic levels in goatfish tissue, and significantly elevated risk associated with those levels, this risk evaluation indicated that an interim fish advisory recommending no consumption of lagoon-caught fish for the general population was warranted. The authors noted that marine species naturally accumulate arsenic even in unimpacted areas, suggesting that these arsenic levels may be natural phenomena, or alternatively, could potentially be the result of applications of pesticides or other government activities. Whole-body arsenic concentrations for the 15 goatfish sampled for the 2002 analysis ranged from 3.47 to 28.1 mg/kg, with a mean of 9.97. All 9 goatfish collected during the current sampling fell within this range (see Figure 18), and the arsenic concentration values for the majority of the other fish samples were within and around this same range. All fish in the current sample would exceed the EPA reference dose if consumed in a whole-body meal of standard size (225 g), and risk-based consumption limit tables indicated that nearly all Wake fish contain arsenic at unsafe concentrations. Given these results, it is likely that the findings of the 2002 risk analysis would continue to apply to contemporary fish stocks within the lagoon. Note that only inorganic arsenic is toxic in low concentrations. The testing methodology employed here measures only total arsenic; while inorganic arsenic can range from 1% to 27% of total arsenic, FDA recommends estimation of 10% inorganic arsenic; for this reason, the EPA RfD of 0.0003 mg/kg/d will be adjusted to 0.003 for this analysis (USFDA 1993), as was done with the previous fish tissue risk assessment (URS Group 2002). Actual risks associated with inorganic arsenic exposure may be higher or lower, depending on the true inorganic fraction of total arsenic.

Our methodology for comparing hypothetical fish servings to EPA (or similar) daily reference doses incorporates multiple assumptions and sources of variability and uncertainty:

- The EPA reference dose is an estimate, with uncertainty that may span an order of magnitude, which is intended as a reference point to gauge potential effects. The EPA may have little confidence in the validity of the data upon which the RfD are based. The toxicological profiles cited in Table 11 contain more details as to the levels of confidence in RfD values. RfD is not a direct estimator of risk, but rather a reference point to gauge the potential effects. At exposures increasingly greater than the RfD, the potential for

adverse health effects increases. However, lifetime exposure above the RfD does not imply that an adverse health effect would necessarily occur.

- The sample concentrations are based on whole-body fish samples, which may be valid for soups, stews, and fish meal products, but may be poor indicators of the concentrations in fish muscle tissue which may be the only portion of larger fish consumed.
- For the sake of standardization, we based our calculations on a hypothetical 60 kg consumer, typical of an adult male. However, children, females, and smaller males may be proportionally more susceptible to the deleterious effects of the same amounts of toxin. Risk may be higher per kg of body weight for pregnant females or persons with pre-existing health conditions.
- Our selection of a standard 8 ounce/225 gram fish serving per day is somewhat arbitrary but in keeping with EPA risk assessment conventions; toxin exposure would vary proportionally with larger or smaller serving sizes.

However, this standardization scheme allows for a relatively standardized comparison among potential contaminants, across fish species, and among sampling locations.

Disclaimer

These results and the accompanying discussion are only offered so that various residue levels may be compared to existing or emerging environmental and human toxicology data for determinations of potential impacts. The authors do not claim technical expertise in environmental or dietary toxicology, and do not intend for these statements to form the basis of any policy allowing or prohibiting human consumption of fish caught around Wake Atoll. Proper interpretation of the potential health and human safety aspects of consumption of contaminated fish are complex and include many factors such as contaminant concentration, size and frequency of fish meals, and individual characteristics of the consumer (e.g., size, sex, age, and reproductive and health status). All contaminant values reported here are based on whole-body samples, and thus may not be representative of the way fish would be eaten by human consumers. Further, thresholds for risk advisories vary by jurisdiction. Determinations about the suitability of fish for consumption by residents of Wake Atoll must be made by appropriate occupational health and safety personnel.

KEY CONCLUSIONS

If brodifacoum residues persist in fish tissues, they are below or near the limits of detectability. Between the 2012 sampling and the results reported here, 7 of 8 suspected brodifacoum detections (87.5%) occurred in a single species, the blacktail snapper (*Lutjanus fulvus*), a species which comprised only 13.6% of the fish sampled. It is unclear whether this result is due to a true presence of brodifacoum residues in these fish or a systematic error associated with the baseline noise upon which detection and quantification limits are based. Development of a species-specific noise baseline for establishment of detection and quantification thresholds may be warranted if concerns about brodifacoum residues in the species persist. Nearly imperceptible trace residues of brodifacoum are not known to have adverse human health effects.

A very low proportion of fish sampled (1-2%) were at or near the 0.3 mg/kg EPA Human Health Threshold for mercury. Both were bluefin trevally (*Caranx* sp.). Ninety percent of fish were below 0.1 mg/kg, though more than half of all fish caught would exceed the EPA reference dose if consumed in a 225-gram whole-body meal (as would the two control fish from a commercial fish market in Hilo, Hawaii). Eight meals per month is the risk-based consumption limit for most Wake fish to avoid risk of chronic mercury exposure.

Arsenic levels appear to be similar to those detected in a 2002 risk evaluation of chemical levels in fish tissues, levels which led the authors of the analysis to recommend an advisory against consuming fish from the lagoon. All fish sampled exceeded the EPA reference dose for arsenic, and EPA risk-based consumption limit tables indicate that any consumption of fish from Wake will exceed the recommended risk limits. However, it should be noted that the two control fish from a public fish market in Hilo, Hawaii, also exceeded the RfD threshold. Arsenic concentrations from this and the previous 2002 health risk assessment are based on a presumed ratio of inorganic arsenic to non-toxic organic arsenic; actual levels of toxic inorganic arsenic may be higher or lower than reported here.

Higher concentrations of toxic metals appear to occur at the Battery Dump site and in milkfish at a number of sites, though these patterns do not extend to the primary contaminants of concern, arsenic and mercury.

The samples collected for this assessment were almost exclusively taken from within the lagoon, and are not intended to represent the contamination status of pelagic fishes.

The data described in this report should inform the decisions of occupational health personnel when making determinations of acceptable risk and contemplating issuance of fish consumption advisories.

ACKNOWLEDGMENTS

This work was funded by the Pacific Air Force Regional Support Center (PRSC) under MIPR F2MUAA3351G002, and coordinated by Kristen Rex and Joel Helm, USAF 611 CES/CEIE, Natural Resources Support, Joint Base Pearl Harbor-Hickam. In addition to the some of the authors, the following personnel assisted with fish sample collection on Wake: Joel Helm, George Hartzog, and Phol Srimartr.

REFERENCES

Abreu, S.N., E. Pereira, C. Vale, and A.C. Duarte. 2000. Accumulation of mercury in sea bass from a contaminated lagoon (Ria de Aveiro, Portugal). Marine Pollution Bulleting 40(4):293-297

AnAge. 2015. AnAge: The animal aging and longevity database. Human ageing Genomic Resources, Liverpool, UK. Web. 29 December 2015.

ATSDR. 2002. Toxicological profile for beryllium. Agency for Toxic Substances and Disease Registry, U.S. Department of Human Health, Public Health Service, Atlanta, GA.

Bachmann, K.A., and T. J. Sullivan. 1983. Dispositional and pharmacodynamics characteristics of brodifacoum in warfarin-sensitive rats. Pharmacology 27: 281-288.

Bebbington, G.N., N.J. Mackay, R. Chvojka, R.J. Williams, A. Dunn, and E.H. Auty. 1977. Heavy metals, selenium and arsenic in nine species of Australian commercial fish. Australian Journal of Marine and Freshwater Research 28:277-286.

Booth, G. S., and P. Z. Mody. 2015. Brodifacoum inhalation and its clinical manifestations in a 21 year old Caucasian man. Laboratory Medicine 47(1):63-66.

Burger, J., and M. Gochfeld. 2005. Heavy metals in commercial fish in New Jersey. Environmental Research 99:403-412.

Burger, J., M. Gochfeld, T. Shukla, C. Jeitner, S. Burke, M. Donio, S. Shukla, R. Snigaroff, D. Snigaroff, T. Stamm, and C. Volz. 2007. Heavy metals in pacific cod (*Gadus microcephalus*) from the Aleutians: location, age, size, and risk. Journal of Toxicology and Environmental Health. 70:1897-1911.

Bustamente, P., P. Bocher, Y. Cherel, P. Miramand, and F. Caurant. 2003. Distribution of trace elements in the tissues of benthic and pelagic fish from the Kerguelen Islands. The Science of the Total Environment 313:25-39.

Crabtree, R., C. Handen, D. Snodgrass, and C. Stevens. 1996. Age, growth, and mortality of bonefish, *Albula vulpes*, from the waters of the Florida Keys. Fishery Bulletin, 94(3): 442-451.

Dee, A.J., and R. L. Radtke. 1989. Age and growth of the brick soldierfish, *Myripristis amaena*. Coral Reefs, 8(2): 79-85.

Dural, M., M. Z. L. Goksu, and A.A. Ozak. 2007. Investigation of heavy metal levels in economically important fish species captured from the Tuzla lagoon. Food Chemistry 102:415-421.

Fang, Y., D. Ye, C. Tu, L. Zhang, J. Ni, J. Shen, Z. Huang, Z. G. M. Wang, and B. Zhu. 2012. Superwarfarin rodent poisons and hemorrhagic disease. Epidemiology 23(6): 932-4.

FNB. 2016. Dietary Reference Intakes (DRIs): Elements. Food and Nutrition Board, Institute of Medicine, National Academies, Washington, DC. Web. 11 January 2016.

Froese, R., and D. Pauly. 1994. FishBase as a tool for comparing the life history patterns of flatfish. Netherlands Journal of Sea Research 32(3/4):235-239.

Harding, L., and D. Goyette. 1989. Metals in Northwest Pacific coastal sediments and fish, shrimp, and prawn tissues. Marine Pollution Bulletin 20(4):187-189.

Hernandez-Hernandez, F., J. Medina, J. Ansuategui, and M. Conesa. 1990. Heavy metal concentrations in some marine organisms from the Mediterranean Sea (Castellon, Spain): metal accumulation in different tissues. Scientia Marina 54(2):113-129.

Island Conservation. 2013. Wake Atoll Rodent Eradication Project: Post-operational report. Island Conservation, Santa Cruz, California.

Juresa, D. and M. Blanusa. 2003. Mercury, arsenic, lead and cadmium in fish and shellfish from the Adriatic Sea. Food Additives and Contaminants 20(3):241-246

Kalay, M., O. Ay, and M. Canli. 1999. Heavy metal concentrations in fish tissues from the northeast Mediterranean Sea. Bulletin of Environmental Contamination and Toxicology 63:673-681.

Katz, S.A., and H. Salem. 1992. The toxicology of chromium with respect to its chemical speciation: A review. Journal of Applied Toxicology 13(3): 217–224.

King, N., and M. H. Tran. 2015. Long-acting anticoagulant rodenticide (superwarfarin) poisoning: a review of its historical development, epidemiology and clinical management. Transfusion Medicine Reviews 29:250-258.

Laas, F. J., D. A. Forss, and M. E. R. Godfreyi. 1985. Retention of brodifacoum in sheep tissues and excretion in faeces. New Zealand Journal of Agricultural Research 28:357-359.

La Rosa, F. G., S. H. Clarke, and J. B. Leikowitz. 1997. Brodifacoum intoxication with marijuana smoking. Archives of Pathology and Laboratory Medicine 121(1):67-69.

Lewis, M.A., G.I. Scott, D.W. Bearden, R.L. Quarles, J. Moore, E.D. Strozier, S.K. Sivertsen, A.R. Dias, and M. Sanders. Fish tissue quality in near-coastal areas of the Gulf of Mexico receiving point source discharges. The Science of the Total Environment 284:249-261

Lipton, R. A., and E. M. Klass. 1984. Human ingestion of a superwarfarin rodenticide resulting in prolonged anticoagulant effect. Journal of the American Medical Association 252(21):3004-3005.

Mormede, S., and I.M. Davies. 2001. Heavy metal concentrations in commercial deep-sea fish from the Rockall Trough. Continental Shelf Research 21:899–916.

Musashino Keisoku. 2012. Quality Control Report, Measurement of Brodifacoum in Fish. Musashino Keisoku Ltd, Tachikawa, Japan.

Park, B.K., I.A. Choonara, B.P. Haynes, A.M. Breckenridge, R.G. Malia, and F.E. Preston. 1986. Abnormal vitamin K metabolism in the presence of normal clotting factor activity in factory workers exposed to 4-hydroxycoumarins. British Journal of Clinical Pharmacology 21:289-294.

Parkes, J., P. Fisher, and G. Forrester. 2011. Diagnosing the cause of failure to eradicate introduced rodents on islands: brodifacoum versus diphacinone and method of bait delivery. Conservation Evidence 8: 100-106.

Perugini, M., P. Visciano, M. Manera, A. Zaccaroni, V. Olivieri, and M. Amorena. 2014. Heavy metal (As, Cd, Hg, Pb, Cu, Zn, Se) concentrations in muscle and bone of four commercial fish caught in the central Adriatic Sea, Italy. Environmental Monitoring and Assessment 186:2205-2213.

Pitt, W.C., A.R. Berentsen, A.B. Shiels, S.F. Volker, J.D. Eisemann, A. Wegmann, and G. Howald. 2015. Non-target impacts and the fate of brodifacoum rodenticide residues after a rat (*Rattus rattus*) eradication on Palmyra Atoll, tropical Pacific. Biological Conservation 185:36-46.

Primus, T., G. Wright, and P. Fisher. 2005. Accidental discharge of brodifacoum baits in a tidal marine environment: a case study. Bulletin of Environmental Contamination and Toxicology 74:913-919.

Prudente, M., E. Kim, S. Tanabe, and R. Tatsukawa. 1997. Metal levels in some commercial fish species from Manila Bay, the Philippines. Marine Pollution Bulletin 34(8):671-674.

Rauch, A. E., R. Weininger, D. Pasquale, P. T. Burkart, H. G. Dunn, C. Weissman, and E. Rydzal. 1994. Superwarfarin poisoning: a significant public health problem. Journal of Community Heath 19(1):55-65.

Tariq, J., M. Jaffar, M. Ashraf, and M. Moazzam. 1993. Heavy metal concentrations in fish, shrimp, seaweed, sediment, and water from the Arabian Sea, Pakistan. Marine Pollution Bulletin 26(11):644-647.

Turkmen, A., M. Turkmen, Y. Tepe, and I. Akyurt. 2005. Heavy metals in three commercially valuable fish species from Iskenderun Bay, Northern East Mediterranean Sea, Turkey. Food Chemistry 91:167-172.

Tuzen, M. 2003. Determination of heavy metals in fish samples of the middle Black Sea (Turkey) by graphite furnace atomic absorption spectrometry. Food Chemistry 80:119-123.

URS Group. 2002. Risk evaluation of chemical levels in fish: Wake Island Airfield, Wake Atoll. Prepared by URS Group, Honolulu, for Air Force Center for Environmental Excellence.

Sztukowski, L.A., and D.C. Kesler. 2013. Bait consumption by Sooty Terns: implications for island eradication programmes. Bird Conservation International 23:36-44.

USEPA. 1996. Method 3052, Rev. 0 Microwave assisted acid digestion of siliceous and organically based matrices. EPA Office of Solid Waste, Washington, DC.

USEPA. 1998. EPA reregistration eligibility decision (RED): rodenticide cluster; 199 [EPA738R-98-007]

USEPA. 2000a. Guidance for Assessing Chemical Contaminant Data for Use in Fish Advisories Volume 1: Fish Sampling and Analysis. Third Edition. Office of Science and Technology, Office of Water, U.S. Environmental Protection Agency, Washington, DC

USEPA. 2000b. Guidance for Assessing Chemical Contaminant Data for Use in Fish Advisories Volume 2: Risk Assessment and Fish Consumption Limits. Third Edition. Office of Science and Technology, Office of Water, U.S. Environmental Protection Agency, Washington, DC

USEPA. 2007a. Method 6020A, Rev. 1. Inductively coupled plasma-mass spectrometry. EPA Office of Solid Waste, Washington, DC.

USEPA. 2007b. Mercury in solids and solutions by thermal decomposition, amalgamation, and atomic absorption spectrophotometry. EPA Office of Solid Waste, Washington, DC.

USFDA. 1993. Guidance Document for Arsenic in Shellfish. U.S. Food and Drug Administration, Center for Food Safety and Applied Nutrition, Washington, DC.

USNLM. 2016. Brodifacoum. TOXNET Toxicology Data Network, U.S. National Library of Medicine, Bethesda, Maryland. Web. 12 January 2016.

WHO. 1996. IPCS International Programme on Chemical Safety Health and Safety Guide no. 93: Brodifacoum Health and Safety Guide. United Nations Environment Programme, International Labour Organization, World Health Organization. Web. 27 December 2015.

APPENDIX A:

Measurement of brodifacoum in fish: Quality control report. November 2012. Musashino Keisoku Ltd.

APPENDIX B:

NWRC Analytical Chemistry Project Report: Determination of brodifacoum in fish (QA-2441)

Method: Determination of Anticoagulants in Fish

APPENDIX C:

NWRC Analytical Chemistry Project Report: Determination of brodifacoum in fish (QA-2441)

Method: Analytical Method for the Determination of Brodifacoum in Fish Using Dispersive Solid Phase Extraction and HPLC-APCI-MS/MS Detection

APPENDIX D:

Savannah River Ecology Laboratory, University of Georgia, metal analysis methods (A. Lindell)

APPENDIX E:

EPA Risk-based Fish Consumption Limit Tables

APPENDIX F:

Dietary Reference Intakes (DRIs): Elements

For: arsenic, chromium, copper, nickel, selenium, vanadium, zinc

ASSOCIATED AND COMPONENT PLANS

A	**WAKE ISLAND FISHING LOGS AND ANNUAL DATA COLLECTION SHEET**
B	**BIOLOGICAL CONTROL, SURVEY, AND MANAGEMENT PLAN FOR WAKE ISLAND AIRFIELD, KOKE'E AIR FORCE STATION, KAUAI, HAWAI'I AND MOUNT KA'ALA AIR FORCE STATION, OAHU, HAWAI'I**
C	**BIRD AIRCRAFT STRIKE HAZARD REDUCTION PLAN FOR WAKE ISLAND**
D	**WAKE ISLAND BIOSECURITY MANAGEMENT PLAN**

COMPONENT PLAN A

WAKE ISLAND FISHING LOGS

AND

ANNUAL DATA COLLECTION SHEET

2008

USAF/ 611 CES - Wake Atoll- Reef & Lagoon Fishing Log

Fishermen:	**Date:**	**Lagoon or Outer Reef:**	**Weather Conditions:**	**Gear Used:**	**No. of Hooks Deployed vs Retrieved:**
John Doe	28 Aug 2016	Lagoon	**(Cloud coverage and wind speed and direction)** Partly cloudy; ~ 5 knots out of N	Rod **(Hand line or rod)** **Gear Lost:** None	**1** and 1

Fish #	Time Started:	Appx. Location of Strike:	Appx. Depth of Strike:	Hook Type: (B = Barbed / BL = Barbless) (G = Galvanized, S = Stainless)	Species Caught:	Weight:	Total Length:	Caught and Kept: (Yes or No)	Other species interactions: (birds, sharks, turtles)	Time Finished:
				E X A M P L E						
Example	800	Flipper Point	2 ft.	B / G	Bonefish	2 lbs	16 inches	Yes	Saw a turtle in lagoon	900
1										
2										
3										
4										
5										
6										
7										

NOTE TO ISLAND RESIDENTS: THOSE WHO CONDUCT LAGOON OR REEF FISHING MUST SUBMIT THIS DATA SHEET TO THE BOS ENVIRONMENTAL OFFICE BEFORE THE END OF EVERY MONTH.

NOTE TO ISLAND VISTORS: THOSE WHO CONDUCT LAGOON OR REEF FISHING MUST SUBMIT THIS DATA SHEET TO THE BOS ENVIRONMENTAL OFFICE BEFORE THEY LEAVE THE ISLAND.

USAF/ 611 CES - Wake Pelagic Fishing Log

Fishermen: Jane Doe		**Date:** 30 Aug 2016	**Vessel Used:** USAF Whaler 1		**Weather Conditions: (Cloud coverage and wind speed and direction)** Sunny; ~ 10 knots out of the N/E		**Gear Used:** Hand Line **(Hand line or rod)** **Gear Lost:** None		**No. of Hooks Deployed vs Retrieved:** 4 and 5	
Fish #	**Time Started:**	**Appx. Location of Strike:**	**Appx. Depth of Strike:**	**Hook Type: (B = Barbed / BL = Barbless) (G = Galvanized, S = Stainless)**	**Species Caught:**	**Weight:**	**Total Length:**	**Caught and Kept: (Yes or No)**	**Other species interactions: (birds, sharks, turtles)**	**Time Finished:**
Example	730	Outside of the harbor channel	40 FT.	BL / G	Trevally	7 lbs.	22 inches	Yes	Spotted 3 sharks and 1 turtle	930
1										
2										
3										
4										
5										
6										
7										
8										

NOTE TO ISLAND RESIDENTS: THOSE WHO CONDUCT LAGOON OR REEF FISHING MUST SUBMIT THIS DATA SHEET TO THE BOS ENVIRONMENTAL OFFICE BEFORE THE END OF EVERY MONTH.

NOTE TO ISLAND VISTORS: THOSE WHO CONDUCT LAGOON OR REEF FISHING MUST SUBMIT THIS DATA SHEET TO THE BOS ENVIRONMENTAL OFFICE BEFORE THEY LEAVE THE ISLAND.

USAF/ 611 CES - Wake Atoll Annual Fishing Review and Assessment

611 CES & USFWS - Evaluation of biology of each target species and likely bycatch species with respect to proposed activity

Target, Live Bait, or Bycatch Species	Common Name	Conservation status of species targeted in other areas or at other geographical scales	CPUE by month (provide table and graph for each species targeted or caught incidentally)	Fishery independent measure of population size and fluctuations	Post release survival rates of any catch-release species	References to studies plans, or reports from other fisheries where this species is targeted	What proportion of Refuge population would be exposed to use as estimated by habitat accessibility?
What species is the row describing?		*What do we know about this species at Wake? What do we know about it at other locations?*	*How much time is spent conducting this activity per number of fish caught?*	*Is there data on the species that doesn't depend on fishing to collect it?*	*How many fish caught and released survive after they're*	*List any known references or studies that are relevant to this species and fishing for it at Wake.*	

COMPONENT PLAN B

BIOLOGICAL CONTROL, SURVEY AND MANAGEMENT PLAN FOR WAKE ISLAND AIR FIELD, KŌKE`E AFS, KAUAI, HAWAI`I AND MOUNT KA`ALA AFS, OAHU, HAWAI`I

Biological Control, Survey and Management Plan

Final Draft

Wake Island Air Field, Wake Atoll
Kōke`e Air Force Station, Kaua`i, Hawai`i
Mt. Ka`ala Air Force Station, O`ahu, Hawai`i

June 2015

BIOLOGICAL CONTROL, SURVEY AND MANAGEMENT PLAN

Wake Island Air Field
Kōke`e Air Force Station, Kauai, Hawai`i
and
Mount Ka`ala Air Force Station, Oahu, Hawai`i

Prepared for

Air Force Civil Engineer Center
and
Pacific Air Forces Regional Support Center

Contract: FA8903-10-D-8601-0089
Project: YGFZ621310

June 2015

THIS PAGE INTENTIONALLY LEFT BLANK

Abbreviations and Acronyms

°C	Degrees Celsius
°F	Degrees Fahrenheit
611 CES/AFCEC and CFPE	611 Civil Engineer Squadron/Air Force Civil Engineer Center
ADC	Animal Damage Control
AFS	Air Force Station
APHIS	Animal and Plant Health Inspection Service
ARS	Agricultural Research Service
BCSMP	Biological Control, Survey, and Management Plan
CBD	Convention on Biological Diversity
CES/CEPT	Civil Engineer Squadron/ Programs Technical Support
Chugach	Chugach Federal Solutions, Inc.
DBH	Diameter at breast height
DLNR	Department of Land and Natural Resources
DOD	Department of Defense
DOI	Department of the Interior
EA	EA Engineering, Science, and Technology, Inc.
EO	Executive Order
ft.	Foot (feet)
GISD	Global Invasive Species Database
GRIN	Germplasm Resources Information Network
HMU	Habitat management unit
in.	Inch(es)
INRMP	Integrated Natural Resources Management Plan
MAS	Microwave Antenna Site
MDA	Missile Defense Agency
msl	Mean sea level
Mt.	Mount
NPIC	National Pesticide Information Center
NRCS	Natural Resources Conservation Service
PIER	Pacific Island Ecosystems at Risk
POL	Petroleum, oil, and lubricant

PRC	Pacific Rim Conservation
SMDC	Space and Missile Defense Command
USAF	United States Air Force
U.S.C.	United States Code
USDA	United States Department of Agriculture
USEPA	United States Environmental Protection Agency
USFWS	United States Fish and Wildlife Service
yd.	Yard(s)

EXECUTIVE SUMMARY

Surveys for invasive and nonnative plant and animal species were conducted on Wake Atoll from 1 to 31 October 2013 and Kōke`e Air Force Station (AFS), Kaua`i, Hawai`i, which includes the Kōke`e Microwave Antenna Site (MAS), and Mount (Mt.) Ka`ala AFS, O`ahu, Hawai`i from 13 to 15 November 2013 to acquire data for development of this Biological Control, Survey and Management Plan (BCSMP) for the installations. **Section 1** (Introduction) of this document briefly describes the legal mandates requiring federal entities to implement pest management plans, and the biological and economic impacts of invasive species. **Section 2** (Physical Environment) describes the environmental settings of each installation relative to those parameters that have the most influence on establishment and propagation of invasive and nonnative species. **Sections 3, 4, and 5** (Invasive and Nonnative Species on Wake Atoll, Kōke`e AFS, and Mt. Ka`ala AFS) present general management methods and philosophies and current management methods for each installation. They then relate the methods and results of the invasive and nonnative plant and animal surveys for each installation and present information about the relevant invasive plants and animals for each installation.

Appendix A provides comprehensive plant lists for each installation. **Appendix B** provides copies of labels for primary recommended herbicides and pesticides. **Appendix C** contains a table outlining proposed invasive plant management actions on Wake Atoll by habitat management unit.

There were 34 invasive and nonnative plant species observed during the survey on Wake Atoll. Of these, 3 are listed on the Federal Noxious Weed List, 1 is listed on the Hawai`i Noxious Weed List, and 1 is listed on the Hawai`i Department of Land and Natural Resources Invasive Species List. Plants presenting the greatest problem on Wake Atoll are casuarina (*Casuarina equisetifolia*) and tangantangan (*Leucaena leucocephala*). Nine invasive and nonnative animal species were observed on Wake Atoll, of which various ant species present the greatest threat to native ecosystems.

There were 23 invasive and nonnative plant species observed during the survey at Kōke`e AFS. Of these, 1 is listed on the Federal Noxious Weed List, 3 are listed on the Hawai`i Noxious Weed List, and 1 is listed on the Hawai`i Department of Land and Natural Resources Invasive Species List. Most invasive vegetation at Kōke`e AFS is maintained through close mowing and does not present a significant threat to the native ecosystem or the installation's military mission.

There were 14 invasive and nonnative plant species observed during the survey at Mt. Ka`ala AFS. Of these, 2 are listed on the Federal Noxious Weed List, 3 are listed on the Hawai`i Noxious Weed List, and none are listed on the Hawai`i Department of Land and Natural Resources Invasive Species List. Most invasive vegetation at Mt. Ka`ala AFS is maintained through close mowing and does not present a significant threat to the native ecosystem or the installation's military mission.

THIS PAGE INTENTIONALLY LEFT BLANK

BIOLOGICAL CONTROL, SURVEY AND MANAGEMENT PLAN FOR WAKE ISLAND AIRFIELD, KŌKE`E AIR FORCE STATION AND MOUNT KA`ALA AIR FORCE STATION

FIGURES

TABLES

APPENDICES

THIS PAGE INTENTIONALLY LEFT BLANK

1. INTRODUCTION

This document provides the results of invasive and nonnative species surveys conducted on Wake Atoll (the Atoll); Kōke`e Air Force Station (AFS), Kaua`i, Hawai`i, which includes the Kōke`e Microwave Antenna Site (MAS); and Mount (Mt.) Ka`ala AFS, O`ahu, Hawai`i, as well as a management plan to address those species. In addition to their potential impacts on human activities, invasive species threaten the integrity and resilience of native ecosystems and are an increasingly frequent problem as global human movement presents opportunities for introduction of nonnative species. Island ecosystems are especially vulnerable to the effects of invasive species, but they also offer unique opportunities for eradication and management given their isolation. This Biological Control, Survey, and Management Plan (BCSMP) was developed in compliance with numerous legal mandates and directives, outlined below. In addition, this BCSMP is consistent with and is a component of the Integrated Natural Resources Management Plan (INRMP) for Wake Atoll, Kōke`e AFS, and Mt. Ka`ala AFS. The use of product names in this plan is for reference and not for endorsement.

1.1 LEGAL MANDATES AND DIRECTIVES FOR MANAGEMENT OF INVASIVE SPECIES

1.1.1 Federal Noxious Weed Act (7 United States Code §§ 2801–2814 as amended 1988 and 1994).

This Act requires that each federal agency:

- Develop a management program to control undesirable plants on federal lands under the agency's jurisdiction
- Establish and adequately fund the program
- Implement cooperative agreements with state agencies to coordinate management of undesirable plants on federal lands
- Establish integrated management systems to control undesirable plants targeted under cooperative agreements.

The Act directs the Secretaries of Agriculture and the Interior to coordinate programs for control, research, and educational efforts associated with noxious weeds. The Secretaries must identify regional control priorities and disseminate technical information to interested state, local, and private entities. The Secretary of Agriculture may provide cost share assistance to state and local agencies if a majority of landowners in an area agree to participate in a noxious weed management program. If an environmental assessment or environmental impact statement is required under the National Environmental Policy Act to implement plant control agreements, federal agencies must complete those assessments or statements within 1 year after the requirement is known (United States Department of Agriculture [USDA] 1994).

1.1.2 Executive Order 13112

On 3 February 1999, Executive Order (EO) 13112 was signed establishing the National Invasive Species Council. This EO requires that a Council representing departments dealing with invasive species be created. Currently there are 10 departments and agencies on the Council, including the Department of Defense (DOD). EO 13112 was empowered by a number of federal laws including the National Environmental Policy Act of 1969, as amended (42 United States Code [U.S.C.] 4321 et seq.); Nonindigenous Aquatic Nuisance Prevention and Control Act of 1990, as amended (16 U.S.C. 4701 et seq.); Lacey Act, as amended (18 U.S.C. 42); Federal Plant Pest Act (7 U.S.C. 150aa et seq.); Federal Noxious Weed Act of 1974, as amended (7 U.S.C. 2801 et seq.); Endangered Species Act of 1973, as amended (16 U.S.C. 1531 et seq.); and other pertinent statutes. The purpose of EO 13112 was to "prevent the introduction of invasive species and provide for their control and to minimize the economic, ecological, and human health impacts that invasive species cause." This EO can be viewed at *www.invasivespecies.gov/laws/execorder.shtml#sec2*. For the purpose of this plan, the most pertinent section is provided below.

1.1.3 Section 2. Federal Agency Duties

(a) Each Federal agency whose actions affect the status of invasive species shall, to the extent practicable and permitted by law,

(1) identify such actions;

(2) subject to the availability of appropriations, and within Administration budgetary limits, use relevant programs and authorities to: (i) prevent the introduction of invasive species; (ii) detect and respond rapidly to and control populations of such species in a cost-effective and environmentally sound manner; (iii) monitor invasive species populations accurately and reliably; (iv) provide for restoration of native species and habitat conditions in ecosystems that have been invaded; (v) conduct research on invasive species and develop technologies to prevent introduction and provide for environmentally sound control of invasive species; and (vi) promote public education on invasive species and the means to address them; and

(3) not authorize, fund, or carry out actions that it believes are likely to cause or promote the introduction or spread of invasive species in the United States or elsewhere unless, pursuant to guidelines that it has prescribed, the agency has determined and made public its determination that the benefits of such actions clearly outweigh the potential harm caused by invasive species; and that all feasible and prudent measures to minimize risk of harm will be taken in conjunction with the actions.

(b) Federal agencies shall pursue the duties set forth in this section in consultation with the Invasive Species Council, consistent with the Invasive Species Management Plan and in cooperation with stakeholders, as appropriate, and, as approved by the Department of State, when Federal agencies are working with international organizations and foreign nations (EO 13112, 1999).

Control is mandatory for those noxious species found on the Federal Noxious Weed List.

1.1.4 Department of Defense

DOD Directive 4715.1E, *Environment, Safety, and Occupational Health*, 19 March 2005; DOD Instruction 4715.03, *Natural Resources Conservation Program*, 18 March 2011; and DOD Instruction 4150.7, DOD *Pest Management Program*, 29 May 2008; collectively establish the need and process by which each DOD installation is to develop a pest management plan and incorporate that plan into natural resources planning and other installation activities. The DOD Pest Management Program is overseen by the Armed Forces Pest Management Board. Details of the DOD Pest Management Program can be seen at: *http://www.afpmb.org/*.

1.1.5 State of Hawai`i Title 11 (Agriculture and Animals) Chapter 152 (Noxious Weed Control)

Title 11 §152-3 (Noxious Weed Control) states that it shall be unlawful to introduce or transport specific noxious weeds or their seeds or vegetative reproductive parts into any area designated pursuant to Section 152-5 as free or reasonably free of those noxious weeds; provided that the introduction or transportation of those noxious weeds may be permitted for educational or research purposes when authorized by a permit issued by the department. [L 1975, c 44, pt of §1; am L 1987, c 92, §3].

Title 11§152-6 (Duties of the Department; Noxious Weed Control and Eradication) states that the USDA shall maintain a constant vigilance for incipient infestations of specific noxious weeds on islands declared reasonably free from those weeds, and shall use those procedures and methods to control or eradicate the infestations of noxious weeds as are determined to be feasible and practicable.

Hawai`i Administrative Rules, Title 4 - Department of Agriculture, Subtitle 6 - Division of Plant Industry, Chapter 68 – Noxious Weed Rules establish the guidelines to implement the requirements of Title 11, Chapter 152 and establish the criteria for designation, control, or eradication of noxious weeds.

1.2 BIOLOGICAL AND ECONOMIC IMPACTS OF INVASIVE PLANTS

Invasive plants can impact ecological systems at a variety of levels. They can impact the structure of ecological systems by changing the type and abundance of organisms in the environment, in addition to its physical features. The organization of ecological systems, in terms of relative abundance of the species and their interrelationships, can also be impacted. Finally, invasive plants can impact the function of ecological systems by altering various processes (e.g., nutrient cycling, soil and water dynamics) that occur within those systems. Typically, invasive plant infestations impact plant and animal communities (ecological systems) at all of these levels (Olson 1999).

Economic impacts of noxious invasive plants on agricultural lands include the loss of productivity (decreased income) from infested areas, increased cost for control of infestations

(increased expense), and loss of land value due to a combination of the first two impacts (loss of potential income). The economic impacts of infestations on wildlands are related to reduction of wildlife habitat and revenues derived from hunting, fishing, and tourism, and the loss of watershed function.

1.3 BIOLOGICAL AND ECONOMIC IMPACT OF INVASIVE ANIMALS

Invasive animal species typically have high reproductive rates, disperse easily, and can tolerate a wide range of environmental conditions. Their natural predators are usually missing from their new environment, allowing invasive animals to out-compete native species for prey, breeding sites, and other resources. Invasive animals can also prey upon native species, spread pathogens and parasites, or alter the genetic makeup of closely related species. Invasive animals, such as the brown tree snake (*Boiga irregularis*) on Guam, have been responsible for the extinction of other native species.

The economic impact of invasive animals can be just as costly as invasive plant species. For example, the United States and Canada spend $14 million per year to control the sea lamprey (*Petromyzon marinus*). Invasive fish species pose a huge economic threat to the commercial and recreational fishing industry. An invasive rodent, the nutria (*Myocastor coypus*), has been responsible for the erosion of thousands of acres in the eastern coastal United States, ranging from Maryland to Florida. This type of ecological and economic impact is immeasurable.

In the Midwest, Japanese beetles (*Popillia japonica)* cause damage to agriculture (e.g., blueberries and corn) and horticulture (e.g., roses). In Summer 2006, Japanese beetles were so thick in southern Illinois that single traps in Massac County caught more than 155,000 beetles in 1 week. The Japanese beetle is the most widespread turf-grass pest in the United States. Efforts to control the larval and adult stages are estimated to cost more than $460 million a year. Losses attributable to the larval stage alone have been estimated at $234 million per year, $78 million for control costs, and an additional $156 million for replacement of damaged turf (Animal and Plant Health Inspection Service [APHIS] 2006).

2. PHYSICAL ENVIRONMENT

2.1 WAKE ATOLL

2.1.1 Location and Area

Wake Island is a small coral atoll in the Pacific Ocean (Micronesia) approximately 2,460 miles west of Honolulu, Hawai`i, 1,590 miles east of Guam, 2,000 miles southeast of Japan, and 690 miles north of Kwajalein Atoll. Wake Atoll lies at approximately 19°18'North latitude and 166°37'East longitude. The Atoll has a total land area of approximately 2.73 square miles and a total circumference of approximately 10 miles. The Atoll consists of three islands (Peale, Wake, and Wilkes islands) arranged in a "V" pattern with a shallow lagoon that is open to the ocean on the northwest side (**Figure 2-1**).

Wake Atoll

2.1.2 Climate

The climate of Wake Atoll is tropical maritime. Northeast trade winds dominate the island and winds blow steadily throughout the year with little variation. More than 50 percent of wind observations taken during the year are from the east to the northeast. The yearly average wind speed is 13.8 miles per hour (United States Air Force [USAF] 2007).

Temperature variation on Wake Atoll is minimal with a yearly maximum of 95° Fahrenheit (F) (35° Centigrade [C]]) and a minimum of 68°F (20°C). Relative humidity ranges from 69 to 80 percent. Mean monthly temperatures range from 76°F (24.4°C) to 83°F (28.3°C). February, the coldest month of the year, has an average daily high of 82°F (27.7°C) and an average daily low of 72°F (22.2°C). August is generally the warmest month with an average daily high temperature of 88°F (31.1°C) and an average daily low of 77°F (25°C). Dense polar air masses occasionally push southward through the region during the winter months. The record low temperature of 64°F (17.8°C) for Wake Atoll was recorded in December 1954 during one of these events.

Rainfall is light averaging only about 35 inches (in.) per year. Rain showers occur most often between midnight and sunrise. The wettest season is from July through October. This coincides with the pacific typhoon season. During this period, rainfall can be significant during storm episodes. Cloud cover is reported to be about 50 percent (Department of the Interior [DOI] 2007); however, clouds are heaviest during the late summer and early fall typhoon season, when cumulus clouds predominate.

2.1.3 Landforms

Wake Atoll is a typical coral atoll. An atoll is a ring-like coral island enclosing a lagoon. Atolls originate from oceanic volcanoes that rise above the ocean surface. Deflation of the magma chamber and subsidence and erosion, over time, reduces the extent of the volcanic cone and allows coral communities to develop around the edges. When the subsidence rate is relatively slow (and about equal to the rate of coral growth) the coral continues to flourish. As the cone subsides beneath the surface, the associated coral reef remains surrounding the location of the former volcanic crater. The crater, now represented by a lagoon, may have one or more coral islands established on the former rim around the crater.

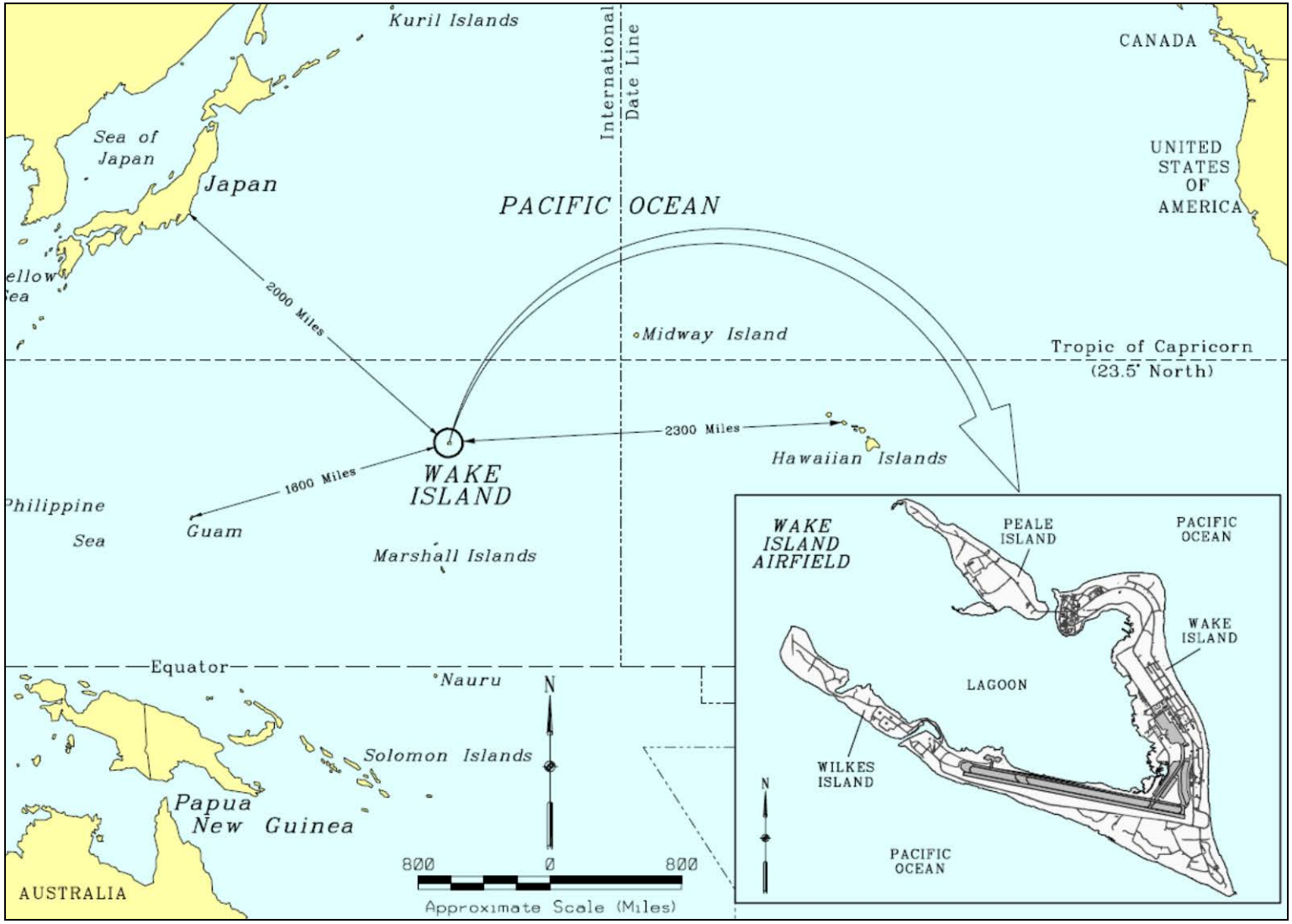
Wake Atoll is collectively comprised of three islands: Peale, Wake, and Wilkes islands (**Figure 2-1**). The three islands enclose the shallow lagoon on three sides. The three islands form a "V" or "wishbone" shape pointed to the southeast. Wake Island is the largest of the three islands and comprises the outer perimeter of the eastern half of the Atoll. Peale and Wilkes islands continue the length of the wishbone's "arms" on the north and south, respectively. The natural channel between Wilkes and Wake islands is currently blocked by a solid fill causeway. The channel between Peale and Wake islands was spanned by a concrete causeway constructed by the occupying Japanese forces during World War II, and later a wooden bridge (now burned down). The lagoon is open on its northwestern end, except for the coral reef that surrounds the Atoll and completes the lagoon enclosure.

The islands have an average elevation of 12 feet (ft.) and a maximum elevation of 21 ft. above mean sea level (msl). The outside, seaward face of Wake Island maintains a fairly uniform elevation of approximately 18 ft., with a gradual slant toward the center of the island and then to the lagoon (DOI 2007). Each of the islands is characterized by fairly level terrain. However, the excavation of World War II tank traps and other defensive trenches on Wilkes and Peale islands has resulted in some localized rugged terrain. There are three high points on the Atoll, each exceeding 20 ft.: on the northern tip of Wake Island at Heel Point; on Peale Island about 500 yards (yd.) from Toki Point, which is at the northwest tip of the island; and on Wilkes Island on the lagoon side about 750 yd. from Kuku Point, which is at the northwest tip of the island (DOI 2007).

Collectively, the three islands include about 1,747 acres. Each arm of the "wishbone" is about 4 miles in length and combined they measure nearly 9 miles from tip to tip. The widest point of the Atoll is 2 miles, measured between Heel Point and Peacock Point on Wake Island. The Pacific shoreline and lagoon shoreline combined measure nearly 25 miles (USAF 1994).

Broad coral-cobble beaches occur along the northern seaward sides of Peale and Wake islands. The beaches range in width from 20 yd. to about 170 yd., with an average width of 100 yd. Irregular, large coral heads form the bright white beaches. Natural sandy terraces and embankments exist only in limited locations. The most notable sandy terraces and embankments occur along the northern coast of Peale Island and the western and northwestern shores of Wilkes Island. Some pristine white sand beaches occur on the lagoon side of Peale Island.

Figure 2-1. Location of Wake Atoll



Source: CH2MHILL in EA 2013

THIS PAGE INTENTIONALLY LEFT BLANK

2.1.4 Landforms

Wake Atoll is a typical coral atoll. An atoll is a ring-like coral island enclosing a lagoon. Atolls originate from oceanic volcanoes that rise above the ocean surface. Deflation of the magma chamber and subsidence and erosion, over time, reduces the extent of the volcanic cone and allows coral communities to develop around the edges. When the subsidence rate is relatively slow (and about equal to the rate of coral growth) the coral continues to flourish. As the cone subsides beneath the surface, the associated coral reef remains surrounding the location of the former volcanic crater. The crater, now represented by a lagoon, may have one or more coral islands established on the former rim around the crater.

Wake Atoll is collectively comprised of three islands: Peale, Wake, and Wilkes islands (**Figure 2-1**). The three islands enclose the shallow lagoon on three sides. The three islands form a "V" or "wishbone" shape pointed to the southeast. Wake Island is the largest of the three islands and comprises the outer perimeter of the eastern half of the Atoll. Peale and Wilkes islands continue the length of the wishbone's "arms" on the north and south, respectively. The natural channel between Wilkes and Wake islands is currently blocked by a solid fill causeway. The channel between Peale and Wake islands was spanned by a concrete causeway constructed by the occupying Japanese forces during World War II, and later a wooden bridge (now burned down). The lagoon is open on its northwestern end, except for the coral reef that surrounds the Atoll and completes the lagoon enclosure.

The islands have an average elevation of 12 ft. and a maximum elevation of 21 ft. above mean sea level (msl). The outside, seaward face of Wake Island maintains a fairly uniform elevation of approximately 18 ft., with a gradual slant toward the center of the island and then to the lagoon (DOI 2007). Each of the islands is characterized by fairly level terrain. However, the excavation of World War II tank traps and other defensive trenches on Wilkes and Peale islands has resulted in some localized rugged terrain. There are three high points on the Atoll, each exceeding 20 ft.: on the northern tip of Wake Island at Heel Point; on Peale Island about 500 yd. from Toki Point, which is at the northwest tip of the island; and on Wilkes Island on the lagoon side about 750 yd. from Kuku Point, which is at the northwest tip of the island (DOI 2007).

Collectively, the three islands include about 1,747 acres. Each arm of the "wishbone" is about 4 miles in length and combined they measure nearly 9 miles from tip to tip. The widest point of the Atoll is 2 miles, measured between Heel Point and Peacock Point on Wake Island. The Pacific shoreline and lagoon shoreline combined measure nearly 25 miles (USAF 1994).

Broad coral-cobble beaches occur along the northern seaward sides of Peale and Wake islands. The beaches range in width from 20 yd. to about 170 yd., with an average width of 100 yd. Irregular, large coral heads form the bright white beaches. Natural sandy terraces and embankments exist only in limited locations. The most notable sandy terraces and embankments occur along the northern coast of Peale Island and the western and northwestern shores of Wilkes Island. Some pristine white sand beaches occur on the lagoon side of Peale Island.

2.1.5 Vegetation

2.1.5.1 Historical Vegetative Cover

The environmental conditions conducive to developing complex and varied plant associations are lacking on Wake Atoll. The lack of soils, soil nutrients, and organic matter is made more inhospitable by rapid drainage through the porous calcareous substrate. With minimal topographic relief, there is little opportunity for the development of microclimatic conditions. High temperatures and limited rainfall keeps the island in a perpetual state of drought. An average annual rainfall of 35 in. provides little drought relief. Combined with harsh ambient environmental conditions, the natural vegetation of Wake Atoll has been subjected to some extreme human disturbance as well as periodic natural disturbances.

Human disturbance reached a peak during the 3 years of Japanese occupation beginning in December 1941. During that period, pre-existing American fortifications were greatly expanded by the Japanese leaving scarcely any of the ground untouched. Ditches, tank traps, platforms, ruined buildings, gun emplacements, revetments and underground facilities were nearly everywhere. Frequent bombardment by American planes and occasionally ships further ravaged the landscape. Starving Japanese soldiers consumed any edible plant materials. A few years after the war, Fosberg (1959) mentions a personal source who reported that the vegetation over the island was generally about a foot high in 1947, with the exception of a few small areas. Fosberg (1959) also described the pisonia (*Pisonia grandis*)/cordia (*Cordia subcordata*) forest as "the most stable and mesophytic vegetation type" on Peale Island in 1953. However, he returned in 1969 to find that almost the entire vegetation type had succumbed to the "overzealous use of a bulldozer" (Fosberg and Sachet 1969). In a few nearby areas, only clumps of "fairsized" pisonia and cordia trees remained. Other vegetation noted by Fosberg (1959) included casuarina (*Casuarina equisetifolia*). On Wake Atoll, Fosberg (1959) reported that casuarina "were doing well around the Transocean Air Lines Compound and buildings elsewhere" in 1953; however, it was not until the 1970s that casuarina trees were extensively planted as ornamentals and wind breaks around buildings in the former housing area of Wake Island.

The conditions at Wake Atoll are fairly typical of the coral atolls of the Marshall, Ellis, and Gilbert islands province in the western Pacific. These conditions lead to a set of predictable natural plant communities from one atoll to another. The frequent occurrence of tropical storms and typhoons subjects the Atoll to a regime of frequent and often devastating disturbance. The low elevation makes the island very susceptible to damage from high winds and waves generated by tropical storms. In the 43-year period between 1952 and 1994, at least 19 typhoons occurred within 100 nautical miles (~115 statute miles) of Wake Atoll (Hitchcock pers. comm.). In 1992, two typhoons caused extensive damage to the base infrastructure. Heavy damage occurred again with high wave action from a typhoon in July 1994 and high water from a tsunami in February 1998 (Space and Missile Defense Command [SMDC] 1999). Super Typhoon Ioke in August 2006 not only damaged base infrastructure but also dramatically thinned out the vegetation by stripping leaves and terminal branches of casuarina and tournefortia (*Tournefortia argentea*) trees and completely washed over the northern end of Peale Island uprooting almost all vegetation.

2.1.5.2 Current Vegetative Cover

The harsh climate, inhospitable substrate, and regime of frequent, catastrophic disturbance combine to maintain the natural vegetation in an early successional stage. Ecologically, each of the indigenous species can be considered a pioneer species with broad ecological tolerance for high salinity, droughty conditions, and frequent disturbance. Three natural plant associations can be described on the unimproved grounds of Wake Atoll based loosely on a moisture gradient. The most xeric, or driest, is the tournefortia forest that occurs on coral rubble and shell substrates. Slightly more mesic conditions support the cordia forest. The hydric association of pemphis scrub is found on saturated sandy substrates. Other common vegetative communities include casurania forest, ruderal vegetation and mowed/maintained vegetation.

Tournefortia is the most widespread of the native trees on the Wake Atoll. Mature trees seldom exceed 20 ft. in height. Tournefortia is usually the first woody plant to occur on the cobble beaches of the windward, northeastern sides of Peale and Wake islands. They appear to thrive in some of the least fertile, most xeric conditions on the Atoll. Along the beach they often occur as neatly rounded shrubs reaching 3-6 ft. in height. In these locations, especially along the northeastern coastline, they often occur in association with scaevola (*Scaevola taccada*). Inland, where there is some shelter, tournefortia forms open, almost pure stands. This is especially true on Peale Island where most of the central portion of the island is fully forested. In these locations, cordia is a common associate, especially in the slightly lower areas where the remnants of Japanese World War II defensive structures are still evident. Presumably, these somewhat lower areas accumulate some organic matter and may retain some moisture.

Cordia is a small to medium sized tree native to the Pacific that grows to an average of 23-33 ft. This tree prefers warm coastal areas on the leeward side of islands, but can tolerate semi-moist inland portions of islands. Cordia has made a comeback on Peale Island since being bulldozed in the 1960s.

Pemphis is a closely branched shrub with very hard wood. It is the predominant species lining the lagoon margin on Wake, Wilkes, and Peale islands. It is also the dominant species lining the open brackish ponds on the golf course, behind the petroleum, oil, and lubricant (POL) area, and the detention basin at the northeastern end of the flightline. A well-developed community is likewise present around the wetland areas of Wilkes Island. The pemphis scrub is best developed on the saturated sandy substrates of the lagoon margin, but they persist inland on the drier sandy flats that adjoin the lagoon, along the edges of the brackish ponds, it again occupies the saturated zone immediately adjacent to the open water. The most common associate is seaside purslane (*Sesuvium portulacastrum*). Seaside purslane is a prostrate, mat-forming, fleshy plant. It is visually striking with glossy green leaves and bright red stems. It is common along the saturated zone of the lagoon on all three islands and the edges of the brackish ponds on Wake and Wilkes islands.

Casuarina forests on the island are typically associated with a minimal understory and ground layer. Casuarina is well-adapted to the austere substrate conditions of tropical atolls and once introduced can be an aggressive invasive plant. It tends to crowd and shade out native vegetation. It has allelopathic properties so it is able to prevent seed germination of other species.

As a result, the casuarina forest progresses towards being a monoculture rapidly. Casuarina forests are characterized by low species richness and diversity. While they provide nest sites for arboreal nesting birds, they preclude the ground nesting sooty terns (*Onychoprion fuscatus*) and gray-backed terns (*Onychoprion lunatus*). Where casuarina invade sandy beaches, their dense root structure prevents sea turtles from digging burrows. Casuarina trees have been exported and planted throughout the subtropics and tropics, worldwide. Rapid growers, they have developed into well-developed stands in the former housing, industrial, and Missile Defense Agency (MDA) areas of Wake Island, much of the eastern half of Wilkes Island, and to a lesser extent on Peale Island. Left alone, casuarina present a very real threat to overtake the entire Atoll.

Ruderal vegetation is found in disturbed or altered habitats that typically receive occasional mowing or other disturbance. Since disturbance and habitat alteration characterize all areas of the Atoll, the frequency of ground maintenance and mowing activities is the key factor. Ruderal areas support mostly introduced or weedy plant species and are found primarily on Wake Island on semi- improved grounds. At these locations, the ground cover is generally over 50 percent with bare shell/coral/sand substrate clearly visible.

Mowed/maintained vegetation occurs in areas where routine grounds maintenance and mowing occurs. These areas occur primarily on Wake Island. Selective grounds maintenance is performed on Wilkes Island in the vicinity of the POL yard and the seabird refuge. No grounds maintenance activities are conducted on Peale Island. Like ruderal areas, mowed/maintained areas support mostly introduced or weedy plant species and are found primarily on Wake Island (e.g., airfield, housing areas and adjacent to roads). Ground cover in the mowed/maintained areas is generally over 50 percent with bare shell/coral/sand substrate clearly visible.

Surveys to update vegetation mapping were conducted on Wake Atoll from 1 to 31 October 2013 by EA Engineering, Science, and Technology, Inc. (EA). Preliminary characterization of vegetation on Wake Atoll was based on review of existing information, including general vegetation maps included in the September 2008 INRMP for Wake Atoll (USAF 2008) and review of aerial photography of the Atoll provided by the 611 CES/CEPT. The delineation of vegetation mapping unit boundaries in the field was based on the identification of the dominant vegetation characterizing cover types observed on the ground and determining boundaries based on the aerial photography and actual on the ground extent of the cover type. Following completion of the vegetation survey, Wake, Wilkes, and Peale islands were separated into a series of habitat management units (HMUs). Most of the HMU boundaries were defined by physical boundaries such as roads, beaches, or other features that could act as fire breaks, and were not based on the boundaries of vegetation communities. Site visits were conducted at each of the HMUs to characterize general topography and physical site characteristics, dominant vegetative cover types (consistent with the vegetation survey) including invasive species and approximate percent of coverage as a component of overall vegetative cover within the HMU. Dominant understory and herbaceous vegetation occurring within each HMU was also characterized. The HMUs were delineated and characterized to assist in the development of natural resources management actions and approaches, and for determining level of effort that could be expected to implement actions within a given HMU. The HMU descriptions provide some site-specific detail useful for determining appropriate management actions within the units. Specific management actions can be developed and applied to each of the units, or to a group of

HMUs depending on management goals and available resources. **Figure 2-2** shows the HMUs delineated on Wake Atoll. **Figures 2-3a through 2-3k** show the HMUs with vegetation mapping units based on the surveys conducted from 1 to 31 October 2013. Each of the vegetation mapping units shown in the figures includes a unique designator number. **Table 2-1** provides the acreage of each of the vegetation mapping unit polygons delineated on the Atoll based on the vegetation survey. The vegetation mapping units in the table are identified by the unique designator numbers shown on Figures 2-3a through 2-3k.

Sixty-five HMUs were delineated on Wake Atoll. The acreages of each HMU, general location and boundary descriptions, general topographic characteristics, vegetation community descriptions, and characteristic plant species for each of the HMUs are included below. **Table 2-2** provides the acreage of each HMU on Wake Atoll and the percent coverage of vegetation communities characterizing each of the 65 units. Note that the acreage total for the HMUs in Table 2-2 is greater than the total for vegetative cover in Table 2-1. The total acreage for the HMUs is greater because it includes built structures within the HMUs. The vegetative acreage in Table 2-1 only includes actual vegetation coverage and does not include built structures. The most up-to-date comprehensive list of vegetation occurring on Wake Atoll can be found in **Appendix A**.

Wake Atoll HMU-1

Looking north across HMU-1

HMU-1 is approximately 37 acres located in the northern section of Wilkes Island. The HMU is characterized by mowed/ruderal scrub habitat with a fringe of tournefortia adjacent to the beach along its north, west, and east sides. Topography in HMU-1 is disturbed and generally flat lying. HMU-1 supports a rookery for several bird species including sooty terns, brown boobies (*Sula leucogaster),* masked boobies (*Sula dactylatra*), red-footed boobies (*Sula sula*), great frigate birds (*Fregata minor*), and wedge-tailed shearwaters (*Puffinus pacificus*). The site is mowed on an annual basis to maintain conditions suitable for the rookery. Vegetation in HMU-1 is characterized by ‘ilima (*Sida fallax*), puncture vine (*Tribulus cistoides*), moon flower (*Ipomoea tuba*), Kunana pepperwort (*Lepidium bidentatum*), yellow purslane (*Portulaca lutea*), common purslane (*Portulaca oleracea*), hairy spurge (*Chamaesyce hirta*), hairy horseweed (*Conyza bonariensis*), Pacific Island thintail (*Lepturus repens*), crowfoot grass (*Dactyloctenium aegyptium*), and swollen fingergrass (*Chloris barbata*).

- Coverage of mowed/maintained area is approximately 90 percent.
- Coverage of tournefortia forest is approximately 10 percent.

Wake Atoll HMU-2

Treated casuarina in HMU-2

HMU-2 is approximately 26 acres located in the southeastern section of Wilkes Island. Topography in HMU-2 is disturbed with areas of gently rolling to rugged terrain. HMU-2 is characterized by casuarina forest in its southern section. There is an area of dead casuarina in the southern section of the HMU as a result of previous management actions to control the tree. The area was treated with Pathfinder II (United States Environmental Protection Agency [USEPA] Registration Number 62719-176) using a basal bark cut/painting method in 2013 (Teig 2013). The casuarina forest changes to tournefortia forest with some cordia, casuarina, and patchy open areas in the north. Understory and open areas in the tournefortia forest are characterized by sourbush (*Pluchea carolinensis*), ‘ilima, moon flower, yellow purslane, common purslane, hairy spurge, Kunana pepperwort, hairy horseweed, swollen fingergrass, crowfoot grass, and button sedge (*Fimbristylis cymosa*). There is a narrow band of pemphis (scrub along the shoreline) on the north and east sides of HMU-2. The casuarina in HMU-2 consists of trees with diameters at breast height (DBHs) of up to approximately 10 in.

- Coverage of casuarina in HMU-2 is approximately 20 percent.
- Coverage of tournefortia forest is approximately 70 percent.
- Coverage of pemphis forest is approximately 10 percent.

Wake Atoll HMU-3

HMU-3 is approximately 22.02 acres located in the southwestern section of Wilkes Island. The topography of HMU-3 is disturbed with areas of gently rolling to rugged terrain. Characteristic vegetation in HMU-3 is the same as HMU-2. The forested area contains casuarina, tournefortia, and cordia. Understory and open areas in the tournefortia forest are characterized by sourbush, ‘ilima, moon flower, yellow purslane, common purslane, hairy spurge, Kunana pepperwort, hairy horseweed, swollen fingergrass, crowfoot grass, and button sedge. There is a narrow band of pemphis scrub along the shoreline on the southwest side of HMU-3. The casuarina in HMU-3 are limited to trees with DBHs of up to approximately 10 in.

- Coverage of casuarina in HMU-3 is approximately 10 percent.
- Coverage of tournefortia forest is approximately 80 percent.
- Coverage of pemphis forest is approximately 10 percent.

Figure 2-2. Location of HMUs on Wake Atoll

THIS PAGE INTENTIONALLY LEFT BLANK

Wake Atoll HMU-4

Ruderal scrub in HMU-4

HMU-4 is approximately 18.66 acres located on Wilkes Island to the southeast of the submarine channel. HMU-4 is bordered on the north and northeast by Wilkes Avenue, on the southwest by ocean shoreline, and to the southeast by an unnamed road associated with the POL yard. Topography in HMU-4 is disturbed with some areas of rugged terrain associated with excavations and areas of pushed up rubble and rock. The northern section of HMU-4 is characterized by casuarina forest intermixed with patchy areas of tournefortia and sourbush. There is a large area of tournefortia and sourbush scrub with some pemphis and open ruderal scrub around the edge in the east and central sections of HMU-4. Cordia occurs in a small area associated with excavations in the north-central section of the HMU and there is a strip of scaevola intermixed with some casuarina and tournefortia along the shoreline. Understory vegetation in the casuarina forest is absent. Vegetation associated with tournefortia, sourbush, and open areas is characterized by upland cotton (*Gossypium hirsutum*), beach moonflower (*Ipomoea violacea*), swollen fingergrass, hairy spurge, Canada horseweed (*Conyza canadensis* var. *pusilla*), hairy horseweed, white beggar-ticks (*Bidens alba*), Jamaican vervain (*Stachytarpheta jamaicensis*), and button sedge. Tournefortia also occurs along the shoreline. The casuarina in HMU-4 range from saplings up to trees with DBHs of up to approximately 18 in.

- Coverage of casuarina in HMU-4 is approximately 30 percent.
- Coverage of tournefortia-mixed in HMU-4 is approximately 40 percent.
- Coverage of cordia is approximately 10 percent.
- Coverage of scaevola-mixed is approximately 20 percent.

Wake Atoll HMU-5

HMU-5 is approximately 21.14 acres located in the northern tip of the section of Wilkes Island to the southeast of the submarine channel. HMU-5 is bordered by the lagoon shoreline to the north, Wilkes Avenue to the south, the POL yard area to the east, and the submarine channel to the west. Topography in HMU-5 generally slopes towards the lagoon and is characterized by disturbed rolling terrain with scattered rock piles. The eastern end of HMU-5 is characterized primarily by tournefortia forest with some pemphis and several large casuarina at and near the eastern boundary. The understory is sparsely vegetated and is primarily associated with openings and cleared areas adjacent to the roads. Understory vegetation is characterized by sourbush, slender mimosa (*Desmanthus pernambucanus*), hairy spurge, Jamaican vervain, beach moonflower, `uhaloa (*Waltheria indica*), `ilima, sandbur (*Cencrus echinatus*), white beggar-ticks, hairy horseweed, Canada horseweed, swollen fingergrass, and Pacific Island thintail.

There are several casuarina saplings and small trees to the west of the end of the fuel tank area. In the western half of HMU-5, the tournefortia and pemphis forest changes to casuarina forest with no understory vegetation. There are some small areas of pemphis and tournefortia forest along the shoreline. The casuarina in the western half of HMU-5 range from saplings up to trees with DBHs of approximately 10 in. Many of the saplings and trees are multi-trunked.

- Coverage of casuarina in HMU-5 is approximately 70 percent.
- Coverage of tournefortia-mixed forest is approximately 25 percent.
- Coverage of herbaceous vegetation in open areas and along roads is approximately 5 percent.

Wake Atoll HMU-6

HMU-6 is approximately 13.31 acres located at the southeast end of Wilkes Island just northwest of the inlet channel to the marina and along the ocean shoreline to the southwest of the fuel tank area. Topography in HMU-6 is disturbed with some areas of rugged terrain associated with excavations, a dump area, and areas of pushed up rubble and rock. Vegetation in the northwestern half of HMU-6 is primarily characterized by casuarina forest with no understory vegetation. Vegetation in open areas adjacent to the roadway and in cleared areas, including the dump area, is characterized by `uhaloa, hairy spurge, hairy horseweed, Canada horseweed, passion fruit (*Passiflora foetida* var. *hispida*), four-spike heliotrope (*Heliotropium procumbens* var. *depressum*), Jamaican vervain, white beggar-ticks, and beach moonflower. The northeast section of HMU-6 is characterized primarily by casuarina with a mix of tournefortia, sourbush, pemphis, and passion fruit. The northwest section of HMU-6 is characterized by a narrow band of casuarina, scaevola, tournefortia, and sourbush along the roadway with some herbaceous vegetation in the open areas.

Casuarina along the shoreline in HMU-6

- Coverage of casuarina in HMU-6 is approximately 75 percent.
- Coverage of tournefortia scrub is approximately 15 percent.
- Coverage of open unvegetated areas is approximately 10 percent.

Wake Atoll HMU-7

HMU-7 is approximately 19.56 acres associated with the POL yard in the southeast section of Wilkes Island. HMU-7 is characterized by mowed/maintained vegetation on flat graded topography. Vegetation in HMU-7 is characterized by button sedge, hairy spurge, Canada

horseweed, hairy horseweed, white beggar-ticks, coat buttons (*Tridax procumbens*), sandbur, thin paspalum (*Paspalum setaceum*), and other grass species.

- Coverage of mowed/maintained areas in HMU-7 is 100 percent.

Wake Atoll HMU-8

HMU-8 is approximately 5.61 acres located in the southeast corner of Wilkes Island. HMU-8 is bordered on the north by the lagoon, the south and east by Wilkes Avenue, and the northwest by HMU-5. The HMU is characterized by disturbed topography along the lagoon shoreline. Vegetation is characterized by casuarina forest mixed with some tournefortia and pemphis, primarily along the shoreline. Understory vegetation is sparse and characterized by `uhaloa, button sedge, hairy spurge, Canada horseweed, Jamaican vervain, beach moonflower, wild poinsettia (*Euphorbia cyathophora*), sandbur, nutgrass (*Cyperus rotundus*) and swollen fingergrass. The casuarina in HMU-8 range from saplings up to trees with DBHs of up to approximately 8 in.

- Coverage of casuarina in HMU-8 is approximately 65 percent.
- Coverage of tournefortia-mixed is approximately 20 percent.
- Coverage of vines and understory is approximately 15 percent.

Wake Atoll HMU-9

HMU-9 is approximately 4.03 acres located at the southeast end of Wilkes Island along the northwest side of the marina entrance channel. The HMU is characterized primarily by casuarina forest on disturbed gently rolling topography. There is an unimproved two-track road that runs north to south through the HMU. Minor tournefortia, pemphis, and cordia also occur in the overstory, primarily in the southeast end of the site. There is a narrow band characterized by pemphis along the mariana channel shoreline. Areas of tangantangan (*Leucaena leucocephala*) occur in the northeast, central, and southwest sections of the HMU. Understory vegetation is sparse and occurs primarily along the road and in open areas. Understory vegetation is characterized by `uhaloa, button sedge, hairy spurge, Canada horseweed, hairy horseweed, Jamaican vervain, beach moonflower, upland cotton, and passion fruit. The casuarina in HMU-8 range from saplings up to trees with DBHs of up to approximately 8 in.

- Coverage of casuarina in HMU-9 is approximately 70 percent.
- Coverage of tangantangan is approximately 15 percent.
- Coverage of scaevola-mixed is approximately 15 percent.

Wake Atoll HMU-10

HMU-10 is approximately 59.67 acres located along the southern shore of the lagoon between the west end of the causeway to Wilkes Island and Taxiway B. The HMU is bordered by the lagoon on the north, Taxiway E to the south, Taxiway B to the east, and Wilkes Island to the west. The topography of HMU-10 is disturbed and primarily flat lying. Mowed and

mowed/ruderal scrub vegetation characterized by casuarina saplings and trees, tangantangan, upland cotton, sourbush, cordia, and pemphis occurs along the lagoon in the western section of HMU-10. The narrow strip of land between the runway and the lagoon in the central section of HMU-10 is characterized by sparse areas of pemphis, casuarina, tournefortia, and beach morning glory (*Ipomoea pes-caprae* spp. *brasiliensis*). Seaside purslane occurs along the shoreline. Vegetation in the mowed/maintained areas of HMU-10 is characterized by white beggar-ticks, hairy spurge, tangantangan, slender mimosa, beach morning glory, wild spider flower (*Cleome gynandra*), swollen fingergrass, Jamaican vervain, button sedge, hairy horseweed, Canada horseweed, upland cotton, puncture vine, and four-spike heliotrope.

- Coverage of casuarina in HMU-10 is approximately 20 percent.
- Coverage of tangantangan is approximately 10 percent.
- Coverage of ruderal scrub and mowed areas is approximately 45 percent.
- Coverage of pemphis scrub is approximately 25 percent.

Wake Atoll HMU-11

HMU-11 is approximately 32.23 acres located at the southwest end of Wake Island. It is bordered on the northwest by the marina channel, on the southeast by the airfield Clear Zone, on the northeast by the marina basin and on the southwest by the ocean. The topography of HMU-11 is scraped and flat lying. HMU-11 is characterized primarily by ruderal herbaceous scrub. Vegetation includes white beggar-ticks, hairy spurge, tangantangan, slender mimosa, beach morning glory, wild spider flower, swollen fingergrass, Jamaican vervain, yellow purslane, button sedge, hairy horseweed, Canada horseweed, hairy horseweed, upland cotton, and puncture vine. The shoreline along the marina entrance channel is characterized by a strip of tangantangan and a few casuarina. Small areas of tangantangan also occur in open areas. A narrow strip of tournefortia and some tangantangan occurs along the ocean shoreline.

Scrub vegetation and tournefortia in HMU-11

- Coverage of casuarina in HMU-11 is approximately 2 percent.
- Coverage of tangantangan is approximately 3 percent.
- Coverage of ruderal-mixed scrub is approximately 95 percent.

Wake Atoll HMU-12

HMU-12 is approximately 30.03 acres located south of the west end of the runway. The HMU is bordered on the northeast by Elrod Drive, the southwest by the ocean, the southeast by HMU-13,

and the northwest by an unnamed road and HMU-11. The topography is disturbed and somewhat flat lying. The area is generally characterized by open ruderal herbaceous vegetation with a narrow mowed strip along the road. Ruderal and mowed vegetation is characterized by Jamaican vervain, tangantangan, crowfoot grass, `uhaloa, white beggar-ticks, beach morning glory, four-spike heliotrope, swollen fingergrass, and button sedge. Tangantangan seedlings are abundant within the ruderal herbaceous scrub. The east end of HMU-12 is characterized by casuarina saplings with some tournefortia. Narrow strips of casuarina saplings and tangantangan occur along the shoreline near the western end of the site and a narrow, patchy strip of tournefortia occurs along the shoreline throughout HMU-12.

- Coverage of casuarina in HMU-12 is approximately 3 percent.
- Coverage of tangantangan is approximately 3 percent.
- Coverage of ruderal-mixed herbaceous vegetation is approximately 94 percent.

Wake Atoll HMU-13

HMU-13 is approximately 18.43 acres located south of the runway. It is bordered on the northeast by Elrod Drive, on the southwest by the ocean, on the southeast by HMU-14 and on the northwest by HMU-12. The topography of HMU-13 is flat and disturbed with some piles of dump material. HMU-13 is characterized by tournefortia scrub with casuarina forest along the shoreline. The area of casuarina forest at the west end of the site includes seedlings and saplings. Along the shoreline the casuarina are primarily saplings. The tournefortia scrub habitat includes scaevola with areas of ruderal herbaceous scrub, a few casuarina saplings, sourbush, and some cordia saplings. The herbaceous vegetation is characterized by white beggar-ticks, Jamaican vervain, hairy spurge, ` uhaloa, upland cotton, Canada horseweed, wild poinsettia, goosegrass (*Eleusine indica*), four-spike heliotrope, coat buttons, `ilima, purslane sp. (*Portulaca* sp.), moon flower, and beach morning glory. HMU-13 includes a graded mowed/maintained area approximately 25 ft. wide along Elrod Drive.

Tournefortia scrub in HMU-13

- Coverage of casuarina in HMU-13 is approximately 30 percent, primarily along the shoreline.
- Coverage of tournefortia is approximately 55 percent.
- Coverage of ruderal-mixed vegetation is approximately 15 percent.

Wake Atoll HMU-14

HMU-14 is approximately 18.70 acres located south of the runway. It is bordered on the north by Elrod Drive, on the south by the ocean, on the east by HMU-15 and HMU-16, and on the west by HMU-13. The topography of HMU-14 is disturbed and somewhat flat lying. HMU-14 is characterized primarily by casuarina forest. There is no understory vegetation within the casuarina forest, which occurs up to the shoreline. There is some scaevola and tournefortia along the edge of the approximately 25 ft.-wide mowed/maintained strip along the roadway. Small tournefortia saplings occur along the shore near the eastern end of the HMU. Herbaceous vegetation occurring in open and mowed areas of HMU-14 is characterized by white beggar-ticks, Jamaican vervain, hairy spurge, `uhaloa, upland cotton, Canada horseweed, wild poinsettia, goosegrass, four-spike heliotrope, coat buttons, `ilima, purslane sp., moon flower, and beach morning glory. The casuarina in HMU-14 range from saplings up to trees with DBHs of up to approximately 18 in. The majority of the casuarina have approximately 8 to 10 in. DBHs.

- Coverage of casuarina in HMU-14 is approximately 85 percent.
- Coverage of mowed areas is approximately 10 percent.
- Coverage of pemphis and other herbaceous vegetation is approximately 5 percent.

Wake Atoll HMU-15

HMU-15 is approximately 12.40 acres located south of the runway. The HMU is bordered on the north by Elrod Drive and on the south, east and west by HMU-14 and HMU-16. HMU-15 is within the solid waste disposal area. There are also some historical Japanese aircraft parking structures in the HMU. HMU-15 is characterized by ruderal scrub vegetation. There is a mowed/maintained area adjacent to Elrod Road and around the Japanese structures. Some casuarina and tournefortia occurs around the structures. Herbaceous vegetation associated with the mowed/maintained area and ruderal scrub is characterized by white beggar-ticks, Jamaican vervain, hairy spurge, `uhaloa, upland cotton, Canada horseweed, wild poinsettia, goosegrass, four-spike heliotrope, coat buttons, `ilima, purslane sp., moon flower, and beach morning glory.

Looking west along the north side of HMU-15

- Coverage of casuarina in HMU-15 is approximately 25 percent.
- Coverage of ruderal scrub is approximately 65 percent.
- Coverage of mowed/maintained area is approximately 10 percent.

Wake Atoll HMU-16

HMU-16 is approximately 36.17 acres located south of the eastern end of the runway. HMU-16 is bordered by the solid waste disposal area to the west, buildings 1607 and 1609 to the north, the ocean shoreline to the south, and an unnamed road to the east. The topography of HMU-16 is disturbed with some areas of rugged terrain associated with the dump, excavations, and areas of pushed up rubble and rock. The site is characterized primarily by casuarina forest with some areas of intermixed tournefortia and cordia scrub. There is a mowed/maintained area in the northeast corner of the HMU. Vegetation in the mowed/maintained area is characterized by white beggar-ticks, Jamaican vervain, hairy spurge, `uhaloa, upland cotton, Canada horseweed, wild poinsettia, goosegrass, four-spike heliotrope, coat buttons, `ilima, purslane sp., moon flower, and beach morning glory. The mowed/maintained area is bordered by casuarina, which extends up to the limestone outcrops on the beach. There are some open areas in the casuarina forest in the central section of HMU-15 associated with dump materials. Vegetation characterizing the open areas in the dump includes tournefortia, cordia, slender mimosa, Jamaican vervain, moon flower, sourbush, and passion fruit. Passion fruit vines cover much of the area.

- Coverage of casuarina in HMU-16 is approximately 65 percent.
- Coverage of tournefortia-mixed scrub is approximately 15 percent.
- Coverage of mowed/maintained area is approximately 20 percent.

Wake Atoll HMU-17

HMU-17 is approximately 5.40 acres located adjacent to the runway. The HMU is bordered by Elrod Road on the north and HMU 16 on the south, east, and west. The topography of HMU-17 is disturbed and scraped flat. The area consists of mowed/maintained habitat over asphalt. There are some small casuarina saplings spread throughout the site. The general herbaceous vegetation is characterized by crabgrass species (*Digitaria* sp.), white beggar-ticks, `uhaloa, Jamaican vervain, hairy spurge, coat buttons, goosegrass, thin paspalum, slender mimosa, Canada horseweed, button sedge, nutgrass, sandbur, and wild spider flower.

- Coverage of casuarina saplings in HMU-17 is approximately 2 percent.
- Coverage of mowed/maintained area is approximately 98 percent.

Wake Atoll HMU-18

HMU-18 is approximately 12.49 acres located north of the runway. The site is bordered on the north by HMU-33, the south by Taxiway E, the east by Taxiway B, and the west by the lagoon. The topography of HMU-18 is characterized by flat lying coastal terrain that has been disturbed in areas by placement of a road, pipeline, and other structures. This area is characterized by tidal inlets with some tidal marsh. Vegetation in HMU-18 is characterized primarily by pemphis scrub and seaside purslane. There are a few tournefortia and cordia trees along the roadway and pipeline edge.

- Coverage of casuarina in HMU-18 is less than 1 percent.
- Coverage of pemphis-mixed is approximately 98 percent.
- Coverage of tournefortia-mixed is approximately 1 percent.

Wake Atoll HMU-19

HMU-19 is approximately 10.82 acres located south of the eastern end of the runway adjacent to the ocean shoreline. The site is bordered on the north by HMU-16 and HMU-20, the south by the ocean shoreline, the east by HMU 24, and the west by HMU-16. The topography of HMU-19 is disturbed with areas of rugged terrain associated with a dump area near the northern end of the site, and other land disturbance activities. HMU-19 is characterized primarily by casuarina forest with some ruderal scrub along the northern boundary. The casuarina trees in this site are more spread out when compared to other similar habitat. There are a few tournefortia and scaevola in the open casuarina forest areas. Scrub areas are characterized by tournefortia, cordia, sourbush, Jamaican vervain, passion fruit, Canada horseweed, hairy spurge, beach moonflower, and slender mimosa. The casuarina in HMU-19 include saplings and trees with average DBHs of approximately 10 in.

- Coverage of casuarina in HMU-19 is approximately 60 percent.
- Coverage of tournefortia-mixed vegetation is approximately 40 percent.

Wake Atoll HMU-20

HMU-20 is approximately 7.21 acres. Building 1615 is just to the west and the MDA is to the east of the site. Unnamed roads border the site on its north, south, and west sides. The site borders HMU-19 on its southern side. The topography of HMU-20 is disturbed and mounded. There is a large dump area in the central section of HMU-20 that is surrounded by a fringe of casuarina forest. The vegetation in the dump area is characterized by tournefortia and scaevola scrub mixed with casuarina saplings, cordia, sourbush, Jamaican vervain, passion fruit, Canada horseweed, hairy spurge, beach moonflower, and slender mimosa. The casuarina in HMU-20 include saplings and young trees with average DBHs of approximately 4 in.

Passion fruit on tournefortia in HMU-20

- Coverage of casuarina in HMU-20 is approximately 70 percent.
- Coverage of tournefortia-mixed scrub is approximately 30 percent.

Wake Atoll HMU-21

HMU-21 is approximately 21.97 acres. HMU-21 is south of the eastern end of the runway and is bordered by HMU-22 to the north, an unnamed roadway to the south, HMU-23 to the east, and HMU-17 to the west. This site includes the MDA. The topography of HMU-21 is disturbed and somewhat flat lying with some hummocky areas associated with past land disturbance activities. HMU-21 is characterized by tournefortia, scaevola and cordia scrub, casuarina forest, and mowed/maintained areas. There is an area dominated by sourbush along the eastern edge of the site. Vegetation associated with the tournefortia, scaevola and cordia scrub includes beach moonflower, white beggar-ticks, and upland cotton. There is very little understory vegetation associated with the casuarina forest. The mowed/maintained areas are characterized by white beggar-ticks, Jamaican vervain, hairy spurge, `uhaloa, upland cotton, Canada horseweed, wild poinsettia, goosegrass, four-spike heliotrope, coat buttons, `ilima, purslane sp., moon flower, and beach morning glory.

- Coverage of casuarina forest is approximately 30 percent.
- Coverage of mowed/maintained area in HMU-21 is approximately 30 percent.
- Coverage of tournefortia-mixed scrub is approximately 25 percent.
- Coverage of cordia is approximately 5 percent.
- Coverage of sourbush scrub is approximately 10 percent.

Wake Atoll HMU-22

HMU-22 is approximately 8.18 acres located south of the east end of the runway. It is bordered on the north by Elrod Drive, the south by HMU-21, the east by an unnamed road, and the west by HMU-17. The topography of HMU-22 is disturbed and flat lying. HMU-22 includes a mowed/maintained area characterized by crabgrass sp., white beggar-ticks, `uhaloa, Jamaican vervain, hairy spurge, coat buttons, goosegrass, thin paspalum, slender mimosa, Canada horseweed, button sedge, nutgrass, sandbur, and wild spider flower.

- Coverage of mowed/maintained area in HMU-22 is approximately 100 percent.

Wake Atoll HMU-23

HMU-23 is approximately 11.32 acres located south of the east end of the runway. It is bordered on the north by Elrod Drive, the south and east by unnamed roads, and the west by HMU-21 and HMU-22. The topography of HMU-23 is disturbed and flat lying. The site is a mowed/maintained area primarily characterized by goosegrass and white beggar-ticks. Other species include Asian crabgrass (*Digitaria bicornis*), nutgrass, button sedge, Japanese love grass (*Eragrostis amabilis*), hairy spurge, swollen fingergrass, coat buttons, upland cotton, slender mimosa, `uhaloa, and Jamaican vervain.

- Coverage of mowed/maintained vegetation in HMU-23 is approximately 100 percent.

Wake Atoll HMU-24

HMU-24 is approximately 12.42 acres located south of the east end of the runway adjacent to the coast. HMU-24 is bordered by an unnamed road to the north, the ocean shoreline to the south, HMU-21 and HMU-25 to the east, and HMU-19 and HMU-20 to the west. The topography of HMU-24 is disturbed and primarily flat lying. The site is characterized primarily by scaevola scrub with some cordia, tournefortia, and scattered large casuarina. Casuarina forest, comprised primarily of saplings and small trees, occurs along the southern boundary of the HMU adjacent to shoreline rock outcrops. The casuarina in the southern section of HMU-24 include saplings and small trees with DBHs of up to approximately 8 in.

- Coverage of casuarina forest is approximately 30 percent.
- Coverage of scaevola scrub in HMU-24 is approximately 70 percent.

Wake Atoll HMU-25

HMU-25 is approximately 24.50 acres located south of the eastern end of the runway adjacent to the coast. The site is bordered on the north and east by unnamed roads, the south by the ocean shoreline, and the west by HMU-24. The topography of HMU-25 is disturbed and primarily flat lying. The western half of the site is characterized primarily by scaevola. The scaevola mixes with tournefortia towards the northeastern section of the HMU. The tournefortia and scaevola are intermixed with cordia and sourbush. There are a few casuarina saplings and small trees in the tournefortia and scaevola scrub. An open mowed/maintained area is located in the northeast section of HMU-25 around the MDA structures. The mowed/maintained area is characterized by goosegrass, white beggar-ticks, Asian crabgrass, nutgrass, button sedge, Japanese love grass, hairy spurge, swollen fingergrass, coat buttons, upland cotton, slender mimosa, `uhaloa, and Jamaican vervain. Vegetation along the beach includes sparse tournefortia seedlings and saplings and a few casuarina saplings and trees.

- Coverage of casuarina is approximately 5 percent.
- Coverage of scaevola scrub is approximately 40 percent.
- Coverage of tournefortia and scaevola is approximately 30 percent.
- Coverage of mowed/maintained area is approximately 10 percent.
- Coverage of tournefortia-mixed on the beach is approximately 15 percent.

Wake Atoll HMU-26

HMU-26 is approximately 34.43 acres located adjacent to the eastern corner of the runway. The site is bordered on the north by Elrod Drive, the south by an unnamed road, the east by the access road to Peacock Point, and the west by an unnamed road. The topography of HMU-26 is disturbed and primarily flat lying. The northern section of HMU-26 is mowed/maintained. The central section of the site is characterized by ruderal scrub including sourbush, tournefortia, and herbaceous vegetation. The southern section of HMU-26 is characterized by tournefortia and cordia forest. There is a small area characterized primarily by scaevola in the south central section of HMU-26. Herbaceous vegetation in the central section of the site and in the

mowed/maintained area is characterized by goosegrass, white beggar-ticks, Asian crabgrass, nutgrass, button sedge, Japanese love grass, hairy spurge, swollen fingergrass, coat buttons, upland cotton, slender mimosa, `uhaloa, and Jamaican vervain.

- Coverage of mowed/maintained area in HMU-26 is approximately 35 percent.
- Coverage of tournefortia-mixed forest is approximately 30 percent.
- Coverage of ruderal scrub is approximately 30 percent.
- Coverage of scaevola is approximately 5 percent.

Mowed habitat in HMU-26 and HMU-65

Wake Atoll HMU-27

HMU-27 is approximately 26.16 acres located south of the eastern end of the runway. The site is just west of Peacock Point and is bordered on the north and west by unnamed roads, the south by the shoreline of the ocean, and the east by HMU-28. The topography of HMU-27 is disturbed and somewhat flat lying. HMU-27 is characterized by tournefortia/scaevola intermixed with cordia. Additional common species in the tournefortia/scaevola include sourbush and scattered casuarina. Few pisonia, sea grapes (*Coccoloba uvifera*), Indian almond (*Terminalia catappa*), coconut palm (*Cocos nucifera*), and scaevola also occur. The tournefortia/scaevola changes to primarily tournefortia towards the shore. There are small areas of ruderal vegetation in open areas in the HMU. Vegetation within open areas is characterized by white beggar-ticks, `uhaloa, Jamaican vervain, upland cotton, and passion fruit. The casuarina in HMU-27 include saplings and small trees with DBHs of up to approximately 6 in.

- Coverage of tournefortia-mixed is approximately 60 percent.
- Coverage of tournefortia forest is approximately 20 percent.
- Coverage of open ruderal scrub vegetation is approximately 10 percent.
- Coverage of casuarina is approximately 10 percent

Wake Atoll HMU-28

HMU-28 is approximately 17.64 acres located in the southeastern corner of Wake Island, adjacent to Peacock Point. The topography of HMU-28 is disturbed with somewhat flat terrain that generally slopes towards the beach. There are pushed up piles of rock and rubble in the northwestern section of the site. HMU-28 is characterized by ruderal scrub and patchy tournefortia saplings and shrubs along, and adjacent to the beach. General vegetation is characterized by tournefortia scrub, beach morning glory, button sedge, sourbush, and cordia. In

the northern section of HMU-28, vegetation is comprised of cordia, sourbush, and tournefortia scrub.

- Coverage of tournefortia-mixed scrub is approximately 75 percent.
- Coverage of cordia-mixed scrub is approximately 25 percent.

Wake Atoll HMU-29

HMU-29 is approximately 34.38 acres located south of the airfield on the southeastern shoreline of Wake Island. It is bordered on the north by Elrod Drive, the south by Peacock Point and HMU-28, the east by the ocean shoreline and on the west by an unnamed road. The topography of HMU-29 is disturbed and graded with some mounded areas. Vegetation in HMU-29 is characterized by tournefortia scrub with cordia, sourbush, upland cotton, and small clumps of casuarina saplings. The tournefortia scrub forest becomes sparser towards the northern section of the site where there are areas of ruderal scrub, cordia, and scaevola. Vegetation is characterized primarily by tournefortia and beach morning glory. Open areas of HMU-29 are characterized by `uhaloa, Jamaican vervain, upland cotton, and passion flower.

- Coverage of tournefortia scrub is approximately 98 percent.
- Coverage of casuarina sapling is approximately 2 percent.

Wake Atoll HMU-30

HMU-30 is approximately 16.82 acres located in the eastern section of Wake Island. The monument area that is across Wake Avenue from Base Operations is in the central section of the HMU. The site is bordered on the north by an unnamed road, on the south by the east end of the airfield, on the east by HMU-31, and on the west by Wake Avenue. The topography of HMU-30 is flat. The majority of HMU-30 is characterized by mowed/maintained and ruderal vegetation with a few scattered tournefortia. Tournefortia also occurs in the northern section of the site where it is intermixed with casuarina. General vegetation in the mowed/maintained and ruderal areas includes beach morning glory, button sedge, and crowfoot grass. Pemphis occurs in areas surrounding the church. Tournefortia scrub also occurs around the bunkers and in the central section of the monument area.

- Coverage of casuarina is approximately 10 percent.
- Coverage of tournefortia scrub is approximately 20 percent.
- Coverage of mowed/maintained vegetation is approximately 70 percent.

Wake Atoll HMU-31

HMU-31 is approximately 37.68 acres located along the eastern shoreline of Wake Island. The site is bordered on the north by HMU-53 and HMU-54 near the northern tip of Wake Island; the east end of the airfield to the south; the ocean shoreline on the east; and unnamed roads, Saipan Avenue, and North Pacific Avenue on the west. The topography of HMU-31 is disturbed and generally flat lying with several hummocky or mounded areas associated with past land

disturbance activities. The vegetated terrain drops off steeply down to the beach in several areas along the shoreline. Vegetation in the southern portion of HMU-31 is characterized by sparse tournefortia scrub with beach morning glory, scaevola, and scattered casuarina saplings. The northern section of HMU-31 is characterized by coastal ruderal scrub intermixed with tournefortia and casuarina.

- Coverage of tournefortia-mixed scrub is approximately 80 percent.
- Coverage of casuarina forest and individual saplings is approximately 20 percent.

Sparse tournefortia scrub in the southern section of HMU-31

Wake Atoll HMU-32

HMU-32 is approximately 4.83 acres located along the eastern portion of Wake Island north of the monument area. The site is bordered on the north and south by unnamed roads, on the east by Saipan Avenue, and on the west by Wake Avenue. The topography of HMU-32 is disturbed and generally flat, but rolling or hummocky in some areas. HMU-32 is characterized by dense casuarina scrub with some intermixed tournefortia, scaevola, and pemphis. The height of the casuarina appears to be wind controlled. There is a narrow clear cut in the casuarina along the northern boundary of the site.

- Coverage of casuarina scrub is approximately 90 percent.
- Coverage of other mixed shrub species is approximately 10 percent.

Wake Atoll HMU-33

HMU-33 is approximately 30.37 acres located along the eastern lagoon shoreline of Wake Island. It is bordered on the north by HMU-39, on the south by HMU-18, on the east by Lagoon Road, and on the west by the lagoon. The topography of HMU-33 is primarily flat lying coastal marsh terrain with disturbed and mounded areas associated with a pipeline and Lagoon Road. HMU-33 is characterized by tidal inlets and tidal marsh. Vegetation includes pemphis scrub with small amounts of seaside purslane. Casuarina occurs in the disturbed area along

Fiddler crabs in tidal marsh habitat in HMU-33

the roadway. The northern portion of HMU-33 is characterized by upland, somewhat flat lying terrain with casuarina intermixed with tournefortia, pemphis, and cordia. There is a small, mowed/maintained area adjacent to the road at the north end of the site.

- Coverage of casuarina scrub is approximately 10 percent.
- Coverage of pemphis is approximately 70 percent.
- Coverage of mixed shrub species is approximately 15 percent.
- Coverage of mowed/maintained area is approximately 5 percent.

Wake Atoll HMU-34

HMU-34 is approximately 15.47 acres located along the eastern lagoon section of Wake Island. The site is bordered by the fire department and HMU-40 to the north, Taxiway B to the south, Taxiway B and the fire department to the east, and Lagoon Road to the west. The topography of HMU-34 is primarily flat lying with coastal marsh terrain and a tidal pond area. The tidal pond area encompasses approximately 25 percent of the HMU. HMU-34 is characterized by tidal inlets and tidal marsh. Vegetation includes pemphis scrub with areas of casuarina forest. Seaside purslane occurs in the wetter areas. There is a narrow band of casuarina forest along the eastern side of the marsh area. There is a mowed/maintained area between the airfield and the casuarina stand that is characterized by nut grass, white beggar-ticks, hairy spurge, beach morning glory, button sedge, and swollen fingergrass.

The casuarina trees in HMU-34 have DBHs of up to approximately 8 in.

- Coverage of casuarina is approximately 30 percent.
- Coverage of pemphis scrub is approximately 35 percent.
- Coverage of mowed/maintained vegetation is approximately 35 percent.

Wake Atoll HMU-35

HMU-35 is approximately 14.16 acres located on the ocean side of the eastern section of Wake Island. The site is bordered by 4th Street to the north, an unnamed road on the south, Saipan Avenue on the east, and Wake Avenue on the west. The topography of HMU-35 is disturbed and primarily flat lying. There are several structures in HMU-35. The vegetation in HMU-35 is characterized by dense casuarina scrub intermixed with a few tournefortia shrubs. The northern end of the site is characterized by dense casuarina intermixed with tournefortia, sea grapes, scaevola, coconut palm, and beach morning glory. There are mowed/maintained areas around the structures and along the roads characterized by button sedge, swollen fingergrass, beach morning glory, Jamaican vervain, white beggar-ticks, coat buttons, `uhaloa, slender mimosa, and upland cotton. The casuarina trees in HMU-35 have DBHs of up to approximately 10 in.

- Coverage of casuarina forest and scrub is approximately 80 percent.
- Coverage of other mixed shrubs is approximately 10 percent.
- Coverage of mowed/maintained vegetation is approximately 10 percent.

Wake Atoll HMU-36

HMU-36 is approximately 3.01 acres located east of the airfield fire department on the eastern side of Wake Island. The site is bordered on the north by 5th Street, on the south by 4th Street, and on the east and west by unnamed roads. The topography of HMU-36 is disturbed and generally flat lying. The vegetation includes casuarina forest with some tournefortia, sea grapes, scaevola, and pemphis. Vegetation in the understory and in open areas is characterized by beach morning glory and swollen fingergrass. Casuarina trees in HMU-36 have DBHs of up to approximately 6 in.

- Coverage of casuarina forest is approximately 75 percent.
- Coverage of other mixed shrubs is approximately 25 percent.

Wake Atoll HMU-37

HMU-37 is approximately 6.52 acres located east of the airfield fire department on the eastern side of Wake Island. The site is bordered on the north by 5th Street, on the south by 4th Street, on the east by an unnamed road, and on the west by Wake Avenue. The topography of HMU-37 is disturbed and generally flat lying. There are several structures in HMU-37. The vegetation in HMU-37 is characterized by casuarina forest with some tournefortia, coconut palm, scaevola, and cordia. There are open areas around the perimeter of HMU-37 with mowed/maintained vegetation characterized by beach morning glory, hairy spurge, sandbur, swollen fingergrass, agave (*Agave* sp.), `uhaloa, and bowstring hemp (*Sansevieria trifasciata*), and Indian almond associated with old structures. Casuarina trees in HMU-37 have DBHs of up to approximately 8-10 in.

- Coverage of casuarina forest is approximately 85 percent.
- Coverage of other mixed shrubs is approximately 5 percent.
- Coverage of mowed/maintained area is approximately 10 percent.

Wake Atoll HMU-38

HMU-38 is approximately 9.57 acres located near the ocean side of the eastern section of Wake Island. The site is bordered by 6th Street to the north, 5th Street to the south, North Pacific Avenue to the East, and Wake Avenue to the west. The topography of HMU-38 is disturbed and generally flat lying. The vegetation includes casuarina forest, with a few scattered tournefortia, sea grapes, and pemphis. The casuarina along the shore side are windblown and stunted. There is a narrow mowed/maintained area along Wake Avenue and mowed/maintained areas

Casuarina and tournefortia along the eastern side of HMU-38

associated buildings. Mowed/maintained vegetation is characterized by beach morning glory, white beggar-ticks, hairy purslane, sandbur, and swollen fingergrass. Examples of ornamental species occurring in association with the existing structures include agave, `uhaloa, bowstring hemp, and Indian almond. Casuarina trees in HMU-38 have DBHs of up to approximately 10 in. in the forested area and up to approximately 24 in. near buildings.

- Coverage of casuarina is approximately 95 percent.
- Coverage of mowed/maintained vegetation is approximately 5 percent.

Wake Atoll HMU-39

HMU-39 is approximately 18.31 acres located on the eastern shore of the lagoon to the west of the airfield fire department. The site is bordered on the north by HMU-49, on the south by HMU-33, on the east by HMU-40 and HMU-41, and on the west by the lagoon. The topography of HMU-39 is disturbed with areas of mounded terrain. Vegetation in HMU-39 is characterized by casuarina forest with a band of pemphis scrub along the edge of the lagoon. There is a small open and mowed/maintained area associated with an old beach house near the central section of the HMU. Several ornamental species including periwinkle (C*atharanthus roseus*) occur in the forest and cleared areas in proximity to structures. Casuarina trees in HMU-39 have DBHs averaging about 10-12 in. with some larger trees present.

- Coverage of casuarina forest is approximately 75 percent.
- Coverage of pemphis scrub is approximately 20 percent.
- Coverage of mowed/maintained and other open area is approximately 5 percent.

Wake Atoll HMU-40

HMU-40 is approximately 14.62 acres located just to the west of the airfield fire department. The site is bordered on the north by Gull Street, on the south by HMU-34, on the east by the airfield fire department, and on the west by Lagoon Road. The topography of HMU-40 is disturbed and flat lying. HMU-40 is characterized by mowed/maintained vegetation around existing structures. Vegetation in the mowed/maintained area is characterized by nut grass, Jamaican vervain, white beggar-ticks, `uhaloa, goose grass, sandbur, hairy spurge, swollen fingergrass, slender mimosa, upland cotton, and Bermuda grass (*Cynodon dactylon*). Cordia, coconut palm, and tournefortia occur in small clumps, and around the perimeter of HMU-40. Casuarina also occurs in small clumps in HMU-40. Casuarina trees in HMU-40 have DBHs of up to approximately 18 in., with a few larger trees also present.

- Coverage of casuarina forest is approximately 5 percent.
- Coverage of mowed/maintained area is approximately 90 percent.
- Coverage of tournefortia and other species is approximately 5 percent.

Wake Atoll HMU-41

Tangantangan adjacent to building in HMU-41

HMU-41 is approximately 4.45 acres located adjacent to the eastern shore of the lagoon. The site is bordered on the north by HMU-49, the south by HMU-40, the east by Canton Avenue, and the west by the lagoon and HMU-39. The water plant is located within HMU-41. The topography of HMU-41 is disturbed and primarily flat lying, but slopes down to the lagoon on its western side. HMU-41 is characterized by mowed/maintained habitat with small areas of casuarina near the north end and the southwest end. The areas of casuarina also include some tangantangan, coconut palms, and tournefortia. The vegetation in the mowed/maintained area is characterized by nut grass, Jamaican vervain, white beggar-ticks, `uhaloa, goose grass, sandbur, hairy spurge, swollen fingergrass, slender mimosa, upland cotton, Bermuda grass, and thin paspalum. Tangantangan is established around the perimeter of the buildings and is starting to spread around the perimeter of the water tanks. There are also casuarina seedlings in places around the water tanks. Some ornamental species (agave, bougainvillea [*Bougainvillea spectabilis*], etc.) also occur around the buildings, along with a few Indian almonds. Casuarina trees have DBHs of up to approximately 12 in. at the north end of HMU-41, and up to about 18 in. or more in the southwest end.

- Coverage of mowed/maintained area is approximately 96 percent.
- Coverage of casuarina is approximately 2 percent.
- Coverage of tangantangan is approximately 2 percent.

Wake Atoll HMU-42

Vegetation in HMU-42

HMU-42 is approximately 43.06 acres located on the east-central section of Wake Island. The topography of HMU-42 is flat and graded. HMU-42 consists of mowed/maintained vegetation on an old coral asphalt base, with a narrow strip of mixed trees around the perimeter. Vegetation in the mowed/maintained area is characterized by button sedge, swollen fingergrass, goose grass, little lovegrass (*Eragrostis minor*), coat buttons, beach

morning glory, and a few casuarina seedlings. The narrow strip of trees around the perimeter is characterized by casuarina, tournefortia, coconut palms, and cordia. There is also an east-west strip of vegetation across HMU-42 characterized by tournefortia, casuarina, and a few coconut palms.

- Coverage of casuarina is approximately 5 percent.
- Coverage of mowed/maintained area is approximately 90 percent.
- Coverage of mixed forest fringe is approximately 5 percent.

Wake Atoll HMU-43

HMU-43 is approximately 3.37 acres located on the eastern section of Wake Island to the east of Wake Avenue. The site is bordered on the northwest by 7th Street, on the southeast by 6th Street, on the northeast by an unnamed road, and on the southwest by Wake Avenue. The topography of HMU-43 is disturbed and flat lying. The vegetation is characterized by casuarina forest with some tournefortia and coconut palms. The casuarina forest is less dense than in HMU-37 and HMU-38. There is a mowed/maintained area along Wake Avenue. The vegetation in the mowed/maintained area is characterized by beach morning glory, hairy spurge, sandbur, swollen fingergrass, agave sp., `uhaloa, bowstring hemp, and Indian almond. Casuarina trees in HMU-43 have DBHs of up to approximately 8-10 in.

- Coverage of casuarina forest is approximately 75 percent.
- Coverage of mowed/maintained area is approximately 25 percent.

Wake Atoll HMU-44

HMU-44 is approximately 3.41 acres located on the eastern section of Wake Island to the northeast of Wake Avenue. The site is bordered on the northwest by 7th Street, on the southeast by 6th Street, on the northeast by North Pacific Avenue, and on the southwest by an unnamed road. The topography of HMU-44 is disturbed and flat lying. The southern section of HMU-44 is characterized by sparse casuarina forest with some coconut palms and tournefortia. The northern section is mowed/maintained with some casuarina scrub and ornamental species near houses and buildings. The mowed/maintained section is characterized by beach morning glory, hairy spurge, sandbur, swollen fingergrass, agave, `uhaloa, bowstring hemp, Indian almond, sea grapes, hairy horseweed, Canada horseweed, and lily species. Casuarina trees in HMU-44 have DBHs of up to approximately 15 in.

- Coverage of casuarina forest is approximately 50 percent.
- Coverage of mowed/maintained area is approximately 50 percent.

Wake Atoll HMU-45

HMU-45 is approximately 3.27 acres located on the eastern section of Wake Island to the northeast of Wake Avenue. The site is bordered on the northwest by 8th Street, on the southeast by 7th Street, on the northeast by North Pacific Avenue, and on the southwest by an unnamed

road. The topography of HMU-45 is disturbed and flat lying. Vegetation is characterized by somewhat open casuarina forest with some sea grape and tournefortia scattered throughout. Casuarina trees in HMU-45 have DBHs of up to approximately 10 in.

- Coverage of casuarina forest is near 100 percent.

Wake Atoll HMU-46

HMU-46 is approximately 3.28 acres located on the eastern section of Wake Island to the northeast of Wake Avenue. The site is bordered on the northwest by 8th Street, on the southeast by 7th Street, on the northeast by an unnamed road, and on the southwest by Wake Avenue. The topography of HMU-46 is disturbed and flat lying. Vegetation in HMU-46 is characterized by somewhat open casuarina forest with some sea grape, coconut palm, and tournefortia. There is an approximately 60 ft.-wide strip of mowed maintained vegetation along Wake Avenue characterized by nut grass, button sedge, hairy spurge, swollen fingergrass, crowfoot grass, white beggar-ticks, little lovegrass, `ilima and some planted coconut palms. Casuarina trees in HMU-46 have DBHs of up to approximately 10 in.

- Coverage of casuarina forest is approximately 85 percent.
- Coverage of mowed/maintained vegetation is approximately 15 percent.

Wake Atoll HMU-47

HMU-47 is approximately 4.81 acres located in the northeastern section of Wake Island to the east of Wake Avenue. The site is bordered on the northwest by 9th Street, on the southeast by 8th Street, on the northeast by North Pacific Avenue, and on the southwest by Iwa Jima Avenue. The topography of HMU-47 is disturbed and flat lying. Vegetation in HMU-47 is characterized by somewhat open casuarina forest with some sea grape, cordia, pisonia, coconut palm, and pemphis. Casuarina trees in HMU-47 generally have DBHs of up to approximately 8 in., with larger trees (DBHs of approximately 20 in. or more) along North Pacific Avenue. Most of the casuarina in HMU-47 are saplings to small trees with DBHs of less than 4 in.

- Coverage of casuarina mixed forest is approximately 100 percent.

Wake Atoll HMU-48

HMU-48 is approximately 5.22 acres located in the northeastern section of Wake Island to the east of Wake Avenue. The site is bordered on the northwest by 9th Street, on the southeast by 8th Street, on the northeast by Iwa Jima Avenue, and on the southwest by Wake Avenue. The topography of HMU-48 is disturbed and somewhat flat lying. Vegetation in HMU-48 is characterized by somewhat open casuarina forest with some cordia, coconut palm, and sourbush. There is an approximately 60 ft.-wide strip of mowed maintained vegetation along Wake Avenue characterized by nut grass, button sedge, hairy spurge, swollen fingergrass, crowfoot grass, white beggar-ticks, little lovegrass, `ilima, and some planted coconut palms. Casuarina trees in HMU-48 have DBHs of up to approximately 10 in.

- Coverage of casuarina is approximately 85 percent.
- Coverage of mowed/maintained vegetation is approximately 15 percent.

Wake Atoll HMU-49

Open casuarina forest in HMU-49

HMU-49 is approximately 13.96 acres located on the lagoon coast on the eastern section of Wake Island. The site is bordered to the northwest by HMU-51, on the southeast by the lagoon and HMU-41, on the northeast by Canto Avenue, and on the southwest by the lagoon. The topography of HMU-49 is disturbed with areas of mounded terrain. The vegetation in HMU-49 is characterized by casuarina, tournefortia, cordia, and coconut palm mixed forest that is very dense in some areas. There are some areas of predominately casuarina that are more spread out. There is also a band of pemphis with some casuarina along the lagoon shoreline. The southeast section of HMU-49 is characterized by less dense casuarina forest, and the northern section is primarily casuarina forest with a band of pemphis, sea purslane, and some button sedge along the shore. Casuarina trees in HMU-49 have DBHs of up to approximately 24 in.

- Coverage of casuarina forest is approximately 35 percent.
- Coverage of casuarina-mixed forest is approximately 30 percent.
- Coverage of pemphis scrub is approximately 30 percent.
- Approximately 5 percent of the HMU is unvegetated.

Wake Atoll HMU-50

HMU-50 is approximately 29.50 acres located on the northern end of the eastern section of Wake Island. The site is bordered to the north and west by Wake Avenue, on the south by 9th Street, and on the east by North Pacific Avenue. The topography of HMU-50 is disturbed and flat lying. The southern third of HMU-50 is characterized by casuarina forest and the northern two-thirds are characterized by tournefortia scrub. The casuarina forest ranges from somewhat open to dense with a few tournefortia in the more open areas. The tournefortia scrub is somewhat open with beach morning glory and a few casuarina. Along the southern end of HMU-50 and Wake Avenue there is a strip of mowed/maintained vegetation characterized by crowfoot grass, swollen fingergrass, nut grass, button sedge, wild spider flower, Canada horseweed, and white beggar-ticks. A row of coconut palm is planted along Wake Avenue on the western edge of

HMU-50. Casuarina saplings and young trees in HMU-50 have DBHs of approximately 4 in. or less.

- Coverage of casuarina forest is approximately 30 percent.
- Coverage of tournefortia scrub is approximately 55 percent.
- Coverage of mowed/maintained vegetation is approximately 15 percent.

Wake Atoll HMU-51

HMU-51 is approximately 43.24 acres located on the lagoon coast at the northern end of the eastern section of Wake Island. The site is bordered to the north and west by Hewa Road, on the south by HMU-49 and an unnamed road, on the east by Wake Avenue, and on the west by the lagoon. The topography of HMU-51 is disturbed and gently rolling with areas of mounded terrain. The southern section of HMU-51 is characterized by pemphis scrub, which turns into a pemphis and casuarina mix towards the central area of the HMU. There is a mowed/maintained area along Hewa Road characterized by button sedge, white beggar-ticks, and planted coconut palms. There are also clumps of pemphis and casuarina in the mowed areas with nut grass, Indian blue grass (*Bothriochloa pertusa*), and hairy spurge. There is an approximately 1/8-acre pond near the golf course with pemphis, a few tournefortia, casuarina, and some seaside purslane around the edge. Along the shoreline to the west of the pond there is a casuarina forest with some cordia, coconut palm, and a few pisonia. This forest also contains tournefortia and pemphis as well as several isolated clumps of tangantangan. There are also small areas of cordia with upland cotton and `ilima in the central area of the casuarina forest. Along the shoreline to the west of the golf course pond, there is another small less than 1/10-acre pond. There is no vegetation in the pond, but there is some tangantangan, casuarina, cordia, and pemphis around the perimeter. There is also a small area of sea purslane on the bank of the pond. Casuarina trees in HMU-51 have DBHs of up to approximately 12 in. Some trees are larger.

- Coverage of casuarina forest is approximately 35 percent.
- Coverage of tangantangan is approximately 5 percent or less.
- Coverage of pemphis is approximately 15 percent.
- Coverage of mowed/maintained vegetation is approximately 45 percent.

Wake Atoll HMU-52

HMU-52 is approximately 45.33 acres located in the northern end of the eastern portion of Wake Island. HMU-52 includes the golf course. The site is bordered to the north and east by Wake Avenue, on the south by Heiwa Road, and on the west by HMU-58. The topography of HMU-52 is disturbed and somewhat flat lying. HMU-52 is characterized by somewhat regularly mowed/maintained vegetation with scattered single and clumps of trees throughout. The mowed vegetation is characterized by white beggar-ticks, crowfoot grass, nut grass, button sedge, `uhaloa, hairy purslane, Indian bluegrass, coat buttons, and little lovegrass. There are individual coconut palms, tournefortia, casuarina, and cordia throughout the site. There are also a few Indian mulberry (*Morinda citrifolia*) and clumps of casuarina, tournefortia, coconut palms, and

cordia mixed with upland cotton and a few planted ornamentals. Casuarina trees in HMU-52 have DBHs of up to approximately 24 in., though most are 8-10 in.

- Coverage of casurina is approximately 3 percent.
- Coverage of mixed forest fringe and individual clumps of trees is approximately 2 percent.
- Coverage of mowed/maintained vegetation is approximately 95 percent.

Wake Atoll HMU-53

HMU-53 is approximately 10.26 acres located at the northeastern tip of Wake Island. The site is bordered to the north, east, and south by unnamed roads and on the west by Wake Avenue. The topography of HMU-53 is disturbed and flat lying. Vegetation in HMU-53 is characterized by casuarina forest with some intermixed tournefortia and small open areas. Sea grape and sourbush are also present. There is a narrow mowed/maintained section along Wake Avenue and in the northwest corner characterized by crowfoot grass, swollen fingergrass, nut grass, button sedge, wild spider flower, Canada horseweed, and white beggar-ticks. There are several old buildings along the east boundary road with agave, sea grapes, and other ornamentals. The casuarina trees in HMU-54 have DBHs of up to approximately 10 in. with some larger trees also present.

Mowed/maintained vegetation in HMU-53

- Coverage of casuarina-mixed forest is approximately 80 percent.
- Coverage of mowed/maintained and open areas is approximately 20 percent.

Wake Atoll HMU-54

HMU-54 is approximately 8.65 acres located at the northeastern tip of Wake Island. The site is bordered to the north by HMU-55, on the south by an unnamed road, on the east by the ocean shoreline and on the west by an unnamed road. The topography of HMU-54 is disturbed and somewhat rolling. The topography slopes down to the ocean along the shoreline. The area is sparsely covered by tournefortia and coastal ruderal scrub including some sourbush, casuarina, beach morning glory, moon flower, and upland cotton. Tournefortia is more prevalent in the north and western sections of the site. The casuarina trees in HMU-53 have DBHs of up to approximately 6 in.

- Coverage of casuarina is approximately 15 percent.
- Coverage of coastal ruderal scrub is approximately 45 percent
- Coverage of tournefortia scrub is approximately 40 percent.

Wake Atoll HMU-55

HMU-55 is approximately 13 acres located at the northeast shore of Wake Island. The site is bordered on the north by ocean shoreline, on the south by an unnamed road, and on the east and west by two-track roads. The topography of HMU-55 is disturbed and somewhat flat lying. The topography slopes down to the ocean along the shoreline. Vegetation in general is characterized by wild poinsettia, upland cotton, anena (*Boerhavia repens*), and sourbush. There is tournefortia scrub with dense, stunted, windblown casuarina along the shoreline. Heading west along the shoreline, the casuarina become more spread out and there are more tournefortia shrubs, beach morning glory, and moon flower. Towards the western end of HMU-55, the vegetation is characterized by open herbaceous scrub with Jamaican vervain, white beggar-ticks, upland cotton, and `uhaloa. Coastal ruderal scrub dominated by tournefortia dominates at the western end of the site. Casuarina trees in HMU-55 have DBHs of up to approximately 4 in. Some larger trees are also present.

- Coverage of casuarina within the casuarina and tournefortia scrub is approximately 35 percent.
- Coverage of tournefortia scrub is approximately 45 percent.
- Coverage of coastal ruderal scrub-mixed is approximately 20 percent.

Wake Atoll HMU-56

HMU-56 is approximately 2.90 acres located at the northeastern tip of Wake Island. The site is bordered on the north, east, and west by unnamed roads and on the south by Wake Avenue. The topography of HMU-56 is disturbed and flat lying. Vegetation in HMU-56 is characterized by casuarina and tournefortia forest with some sea grapes, sourbush, and upland cotton. There is a mowed/maintained area along Wake Avenue characterized by white beggar-ticks, button sedge, swollen fingergrass, and a row of planted coconut palms. The casuarina trees in HMU-56 have DBHs of up to approximately 10 in., though most are approximately 4 in. or less.

- Coverage of casuarina is approximately 50 percent.
- Coverage of other mixed shrubs is approximately 20 percent.
- Coverage of mowed/maintained vegetation is approximately 30 percent.

Wake Atoll HMU-57

Open ruderal scrub in HMU-57

HMU-57 is approximately 19.64 acres located at the northern end of the eastern portion of Wake Island. The site is bordered on the north by ocean shoreline, on the south by Wake Avenue, on the east by a two-track road, and on the west by an unnamed road. The topography of HMU-57 is disturbed and somewhat flat lying. There is a somewhat steep bank sloping down to the shoreline. The site is characterized by casuarina forest and coastal ruderal scrub with a small area of tournefortia scrub at the east end and along the beach. The tournefortia scrub pinches out towards the west end of HMU-57. Casuarina forest occurs in the western section of the site. The coastal ruderal scrub is characterized by casuarina intermixed with some tournefortia, pisonia, cordia, sourbush, scaevola, and a few sea grapes. Open tournefortia scrub along the shoreline includes some casuarina, sourbush, and beach morning glory. There is also an open area of ruderal scrub characterized by wild spider flower, hairy purslane, button sedge, *Phyllanthus amarus*, crowfoot grass, Jamaican vervain, goosegrass, Indian bluegrass (*Bothriochloa pertusa*), `uhaloa, upland cotton, coat buttons, moon flower, beach morning glory, and wild poinsettia. Tangantangan occurs in the central area of HMU-57 behind the houses. There is an area of mowed/maintained vegetation characterized by crowfoot grass, nut grass (*Cyperus rotundus*), white beggar-ticks, and a row of planted coconut palms along Wake Avenue. Small areas characterized primarily by cordia also occur adjacent to mowed areas along Wake Avenue. The casuarina trees in HMU-57 have DBHs of up to approximately 8-10 in. with occasional larger trees.

- Coverage of casuarina is approximately 45 percent.
- Coverage of coastal ruderal scrub-mixed is approximately 8 percent.
- Coverage of tournafortia-mixed scrub is approximately 35 percent.
- Coverage of mowed/maintained vegetation is approximately 10 percent.
- Coverage of tangantangan is approximately 2 percent.

Wake Atoll HMU-58

Characteristic habitat in HMU-58

HMU-58, the housing area, is approximately 61.73 acres located at the northwestern tip of the eastern section of Wake Island. The topography of HMU-58 is disturbed and flat lying. The area is mostly mowed/maintained with some landscaped shrubs and trees. The mowed/maintained vegetation is similar to HMU-52 with white beggar-ticks, crowfoot grass, nut grass, button sedge, `uhaloa, hairy spurge, Indian bluegrass, coat buttons, and Japanese love grass. There are large planted casuarina around the buildings and parking areas. There is a large clump of tangantangan near the shoreline adjacent to the power plant and smaller clumps of tangantangan associated with buildings and structures. There are also coconut palms, tournefortia, sea grapes, casuarina, a few *Plumeria* sp., Norfolk Island pine (*Araucaria heterophylla*), bougainvillea (*Bougainvillea spectabilis*), and palm species scattered through the HMU. Examples of additional trees and shrubs around houses include royal poinciana (*Delonix regia*), *Ficus* sp., ornamental hybrids of hibiscus (*Hibiscus* spp.), desert rose (*Adenium obesum*) and Indian almond. Many cultivated plants occur in pots and containers around the housing and billeting areas. Examples of cultivated plants include bitter melon (*Momordica charantia*), lemon grass (*Cymbopogon citratus*), sweet basil (*Ocimum basilicum*), holy basil (*Ocimum tenuiflorum*), eggplant (*Solanum melongena*), and chili pepper (*Capsicum annuum*). The casuarina trees around the buildings have DBHs of up to approximately 24 in. or more, and some are over 30 in.

- Coverage of casuarina is approximately 10 percent.
- Coverage of tangantangan is approximately 3 percent.
- Coverage of mowed/maintained area is approximately 80 percent.
- Coverage of other trees/shrubs/plants is approximately 7 percent.

Wake Atoll HMU-59

HMU-59 is approximately 12.34 acres located on the southern lagoon side of Peale Island. HMU-59 is separated from the rest of Peale Island at high tide by a narrow tidal cut. The topography of HMU-59 is disturbed and undulating. The vegetation is characterized by pemphis and casuarina forest/scrub with upland cotton and tournefortia. Tournefortia is more common in the western end of the HMU. The casuarina trees in HMU-59 have DBHs of up to approximately 8 in.

- Coverage of casuarina is approximately 35 percent.
- Coverage of pemphis and other species is approximately 65 percent.

Wake Atoll HMU-60

HMU-60 is approximately 58.18 acres located on the southern end of Peale Island. The site is bordered on the north by Pan Am Road and HMU-63, on the south and west by the lagoon, and on the east by Peale Avenue and Pan Am Road. The topography of HMU-60 is disturbed and undulating with areas of excavated and pushed up terrain. There is casuarina forest in the southeastern end of the HMU. Casuarina also occurs along the shoreline intermixed with pemphis scrub, upland cotton, and some tournefortia, cordia, and sea grape. Coconut palms and ornamental hybrids of hibiscus occur around old structures. Tournefortia forest occurs in the central and northeastern areas of HMU-60. There are areas of cordia with scattered pisonia within the tournefortia forest. There are also a few small areas of tangantangan up to 15 ft. in height along Peale Avenue. The casuarina trees in HMU-60 have DBHs of mostly 4-8 in. with some up to 18 in. or greater.

Casuarina in HMU-60

- Coverage of casuarina is approximately 15 percent.
- Coverage of tangantangan is approximately 2 percent.
- Coverage of tournefortia-mixed is approximately 58 percent.
- Coverage of pemphis scrub is approximately 25 percent.

Wake Atoll HMU-61

HMU-61 is approximately 28.97 acres located on the southeastern shore of Peale Island. The site is bordered on the north by HMU-64, on the south by HMU-60, on the east by the ocean shoreline, and on the southwest by Peale Avenue. The topography of HMU-61 is disturbed and undulating with areas of excavated and pushed up terrain. Casuarina forest occurs in the southern end of the site and intermixed with tournefortia along the shoreline. Casuarina becomes mixed with tournefortia forest, soma cordia, pemphis, and coconut palm inland towards Peale Avenue. Heading north, the casuarina forest changes to tournefortia forest with areas of cordia forest, some sea grape, casuarina, and sourbush. There is an area of tangantangan adjacent to Peale Avenue in the central section of HMU-61 with saplings up to approximately 15 ft. in height. Vegetation occurring in scattered small open areas is characterized by moon flower,

`ilima, `uhaloa, hairy spurge, upland cotton, coastal pricklypear (*Opuntia littoralis*), wild poinsettia, Jamaican vervain, hairy horseweed, carry me seed (*Phyllanthus. amarus*), American century plant (*Agave americana*), little love grass (*Eragrostis minor*), and sandbur.

- Coverage of casuarina is approximately 30 percent.
- Coverage of tangantangan is approximately 4 percent within tournefortia/cordia.
- Coverage of tournefortia-mixed forest is approximately 66 percent.

Wake Atoll HMU-62

HMU-62 is approximately 41.49 acres located in the central area of Peale Island. The site is bordered on the north, south, and west by Pan Am Road and on the east by Peale Avenue. The topography of HMU-62 is disturbed and undulating with areas of excavated and pushed up terrain. The central west area is primarily tournefortia forest/scrub with cordia, some casuarina, and some areas of cordia forest/scrub. The north-central section of HMU-62 is characterized primarily by cordia forest and the north end of the HMU is tournefortia forest. There is an area of cordia intermixed with sea grape pisonia and tournefortia in the southeastern section of HMU-62 adjacent to Peale Avenue. Vegetation in open and understory areas is characterized by hairy spurge, wild poinsettia, Jamaican vervain, `ilima, hairy horseweed, moon flower, carry me seed, sandbur, crowfoot grass, and nut grass. The casuarina trees in HMU-62 have DBHs of up to approximately 24 in.

Sea grape and casuarina in HMU-62

- Coverage of casuarina within tournefortia and cordia forest is approximately 15 percent.
- Coverage of tournefortia forest is approximately 42 percent.
- Coverage of cordia forest is approximately 43 percent.

Wake Atoll HMU-63

HMU-63 is approximately 51.06 acres located at the northwestern end of Peale Island. The site is bordered on the north by ocean shoreline, the south by HMU-60 and Pan Am Road, the east by Peale Avenue, and the west by the lagoon shoreline. The topography of HMU-63 is disturbed and undulating with areas of excavated and pushed up terrain. The HMU is characterized primarily by tournefortia forest/scrub. The forested area to the south of the coast guard station is characterized by tournefortia with some cordia, pemphis, and casuarina. American century plant

and other ornamentals occur in association with old buildings. There is an open grassy area around and to the south of the Coast Guard structures characterized by crowfoot grass and Bermuda grass. Tournefortia forest with casuarina and pemphis occurs along the western shoreline. The percentage of casuarina increases to the south along the shoreline. Tangantangan occurs at the southern end of HMU-63 adjacent to Peale Avenue. Tangantangan also occurs around the Pan Am ramp and in small areas along the shoreline.

- Coverage of tournefortia-mixed forest scrub is approximately 83 percent.
- Coverage of casuarina within the tournefortia forest is approximately 5 percent.
- Coverage of tangantangan within the tournefortia forest is approximately 2 percent.
- Coverage of open area and ruderal mixed area is approximately 10 percent.

Wake Atoll HMU-64

HMU-64 is approximately 18.76 acres located on the northeastern shore of Peale Island. The site is bordered on the north by HMU-63, the south by HMU-61, the east by ocean shoreline, and the west by Peale Avenue. The topography of HMU-64 is disturbed and undulating with areas of excavated and pushed up terrain. The south end of HMU-64 is characterized primarily by cordia forest. Tournefortia forest with some cordia, pemphis, and casuarina also occurs in the southern section. Tangantangan shrubs up to approximately 10 ft. occur in the southern section adjacent to Peale Avenue. The northern section of the HMU is tournefortia forest/scrub with some sourbush. There are some casuarina at the north end of HMU-64. Vegetation in open areas and the understory is characterized by hairy spurge, wild poinsettia, Jamaican vervain, `ilima, hairy horseweed, moon flower, Indian blue grass, crowfoot grass, button sedge, nut grass, carry me seed, and sandbur. The casuarina trees in HMU-64 have DBHs of up to approximately 16 in.

- Coverage of casuarina within tournefortia forest scrub is approximately 8 percent.
- Coverage of tangantangan within tournefortia forest scrub is approximately 2 percent.
- Coverage of tournefortia-mixed forest scrub is approximately 70 percent.
- Coverage of cordia forest is approximately 20 percent.

Wake Atoll HMU-65

HMU-65 is approximately 357.39 acres located on the southeastern section of Wake Island. The HMU includes the Air Field and associated clear zones and infrastructure. The topography of HMU-65 can be described as disturbed and flat lying. The HMU is mostly mowed/maintained vegetation with coconut palms planted around base operations and other buildings. There are some patches of mowed tangantangan in the western section of HMU-65 and in the clear zone along the southwest side of the Air Field. Vegetation in the clear zone at the west end of the Air Field is characterized by white beggar-ticks, hairy spurge, tangantangan, slender mimosa, swollen fingergrass, Jamaican vervain, button sedge, Canada horseweed, hairy horseweed, upland cotton, puncture vine, casuarina seedlings, four-spike heliotrope, and goosegrass. The vegetation in the eastern three-quarters of the clear zone is characterized by crowfoot grass, swollen fingergrass, button sedge, white beggar-ticks, Jamaican vervain, some spread out casuarina seedlings, beach morning glory, and coat buttons.

- Coverage of mowed/maintained area is approximately 95 percent.
- Coverage of mowed tangantangan is approximately 3 percent.
- Coverage of casuarina seedlings is approximately 1 percent.
- Coverage of ornamental species is approximately 1 percent.

Mowed vegetation at the west end of HMU-65

THIS PAGE INTENTIONALLY LEFT BLANK

Figures 2-3a-k. Dominant Vegetation in HMUs on Wake Atoll

Figure 2-3b
Vegetation and Habitat Mapping Units on Wake Atoll

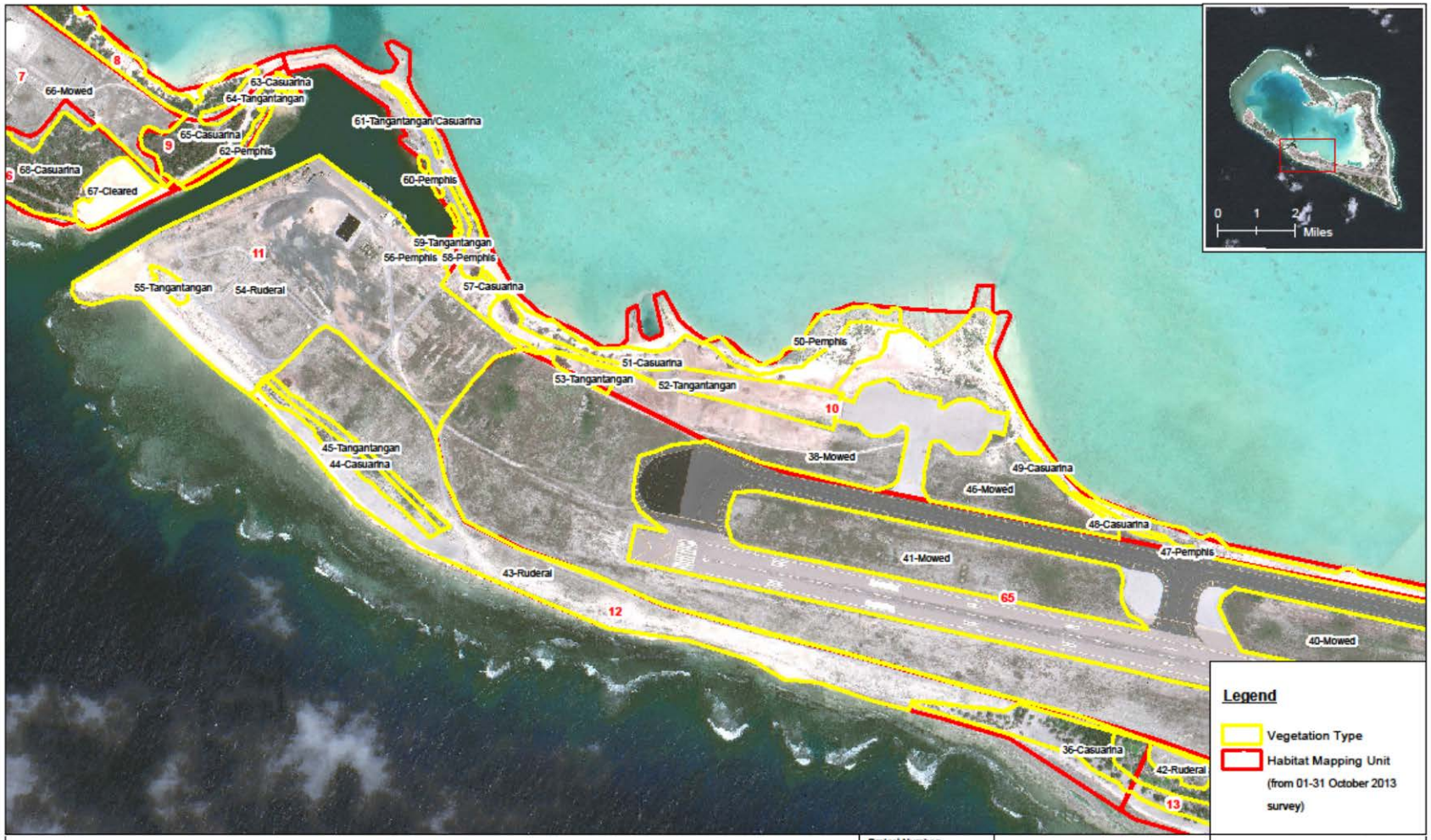


Figure 2-3c
Vegetation and Habitat Mapping Units on Wake Atoll

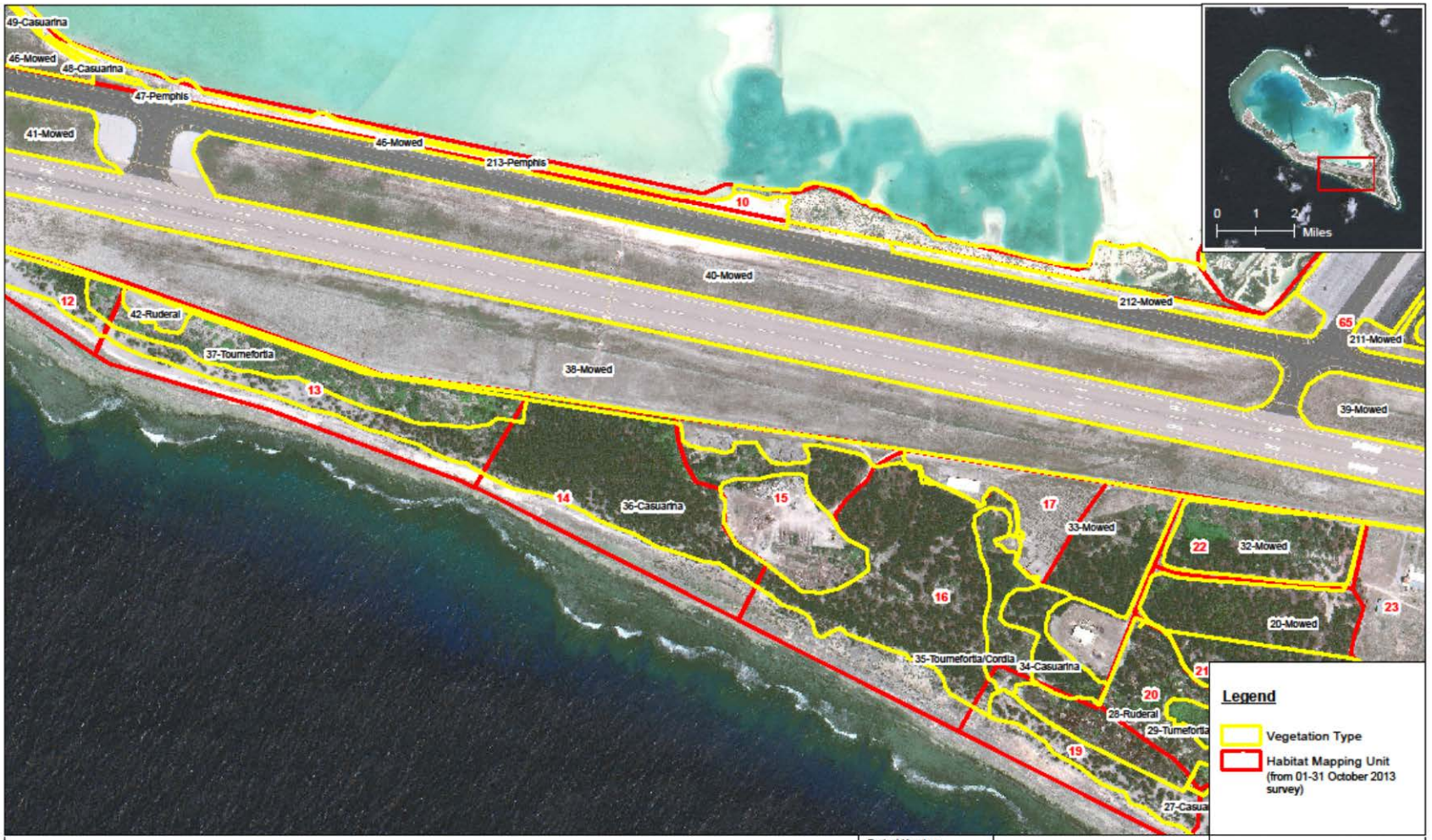


Figure 2-3d
Vegetation and Habitat Mapping Units on Wake Atoll

Figure 2-3e
Vegetation and Habitat Mapping Units on Wake Atoll

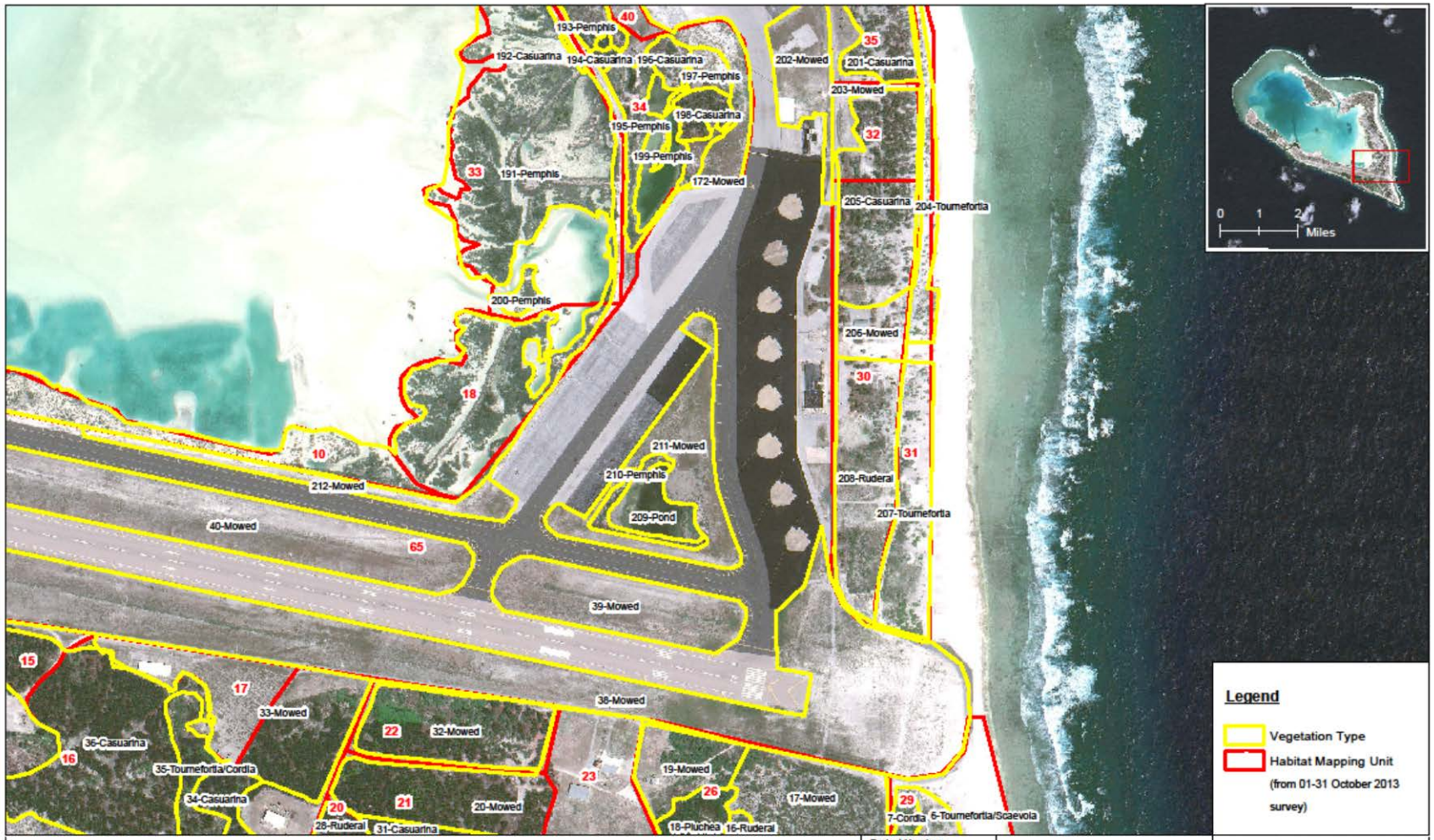


Figure 2-3f
Vegetation and Habitat Mapping Units on Wake Atoll

Project Number: 6242189
Date: January 2015

Data Sources:
Aerial Photography/GIS - USAF 611th CES/CEPT

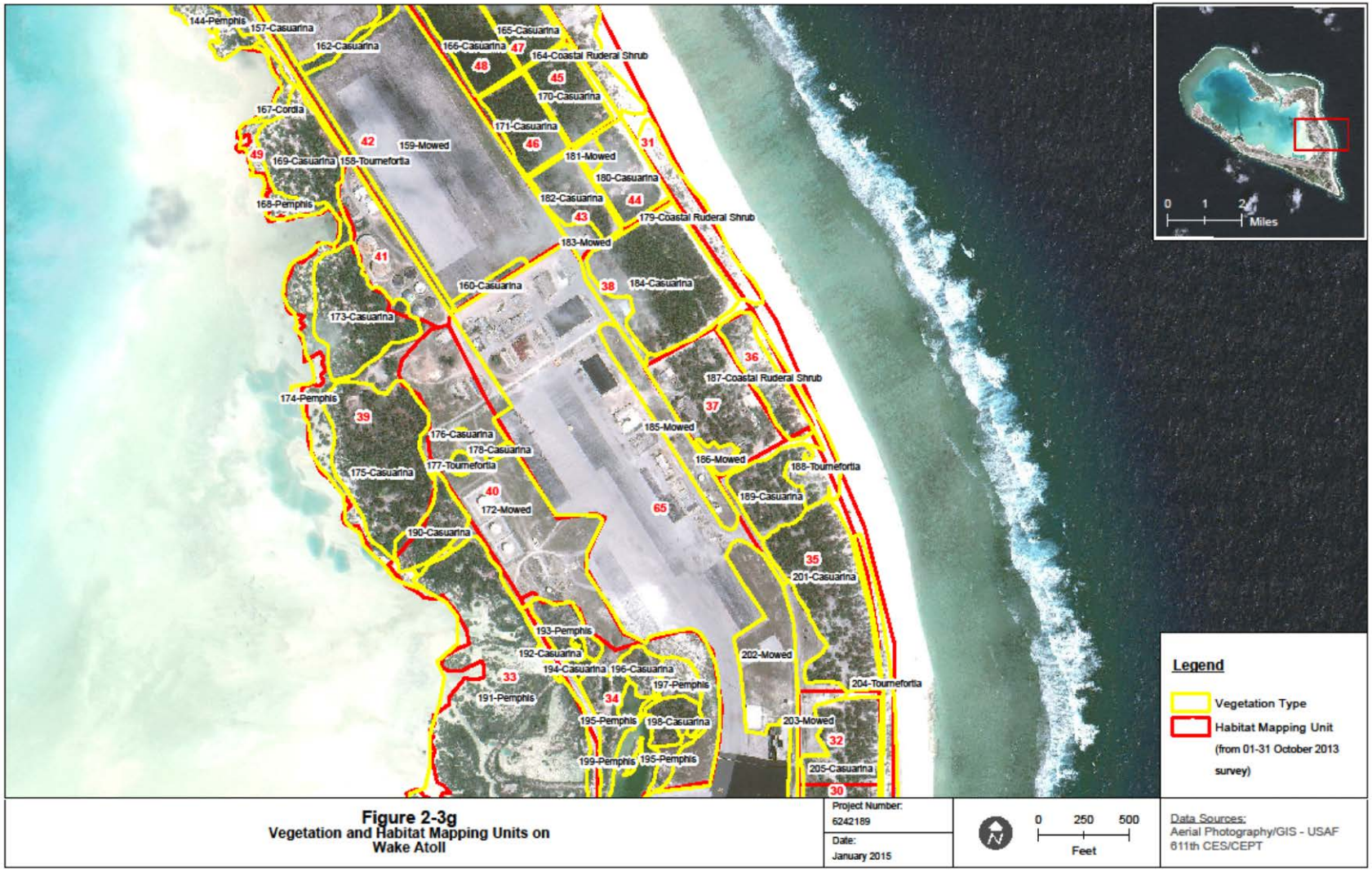


Figure 2-3g
Vegetation and Habitat Mapping Units on Wake Atoll

Figure 2-3h
Vegetation and Habitat Mapping Units on Wake Atoll

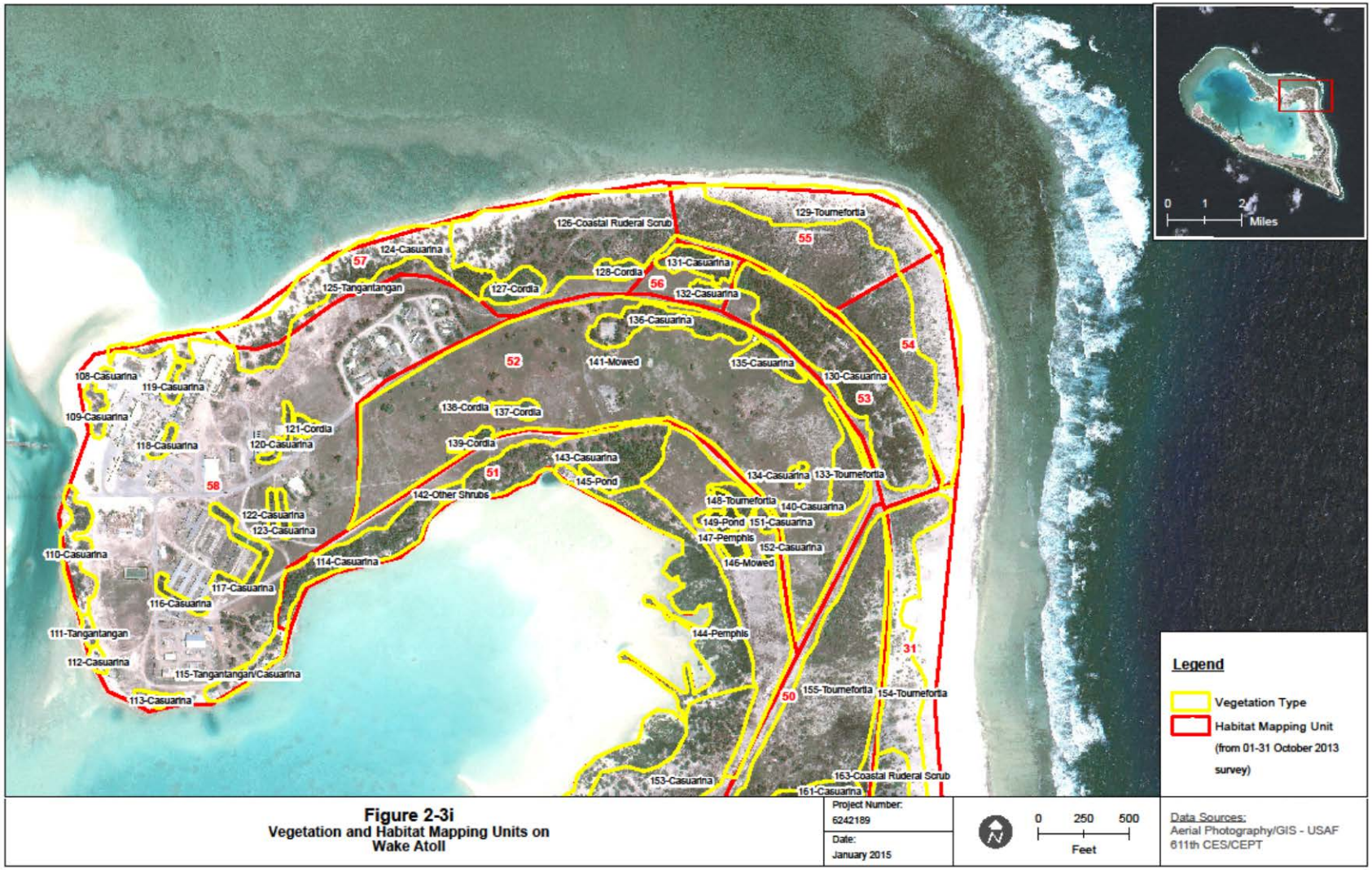


Figure 2-3i
Vegetation and Habitat Mapping Units on Wake Atoll

Figure 2-3j
Vegetation and Habitat Mapping Units on Wake Atoll

Figure 2-3k
Vegetation and Habitat Mapping Units on Wake Atoll

THIS PAGE INTENTIONALLY LEFT BLANK

Table 2-1. Wake Atoll Vegetation Mapping Unit Acreages

Vegetation Unit	Area (acres)
1-Tournefortia	1.53
2-Ruderal	11.18
3-Tournefortia	9.55
4-Ruderal	3.37
5-Cordia	0.15
6-Tournefortia/Scaevola	1.46
7-Cordia	0.68
8-Ruderal	0.93
9-Tournefortia	0.00
10-Tournefortia	1.45
11-Tournefortia/Scaevola	9.28
12-Tournefortia	18.83
13-Casuarina	0.65
14-Scaevola	0.44
15-Tournefortia	9.72
16-Ruderal	5.75
17-Mowed	7.73
18-Pluchea	3.38
19-Mowed	3.71
20-Mowed	19.21
21-Cordia	0.70
22-Cordia	0.18
23-Pluchea	1.16
24-Tournefortia	2.39
25-Scaevola	6.82
26-Scaevola	5.41
27-Casuarina	7.49
28-Ruderal	9.19
29-Turnefortia/Scaevola	1.00
30-Scaevola	4.61
31-Casuarina	4.26
32-Mowed	7.11
33-Mowed	11.34
34-Casuarina	2.78
35-Tournefortia/Cordia	3.49
36-Casuarina	41.65
37-Tournefortia	8.20
38-Mowed	112.67
77-Casuarina	1.45
78-Casuarina	1.48
79-Tournefortia	38.27
80-Pemphis	1.37
81-Cordia	3.76
82-Mowed/Ruderal	34.12
83-Tournefortia	2.76
84-Tournefortia	125.29
85-Grassland	5.15
86-Cordia	5.95
87-Tangantangan	0.01

Vegetation Unit	Area (acres)
39-Mowed	7.86
40-Mowed	35.79
41-Mowed	12.81
42-Ruderal	0.92
43-Ruderal	24.59
44-Casuarina	1.56
45-Tangantangan	1.06
46-Mowed	17.06
47-Pemphis	0.06
48-Casuarina	0.32
49-Casuarina	0.12
50-Pemphis	1.94
51-Casuarina	4.61
52-Tangantangan	4.16
53-Tangantangan	0.69
54-Ruderal	31.94
55-Tangantangan	0.40
56-Pemphis	0.10
57-Casuarina	0.10
58-Pemphis	0.77
59-Tangantangan	0.15
60-Pemphis	0.17
61-Tangantangan/Casuarina	0.26
62-Pemphis	0.75
63-Casuarina	0.13
64-Tangantangan	0.18
65-Casuarina	6.99
66-Mowed	21.47
67-Cleared	1.72
68-Casuarina	9.44
69-Scaevola	4.26
70-Casuarina	0.16
71-Casuarina	0.41
72-Tournefortia	8.76
73-Cordia	1.53
74-Casuarina	19.61
75-Pemphis	2.31
76-Pemphis	2.15
117-Casuarina	0.97
118-Casuarina	0.25
119-Casuarina	0.30
120-Casuarina	0.41
121-Cordia	0.26
122-Casuarina	0.27
123-Casuarina	0.27
124-Casuarina	7.33
125-Tangantangan	0.06
126-Coastal Ruderal Scrub	20.96
127-Cordia	0.94

Table 2-1. Wake Atoll Vegetation Mapping Unit Acreages

Vegetation Unit	Area (acres)
88-Tangantangan	0.00
89-Tangantangan	0.01
90-Tangantangan	0.01
91-Cordia	0.68
92-Cordia	0.44
93-Casuarina	0.99
94-Cordia	6.71
95-Cordia	4.43
96-Tournefortia/Casuarina	3.07
97-Cordia Mix	1.65
98-Cordia	1.01
99-Tournefortia	0.62
100-Cordia	0.49
101-Pisonia	1.02
102-Cordia	5.22
103-Pemphis	12.96
104-Pemphis	8.02
105-Casuarina	1.90
106-Casuarina	9.29
107-Tangantangan	0.01
108-Casuarina	0.08
109-Casuarina	0.49
110-Casuarina	1.65
111-Tangantangan	0.23
112-Casuarina	0.21
113-Casuarina	0.28
114-Casuarina	4.22
115-Tangantangan/Casuarina	0.07
116-Casuarina	0.39
158-Tournefortia	2.30
159-Mowed	38.82
160-Casuarina	0.55
161-Casuarina	11.73
162-Casuarina	0.90
163-Coastal Ruderal Scrub	2.96
164-Coastal Ruderal Shrub	4.62
165-Casuarina	4.16
166-Casuarina	4.39
167-Cordia	0.58
168-Pemphis	1.33
169-Casuarina	4.25
170-Casuarina	2.72
171-Casuarina	2.81
172-Mowed	25.23
173-Casuarina	5.18
174-Pemphis	4.13
181-Mowed	0.36
182-Casuarina	2.37
183-Mowed	1.52

Vegetation Unit	Area (acres)
128-Cordia	0.47
129-Tournefortia	9.56
130-Casuarina	7.88
131-Casuarina	1.06
132-Casuarina	0.28
133-Tournefortia	1.49
134-Casuarina	0.15
135-Casuarina	0.70
136-Casuarina	2.15
137-Cordia	0.41
138-Cordia	0.07
139-Cordia	0.38
140-Casuarina	0.16
141-Mowed	41.11
142-Other Shrubs	0.23
143-Casuarina	5.04
144-Pemphis	14.73
145-Pond	0.25
146-Mowed	10.13
147-Pemphis	0.56
148-Tournefortia	0.41
149-Pond	0.53
151-Casuarina	0.21
152-Casuarina	0.12
153-Casuarina	7.15
154-Tournefortia	10.28
155-Tournefortia	12.44
156-Casuarina	0.76
157-Casuarina	4.30
198-Casuarina	1.23
199-Pemphis	0.11
200-Pemphis	0.67
201-Casuarina	7.48
202-Mowed	5.66
203-Mowed	2.54
204-Tournefortia	3.40
205-Casuarina	8.82
206-Mowed	2.33
207-Tournefortia	6.03
208-Ruderal	8.19
209-Pond	2.27
210-Pemphis	1.06
211-Mowed	7.45
212-Mowed	3.22
213-Pemphis	0.23
150-Pond	0.27

Table 2-1. Wake Atoll Vegetation Mapping Unit Acreages

Vegetation Unit	Area (acres)
184-Casuarina	7.92
185-Mowed	2.96
186-Mowed	0.52
187-Coastal Ruderal Shrub	2.49
188-Tournefortia	2.12
189-Casuarina	2.85
190-Casuarina	2.02
191-Pemphis	40.52
192-Casuarina	0.11
193-Pemphis	1.39
194-Casuarina	0.26
195-Pemphis	3.08
196-Casuarina	0.86
197-Pemphis	0.99

Vegetation Unit	Area (acres)
Total Acres	1281.65

THIS PAGE INTENTIONALLY LEFT BLANK

Table 2-2. Wake Atoll HMU Acreages and Percent Cover of Vegetation Communities

Percent Cover of Vegetation Communities by HMU

HMU Number	HMU Area (acres)	Casuarina	Casuarina-Mixed	Coastal Ruderal Scrub	Coastal Ruderal Scrub-Mixed	Cordia	Cordia-Mixed	Herbaceous	Mixed Forest Fringe	Mixed Shrub	Mowed/Maintained	Mowed/Maintained Mixed	Ornamental	Other Trees/Shrubs/Plants	Pemphis	Pemphis-Mixed	Ruderal Mixed	Ruderal Scrub	Scaevola	Scaevola-Mixed	Sourbush Scrub	Tangantangan	Tournefortia	Tournefortia-Mixed	Unvegetated	Vines	Total
1	37.00										90											10					100
2	26.00	20													10							70					100
3	22.02	10													10							80					100
4	18.66	30				10														20			40				100
5	21.14	70						5															25				100
6	13.31	75																				15		10			100
7	19.56										100																100
8	5.61	65																					20		15		100
9	4.03	70																		15		15					100
10	59.67	20													25			45				10					100
11	32.23	2															95					3					100
12	30.03	3															94					3					100
13	18.43	30															15						55				100
14	18.70	85									10					5											100
15	12.40	25									10							65									100
16	36.17	65									20												15				100
17	5.40	2									98																100
18	12.49	1														98							1				100
19	10.82	60																					40				100
20	7.21	70																					30				100
21	21.97	30				5					30										10		25				100
22	8.18										100																100
23	11.32										100																100
24	12.42	30																	70								100
25	24.50	5									10								40				45				100
26	34.43										35							30	5				30				100
27	26.16	10																10				20	60				100
28	17.64						25																75				100
29	34.38	2																				98					100
30	16.82	10										70										20					100
31	37.68	20																					80				100
32	4.83	90								10																	100
33	30.37	10								15	5				70												100
34	15.47	30									35				35												100
35	14.16	80								10	10																100
36	3.01	75								25																	100
37	6.52	85								5	10																100
38	9.57	95									5																100
39	18.31	75									5				20												100
40	14.62	5									90											5					100
41	4.45	2									96											2					100
42	43.06	5							5		90																100
43	3.37	75									25																100
44	3.41	50									50																100
45	3.27	100																									100
46	3.28	85									15																100
47	4.81	100																									100
48	5.22	85									15																100
49	13.96	35	30												30										5		100
50	29.50	30									15												55				100
51	43.24	35									45				15							5					100
52	45.33	3							2		95																100
53	10.26		80								20																100
54	8.65	15		45																			40				100
55	13.00	35			20																		45				100
56	2.90	50								20	30																100
57	19.64	45			8						10											2		35			100
58	61.73	10									80			7								3					100
59	12.34	35													65												100
60	58.18	15													25							2		58			100
61	28.97	30																				4		66			100
62	41.49	15				43																	42				100
63	51.06	5															10					2		83			100
64	18.76	8				20																2		70			100
65	357.39	1									95		1									3					100
Number of HMUs with Vegetation Community Present		**58**	**2**	**1**	**2**	**4**	**1**	**1**	**2**	**6**	**32**	**1**	**1**	**1**	**10**	**2**	**4**	**4**	**3**	**2**	**1**	**13**	**13**	**18**	**2**	**1**	
Vegetation Community Total (acres)	1660.51	306	12	4	4	25	4	1	3	8	640	12	4	4	83	13	67	48	20	4	2	27	138	227	2	1	

THIS PAGE INTENTIONALLY LEFT BLANK

2.1.5.3 Fish and Wildlife

Mammals

Cats and Dogs

Cat observed on Wake Island in 2011

There are no indigenous mammals on Wake Atoll. Historically, dogs and cats resided with the residents on the Atoll. There currently are no dogs (*Canis familiaris*) on the Atoll. Historically, domesticated cats (*Felis catus*) were kept by island residents and naturalized feral cats were common on all three islands. A cat eradication program was funded in 2000 and three collaborating organizations, Endangered Species Recovery Council, Wildlife Management International of New Zealand, and Marine Endeavours began a concerted effort to remove feral cats from Wake Atoll. By January 2004, approximately 170 cats had been removed. In June 2007, Rauzon and Gilardi (2007) reported that a few cats (four individuals) were present, two of which were known pets (spayed and taken care of by island residents). The remaining cats were probably the same gender, because no cat reproduction was detected. In 2010/2011, Pacific Rim Conservation (PRC) conducted biological monitoring surveys. During these surveys, three feral cats were observed in November 2010 and February 2011 (PRC 2011). One cat was observed on a two-track road behind the housing area during the site visit for this plan in October 2013. It appeared to be the same cat that is shown in the photo. Based on correspondence with Maureen Raleigh on 28 March 2014, there are two domesticated cats remaining on Wake Island. Ms. Raleigh cares for both cats. Both cats are females. One cat appears to be part Siamese and the other is grey and striped. Both cats are believed to be around 17 years old and are tame. There was a third cat on the island, but it died in 2013. It was a small black cat that arrived with a barge in 2006.

There will be no pets allowed on Wake Atoll after the currently remaining pets die, with the exception of certified working service dogs, which will only be approved on a case by case basis by the PRSC natural resource specialist in conjunction with the Det 1 Commander.

Rats

Two species of rats, Polynesian rat (*Rattus exulans*) (also referred to as the Pacific rat) and the Asian house rat (*Rattus tanezumi*), were inadvertently introduced to Wake Atoll. Polynesian rats were thought to have been introduced to the Atoll by early Micronesian explorers. The Asian house rat was thought to be introduced by Vietnamese refugees during the 1970s, when it was observed that associated cargo was contaminated with rats. The Polynesian rat, in particular, and the Asian house rat became extremely abundant throughout Wake Atoll. The Norway rat (*Rattus norvegicus*) and the black rat (*Rattus rattus*) might have occurred on Wake Atoll previously (SMDC 1999), but a 1-month-long rat reconnaissance survey conducted in October 2007 by

15 Air Wing, USFWS, USDA, United States Environmental Protection Agency (USEPA), and rat-eradication experts from the United States and abroad, resulted in no observations of these species (USAF 2008).

Rats are known to prey upon seabird eggs and chicks, native plants, and other invertebrates, and have caused the extinction and extirpation of multiple species world-wide. They also cause damage to arrestor tapes, buildings, and other infrastructure; contaminate food stores; and can pose a potential health threat.

Polynesian rat on Wake Atoll in October 2013

Section 3.2 provides a description of rat eradication efforts on Wake Atoll to date.

Birds

Wildlife on Wake Atoll is dominated by a diversity of seabirds and migratory shorebirds and waterfowl. Prior to the presence of humans on Wake Atoll, the islands likely supported a diverse assemblage of seabirds and shorebirds. Accounts from the Tanager Expedition in 1923 noted observations of 19 species of birds including many that are currently present (Bryan 1942). Japanese feather hunters from the early part of the 20th century adversely affected bird populations. The destruction of habitat prior to and during World War II devastated the remaining bird populations. Surveys that followed the war found very few birds present (Bryan 1959; Fosberg, 1959). It was not until the early 1990s that seabird species richness and population sizes began to increase. Recent surveys by the Endangered Species Recovery Council (Ogden 1999), and Rauzon and Gilardi (2007) recorded 32 bird species on Wake Atoll. In October 2010, PRC was contracted by Chugach to conduct biological monitoring of sea birds and wetland birds on Wake Atoll. Monitoring occurred from October-November 2010 and January-February 2011. A total of 12 species of seabirds and 15 species of wetland birds were observed during these surveys. **Table 2-3** provides a list of bird species that have been recorded on Wake Atoll.

Wilkes and Peale islands support large populations of resident and migratory seabirds and visiting winter resident shorebirds and waterfowl. The open terrain and current lack of disturbance on those two islands is conducive for nesting seabirds. Common bird nesting areas on Wake Atoll are shown in **Figure 2-4**. Below are more details on common species of seabirds, common migrating shorebirds, and wetland birds found on Wake Atoll.

Table 2-3. Bird Species Recorded on Wake Atoll

Common Name	Scientific Name
Accipitridae (hawks, eagles, kites)	
Black kite	*Milvus migrans*
Sea eagle	*Haliaeetus* sp.
Anatidae (Ducks, Geese, Swans)	
Aleutian cackling goose	*Branta hutchinsii leucopareia*
Common goldeneye	*Bucephala clangula*
Eurasian green-winged teal	*Anas crecca crecca*
Eurasian wigeon	*Anas penelope*
Garganey	*Anas querquedula*
Northern pintail	*Anas acuta*
Northern shoveler	*Anas clypeata*
Tufted duck	*Aythya fuligula*
Ardeidae (herons, egrets, and bitterns)	
Cattle egret	*Bubulcus ibis*
Pacific reef heron	*Egretta sacra*
Charadriidae (plovers, dotterels, lapwings)	
Lesser sand plover	*Charadrius mongolus*
Pacific golden plover	*Pluvialis fulva*
Columbidae (pigeons and doves)	
Rock pigeon	*Columba livia*
Cuculidae (cockoos)	
Long-tailed cuckoo	*Eudynamis taitensis*
Diomedeidae (albatrosses)	
Black-footed albatross	*Phoebastria nigripes*
Laysan albatross	*Phoebastria immutabilis*
Estrildidae (old world sparrows)	
Java sparrow	*Padda oryzivora*
Fregatidae (frigatebirds)	
Great frigatebird	*Fregata minor*
Lesser frigatebird	*Fregata ariel*
Fringillidae (true finches)	
Common canary	*Serinus canaria*
Hydrobatidae (storm petrels)	
Leach's storm petrel	*Oceanodroma leucorrhoa*
Laridae (seagulls)	
Glaucous-winged gull	*Larus glaucescens*
Laughing gull	*Larus atricilla*
Phaethontidae (tropicbirds)	
Red-tailed tropicbird	*Phaethon lepturus*
White-tailed tropicbird	*Phaethon lepturus*
Procellariidae (petrels, sheerwaters, and prions)	
Black-winged petrel	*Pterodroma nigripennis*
Christmas sheerwater	*Puffinus nativitatus*
Newell's shearwater	*Puffinus griseus*
Sooty shearwater	*Puffinus griseus*
Wedge-tailed shearwater	*Puffinus pacificus*
Scolopacidae (sandpipers)	
Bristle-thighed curlew	*Numenius tahitiensis*

Table 2-3. Bird Species Recorded on Wake Atoll

Common Name	Scientific Name
Common sandpiper	*Actitis hypoleucos*
Common snipe	*Gallinago gallinago*
Dunlin	*Calidris alpina*
Gray-tailed tattler	*Heteroscelus brevipes*
Greater yellowlegs	*Tringa melanoleuca*
Long-billed dowitcher	*Limnodromus scolopaceus*
Pectoral sanderling	*Calidris melanotos*
Ruddy turnstone	*Arenaria interpres*
Ruff	*Philomachus pugnax*
Sanderling	*Calidris alba*
Sharp-tailed sandpiper	*Calidris acuminata*
Wandering tattler	*Heteroscelus incanus*
Whimbrel	*Numenius phaeopus*
Sternidae (terns)	
Black noddy	*Anous minutus*
Brown noddy	*Anous stolidus*
Gray-backed tern	*Onychoprion lunatus*
Sooty tern	*Onychoprion fuscatus*
White tern	*Gygis alba*
Strigidae (true owl)	
Brewster's brown booby	*Sula leucogaster brewsteri*
Brown booby	*Sula leucogaster*
Masked booby	*Sula dactylatra*
Red-footed booby	*Sula sula*
Source: Rauzon et al. 2008; PRC 2011	

Figure 2-4. Common Bird Nesting Areas on Wake Atoll

THIS PAGE INTENTIONALLY LEFT BLANK

Reptiles and Amphibians

Two species of geckos and two species of skinks were collected on Wake Island during the Tanager Expedition in 1923 (Bryan 1959). The geckos included the mourning gecko (*Lepidodactylus lugubris*) and the stump-toed gecko (*Peropus mutilatus*). The mourning gecko is common Wake Atoll. The mourning gecko reaches a total length of 3.5-4 in. Half of its length consists of tail. Its color may vary, but it is most often a pale to dark brown with brown overlapping zigzag patterning on the back. The mourning gecko can change color from light to dark depending on stress, background or temperature. The belly is mostly cream and is often semi-transparent. There are no recent recordings of the stump-toed gecko on Wake Atoll.

Skinks collected during the Tanager Expedition include the snake-eyed skink (*Cryptoblepharus boutonii*) and the azure-tailed skink (*Emoia cyanura*). There are no recent recordings of the snake-eyed skink, but the azure-tailed skink is common on Wake Atoll. The azure tailed skink is best identified by a sharply defined, light-colored mid-dorsal line that extends from the tip of the snout to the bright azure tail. Most adults have at least two additional lateral light-colored stripes on a dark brown background. Adults reach approximately 5 in. in length.

In March 1949, a brown tree snake (*Boiga irregularis*) was collected on Wake Island (Bryan 1959). No other accounts of brown tree snakes have been reported on the island.

PRC also conducted monitoring surveys for sea turtles in October/November 2010 and January/February 2011. The goal of the survey was to document and monitor the number of nests and tracks by sea turtles on Wake Atoll. Sea turtle activity was surveyed weekly on Wake, Peale, and Wilkes islands by walking along the shorelines identified as having suitable nesting habitat. No signs of sea turtles on any of the shoreline areas surveyed were recorded (PRC 2011). The federally threatened green sea turtle (*Chelonia mydas*) is regularly observed in the nearshore ocean and lagoon waters at Wake Atoll.

Invertebrates

Hermit crabs (*Coenibita perlata*) are common on Wake Atoll. They are present in most habitats and are commonly found in the shade during the day. At least two other species of land crabs *(Geograpsus crinipes* and *Geograpsus* sp.) are also present on Wake Atoll. *Geograpsus* sp. digs burrows in the casuarina and tournefortia forests. Ghost crabs (*Ocypode ceratophtala*) are found in sandy deposits within the intertidal zone. Fiddler crabs (*Uca* sp.) occur in the Pemphis/sea purslane wetlands along the lagoon margin and pond edges. Thin-shelled rock crabs (*Graspus tenuicrustatus*) occur in the intertidal zone and were commonly observed during site visits conducted in October 2013 in support of the development of this BCSMP.

Fiddler crabs on Wake Island

Thin-shelled rock crab on Wilkes Island

Hermit crab on casuarina on Wake Island

In 2009, an arthropod monitoring survey was conducted by the Pacific Islands Conservation Research Association. The goal of the survey was to collect baseline information on the arthropod fauna on Wake Atoll, identify the presence of native arthropods, and assist in detection of harmful resident and newly arrived pest species. Twenty-four random sites were sampled for arthropods. Four sites were sampled in each of the following habitat types: pisonia/cordia, tournefortia, pemphis wetland, seabird breeding colony, grassland, and casuarina. A total of 2,170 specimens representing 148 species were collected and identified. Some of the arthropods collected included jumping spiders (*Salticidae* sp.), larder beetles (*Dermestidae* sp.), rove beetles (*Staphylinidae* sp.), click beetles (*Elatridae* sp.), springtails (*Collembola* sp.), biting midges (*Ceratopogonidae* sp.), fruit flies (*Drosophillidae* sp.), wasps (*Brachonidae* sp.), soft ticks (*Argasidae* sp.), tiger and lichen moths (*Arctiidae* sp.), leaf miners (*Gracillariidae* sp.), and tropical house crickets (*Gryllodes sigillatus*) (Hebshi et al. 2011).

The following invasive ant species have been documented on the Atoll: fire ant (*Solenopsis geminate*), bigheaded ant (*Pheidole megacephala*), *Paratrechina* spp., and long-legged ant (*Anoplolepis gracilipes*) (Hebshi and Patrick 2007).

2.2 KŌKE`E AIR FORCE STATION

2.2.1 Location and Area

Kōke`e AFS is a radar tracking station of the 15th Airlift Wing operated by the Hawai`i Air National Guard. A nearby microwave antenna station, Kōke`e MAS, supports communications and is considered part of the installation for this BCSMP. Kōke`e AFS is located in the northwestern quadrant of the island of Kaua`i, at approximately 22°09'04" north latitude and 159°38'53" west longitude. Kōke`e AFS includes 10.09 acres surrounded by forest and is within Kōke`e State Park on the Kahuamaʻa Flat of the Alakaʻi Plateau. The main road into Kōke`e State Park passes immediately to the west of the installation and is used year-round by tourists, hunters, military personnel, and other state park visitors.

Looking northwest towards Kōke`e AFS

The Kōke`e MAS is located on a 1.25-acre triangular piece of land within Waimea State Park. The facility is bordered on its eastern side by Waimea Canyon Road (State Route 550) near Mile Marker 9, approximately 9.5 miles south of Kōke`e AFS (**Figures 2-5 and 2-6**). Except for the road, the site is surrounded by forest.

Looking south on Rt. 550 at Kōke`e MAS

2.2.2 Climate

Precipitation and temperature records from the weather station nearest to Kōke`e AFS in proximity and elevation were collected to characterize climatic conditions at the station. This station is located approximately 1.7 miles southwest of the AFS at the Kōke`e State Park ranger station. The estimated annual precipitation at Kōke`e AFS is 69 in. In contrast, the annual rainfall at Mount Waialeale, which is 10 miles from Kōke`e AFS, has an average annual rainfall of 480 in. Mount Waialeale has the world's highest recorded average annual rainfall. Temperatures at Kōke`e AFS average about 55°F in January and 64°F in August.

2.2.3 Landforms

Kōke`e AFS lies on the Kahuama`a Flat of the Alakai Plateau, a gently eastward-sloping plain at an elevation of approximately 4,200 ft. above msl. The station is situated on a knoll which rises approximately 40 ft. from the lower portions of the installation. The station is surrounded by forest.

Kōke`e MAS is at an elevation of 2,900 ft. above msl. On the northern and western sides, the terrain drops steeply. The southern side descends more gently toward a small gully, while the east side borders Waimea Canyon Road (State Route 550).

2.2.3.1 Current Vegetative Cover

The grounds of Kōke`e AFS are entirely developed and landscaped inside the security fence, and in an approximately 6 ft. wide area around the outside perimeter of the fence. There are no naturally occurring native species within the fenced area at Kōke`e AFS; however, native vegetation occurs outside of the fence within the leased area of the facility. This area is characterized by a diverse mesic forest. Kōke`e MAS is, for the most part, cleared adjacent to structures. The area surrounding the structures is characterized by koa forest.

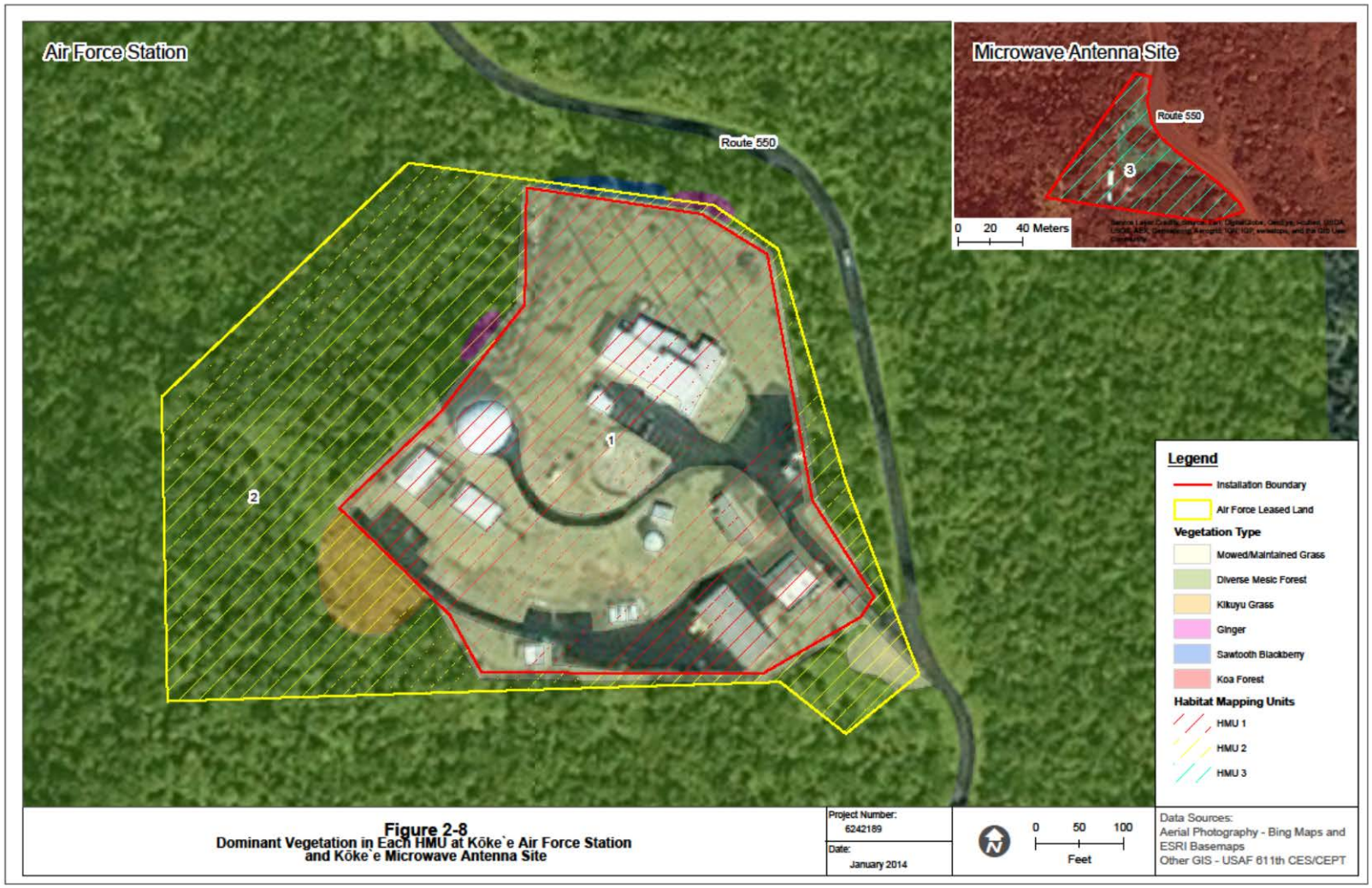
Vegetation was characterized during site visits conducted at Kōke`e AFS in November 2013. Kōke`e AFS and Kōke`e MAS were divided into three HMUs. HMU-1 includes the area within the security fence at Kōke`e AFS, HMU-2 includes the leased land outside of the fence, and HMU-3 includes Kōke`e MAS (**Figure 2-7**). A description of the topography and dominant vegetation for each of the HMUs is described below. **Figure 2-8** includes the HMUs and vegetation mapped on Kōke`e AFS and Kōke`e MAS. **Appendix A** contains the most up-to-date comprehensive list of vegetation found on Kōke`e AFS.

Figure 2-5. Location of Kōke`e AFS

Figure 2-6. Location of Kōke`e MAS

Figure 2-7. Location of HMUs at Kōke`e AFS and Kōke`e MAS

Figure 2-8. Dominant Vegetation in Each HMU on Kōke`e AFS and Kōke`e MAS



Kōke`e AFS HMU-1

Mowed and maintained grass in Kōke`e HMU-1

Kōke`e HMU-1 is approximately 4.18 acres and includes the area within the security fence. The HMU is characterized by disturbed rolling topography associated with a knoll. There are several small outcrop areas in the HMU. Vegetation in the HMU is mowed and maintained with scattered planted fruit and ornamental shrubs and trees. Grass species in the HMU are characterized by kikuyugrass (*Pennisetum clandestinum*), narrow-leaved carpetgrass (*Axonopus fissifolius*), common velvet grass (*Holcus lanatus*), pangola grass (*Digitaria eriantha ssp. pentzii*), and yellow foxtail (*Setaria parviflora*). Other vegetation characterizing the site includes narrowleaf plantain (*Plantago lanceolata*), daisy fleabane (*Erigeron karvinskianus*), common dandelion (*Taraxacum officinale*), woodland strawberry (*Fragaria vesica*), smooth cat's ear (*Hypochaeris glabra*), and cathedral bells (*Kalanchoe pinnata*). Patches of mosses also occur in the mowed area. Examples of planted trees and shrubs include methley plum (*Prunus cerasifera*), common pear (*Pyrus communis*), apple (*Pyrus malus*), pine (*Pinus* sp.), and hydrangea (*Hydrangea macrophylla*).

Invasive species observed in HMU-1 during November 2013 site visits include kikuyu grass, common velvet grass, narrowleaf plantain, daisy fleabane, woodland strawberry, and cathedral bells.

Kōke`e AFS HMU-2

View along the fence line in Kōke`e HMU-2

Kōke`e HMU-2 is approximately 3.9 acres and includes the leased area outside of the security fence. The topography of the site is characterized by rolling topography that decreases in elevation to the west. Vegetation in the HMU is characterized by mowed/maintained habitat adjacent to the entrance and in a narrow strip around the perimeter of the site, and forest and shrub habitat across most of the reminder of the site. Vegetation in the mowed/maintained area is the same as described for HMU-1. Vegetation in the canopy of forested habitat in HMU-2 is characterized by`ohi`a (*Metrosideros polymorpha*), `olapa, `ohe (*Tetraplasandra* sp.), olopua (*Nestegis sandwicensis*), koa,`ohi`a ha (*Syzygium sandwicensis*), `aulu (*Pouteria sandwicensis*), `ahakea lau li` i (*Bobea brevipes*), and firetree (*Morella faya*). The forest understory is somewhat open and is characterized by a number of shrubs including sawtooth blackberry (*Rubus argutus*), fragrant mokihana (*Melicope anisata*), Hawai`ian holly, mamane mamani (*Sophora chrysophylla*), olomea (*Perrottetia sandwicensis*), po`ola (*Claoxylon sandwicense*), koi (*Coprosma kauensis*), and ha`'iwale (*Cyrtandra longifolia*).

Examples of vine and herbaceous vegetation in the forest and open areas includes banana poka (*Passiflora tarminiana*), common vetch (*Vicia sativa*), montbretia crocosmia (*Crocosmia crocosmiiflora*), pa`iniu (*Astelia argyrocoma*), `uki`uki (*Dianella sandwicensis*), daisy fleabane, trailing periwinkle (*Vinca major*), woodland strawberry, yellow ginger (*Hedychium flavescens*), Kahili ginger (*Hedychium gardnerianum*), kikuyu grass, and yellow foxtail. Examples of ferns characterizing the site include `ama`'u (*Sadleria cyatheoides*), laukahi (*Elaphoglossum aemulum*), uluhe (*Dicranopteris linearis*), palapala`i (*Microlepia strigosa*), ho`i'o (*Diplazium sandwichianum*), and pala`a (*Odontosoria chinensis*).

Invasive species observed in HMU-2 during November 2013 site visits include firetree, sawtooth blackberry, banana poka, daisy fleabane, woodland strawberry, yellow ginger, Kahili ginger, and kikuyu grass.

Kōke`e AFS HMU-3

Kōke`e HMU-3 is approximately 1.5 acres and includes Kōke`e MAS. The topography of the site adjacent to the antenna and associated structures is disturbed and decreases in elevation to the west and south on relatively steep slopes. The site is bordered by Route 550 to the east. The site, excluding the facility structures and unpaved access road, is characterized by koa forest, with some herbaceous vegetation immediately adjacent to structures. Herbaceous vegetation adjacent to the structures is characterized by narrow-leaved carpetgrass, common velvet grass, molassesgrass (*Melinis minutiflora*), kikuyu grass, narrowleaf plantain, Florida tasselflower (*Emilia fosbergii*), common dandelion, and smooth cat's ear. Vegetation associated with the kao forest includes kao, guava (*Psidium* sp.), strawberry guava (*Psidium cattleianum*), Java plum (*Syzygium cumini*), uluhe, and lantana (*Lantana camara*).

Koa forest adjacent to Kōke`e MAS

Invasive species observed in HMU-3 during November 2013 site visits include kikuyu grass, common velvet grass, narrowleaf plantain, molassesgrass, strawberry guava, Java plum, and lantana.

2.2.4 Fish and Wildlife

Mammals

No indigenous mammals are known to reside within Kōke`e AFS. The installation within the fence is characterized primarily by mowed turf. The area outside of the fence is characterized by native mesic forest. Two mammals were recorded on Kōke`e AFS during surveys conducted in 1996: the Hawai`ian hoary bat (*Lasiurus cinereus semotus*) and Norway rat (EA 1996). Other mammals that may occur at the installation include rabbits (*Sylvilagus* spp.), cats, and feral pigs

(*Sus scrofa*). No mammals were observed on the site during the November 2013 site visit associated with development of this BCSMP.

Information on mammals documented at Kōke`e MAS is lacking. Except for the area immediately adjacent to individual structures, the site is not fenced. The area surrounding the antenna and structures is characterized by kao forest. There is the potential for wildlife species associated with the surrounding forest to occasionally occur within the boundaries of the site. No mammals were observed on the site during the November 2013 site visit conducted in association with the development of this BCSMP; however, there was abundant sign of rutting by feral pigs.

Birds

Banded Hawai`ian goose on Kōke`e AFS

A total of 14 bird species were observed on and adjacent to Kōke`e AFS during January 1997 surveys. Of these, five were native and nine were non-native species. The mowed turf habitat is typically used by non-native species such as sparrows, doves, and other ground feeders, and by the native migratory Pacific golden plover. Golden plover, red junglefowl (*Gallus gallus*), zebra dove (*Geopelia striata*), common myna (*Acridotheres tristis*), and house finch (*Carpodacus mexicanus*) were all observed on the installation grounds. In addition, the native `elepaio (*Chasiempis sandwichensis*), a type of flycatcher, was observed on the improved portion of the site. The northern cardinal (*Cardinalis cardinalis*) and red-crested cardinal (*Paroaria coronata*) were also observed. Several bird species were heard and seen in mesic forest on, and adjacent to the installation. Native birds seen in the surrounding forest were `apapane (*Himatione sanguinea*), common `amakihi (*Hemignathus virens*), and `anianiau (*Hemignathus parvus*). Additional native birds reported in the area include `i`iwi (*Vestiaria coccinea*), the Hawai`ian owl (*Asio flammeus sandwichensis*) (a subspecies of the short-eared owl), Newell's shearwater (*Puffinus auricularis newelli*), and the Hawai`ian petrel (`ua`u, *Pterodroma phaeopygia sandwichensis*) (Bruner 1990, 1992; Hawai`ian Audubon Society 1993). During the November 2013 site visit associated with this BCSMP, one banded (Band No. 83) Hawai`ian goose, or nēnē (*Branta sandvicensis*) was present and foraging within the fence. The goose has been coming to the site since the Summer of 2013. The Hawai`ian goose is federally endangered. There were also several chickens and roosters along with a group of chicks within the fence during the site visit. It was indicated during the site visit that the chickens do not normally stay on the site for extended periods.

Information on birds documented at Kōke`e MAS is lacking. The area surrounding the antenna and structures is characterized by kao forest. It is likely that some bird species associated with the surrounding kao forest occasionally occur within the boundaries of the site. Other than the nēnē, no bird species were identified on the site during the November 2013 site visit associated with this BCSMP.

Reptiles and Amphibians

No information on the reptiles and amphibians within the Kōke`e AFS is currently available. No reptiles or amphibians were observed on Kōke`e AFS or Kōke`e MAS during the November 2013 site visit associated with this BCSMP.

Invertebrates

No information on invertebrates within the Kōke`e AFS is currently available. No invertebrates were identified on Kōke`e AFS or Kōke`e MAS during the November 2013 site visit associated with this BCSMP.this page intentionally left blank

2.3 MT. KA`ALA AIR FORCE STATION

2.3.1 Location and Area

Mt. Ka`ala AFS is a radar station that tracks air traffic throughout the Hawai`ian Islands for both military and civilian purposes. The 611th PRSC is responsible for Mt. Ka`ala AFS. The 169th Aircraft Control & Warning Squadron, Hawai`i Air National Guard is a tenant on the site.

Looking northeast from Mt. Ka`ala AFS

Mt. Ka`ala AFS includes 6.6 acres at the summit of Mt. Ka`ala, which is at the northern end of the Wai`anae Mountain Range. Mt. Ka`ala rises 4,025 ft. above mean sea level and is the highest point on O`ahu. The station is approximately 20 miles northwest of Honolulu and 17 miles northwest of Hickam Air Force Base. The site is accessed from a steep and winding road which starts in Waialua, on the north shore of O`ahu. Mt. Ka`ala AFS is located at approximately 21°30'27" north latitude and 158°8'33"West longitude (**Figure 2-9**).

2.3.2 Climate

Mt. Ka`ala AFS is located in a tropical montane forest setting typical of the higher windward elevations of Oahu. The closest climate station with long-term records is approximately 2 miles south of the installation. Climate conditions can vary strongly over short distances in the Waianae Range, so accurate climate data for Mt. Ka`ala AFS is not available. The climate at Mt. Ka`ala AFS is mild, but rainy. The available information suggests that mean annual rainfall in this area is almost 92 in. Historically, December is the wettest month. Actual (but unmeasured) precipitation is thought to be higher due to frequent heavy condensation on vegetation (fog drip).

2.3.1 Landforms

Mt. Ka`ala AFS is located on a small flat area at the summit of Mt. Ka`ala, in the Waianae Mountain Range, the highest point on the island of Oahu (elevation approximately 4,020 ft. above msl). The terrain within the installation boundary is relatively even, but steep slopes fall away from the installation on three sides.

2.3.1 Vegetation

2.3.1.1 Historical Vegetative Cover

The historic vegetation in the area of the installation can be presumed to have resembled the regional vegetation, which is `ohi`a wet forest. This native plant community has also been referred to as a cloud forest since it occurs in the cloud zone. High rainfall, daily cloud cover, acid soils, low temperatures, and exposure to the tradewinds are typical of this environment. The

low-statured forest (6 to10 ft. tall in most places) is characterized by gnarled, spreading, many-branched trees and a well-developed shrub layer. Epiphytic and terrestrial mosses, liverworts, ferns, and smaller vascular plants are abundant. `ohi`a is the dominant tree species. Scattered through this low forest are somewhat taller trees, `olapa (*Cheirodendron trigynum*) and lapalapa (*Cheirodendron platyphyllum*). The shrub layer is dense and includes species such as the Hawai`ian holly (*Ilex anomala*); kanawa`o (*Broussaisia arguta*), a member of the hydrangea family; the anise-scented alani (*Melicope clusiifolia*); a native blueberry, the `ohelo kau la`au (*Vaccinium calycinum*); and Maui mirrorplant (*Coprosma ochracea*), a member of the coffee family. The ground is covered by a dense, spongy layer of mosses and liverworts with scattered clumps of ferns, such as `akolea (*Athyrium microphyllum*) and Hawai`i teinsorus fern (*Diplazium sandwichianum*), and heads makole (*Coprosma granadensis*), a creeping herb with colorful orange-red berries.

2.3.1.2 Current Vegetative Cover

Mt. Ka`ala AFS is located in a vegetation/climate zone characterized by montane wet forest plant associations (Wagner et al. 1990). Largely native plant associations constitute the vegetation in the vicinity of the installation. Mt. Ka`ala AFS was almost entirely cleared of historic vegetation communities when it was developed. Native vegetation occurs in only a few places, in narrow strips adjoining the installation boundary, outside of the fence line. This vegetation is part of the`ohi`a wet forest community described above in Section 2.3.6.1. Most of the vegetated areas on the site consist of mowed turf and weedy forbs, with a small number of ornamental plantings.

Vegetation was characterized on Mt. Ka`ala AFS during a site visit conducted on 13 November 2013. The entire site was considered one HMU (**Figure 2-10**). **Figure 2-11** shows vegetation mapped on Mt. Ka`ala AFS. A description of the topography and dominant vegetation for the HMU is provided below. **Appendix A** contains the most up-to-date comprehensive list of vegetation found on Mt. Ka`ala AFS.

Figure 2-9. Location of Mt. Ka`ala AFS

Figure 2-10. Location of the HMU at Mt. Ka`ala AFS

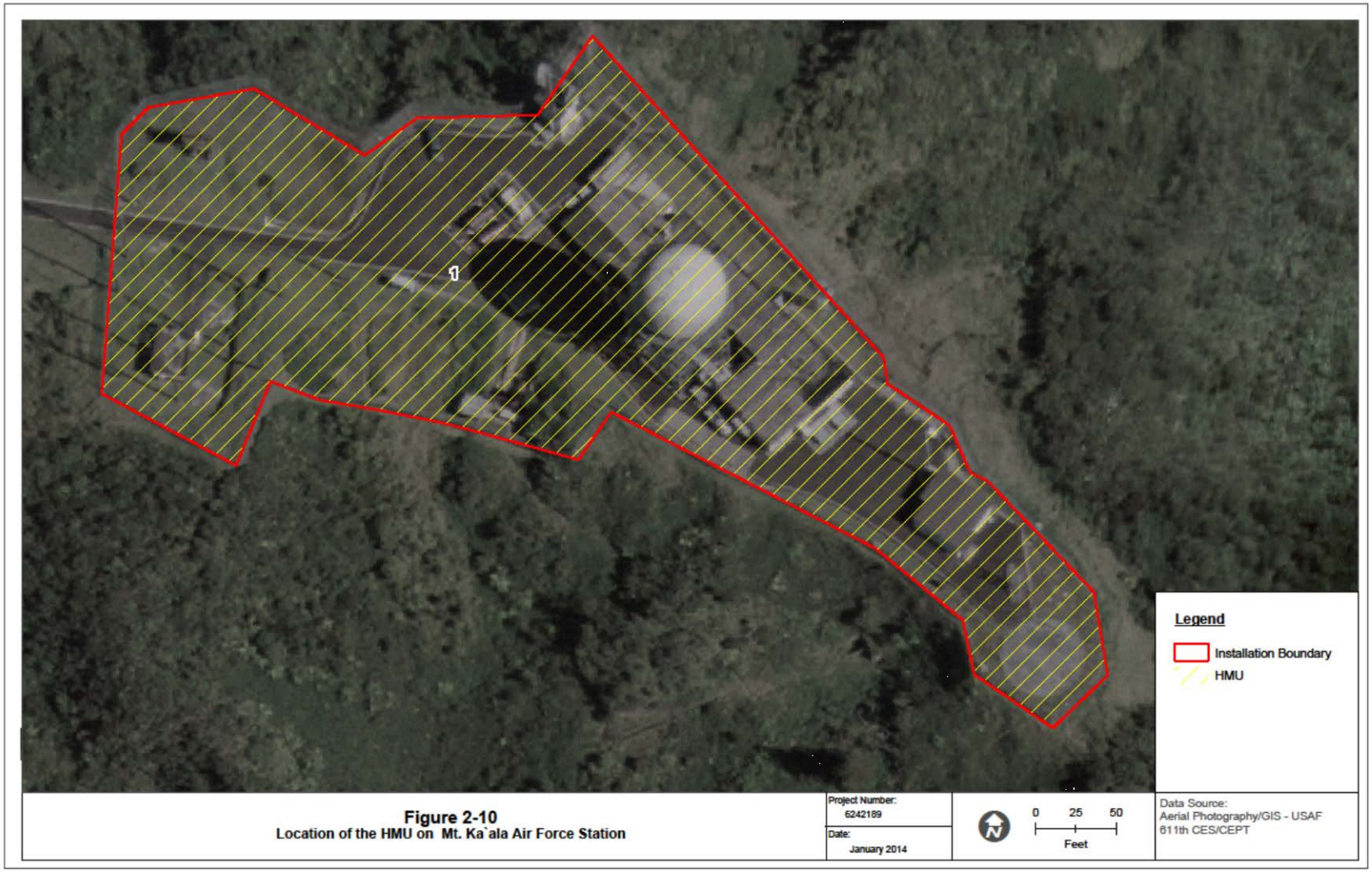
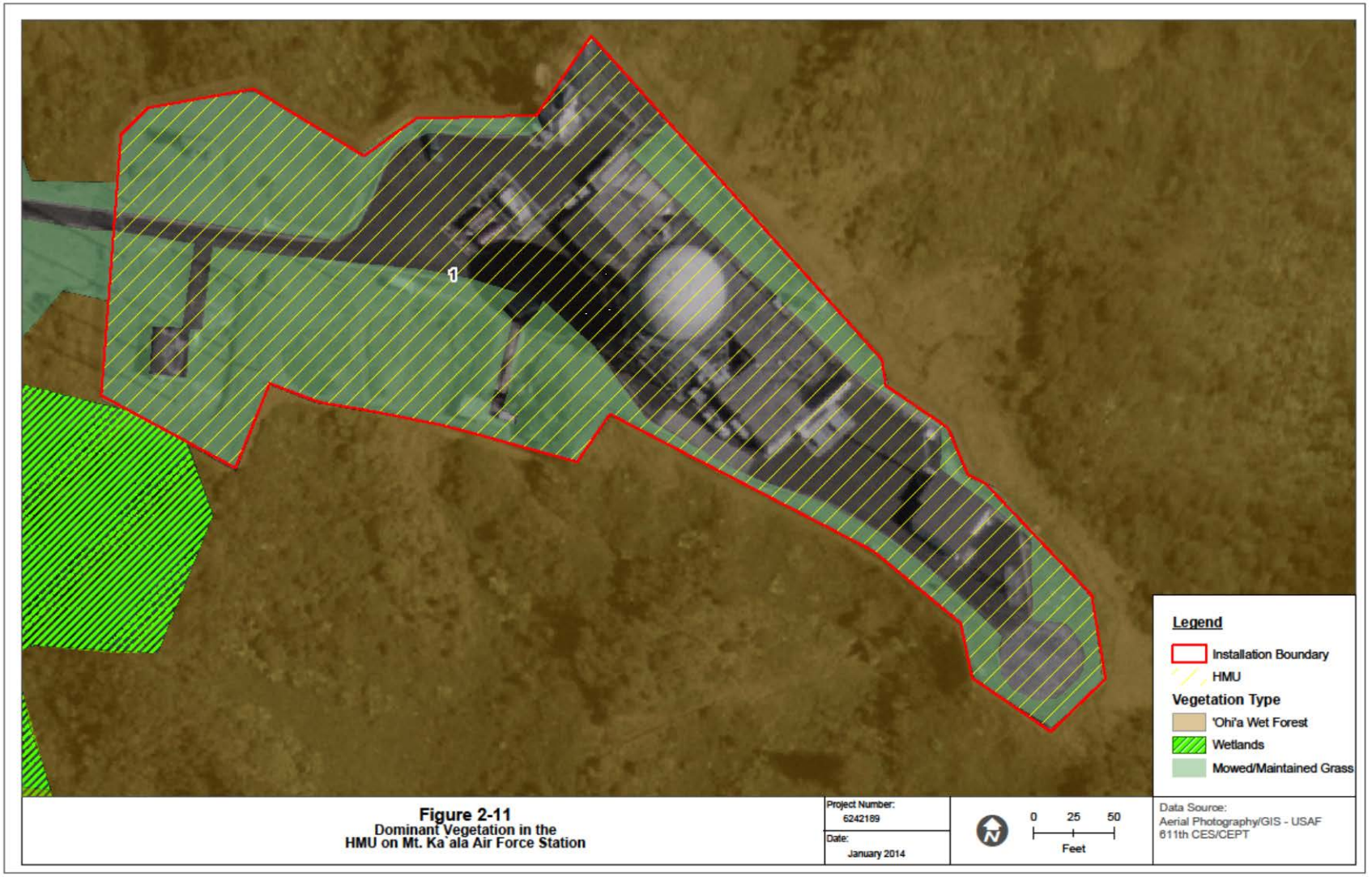


Figure 2-11. Dominant Vegetation in the HMU on Mt. Ka`ala AFS



THIS PAGE INTENTIONALLY LEFT BLANK

Mt. Ka`ala AFS HMU-1

Mowed and maintained vegetation on Mt. Ka`ala AFS

Mt. Ka`ala HMU-1 is approximately 3.1 acres and includes all of the fenced area of the installation. The topography of Mt. Ka`ala AFS is disturbed and primarily flat lying. The site was scraped in the past to create flat lying topography. There is a depression within the fence line adjacent to the south-central boundary associated with the pump house. Vegetation on the site is mowed and maintained. Grasses on the site are characterized by kikuyu grass, Bermuda grass, Hilo grass (*Paspalum conjugatum*), Vasey's grass (*Paspalum urvillei*), annual bluegrass (*Poa annua*), and West Indian dropseed (*Sporobolus indicus*). Other herbaceous plants associated with the mowed/maintained area include common toad rush (*Juncus bufonius*), montbretia crocosmia, common dandelion, oriental hawksbeard (*Youngia japonica*), chickweed (*Cerastium fontanum*), common plantain (*Plantago major*), and narrowleaf plantain. Additional plants associated with the pumphouse area include hydrangea, sawtooth blackberry, Maui pamakani (*Ageratina adenophora*), and impatiens (*Impatiens walleriana*).

Invasive species observed in Mt. Ka`ala HMU-1 during the 13 November 2013 site visit include kikuyu grass, Bermuda grass, Vasey's grass, West Indian dropseed, and sawtooth blackberry.

2.3.2 Fish and Wildlife

Mammals

No indigenous mammals are known to reside within Mt. Ka`ala AFS. The installation is mostly comprised of maintained turf and a small area of shrubs associated with the depression around the pump house. During the November 2013 site visit for this BCSMP, installation personnel indicated that rats occur within and outside the fenced facility, but the species of rat had not been determined. Habitat surrounding the installation is characterized by`ohi`a wet forest. Mammals associated with the montane wet forest would be expected to occur in the habitat adjacent to the facility. No recent surveys of wildlife on or adjacent to the facility have been conducted. Mammals that have been reported to occur adjacent to the facility include feral dogs, feral pigs, and Norway rats.

Birds

Mt. Ka`ala AFS supports both native and non-native birds. Turf areas throughout the installation are typically used by non-native species of birds such as sparrows, doves, and other ground feeders. In 1996, three native Pacific golden plovers were observed within the turf areas at Mt. Ka`ala AFS. This shorebird breeds in western Alaska and Siberia and winters on islands across the Pacific Ocean. During the November 2013 site visit for the INRMP update, installation

personnel indicated that birds occur on the site, but the species had not been identified. The disturbed shrublands adjacent to the installation also provide habitat for both native and non-native birds. The `ohi`a' wet forest wetland habitat has a unique, diverse assemblage with a complex structure that provides habitat for several native forest bird species, such as the `apapane (Hawai`i Department of Land and Natural Resources [DLNR] 1990). In 1996, observers heard a Japanese bush-warbler (*Cettia diphone*) and Japanese white-eye (*Zosterops japonicus*) in the`ohi`a wet forest outside of the installation boundary. Several bird species that are expected to occur in the surrounding rain forest are `apapane, common `amakihi, and `i`iwi. These species are native to the Hawaiian Islands (USAF 2007).

Reptiles and Amphibians

No information on the reptiles and amphibians within the Mt. Ka`ala AFS is currently available. No reptiles or amphibians were observed on Mt. Ka`ala AFS during the November 2013 site visit associated with this BCSMP.

Invertebrates

No information on invertebrates within the Mt. Ka`ala AFS is currently available. No invertebrates were identified on Mt. Ka`ala AFS during the November 2013 site visit associated with this BCSMP.

3. WAKE ATOLL INVASIVE AND NONNATIVE SPECIES

This section includes a discussion of nonnative plant and animal management methods and the general management philosophy used in developing nonnative and invasive species management plans. Plant and animal survey methods and results, and descriptions and specific management plan recommendations for each target species, are organized by location. Management of each invasive or nonnative species has been assigned a priority (indicated in each species' profile) based on the following scale:

- *0 – Mission Critical*. Control of the species is immediately necessary as it is a direct impediment to the military mission.

- *1 – High Priority*. Control of the species should be undertaken in accordance with DOD Policy or Instruction; Air Force Policy or Instruction; or Federal Regulation, Policy, Act or other regulatory driver or agreement that requires control or removal of the species, such as a Biological Opinion issued by the USFWS or National Oceanic and Atmospheric Administration.

- *2 – Medium Priority*. The species should be monitored and management measures should be undertaken to maintain the current status of the species.

- *3 – Low Priority*. Management of the species would have positive consequences for military readiness and native ecosystems, but is not immediately practical or necessary.

Overall management priority for each of the invasive and nonnative species is provided with the descriptions and possible and proposed management methods discussions in Section 3.3.3.

3.1 GENERAL INVASIVE AND NONNATIVE SPECIES MANAGEMENT METHODS

Techniques currently available for managing invasive species fall into one of four general categories: biological, chemical, cultural, and mechanical. A description of each category is presented below.

The recommendations provided below assume a good stewardship philosophy, bolstered by mandates from the DOD, USEPA, and the public, which collectively call for the reduction of environmental risks and impacts associated with the use of pesticides. Consequently, management recommendations focus, where practicable, on Integrated Pest Management strategies and on an adaptive approach to applying these strategies. The adaptive approach is based on a continuous cycle of application, evaluation and monitoring, and adjustment based on the best available data. The use of specific herbicide and pesticide names are for reference only and are not for endorsement of the product.

3.1.1 Biological Management

Biological control uses living organisms (pathogens, insects, or nematodes) to suppress the invasive species infestation to an acceptable level. Many invasive and nonnative species have few natural, indigenous enemies outside their native habitats. Efforts to develop biological control agents often involve finding such natural enemies in the land of origin for the particular species.

Biological control agents are often considered to be a viable alternative for remote infestations that are not easily accessed for treatment by other means (Sheley and Petroff 1999). Biological control is not a viable alternative for small, readily accessible infestations because biological agents work slowly, might not completely prevent reproduction, and will, therefore, not completely eradicate the invasive species. The risk associated with a biological control agent is the possibility of the agent preying on native species either during or after the eradication process.

Biological controls are rarely practical for invasive animal species, especially vertebrates, given the high risk of affecting non-target species that comes with lack of host or prey selectivity in most natural enemies of animals. However, biological control can be an important part of an integrated invasive plant management plan for remote areas in which control, rather than complete eradication of the target noxious plant, is a management goal.

3.1.2 Cultural Management

Cultural techniques for invasive species management, based on competitive exclusion, are aimed at promoting vigorous, desirable plant or animal communities which minimize the potential for nonnative invasion. If a site is heavily infested and has no desirable species, or the short-term loss of those species is acceptable and revegetation might be the best long-term alternative. On appropriate sites (i.e., considering erosion potential, temporary loss of wildlife cover, and other factors), an herbicide application followed by plowing or disking and drill-seeding is most effective for establishing desirable plant species. Establishing competitive native grasses, forbs, and woody species can minimize the reinvasion of nonnatives and provide food and shelter for wildlife.

Planting native species can be an effective, though expensive, way to reduce the likelihood of exotic species reinvasion following removal of nonnative species. Commercial plant nurseries currently provide seeds and plants of several wetland and upland species. Since some species cover a wide range of habitats and latitudes, care should be taken to obtain plant material suitable to the habitat under consideration and, preferably, of local genetic stock. Introduction of seeds, plant parts, or whole plants should include thorough screening for any unwanted pests, plant or animal (Langeland and Stocker 2000).

It often takes several years for plantings to become thoroughly established and extra care (water, nutrients) and protection (from fire and pests) might be necessary during this time. Also during this establishment phase, past management practices might have to be altered to avoid injury to

the plantings. If periodic burning or flooding, for example, is part of the current management practice, it might be necessary to reduce the intensity or duration until the plantings are able to exhibit their typical resistance to injury. Little is known about the requirements for successful establishment of many native species, and less is known about their tolerances to cultural invasive plant management techniques. Even when tolerances are better known, responses might be affected by historical site effects; traits of particular genetic strains; site-specific nutrition and light conditions; and interactions of soil type, hydroperiod, and microclimate (Langeland and Stocker 2000).

In general, fire can be used to suppress plant growth, and even kill certain plants that are not fire-tolerant. Most often, woody species are reduced while effects are less noticeable on certain herbaceous species. Effects of a single burn are hard to predict, but under some conditions a single fire effect can persist for several growing seasons. The length of effect is due to intensity of fire, time of year of fire (fire during the growing season can be more destructive than during dormant seasons), and the plant species involved. The use of a post-burn herbicide treatment will be more effective if time is allowed for adequate regrowth before the treatment (Langeland and Stocker 2000). The use of fire is not recommended for invasive vine species that have grown to the top of a tree. The invasive plant can create a ladder fuel that will allow the fire to burn to the top of the tree which can be lethal.

Smoke is now recognized as a germination-triggering mechanism for some fire-dependent as well as some nonfire-dependent species, so plant species composition following a burn is due, in part, to the type of fire and the distribution of the smoke from that fire. A single burn might or might not start a replacement sequence (succession) with its own effects on species composition. Whether fire can play a logical role in suppression or elimination of invasive exotic plant species depends on many factors. In addition to the principal factors described above, the resource manager must consider potential fire effects on soil loss and water quality, historical and economic impacts on buildings, possible harm to human life, the creation of smoke hazards, and the potential for escape of a fire to non-target areas (Langeland and Stocker 2000).

Fire has been very successfully used to manage plant species in grasslands, to maintain open savannahs (scattered trees in herbaceous species-dominated habitats), and to promote seral (fire-induced or fire-tolerant) stages of forest succession areas (Langeland and Stocker 2000). The use of fire as a management tool on Wake Atoll should be closely evaluated and should take into account the occurrence of dense seabird colonies with seasonal nesting habits that make impacts from fire to eggs and chicks hard to avoid in many areas.

The Nature Conservancy's Global Fire Initiative is conducting ongoing research on invasive plant species and fire. The Initiative's Web site (*http://www.tncfire.org/crosscutting_fandi.htm*) provides a list of references on this topic.

Cultural management of invasive animals involves activities designed to modify the behavior of target animals. Common cultural management techniques include audible repellents (e.g., noisemakers of various sorts, sonic devices emitting unpleasant signals), visual repellents (e.g., flashing lights), and habitat modification. Audible and visual repellents typically enjoy

short-term success, but lose effectiveness with time as many animals quickly acclimate to such stimuli. A long-term form of cultural management is habitat modification; either improving the habitat to attract or support more of a desirable species, removing habitat that supports undesirable species, or a combination of habitat modifications across the landscape to "move" animals from one area to another. Obviously, such habitat modifications need to consider the entire plant and animal community affected by such actions. In developing management plans utilizing cultural control methods such as habitat modification, it is imperative to understand the behaviors of all of the species impacted by planned actions.

3.1.3 Mechanical Management

Mechanical control methods for plants are often considered for small, readily accessible infestations. Intense follow-up with other control methods are essential after the use of heavy equipment because disturbance of the soil creates favorable conditions for regrowth from seeds and root fragments, and recolonization by invasive nonnative plants. Plans for management or replanting of sites with native vegetation following mechanical removal should be carefully developed prior to implementation of mechanical removal. Large-scale mechanical removal might not be appropriate in natural areas because of disturbance to soils and non-target vegetation caused by heavy equipment (Langeland and Stocker 2000). The methods and equipment differ between the smaller, herbaceous weeds and the larger, woody species. Hand pulling, hoeing, tillage, and mowing are common small-scale mechanical controls used on herbaceous forms. Whole-plant removal and cutting are often used with shrubs and trees. Hand pulling and hoeing are typically successful when complete plants (i.e., above ground and below ground parts) can be removed. Pulling plants from the ground (during small- or large-scale removal) could cause unwanted soil disturbances in some natural areas. This soil disturbance might result in further invasion by invasive nonnative plant species, again requiring follow-up control measures (Langeland and Stocker 2000).

Mowing can reduce seed production in some plants, especially annuals, depending on the stage of growth at mowing time and the weather after mowing. Plant material cut during mowing is generally left in place. If removed, it should be burned on site to reduce spread of weed propagules. Mowing is a viable control option if it is done at high enough frequency to prevent seed production by noxious weeds, and to eventually eliminate root reserves supporting regrowth. Whole-plant removal for shrubs and trees can be quite effective, particularly if followed by a combination of fire and herbicide treatments.

Mechanical management for animals primarily involves barriers to either animal activity (e.g., wrapping hardware cloth around young trees to avoid ungulate browsing) or to animal movement (e.g., use of fences to exclude animals from specific areas). Either of these methods can be quite expensive in terms of materials and or time required for implementation. Hunting and trapping might also be included as forms of mechanical control.

3.1.4 Chemical Management

Use of selective herbicides can reduce target invasive and nonnative plant species and shift the competitive advantage to desired, native species. Chemical control is often temporary, requiring repeated applications. Long-term commitment and sustained effort are essential for effective management using herbicides. Furthermore, chemical treatment can be expensive and must be used judiciously in order to meet DOD pesticide-use reduction goals. Chemical treatment must also conform to the installation's Pest Control and Pesticide/Herbicide Management Plan.

For herbaceous weeds, chemical treatment with a broadleaf herbicide such as triclopyr amine (e.g., Garlon 3A) or a broad-spectrum post-emergent such as glyphosate (e.g., Roundup or Rodeo) are common control methods. However, these herbicides need to be carefully applied by certified pesticide applicators using spot application methods (e.g., spot sprayers, rollers, or sponges) to prevent impacts on desirable, native forbs and grasses. Because of its soil activity, herbicides containing imazapyr (e.g., Plateau) should only be used with caution. Under certain conditions, it can spread through underground root systems to desirable plants in untreated areas.

For woody plants, control can be established with application of herbicides in a variety of ways. The most common application methods are foliar spray, cut stump treatment, basal bark application, frill or girdle application, and various direct injection techniques. In foliar treatments the herbicides are premixed with diluent and sprayed onto the foliage of the plant until the solution begins to run off of the leaf surface ("sprayed-to-wet"). The basal bark application consists of the herbicide being applied directly to the bark at the base of the tree, typically with a backpack sprayer. The frill or girdle method (aka "hack and squirt") involves cutting gashes into the tree that go all the way around the tree and then spraying or squirting herbicide into the gashes. Direct injection techniques utilize the same principle but employ specialized equipment to deliver the herbicide to the cambium for uptake. Herbicides such as triclopyr ester (e.g., Garlon 4) can be used to treat woody plants.

Nonselective herbicides (i.e., herbicides which kill all vegetation) such as glyphosate are reserved only for situations where total denudation is considered a viable option or where application can be tightly controlled to prevent impacts on non-target species. Total denudation must be carefully considered before implementation, as failure to follow through in a timely and complete fashion can produce a worse invasive/nonnative problem than the one being "controlled." It is recommended that a marker dye be added to herbicides before they are applied to vegetation. This allows the applicator to see exactly where the herbicide is being applied. Read and follow label directions for use of marker dyes.

Chemical management for animals has historically referred to chemicals that kill, "-cides," (e.g., avicides, rodenticides) or inhibit growth, "-statics," (e.g., bacteriostatics) of target organisms. Recent developments in wildlife management have extended chemical control for some wildlife species to include preventing reproduction at an individual level.

3.1.5 General Management Philosophy

Comprehensive control of invasive and nonnative species should be a part of any overall site management and restoration program. For plants, the focus should be on the species and communities desired in place of the "weed" species, rather than on simply eliminating undesirable species. The species and communities desired will depend upon the management goals for a specific area.

This management plan suggests priorities for the control or elimination of invasive and nonnative species listed as a severe infestation level located in high priority areas on the installations. Focus should also be given to species listed as a minor infestation level in order to prevent the spread and increase of these species.

Methods for preventing the establishment of invasive plant species include using soil components and mulches obtained from non-weed infested sources, utilizing seed and other plant materials that has been checked and certified as noxious weed-free and that has a weed content of 0.05 percent or less, using plant materials that have a high likelihood of survival, and maintaining all planted material and native vegetation located on the site for the life of the project.

Best Management Practices such as seed testing with the *Rules for Testing Seed*, published by the Association of Official Seed Analysts should be followed during landscaping projects to prevent new species from becoming established.

3.1.5.1 Primary Herbicides

There are six primary herbicides recommended in this plan based on their range of action and important ecological considerations. One or more commonly applied commercial formulation of each herbicide is provided. Glyphosate, Imazapyr (as Arsenal), and Dicamba are currently listed on the approved DOD Pesticide List provided at the Armed Forces Pest Management Web site: *http://www.afpmb.org/pubs/standardlists/dod%20pesticides%20list.pdf.* All chemicals including herbicides must be pre-approved by the installation Environmental Office, prior to application. **Appendix B** provides copies of labels for primary recommended herbicides.

***Triclopyr ester*.** This herbicide is recommended because it is a systemic herbicide (is taken up by and spreads throughout the plant) that is effective against (selective for) woody plants and broadleaf weeds. This selectivity makes triclopyr ester suitable for use in areas where it is desirable to kill trees, brush, or broadleaf weeds, but maintain grasses for vegetative cover. Common formulations of triclopyr ester are Garlon 4 and Pathfinder II. Triclopyr ester provides relatively low residual control, being active in the soil for only about 46 days. Triclopyr ester is toxic to fish and should not be applied where, or under conditions when, it might contaminate water sources. For basal bark and cut stem applications, Garlon 4 must be mixed with an oil diluent such as Penevator, CWC basal diluent, Arborchem basal oil, or the JLB Oils (Plus and Plus Improved). A vegetable-based oil, such as Biodiesel (methyl ester), is recommended for mixing because it is nontoxic, biodegradable, and cost-effective. The herbicide Pathfinder II

contains a premixture of triclopyr ester and oil. Neither Garlon 4 or Pathfinder II can be used in or over water. Read and follow all directions on the product label.

Triclopyr amine. This herbicide differs from triclopyr ester in that it can be used for foliar treatments in or over water. It can also be used for cut-stump treatments in standing water. The most common formulations of triclopyr amine are Garlon 3A and Renovate. Both must be mixed with water. Read and follow all directions on the product label.

***Imazapyr*.** This herbicide is recommended as an alternative to triclopyr ester in areas close to water sources containing fish because it is relatively nontoxic to fish. Imazapyr is a broad spectrum (works against all types of plants including grasses) systemic herbicide, with residual soil activity of 6 months up to 2 years. That means that imazapyr that gets into the soil, whether directly during the application process, or indirectly through plant roots, has the potential to inhibit growth of all plants for up to 2 years. This herbicide should not be used where exposed soil could lead to erosion and the site cannot be mechanically protected (e.g., netting to protect and stabilize the soil), or on sites for which immediate revegetation (e.g., with native species) is desirable. Another consideration for this herbicide is that it appears to be most effective when used in foliar, cut stump, or frilling applications, as opposed to basal bark applications. Although quite effective, visible evidence of imazapyr's activity is often not evident for several months. Two common formulations of imazapyr are Plateau and Arsenal. Read and follow all directions on the product label.

***Glyphosate*.** This is a broad-spectrum herbicide with virtually no residual activity. Because glyphosate is a post-emergent herbicide, areas treated with it can be reseeded within a few days. Plants emerging after treatment, if they are from seed or from unaffected rhizomes, will not be affected by the treatment. Glyphosate adheres very tightly to soil particles, so there is little opportunity for it to leach into groundwater. Common formulations of glyphosate include Rodeo (requires a surfactant) and Roundup. Rodeo is labeled for use around wetlands. Read and follow all directions on the product label.

Picloram. Picloram kills or damages annual and perennial broadleaf herbs and woody plants. It acts as an "auxin mimic" or synthetic growth hormone that causes uncontrolled and disorganized growth in susceptible plants. Picloram does not bind strongly with soil particles and is not degraded rapidly in the environment, allowing it to be highly mobile and persistent (half-life of picloram in soils can range from one month to several years). In soils, picloram is degraded primarily by microbial metabolism, but it can be degraded by sunlight when directly exposed in water or on the surface of plants or soil. Picloram can move off-site through surface or subsurface runoff and has been found in the groundwater of 11 states. Picloram can also "leak" out of the roots of treated plants, and be taken up by nearby, desirable species. Picloram is not highly toxic to birds, mammals, and aquatic species. Some formulations are highly toxic if inhaled, while other formulations can cause severe eye damage if splashed into the eyes. Because of the persistence of picloram in the environment, chronic exposure to wildlife is a concern, and studies have found weight loss and liver damage in mammals following long-term exposure to high concentrations. Concentrations in runoff reported by researchers are often adequate to prevent the growth of non-target terrestrial and aquatic plants, and therefore,

picloram should not be applied near waters used for irrigation. Picloram is often sold mixed with 2,4-D, and this formulation has also been used in natural areas against herbaceous species including leafy spurge and spotted knapweed Some common formulations include Grazon PC, Tordon K, and Tordon 22K.

Dicamba. Dicamba is a benzoic acid herbicide. It can be applied to the leaves or to the soil. Dicamba controls annual and perennial broadleaf weeds in grain crops and grasslands, and it is used to control brush and bracken in pastures. It will kill broadleaf weeds before and after they sprout. In combination with a phenoxyalkanoic acid or other herbicide, dicamba is used in pastures, range land, and natural areas to control weeds. Dicamba does not bind to soil particles and is highly soluble in water. It is therefore highly mobile in the soil and could contaminate groundwater. Its leaching potential increases with precipitation and the volume applied. Metabolism by soil microorganisms is the major pathway of loss under most soil conditions. The rate of biodegradation increases with temperature and increasing soil moisture, and tends to be faster when soil is slightly acidic. Dicamba slowly breaks down in sunlight. Volatilization from soil surfaces is probably not significant, but some volatilization could occur from plant surfaces. It is stable to water and other chemicals in the soil. In humid areas, dicamba will be leached from the soil in 3-12 weeks. The half-life of dicamba in soil has varied from 4 to 555 days with the typical half-life being 1-4 weeks. Under conditions suitable to rapid metabolism, the half-life is less than 2 weeks. Common formulations include Metambane, Dianat, Banfel, and Banvel.

3.1.5.2 Primary Pesticides

There are three primary pesticides mentioned in this plan in relation to controlling invasive ant species. One or more commonly applied commercial formulation of each pesticide is provided. All three are currently listed on the approved DOD Pesticide List provided at the Armed Forces Pest Management Web site: *http://www.afpmb.org/pubs/standardlists/dod%20pesticides%20list.pdf.* All chemicals including pesticides must be pre-approved by the installation Environmental Office, prior to application. **Appendix B** provides copies of labels for primary recommended pesticides

Hydramethylnon. Hydramethylnon is used in products to control ants, termites, cockroaches, silverfish, and crickets. They are usually formulated as granules or integrated into gels or baits. It is a slow-acting poison that disrupts energy production in animal cells and must be ingested to be effective. Slow acting poisons are especially effective for social insects such as ants or termites because they allow the animal to live long enough to return to the colony and spread the poison. Hydramethylnon has a half-life of 7-391 days in soil and 1 hour in water. It does not dissolve in water and thus is not likely to contaminate groundwater. It binds tightly to soil, reducing risk of environmental mobility and availability. Plants do not take up hydramethylnon from the soil, and it is nearly non-toxic to birds and bees. It is toxic to freshwater fish and invertebrates, but aquatic wildlife is unlikely to come into contact with the poison since it does not dissolve in water. Products containing hydramethylnon include Amdro, Maxforce, Combat, Siege, and Sensible (National Pesticide Information Center [NPIC] 2002). Read and follow all directions on the product label.

Boric acid. The toxicity of boric acid depends on the composition of the sodium borate salts it forms with other elements. Boric acid can be formulated as a liquid, pellet, tablet, granule, dust, wettable powder, rod, or bait. It can be used to control insects, mites, spiders, algae, fungi, molds, and weeds in both indoor and outdoor settings. It works by affecting the nervous system when ingested by insects, and also prevents plants from producing energy and reproducing. Boric acid is soluble in water and is thus capable of contaminating groundwater. Its mobility in the soil depends on the metals present in the soil and soil pH. It is practically non-toxic to birds, freshwater fish, amphibians, and aquatic invertebrates. It is also relatively nontoxic to bees. The most common product containing boric acid is Borax (NPIC 2013). Read and follow all directions on the product label.

Fipronil. Fipronil is an insecticide used to control a variety of insects including ants, beetles, fleas, cockroaches, termites, ticks, weevils, thrips, rootworms, and mole crickets. It is a white powder usually incorporated into granules, gel baits, or liquids. Fipronil kills insects that ingest or come into contact with it by disrupting the central nervous system. The half-life of fipronil is about 125 days in soil and 4-12 hours in water when exposed to sunlight. It binds tightly to soil and is not soluble in water, thus it is not likely to contaminate groundwater. It has low mobility and availability in the environment and is not taken up well by plants. Fipronil is highly toxic to freshwater and marine fish and invertebrates, some birds, and honey bees. Products containing fipronil include Xtinguish and Presto, among others (NPIC 2009). Read and follow all directions on the product label.

3.2 CURRENT PREVENTION AND MANAGEMENT MEASURES FOR INVASIVE AND NONNATIVE SPECIES

Current management methods for the prevention and control of invasive species are laid out by the Defense Transportation Regulation Part V, the Wake Atoll Standard Operating Procedures, the Wake Atoll Invasive Species Management Plan, and the Wake Atoll Pest Control and Pesticide/Herbicide Management Plan. Those methods have been summarized below.

Cargo destined for Wake Atoll must be loaded in an area with documented rodent control operations. Rodent control techniques such as traps and baited glue boards will be aboard each vessel destined for Wake. All containers on board should be inspected for signs of invasive species including live or dead animals, animal excrement, or signs of chewing. If any invasive species is discovered in cargo destined for Wake Atoll the pilot or captain will not unload their cargo upon arrival at Wake and will immediately contact Wake Base Ops (DSN: 315-424-2222 or Commercial: 808-424-2222) to alert them of the invasive species. Vessels should be inspected for invasive species during off-loading activities and all dock lines should have dock line guards to prevent rodent travel. Food stored at cargo facilities should be kept in closed rodent-proof containers, refrigerators, or freezers. Should an invasive species reach the Atoll in spite of these prevention measures, steps should be taken immediately to ensure it does not spread, does not leave the off-loading site, and is captured if possible (Defense Transportation Regulation 2013; USAF 2012). Ballast water management plans and records may be requested from shipping companies whose barges or tugs spend time at Wake Atoll (USAF 2013b).

The Invasive Species Protocol for Wake Island identifies further management policies to prevent the introduction of invasive species, which prohibit bringing live animals or plants, seeds, food products containing seeds, soil or compost material (unless approved by the island's Environmental Department), salt water or aquarium items onto the island. The Protocol also requires inspection of all luggage, packages, mail, clothes, and footwear for seeds, insects, or insect eggs upon arrival at Wake Island, and that dive gear brought to or leaving the island be properly disinfected following procedures laid out in the Wake Island Invasive Species Management Plan (USAF 2013c). Information on invasive species is provided to visitors and employees prior to their arrival at Wake Atoll and upon their departure (USAF 2011).

The use of pesticides and herbicides on Wake Atoll is regulated by the 2013 Pest Control and Pesticide/Herbicide Management Plan. This plan dictates that barracks, family housing, dining and cooking areas, shops, and other island facilities are inspected weekly for signs of pests, including invasive pests such as ants and the African snail (*Achatina fulica*). The main control methods for plants are removing dead or diseased vegetation near buildings or other facilities to avoid risk of fire or damage to structures if toppled by wind (USAF 2013c).

Polynesian rats are extremely abundant on Wake Atoll. The Asian house rat was also abundant. Observations in April and May of 2008 indicated that rats were particularly abundant along the road from the garbage dump area to the port/marina and also on Wilkes Island at the bird sanctuary (Chugach 2011). PRC documented and tracked changes in the relative abundance of rats on Wake Island in October/November 2010 and January/February 2011. Live and dead rats were recorded along a previously established driving route, which included the downtown area of Wake Island and areas surrounding the runway. A total of six surveys were completed during the monitoring period. The average rat abundance along the driving transects in October/November 2010 was 30.1 and 32.3 in January/February 2011. The highest number of live rats recorded was 54 in October 2010. All rats observed were small and appeared to be Polynesian rats (PRC 2011).

An effort was made in May 2012 to eradicate the Polynesian rat and Asian house rat from the Atoll. This USAF-funded project was implemented by a collaborating group representing USFWS, Island Conservation, Pathfinder Aviation and the 611th Air Support Group PACAF. Efforts included primarily aerial baiting, hand-broadcasting of baits, and the use of bait stations. The rodenticide used in the eradication effort was Brodifacoum 25W. A Supplemental Label for Brodifacoum 25W Conservation to control and eradicate Polynesian and Asian house rats on Wake Atoll (USEPA Registration No. 56228-36) was issued by USEPA on 4 April 2012 to address special application requirements for the Atoll. The supplemental label only applied to Wake Atoll and expired on 1 September 2014.

Aerial baiting was initiated on 13 May 2012 with the first application and concluded on 23 May 2012 with the second application. Aerial broadcasting could not be used in some areas as a result of the need to comply with federal regulations and site-specific requirements of the USAF. Hand-broadcasting of bait and use of bait stations was applied in aerial exclusion zones, buffer areas, and inside and outside of buildings. Approximately 147 acres associated with the runway and taxiways and fuel storage areas were not baited due to Federal and USAF restrictions

(Brown et al. 2013). The hand-broadcasting and bait station operations occurred concurrently with the aerial operation, and most bait stations were maintained periodically until November 2012.

A permit (Permit No. MB73909A-0) was obtained from USFWS, Pacific Islands Fish and Wildlife Office, Honolulu, Hawai`i for the take of migratory birds in the course of the eradication efforts. The permit issued pursuant to 50 CFR 21.27 (Migratory Bird Permits, Special Purpose Permits) included special measures to prevent bait from entering the water including hand broadcasting of baits near the water and the baiting of canopy trees that overhang water by hand. The permit also required the submittal of a report of activities by 31 January 2013 and 2014 including the number and species of migratory birds taken, the date they were taken, the manner in which the birds were taken, condition of the bird, disposition of the bird, and an evaluation of how to avoid similar incidents in the future. In May 2012, two birds, a Pacific golden plover (*Pluvialis fulva*) and a ruddy turnstone (*Arenaria interpres*), were found dead and assumed to have been killed by Brodifacoum 25W. The reason for their death was not confirmed.

The rat eradication project required the 611th Air Support Group to obtain a National Pollutant Discharge Elimination System (NPDES)-Pesticide General Permit for the aerial broadcast of a rodenticide adjacent to a United States body of water. The 611th Air Support Group submitted a Notice of Intent to the USEPA for the permit (No. MWG87A005), which became effective on 2 March 2012.

On 1 June 2012, a juvenile Polynesian rat was found inside a bait station. Observation of a live rat was made on 25 June 2012, and another was observed in a different location on 30 June 2012. Site-specific actions were taken to target these rats. Three to four months later, more observations of surviving rats were made. Increasing numbers of Polynesian rats sighted or caught on Wake Island confirmed that the eradication was unsuccessful (Brown et al. 2013). All rats that were caught since the eradication effort were identified as Polynesian rats. No surviving or re-establishing rats have been detected on Peale Island. The USDA confirmed in 2014 that all remaining rats on Wake Atoll are Polynesian rats and that the Asian house rat has been eradicated. Eradication of the Polynesian rat from Wake and Wilkes Island was not successful.

Since the May 2012 eradication effort, the Polynesian rat population has been rapidly rebounding. Polynesian rats were commonly observed in the evening in the golf course area and roads along the shoreline during site visits conducted in October 2013 in association with this plan. During recent (2014) discussions between Kristen Rex (611 CES/AFCEC and CFPE) and Wake personnel, it was stated that rat numbers are increasing in the housing areas and are noticeably heavier on the runway and at the terminal buildings. Site visits in 2014 identified ongoing rat nesting at arrestor tapes and barrier sheds on the runway. Higher rat numbers at the arrestor tapes pose a large safety concern for active runways; and the increased numbers at the terminal building pose a biosecurity threat to incoming and outgoing cargo and passengers. Rat logs have been provided to Wake personnel to record the increased occurrence of rats around aircraft. Ongoing efforts to control the rat, including the use of bait stations, are being implemented. Some efforts have been made to control rat populations in and around the

commensal and marina areas since August 2012; however, these efforts have been very localized with the primary focus on biosecurity as well as health and safety. An approach for a follow-on eradication effort is being developed and evaluated for implementation.

A review of the planning, design, and implementation of the 2012 rat eradication project was conducted by Brown et al. (2013) and a range of recommendations were provided, of relevance to possible future eradication attempts on Wake Atoll (Brown et al. 2013). The review focused on the factors contributing to the unsuccessful eradication attempt from Wake and Wilkes islands; an assessment of whether the strategy, design, planning, and implementation of the eradication and biosecurity program were adequate to expect a reasonable probability of success; and what lessons could be learned and applied to a future eradication attempt on Wake Atoll, including identifying any additional research needs. The following provides a summary of some key findings of the Brown et al. (2013) review.

The most important included at least one and probably an interaction of the following three issues:

1. Several factors were identified that might have contributed to the unsuccessful eradication. Bait gaps or localized shortages in bait availability created by poor understanding of habitats such as pemphis and underground and abandoned structures, inadequately designed baiting methodology in commensal and intertidal environments, and complicated combinations (and integration) of various baiting methodologies, all exacerbated by low overall bait rates with insufficient buffer and some known application errors, or difficulties.

2. Rat breeding during the operation causing temporal or spatial unavailability of bait to juveniles emerging from natal nests, or more speculatively, behavioral avoidance of bait by a small percentage of females.

3. A poor understanding of the interaction between the two species that might have provided inadequate bait accessibility for the Polynesian rat.

The assessment of the strategy, design, planning, and implementation of the eradication effort identified several issues including:

1. Deviation from established best practice procedures that have been developed overseas, but which are largely directly applicable everywhere.

2. Lack of a structured project process that would have helped identify and resolve many issues that needed further investigation.

3. An on-off approach to the project over a number of years that probably contributed to a lack of flow in the project process.

4. The inability of some key project personnel to fully commit to the project, or focus on its planning.

5. A lack of knowledge of the island by some key project staff that may have led to some errors and omissions in the planning process.

6. Concerns regarding methodology and the number of information gaps in the planning that should have led to the consideration of postponing the project until those issues were more fully addressed.

7. There was a diffusion of responsibility for project success or failure across multiple project managers and multiple organizations. One dedicated project manager from start to finish, with a core staff and the support of an advisory team would have more likely been aware of project weaknesses and either fixed or mitigated them.

A summary of key lessons identified by Brown et al. (2013) from the 2012 eradication project include:

1. Existing eradication best practice documents have been developed that could be used as a basis to develop specific tropical island versions of eradication best practices. These documents need to be used in the development of future operational plans and baiting strategies, and any deviations from such best practice principles need to be justified within the documents.

2. A thorough and connected planning process needs to be followed with attention to ensuring that all aspects of each step are addressed adequately. Vital components of the planning process such as the Feasibility Study and Commensal Rat Plan need to address all the key issues and need to be critically reviewed by independent eradication experts.

3. Compliance with regulations and island manager-imposed conditions is a necessity; however, the acceptance of such restrictions where they may cause deviation from eradication best practice principles should be acknowledged by operational planners and stakeholder agencies as potentially compromising the prospects for a successful outcome. Wherever federal or site-specific requirements compromise efficacy, they need to be identified early so that a special exemption can be sought, or the risks openly acknowledged by all parties.

4. Agreements on paper need to match the practicality of successful implementation on the ground.

5. Focus needs to be given to island residents and how they can be incentivized to help maximize the potential for successful eradication.

6. There needs to be greater demonstrated response to prior data and to reviews of project documents and methodology.

7. Optimizing circumstances for eradication is more difficult when there are over-riding priorities on the island (i.e., operation of the air-field). Contingency planning is needed to ensure only the most essential operations occur during the brief window of active bait distribution.

8. A single project manager should lead the eradication process. The project manager should have a high degree of rat eradication expertise and should be allowed to operate relatively freely and with some flexibility within the bounds of an Operational Plan that has been approved by all key stakeholders.

9. Key staff on the eradication team should have considerable familiarity with Wake Atoll, its inhabitants and its off-island managers, and ideally the project manager should be directly involved in the project from beginning to end.

10. Greater flexibility is required in the determination of bait rates, either by more detailed bait uptake research or building in a more appropriate margin for error in the bait rates. Allowances need to be permitted for adaptive situations, such as extra baiting levels in special treatment areas or supplemental application where baiting has been deemed insufficient.

11. Stakeholders should be prepared to postpone the project if pre-determined conditions are not met at pre-determined times.

12. The Feasibility Study for the eradication project needs to identify all issues of concern, and subsequent work should attempt to resolve the issues before the operational planning commences. The entire feasibility assessment and subsequent planning process needs to be revisited and the key issues addressed more fully prior to implementing a second attempt to eradicate Polynesian rats on Wake Atoll.

13. Resources should be allocated for post-operational monitoring. Options such as post-operational use of rodent-detecting dogs to detect any surviving rats should be evaluated. Any detection made could be followed up by pre-determined emergency response measures.

14. Bait palatability needs further research, especially where abundant alternative food resources occur and when rat breeding is occurring. The possible effect of ant activity on bait palatability to rodents also warrants investigation. Preference trials could be conducted between ant-tainted and fresh bait palatability to rats.

15. More data should be collected on rat population and breeding indices, in conjunction with plant phenology (especially known rat food sources) and year-to-year climate cycles and variation, to further refine the optimum times to undertake eradication on Wake Atoll and other tropical islands.

16. Immediate pre-drop monitoring should be completed on rat and crab densities to ensure to the extent possible that populations (or crab activity) are comparable to earlier data. Any increases in numbers should warrant re-evaluation of intended bait rates.

17. Staff scheduling should ensure all legal and critical staffing requirements (i.e., presence of authorized pesticide handlers and GIS personnel) are covered at all stages of the project. Potential replacements also need to be identified and be available if required, rather than have the project compromised by the loss of a key person.

At the request of the 611th CES/CEAN (PACAF), DOD Certified Entomologists Lieutenant Colonel Teig and Captain Mundal visited Wake Atoll in March of 2013 to evaluate the effectiveness of aerial application of rodenticides conducted in May 2012 to eradicate rats, and to make recommendations for future management. Based on their observations, the team recommended that quarterly surveillance and baiting of Polynesian rats be continued by a team of DOD Certified Pesticide Applicators; that a baiting and trapping strategy be developed to improve success; nighttime surveys be conducted to identify if the Polynesian rat population is growing; and removal of ironwood trees and thatch (controlled burns) to reduce favorable food and harborage for the rats (Teig 2013).

As a follow up to the analysis of rodent eradication efforts conducted in March, Lieutenant Colonels Mark Breidenbaugh and Karl Haagsma conducted a site visit in April 2013 (USAF 2013a). The purpose was to follow up on the analysis of rodent eradication efforts begun by the team in March. Directed by their initial findings, the trip's objective was to further examine the scope of rodent infestations on Wake as well as to develop a preliminary course of action for future invasive species control. Based on the site visit, the team noted that trapping and surveillance activities suggested that although the Polynesian rat population appeared to be growing, the majority of the rats seemed to be located in a few generalized areas, including in and around the landfill area, and in and around the golf course area adjacent to Heel Point (USAF 2013a). Several potential forms of competition for ground baiting were identified including a potential lack of competiveness of the bait with natural food sources over time. They noted that the rats, in addition to undoubtedly feeding on a wide variety of food, were also likely consuming the fruits of ironwood trees, Asteraceae flower heads and sedge rhizomes (USAF 2013a). They also noted that ants were a significant competitor for the ground-based baits. Hermit crabs and cockroaches (e.g., *Periplaneta americana*) were also observed eating the baits (USAF 2013a). The team noted that ground station baiting is one of the best options for rodent population suppression; however, the key factor is to maintain availability of the baits and prevent infestation of unwanted organisms into the bait stations. The team suggested focusing the baiting efforts in areas that appear to have the densest populations of rodents, with the caveat that steps be taken simultaneously to prevent bait uptake by competing organisms. They suggested that the level of effort would require several personnel committed to these activities on a full-time permanent or semi-permanent basis (USAF 2013a). Because of the associated expense they suggested that an intense trapping period with multiple workers be utilized. The team also suggested the control of ironwood trees and the removal of their thatch to improve success of rat control efforts. The team indicated that another aerial eradication effort could be

effective if the alternative food source and refugia issues could be adequately addressed (USAF 2013a).

The USAF partnered with the USDA in 2014 to conduct studies on the efficacy of rodenticide baits for control of wild caught Polynesian rats on Wake Atoll. A large component of the project included conducting taste preference trails (palatability studies) on rats that may support future efforts to eradicate the remaining Polynesian rat population on Wake Atoll. Testing for resistance to anti-coagulant compounds was also a component of the project. Brodifacoum baits were used for the recent (2012) eradication efforts on Wake Atoll, but it is unknown if brodifacoum is efficacious against the local population of Polynesian rats, or if the baits are palatable and thus consumed by the rats. 2014 USDA led research efforts on the Atoll also yielded census and index surveys for the seabird, shorebird, and waterfowl populations using the Atoll. In March 2015, USDA returned to Wake to conduct the second portion of the semi-annual seabird and shorebird surveys as well as lagoon fish sampling for heavy metals and Brodifacoum residuals from the rat eradication project.

3.3 INVASIVE AND NONNATIVE PLANTS ON WAKE ATOLL

3.3.1 Methods

Surveys to update vegetation mapping were conducted on Wake Island, Wilkes Island, and Peale Island from 1 to 31 October 2013 by EA. The islands were separated into sites referred to as HMUs in order to delineate areas within which various natural resources management actions should occur (**Figure 2-2**). Most HMUs are defined by physical boundaries such as roads or beaches. **Figure 2-3a-k** depicts the vegetation map overlaid with the location of each HMU on the Atoll. A description of the topography and dominant vegetation for each HMU is described under “Vegetation” in the “Physical Environment” section above.

3.3.2 Results

There were 34 species of invasive and nonnative plants observed during the survey. **Table 3-1** provides the invasive and nonnative species observed during the survey. The table indicates species that are on the Federal Noxious Weed List, the Hawai`i Noxious Weed List, and the Hawai`i DLNR Invasive Plants list. Invasive and nonnative species that have been observed on Wake Atoll in the past but, were not recorded during the survey are included for reference. In addition to the species addressed in this plan, **Table 3-2** lists plants that have been identified as likely threats to Wake Atoll, if introduced (USAF 2011).

Table 3-1. Invasive and Nonnative Plants Observed on Wake Atoll

Scientific Name	Common Name	Federal Noxious Weed[1]	HI Noxious Weed[2]	HI DLNR[3] Invasive Plant
Amaranthus dubius	Spleen amaranth			
Amaranthus viridis	Slender amaranth			
Bidens alba	White beggar-ticks			
Casuarina equisetifolia	Casuarina			
Catharanthus roseus	Periwinkle			
Cenchrus echinatus	Sandbur			
Chamaesyce hirta	Hairy spurge			
Chamaesyce hypericifolia	Graceful spurge			
Chamaesyce prostrata	Prostrate spurge			
Coccinia grandis	Ivy gourd		X	X
Coccoloba uvifera	Sea grapes			
Conyza bonariensis	Hairy horseweed			
Cuscuta pentagona	Five-angled dodder			
Cynodon dactylon	Bermuda grass			
Cyperus rotundus	Nutgrass			
Digitaria insularis	Sourgrass			
Eichhornia crassipes	Water hyacinth			
Eleusine indica	Goosegrass			
Epipremnum pinnatum	Taro vine			
Eragrostis amabilis	Japanese love grass			
Euphorbia cyathophora	Wild poinsettia			
Ipomoea aquatica	Swamp morning-glory	X		
Leucaena leucocephala	Tangantangan			
Passiflora foetida var. hispida	Passion fruit			
Pennisetum polystachion	Feathery pennisetum	X		
Pluchea carolinensis	Sourbush			
Portulaca oleracea	Common purslane			
Ricinus communis	Castor bean			
Sansevieria trifasciata	Bowstring hemp			
Setaria verticillata	Bristly foxtail			
Terminalia catappa	Indian almond			
Tradescantia spathacea	Oyster plant			
Tribulus terrestris	Puncture vine			
Tridax procumbens	Coatbuttons	X		

1. USDA-APHIS 2012.
2. Division of Plant Industry 2003.
3. DLNR.

Table 3-2. Invasive and Nonnative Plants that are a Potential Threat to Wake Atoll

Scientific Name	Common Name	Federal Noxious Weed[1]	HI Noxious Weed[2]	HI DLNR[3] Invasive Plant
Abutilon grandifolium	Hairy abutilon			
Amaranthus spinosus	Spiny pigweed			
Antigonon leptopus	Chain-of-love			
Buchnera Americana	American blueheart			
Chenopodium murale	Nettleleaf goosefoot			
Chromolaena odorata	Siam weed		X	
Coronopus didymus	Swine cress			
Flaveria trinervia	Clustered yellowtops			
Mikania micrantha	Mile-a-minute vine	X		
Pluchea indica	Indian pluchea			
Sporobolus pyramidatus	Grass			
Turnera ulmifolia	Yellow alder			
Verbesina encelioides	Golden crown-beard			

1. USDA-APHIS 2012.
2. Division of Plant Industry 2003.
3. DLNR.

3.3.3 Management Plan for Invasive and Nonnative Plants

This section provides descriptions and possible and proposed management methods for primary invasive and nonnative plant species. Current general management methods for invasive species are described above, though some species profiles may contain additional species-specific current management information. Where no new management actions are proposed, current management methods should continue, or management may follow the options listed in each plant profile. Species are listed in alphabetical order by scientific name. **Appendix C** provides a table of invasive plant management actions by HMU.

3.3.3.1 Spleen amaranth (*Amaranthus dubius*)

Management Priority: 3

Spleen amaranth is an allelopathic annual herb that is native to the paleotropics and tropical America (Pacific Island Ecosystem at Risk [PIER] 2013; Wagner et al. 1999 as cited in PIER 2013; Smith 1981 as cited in PIER 2013). It is naturalized in disturbed areas in Hawai`i (Wagner et al. 1999 as cited in PIER 2013).

This species was not recorded in the most recent vegetation survey on Wake Atoll. However, it has been observed in the past and is invasive.

No information on management of spleen amaranth is available in the literature. If the species is observed, please refer to the "other species" profile for management suggestions.

3.3.3.2 Slender amaranth (*Amaranthus viridis*)

Management Priority: 3

Slender amaranth is an annual herb native to South America that is naturalized in Hawai`i (Wagner et al. 1999 as cited in PIER 2013; Germplasm Resources Information Network [GRIN] 2013 as cited in PIER 2013). It tolerates a range of soil types and grows in disturbed and open areas such as gardens, roadsides, and plantations (CABI 2013; Smith 1981 as cited in PIER 2013). It reproduces via seeds that are produced year round (CABI 2013).

This species was not recorded in the most recent vegetation survey on Wake Atoll. However, it has been observed in the past and is invasive.

Biological: There are no biological control agents currently available for slender amaranth. Slender amaranth has many natural enemies in its native range, and some of these are under investigation for biological control (Baloch et al. 1976 as cited in CABI 2013; Napompeth 1982 as cited in CABI 2013).

Cultural: Because slender amaranth is sensitive to shading, cultivation of crops or other species that will provide canopy closure may reduce its competitive abilities (CABI 2013).

Mechanical: Manual removal of slender amaranth is effective but only efficient for small infestations. Applications of herbicides following manual removal may improve effectiveness (CABI 2013).

Chemical: Slender amaranth can be controlled by most herbicides that are effective for broad-leaved species. These include the triazine herbicides, axadiazon, ozyflourfen, oryzalin, MCPA, 2,4-D, cinmethylin, DCPA, naproppamide, prometryne, diuron, linuron, sulfallate, chloramben, nitrofen, bentazone, pebulate, nitralin, trifluralin, EPTC, glyphosate, and paraquat. This list is not exhaustive, and herbicide choice may depend on time of application and the presence of non-target species (CABI 2013).

3.3.3.3 White beggar-ticks (*Bidens alba*)

Management Priority: 3

White beggar-ticks is an annual or perennial herb native to South America, Florida, and the West Indies that grows to be 1 to 5 ft. tall. It grows in disturbed and open areas and reproduces via seeds that develop barbs that can stick to clothing and fur and aid in dispersal. Seeds can also be dispersed in soil or machinery that is moved from one location to another. It is highly invasive on the Marshall Islands (Englberger 2009 as cited in CABI 2013).

Biological: No biological control agents are available for white beggar-ticks.

Cultural: No cultural control measures are available for white beggar-ticks. This species should not be intentionally planted.

Mechanical: Manual removal is possible but difficult and effective only when done repeatedly over a long time period (Englberger 2009 as cited in CABI 2013).

Chemical: Foliar spraying of triclopyr is effective (Englberger 2009 as cited in CABI 2013).

3.3.3.4 Casuarina (*Casuarina equisetifolia*)

Management Priority: 0

Casuarina is an evergreen tree native to Australia (Motooka et al. 2003). It can grow up to 60 ft. tall, tolerates salt, wind, and poor soils, and fixes atmospheric nitrogen. Its canopy produces shady conditions and its leaves and cone-like fruit form a thick layer on top of the soil where they fall (Global Invasive Species Database [GISD] 2010). It is also allelopathic, releasing a chemical that is toxic to other plant species (Morton 1980, in Florida Department of Environmental Protection Undated as cited in GISD 2010). These conditions inhibit the growth of native plant species and often result in monospecific stands of casuarina. These stands can further displace native plant species as they alter soil hydrology and chemistry in their vicinity (PIER 2013). They also do not provide adequate habitat for native fauna, especially seabirds (Klukas 1969, in Snyder 1992 as cited in GISD 2010; USAF 2012). Casuarina reproduces via seeds that are dispersed by wind. In climates with distinct wet and dry seasons seeds Casuarina grows very fast and has a high rate of reproductive success, making it very difficult to control (CABI 2013). The 2009 Wake Island Ironwood and Lagoon Environmental, Safety, Occupational Health Committee Compliance Assessment Management Program findings note that its seeds also provide food for invasive rats.

Management efforts on Wake Atoll should focus on limiting the spread of the existing trees and uprooting any seedlings found in new areas. The 2009 Wake Island Ironwood and Lagoon Environmental, Safety, Occupational Health Committee Compliance Assessment Management Program Finding notes that the herbicide Pathfinder II was approved for use to control casuarina on Wake Atoll, but that further studies should be carried out to determine the most efficient control mechanism.

Currently areas with seedlings and saplings are prioritized for treatment. Small infestations are removed manually or with a weed wrench at a rate of at least 0.25 acres per month; larger infestations may require choppers and/or tree harvesters. Stumps are treated with herbicide after cutting. Herbicide is sometimes applied to the basal bark prior to cutting. All chemical and mechanical removal is done after the summer bird nesting peak (USAF 2011; USAF 2012).

In looking to future management, mechanical removal of all larger casuarina trees with excavators, chippers, and chainsaws would provide opportunities to sell wood oversees or use the mulch for gardens. This kind of mechanical removal may be more expensive in the short term than chemical control, but would require less follow-up maintenance. However, it could

also destabilize soils in coastal areas and could increase erosion if re-vegetation does not follow tree removal. Mowing in conjunction with tree removal will help control casuarina. A control strategy that only involved mowing would be less expensive and would reduce the risk of increased erosion. However, this control method would not reduce the current area covered by casuarina and thus would not result in any benefit to the natural environment (USAF 2012).

Biological: USDA researchers have been looking for insects, pathogens, and fungi that are natural enemies of casuarina. So far, 12 species have been identified and are undergoing further testing to determine whether their introduction as a biological control measure would be effective. There currently are no approved biological controls for casuarina (Flores 2008 as cited in GISD 2010; Elfers 1988 as cited in GISD 2010; Binggeli 1997 as cited in GISD 2010).

Cultural: No cultural management methods are available for casuarina. The species should not be intentionally planted.

Mechanical: Manual removal of seedlings and saplings is recommended for small infestations (Swearingen 1997 as cited in GISD 2010). Cutting can induce sprouting and thus should only be used in conjunction with herbicide applications. Burning has been successful in some cases but must be undertaken with care as disturbing native species or changing soil conditions with fire can actually promote the establishment of casuarina (Snyder 1992 as cited in GISD 2010).

Chemical: Larger infestations of casuarina can be controlled effectively by applying systematic herbicides to cut stumps, foliage, or bark (GISD 2010). The Florida Exotic Pest Plant Council (2013) recommends applying a 50 percent aqueous solution of Garlon 3A or a 10-20 percent solution of Garlon 4 Ultra to the surface of casuarina stumps, noting that the herbicide application should be concentrated on the layer of tissue immediately inside the bark. The same herbicides at the same concentrations can be applied using the hack and squirt method in which herbicide is applied to deep cuts in the bark of the tree. For this method, cuts should be angled down to allow herbicide to pool. For smaller trees with DBHs of up to 6 in., herbicides containing triclopyr ester (such as Pathfinder II) or a 10-20 percent solution of Garlon 4 Ultra in oil can be applied to the bark around the base of the tree. Spraying herbicides such as Garlon 3A or Garlon 4 Ultra in a 3-5 percent solution in water directly onto the leaves of casuarina can also be effective. Care should be taken to avoid non-target species (Pernas et al. 2013).

3.3.3.5 Periwinkle (*Catharanthus roseus*)

Management Priority: 2

Periwinkle is a perennial herb native to Madagascar that is cultivated as an ornamental worldwide (Stone 1970 as cited in PIER 2013). It prefers sandy soils and is often found growing in coastal sand dune habitats (Csurhes and Edwards 1998 as cited in PIER 2013). It grows to be 1 to 2 ft. tall and reproduces by seed (PIER 2013).

Biological: There are no biological control agents available for periwinkle.

Cultural: Because periwinkle is often introduced intentionally as an ornamental, controlling its cultivation could be an important step towards managing it as an invasive species (Stone 1970 as cited in PIER 2013).

Mechanical: No information on mechanical management of periwinkle is available in the literature. If the species is observed, please refer to the "other species" profile for management suggestions.

Chemical: No information on chemical management of periwinkle is available in the literature. If the species is observed, please refer to the "other species" profile for management suggestions.

3.3.3.6 Sandbur (*Cenchrus echinatus*)

Management Priority: 2

Sandbur is an annual grass native to tropical America that grows up to 3 ft. tall (JSTOR Plant Science 2010 as cited in GISD 2010). It tolerates a variety of soil types and moisture contents but prefers sandy soil and is often found along coastal habitats where it is a nuisance to people and native fauna, including birds (GISD 2010; Motooka et al. 2003 as cited in GISD 2010; PIER 2010 as cited in GISD 2010). It can grow in dense mats which exclude native species (Flint & Rehkemper 2002 as cited in GISD 2010). It reproduces via seeds with burrs that attach readily to clothing, fur, or feathers and can thus be dispersed by anything that brushes against the plant (GISD 2010). These burrs also float and can be dispersed by water (Smith 2002 as cited in PIER 2013).

Sandbur management on Wake Atoll is currently dependent on the availability of funding. When funding is available the Air Force plans to control and, if possible, eliminate sandbur infestations through a multi-year plan employing hand-pulling and limited herbicide where necessary. This plan will aim to prevent any plant from going to seed (USAF 2011).

Biological: The concentrated extracts of the shoots and roots of the plant *Alocasia sanderiana* have been used as a pre-emergence herbicide for sandbur (Gonzal et al. 1989 as cited in CABI 2013). Three fungal pathogens (*Exserohilum rostratum*, *E. longirostratum*, and *Drechslera gigantea*) have also been studied for their combined effectiveness against sandbur (Charudattan et al. 1999 as cited in CABI 2013).

Cultural: Tilling, cutting, mowing, and mulching are often used effectively by small-scale farmers to control sandbur in agricultural land (CABI 2013).

Mechanical: Manual removal of sandbur is possible but difficult due to the burrs it produces. Multiple rounds of removal may be necessary and will be most effective if completed before the plant produces seeds (PIER 2013).

Chemical: Sandbur is sensitive to glyphosate, chlorazifop, atrazine, and benfluralin. A pre-emergence herbicide may be useful in reducing the seedbank (Motooka et al. 2003 as cited in PIER 2013; Parsons and Cuthbertson 1992 as cited in PIER 2013).

3.3.3.7 Hairy spurge (*Chamaesyce hirta*)

Management Priority: 3

Hairy spurge is an annual herb native to tropical America and the West Indies (CABI 2014; Stone 1970 as cited in PIER 2013; Wagner et al. 1999 as cited in PIER 2013). It is an early colonizer of disturbed and open areas and is tolerant of mowing, thus it is often found in lawns and agricultural fields (CABI 2014; Holm et al 1977 as cited in PIER 2013). It is fast-growing and reproduces via seeds that are produced year-round (CABI 2014). It reproduces via seeds that are dispersed when the pods in which they develop explode upon reaching maturity (Holm et al. 1977 as cited in CABI 2014).

Biological: There are no biological control agents available for hairy spurge.

Cultural: There are no cultural control methods for hairy spurge. This species should not be intentionally planted.

Mechanical: Manual removal and hoeing are usually effective for hairy spurge (Parker 1992 as cited in CABI 2014).

Chemical: Hairy spurge is sensitive to ethalfluralin + EPTC (Locascio and Stall 1983 as cited in CABI 2014), chlorimuron (Karmakar et al. 1994 as cited in CABI 2014), atrazine (Gautam and Chauhan 1984 as cited in CABI 2014), oxadiazon (Nishimoto et al. 1980 as cited in CABI 2014), diuron, fluchloralin (Challa 1984 as cited in CABI 2014), oxyfluorfen (Rajamani et al. 1992 as cited in CABI 2014), oryzalin + fluometuron + metolachlor (Quinones Undated as cited in CABI 2014), ametryn, cyanazine, metribuzin, prometryn, simazine (Soerjani et al. 1987 as cited in CABI 2014), butachlor (Barman and Mehta 1989 as cited in CABI 2014), fluazifop-butyl (Singh et al. 1994 as cited in CABI 2014), and isoproturon + 2,4-D (Deshmukh et al. 1995 as cited in CABI 2014).

3.3.3.8 Graceful spurge (*Chamaesyce hypericifolia*)

Management Priority: 3

Graceful spurge is an annual herb native to tropical and subtropical America that grows up to 32 in. in height (Whistler and Steele 1999 as cited in PIER 2013; Wagner et al. 1999 as cited in PIER 2013). It reproduces via seeds and is common in low elevation disturbed and open habitats (Wagner et al. 1999 as cited in PIER 2013).

Graceful spurge was observed in several locations along roads bordering the western boundary of the HMU.

No information on management of graceful spurge is available in the literature. If the species is observed, please refer to the "other species" profile for management suggestions.

3.3.3.9 Prostrate sandmat (*Chamaesyce prostrata*)

Management Priority: 3

Prostrate sandmat is an annual herb native to the Americas (GRIN 2013 as cited in PIER 2013; Stone 1970 as cited in PIER 2013). It reproduces via seeds and is common in low elevation disturbed and open habitats (Wagner et al. 1999 as cited in PIER 2013; Whister 1988 as cited in PIER 2013).

This species was not documented in the most recent vegetation survey on Wake Atoll. However, it has been observed in the past and is invasive.

No information on management of prostrate sandmat is available in the literature. If the species is observed, please refer to the "other species" profile for management suggestions.

3.3.3.10 Ivy gourd (*Coccinia grandis*)

Management Priority: 2

Ivy gourd is a perennial herbaceous vine native to East Africa (Englberger 2009 as cited in CABI 2014). It has an extensive root system with tubers from which new plants can sprout, and also sets new roots when stems touch the ground (Englberger 2009 as cited in CABI 2014; Muniappan et al. 2009 as cited in CABI 2014). The vine also reproduces via seeds which are dispersed by birds, rodents, and potentially pigs. Ivy gourd has medicinal qualities and produces edible fruit and is thus often introduced intentionally to areas outside its native range (Englberger 2009 as cited in CABI 2014; Muniappan et al. 2009 as cited in CABI 2014). It readily invades disturbed areas and rapidly climbs and smothers native vegetation. It also hosts numerous insects that are known agricultural pests (Muniappan et al. 2009 as cited in CABI 2014). Ivy gourd is identified as a Hawai`i Noxious Weed and is on the Hawai`i Department of Natural Resources High Profile Invasive Species list (Division of Plant Industry 2003; Hawai`i Invasive Species Council 2014).

Biological: Three insect species have been used as biological control agents in Hawai`i. The moth *Melittia oedipus* and the weevil *Acythopeus cocciniae* both affected ivy gourd populations in Hawai`i, while the weevil *Acythopeus burkhartorum* has not had a significant effect (Muniappan et al. 2009 as cited in CABI 2014).

Cultural: Because ivy gourd is often introduced intentionally, controlling the cultivation of the vine may be an important management measure (Englberger 2009 as cited in CABI 2014; Muniappan et al. 2009 as cited in CABI 2014).

Mechanical: Ivy gourd can be manually or mechanically dug up and removed if care is taken to remove all parts of the tuberous root system, as the plant can regenerate from root or stem fragments left behind. For this reason cutting and slashing are not recommended as management methods (Englberger 2009 as cited in CABI 2014).

Chemical: Foliar application of 1 pound triclopyr or dicamba per acre will defoliate the plant (Motooka et al. 2003). Basal bark applications of 2,4-D or triclopyr are also effective. However, the climbing nature of ivy gourd makes it difficult to avoid applying chemicals to non-target species, and finding the base of the vine is also difficult (Englberger 2009 as cited in CABI 2014; Muniappan et al. 2009 as cited in CABI 2014).

3.3.3.11 Sea grape (*Coccoloba uvifera*)

Management Priority: 3

Sea grape is a perennial shrub or tree native to tropical America that grows in coastal habitats. In beach habitats it usually grows as a sprawling shrub but may grow up to 50 ft. tall as a tree when less exposed to salt and sand. It is tolerant of a range of exposures to light, wind, and moisture. It is often used in landscaping and as a windbreak. It reproduces primarily via seeds that develop in reddish fruits that are dispersed by birds, though regeneration from cuttings is also possible (Christman 2004).

Biological: There are no biological controls specified for sea grapes.

Cultural: No cultural control methods are presented for sea grapes.

Mechanical: No mechanical control methods are presented for sea grapes.

Chemical: Although no chemical controls are specified for sea grape, frill or girdle (aka "hack and squirt"), or basal bark application of herbicides such as triclopyr ester (e.g., Garlon 4) should be effective. A 10 percent application rate of a Garlon 4 mixture including Garlon 4, Chopper Generation II, Cide-Kick II and Improved JB Oil Plus should be effective in controlling sea grape.

3.3.3.12 Hairy horseweed (*Conyza bonariensis*)

Management Priority: 3

Hairy horseweed is an annual herb native to temperate regions of South America. It grows up to 40 in. in height and prefers undisturbed habitats, often growing in pastures or orchards, along field edges, and in fields of perennial crops. It reproduces via wind-dispersed seeds and has been unintentionally introduced in many regions as an agricultural seed contaminant (CABI 2013). Though hairy horseweed can tolerate a wide variety of environmental conditions, it favors nutrient-rich soil and, therefore, may be more abundant where nitrogen-fixing plants are also common (Prieur-Richard et al. 2002 as cited in CABI 2013).

Biological: There are no biological control agents available for hairy horseweed.

Cultural: As hairy horseweed prefers undisturbed habitat, frequent tilling of agricultural fields or cultivation of annual crops may contribute to control measures. However, once the weed is established and has produced seeds tilling may contribute to seed dispersal; thus timing of tillage is an important factor in managing hairy horseweed (CABI 2013).

Mechanical: Frequent tilling may inhibit the establishment of hairy horseweed (CABI 2013).

Chemical: Hairy horseweed is susceptible to many commonly used herbicides including dicamba, 2,4-D, atrazine, simazine, and glyphosate. It is resistant to triazines and there are conflicting studies regarding its potential resistance to paraquat (CABI 2013).

3.3.3.13 Fiveangled dodder (*Cuscuta pentagona*)

Management Priority: 2

Fiveangled dodder is a perennial vine native to North America (CABI 2014; USDA-Natural Resources Conservation Service [NRCS] 2013). It tolerates a wide range of environmental conditions and host plants and is spread readily through the contamination of crop seeds, especially lucerne, niger, and clover seeds from which fiveangled dodder seeds are difficult to distinguish. It readily invades disturbed areas of vegetation such as agricultural fields. It reproduces via seeds but can also spread via vegetative growth. It has the capacity to grow and spread rapidly and kills its host plant by parasitism and competition for resources (CABI 2014).

Biological: Attempts to control fiveangled dodder with biological agents have used the fly *Melanagromyza cuscutae* and weevils in the genus *Smicronyx.* The weevils *S. jungermanniae* and *S. tartaricus* have given successful control in Eastern Europe (Julien 1987 as cited in CABI 2014; Parker and Riches 1993 as cited in CABI 2014).

Cultural: Because fiveangled dodder is often introduced accidentally through crop seed contamination, increased vigilance and inspection of agricultural shipments is vital to prevent the further spread of this species (CABI 2014). In agricultural settings, rotations with non-susceptible crops such as cereals, kidney bean, cotton, squash, and cucumber can play a role in controlling fiveangled dodder (Parker and Riches 1993 as cited in CABI 2014).

Mechanical: Young seedlings can be controlled by shallow tilling, and small infestations can be pulled up if care is taken to remove all parts of the plant. The plant is not heat resistant and thus flaming can be used as a control measure (CABI 2014). Grazing by sheep has also proven effective (Nicol et al. 2007 as cited in CABI 2014).

Chemical: Chemical control of fiveangled dodder is challenging because of the difficulty of avoiding non-target plants such as the host plant. Paraquat, diquat, glyphosate, imazaquin, imazethepyr, glufosenate, clopyralid, and metsulfuron have all been effective in various crops and circumstances (Crocker 1987 as cited in CABI 2014; Dawson et al. 1994 as cited in CABI

2014; Heap 1992 as cited in CABI 2014; Sarpe et al. 1992 as cited in CABI 2014). The use of soil-acting herbicides such as trifluralin, propyzamide, chlorthal-dimethyl, prodiamine, pendimethalin, pebulate and ethofumesate may also be effective in preventing germination of fiveangled dodder (Parker and Riches 1993 as cited in CABI 2014; Dawson et al. 1994 as cited in CABI 2014).

3.3.3.14 Bermuda grass (*Cynodon dactylon*)

Management Priority: 3

Bermuda grass is a perennial grass native to Asia that spreads by seeds, rhizomes, and stolons. It prefers warm climates and full sun but tolerates a wide variety of soil conditions (CABI 2013; USDA-NRCS 2013). In Hawai`i, it is cultivated and naturalized along roadsides and in lawns and pastures (Wagner et al. 1999 as cited in PIER 2013; Wiggins and Porter 1971 as cited in PIER 2013). It is most problematic as an agricultural weed that can compete with crops for resources, but is also used intentionally in many areas as turf or for erosion control (CABI 2013).

Biological: There are no approved biological control agents for Bermuda grass, but multiple fungal pathogens are being studied as possibilities (Uygur 2000 as cited in CABI 2013).

Cultural: Because Bermuda grass is often planted intentionally as lawn grass or turf, controlling its cultivation may be an important factor in managing it as an invasive species (CABI 2013).

Mechanical: Small patches of Bermuda grass can be manually dug up (GISD 2010). However, manual removal is often ineffective if all rhizomes are not removed. Mowing Bermuda grass only results in its proliferation. Plowing areas of Bermuda grass multiple times and subsequently planting more desirable species, especially those that will produce shady conditions, may be effective in removing patches of Bermuda grass (CABI 2013).

Chemical: Paraquat or glyphosate can be effective when applied to young plants in spring or autumn during rhizome growth (Weber 2003 as cited in PIER 2013).

3.3.3.15 Nutgrass (*Cyperus rotundus*)

Management Priority: 3

Nutgrass is a perennial sedge native to Africa and Eurasia that grows up to 2 ft. in height (GRIN 2013 as cited in PIER 2013; Stone 1970 as cited in PIER 2013). It reproduces mainly via tubers and rhizomes, but also occasionally produces seeds which are dispersed by wind and water. The plant is tolerant of a wide range of soil moisture conditions and climates, but requires full sun for growth. The tubers remain viable in the soil for long periods of time and will sprout whenever sunlight becomes available if the plant has died back due to shading (Holm et al. 1977 as cited in PIER 2013). Thus it grows well in open and disturbed areas and is highly persistent once established (PIER 2013).

Biological: There are no biological control agents available for nutgrass (Waterhouse and Norris 1987 as cited in PIER 2013).

Cultural: There are no cultural control measures available for nutgrass. This species should not be intentionally planted.

Mechanical: Growth can be inhibited by shading, but tubers remain viable for long periods of time and the plant will re-grow if shade is removed (Holm et al. 1977 as cited in PIER 2013). Physical obstructions to growth such as organic mulch are generally not effective, though plastic mulches have been shown to work (Henson and Little 1969 in Webster 2005 as cited in GISD 2009; Bangarwa et al. 2008 as cited in GISD 2009).

Chemical: Glyphosate and paraquat are effective herbicides for nutgrass (Doll and Piedrahita 1982 and Zandstra et al. 1974 in Webster et al. 2008 as cited in GISD 2009).

3.3.3.16 Sourgrass (*Digitaria insularis*)

Management Priority: 3

Sourgrass is a perennial grass native to tropical America that grows up to 5 ft. (Stone 1970 as cited in PIER 2013; GRIN 2013 as cited in PIER 2013). It grows in tufts and can form dense stands in disturbed and open areas (Motooka et al. 2003). It prefers wetter soils and is often found in pastures or agricultural fields (CABI 2013). It reproduces primarily via seeds, but may also reproduce vegetatively via rhizomes or cuttings. Seeds are mainly distributed by wind and water. Sourgrass may form monospecific stands that displace and exclude native grass species through competition for resources and shading (CABI 2013).

Biological: There are no biological control agents available for sourgrass.

Cultural: In Hawai`i, buffel grass (*Cenchrus ciliaris*) and Guinea grass (*Panicum maximum*) have been effective in crowding out sourgrass (Pyon 1976 as cited in CABI 2013).

Mechanical: Grazing has been suggested as a control measure where sourgrass occurs in pastures (Motooka et al. 2003).

Chemical: Glyphosate is commonly effective in killing sourgrass, although there have been instances in which the plant has developed glyphosate resistance (Motooka et al. 2003; Cerdeira et al. 2011 as cited in CABI 2013).

3.3.3.17 Water hyacinth (*Eichhornia crassipes*)

Management Priority: 2

Water hyacinth is a perennial aquatic herb native to South America that has been cultivated world-wide (Holm et al. 1977 as cited in CABI 2013). It grows and spreads rapidly in all

freshwater ecosystems and forms large, dense, monospecific mats that adversely affect biodiversity and inhibit human activities such as fishing and transportation. Water hyacinth reproduces via seeds that are dispersed mainly by water and vegetatively via stolons that develop at the base of the leaves (CABI 2013). Because of its ability to reproduce rapidly and prolifically, an integrated management plan is recommended to achieve the highest level of control (CABI 2013).

This species was not recorded in the most recent vegetation survey on Wake Atoll. However, it has been observed in the past and is invasive.

Biological: Multiple biological control agents have been identified and released in different areas of the world for the control of water hyacinth. These include seven arthropod species (*Neochetina bruchi, Neochetina eichhorniae, Xubida infusellus, Niphograpta albiguttalis, Bellura densa, Eccritotarsus catariensis,* and *Orthogalumna terebrantis*) and three fungi (*Acremonium zonatum, Cercospora piaropi* and *Cercospora rodmanii*) (Harley 1990 as cited in CABI 2013; Julien and Griffiths 1998 as cited in CABI 2013). *N. bruchi* and *N. eichhorniae* have reduced water hyacinth infestations by 80-90 percent in many regions (Hill 1999 as cited in CABI 2013). Other potential biological control agents are currently being studied (CABI 2013).

Cultural: Because water hyacinth is often intentionally cultivated as an ornamental, controlling its cultivation may be an important management technique (Holm et al. 1977 as cited in CABI). Water hyacinth requires high nutrient availability in the aquatic ecosystems it invades, so reducing flows of nitrogen and phosphorus (e.g., from fertilizer or sewage) to the water body is recommended (Coetzee and Hill 2012 as cited in CABI 2013).

Mechanical: Small infestations may be removed by hand. Larger infestations may require the use of boats or other machinery capable of removing the plant from the water body and crushing it. Floating booms or other barriers may be somewhat effective in preventing the spread of water hyacinth (CABI 2013).

Chemical: 2,4-D and glyphosate are both effective on water hyacinth. Although glyphosate is more expensive than 2,4-D, it may be preferable as it does not contaminate drinking water and kills the weed more slowly, which may decrease the risk of development of anaerobic conditions as the weed decomposes (Findlay and Jones 1996 as cited in CABI 2013). Paraquat and diquat have also been effective, but are highly toxic to mammals and are thus not recommended (CABI 2013). Other effective herbicides include ametryn, terbutryn, aminotriazol (amitrole), and penoxsulam (CABI 2013; Wersal and Madsen 2010 as cited in CABI 2013). Multiple treatments are almost always necessary to curb re-growth (CABI 2013).

3.3.3.18 Goosegrass (*Eleusine indica*)

Management Priority: 3

Goosegrass is an annual tufted grass native to Africa. It grows best in more fertile soils but can tolerate a range of soil types and environmental conditions (CABI 2013). It reproduces via seeds

that are dispersed by wind or when stuck with mud to clothing, fur, skin, or machinery (Waterhouse 1994 as cited in PIER 2013). It prefers full sunlight and is often found in disturbed and open areas, and once established grows quickly and is hard to control (Swarbrick 1997 as cited in PIER 2013).

Biological: There are no biological control agents available for goosegrass, though ongoing research is analyzing possibilities (Figliola et al. 1988 as cited in CABI 2013).

Cultural: There are no cultural control methods for goosegrass. This species should not be intentionally planted.

Mechanical: Mulches can be used to prevent germination of seeds. Seedlings can be shaded out by other plants, but once established the strong root system makes manual removal difficult (PIER 2013).

Chemical: Goosegrass is susceptible to most herbicides that are effective on grasses including uracisl (bromacil), arsenicals, substituted ureas (diuron, etc.), dinitoanilines (trifluralin, etc.) dimethylethers (oxyfluorfen, etc.), triazines (atrazine, etc.), thiolcarbamates (EPTC, etc.), imidazolinones (imazaquin, etc.) graminicides (fluazifop, sethoxydim, etc.), propanil, oxadiazon, quinclorac, clomazone, paraquat, diphenamid, glufosinate, flumioxazin, and glyphosate. Herbicide resistance has developed in some populations, and repeated use of the same type of compound is discouraged (CABI 2013).

3.3.3.19 Taro vine (*Epipremnum pinnatum*)

Management Priority: 3

Taro vine is a perennial climbing vine native to Asia, Oceania, and the Pacific Islands (Govaerts 2012 as cited in CABI; USDA-Agricultural Research Service (ARS), 2012 as cited in CABI 2013). It climbs and engulfs native trees and shades out understory vegetation (ISSG 2012 as cited in CABI 2013). It reproduces via seeds that are dispersed by frugivorous birds and mammals and vegetatively through cuttings and stem fragments which remain viable long after they are separated from the parent plant. The vegetative mode of reproduction is more common than seed production in many regions outside the plant's native range (Darwin Initiative Project 2006 as cited in CABI 2013; Acevedo-Rodriquez and Strong 2005 as cited in CABI 2013; Acevedo-Rodriguez, personal observation as cited in CABI 2013). Taro vine is tolerant of a range of soil, temperature, and moisture conditions, and thus easily escapes cultivation in gardens (Gilman 2011 as cited in CABI 2013).

Biological: No biological control agents are available for taro vine.

Cultural: Because this species is often introduced through intentional cultivation, controlling its cultivation may be important in managing its invasiveness (Gilman 2011 as cited in CABI 2013).

Mechanical: Physical removal of taro vine is very difficult, but effective if repeated frequently over long periods and if care is taken to completely remove all tubers, rhizomes, and plant fragments, from which the plant can regenerate if left behind (Englberger 2009 as cited in CABI 2013).

Chemical: No information on chemical management of taro vine is available in the literature. If the species is observed, please refer to the "other species" profile for management suggestions.

3.3.3.20 Japanese love grass (*Eragrostis amabilis*)

Management Priority: 3

Japanese love grass is an annual grass native to the Paleotropics (Wagner et al. 1999 as cited in PIER 2013). It grows in disturbed and open areas and is common in lawns (Whistler 1988 as cited in PIER 2013). It reproduces via seeds and is often introduced intentionally as an ornamental (CABI 2013; PIER 2013). As this species is often introduced as an ornamental, controlling its intentional planting may be an important management measure (CABI 2013) No further information on management of Japanese love grass is available in the literature. If the species is observed, please refer to the "other species" profile for management suggestions.

3.3.3.21 Wild poinsettia (*Euphorbia cyathophora*)

Management Priority: 3

Wild poinsettia is an annual or perennial herb native to North and South America and the West Indies (USDA-NRCS 2013; Wagner et al. 1999 as cited in PIER 2013). It occurs most frequently in low elevation open and disturbed sites and along sandy beaches and coastal areas (Smith 1981 as cited in PIER 2013). It reproduces via seeds (PIER 2013).

No information on management of wild poinsettia is available in the literature. Refer to the "other species" profile for management suggestions.

3.3.3.22 Swamp morning-glory (*Ipomoea aquatica*)

Management Priority: 2

Swamp morning-glory is a perennial aquatic vine native to tropical Asia and India that can exceed 10 ft. in length and is about 0.5 in. in diameter (CABI 2014). It is found in freshwater habitats such as canals, ditches, lakes, ponds, and marshes and in moist soils such as along stream banks (GISD 2006). In these ecosystems it forms dense mats which can shade out native submerged vegetation which may be important for native fish and wildlife (GISD 2006; Langeland and Burks 1998 as cited in GISD 2006). These mats also create ideal breeding grounds for mosquitos (Fears Undated as cited in GISD 2006). It is rich in iron and is used as food in many parts of Asia and introduced as an ornamental in other regions (Fears Undated as cited in GISD 2006; Malalavidhane et al. 2000 as cited in GISD 2006). Swamp morning-glory

reproduces via seeds that are dispersed in nature by water and vegetatively as free-floating plant fragments can sprout new plants (Fears Undated as cited in GISD 2006).

Swamp morning-glory was not documented during the most recent vegetation survey on Wake Atoll. However, it is invasive and should be treated immediately if seen.

Biological: The beetle *Metriona circumdata* is used as a biological control agent in India (George and Venkataraman 1987 as cited in CABI 2014). There may be a potential for certain fish species to provide biological control as well (CABI 2014).

Cultural: Because swamp morning-glory is often intentionally introduced, controlling its cultivation may be an important management measure (Fears Undated as cited in GISD 2006).

Mechanical: Though complete mechanical removal is not considered practical, plants can be removed manually and mechanically as long as care is taken to remove all parts of the plant and its roots (Chin and Fong 1978 as cited in CABI 2014; Middleton 1990 as cited in CABI 2014).

Chemical: Aquatic herbicides such as DCMU/Diuron, paraquat, and 2,4-D have been effective in controlling swamp morning-glory (Schardt & Schmitz 1990 in Fears Undated as cited in GISD 2006; Ninomiya et al. 2003 as cited in GISD 2006). Some have suggested that glyphosate may also be effective, but like paraquat and DCMU it is a broad spectrum herbicide and may have adverse effects on non-target vegetation (GISD 2006).

3.3.3.23 Tangantangan (*Leucaena leucocephala*)

Management Priority: 0

Tangantangan is a perennial nitrogen-fixing tree native to Mexico and Central America (GISD 2010). It is often planted intentionally as a windbreak and subsequently forms monospecific stands that displace and exclude native species (GISD 2010). It establishes and spreads easily in disturbed areas and is very difficult to eradicate once established (CABI 2014). It is well adapted to well drained soils that are derived from calcareous materials such as coral (Brewbaker 1987 as cited in CABI 2014; Shelton and Brewbaker 1994 as cited in CABI 2014; Blamey and Hutton 1995 as cited in CABI 2014). Because tangantangan fixes atmospheric nitrogen it changes the characteristics of the soil in which it grows, altering the environment for other plant species (CABI 2014). It reproduces year-round via seeds with hard coats that enable them to remain viable for a long time in the soil (Hughes 1998a, b as cited in CABI 2014). It is also allelopathic, releasing toxins that inhibit the growth of other plant species (CABI 2014).

Tangantangan is currently controlled by mowing in Wake Island. However, because this species is capable of producing seeds at a very young age, a rigorous and frequent mowing schedule must be followed to ensure the tangantangan plants do not reach a height at which they are capable of reproducing.

Biological: There are no biological control measures available for tangantangan.

Cultural: Because tangantangan is sometimes intentionally planted as a windbreak, or for animal fodder, controlling its cultivation could be an important factor in managing it as an invasive (CABI 2014).

Mechanical: Fire is not recommended as a control since the plant can regenerate from basal shoots following burning (Cronk and Fuller 1995 as cited in CABI 2014). Grazing by goats can be effective in controlling the spread of tangantangan (PIER 2007 as cited in CABI 2014). The tree will resprout after cutting and thus removal of the root mass is necessary unless cutting is followed by herbicide application (PIER 2007 as cited in CABI 2014). Young trees may be uprooted by hand (Weber 2003 as cited in CABI 2014).

Chemical: Effective control of tangantangan can be achieved with foliar applications of triclopyr, soil applications of tebuthiuron, or basal bark applications of triclopyr ester, 2,4-D in diesel, or potentially diesel alone. Applications of picloram to cut stumps or triclopyr ester to stump bark are also effective (PIER 2007 as cited in CABI 2014).

3.3.3.24 Passion fruit (*Passiflora foetida* var. *hispida*)

Management Priority: 2

Passion fruit is an annual or perennial vine native to South America (GISD 2006). It tolerates a variety of environmental conditions and often establishes in disturbed and open areas where it climbs over low vegetation and can form a dense ground cover, displacing and excluding native species (PIER 2002 as cited in GISD 2006; Whistler 1995 as cited in GISD 2006). It reproduces via seeds that are dispersed by frugivorous birds and mammals (MacDougal 1994 as cited in CABI 2014; PIER 2002 as cited in GISD 2006). The seeds can remain viable for many years in soil (CABI 2014).

Biological: There are no biological control agents available for passion fruit.

Cultural: As passion fruit is often an agricultural weed, attention to inhibiting the spread of its seeds in agricultural field maintenance could be an important factor in controlling this species (CABI 2014).

Mechanical: Passion fruit can be uprooted manually or by hoeing (CABI 2014). Grazine is not effective as the plant and its unripe fruit are toxic (GISD 2006).

Chemical: Triclopyr (Garlon 4) or glyphosate (Roundup) are both effective in controlling passion fruit (Englberger 2009 as cited in PIER 2013).

3.3.3.25 Feathery pennisetum (*Pennisetum polystachion*)

Management Priority: 3

Feathery pennisetum is an annual or perennial grass native to Africa that can grow over 3 ft. in height (CABI 2014; USDA-ARS 2008 as cited in CABI 2014). It is often introduced as an ornamental, or as a pasture grass for cattle and subsequently invades the natural environment, especially disturbed and open sites (CABI 2014; GISD 2006; Weber 2003 as cited in PIER 2013). It is well adapted to soils with low fertility and grows rapidly once established, often in dense patches covering large areas. This can displace and exclude native vegetation (Weber 2003 as cited in PIER 2013). It reproduces via seeds that are dispersed by water or wind, or when stuck to clothing or fur (GISD 2006).

This species was not observed in the most recent vegetation survey on Wake Atoll. However, it has been observed in the past and is invasive.

Biological: There are no biological control agents available for feathery pennisetum.

Cultural: As this species is often introduced as an ornamental or a pasture grass, controlling its intentional cultivation may be an important management measure (CABI 2014). Education regarding agricultural seed contamination and inspection of agricultural shipments may also prevent the further spread of this species (CABI 2014).

Mechanical: Small infestations can be pulled up manually (CABI 2014). Cutting or mowing plants before flowering and seed production can also be effective (Watson 1986 as cited in CABI 2014).

Chemical: Glyphosate, paraquat, glufosinate, fluazifop-butyl, imazapyr, and haloxyfop-methyl are all effective herbicides for feathery pennisetum. Chemical control is most effective on young plants or following slashing. Imazapyr is most effective for long-term control and for established plants (CABI 2014).

3.3.3.26 Sourbush (*Pluchea carolinensis*)

Management Priority: 2

Sourbush is a perennial shrub native to tropical America that grows 3-8 ft. in height (Peng et al. 1998 as cited in PIER 2013; Stone 1970 as cited in PIER; USDA-NRCS 2013). It tolerates a wide variety of soil and environmental conditions but requires full sunlight, and grows well in disturbed and open areas. In many places it is replaced by other species during the natural successional process (Smith and Tunison 1992 as cited in Francis Undated; University of Hawai`i Botany 2002 as cited in Francis Undated). It can grow in dense thickets that displace native vegetation (Motooka et al. 2003). It reproduces via seeds that are dispersed by wind (Francis Undated).

Biological: There are no biological control agents available for sourbush (Francis Undated).

Cultural: There are no cultural control measures for sourbush. This species should not be intentionally planted.

Mechanical: There are no mechanical control measures for sourbush.

Chemical: Sourbush is sensitive to foliar application of 1 percent glyphosate or drizzle application of 0.5 pounds triclopyr per acre; 1 pound 2,4-D per acre; 0.5 pounds dicamba per acre; and 0.25 pounds triclopyr per acre have also given effective control of sourbush (Motooka et al. 2003).

3.3.3.27 Common purslane (*Portulaca oleracea*)

Management Priority: 3

Common purslane is an annual herb native to the Old World (Wagner et al. 1999 as cited in PIER 2013). It establishes well in disturbed and open habitats and is often found in agricultural fields and coastal habitats (Whistler 1983 as cited in PIER 2013). It reproduces via seeds that are dispersed by water, wind, and birds, and may also spread vegetatively, as cut stems will take root when in contact with soil (Holm et al. 1977 as cited in PIER 2013).

Biological: While no biological agents have been intentionally introduced to control this species, the sawfly *Schizocerella pilicornis* (from the Americas) and the weevil *Hypurus bertrandi* (from France) have been translocated unintentionally to other countries in which they are only known to attack common purslane (Waterhouse 1993 as cited in PIER 2013).

Cultural: Common purslane usually cannot compete with turf grass; thus cultivation of healthy turf grass populations may be an effective control measure (Cudney et al. Undated).

Mechanical: Common purslane can be manually removed only if care is taken to fully remove all parts of the plant, as cut stems can take root when in contact with soil (Holm et al. 1977 as cited in PIER 2013). Mulches can prevent seedling development if they are at least 3 in. thick. Soil solarization can also kill common purslane (Cudney et al. Undated).

Chemical: Pendimethalin, dithiopyr, and a combination of benefin with trifluralin or oryzalin are effective pre-emergent controls for common purslane. Once the plant is established it is sensitive to MCPP, MSMA, dicamba, and 2,4-D (Cudney Undated).

3.3.3.28 Castor bean (*Ricinus communis*)

Management Priority: 2

Castor bean is an annual woody tree or shrub native to Africa that usually grows 3-16 ft. in height. It tolerates a wide variety of environmental conditions and can grow in dense monospecific thickets that displace and exclude native vegetation (GISD 2006; CABI 2014). It establishes well in disturbed and open habitats (Weber 2003 as cited in CABI 2014). Castor bean reproduces via seeds that are dispersed when the pods in which they develop explode upon seed maturity. Seeds are also dispersed by granivorous birds and rodents (PIER 2005 as cited in GISD 2006).

Biological: There are no biological control agents available for castor bean (CABI 2014)

Cultural: Large areas of castor bean can be controlled through cultivation of the area over long time periods (Motooka et al. 2003).

Mechanical: Small areas of castor bean can be removed manually (Motooka et al. 2003).

Chemical: Foliar applications of glyphosate, 1 percent triclopyr ester, or picloram + 2,4-D are effective, as are cut stump applications of picloram + 2,4-D or 10 percent triclopyr amine. Castor bean can also be controlled by 10 percent triclopyr ester in oil applied to basal bark (Motooka et al. 2003).

3.3.3.29 Bowstring hemp (*Sansevieria trifasciata*)

Management Priority: 3

Bowstring hemp is a perennial succulent herb native to tropical Africa that has been widely introduced as an ornamental and a fiber crop (CABI 2014; GISD 2010). It tolerates a wide range of environmental conditions (Gilman 1999 as cited in CABI 2014). It reproduces via seeds that are dispersed by birds and other frugivorous animals, as well as vegetatively via rhizomes and leaf segments that readily resprout (Arnold 2004 as cited in CABI 2014; ISSG 2012 as cited in CABI 2014). The plant flowers year round and grows quickly into dense, impenetrable thickets in disturbed and open habitats (Gilman 1999 as cited in CABI 2014; ISSG 2012 as cited in CABI 2014; PIER 2012 as cited in CABI 2014; Randall 2002 as cited in CABI 2014).

Biological: There are no biological control agents available for this species.

Cultural: As this species has been introduced as an ornamental, controlling its intentional cultivation may be an important management measure to control its spread as an invasive (CABI 2014).

Mechanical: Manual removal is possible, but difficult due to the extensive networks of rhizomes. All parts of the plant must be fully removed to prevent the possibility of resprouting (CABI 2014).

Chemical: Applications of imazapyr at 200 milliliters per 100 liters of water, metsulfuron-methyl at 10g/100L water with a wetting agent, and glyphosate at 1 liter per 100 liters of water are all effective on bowstring hemp (CABI 2014).

3.3.3.30 Bristly foxtail (*Setaria verticillata*)

Management Priority: 3

Bristly foxtail is an annual grass native to Europe that grows to over 3 ft. in height. It tolerates a wide range of environmental conditions and rapidly invades disturbed and open areas, displacing

native grasses (Aluka 2008 as cited in GISD 2010; Dekker 2003 as cited in GISD 2010; GISD 2010). It reproduces via seeds which are dispersed by sticking to the fur of small mammals or to clothing (PIER 2008 as cited in GISD 2010). The plant often builds up a considerable seed bank (Dekker 2003 as cited in GISD 2010).

Biological: There are no biological control agents available for bristly foxtail.

Cultural: Because bristly foxtail can be dispersed by clothing, education efforts regarding ways to prevent the spread of seeds on clothing may be an important management method (PIER 2008 as cited in GISD 2010).

Mechanical: Tilling is an effective form of control for bristly foxtail (CABI 2014).

Chemical: Most herbicides used for annual grasses are effective for bristly foxtail, including sethoxydim, chlorthal dimethyl, EPTC, metobromuron, linuron, prometryn, pendimethalin, fenoxaprop, metoxuron, trifluralin, haloxyfop, vernolate, diclofop, fluazifop and glyphosate (CABI 2014). It is resistant to atrazine, triazine, trifluralin, and simazine (Demirci and Nemli 1998 as cited in CABI 2013; Prado et al. 1992 as cited in CABI 2013; Monteiro and Rocha 1992 as cited in CABI 2013).

3.3.3.31 Indian almond (*Terminalia catappa*)

Management Priority: 3

Indian almond is a perennial deciduous tree native to coastal areas throughout the Indian Ocean, tropical Asia, and the Pacific (CABI 2014). It grows well on beaches and along rocky shorelines and establishes readily in disturbed areas (Exell 1954 as cited in CABI 2014; Smith 1985 as cited in CABI 2014; Jensen 1995 as cited in CABI 2014). Indian almond is often planted as a shade tree, for its fruit, or because it provides good lumber (CABI 2014). It reproduces via seeds that develop in fruits that float, aiding dispersal by water (Kadambi 1954 as cited in CABI 2014; Nakanishi 1989 as cited in CABI 2014; Troup and Joshi 1984 as cited in CABI 2014). Seeds are also dispersed by frugivorous animals such as bats (Stow 2008 as cited in GISD 2010).

Biological: Numerous grasshoppers, beetles, leaf miners, and leaf rollers defoliate seedlings in India and Malaysia and could be considered for biological control of Indian almond. Two fruit flies, *Anastrepha suspense* and *Ceratitis capitata*, also defoliate the tree. All these species require further investigation before they could be approved as biological control agents (Morton 1985 as cited in GISD 2010).

Cultural: As this species is often introduced intentionally, controlling its cultivation could be an important factor in managing it as an invasive species (CABI 2014).

Mechanical: No information on mechanical management of Indian almond is available in the literature. If the species is observed, please refer to the “other species” profile for management suggestions.

Chemical: No information on chemical management of Indian almond is available in the literature. If the species is observed, please refer to the "other species" profile for management suggestions.

3.3.3.32 Oyster plant (*Tradescantia spathacea*)

Management Priority: 3

Oyster plant is a perennial succulent herb native to southern Mexico and Central America (Govaerts 2012 as cited in CABI 2014; USDA-ARS 2012 as cited in CABI 2014; Randall 2002 as cited in CABI 2014). It is often planted as an ornamental and subsequently invades the natural environment (CABI 2014). It establishes readily in low elevation disturbed areas and natural forests and forms a dense ground cover that displaces and excludes native vegetation (Richard and Ramey 2007 as cited in CABI 2014; Langeland and Burks 1998 as cited in CABI 2014; ISSG 2012 as cited in CABI 2014). It also thrives on rocky cliffs and walls of coral or stone (Smith 1979 as cited in CABI 2014; PIER 2012 as cited in CABI 2014). It reproduces throughout the year via wind-dispersed seeds and vegetatively through cuttings, offshoots, or root fragments which easily resprout when in contact with soil (Langeland and Burks 1998 as cited in CABI 2014). Contact with its leaves or sap can result in itching, stinging, and a rash (Morton 1982 as cited in CABI 2014).

Biological: There are no biological control agents available for oyster plant.

Cultural: Because oyster plant is often intentionally planted, controlling its cultivation may be an important management measure.

Mechanical: Small infestations can be pulled up by hand, but care must be taken to remove all parts of the plant and roots in their entirety to avoid regrowth (CABI 2014).

Chemical: Foliar applications of 3-10 percent triclopyr in water or oil or 2 percent glyphosate are effective (Florida Exotic Pest Plant Council 2011 as cited in CABI 2014).

3.3.3.33 Puncture vine (*Tribulus terrestris*)

Management Priority: 3

Puncture vine is generally considered to be a native of tropical America and now occurs in many tropical and temperate regions (CABI 2014). It is a weed of coastal areas of the United States from Texas to Georgia, and in Hawaii, Mauritius and Madagascar. Puncture vine is commonly found as a weed on sandy soils along coasts and also open places inland. It is found on roadsides, recreational areas and agricultural land. It reproduces by seed. The plant begins to flower and set seeds while only a few inches tall, continuing to do so throughout the year. It is known to flower from spring to fall in the sub-tropics and all year round in the tropics. Flowers open just after sunrise and close at sunset, lasting about two days. The plant's rapid growth allows it to form sizable radial patches very quickly (Holm et al., 1977 in CABI 2014). The

spiny fruits of the puncture vine are well equipped for dispersal from field to field by attaching to wildlife. They are also dispersed on human clothes and footwear. The large and small spines on the fruit are arranged at different angles so that, no matter how the seed falls, one of the spines always points upward for attachment. The spiny fruits can be transported over some considerable distances because they are readily attached to the tires of farm and mowing equipment (CABI 2014).

Biological: The main natural enemy of puncture vine is the weevil *Microlarinus lypriformis* which has been a successful biocontrol agent in a number of countries. The related *M. lareynii* has also been effective (CABI 2014). The control by *M. lypriformis* in Hawai`i has been particularly successful since its introduction in 1963; it destroyed all growth of puncture vine on the island of Kaua`i within 1 year (CABI 2014).

Cultural: Puncturevine spreads by seed, so controlling plants prior to seed production will prevent further seed entering the seedbank. When working in puncturevine infestations, make sure to clean shoes, clothing and tires to prevent spreading seeds to other areas. After puncturevine control, plant areas with site appropriate plants to provide competition and reduce further puncturevine invasion.

Mechanical: Control of puncture vine is difficult due to the long seed life and drought tolerance. Shallow cultivation to sever the taproot is effective in controlling large plants, but it might stimulate the germination of seed (Newbould 1998 as cited in CABI 2014). Puncturevine can be hand-pulled or controlled by hoeing. Hand removal, hoeing, or cultivation should be initiated prior to flowering and seed production. Mowing is not an effective method of control since the plant grows low to the ground.

Chemical: Apply 2,4-D, glyphosate, dicamba, chlorsulfuron or imazapic to young, actively growing plants. Ametryn is the most widely used herbicide for puncture vine in Australia; it is non-selective, but can be used with care. A mixture of amitrole-T and 2,4-D can be used for non-selective control. Picloram, glyphosate, linuron, 2,4-D and chlorsulfuron are also effective, and a wide range of herbicides are available for controlling puncture vine in specific crops or situations. All herbicides are more effective on seedlings than on mature plants (Parsons and Cuthbertson 1992 as cited in CABI 2014). Imazethapyr and imazaquin give almost complete control when applied pre-emergence or early post-emergence to puncture vine (Johnson and Talbert 1993 cited in CABI 2014).

3.3.3.34 Coatbuttons (*Tridax procumbens*)

Management Priority: 3

Coatbuttons is a perennial herb native to Central America (Holm et al. 1997 as cited in CABI 2014). It establishes readily in disturbed and open areas and prefers coarse soils (Holm et al. 1977 as cited in PIER 2013; Wagner et al. 1999 as cited in PIER 2013). It is most problematic as an agricultural weed and reproduces via prolific seed development (Holm et al. 1977 as cited in PIER 2013).

Biological: There are no biological control agents available for coatbuttons.

Cultural: Cultivation of more desirable species is an effective control measure for coatbuttons (Adams and Baker 1962 as cited in CABI 2014; Ivens 1989 as cited in CABI 2014).

Mechanical: Manual removal and tilling are effective for coatbuttons (Adams and Baker 1962 as cited in CABI 2014; Ivens 1989 as cited in CABI 2014).

Chemical: Coatbuttons can be controlled using ametryne, atrazine, diuron, 2,4-D (Terry 1983 as cited in CABI 2014), oxyfluorfen (Prasad et al. 1987 as cited in CABI 2014), Avirosan, oxadiazon, (Vernier 1985 as cited in CABI 2014); metobromuron + metolachlor (Olifintoye and Adesiyun 1989 as cited in CABI 2014), bromacil (Jayachandra 1972 as cited in CABI 2014), and MCPA (Ivens 1989 as cited in CABI 2014).

3.4 INVASIVE AND NONNATIVE ANIMALS ON WAKE ATOLL

3.4.1 Methods

The primary sources of information for the development of the invasive, nonnative, and nuisance animal management plan were reports of previously conducted field surveys and other documents providing information about the diversity and distribution of invasive, nonnative, and nuisance animals recorded on Wake Atoll. In addition, an ocular survey for such animal species was conducted in conjunction with the invasive and nonnative plant survey.

3.4.2 Results

Table 3-3 provides a summary of the invasive, nonnative, and nuisance animal species on Wake Atoll. The table provides species that are known to occur on Wake Atoll and species observed during the survey.

Table 3-3. Invasive, Nonnative and Nuisance Animal Summary for Wake Atoll

Scientific Name	Common Name	Observed During the Survey	Previously Observed on Wake Atoll
Achatina fulica	African snail	X	X
Anolis carolinensis	Green anole		X
Anoplolepis gracilipes	Yellow crazy ant		X
Boiga irregularis	Brown tree snake		X
Linepithema humile	Argentine ant		X
Paratrechina spp.	NA	X	X
Pheidole megacephala	Bigheaded ant	X	X
Rattus exulans	Polynesian rat	X	X
Solenopsis geminata	Tropical fire ant		X

3.4.3 Management Plan for Primary Invasive, Nonnative, and Nuisance Animal Species

A brief description of each of the primary invasive, nonnative, and nuisance animal species, followed by possible and proposed management techniques, is provided below.

3.4.3.1 African snail (*Achatina fulica*)

Management Priority: 3

The African snail is a nocturnal land snail native to coastal eastern Africa with a reddish brown, narrow, conical shell. Adults may have shells over 8 in. in length, but shells of 2-4 in are more common (CABI 2014; Cooling 2005 as cited in GISD 2010). It is adapted to warm, humid tropical climates and is often found in disturbed areas or edge habitats such as forest edges or plantations (Raut and Barker 2002 as cited in GISD 2010; Venette and Larson 2004 as cited in GISD 2010). Populations of African snails are naturally volatile and thus their response to control efforts may not be immediately apparent (GISD 2010). The natural volatility of African snail populations sometimes rationalizes a lack of management actions against the snail (Simberloff & Gibbons 2004 as cited in GISD 2010). The snail is mainly an agricultural pest, feeding on the leaves, stems, flowers, and fruits of many economically important crops. They can affect native gastropod populations through competition and alternative plant communities through herbivory (Raut and Barker 2002 as cited in GISD 2010). It is spread to new locations mainly through human travel and commerce, especially the trade of horticultural and agricultural goods that may harbor small snails or snail eggs (Thiengo et al. 2007 as cited in GISD 2010).

Distinct African snail infestations were observed on Peale Island and Wake Island in 1998 (USDOI 1999 as cited in USAF 2011). Live African snails and empty shells are often found in densely forested casuarina (*Casuarina equisetifolia*) areas with heavy litter accumulations, or in dense stands of cotton plants (*Gossypium hirsutum*). It is prey for the Guam rail, which some have suggested introducing to Wake Island (Birdlife International 2008 as cited in USAF 2011; USAF 2007 as cited in USAF 2011). *A. fulica* poses a serious threat to endemic plant and animal species in Hawai`i (USAF 2007).

Biological: There are no biological control agents available for the African snail. The rosy wolfsnail (*Euglandina rosea*) has been introduced in many areas to control the African snail, but these programs have not been successful and the rosy wolfsnail has had negative effects on the ecosystems into which it was introduced (GISD 2010).

Cultural: Preventing the spread of African snails involves increased vigilance and inspection by humans involved with commerce, given that their main method of invasion in new locations is through human movement of plants, soils, and other materials (Thiengo et al. 2007 as cited in GISD 2010).

Mechanical: Manual collection and destruction of African snails and their eggs through drowning or crushing is effective (CABI 2014). Fences of corrugated tin or wire mesh may also keep the snail out of enclosed areas, as will ditches or 5 ft. strips of bare soil (CABI 2014; GISD 2010).

Chemical: Dehydrating chemicals such as sodium chloride (table salt), calcium arsenate, and metaldehyde can kill African snails through dehydration, but are not selective and may harm non-target mollusks and other species (Prasad et al. 2004 as cited in GISD 2010). Thus chemical control of African snails is usually not recommended (CABI 2014). Naturally occurring chemicals such as extract from the fruit of *Thevetia peruviana* and the wood of alligator apple (*Annona glabra*) may also act as repellents for African snails (Prasad et al. 2004 as cited in GISD 2010; Panigrahi and Raut 1994 in Raut & Barker 2002 as cited in GISD 2010).

3.4.3.2 Green anole (*Anolis carolinensis*)

Management Priority: 3

The green anole is an arboreal lizard native to the Southeastern United States that grows to 5-8 in. snout-vent length, measured from snout to base of tail) (Muensch et al. 2006 as cited in GISD 2010; Savannah River Ecology Laboratory Undated). It lives in disturbed and undisturbed forest habitats and has also been observed in wetland areas (Wiles & Guerrero 1996 and Mount 1975 in Gates and Gates 2006 as cited in GISD 2010). It feeds on insects and has had a significant effect on native insect populations on the Ogasawara Islands of Japan where it has eliminated multiple species including important pollinators (Abe et al. 2008 as cited in GISD 2010). It is most frequently introduced unintentionally to new locations through human activities and commerce (Karube and Suda 2004 in Abe et al. 2008 as cited in GISD 2010).

A Thai worker reported seeing a green anole during a May 2008 TEC Inc. site visit. This was the first report of the species on Wake Atoll. The green anole eats insects, and most insects on Wake Atoll are introduced. None of the native wildlife on Wake Atoll eat insects, so the presence of this lizard may not be of great ecological concern. However, establishment of all introduced species should be prevented given the possibility of unforeseen consequences (USAF 2011).

Biological: There are no biological control agents available for the green anole.

Cultural: Preventing the spread of the green anole involves increased vigilance and inspection by humans regarding commerce, given that the lizard's main method of invading new locations is through human activities and commerce (Karube and Suda 2004 in Abe et al. 2008 as cited in GISD 2010).

Mechanical: Steel mesh fences with tephlon coverings inhibit the movement of the green anole, and adhesive traps placed on tree trunks are effective in capturing the lizards (Toda et al. 2010 as cited in GISD 2010).

Chemical: Consumer reptile sprays have been tested against the green anole, but these are not recommended as they may have negative environmental impacts (Toda et al. 2010 as cited in GISD 2010).

3.4.3.3 Yellow crazy ant (*Anoplolepis gracilipes*)

Management Priority: 3

The yellow crazy ant is a 3/64- to 13/64-in. long ant believed to be native to Africa or Asia. It is identifiable by its very long legs and antennae and is yellow-brown in color (Holway et al. 2002 as cited in GISD 2009). They are omnivorous scavengers and will eat invertebrates, arthropods, seeds, grains, and decaying plant matter, among other things (Holway et al. 2002 as cited in GISD 2009; Ness and Bronstein 2004 as cited in GISD 2009; Haines et al. 1994 in O'Dowd et al. 1999 as cited in GISD 2009). They can kill invertebrate or small vertebrate prey by spraying formic acid (GISD 2009). They rely heavily on food sources that provide protein and also on carbohydrates found in the honeydew produced by certain homopteran species (Holway et al. 2002 as cited in GISD 2009). The yellow crazy ant frequently inhabit disturbed environments and are commonly associated with human habitations, but have also been known to invade previously undisturbed habitats (CBD 2003 as cited in GISD 2009; Ness and Bronstein 2004 as cited in GISD 2009; O'Dowd et al. 1999 as cited in GISD 2009). They are a threat to native ecosystems because they compete with and displace native ant species and can devastate populations of other native animals (O'Dowd et al. 1999). For example, the yellow crazy ant has drastically reduced populations of the red land crab (*Gecarcoidea natalis*) which plays a vital role in nutrient cycling on Christmas Island, and has decreased the population of sooty terns (*Sterna fuscat*) on Bird Island in the Seychelles (CBD 2003; Feare 1999, in CBD 2003). The ant can also devastate agricultural crops and facilitate the establishment of other invasive species (Holway et al. 2002 as cited in CABI 2014; Ness and Bronstein 2004 as cited in CABI 2014; McGlynn 1999 as cited in CABI 2014). The yellow crazy ant is most commonly introduced via human activities such as commerce (Haines et al. 1994 as cited in CABI 2014).

Currently, management of ant species is dependent upon funding. When funding is available, attempts will be made to treat ants to control their expansion (USAF 2011).

Biological: Though there are currently no biological control agents available for *A. gracilipes*, research is being done on the potential use of pheromones, compounds that the ants produce and

use for communication, in disrupting reproduction by the queen (CBD 2003 as cited in ISSG Undated).

Cultural: Preventing the spread of the yellow crazy ant involves increased vigilance and inspection by humans regarding commerce, given that the ant's main method of invading new locations is through human movement of soils and other materials (Haines et al. 1994 as cited in CABI 2014).

Mechanical: There are no mechanical control measures available for this species.

Chemical: The stomach poisons Maxforce and Amdro (hydramethylnon), sulfuramid, and Borax (sodium tetraborate decahydrate) may be used to control the yellow crazy ant (GISD 2009). Presto (fipronil) and Xtinguish (fipronil) are also effective (ISSG Undated).

3.4.3.4 Brown tree snake (*Boiga irregularis*)

Management Priority: 0

The brown tree snake is a climbing snake native to eastern Indonesia, coastal areas of northern and eastern Australia, the Solomon Islands, and New Guinea (Fritts and Rodda 1998, Rodda et al. 1992, and Savidge 1987 in Mortensen et al. 2008 as cited in GISD 2009). They can reach 10 ft. in length, but are more commonly 3-6 ft. They are mildly venomous but have small fangs and are generally not dangerous to adults (USDA-APHIS 2001 as cited in GISD 2009). The snake is common in human-disturbed habitats and forests and forages on the ground at night, often hiding during the day in trees (especially *Pandanus* trees), caves, rock crevices, and sometimes dark corners of the roofs of human-built structures (Fritts and Leasman-Tanner 2001 as cited in GISD 2009; Hetherington et al. 2008 as cited in GISD 2009). They are generalist carnivores that eat reptiles, amphibians, small mammals, birds, and bird eggs and even scavenge through human garbage when wild food sources are scarce (Fritts and Leasman-Tanner 2001 as cited in GISD 2009). The brown tree snake can be unintentionally introduced to new areas through human activities and commerce (Perry et al. 1998 as cited in GISD 2009; Rodda et al. 1992 as cited in GISD 2009). Where introduced they have the potential to decimate populations of their prey items, as well as indirectly affecting plant populations through predation on pollinators (GISD 2009). Since its introduction on Guam shortly after World War II, the brown tree snake has caused the extinction of two of three native bat species and half of the indigenous bird and reptile species (Rodda & Fritts 1992 as cited in GISD 2009; Savidge 1987 as cited in GISD 2009; USDA 2011).

The brown tree snake was reportedly seen in March 1949 on Wake Island, but there have been no further reports (USAF 2007 as cited in USAF 2011). However, it has reached high densities on Guam and management measures are in place to prevent its introduction to Wake Island via cargo from Guam. Current control strategies in place on Guam include the use of snake traps, barriers, prey control, hand capture, oral toxicants, canine inspections of outbound cargo, education of port staff and DOD personnel regarding brown tree snake sightings, monitoring of these programs to evaluate effectiveness, and propositions for change where these methods are

not effective (USDA 2011). Aircraft and ships destined for Wake Island from Guam must provide proof of canine inspection for brown tree snakes prior to arrival at Wake (Defense Transportation Regualtion 2013).

Biological: There are no approved biological control agents available for the brown tree snake (GISD 2009).

Cultural: Preventing the spread of the brown tree snake involves increased vigilance and inspection by humans regarding commerce, given that the snake's main method of invading new locations is through human activities and commerce. The snakes hide in cool, dark places during the day, can live for months without eating, and may be found on ships and aircraft, making their unintentional introduction to new environments relatively easy (Perry et al. 1998 as cited in GISD 2009; Rodda et al. 1992 as cited in GISD 2009).

Mechanical: Snake traps using live mice as bait are the most commonly used capture technique for the brown tree snake on Guam (Gragg et al. 2007 as cited in GISD 2009). Placing barriers around areas to exclude snakes is also effective (Rodda et al. 1998 as cited in GISD 2009; Perry et al. 2004 as cited in GISD 2009).

Chemical: Toxic baits can kill brown tree snakes. In Guam, acetaminophen tablets inserted into dead mice are used to kill brown tree snakes (Avery et al. 2004 as cited in GISD 2009; Savarie et al. 2005 as cited in GISD 2009; Westbrook and Ramos 2005 as cited in GISD 2009).

3.4.3.5 Argentine ant (*Linepithema humile*, synonym *Iridomyrmex humilis*)

Management Priority: 3

The Argentine ant is a 5/64 to 1/8 in long ant native to subtropical South America (Newell and Barber 1913 as cited in CABI 2014; Suarez et al. 2001 as cited in CABI 2014; Tsutsui and Suarez 2003 as cited in CABI 2014; Wild 2004 as cited in CABI 2014). It has spread to Mediterranean climates throughout the world via human activities and commerce. Populations of the Argentine ant are uniclonal, meaning that the colonies are highly genetically related and will work together to gather food and protect the colony, which makes them highly successful invaders. They are well adapted to a variety of environmental conditions and are often associated with human habitation and disturbed habitats (CABI 2014). They are generalist omnivores that feed mainly on insects, nectar, and honeydew produced by hemipterans, which they tend (Abril et al. 2007 as cited in CABI 2014; Markin 1970 as cited in CABI 2014; Ness and Bronstein 2004 as cited in CABI 2014). Established populations of the ant can out-compete native ant populations and devastate native arthropods through competition and predation (Cole et al. 1992 as cited in CABI 2014; Bolger et al. 2000 as cited in CABI 2014).

Currently, management of ant species is dependent upon funding. When funding is available, attempts will be made to treat ants to control their expansion (USAF 2011).

Biological: There are no biological control agents available for the Argentine ant. However, it has been suggested that interrupting the uniclonality of its populations by introducing genetically diverse males or altering the chemicals used for intracolony recognition could give some control over introduced populations by increasing intracolony competition (Silverman and Liang 2001 as cited in CABI 2014; Suarez et al. 1999 as cited in CABI 2014).

Cultural: Preventing the spread of the Argentine ant involves increased vigilance and inspection by humans involved with commerce, given that their main method of invasion in new locations is through human movement of soils and other materials. Argentine ant infestations in or near human habitations can be prevented by eliminating food and water sources that might attract the ants and by repairing cracks in walls through which they might enter (CABI 2014; Soeprono and Rust 2004 as cited in CABI 2014).

Mechanical: The application of powder barriers or repellent or sticky bands on trees and vines can aid in the control of Argentine ants, but will not eradicate an infestation (Phillips et al. 1987 as cited in CABI 2014; Rust and Knight 1990 as cited in CABI 2014; Shorey et al. 1992, 1996 as cited in CABI 2014).

Chemical: Insecticidal baits are effective against Argentine ant infestations (Forschler 1997 as cited in CABI 2014; Vega and Rust 2003 as cited in CABI 2014). Insecticidal barriers may also be applied around the bases of plants, structures, or other areas frequented by Argentine ants (Rust 2001 as cited in CABI 2014). However, these insecticides only kill ants that come into direct contact with the barriers and thus do not have an effect on the reproductive capacity of the colony (Soeprono and Rust 2004 as cited in CABI 2014).

3.4.3.6 *Paratrechina* sp.

Management Priority: 3

Paratrechina ants are native to Africa and Asia (Nickerson and Barbara 2000 as cited in GISD 2010). They are 5/64 to 1/8 in. long and identifiable by their erratic and irregular rapid movements. They are highly adaptable and occur in a wide variety of environments, but are often found in disturbed areas associated with human habitation or activities. They may forage far from their nests, making nests difficult to find (GISD 2010). *Paratrechina* ants are known to carry pathogens in hospitals and to displace native ant species and other invertebrates (Harris et al. 2005 as cited in GISD 2010; Nickerson and Barbara 2000 as cited in GISD 2010). The dispersal of these ants to non-native locations is commonly mediated by human commerce (Miller 1994 as cited in GISD 2010; O'Connor pers. comm. as cited in GISD 2010). They are omnivorous opportunistic feeders and will eat seeds, live and dead insects, fruit, honeydew, plant exudates and household foods. Large groups of *Paratrechina* ants may work together to carry larger food items, such as lizards (Harris et al. 2005 as cited in GISD 2010; Nickerson and Barbara 2000 as cited in GISD 2010).

The *Paratrechina* species on Wake Atoll is most likely *P. longicornis* as the only other species in the genus, *P. zanjenensis*, seems to be highly specialized to its native habitat in the miombo woodlands of Africa (LaPolla 2013).

Currently, management of ant species is dependent upon funding. When funding is available, attempts will be made to treat ants to control their expansion (USAF 2011).

Biological: No biological control agents are available for *Paratrechina*.

Cultural: Preventing the spread of *Paratrechina* involves increased vigilance and inspection by humans involved with commerce, given that their main method of invasion in new locations is through human movement of soils and other materials (Miller 1994 as cited in GISD 2010). *P. longicornis* infestations in, or near human habitations can be prevented by eliminating food sources that might attract the ants and by repairing cracks in walls through which they might enter (Nickerson and Barbara 2000 as cited in GISD 2010).

Mechanical: No mechanical control measures are available for *Paratrechina*.

Chemical: The ant neurotoxin Xtinguish (fipronil) has been effective in controlling *Paratrechina longicornis*. Exterm-An-Ant attracts workers, but it is not known whether the bait has any effect on queens once brought back to the nest (Harris et al. 2005 as cited in ISSG Undated). Insecticidal baits do not work well on *P. longicornis* as the ants do not feed long enough on the baits for them to be effective (Stanley 2004 as cited in ISSG Undated; Stanley and Robinson 2007 as cited in ISSG Undated).

3.4.3.7 Bigheaded ant (*Pheidole megacephala*)

Management Priority: 3

The big headed ant is an ant native to southern Africa that is 5/64 to 5/32 in. long and ranges from pale yellow to dark brown in color. The body is covered sparsely with long hairs. It occurs in a wide variety of environments ranging from forests to grasslands and agricultural areas to wetlands. It displaces native ant species, decreases biodiversity of other invertebrates through direct aggression, and is also known to facilitate the establishment of introduced plant species. It is most often introduced accidentally by pathways involved with human commerce (e.g., by vehicles or cargo ships that unknowingly carry the ant to new locations). It is an omnivorous scavenger and will kill and eat invertebrates and small vertebrates. It also eats seeds and tends phytophagous insects, and is known to chew on electrical wires, telephone cables, and irrigation pipes (GISD 2011).

Currently, management of ant species is dependent upon funding. When funding is available, attempts will be made to treat ants to control their expansion (USAF 2011).

Biological: There are no biological control agents available for this species.

Cultural: Preventing the spread of the big headed ant involves increased vigilance and inspection by humans involved with commerce, given that their main method of invasion in new locations is through human movement of soils and other materials (GISD 2011).

Mechanical: Fire may be an effective method of control for this ant species as it may destroy their nests and create a more favorable environment for native ant species (GISD 2011).

Chemical: Chemical control can be achieved by applying the insecticidal bait Amdro (hydramethylnon) to the entire infested area (McEwen et al. 1979 as cited in CABI 2014; Horwood 1988 as cited in CABI 2014; Reimer and Beardsley 1990 as cited in CABI 2014; Reimer et al. 1991 as cited in CABI 2014; Hara and Hata 1992 as cited in CABI 2014; Petty and Manicom 1995 as cited in CABI 2014). Insect growth regulators such as fenoxycarb, methoprene, and pyriproxyfen and the stomach toxicant hydramethylnon may also be used (GISD 2011). The frequency with which these chemicals must be used to obtain control of the big headed ant may render the cost prohibitive, in which case less expensive sticky barriers may be effective (Samways 1985 as cited in CABI 2014; Murray 1982 as cited in CABI 2014).

3.4.3.8 Polynesian rat (*Rattus exulans*)

Management Priority: 0

The Polynesian rat is a reddish- or grey-brown rat native to Southeast Asia that is about 4.5-6 in. from nose to the base of the tail (CABI 2014; GISD 2010). It is highly associated with human habitation and is a generalist feeder, eating fruits, grains, insects, seeds, snails, and human food scraps (Strecker and Jackson 1962 as cited in CABI 2014). It affects native wildlife directly through predation and indirectly through competition for food. It can be particularly damaging to ground-nesting bird populations as it will eat eggs and hatchlings (CABI 2014). They can also damage tools and equipment by chewing. Rats are often transported unintentionally to new environments through human activity and commerce (National Animal Pest Alert 2011 as cited in CABI 2014). These rats breed year round and can reproduce rapidly; thus complete eradication is the best long-term management approach when the species is invasive (CABI 2014).

The Polynesian rat was targeted for eradication in May 2012. However, they are still seen on the Atoll and their numbers are increasing. Thus follow-up eradication efforts are ongoing according to the original eradication plan.

Biological: Current research is focusing on developing oral contraceptive methods to control the Polynesian rat (GISD 2010).

Cultural: As this species is primarily transported to new locations through human transportation, increased vigilance and inspection by humans regarding travel and commerce is an important management action for the Polynesian rat.

Mechanical: Snap traps are effective in catching the Polynesian rat (GISD 2010).

Chemical: Many eradication efforts have used anticoagulant poisons such as bromadialone and brodifacoum to control rats. Talon 20 P baits, which are pellets containing brodifacoum at 20 ppm, have been aerially sown at 15 kilogram perhectare at an approximate cost of United States dollars ($75 per hectare) in recent successful eradications (Atkinson and Towns 2001 as cited in GISD 2010). However, this compound can persist in non-target wildlife, and precautions should be taken to reduce effects on non-target species (GISD 2010).

3.4.3.9 Tropical fire ant (*Solenopsis geminata*)

Management Priority: 2

The tropical fire ant is an orange-brown colored ant native to tropical America that is from 1/8 to 13/64 in. long (Holway et al. 2002 as cited in GISD 2010). It has spread to warm climates throughout the world via human commerce (GISD 2010). It is capable of invading a wide range of environments, but more readily establishes in disturbed areas. It has also been associated with human habitation (McGlynn 1999 as cited in GISD 2010; Holway et al. 2002 as cited in GISD 2010; Ness and Bronstein 2004 as cited in GISD 2010). The ants are generalist omnivores and feed on grains, seeds, invertebrates, arthropods, and small vertebrates which they can kill with a venomous sting. They prefer protein-rich foods but will also eat foods that are high in carbohydrates and fats and tend homopteran species that produce honeydew (Holway et al. 2002 as cited in GISD 2010; Ness and Bronstein 2004 as cited in GISD 2010). Tropical fire ant populations can be multiclonal, in which case each nest has its own queen which workers defend, or uniclonal, in which case multiple nests with multiple queens are highly genetically related and work together to gather food. Uniclonal ant populations can invade new habitats and reach high densities much more rapidly than multiclonal populations (Ness and Bronstein 2004 as cited in GISD 2010; McGlynn 1999 as cited in GISD 2010). In large numbers these ants can displace native ant species and have deleterious effects on other species such as butterflies (McGlynn 1999 as cited in GISD 2010). They have also been known to chew through plastic and ruin irrigation tubing (GISD 2010).

Currently, management of ant species is dependent upon funding. When funding is available, attempts will be made to treat ants to control their expansion (USAF 2011).

Biological: There are no biological control agents available for the tropical fire ant (ISSG Undated).

Cultural: Preventing the spread of the tropical fire ant involves increased vigilance and inspection by humans involved with commerce and tourism, given that their main method of invasion in new locations is through the movements of humans and materials (Hoffmann and O'Connor 2004 as cited in GISD 2010).

Mechanical: There are no mechanical control methods available for the tropical fire ant (ISSG Undated).

Chemical: Baits with fenoxycarb or aminohydrozone have been specially developed for fire ants. Soil drenches containing bendiocarb, acephate, carbaryl, chlorpyrifos, and diazinon can be sprayed on and in nests. Multiple treatments may be necessary to ensure control (ISSG Undated).

4. KŌKE`E AFS INVASIVE AND NONNATIVE SPECIES

Sections 3.1.1 through 3.1.5 of this BCSMP provide discussions of general invasive and nonnative species management methods, biological management, cultural management, mechanical management, chemical management, general management philosophy, and primary herbicides described for management for Kōke`e AFS. Management of each invasive or nonnative species has been assigned a priority (indicated in each species' profile) based on the following scale:

- *0 – Mission Critical*. Control of the species is immediately necessary as it is a direct impediment to the military mission.

- *1 – High Priority*. Control of the species should be undertaken in accordance with DOD Policy or Instruction; Air Force Policy or Instruction; or Federal Regulation, Policy, Act or other regulatory driver or agreement that requires control or removal of the species, such as a Biological Opinion issued by the USFWS or National Oceanic and Atmospheric Administration.

- *2 – Medium Priority*. The species should be monitored and management measures should be undertaken to maintain the current status of the species.

- *3 – Low Priority*. Management of the species would have positive consequences for military readiness and native ecosystems but is not immediately practical or necessary.

Overall management priority for each of the invasive and nonnative species is provided with the descriptions and possible and proposed management methods discussions in Section 4.2.3.

4.1 CURRENT PREVENTION AND MANAGEMENT MEASURES FOR INVASIVE AND NONNATIVE SPECIES

All vegetation within the fence that surrounds Kōke`e AFS is mowed, as is an approximate 6-ft. tract around the outside of the fence. This includes invasive grasses and other plant species. Exceptions include a few ornamental or cultivated species near buildings. Kōke`e MAS (HMU-3) consists of three buildings and an antenna, each individually fenced such that vegetation within the fence is minimal. Vegetation at Kōke`e MAS is not managed.

The only invasive animals that frequent Kōke`e AFS are rats (*Rattus* spp.) and feral cats (*Felis domesticus*) (USFWS 2010). Rats are controlled via poison baits when necessary in cooperation with the Hawai`i Department of DLNR and with technical assistance from the APHIS-Animal Damage Control (ADC) of the USDA (USAF 2007). Kōke`e AFS has a policy for trapping and removing feral cats, depending on availability of funding, and a policy for not feeding feral cats. Garbage cans are secured to exclude feral cats and rats. Feral pigs and goats exist in the forest surrounding the site; these are excluded from the AFS by fencing and are controlled by hunting (USFWS 2010).

4.2 INVASIVE AND NONNATIVE PLANTS AT KŌKE`E AFS

4.2.1 Methods

Vegetation surveys were conducted at Kōke`e AFS and Kōke`e MAS from 13 to 15 November 2013. The site was delineated into three HMUs in order to delineate areas within which various natural resources management actions should occur (**Figure 2-7**). HMU-1 includes land inside the site fence. HMU-2 includes land surrounding the fence. HMU-3 includes the Kōke`e MAS. **Figure 2-8** depicts the vegetation map overlaid with the location of each HMU. A description of the topography and dominant vegetation for the sites is described in Section 2.2.6of this BCSMP.

4.2.2 Results

There were 23 species of invasive and nonnative plants observed during the 13-15 November 2013 site visits. **Table 4-1** provides the invasive and nonnative species observed during the site visits. The table indicates species that are on the Federal Noxious Weed List, the Hawai`i Noxious Weed List, and the Hawai`i DLNR Invasive Plants list. **Table 4-1** also indicates whether the plant was observed at Kōke`e AFS or Kōke`e MAS. Invasive and nonnative species that have been observed at Kōke`e AFS in the past, but were not observed during the survey are included for reference, as are species that occur just outside the fence at the site. The names of the species observed and suggested management actions in each HMU are provided in **Table 4-2**.

Table 4-1. Invasive and Nonnative Plants Observed at Kōke`e Air Force Station

Scientific Name	Common Name	Federal Noxious Weed[1]	HI Noxious Weed[2]	HI DLNR[3] Invasive Plant	Observed at Kōke`e AFS	Observed at Kōke`e MAS
Cuphea carthagenensis	Tar weed				X	
Erigeron karvinskianus	Daisy fleabane				X	
Fragaria vesca	Woodland strawberry				X	
Hedychium flavescens	Yellow ginger				X	
Hedychium gardnerianum	Kahili ginger				X	
Holcus lanatus	Velvet grass				X	
Kalanchoe pinnata	Cathedral bells				X	
Lantana camara	Lantana					X
Melinis minutiflora	Molassesgrass					X
Mimosa pudica	Sensitive plant					X
Morella faya	Firetree		X	X	X	
Paspalum urvillei	Vasey's grass				X	
Passiflora tarminiana	Banana poka		X		X	
Pennisetum clandestinum	Kikuyugrass	X			X	X

Table 4-1. Invasive and Nonnative Plants Observed at Kōke`e Air Force Station

Scientific Name	Common Name	Federal Noxious Weed[1]	HI Noxious Weed[2]	HI DLNR[3] Invasive Plant	Observed at Kōke`e AFS	Observed at Kōke`e MAS
Plantago lanceolata	Narrowleaf plantain				X	X
Psidium cattleianum	Strawberry guava					X
Rubus argutus	Sawtooth blackberry		X		X	
Sechium edule	Chayote				X	
Setaria palmifolia	Palm grass				X	
Sporobolus indicus var. capensis	African dropseed				X	
Syzygium cumini	Java plum					X
Zantedeschia aethiopica	Calla lily				X	
Holcus lanatus	Velvet grass					X

1. USDA-APHIS 2012.
2. Division of Plant Industry 2003.
3. DLNR.

Table 4-2. Invasive and Nonnative Management Actions by HMU at Kōke`e AFS

HMU	Invasive Vegetation Species	Approximate Percent Cover	Management Action	Approximate Labor Hours	Approximate Cost	Priority
HMU-1	*Pennisetum clandestinum*	20% (intermixed in mowed turf)	Regular mowing	4 hours mowing (every 2 weeks)	Mech Labor (per 2 weeks): $80.00 Total: $80.00	2
HMU-2	*Passiflora tarminiana*	<1% (adjacent to fence cut)	Manual removal	2 hours for manual removal	Mech Labor: $40.00 Total: $40.00	2
	Pennisetum clandestinum	10%	Foliar application of 5% glyphosate in area near southwest corner of the perimeter fence Regular mowing around perimeter fence	2 hours for chemical treatment 2 hours mowing (every 2 weeks)	Chem Labor: $40.00 Chemical: $38.00 Mech Labor (per 2 weeks): $40.00 Total: $118.00	2
	Hedychium flavescens	2% (along fence cut intermixed with *Hedychium gardnerianum*)	Manual removal	4 hours for manual removal	Mech Labor: $80.00 Total: $80.00	1
	Hedychium gardnerianum	2% (along fence cut intermixed with *Hedychium flavescens*)	Manual removal	4 hours for manual removal	Mech Labor: $80.00 Total: $80.00	1
	Rubus argutus	1% (along fence cut)	Foliar application of 5% glyphosate with a wicker For monocultures apply a foliar application with a coarse droplet to minimize any overspray.	1 hour for chemical treatment	Chem Labor: $20.00 Chemical: $38.00 Total: $58.00	2
HMU-3	*Lantana camara*	2%	Manual removal	2 hours for manual removal	Mech Labor: $40.00 Total: $40.00	2
	Pennisetum clandestinum	2% (around structures)	Foliar application of 5% glyphosate	1 hour for chemical treatment	Chem Labor: $40.00 Chemical: $38.00 Total: $78.00	2
	Psidium cattleianum	<1%	Hack and squirt application of 5% glyphosate	1 hour for chemical treatment	Chem Labor: $40.00 Chemical: $38.00 Total: $78.00	2

4.2.3 Management Plan for Invasive and Nonnative Plants

This section provides descriptions and possible and proposed management methods for primary invasive and nonnative plant species. General management methods for invasive species are described in Sections 3.1.1 through 3.1.5 of this BCSMP, though some species profiles may contain additional species-specific management information. Where no new management actions are proposed, current management methods (i.e., mowing) should continue, or management may follow the options listed in each plant profile. Species are listed in alphabetical order by scientific name.

4.2.3.1 Tar weed (*Cuphea carthagenensis*)

Management Priority: 3

C. carthagenensis is an herb native to tropical America that is naturalized in Hawai`i in open disturbed sites. It prefers wetter conditions and reproduces by seed (Wagner et al. 1999 as cited in PIER 2013).

No information on management of *C. cathagenensis* is available in the literature. If the species is observed, please refer to the "other species" profile for management suggestions.

4.2.3.2 Daisy fleabane (*Erigeron karvinskianus*)

Management Priority: 3

Daisy fleabane is an herb native to the neotropics that is naturalized in Hawai`i in wet disturbed areas (Wagner et al. 1999 as cited in PIER 2013). It is often cultivated as an ornamental and spreads to the natural ecosystem (GISD 2008). It tolerates a wide variety of environmental conditions and grows in dense mats which displace native vegetation and inhibit regeneration of native species. It reproduces via seeds that are wind dispersed and flowers year round except during the colder months in temperate regions (Hind 2012 as cited in CABI 2013; New Zealand's Biosecurity System 2008 as cited in CABI 2013).

Biological: There are no known biological controls for daisy fleabane.

Cultural: As this species is often introduced as a cultivated ornamental, control or monitoring of its cultivation may be an important measure for preventing its further spread as an invasive (CABI 2013).

Mechanical: Small patches may be manually dug up, but care must be taken to remove all roots and seeds (Weedbusters 2012 as cited in CABI 2013).

Chemical: Daisy fleabane can be controlled by spraying hormone-type herbicides such as dicamba, 2,4-D, and triclopyr and is also sensitive to plyphosate and metsulfuron (Weedbusters

2012 as cited in CABI 2013; Motooka et al. 2003). Hexazinone and tebuthiuron applied to the soil are also effective (Motooka et al. 2002).

4.2.3.3 Woodland strawberry (*Fragaria vesca*)

Management Priority: 3

Woodland strawberry is a perennial herb native to Eurasia and North America that is often cultivated for its fruit (Wagner et al. 1999 as cited in PIER 2013). It tolerates a wide variety of environmental conditions and was introduced in Hawai`i in 1829 (Stone et al. 1992 as cited in CABI 2013). It reproduces sexually via seeds that are dispersed by birds and mammals that eat its red fruit as well as vegetatively via runners (Hollender et al. 2012 as cited in CABI 2013; GISD 2008). It establishes easily in disturbed and open areas and grows in dense patches, but does not seem to dominate native vegetation in Hawai`i (CABI 2013).

Biological: No biological control agents are available or approved for woodland strawberry (CABI 2013).

Cultural: Because woodland strawberry often spreads to the native environment after escaping cultivation, managing its cultivation could be an important step in managing it as an invasive species (CABI 2013).

Mechanical: No mechanical control measures are available for woodland strawberry (CABI 2013). There is conflicting information regarding the effects of heavy grazing on woodland strawberry (Munger 2006).

Chemical: Some studies suggest that woodland strawberry is resistant to picloram, clopyralid, and glyphosate (Biring et al. 1999 as cited in Munger 2006; Rice and Toney 1996 as cited in Munger 2006).

4.2.3.4 Yellow ginger (*Hedychium flavescens*)

Management Priority: 1

Yellow ginger is a perennial herb native to the Himalayas that grows to be 5-7 ft. tall. Its flowers are pale to dark yellow with yellow stamens. It is often introduced as a cultivated ornamental and subsequently invades the surrounding ecosystems (GISD 2006). In Hawai`i it mainly reproduces vegetatively via rhizomes, but it may also reproduce sexually via seeds. This rhizomal growth often results in dense stands that displace native plant species and inhibit their regeneration (CABI 2013). Yellow ginger grows mainly in disturbed areas and prefers moist sunny environments but it tolerates a wide variety of conditions and can be found in the understory (CABI 2013).

If resources are available, treatment of Yellow ginger outside the fence at Kōke`e AFS would be beneficial.

Biological: There are no known biological control agents for yellow ginger.

Cultural: Yellow ginger is often introduced as an ornamental plant and can spread rapidly to native ecosystems. The species is likely to keep spreading wherever it is planted as an ornamental. Therefore controlling the cultivation of kahili ginger in new environments may prevent further spreading of the species (CABI 2013).

Mechanical: Plants can be removed manually, but care must be taken to ensure all rhizomes are fully removed to prevent regeneration (GISD 2006).

Chemical: Spraying foliage or cut stumps with herbicide can be effective. Use 25 g Escort/100 L water with 0.1 percent Pulse or 2 percent Roundup with 0.2 percent Pulse and Amitrole. Applications will be most effective from spring to late autumn while the plant is growing (GISD 2006).

4.2.3.5 Kahili ginger (*Hedychium gardnerianum*)

Management Priority: 1

Kahili ginger is a perennial herb that grows to over a meter tall and is native to India (GISD 2010). It has bright yellow flowers with red stamens and is highly invasive due to its reproductive strategies and its ability to exclude native vegetation. The plant reproduces both sexually (by seeds) and vegetatively (via rhizomes, which can generate a new plant without fertilization). Seeds are mainly dispersed by birds, but also grow very well after dropping to the ground next to the host plant (Sperry Undated). One study showed that adult kahili ginger plants create favorable conditions for their own seeds and those of strawberry guava (*Psidium cattleianum*), another invasive species in Hawai`i (Minden et al. 2009 as cited in Sperry Undated). Kahili ginger is shade tolerant and forms dense stands that prevent growth of native flora (Anderson and Gardner 1999 as cited in GISD 2010).

If resources are available, treatment of kahili ginger outside the fence at Kōke`e AFS would be beneficial.

Biological: The bacterium *Ralstonia (=Pseudomonas) solanacearum* causes kahili ginger to wilt and is considered a practical long-term management strategy as it is highly host-specific and does not affect other related species (Anderson and Gardner 1999 as cited in GISD 2010).

Cultural: Kahili ginger is often introduced as an ornamental plant and can spread rapidly to native ecosystems. The species is likely to keep spreading wherever it is planted as an ornamental. Therefore controlling the cultivation of kahili ginger in new environments may prevent further spreading of the species (CABI 2013).

Mechanical: Isolated infestations of kahili ginger may be manually removed. It is important to remove the rhizomes (the "root" of the plant) as well as the stalks and flowers (GISD 2010; Sperry Undated). Removing the flowers slows, but does not stop the growth and spreading of

the plant. If the seeds are not yet formed flowers can be left on the ground; however if seeds are present flowers should be disposed of in a manner that ensures they will not come in contact with soil or other potentially fertile environments (GISD 2010).

Chemical: Common herbicides that can be used to control kahili ginger include Escort, Amitrole, and Roundup. These should be applied lightly on the roots and leaves from spring to late autumn using the concentrations recommended by the manufacturer. Escort (metsulfuron-methyl) is the most effective herbicide for kahili ginger. Effects of herbicide appear 3 months after application and the plant will die after 12 to 15 months (Aukland Regional Council 1999 as cited in CABI 2013). However, Escort has considerable environmental consequences and thus may not be suitable for widespread infestations of the plant such as in Hawai`i (Harris et al. 1996 and Tunison and Stone 1992 in Anderson and Gardner 1999, as cited in GISD 2010).

4.2.3.6 Velvet grass (*Holcus lanatus*)

Management Priority: 3

Velvet grass is a perennial grass native to Europe that grows to 12-24 in. (Wagner et al. 1999 as cited in PIER 2013). Its flowers are "silvery to purple" and it reproduces via prolific production of seeds that are dispersed by wind (Motooka et al. 2003; Weber 2003 as cited in PIER 2013). It tolerates a variety of soil conditions and colonizes disturbed and open areas where it may form dense patches that inhibit growth or regeneration of native plant species (Weber 2003 as cited in PIER 2013). In Hawai`i, it is common in grasslands, moist shrubland, pastures, along roadsides, and in other disturbed areas (Wagner et al. 1999 as cited in PIER 2013). Its growth and dispersal in Hawai`i has also been associated with ground disturbances by feral pigs (US Forest Service 2013 as cited in CABI 2013).

Biological: There are no approved biological control agents for velvet grass (CABI 2013).

Cultural: Because ground disturbance by feral pigs can promote the growth of velvet grass, controlling feral pig populations may be one factor in managing the growth and spread of velvet grass (US Forest Service 2013 as cited in CABI 2013).

Mechanical: Velvet grass can be controlled by intensive mowing or grazing as well as burning or plowing (Thompson and Turkington 1988 as cited in CABI 2013).

Chemical: Velvet grass can be controlled with 1-1.5 percent glyphosate applied to the leaves (Motooka et al. 2003). Atrazine or diuron is also effective (Weber 2003 as cited in PIER 2013). Herbicides are most effective when applied to seedlings or to adults as flowers are emerging. Multiple herbicide applications may be necessary to maintain control of velvet grass (Garry Oak Ecosystems Recovery Team 2003 as cited in CABI 2013).

4.2.3.7 Cathedral bells (*Kalanchoe pinnata*)

Management Priority: 2

Cathedral bells is a perennial succulent shrub native to Africa and India (CABI 2013; PIER 2013). It is widely available as an ornamental and often invades native environments following intentional cultivation (CABI 2013). It reproduces both sexually and vegetatively via epiphyllous budding (in which daughter plants are formed from the edges of detached leaves) and via suckers that are produced around the base of the plant (CABI 2013). Cathedral bells forms dense stands and releases allelopathic chemicals which inhibit the growth of native plants and contribute to its success as an invasive (Huang et al. 1997 as cited in CABI 2013; Motooka et al. 2003). It is naturalized and abundant in Hawai`i and is considered a threat to island ecosystems (PIER 2004; Wagner et al. 1999 as cited in CABI 2013).

Biological: There are no biological control agents available for cathedral bells.

Cultural: Because cathedral bells often spreads to the native environment after escaping cultivation, managing its cultivation could be an important step in managing it as an invasive species (CABI 2013).

Mechanical: Cathedral bells can be manually removed if care is taken that the entire plant, including all leaves and roots, is fully removed (Soria et al. 2002 as cited in CABI 2013). Hand removal was estimated to cost $2095 (Australian) (U.S. $1862.04) per hectare in Australia (Sparkes *et al.* 2002 as cited in CABI 2013).

Chemical: Cathedral bells are susceptible to 2,4-D and are likely also sensitive to other hormone-type herbicides. The cost of treatment with 2,4-D was estimated at approximately Au$160 (US$142.21) per hectare in Australia (Sparkes et al. 2002 as cited in CABI 2013). Drizzle applications of 10 percent glyphosate in water have also been effective on Hawai`i (Motooka et al. 2003).

4.2.3.8 Lantana (*Lantana camara*)

Management Priority: 2

Lantana is a shrub native to tropical America that has many sub varieties and tolerates a wide range of environmental conditions. It grows in thick clumps that displace native plant species and inhibit their regeneration. It is allelopathic, releasing chemicals into the soil which further prevent the growth of native plants nearby. It prefers open or disturbed areas such as grasslands, coastal areas, wetlands, and agricultural areas, but will also establish in disturbed forests. The root system of lantana is very strong and the plant can tolerate repeated cuttings. It reproduces via seeds that develop in a blue-black fruit and are dispersed by frugivorous birds. In Hawai`i the introduction of six frugivorous bird species has been blamed for the extensive infestation of lantana. It is often introduced as an ornamental and spreads easily from gardens to native ecosystems (GISD 2006).

Biological: Biological control agents have been extensively researched for lantana given its extraordinarily broad range and many have proven effective in various areas. Over 24 biological control agents have been released in Hawai`i, the most effective of which are the caterpillar

Hypena strigata, the fly *Ophiomyia lantanae*, and the lace bug *Teleonemia scrupulosa* (Motooka et al. 2003 as cited in PIER 2013).

Cultural: Lantana is often cultivated as an ornamental species, so control or management of intentional cultivation may be an important part of managing lantana as an invasive (GISD 2006).

Mechanical: Small infestations of lantana may be dug up by hand or with machinery. Fire is also an effective measure over larger areas but must be followed by additional treatment to prevent regrowth (GISD 2006; PIER 2013).

Chemical: Lantana is susceptible to foliar spraying of glyphosate and 1 percent imazapyr;10 percent triclopyr ester applied to basal bark is also effective, as are 50 percent triclopyr amine or 10 percent imazapyr applied to cut surfaces (Motooka et al. 2003). Herbicide effectiveness is affected by climate, plant size, and time and method of application (CABI 2013).

4.2.3.9 Molassesgrass (*Melinis minutiflora*)

Management Priority: 3

Molassesgrass is a perennial grass native to Africa that owes its common name to its sticky, sweet-smelling foliage (GISD 2008). Molassesgrass can reach 7 ft. in height and grows well in poor soil conditions. It has been introduced intentionally in many areas as pasture grass for livestock and accidentally in others as a crop seed contaminant. It reproduces via seeds, which are produced in autumn and early winter and dispersed by wind, and vegetatively via stolons and rhizomes (CABI 2013). It grows in mats that form monospecific patches that displace native plant species and inhibit their regeneration (Smith 1985 as cited in PIER 2013). In drought conditions it will die and can create a fire hazard, which can be especially dangerous given its high oil content (Motooka et al. 2003 as cited in PIER 2013). However, the dense mats of grass are adapted to fire and often regenerate quickly following burning (Smith 1985 as cited in PIER).

Biological: There are no known or approved biological control agents for molassesgrass (CABI 2013).

Cultural: As this species is often introduced intentionally as fodder for livestock, control of cultivation of molassesgrass may be important in managing it as an invasive. Close inspection of agricultural seeds for contamination with molassesgrass may help prevent accidental introduction of the species to new environments (CABI 2013).

Mechanical: Mechanical removal of molassesgrass is possible if all rhizomes and stems are fully removed (CABI 2013). Grazing and mowing are also effective control measures (State of Queensland Department of Agriculture, Fisheries and Forestry 2012).

Chemical: Foliar applications of 1 percent glyphosate in water have been effective in Hawai`i (Motooka et al. 2003 as cited in PIER 2013).

4.2.3.10 Sensitive plant (*Mimosa pudica*)

Management Priority: 3

Sensitive plant is a perennial herb native to South America that is often introduced as a cultivated ornamental (GISD 2010). It grows in open and disturbed areas and prefers full sunlight and low-nutrient soils (Feng et al. 1998 in Francis Undated; Francis Undated). The roots fix nitrogen, allowing sensitive plant to outcompete native plant species in low-nutrient areas (Pokhriyal et al. 1990 as cited in Francis Undated). Burning encourages its establishment and growth. It reproduces via seeds that have bristles allowing them to stick to fur or clothing, which aids in their dispersal (Francis Undated). It is a serious problem in many agricultural fields as a crop weed, but in other areas it is valued as a pasture plant for livestock (Francis Undated).

Biological: There are currently no approved biological control agents for sensitive plant although research has been done on biological control of other mimosa species (CABI 2013).

Cultural: As *M. pudica* is often introduced as an ornamental, controlling cultivation of this species may be important in managing it as an invasive (GISD 2010). Pasture grazing should be monitored as *M. pudica* can readily establish in areas that are overgrazed by cattle (Chadhokar 1978 as cited in CABI 2013).

Mechanical: Manual removal of young *M. pudica* is possible, but older plants are difficult to remove by hand given their woody roots and thorny stems (McConnell and Muniappan 1991 as cited in CABI 2013). Hoes can be used for mechanical removal (Joseph and Bridgit 1993 as cited in CABI 2013).

Chemical: Applications of foliar herbicides such as glyphosate have proven effective on *M. pudica*. The amount of herbicide needed can be reduced by first slashing or burning the plant and applying herbicide to regrowth. Herbicides are most effective if sprayed following rain when the plant is actively growing (CABI 2013; Chadhokar 1978 as cited in CABI 2013). Other herbicides that are effective include dicamba, triclopyr, picloram, fenoprop, and amitrole (CABI 2013; Parsons and Cuthbertson 1992 as cited in CABI 2013).

4.2.3.11 Firetree (*Morella faya*)

Management Priority: 3

Firetree is an evergreen tree or shrub native to the Azore, Madeira, and Canary islands (GISD 2006). It is a fast-growing species that reproduces sexually via seeds produced in small fruits. Seeds are dispersed by frugivorous birds and seed dispersal is aided in Hawai`i by feral pigs (Binggeli 1997 as cited in GISD 2006; Motooka et al. 2003) In Hawai`i, many of the birds that contribute to dispersal of firetree are introduced (GISD 2006). Firetree grows in dense, monospecific stands that displace and exclude native vegetation (CABI 2013). It is a pioneer species that requires exposure to sunlight and therefore readily establishes in open or disturbed areas (Fernandez-Palacios and Arevalo 1998 as cited in CABI 2013). It fixes atmospheric

nitrogen, increasing nitrogen availability in the soil and thus altering the species composition of the resulting environment (CABI 2013). Firetree has been identified as one of the most important environmental weeds in the Hawai`i Volcanoes National Park, and is also on the Hawai`i Department of Natural Resources High-Profile Invasive Species list (CABI 2013; Hawai`i Invasive Species Council 2014).

Biological: The fungal leaf pathogen *Septoria hodgesii* has been shown to be pathogenic on firetree and was released in 1998 but had negligible effects (Smith 2002 as cited in CABI 2013). The moth *Caloptilia* sp. nr. *schinella*, a natural pest to firetree in its native habitat, was released in Hawai`i in 1991 and has since established and spread (Markin 2002 as cited in GISD 2006). However, its effects in controlling firetree have been minimal (Smith *et al* 2002 as cited in PIER 2013). The pathogen *Botrytis cinerea* has been shown to rot firetree fruit in Hawai`i, and research is ongoing to determine whether a specific strain of this pathogen might be useful in actively controlling firetree populations (Duffy and Gardner 1994 as cited in GISD 2006).

Cultural: As feral pigs play a role in seed dispersal, management of feral pigs may contribute to control of *M. faya* as an invasive species (Binggeli 1977 as cited in GISD 2006).

Mechanical: Girdling of firetree has been shown to allow for growth of native species, though it does not fully eliminate firetree individuals (Loh and Daehler 2007 as cited in CABI 2013). Goats can be used to control the firetree by grazing (Motooka *et al.* 2003 as cited in PIER 2013).

Chemical: Saplings can be controlled by foliar or basal bark applications of triclopyr. Cut-stump applications of 9 percent imazapyr in water, 100 percent glyphosate, or 10 percent triclopyr amine are also effective (Motooka et al. 2003).

4.2.3.12 Vasey's grass (*Paspalum urvillei*)

Management Priority: 3

Vasey's grass is a perennial grass that grows in clumps 2.5-8 ft. tall. It is native to tropical America and displaces native plant species in disturbed and open areas in Hawai`i (CABI 2013; GISD 2008). It prefers moist areas with heavy soil and lots of sunlight. It reproduces via seeds which can last up to 9 months in the soil (CABI 2013).

This species was not observed during the latest survey at Kōke`e AFS. However, if seen, it should be treated.

Biological: There are no known biological control agents for Vasey's grass (CABI 2013).

Cultural: Vasey's grass has been spread by hikers who unknowingly carry the seeds on their clothing. Heightened awareness of this possibility could prevent further spread of the plant to new areas in the future (Motooka et al. 2003).

Mechanical: Grazing has been shown to reduce cover of Vasey's grass in certain situations (Newman and Sollenberger 2005 as cited in CABI 2013). Manual removal of small populations can be effective when care is taken to fully remove all rhizomes. Slashing can also be effective when followed by application of an herbicide (Western Australian Herbarium 2012 as cited in CABI 2013).

Chemical: Vasey's grass is susceptible to imazapyr and glyphosate. Drizzle applications of these herbicides have been effective in Hawai`i (Motooka et al. 2003).

4.2.3.13 Banana poka (*Passiflora tarminiana*)

Management Priority: 2

Banana poka is a perennial liana (woody vine) native to the South American Andes. It produces seeds that develop in large edible fruits, and these seeds are dispersed by feral pigs and frugivorous and granivorous birds (many of which are exotic species in Hawai`i) (LaRosa 1894 as cited in CABI 2013; GISD 2005). Banana poka is often cultivated for its fruit and subsequently invades the native environment. It can be found in a wide range of elevations in Hawai`i and tolerates a variety of light levels (CABI 2013). It is generally found in disturbed habitats where it smothers and topples native trees and suppresses tree regeneration (Binggeli 1997 as cited in GISD 2005).

Biological: Three biological control agents have been released in Hawai`i: These include two foliage-feeding moths (*Cyanotricha necryia* in 1998 and *Pyrausta perelegans* in 1991) and one fungus (*Septoria passiflorae* in 1996). While neither moth species established strongly, there have been 80-95 percent reductions in *P. tarminiana* biomass over more than 2000 hectares in Hawai`i, indicating that the fungus may be effective. Current research is investigating the fly *Zapriotheca* nr. *nudiseta*, which feeds on flower buds, and the defoliating moths *Josia fluonia* and *J. ligata* for their potential role as biocontrol agents for banana poka (Landcare Research 1999, 2001 as cited in GISD 2005).

Cultural: Since banana poka is most commonly introduced intentionally, controlling its cultivation outside its native range may be an important management technique (Binggeli 1997 as cited in GISD 2005).

Mechanical: Small plants can be pulled out by hand, while older or larger vines need to be dug out (PIER 2013).

Chemical: Chemical control of banana poka is complicated because the majority of the plants biomass is in the canopy layer and thus out of reach from the ground. The plant's close physical proximity to non-target species is also problematic. Both glyphosate and triclopyr at 5, 50, and 100 percent have successfully killed cut stumps, but some vines have been shown to re-root if they are not treated with herbicide. Cut stump applications of triclopyr amine at 10 percent in water have also been effective (Motooka et al. 2003).

4.2.3.14 Kikuyugrass (*Pennisetum clandestinum*)

Management Priority: 2

Kikuyugrass is a perennial grass native to tropical regions of eastern Africa. It prefers moist conditions but can tolerate a range of humidity and light exposure. It reproduces vegetatively via rhizomes and sometimes sexually via seeds. Its rhizomes form dense mats that release allelopathic chemicals and its long blades shade out other plants. These characteristics physically and chemically inhibit the growth of native plant species in its vicinity (Holm et al. 1977 as cited in PIER 2013). It is often planted intentionally as turf or for erosion control (CABI 2013). In Hawai`i it is considered a serious threat to native vegetation (Wagner et al. 2009 as cited in PIER 2013).

Biological: Biological control has not been investigated for this species as it is often planted intentionally for turf or erosion control (CABI 2013).

Cultural: This species is often planted intentionally as turf or for erosion control. Therefore, measures to control its intentional cultivation may be necessary to manage its invasiveness (CABI 2013).

Mechanical: Kikuyugrass is highly resistant to mowing and grazing (Holm et al. 1977 as cited in PIER 2013). It is also difficult to remove manually because of the dense layer of rhizomes (PIER 2013). Therefore, manual removal is usually ineffective unless conducted with heavy equipment (CABI 2013).

Chemical: Glyphosate at 0.5 percent and Dalapon have been successful in controlling kikuyugrass (Smith 1985 as cited in PIER 2013). Kikuyugrass is also sensitive to imazapyr. Roundup at 1 percent without Pulse, Gallant at 0.5 percent and Dowpon 740-SP (16-20g/L water) are effective in controlling new growth (Timmins and Mackenzie 1995 as cited in PIER 2013).

4.2.3.15 Narrowleaf plantain (*Plantago lanceolata*)

Management Priority: 3

Narrowleaf plantain is a perennial herb native to Europe and parts of Asia that is common in parks and coastal and open disturbed areas in Hawai`i (Wagner et al. 1999 as cited in PIER 2013). It reproduces sexually via seeds and tolerates a wide variety of environmental conditions. Seeds are dispersed by wind or by sticking to fur or clothing (CABI 2013).

Biological: Biological control agents are not available for narrowleaf plantain.

Cultural: *P. lanceolata* can be accidentally introduced as a contaminant in agricultural produce. Increased awareness of this possibility and efforts to avoid contamination may contribute to the control of narrowleaf plantain (CABI 2013).

Mechanical: Narrowleaf plantain can be controlled by grazing or mowing (Weber 2003 as cited in PIER 2013).

Chemical: Post emergent broadleaf herbicides such as 2,4-D, triclopyr, MCPA, and mecoprop can control plantain seedlings, but control of established plantain plants with post emergent treatment is much more difficult. For established plants, 2,4-D works best while triclopyr, MCPA, and mecoprop will only reduce its vigor. Repeat applications are needed to kill weakened perennial weeds and new germinating seedlings.

4.2.3.16 Strawberry guava (*Psidium cattleianum*)

Management Priority: 2

Strawberry guava is an evergreen shrub with white flowers, purple-red fruit, and smooth, papery bark that can be 7-26 ft. tall. Native to Brazil, it is often introduced as an ornamental species and then spreads to native ecosystems. It thrives especially in humid areas such as rainforests but tolerates a wide variety of environmental conditions (CABI 2013). It grows in dense monospecific thickets that exclude native vegetation by competing for soil nutrients and light (CABI 2013, GISD 2010). Strawberry guava reproduces both sexually via seeds, which are dispersed by birds and mammals, and asexually via suckers (GISD 2010). It is also allelopathic, releasing chemicals that suppress growth of other plant species in its vicinity (Sperry Undated). Some consider strawberry guava to be the most serious invader of Hawai`ian ecosystems (Smith 1985 as cited in CABI 2013).

Biological: Biological control methods for strawberry guava have not been considered practical in Hawai`i because of the commercial cultivation of related common guava. However, recent efforts to find a biological control for strawberry guava have focused on the possibility of finding a highly specific insect which would defoliate the plants (GISD 2010).

Cultural: Because strawberry guava seeds are often dispersed by nonnative animal species such as feral pigs and frugivorous birds, control of invasive and nonnative fauna is one important control measure (GISD 2010; Sperry Undated). Strawberry guava is also a popular ornamental fruit tree, and is likely to spread to native ecosystems wherever it is cultivated due to its high reproductive success (CABI 2013). Thus controlling cultivation of strawberry guava may also be an important management measure.

Mechanical: The strong root system associated with strawberry guava makes manual removal impractical. Cutting of stems and branches leads to proliferation of suckers and new stems and is thus not recommended as a control measure unless accompanied by application of an herbicide (CABI 2013; Sperry Undated).

Chemical: Strawberry guava is resistant to many foliar herbicides but is sensitive to tebuthiuron, glyphosate, triclopyr, picloram, and dicamba (CABI 2013; GISD 2010). Undiluted picloram applied to cut stumps is highly effective but also affects non-target species. Undiluted glyphosate (Roundup) and undiluted triclopyr ester (Garlon 4) have also been effective when

applied using the "hack and squirt" method. Garlon's short half-life, well-documented effects, and lack of mobility make it one of the most highly recommended herbicides for strawberry guava (GISD 2010).

4.2.3.17 Sawtooth blackberry (*Rubus argutus*)

Management Priority: 2

Sawtooth blackberry is a woody shrub native to the eastern United States with white flowers and black fruit (CABI 2013; Wagner et al. 1999 as cited in PIER 2013; Sperry Undated). It reproduces sexually, via seeds which are dispersed by frugivorous birds, and vegetatively, via stems that are able to sprout roots when touching the ground. This means that damage to the stems above ground rarely affects the survival of the plant (Sperry Undated). Sawtooth blackberry forms dense, thorny brambles that preclude the growth of other plants and can inhibit the movement of native fauna (Weber 2003 as cited in PIER 2013; Sperry Undated). It colonizes disturbed and open areas and is mildly shade tolerant (Sperry Undated).

If resources are available, treatment of sawtooth blackberry outside the fence at Kōke`e AFS would be beneficial.

Biological: Biological control has been prioritized for sawtooth blackberry as the extent of the infestation makes mechanical and chemical removal impractical. In the 1960s, five insects were released in Hawai`i as control agents for sawtooth blackberry. Three of these insects, *Schreckensteinia festaliella*, *Croesia zimmermani*, and *Priophorus morio*, are still present in Hawai`i and have negative effects on populations of both sawtooth blackberry and native *Rubus* species (Nagata and Markin 1986 as cited in CABI 2013; Tunison 1991 as cited in CABI 2013). Further research is being conducted on fungus species that could be used to control sawtooth blackberry, but would not affect native *Rubus* (Smith et al. 2002 as cited in PIER 2013).

Cultural: No cultural management methods are available for sawtooth blackberry. The species should not be intentionally planted.

Mechanical: Vegetative growth of sawtooth blackberry can be inhibited by mowing or cutting stems before they can arch over to reach the ground and sprout roots (CABI 2013).

Chemical: Widespread chemical control of sawtooth blackberry is impractical because it is present over a large area (CABI 2013). Application of glyphosate on cut stems of sawtooth blackberry can be effective for small populations but would be extremely labor intensive for larger infestations (Tunison 1991 as cited in CABI 2013). "Drizzle" applications of glyphosate and triclopyr and foliar applications of triclopyr amine at 0.5 percent have been effective in Hawai`i in the past (Motooka et al. 2003 as cited in CABI 2013).

4.2.3.18 Chayote (*Sechium edule*)

Management Priority: 3

Chayote is a perennial herbaceous vine that is likely native to Central America. It reproduces via seeds produced in a pear-shaped, greenish fruit (CABI 2013). Chayote is often cultivated for its edible fruit and subsequently invades the natural environment (GISD 2008). It grows best in disturbed or open areas with moist soils and full exposure to sunlight (GISD 2008; Staples and Herbst 2005 as cited in PIER 2013).

This species was not observed during the latest survey at Kōke`e AFS. However, if seen, it should be treated.

Biological: There are no biological control agents available for chayote.

Cultural: As chayote is often introduced intentionally, controlling its cultivation could be an important management technique (GISD 2008).

Mechanical: No information on mechanical management of *E. cyathophora* is available in the literature. If the species is observed, please refer to the "other species" profile for management suggestions.

Chemical: No information on chemical management of *E. cyathophora* is available in the literature. If the species is observed, please refer to the "other species" profile for management suggestions.

4.2.3.19 Palm grass (*Setaria palmifolia*)

Management Priority: 3

Palm grass is a perennial grass native to Asia that grows up to 7 ft. tall (CABI 2013). It prefers open areas, tolerates salt, wind, and a variety of climates, and colonizes disturbed areas and forest openings where its height allows it to shade out other plants. It reproduces both sexually via seeds, which are dispersed by wind and granivorous birds, and vegetatively via rhizomes (Sperry Undated). These rhizomes form dense mats in the soil around tufts of palm grass making it difficult for other plants to grow. These characteristics allow palm grass to exclude and out compete native plant species.

This species was not observed during the latest survey at Kōke`e AFS. However, if seen, it should be treated.

Biological: No biological control measures are known for palm grass.

Cultural: Palm grass is often introduced to new environments as an ornamental plant and spreads to native ecosystems (CABI 2013). Controlling cultivation of palm grass may be an important management measure.

Mechanical: Individual clumps of palm grass may be manually removed. Protective clothing should be worn during removal because of the irritating hairs on palm grass leaves (CABI 2013; Sperry Undated).

Chemical: Chemical control of palm grass has been achieved in Hawai`i using foliar applications of glyphosate at a concentration of 1 percent. However, the seed bank and rhizomes are hardy and frequent monitoring and reapplication of herbicides are necessary to prohibit regrowth (Motooka 2003 as cited in CABI 2013).

4.2.3.20 African dropseed (*Sporobolus indicus* var. *capensis*)

Management Priority: 3

African dropseed is a perennial grass native to Africa. It grows in dense tufts and is often intentionally introduced as a pasture grass (GISD 2010). It reproduces via seeds which may remain viable in the soil for up to 10 years (Department of Primary Industries and Fisheries 2007 as cited in GISD 2010). It easily establishes in disturbed and open areas and can form extensive mats that displace and exclude the growth of native species (GISD 2010).

This species was not observed during the latest survey at Kōke`e AFS. However, if seen, it should be treated.

Biological: There are currently no biological control agents available for African dropseed. Research is focusing on whether a pathogen native to Australia could be used in the future (Palmer et al. 2010 as cited in GISD 2010).

Cultural: Because African dropseed is often introduced intentionally as pasture or lawn grass, so controlling its cultivation may be an important management technique (GISD 2010).

Mechanical: Manual removal of African dropseed is effective, but not efficient. Slashing encourages seed production and should not be used as a control measure. Fire could be used to reduce the seed bank by both destroying seeds and encouraging survivors to germinate, which could reduce the seed bank if the new plants are not allowed to seed (Department of Primary Industries and Fisheries 2007 as cited in GISD 2010).

Chemical: African dropseed is susceptible to flupropanate and glyphosate herbicides. Application methods depend on the extent of infestation (Department of Primary Industries and Fisheries 2007 as cited in GISD 2010).

4.2.3.21 Java plum (*Syzygium cumini*)

Management Priority: 3

Java plum is a fruiting evergreen tree native to Indo-Malaysia (PIER 2013; Stone 1970 as cited in PIER 2013). It reproduces via seeds that are dispersed by frugivorous birds and mammals that eat its large black fruit (GISD 2006). Feral pigs may also play a role in dispersal (PIER 2013). It often colonizes in moist areas such as along stream banks in valleys and forests (Motooka et al. 2003). It grows rapidly, often in monospecific stands, and out shades native plant species (CABI 2013). Vigorous efforts have been made to control this species with herbicides in Hawai`i (GISD 2006).

Biological: There are no approved biological control agents for Java plum (GISD 2006).

Cultural: In some cases, introduction of this species has been the result of intentional cultivation. Controlling the spread of Java plum may involve controlling or monitoring its cultivation (CABI 2013).

Mechanical: Young seedlings can be uprooted manually (PIER 2013).

Chemical: Foliar applications of triclopyr and picloram have proven effective. Basal bark applications of 2,4-D, dicamba, 10 percent triclopyr ester in oil, and glyphosate are successful on young trees, but not on larger trees that have thicker bark. Stump applications of imazapyr, 2,4-D, 50 percent triclopyr amine in water, or 10 percent triclopyr ester in water are also effective (Motooka et al. 2003).

4.2.3.22 Calla lily (*Zantedeschia aethiopica*)

Management Priority: 3

Calla lily is an evergreen perennial native to South Africa and Lesotho (Smith 1979 as cited in PIER 2013). It grows in riparian, grassland, coastal scrub, and forest habitats as well as freshwater wetlands and reproduces via seeds that are dispersed by water, birds, and mammals. It also reproduces vegetatively via rhizome fragments that can be carried by water. Calla lily often forms dense patches that displace and exclude native plants (Weber 2003 as cited in PIER 2013). It is widely cultivated as an ornamental and subsequently invades the native environment, often establishing after being dumped in garden cuttings (PIER 2013).

This species was not observed during the latest survey at Kōke`e AFS. However, if seen, it should be treated.

Biological: No biological control agents are available for calla lilly.

Cultural: Because calla lily is often introduced intentionally, controlling the cultivation of this species may be an important factor in managing it as an invasive (PIER 2013).

Mechanical: Calla lilly can be manually removed, but care must be taken that all roots and pieces of roots are removed completely and disposed of at a refuse transfer station, as they can re-grow if left on or in the ground (Weedbusters 2012 as cited in PIER 2013).

Chemical: Application of 2,4-D, chlorsulferon, or blyphosate before fruits are ripe can prevent seed production (Weber 2003 as cited in PIER 2013).

4.3 INVASIVE AND NONNATIVE ANIMALS AT KŌKE`E AFS

4.3.1 Methods

The primary sources of information for the development of the invasive, nonnative, and nuisance animal management plan were reports of previously conducted field surveys and other documents providing information about the diversity and distribution of invasive, nonnative, and nuisance animals recorded at Kōke`e AFS. In addition, an ocular survey for such animal species was conducted on 13-15 November 2013 in conjunction with the invasive and nonnative plant survey.

4.3.2 Results

Table 4-3 provides a summary of the invasive, nonnative, and nuisance animal species at Kōke`e Air Force Station. The table provides species that are known to occur at Kōke`e AFS and species observed during the survey.

Table 4-3. Invasive, Nonnative and Nuisance Animal Summary for Kōke`e AFS

Scientific Name	Common Name	Observed During the Survey	Previously Observed at Kōke`e AFS
Felis domesticus	Feral cat		X
Rattus spp.	Rats		X
Sus scrofa	Feral pig	X (sign)	X

4.3.3 Management Plan for Primary Invasive, Nonnative, and Nuisance Animal Species

Current general management methods for invasive species are described above. The only invasive animals that frequent Kōke`e AFS are rats and feral cats. Rats are controlled via poison baits when necessary in cooperation with the Hawai`i DLNR and with technical assistance from the APHIS-ADC of the USDA (USAF 2007). Kōke`e AFS has a policy for trapping and removing feral cats and not feeding feral cats. Garbage cans are secured to exclude feral cats and rats. Feral pigs and goats exist in the forest surrounding the site; these are excluded from the AFS by fencing and are controlled by hunting.

5. MT. KA`ALA AFS INVASIVE AND NONNATIVE SPECIES

Sections 3.1.1 through 3.1.5 of this BCSMP provides discussions of general invasive and nonnative species management methods, biological management, cultural management, mechanical management, chemical management, general management philosophy, and primary herbicides described for management for Mt. Ka`ala AFS. Management of each invasive or nonnative species has been assigned a priority as defined above.

Overall management priority for each of the invasive and nonnative species is provided with the descriptions and possible and proposed management methods discussions in Section 5.2.3.

5.1 CURRENT PREVENTION AND MANAGEMENT MEASURES FOR INVASIVE AND NONNATIVE SPECIES

With the exception of a few ornamental shrubs and shrubs and small trees in proximity to the pump house, all vegetation within the fence at Mt. Ka`ala AFS is mowed. There is also an approximate 6-ft. area of mowed vegetation around the outside perimeter of the fence. The mowed areas include invasive grasses and other plant species.

The only invasive animals that frequent Mt. Ka`ala AFS are rats, which are controlled via poison baits when necessary in cooperation with the Hawai`i DLNR and with technical assistance from the APHIS-ADC of the USDA (USAF 2007). Garbage cans are secured to exclude rats. Feral pigs and goats exist in the forest surrounding the site; these are excluded from the AFS by fencing and are controlled by hunting.

5.2 INVASIVE AND NONNATIVE PLANTS AT MT. KA`ALA AFS

5.2.1 Methods

Vegetation surveys were conducted at the Mt. Ka`ala AFS from 13 to 15 November 2013. The site was separated into two HMUs in order to delineate areas within which various natural resources management actions should occur (**Figure 2-10**). HMU-1 included vegetation inside the fence, and HMU-2 included an undefined area outside the fence. **Figure 2-11** depicts the vegetation map overlaid with the location of each HMU. A description of the topography and dominant vegetation for the site is described in the "Vegetation" section above.

5.2.2 Results

There were 14 species of invasive and nonnative plants observed during the survey. **Table 5-1** provides the invasive and nonnative species observed during the survey. The table indicates species that are on the Federal Noxious Weed List, the Hawai`i Noxious Weed List, and the Hawai`i DLNR Invasive Plants list. Invasive and nonnative species that have been observed at Mount Ka`ala AFS in the past, but were not observed during the survey are included for reference. The names of the species observed and suggested management actions in each HMU are provided in **Table 5-2**.

Table 5-1. Invasive and Nonnative Plants Observed at Mount Ka`ala Air Force Station

Scientific Name	Common Name	Federal Noxious Weed[1]	HI Noxious Weed[2]	HI DLNR[3] Invasive Plant
Ageratina adenophora	Sticky snakeroot	X	X	
Buddleja asiatica	Dogtail			
Casuarina equisetifolia	Casuarina			
Cerastium fontanum	Common mouse-ear			
Clidemia hirta	Koster's curse		X	
Cynodon dactylon	Bermuda grass			
Hedychium flavescens	Yellow ginger			
Hedychium gardnerianum	Kahili ginger			
Impatiens walleriana	Buzzy lizzy			
Paspalum urvillei	Vasey's grass			
Pennisetum clandestinum	Kikuyugrass	X		
Psidium cattleianum	Strawberry guava			
Rubus argutus	Sawtooth blackberry		X	
Sporobolus indicus	West Indian dropseed			

1. USDA-APHIS 2012.
2. Division of Plant Industry 2003.
3. DLNR.

Table 5-2. Invasive and Nonnative Management Actions for HMU-1 at Mt. Ka`ala AFS

HMU	Invasive Vegetation Species	Approximate Percent Cover	Management Action	Approximate Labor Hours	Approximate Cost	Priority
HMU-1	*Pennisetum clandestinum*	20% (intermixed in mowed turf)	Regular mowing	4 hours mowing (every 2 weeks)	Mech Labor (per 2 weeks): $80.00 Total: $80.00	2
	Rubus argutus	5% (along cut area outside of the perimeter fence)	Foliar application of 5% glyphosate with a wicker For monocultures apply a foliar application with a coarse droplet to minimize any overspray.	1 hour for chemical treatment	Chem Labor: $20.00 Chemical: $38.00 Total: $58.00	2

5.2.3 Management Plan for Invasive and Nonnative Plants

This section provides descriptions and possible and proposed management methods for primary invasive and nonnative plant species. General management methods for invasive species are described in Sections 3.1.1 through 3.1.5 of this BCSMP, though some species profiles may

include additional species-specific management information. Where no new management actions are proposed, current management methods should continue (i.e., mowing), or management may follow the options listed in each plant profile. Species are listed in alphabetical order by scientific name.

5.2.3.1 Sticky snakeroot (*Ageratina adenophora*)

Management Priority: 3

Sticky snakeroot is a perennial shrub native to Mexico that grows 3-7 ft. high with purplish stems and white flowers (CABI 2013; Wagner et al. 1999 as cited in PIER 2013). It grows well in disturbed open areas and edge habitats, but tolerates a wide variety of environmental conditions. Sticky snakeroot forms thick clumps that displace native vegetation and prevent its regrowth (Weber 2003 as cited in PIER 2013). It reproduces via seeds which have white feathery hairs that allow them to be dispersed by wind and water. Broken stems can also take root when in contact with soil (CABI 2013).

Biological: In 1945, the trypetid gallfly *Procecidochares utilis*, a natural enemy of sticky snakeroot native to the plant's natural range, was introduced in Hawai`i. This measure was successful in all areas except those with the highest annual rainfalls (Bess and Harmamoto 1972 as cited in CABI 2013). The fungus *Entyloma compositarum* has also been an effective control measure (Smith et al. 2002 as cited in PIER 2013).

Cultural: No cultural management methods are available for sticky snakeroot. The species should not be intentionally planted.

Mechanical: Manual removal of sticky snakeroot is possible and is most effective when followed by plowing and sowing of more desirable pasture species (Motooka et al. 2003 as cited in PIER 2013).

Chemical: High volume applications of dicamba with MCPA, picloram with triclopyr, or glyphosate can be successful when applied in late summer or fall. Herbicides should be applied to the whole plant with special attention to the plant base (CABI 2013).

5.2.3.2 Dogtail (*Buddleja asiatica*)

Management Priority: 3

Dogtail is a 3-7 ft. shrub native to eastern Asia. In Hawai`i, it occurs primarily in disturbed and open areas at altitudes of 260-9,500 ft. (Stone 1970 as cited in PIER 2013). It reproduces via seeds that are dispersed by wind (PIER 2013). Its flowers are white, lavender, or green and hang in "drooping tail-like inflorescences" (Motooka et al. 2003).

Biological: There are no biological control agents available for dogtail.

Cultural: No cultural management methods are available for dogtail. The species should not be intentionally planted.

Mechanical: No information on mechanical management of dogtail is available in the literature. If the species is observed, please refer to the "other species" profile for management suggestions.

Chemical: Hormone-type herbicides and glyphosate are effective in controlling dogtail. Basal bark applications of 10 percent triclopyr ester in oil are highly effective, as are foliar applications of 2 percent triclopyr amine in water (Motooka et al. 2003).

5.2.3.3 Casuarina (*Casuarina equisetifolia*)

Management Priority: 1

Casuarina is an evergreen tree native to Australia that was introduced in O`ahu in 1895 (Motooka et al. 2003). It can grow up to 60 ft. tall, tolerates salt, wind, and poor soils, and fixes atmospheric nitrogen. Its canopy produces shady conditions and its leaves and cone-like fruit form a thick layer on top of the soil where they fall (GISD 2010). It is also allelopathic, releasing a chemical that is toxic to other plant species (Morton 1980, in Florida Department of Environmental Protection Undated as cited in GISD 2010). These conditions inhibit the growth of native plant species and often result in monospecific stands of casuarina. These stands can further displace native plant species as they alter soil hydrology and chemistry in their vicinity (PIER 2013). They also do not provide adequate habitat for native fauna (Klukas 1969, in Snyder 1992 as cited in GISD 2010). Casuarina reproduces via seeds that are dispersed by wind. In climates with distinct wet and dry seasons seeds develop at the same time, whereas in more consistently stable climates seed development occurs throughout the year making collection and destruction of seeds difficult (CABI 2013). Casuarina grows very quickly and has a high rate of reproductive success, making it very difficult to control (CABI 2013).

This species was not observed during the most recent vegetation survey at Mt. Ka`ala AFS. However, if seen, it should be treated immediately.

Biological: USDA researchers have been looking for insects, pathogens, and fungi that are natural enemies of Casuarina. So far, 12 species have been identified and are undergoing further testing to determine whether their introduction as a biological control measure would be effective. So far, there are no approved biological controls for Casuarina (Flores 2008 as cited in GISD 2010; Elfers 1988 as cited in GISD 2010; Binggeli 1997 as cited in GISD 2010).

Cultural: No cultural management methods are available for Casuarina. The species should not be intentionally planted.

Mechanical: Manual removal of seedlings and saplings is recommended for small infestations (Swearingen 1997 as cited in GISD 2010). Cutting can induce sprouting and thus should only be used in conjunction with herbicide applications. Burning has been successful in some cases but

must be undertaken with care as disturbing native species or changing soil conditions with fire can actually promote the establishment of Casuarina (Snyder 1992 as cited in GISD 2010).

Chemical: Larger infestations of Casuarina can be controlled effectively by applying systematic herbicides to cut stumps, foliage, or bark (GISD 2010). The Florida Exotic Pest Plant Council (2013) recommends applying a 50 percent aqueous solution of Garlon 3A or a 10-20 percent solution of Garlon 4 Ultra to the surface of Casuarina stumps, noting that the herbicide application should be concentrated on the layer of tissue immediately inside the bark. The same herbicides at the same concentrations can be applied using the hack and squirt method in which herbicide is applied to deep cuts in the bark of the tree. For this method cuts should be angled down to allow herbicide to pool. For smaller trees with DBHs of up to 6 in., herbicides containing triclopyr ester (such as Pathfinder II) or a 10-20 percent solution of Garlon 4 Ultra in oil can be applied to the bark around the base of the tree. Spraying herbicides such as Garlon 3A or Garlon 4 Ultra in a 3-5 percent solution in water directly onto the leaves of *C. equisetifolia* can also be effective. Care should be taken to avoid non-target species (Pernas et al. 2013).

5.2.3.4 Common mouse-ear (*Cerastium fontanum*)

Management Priority: 3

Common mouse-ear is a perennial herb that forms tufts or mats (PIER 2013). Its native range is not known but it is naturalized in temperate environments worldwide (GRIN 2013 as cited in PIER 2013). It grows in disturbed areas and edge habitats such as roadsides, pastures, and lawns (Wagner et al. 1999 as cited in PIER 2013; Flora of North America 2013 as cited in PIER 2013). It reproduces via seeds, but there is limited information on its reproductive capacity (Frenot and Gloaguen 1994 as cited in PIER 2013).

No information on management of common mouse-ear is available in the literature. If the species is observed, please refer to the "other species" profile for management suggestions.

5.2.3.5 Koster's curse (*Clidemia hirta*)

Management Priority: 3

Koster's curse is a perennial shrub native to tropical America that is approximately 1.5-10 ft. tall (Wagner et al. 1999 as cited in PIER 2013; GRIN 2013 as cited in PIER 2013). It grows in disturbed areas and forms thick monospecific stands, out shading and displacing other plant species and inhibiting new native plant growth (Peters 2001 in GISD 2006). In Hawai`i it is highly invasive and has been resistant to control measures in the past (GISD 2006). The species reproduces via seeds that develop in blue-black berries. Seeds are dispersed by frugivorous birds and mammals that eat the seeds and by mammals such as feral pigs or humans that can carry seeds on fur or clothing (CABI 2013). The seeds can remain viable in the soil for up to 4 years (Smith Undated as cited in GISD 2006).

This species was not observed during the most recent vegetation survey at Mt. Ka`ala AFS. However, if seen, it should be treated immediately.

Biological: In the 1950s the thrip *Liothrips urichi* was released in Hawai`i for biological control of Koster's curse. This species was effective in open areas exposed to sunlight but ineffective in shady areas. Multiple agencies are researching the possibility of using various fungi, beetles, and moths as possible biological control agents for Koster's curse in Hawai`i in the future (CABI 2013).

Cultural: Controlling feral pig populations is key to controlling the spread of Koster's curse as ground disturbances by these animals provide favorable conditions for the plant. Koster's curse should not be intentionally planted (CABI 2013).

Mechanical: Manual removal can be effective for small populations, but the prolific and long-lived nature of the seed bank makes it unlikely to be a long-term solution to Koster's curse infestations (GISD 2006).

Chemical: Though Koster's curse is susceptible to various herbicides it requires multiple follow-up applications to prevent regeneration (GISD 2006). Effective herbicides include applications of 1-2 percent triclopyr amine in water to the leaves, applications of 50 percent triclopyr amine to cut stumps, and applications of triclopyr ester to basal bark on plants under 9 ft. tall (Motooka et al. 2013).

5.2.3.6 Bermuda grass (*Cynodon dactylon*)

Management Priority: 3

Bermuda grass is a perennial grass native to Asia that spreads by seeds, rhizomes, and stolons. It prefers warm climates and full sun but tolerates a wide variety of soil conditions (CABI 2013; USDA-NRCS 2013). In Hawai`i it is cultivated and naturalized along roadsides and in lawns and pastures (Wagner et al. 1999 as cited in PIER 2013; Wiggins and Porter 1971 as cited in PIER). It is most problematic as an agricultural weed that can compete with crops for resources, but is also used intentionally in many areas as turf or for erosion control (CABI 2013).

Biological: There are no approved biological control agents for Bermuda grass, but multiple fungal pathogens are being studied as possibilities (Uygur 2000 as cited in CABI 2013).

Cultural: Because Bermuda grass is often planted intentionally as lawn grass or turf, controlling its cultivation may be an important factor in managing it as an invasive species (CABI 2013).

Mechanical: Small patches of Bermuda grass can be manually dug up (GISD 2010). However, manual removal is often ineffective if all rhizomes are not removed. Mowing Bermuda grass only results in its proliferation. Plowing areas of Bermuda grass multiple times and subsequently planting more desirable species, especially those that will produce shady conditions, may be effective in removing patches of Bermuda grass (CABI 2013).

Chemical: Paraquat or glyphosate can be effective when applied to young plants in spring or autumn during rhizome growth (Weber 2003 as cited in PIER 2013).

5.2.3.7 Yellow ginger (*Hedychium flavescens*)

Management Priority: 1

Yellow ginger is a perennial herb native to the Himalayas that grows to be 5-6.5 ft. tall. Its flowers are pale to dark yellow with yellow stamens. It is often introduced as a cultivated ornamental and subsequently invades the surrounding ecosystems (GISD 2006). In Hawai`i, it mainly reproduces vegetatively via rhizomes, but it may also reproduce sexually via seeds. This rhizomal growth often results in dense stands that displace native plant species and inhibit their regeneration (CABI 2013). Yellow ginger grows mainly in disturbed areas and prefers moist sunny environments but it tolerates a wide variety of conditions and can be found in the understory (CABI 2013).

If resources are available, treatment of yellow ginger outside the fence at Mt. Ka`ala AFS would be beneficial.

Biological: There are no known biological control agents for Yellow ginger.

Cultural: Yellow ginger is often introduced as an ornamental plant and can spread rapidly to native ecosystems. The species is likely to keep spreading wherever it is planted as an ornamental. Therefore controlling the cultivation of Yellow ginger in new environments may prevent further spreading of the species (CABI 2013).

Mechanical: Plants can be removed manually but care must be taken to ensure all rhizomes are fully removed to prevent regeneration (GISD 2006).

Chemical: Spraying foliage or cut stumps with herbicide can be effective. Use 25 grams Escort/100 liters of water with 0.1 percent Pulse or 2 percent Roundup with 0.2 percent Pulse and Amitrole. Applications will be most effective from spring to late autumn while the plant is growing (GISD 2006).

5.2.3.8 Kahili ginger (*Hedychium gardnerianum*)

Management Priority: 1

Kahili ginger is a perennial herb that grows to over a meter tall and is native to India (GISD 2010). It has bright yellow flowers with red stamens and is highly invasive due to its reproductive strategies and its ability to exclude native vegetation. The plant reproduces both sexually (by seeds) and vegetatively (via rhizomes, which can generate a new plant without fertilization). Seeds are mainly dispersed by birds, but also grow very well after dropping to the ground next to the host plant (Sperry Undated). One study showed that adult kahili ginger plants create favorable conditions for their own seeds and those of strawberry guava (*Psidium cattleianum*), another invasive species in Hawai`i (Minden et al. 2009 as cited in Sperry

Undated). Kahili ginger is shade tolerant and forms dense stands that prevent growth of native flora (Anderson and Gardner 1999 as cited in GISD 2010).
This species was not observed during the most recent vegetation survey at Mt. Ka`ala AFS. However, if seen it should be treated immediately.

Biological: The bacterium *Ralstonia (=Pseudomonas) solanacearum* causes Kahili ginger to wilt and is considered a practical long-term management strategy as it is highly host-specific and does not affect other related species (Anderson and Gardner 1999 as cited in GISD 2010).

Cultural: Kahili ginger is often introduced as an ornamental plant and can spread rapidly to native ecosystems. The species is likely to keep spreading wherever it is planted as an ornamental. Therefore controlling the cultivation of kahili ginger in new environments may prevent further spreading of the species (CABI 2013).

Mechanical: Isolated infestations of kahili ginger may be manually removed. It is important to remove the rhizomes (the "root" of the plant) as well as the stalks and flowers (GISD 2010; Sperry Undated). Removing the flowers slows but does not stop the growth and spreading of the plant. If the seeds are not yet formed flowers can be left on the ground; however if seeds are present flowers should be disposed of in a manner that ensures they will not come in contact with soil or other potentially fertile environments (GISD 2010).

Chemical: Common herbicides that can be used to control kahili ginger include Escort, Amitrole, and Roundup. These should be applied lightly on the roots and leaves from spring to late autumn using the concentrations recommended by the manufacturer. Escort (metsulfuron-methyl) is the most effective herbicide for kahili ginger. Effects of herbicide appear 3 months after application and the plant will die after 12-15 months (Aukland Regional Council 1999 as cited in CABI 2013). However, Escort has considerable environmental consequences and thus may not be suitable for widespread infestations of the plant such as in Hawai`i (Harris et al. 1996 and Tunison and Stone 1992 in Anderson and Gardner 1999, as cited in GISD 2010).

5.2.3.9 Buzzy lizzy (*Impatiens walleriana*)

Management Priority: 3

Buzzy Lizzy is a perennial or annual herb native to Asia. It is often introduced as an ornamental and subsequently invades the surrounding environment (GISD 2008). In Hawai`i it is found mostly in moist, shady areas (Wagner et al. 1999 as cited in PIER 2013). It reproduces via seeds and cuttings (Csurhes and Edwards 1998 as cited in PIER 2013).

Because buzzy lizzy is often cultivated intentionally, controlling or closely monitoring the cultivation of this species may be an important factor in managing it as an invasive (GISD 2008). No further information on management of buzzy lizzy is available in the literature. If the species is observed, please refer to the "other species" profile for management suggestions.

5.2.3.10 Vasey's grass (Paspalum urvillei)

Management Priority: 3

Vasey' grass is a perennial grass that grows in clumps 2.5-8 ft. tall. It is native to tropical America and displaces native plant species in disturbed and open areas in Hawai`i (CABI 2013; GISD 2008). It prefers moist areas with heavy soil and lots of sunlight. It reproduces via seeds which can last up to 9 months in the soil (CABI 2013).

Biological: There are no known biological control agents for Vasey' grass (CABI 2013).

Cultural: Vasey's grass has been spread by hikers who unknowingly carry the seeds on their clothing. Heightened awareness of this possibility could prevent further spread of the plant to new areas in the future (Motooka et al. 2003).

Mechanical: Grazing has been shown to reduce cover of Vasey' grass in certain situations (Newman and Sollenberger 2005 as cited in CABI 2013). Manual removal of small populations can be effective when care is taken to fully remove all rhizomes. Slashing can also be effective when followed by application of an herbicide (Western Australian Herbarium 2012 as cited in CABI 2013).

Chemical: Vasey's grass is susceptible to imazapyr and glyphosate. Drizzle applications of these herbicides have been effective in Hawai`i (Motooka et al. 2003).

5.2.3.11 Kikuyugrass (*Pennisetum clandestinum*)

Management Priority: 2

Kikuyugrass is a perennial grass native to tropical regions of eastern Africa. It prefers moist conditions but can tolerate a range of humidity and light exposure. It reproduces vegetatively via rhizomes and sometimes sexually via seeds. Its rhizomes forms dense mats that release allelopathic chemicals and its long blades shade out other plants. These characteristics physically and chemically inhibit the growth of native plant species in its vicinity (Holm et al. 1977 as cited in PIER 2013). It is often planted intentionally as turf or for erosion control (CABI 2013). In Hawai`i it is considered a serious threat to native vegetation (Wagner et al. 2009 as cited in PIER 2013).

Biological: Biological control has not been investigated for this species as it is often planted intentionally for turf or erosion control (CABI 2013).

Cultural: This species is often planted intentionally as turf or for erosion control. Therefore, measures to control its intentional cultivation may be necessary to manage its invasiveness (CABI 2013).

Mechanical: Kikuyugrass is highly resistant to mowing and grazing (Holm et al. 1977 as cited in PIER 2013). It is also difficult to remove manually because of the dense layer of rhizomes (PIER 2013). Therefore manual removal is usually ineffective unless conducted with heavy equipment (CABI 2013).

Chemical: Glyphosate at 0.5 percent and dalapon at have been successful in controlling kikuyugrass (Smith 1985 as cited in PIER 2013). Kikuyugrass is also sensitive to imazapyr. Roundup at 1 percent without Pulse, Gallant at 0.5 percent and Dowpon 740-SP (16-20g/L water) are effective in controlling new growth (Timmins and Mackenzie 1995 as cited in PIER 2013).

5.2.3.12 Strawberry guava (*Psidium cattleianum*)

Management Priority: 2

Strawberry guava is an evergreen shrub with white flowers, purple-red fruit, and smooth, papery bark that can be 7-26 ft. tall. Native to Brazil, it is often introduced as an ornamental species and then spreads to native ecosystems. It thrives especially in humid areas such as rainforests but tolerates a wide variety of environmental conditions (CABI 2013). It grows in dense monospecific thickets that exclude native vegetation by competing for soil nutrients and light (CABI 2013, GISD 2010). Strawberry guava reproduces both sexually via seeds, which are dispersed by birds and mammals, and asexually via suckers (GISD 2010). It is also allelopathic, releasing chemicals that suppress growth of other plant species in its vicinity (Sperry Undated). Some consider strawberry guava to be the most serious invader of Hawai`ian ecosystems (Smith 1985 as cited in CABI 2013).

Biological: Biological control methods for strawberry guava have not been considered practical in Hawai`i because of the commercial cultivation of related common guava. However, recent efforts to find a biological control for strawberry guava have focused on the possibility of finding a highly specific insect which would defoliate the plants (GISD 2010)

Cultural: Because strawberry guava seeds are often dispersed by nonnative animal species such as feral pigs and frugivorous birds, control of invasive and nonnative fauna is one important control measure (GISD 2010; Sperry Undated). Strawberry guava is also a popular ornamental fruit tree, and is likely to spread to native ecosystems wherever it is cultivated due to its high reproductive success (CABI 2013). Thus controlling cultivation of strawberry guava may also be an important management measure.

Mechanical: The strong root system associated with strawberry guava makes manual removal impractical. Cutting of stems and branches leads to proliferation of suckers and new stems and is thus not recommended as a control measure unless accompanied by application of an herbicide (CABI 2013; Sperry Undated).

Chemical: Strawberry guava is resistant to many foliar herbicides but is sensitive to tebuthiuron, glyphosate, triclopyr, picloram, and dicamba, (CABI 2013; GISD 2010). Undiluted picloram

applied to cut stumps is highly effective but also affects non-target species. Undiluted glyphosate (Roundup) and undiluted triclopyr ester (Garlon 4) have also been effective when applied using the "hack and squirt" method. Garlon's short half-life, well-documented effects, and lack of mobility make it one of the most highly recommended herbicides for strawberry guava (GISD 2010).

5.2.3.13 Sawtooth blackberry (*Rubus argutus*)

Management Priority: 2

Sawtooth blackberry is a woody shrub native to the eastern United States with white flowers and black fruit (CABI 2013; Wagner et al. 1999 as cited in PIER 2013; Sperry Undated). It reproduces sexually, via seeds which are dispersed by frugivorous birds, and vegetatively, via stems that are able to sprout roots when touching the ground. This means that damage to the stems above ground rarely affects the survival of the plant (Sperry Undated). Sawtooth blackberry forms dense, thorny brambles that preclude the growth of other plants and can inhibit the movement of native fauna (Weber 2003 as cited in PIER 2013; Sperry Undated). It colonizes disturbed and open areas and is mildly shade tolerant (Sperry Undated).

If resources are available, treatment of sawtooth blackberry outside the fence at Mt. Ka`ala AFS would be beneficial.

Biological: Biological control has been prioritized for sawtooth blackberry as the extent of the infestation makes mechanical and chemical removal impractical. In the 1960s five insects were released in Hawai`i as control agents for sawtooth blackberry. Three of these insects, *Schreckensteinia festaliella*, *Croesia zimmermani*, and *Priophorus morio*, are still present in Hawai`i and have negative effects on populations of both sawtooth blackberry and native *Rubus* species (Nagata and Markin 1986 as cited in CABI 2013; Tunison 1991 as cited in CABI 2013). Further research is being conducted on fungus species that could be used to control sawtooth blackberry but would not affect native *Rubus* (Smith et al. 2002 as cited in PIER 2013).

Cultural: No cultural management methods are available for sawtooth blackberry. The species should not be intentionally planted.

Mechanical: Vegetative growth of sawtooth blackberry can be inhibited by mowing or cutting stems before they can arch over to reach the ground and sprout roots (CABI 2013).

Chemical: Widespread chemical control of sawtooth blackberry is impractical because it is present over a large area (CABI 2013). Application of glyphosate on cut stems of sawtooth blackberry can be effective for small populations but would be extremely labor intensive for larger infestations (Tunison 1991 as cited in CABI 2013). "Drizzle" applications of glyphosate and triclopyr and foliar applications of triclopyr amine at 0.5 percent have been effective in Hawai`i in the past (Motooka et al. 2003 as cited in CABI 2013).

5.2.3.14 West Indian dropseed (*Sporobolus indicus*)

Management Priority: 3

West Indian dropseed is a perennial grass native to Africa that grows in dense tufts capable of excluding native vegetation. It grows in disturbed areas, grasslands and pastures and is naturalized in these environments in Hawai`i, where it was first identified in 1924 (GISD 2010; Motooka et al. 2003). It reproduces via seeds that are sticky when wet, facilitating their dispersal via animal fur and human clothing. These seeds are produced in vast quantities year round and the seed bank is viable for up to 10 years (Department of Primary Industries and Fisheries 2007 as cited in GISD 2010).

Biological: Past efforts to identify a biological control agent for West Indian dropseed have failed and, currently, there are no approved biological controls (Palmer et al. 2010 as cited in GISD 2010).

Cultural: Because West Indian dropseed takes advantage of disturbed areas it is recommended that land management efforts focus on preventing overgrazing and reducing bare or waste areas (Department of Primary Industries and Fisheries 2007 as cited in GISD 2010).

Mechanical: Manual removal of small patches or individual plants is possible but would be labor and cost intensive for larger infestations. Slashing is not recommended as it often encourages seed growth and dispersal (Department of Primary Industries and Fisheries 2007 as cited in GISD 2010).

Chemical: *West Indian dropseed* pastures are susceptible to flupropanate and glyphosate (Weber 2003 as cited in PIER 2013; Motooka et al. 2003). Amitrole plus atrazine, hexazinone, or 2,2-DPA can also be sprayed on *S. indicus* (Weber 2003 as cited in PIER 2013).

5.3 INVASIVE AND NONNATIVE ANIMALS AT MT. KA`ALA AFS

5.3.1 Methods

The primary sources of information for the development of the invasive, nonnative, and nuisance animal management plan were reports of previously conducted field surveys and other documents providing information about the diversity and distribution of invasive, nonnative, and nuisance animals recorded at Mt. Ka`ala Air Force Station. In addition, an ocular survey for such animal species was conducted on 13-15 November 2013 in conjunction with the invasive and nonnative plant survey.

5.3.2 Results

Table 5-3 provides a summary of the invasive, nonnative, and nuisance animal species at Mt. Ka`ala Air Force Station. The table provides species that are known to occur at Mt. Ka`ala AFS and species observed during the survey.

Table 5-3. Invasive, Nonnative and Nuisance Animal Summary for Mt. Ka`ala AFS

Scientific Name	Common Name	Observed During the Survey	Previously Observed at Kōke`e AFS
Rattus spp.	Rats		
Sus scrofa	Feral pig		

5.3.3 Management Plan for Primary Invasive, Nonnative, and Nuisance Animal Species

Current general management methods for invasive species are described above. The only invasive animals that frequent Kōke`e AFS are rats, which are controlled via poison baits when necessary in cooperation with the Hawai`i DLNR and with technical assistance from the APHIS-ADC of the USDA (USAF 2007). Feral pigs and goats exist in the forest surrounding the site; these are excluded from the AFS by fencing and are controlled by hunting.

THIS PAGE INTENTIONALLY LEFT BLANK

6. LIST OF PREPARERS

Shannon Cauley, USACE CWD, CPSS
B.S. Geology
Graduate Studies Natural Resources
Graduate Studies Geology
USACE Certified Wetland Delineator
Certified Professional Soil Scientist
Years of Experience: 31

Madilyn Gamble
B.S. Biology
Years of Experience: 1

Renee Kinchla
MRP City and Regional Planning
BS Environmental Design
Years of Experience: 7

Jeannette Matkowski
B.S. Biology
Years of Experience: 11

Bob Okoniewski
AS General Studies
Years of Experience: 28

Dan Savercool, CSE
AAS Natural Resources Conservation
BA Zoology/Marine Science
MS Biological Oceanography
Senior Certified Military Natural Resources Professional
Certified Senior Ecologist
Years of Experience: 32

THIS PAGE INTENTIONALLY LEFT BLANK

7. REFERENCES

Abe, T., S. Makino, and I. Okochi. 2008. Why have endemic pollinators declined on the Ogasawara Islands? Biodivers Conserv (2008) 17:1465–1473.

Abril, S., J. Oliveras, and C. Gómez. 2007. Foraging activity and dietary spectrum of the Argentine ant (Hymenoptera: Formicidae) in invaded natural areas of the northeast Iberian Peninsula. Environmental Entomology, 36(5):1166-1173.

Acevedo-Rodríguez, P. and M.T. Strong. 2005. Monocots and Gymnosperms of Puerto Rico and the Virgin Islands. Contributions from the United States National Herbarium, Volume 52:415 pp.

Adams, C. and H. Baker. 1962. Weeds of cultivation and grazing lands. In: Wills J, ed. Agriculture and Land Use in Ghana. London, UK: Oxford Press.

Aluka. 2008. Entry for Setaria verticillata (L.) P. Beauv. [family POACEAE]. Available at http://www.aluka.org/action/showMetadata?doi=10.5555%2FAL.AP.FLORA.FTEA008587. [Accessed 20 June 2008].

Anderson, R.C. and D.E. Gardner. 1999. An Evaluation of the Wilt-Causing Bacterium Ralstonia solanacearum as a Potential Biological Control Agent for the Alien Kahili Ginger (Hedychium gardnerianum) in Hawai`ian Forests, Biological Control 15: 89–96.

Arnold, M.A. 2004. Sansevieria trifasciata. In: Landscape Plants For Texas And Environs, Ed. 3., USA: Stipes Publishing.

Atkinson, I.A.E. and D.R. Towns. 2001. Advances in New Zealand mammalogy 1990-2000: Pacific rat. Journal of the Royal Society of New Zealand 31(1): 99-109.

Auckland Regional Council. 1999. Pestfacts. Wild ginger: Hedychium gardnerianum, *H. flavescens*.

Avery, M.L., E.A. Tillman, and P.J. Savarie. 2004. Responses of captive fish crows (Corvus ossifragus) to acetaminophen baits and bait stations for brown tree snake (Boiga irregularis) control on Guam. Bird Behavior 16(1-2): 1-6.

Baloch G.M., T. Zafar, and A.G. Khan. 1976. Natural enemies of Abutilon, Amaranthus, Rumex and Sorghum in Pakistan. Trinidad, Commonwealth Institute of Biological Control: Report of work carried out during 1975. Commonwealth Institute of Biological Control. Trinidad, West Indies, 69-70.

Bangarwa, S.K., J.K. Norsworthy, P. Jha, and M. Malik. 2008. Purple nutsedge (*Cyperus rotundus*) management in an organic production system, Weed Science 56(4): 606-613.

Barman, J. and H.M. Mehta. 1989. Herbicidal weed management in irrigated rice (Oryza sativa L. CV. GR-4) nursery. Gujarat Agricultural University Research Journal, 15(1):81-83.

Bess, H.A. and F.H. Harmamoto. 1972. Biological control of pamakani, Eupatorium adenophorum, in Hawai`i by a tephritid gall fly, Procecidochares utilis. 3. Status of the weed, fly and parasities of the fly in 1966-71 versus 1950-57. Proceedings of the Hawai`ian Entomological Society, 21:165-178.

Binggeli, P. 1997. Casuarina equisetifolia L. (Casuarinaceae), Woody Plant Ecology.

Binggeli, P. 1 997. Myrica faya L. (Myricaceae). Available at http://members.lycos.co.uk/WoodyPlantEcology/docs/web-sp12.htm. [Accessed 25 February 2003].

Birdlife International. 2008. Species Factsheet: Gallirallus owstoni. Available at http://www.birdlife.org [Accessed 5 June 2008].

Biring, B.S., W.J. Hays-Byl, and S.E. Hoyles. 1999. Twelve-year conifer and vegetation responses to discing and glyphosate treatments on a BWBSmw backlog site. Working Paper 43. Victoria, BC: British Columbia Ministry of Forests, Research Branch. 34 p. [41236].

Blamey, F.P.C. and E.M. Hutton. 1995. Tolerance of Leucaena to acid soil conditions. In: Shelton HM, Piggin CM, Brewbaker JL, eds. Leucaena - Opportunities and Limitations. Proceedings of a Workshop, Bogor, Indonesia. Canberra, Australia: ACIAR Proceedings No. 57, 83-86.

Bolger, D.T., A.V. Suarez, K.R. Crooks, S.A. Morrison, and T.J. Case. 2000. Arthropods in urban habitat fragments in Southern California: area, age, and edge effects. Ecological Applications, 10(4):1230-1248.

Brewbaker, J.L. 1987. Leucaena: a multipurpose tree genus for tropical agroforestry. In: Steppler HA, Nair PKR, eds. Agroforestry: a decade of development. Nairobi, Kenya: International Council for Research in Agroforestry, 289-323; 93 ref.

Brown, D., W. Pitt, and B. Tershy. 2013. Wake Atoll Rat Eradication Review. Final Draft, 5 September.

CABI. 2013. Ageratina adenophora. In: Invasive Species Compendium. Wallingford, UK: CAB International. www.cabi.org/isc.

CABI. 2013. Amaranthus viridis. In: Invasive Species Compendium. Wallingford, UK: CAB International. www.cabi.org/isc.

CABI. 2013. Bidens alba. In: Invasive Species Compendium. Wallingford, UK: CAB International. www.cabi.org/isc.

CABI. 2013. Casuarina equisetifolia. In: Invasive Species Compendium. Wallingford, UK: CAB International. www.cabi.org/isc.

CABI. 2013. Cenchrus echinatus. In: Invasive Species Compendium. Wallingford, UK: CAB International. www.cabi.org/isc.

CABI. 2013. Clidemia hirta. In: Invasive Species Compendium. Wallingford, UK: CAB International. www.cabi.org/isc.

CABI. 2013. Conzya bonariensis. In: Invasive Species Compendium. Wallingford, UK: CAB International. www.cabi.org/isc.

CABI. 2013. Cynodon dactylon. In: Invasive Species Compendium. Wallingford, UK: CAB International. www.cabi.org/isc.

CABI. 2013. Digitaria insularis. In: Invasive Species Compendium. Wallingford, UK: CAB International. www.cabi.org/isc.

CABI. 2013. Eichhornia crassipes. In: Invasive Species Compendium. Wallingford, UK: CAB International. www.cabi.org/isc.

CABI. 2013. Eleusine indica. In: Invasive Species Compendium. Wallingford, UK: CAB International. www.cabi.org/isc.

CABI. 2013. Epipr emnum pinnatum. In: Invasive Species Compendium. Wallingford, UK: CAB International. www.cabi.org/isc.

CABI. 2013. Eragrostis amabilis. In: Invasive Species Compendium. Wallingford, UK: CAB International. www.cabi.org/isc.

CABI. 2013. Erigeron karvinskianus. In: Invasive Species Compendium. Wallingford, UK: CAB International. www.cabi.org/isc.

CABI. 2013. Fragraria vesca. In: Invasive Species Compendium. Wallingford, UK: CAB International. www.cabi.org/isc.

CABI. 2013. Hedychium flavescens. In: Invasive Species Compendium. Wallingford, UK: CAB International. www.cabi.org/isc.

CABI. 2013. Hedychium gardnerianum. In: Invasive Species Compendium. Wallingford, UK: CAB International. www.cabi.org/isc.

CABI. 2013. Holcus lanatus. In: Invasive Species Compendium. Wallingford, UK: CAB International. www.cabi.org/isc.

CABI. 2013. Kalanchoe pinnata. In: Invasive Species Compendium. Wallingford, UK: CAB International. www.cabi.org/isc.

CABI. 2013. Lantana camara. In: Invasive Species Compendium. Wallingford, UK: CAB International. www.cabi.org/isc.

CABI. 2013. Melinis minutiflora. In: Invasive Species Compendium. Wallingford, UK: CAB International. www.cabi.org/isc.

CABI. 2013. Mimosa pudica. In: Invasive Species Compendium. Wallingford, UK: CAB International. www.cabi.org/isc.

CABI. 2013. Morella faya. In: Invasive Species Compendium. Wallingford, UK: CAB International. www.cabi.org/isc.

CABI. 2013. Passiflora tripartita var. mollissima. In: Invasive Species Compendium. Wallingford, UK: CAB International. www.cabi.org/isc.

CABI. 2013. Paspalum urvillei. In: Invasive Species Compendium. Wallingford, UK: CAB International. www.cabi.org/isc.

CABI. 2013. Pennisetum clandestinum. In: Invasive Species Compendium. Wallingford, UK: CAB International. www.cabi.org/isc.

CABI. 2013. Plantago lanceolata. In: Invasive Species Compendium. Wallingford, UK: CAB International. www.cabi.org/isc.

CABI. 2013. Psidium cattleianum. In: Invasive Species Compendium. Wallingford, UK: CAB International. www.cabi.org/isc.

CABI. 2013. Sechium edule. In: Invasive Species Compendium. Wallingford, UK: CAB International. www.cabi.org/isc.

CABI. 2013. Setaria palmifolia. In: Invasive Species Compendium. Wallingford, UK: CAB International. www.cabi.org/isc.

CABI. 2013. Syzygium cumini. In: Invasive Species Compendium. Wallingford, UK: CAB International. www.cabi.org/isc.

CABI. 2013. Rubus argutus. In: Invasive Species Compendium. Wallingford, UK: CAB International. www.cabi.org/isc.

CABI. 2014. Achatina fulica. In: Invasive Species Compendium. Wallingford, UK: CAB International. www.cabi.org/isc.

CABI. 2014. Anoplolipes gracilipes. In: Invasive Species Compendium. Wallingford, UK: CAB International. www.cabi.org/isc.

CABI. 2014. Chamaesyce hirta. In: Invasive Species Compendium. Wallingford, UK: CAB International. www.cabi.org/isc.

CABI. 2014. Coccinia grandis. In: Invasive Species Compendium. Wallingford, UK: CAB International. www.cabi.org/isc.

CABI. 2014. Cuscuta pentagona. In: Invasive Species Compendium. Wallingford, UK: CAB International. www.cabi.org/isc.

CABI. 2014. Ipomoea aquatica. In: Invasive Species Compendium. Wallingford, UK: CAB International. www.cabi.org/isc.

CABI. 2014. Linepithema humile. In: Invasive Species Compendium. Wallingford, UK: CAB International. www.cabi.org/isc.

CABI. 2014. Leucaena leucocephala. In: Invasive Species Compendium. Wallingford, UK: CAB International. www.cabi.org/isc.

CABI. 2014. Passiflora foetida. In: Invasive Species Compendium. Wallingford, UK: CAB International. www.cabi.org/isc.

CABI. 2014. Pennisetum polystachion. In: Invasive Species Compendium. Wallingford, UK: CAB International. www.cabi.org/isc.

CABI. 2014. Pheidole megacephala. In: Invasive Species Compendium. Wallingford, UK: CAB International. www.cabi.org/isc.

CABI. 2014. Rattus exulans. In: Invasive Species Compendium. Wallingford, UK: CAB International. www.cabi.org/isc.

CABI. 2014. Ricinus communis. In: Invasive Species Compendium. Wallingford, UK: CAB International. www.cabi.org/isc.

CABI. 2014. Sansevieria trifasciata. In: Invasive Species Compendium. Wallingford, UK: CAB International. www.cabi.org/isc.

CABI. 2014. Setaria verticillata. In: Invasive Species Compendium. Wallingford, UK: CAB International. www.cabi.org/isc.

CABI. 2014. Terminalia catappa. In: Invasive Species Compendium. Wallingford, UK: CAB International. www.cabi.org/isc.

CABI. 2014. Tradescantia spathacea. In: Invasive Species Compendium. Wallingford, UK: CAB International. www.cabi.org/isc.

CABI. 2014. Tribulus cistoides. In: Invasive Species Compendium. Wallingford, UK: CAB International. www.cabi.org/isc.

CABI. 2014. Tridax procumbens. In: Invasive Species Compendium. Wallingford, UK: CAB International. www.cabi.org/isc.

Cerdeira, A.L., D.L.P. Gazziero, S.O. Duke, and M.B. Matallo. 2011. Agricultural impacts of glyphosate-resistant soybean cultivation in South America. Journal of Agricultural and Food Chemistry, 59(11):5799-5807. Available at http://pubs.acs.org/doi/abs/10.1021/jf102652y.

Chadhokar, P.A. 1978. Weed problems of grazing lands and control of some problem weeds in the Markham Valley of Papua New Guinea. PANS, 24(1):63-66.

Challa, P. 1984. Chemical weed control in mango root stock nursery. Tropical Pest Management, 30(4):466-467.

Chin, L.Y. and F.W. Fong. 1978. Preliminary studies on the productivities of the two most abundant macrophytes in Subang Lake. Malaysian Agricultural Journal, 51(4):422-435.

Christman, S. 2004. Coccoloba uvifera. Floridata. Available at http://www.floridata.com/ref/c/coccuvi.cfm. [Accessed 7 January 2014].

Chugach Federal Solutions Inc. (Chugach). 2011. Wake Island Air Field Activity Standard Operating Procedures Invasive Species Prevention and Control. Written for the United States Air Force. August.

Cole, F.R., A.C. Medeiros, L.L. Loope, and W.W. Zuehlke. 1992. Effects of the Argentine ant on arthropod fauna of Hawai`ian high-elevation shrubland. Ecology, 73(4):1313-1322.

Convention on Biological Diversity (CBD). 2003. Pilot Assessments: The Ecological and Socio-Economic Impact of Invasive Alien Species on Island Ecosystems. Subsidiary Body on Scientific, Technical and Technological Advice (Ninth meeting: Item 7.1 of the provisional agenda, Montreal, 10-14 November 2003).

Crocker, J.A. 1987. Herbicides for the control of golden dodder in amenity areas. In: Proceedings of the Eighth Australian Weeds Conference, Sydney, New South Wales, Australia, 21-25 September, 1987 [ed. by Lemerle, D.\Leys, A. R.]. Sydney, Australia: Weed Society of New South Wales, 455-457.

Cronk, Q.C.B. and J.L. Fuller. 1995. Plant invaders: the threat to natural ecosystems. London, UK: Chapman & Hall.

Csurhes, S. and R. Edwards. 1998. Potential environmental weeds in Australia: Candidate species for preventative control. Canberra, Australia. Biodiversity Group, Environment Australia. 208 pp.

Cudney, D.W., C.L. Elmore, R.H. Molinar. Undated. Produced by Integrated Pest Management Education and Publications, University of California Statewide Integrated Pest Management Program. Available at http://www.ipm.ucdavis.edu/PMG/PESTNOTES/pn7461.html. Accessed 2 January 2014.

Cudney, D.W., J.A. Downer, V.A. Gibeault, J.M. Henry, C.L. Elmore, J.S. Reints. 1994. Herbicide program can control kikuyugrass in cool-season turf. California Agriculture, 48(2):24-28.

Darwin Initiative Project. 2006. Combating Invasive Alien Plants Threatening the East Usambara Mountains, Tanzania. Usambara Invasive Plants. Species descriptions. Available at http://www.tropical-biology.org/research/dip/species.htm.

Dawson, J.H., L.J. Musselman, P. Wolswinkel, and I. Dorr. 1994. Biology and control of Cuscuta. Reviews of Weed Science, 6:265-317.

Defense Transportation Regulation. 2013. Part V – Department of Defense Customs and Border Clearance Policies and Procedures. Chapter 511: United States Pacific Command (USPACOM).

Dekker, J. 2003. The foxtail (Setaria) species-group. Weed Science, 51:641–656.

Demirci, M. and Y. Nemli. 1998. In vitro studies on detection of trifluralin resistance in Setaria verticillata (L.) P.B. (In vitro testlerle trifluraline karsi Setaria verticillata (L.) P.B.'nin dayanikliliginin saptanmasina yönelik bazi Çalismalar.) In: Proceedings Second Turkish Weed Science Congress, Bornova, Izmir, Turkey, 1-4 September 1997 [ed. by Nemli, Y.\Demirkan, H.]. Bornova, Turkey: Ege Universitesi Basimevi, 73-80.

Department of Primary Industries and Fisheries. 2007. Weedy Sporobolus grasses. Best Practice Manual. The original edition (1999, 2001) was compiled by the Giant Rats Tail team: Felicity Mclntosh, Bill Schulke, Graeme Elphinstone, Steven Bray, Wayne Vogler, Col Paton, Bernie Shore, Michael Yee and Nigel Gallas. The revised edition (2007) has been updated by Steven Bray and David Officer. Available at http://www.dpi.qld.gov.au/documents/Biosecurity_GeneralPlantHealthPestsDiseaseAndWeeds/Weedy-Sporobolus-manual.pdf. [Accessed 10 April 2010].

Deshmukh, S.V., H.B. Kale, and S.B. Atale. 1995. Effect of 2,4-diphenoxy acetic acid, isoproturon and Isoguard Plus on weed control in irrigated, late-sown wheat (Triticum aestivum). Indian Journal of Agronomy, 40(2):296-297; 2 ref.

Division of Plant Industry. 2003. List of plant species designated as noxious weeds (20 October 2003). Hawai`i Department of Agriculture.

Duffy, B.K. and D.E. Gardner. 1994. Locally established fruit rot of Myrica faya, a noxious weed in Hawai`i. Plant Disease. 78(9). 1994. 919-923

Elfers, S.C. 1988. Element Stewardship Abstract for Casuarina equisetifolia. The Nature Conservancy.

Englberger K. 2009. Invasive weeds of Pohnpei: A guide for identification and public awareness. Kolonia, Federated States of Micronesia: Conservation Society of Pohnpei, 29 pp.

Fears, N. Undated. Water Spinach Exotic Aquatics on the Move [Online Database] Sea Grant. Available at http://www.iisgcp.org/EXOTICSP/waterspinach.htm. [Accessed 24 October 2003].

Feng, Z., P.G. Hartel, R.W. Roncadori, S.J.S. Sung, and J.E. Box. 1998. Inhibition of fungal colonization on the rhizoplane of the CS2-production plant, Mimosa pudica L. In: Plant and Soil Sciences 82. Kluwer Academic Publishers, Dordrecht, Netherlands. 115-126.

Fernández-Palacios JM, Arévalo Jr. 1998. Regeneration strategies of tree species in the laurel forest of Tenerife (The Canary Islands). Plant Ecology, 137:21-29.

Figliola, S.S., N.D. Camper, and W.H. Ridings. 1988. Potential biological control agents for goosegrass (Eleusine indica). Weed Science, 36(6):830-835.

Findlay, J.B.R. and D. Jones. 1996. The integrated control of water hyacinth, Eichhornia crassipes, in Africa based on Roundup R herbicide treatments. In: Moran VC, Hoffmann JH, eds. Proceedings of the 9th international symposium on biological control of weeds, Stellenbosch, South Africa, 19-26 January 1996:435-440.

Flint, E. and C. Rehkemper. 2002. Control and eradication of the introduced grass, Cenchrus echinatus, at Laysan Island, Central Pacific Ocean. In: C.R. Veitch, M.N. Clout (eds) Turning the Tide: The Eradication of Invasive Species. Proceedings of the International Conference on Eradication of Island Invasives. pp 110. Available at http://www.issg.org/pdf/publications/turning_the_tide.pdf. [Accessed 24 September 2010]

Flora of North America Editorial Committee, eds. 2013. Flora of North America North of Mexico (online edition).

Flores, A. 2008. ARS Researchers Search for Casuarina Biological Control Agents. USDA-ARS (United States Department of Agriculture - Agricultural Research Service). Available at http://www.ars.usda.gov/is/pr/2008/080902.htm. [Accessed 11 November 2009].

Florida Department of Environmental Protection - Bureau of Invasive Plant Management. Undated. Weed Alert: Australian pine (Casuarina species). Available at http://www.fleppc.org/Weed_Alerts.htm. [Accessed 11 November 2009].

Florida Exotic Pest Plant Council. 2011. Florida EPPC's 2011 Invasive Plant Species List. Available at http://www.fleppc.org/list/11list.html.

Forschler B. 1997. A prescription for ant control success. Pest Control, 65(6):34-38.

Francis, J.K. Undated. Sensitive plant fact sheet. Available at http://www.fs.fed.us/global/iitf/pdf/shrubs/Mimosa%20pudica.pdf#xml=http://www.fs.fed.us/cgi-

bin/texis/searchallsites/search.allsites/xml.txt?query=fabaceae&db=allsites&id=424cbeea0. [Accessed 9 May 2006].

Francis, J.K. Undated. Pluchea carolinensis (Jacq.) G. Don. Available at http://www.fs.fed.us/global/iitf/pdf/shrubs/Pluchea%20carolinensis.pdf. [Accessed 2 January 2014].

Frank, J.R. and J.A. Simon. 1981. Glyphosate and paraquat effectiveness in woody nursery stock. Weed Science, 29(4):455-461.

Frenot, Y. and J.C. Gloaguen. 1994. Reproductive performance of native and alien colonizing phanerogams on a glacier foreland, Iles Kerguelen. Polar Biology, Volume 14, Number 7 /October 1994.

Fritts, T.H. and D. Leasman-Tanner. 2001. The Brown Treesnake on Guam: How the arrival of one invasive species damaged the ecology, commerce, electrical systems, and human health on Guam: A comprehensive information source.

Fritts, T.H. and G.H. Rodda. 1998. The role of introduced species in the degradation of island ecosystems: a case history of Guam. Annual Review of Ecology and Systematics 29: 113–140.

Garry Oak Ecosystems Recovery Team. 2003. Holcus lunatus. Victoria, Canada: Garry Oak Ecosystems Recovery Team. Invasive species in Garry Oak and associated ecosystems in British Columbia. Available at http://www.goert.ca/documents/InvFS_holclana.pdf.

Garry Oaks Ecosystem Recovery Team. 2009. Annual bluegrass Poa annua. Available at http://www.goert.ca/documents/P.annua.pdf. [Accessed 23 August 2010].

Gates, W.R. and A.R. Gates. 2006. Anolis carolinensis carolinensis (Northern green anole). Behavior. Herpetological Review. 37(3). SEP 2006. 344.

Gautam, D.R. and J.S. Chauhan. 1984. Possibilities of reducing the soil cultivation by using herbicides in peach nursery production. Journal of Tree Sciences, 3(1/2):99-104.

George, M. and K. Venkataraman. 1987. Occurrence and life history of Cassida circumdata Herbst (Coleoptera: Chrysomelidae) in Keoladeo National Park, Bharatput, India. Journal of the Bombay Natural History Society, 84(1):248-253.

Gilman, E.F. 1999. Sansevieria trifascita Hahnii. University of Florida, Cooperative Extension Service, Fact Sheet FPS-534.

Gilman, E.F. 2011. Epipremnum aureum Golden Pothos., USA: University of Florida IFAS Extension. [FPS 194.] Available at http://edis.ifas.ufl.edu/fp194.

Global Invasive Species Database (GISD). 2005. Passiflora tarminiana. Available at http://www.issg.org/database/species/ecology.asp?si=336&fr=1&sts=sss&lang=EN. [Accessed 30 December 2013].

Global Invasive Species Database (GISD). 2006. Clidemia hirta. Available at http://www.issg.org/database/species/ecology.asp?si=53&fr=1&sts=sss&lang=EN. [Accessed 19 December 2013].

Global Invasive Species Database (GISD). 2006. Ipomoea aquatica. Available at http://www.issg.org/database/species/ecology.asp?si=477&fr=1&sts=sss&lang=EN. [Accessed 19 December 2013].

Global Invasive Species Database (GISD). 2006. Lantana camara. Available at http://www.issg.org/database/species/ecology.asp?si=56&fr=1&sts=sss&lang=EN. [Accessed 19 December 2013].

Global Invasive Species Database (GISD). 2006. Morella faya. Available at http://www.issg.org/database/species/ecology.asp?si=100&fr=1&sts=sss&lang=EN. [Accessed 30 December 2013].

Global Invasive Species Database (GISD). 2006. Passiflora foetida . Available at http://www.issg.org/database/species/ecology.asp?si=341&fr=1&sts=sss&lang=EN. [Accessed 30 December 2013].

Global Invasive Species Database (GISD). 2006. Pennisetum polystachion (Cenchrus polystachios). Available at http://www.issg.org/database/species/ecology.asp?si=210&fr=1&sts=sss&lang=EN. [Accessed 30 December 2013].

Global Invasive Species Database (GISD). 2006. Ricinus communis . Available at http://www.issg.org/database/species/ecology.asp?si=1000&fr=1&sts=sss&lang=EN. [Accessed 30 December 2013].

Global Invasive Species Database (GISD). 2006. Syzygium cumini. Available at http://www.issg.org/database/species/ecology.asp?si=505&fr=1&sts=sss&lang=EN. [Accessed 19 December 2013].

Global Invasive Species Database (GISD). 2008. Erigeron karvinskianus. Available at http://www.issg.org/database/species/ecology.asp?si=1278&fr=1&sts=sss&lang=EN [Accessed 19 December 2013].

Global Invasive Species Database (GISD). 2008. Fragaria vesca. Available at http://www.issg.org/database/species/ecology.asp?si=1328&fr=1&sts=sss&lang=EN. [Accessed 19 December 2013].

Global Invasive Species Database (GISD). 2008. Impatiens walleriana. Available at http://www.issg.org/database/species/ecology.asp?si=1272&fr=1&sts=sss&lang=EN. [Accessed 19 December 2013].

Global Invasive Species Database (GISD). 2008. Melinis minutiflora. Available at http://www.issg.org/database/species/ecology.asp?si=1310&fr=1&sts=sss&lang=EN. [Accessed 20 December 2013].

Global Invasive Species Database (GISD). 2008. Paspalum urvillei. Available at http://www.issg.org/database/species/ecology.asp?si=1263&fr=1&sts=sss&lang=EN. [Accessed 19 December 2013].

Global Invasive Species Database (GISD). 2008. Sechium edule. Available at http://www.issg.org/database/species/ecology.asp?si=1305&fr=1&sts=sss&lang=EN. [Accessed 30 December 2013].

Global Invasive Species Database (GISD). 2009. Anoplolepis gracilipes. Available at http://www.issg.org/database/species/ecology.asp?si=110&fr=1&sts=sss&lang=EN. [Accessed 19 December 2013].

Global Invasive Species Database (GISD). 2009. Boiga irregularis. Available at http://www.issg.org/database/species/ecology.asp?si=54&fr=1&sts=sss&lang=EN. [Accessed 6 January 2013].

Global Invasive Species Database (GISD). 2009. Cyperus rotundus. Available at http://www.issg.org/database/species/ecology.asp?si=1448&fr=1&sts=sss&lang=EN. [Accessed 19 December 2013].

Global Invasive Species Database (GISD). 2010. Achatina fulica. Available at http://www.issg.org/database/species/ecology.asp?si=64&fr=1&sts=sss&lang=EN. [Accessed 3 January 2013].

Global Invasive Species Database (GISD). 2010. Anolis carolinensis. Available at http://www.issg.org/database/species/ecology.asp?si=604&fr=1&sts=sss&lang=EN. [Accessed 3 January 2013].

Global Invasive Species Database (GISD). 2010. Cenchrus echinatus. Available at http://www.issg.org/database/species/ecology.asp?si=1655&fr=1&sts=sss&lang=EN. [Accessed 31 December 2013].

Global Invasive Species Database (GISD). 2010. Casuarina equisetifolia. Available at http://www.issg.org/database/species/ecology.asp?si=365&fr=1&sts=sss&lang=EN. [Accessed 17 December 2013].

Global Invasive Species Database (GISD). 2010. Cynodon dactylon. Available at http://www.issg.org/database/species/ecology.asp?si=202&fr=1&sts=sss&lang=EN. [Accessed 19 December 2013].

Global Invasive Species Database (GISD). 2010. Hedychium flavescens. Available at http://www.issg.org/database/species/ecology.asp?si=196&fr=1&sts=sss&lang=EN. [Accessed 17 December 2013].

Global Invasive Species Database (GISD). 2010. Hedychium gardnerianum. Available at http://www.issg.org/database/species/ecology.asp?si=57&fr=1&sts=sss&lang=EN. [Accessed 17 December 2013].

Global Invasive Species Database (GISD). 2010. Leucaena leucocephala. Available at http://www.issg.org/database/species/ecology.asp?si=23&fr=1&sts=sss&lang=EN. [Accessed 17 December 2013].

Global Invasive Species Database (GISD). 2010. Mimosa pudica. Available at http://www.issg.org/database/species/ecology.asp?si=1002&fr=1&sts=sss&lang=EN. [Accessed 17 December 2013].

Global Invasive Species Database (GISD). 2010. Paratrechina longicornis. Available at http://www.issg.org/database/species/ecology.asp?si=958&fr=1&sts=sss&lang=EN. [Accessed 18 December 2013].

Global Invasive Species Database (GISD). 2010. Psidium cattleianum. Available at http://www.issg.org/database/species/ecology.asp?si=59&fr=1&sts=sss&lang=EN. [Accessed 18 December 2013].

Global Invasive Species Database (GISD). 2010. Rattus exulans. Available at http://www.issg.org/database/species/ecology.asp?si=170&fr=1&sts=sss&lang=EN. [Accessed 10 January 2014].

Global Invasive Species Database (GISD). 2010. Sansevieria trifasciata. Available at http://www.issg.org/database/species/ecology.asp?si=1797&fr=1&sts=sss&lang=EN. [Accessed 18 December 2013].

Global Invasive Species Database (GISD). 2010. Setaria verticillata. Available at http://www.issg.org/database/species/ecology.asp?si=927&fr=1&sts=sss&lang=EN. [Accessed 19 December 2013].

Global Invasive Species Database (GISD). 2010. Solenopsis geminata. Available at http://www.issg.org/database/species/ecology.asp?si=169&fr=1&sts=sss&lang=EN. [Accessed 19 December 2013].

Global Invasive Species Database (GISD). 2010. Sporobolus indicus var. capensis. Available at http://www.issg.org/database/species/ecology.asp?si=1587&fr=1&sts=sss&lang=EN. [Accessed 30 December 2013].

Global Invasive Species Database (GISD). 2010. Terminalia catappa. Available at http://www.issg.org/database/species/ecology.asp?si=1581&fr=1&sts=sss&lang=EN. [Accessed 30 December 2013].

Global Invasive Species Database (GISD). 2011. Pheidole megacephala. Available at http://www.issg.org/database/species/ecology.asp?si=132&fr=1&sts=sss&lang=EN. [Accessed 30 December 2013].

Gonzal, L.R., J.A. Sales, M.A. Sales. 1989. Efficacy of Kris Plant (Alocasia sanderiana Bull.) extract as herbicide. Proceedings of the International Seminar on Underutilized Bioresources in the Tropics, Manila, Philippines, 1988.

Govaerts, R. 2012. World Checklist of Araceae. London, UK: Royal Botanic Gardens, Kew. Available at http://apps.kew.org/wcsp/.

Germplasm Resources Information Network (GRIN). 2013. United States Department of Agriculture, Agricultural Research Service. Online Database. Beltsville, USA: National Germplasm Resources Laboratory. Available at http://www.ars-grin.gov/.

Haines, I.H., Haines, J.B. and Cherrett, and J M. 1994. The impact and control of the Crazy ant, Anoplolepis longipes (Jerd.), in the Seychelles. pp. 206–218 in Williams, D. F. (ed.), Exotic ants. Biology, impact, and control of introduced species. Westview, Boulder, CO.

Hara, A.H. and T.Y. Hata. 1992. Ant control on protea in Hawai`i. Scientia Horticulturae, 51(1-2):155-163.

Harley, K.L.S. 1990. The role of biological control in the management of water hyacinth, Eichhornia crassipes. Biocontrol News and Information, 11(1):11-22.

Harris, R. K. Abbott, K. Barton, J. Berry, W. Don, D. Gunawardana, P. Lester, J. Rees, M. Stanley, A. Sutherland, and R. Toft. 2005. Invasive ant pest risk assessment project for Biosecurity New Zealand. Series of unpublished Landcare Research contract reports to Biosecurity New Zealand. BAH/35/2004-1. Available at http://www.landcareresearch.co.nz/research/biocons/invertebrates/Ants/ant_pest_risk.asp. [Accessed 20 May 2007].

Hawai`i Invasive Species Council. 2014. Hawai`i's high-profile invasive species. Available at http://dlnr.Hawai`i.gov/hisc/info/species/. [Accessed 9 January 2014].

Heap, J.W. 1992. Golden dodder and silverleaf nightshade. Study tour to USA. Technical Report - Department of Agriculture, South Australia, No. 190:34 pp.

Hetherington, T.E., B. Coupe, G. Perry, N.L. Anderson, and J.B. Williams. 2008. Diurnal refuge-site selection by Brown Treesnakes (Boiga irregularis) on Guam Amphibia-Reptilia. 29(2). 284-287.

Hill, G., M. Cock, and G. Howard. 1999. A global review of water hyacinth - its control and utilization. CABI Bioscience and IUCN.

Hind. N. 2012. Erigeron karvinskianus: Compositae. Curtis's Botanical Magazine, 29(1):52-65. Available at http://onlinelibrary.wiley.com/journal/10.1111/(ISSN)1467-8748.

Hitchcock, L.E. 1996. *Notes: Typhoon report from JTWC at Guam dated 3 OCT 96.* As referenced in USAF 2008a.

Hoffmann, B.D. and S. O'Connor. 2004. Eradication of two exotic ants from Kakadu National Park. Ecological Management & Restoration, August 2004, vol. 5, no. 2, pp. 98-105(8).

Hollender, C.A., A.C. Geretz, J.P. Slovin, and Z.C. Liu. 2012. Flower and early fruit development in a diploid strawberry, Fragaria vesca. Planta, 235(6):1123-1139. Available at http://www.springerlink.com/content/e7285p0h63047502/.

Holm, L.G., D.L. Plucknett, J.V. Pancho, J.P. Herberger. 1977. The World's Worst Weeds. Distribution and Biology. Honolulu, Hawai`i, USA: University Press of Hawai`i.

Holway, D.A., L. Lach, A.V. Suarez, N.D. Tsutsui, and T.J. Case. 2002. The Causes and Consequences of Ant Invasions, Annu. Rev. Ecol. Syst. 33: 181-233.

Horwood, M.A. 1988. Control of Pheidole megacephala (F.) (Hymenoptera: Formicidae) using methoprene baits. Journal of the Australian Entomological Society, 27(4):257-258.

Huang, Z.L., L. ShaoXiang, T. ShaoMan, L. SongYu, Y. GuoQing, and M. XiaoYong. 1997. Effects of leaf extracts of Eucalyptus and other plant species on the rooting of cuttings and seed germination of several plant species. Forest Research, 10(5):546-550; 15 ref.

Hughes, C.E. 1998a. Monograph of Leucaena Benth. (Leguminosae: Mimosoideae). Systematic Botany Monographs, No. 55: 1-242.

Hughes, C.E. 1998b. The genus Leucaena: a genetic resources handbook. Tropical Forestry Paper 37. Oxford, UK: Oxford Forestry Institute.

ISSG. 2012. Global Invasive Species Database (GISD). Aucklan d, New Zealand: University of Auckland. http://www.issg.org/database

ISSG. Undated. Ant Management: Crazy Ant (Paratrechina longicornis). Available at http://www.issg.org/database/species/reference_files/parlon/parlon_man.pdf. [Accessed 3 January 2014].

ISSG. Undated. Ant Management: Yellow Crazy Ant (Anoplolipes gracilipes). Available through GISD 2009 at http://www.issg.org/database/species/ecology.asp?si=110. [Accessed 3 January 2014].

ISSG. Undated. Control Methods for Solenopsis spp. Available at http://www.issg.org/database/species/reference_files/SolCont.pdf. [Accessed 3 January 2014].

Ivens, G.W. 1989. East African Weeds and their Control, 2nd edition. Nairobi, Kenya: Oxford University Press.

Jayachandra, M.V. 1972. Post-emergent control of dicot weeds with bromacil. Current Science, 41(3):120.

Johnson D.H. and R.E. Talbert. 1993. Imazethapyr and imazaquin control puncturevine (*Tribulus terrestris*) but carry over to spinach (*Spinacia oleracea*). Weed Technology, 7(1):79-83

Joseph. K and T.K. Bridgit. 1993. Effect of chemical and integrated weed management in upland rice. Journal of Tropical Agriculture, 31:77-80.

JSTOR Plant Science. 2010. Cenchrus echinatus L. [family POACEAE] Available at http://plants.jstor.org/taxon/flora/Cenchrus.echinatus. [Accessed 26 July 2010].

Julien, M.H. 1987. Biological Control of Weeds. A World Catalogue of Agents and their target weeds. Wallingford, UK: CAB International.

Julien, M.H. and M.W. Griffiths. 1998. Biological control of weeds: a world catalogue of agents and their target weeds. Biological control of weeds: a world catalogue of agents and their target weeds., Ed. 4:x + 223 pp.

Kadambi, K. 1954. Terminalia catappa, Linn., its silviculture and management. Indian Forester, 80 (11), (718-20 + 1 photo + 1 map). 11 refs.

Karmakar, S., S.P. Bhattacharya, and D. Pal. 1994. Efficiency of new generation herbicides for controlling weeds in kharif groundnut. Environment and Ecology, 12(2):308-311.

Landcare Research. 1999. What's New in biological control of Weeds? No. 13 Nov 1999. Available at http://www.landcareresearch.co.nz/publications/newsletters/weeds/wtsnew13.pdf. [Accessed 20 January 2003].

Landcare Research. 2001. What's New in biological control of Weeds? No. 19 Nov 2001. Available at http://www.landcareresearch.co.nz/publications/newsletters/weeds/wtsnew19.pdf. [Accessed 20 January 2003].

Langeland, K.A. and K.C. Burks. 1998. Identification and Biology of Non-native Plants in Florida's Natural Areas. Gainesville, Florida, USA: University of Florida.

Langeland, K.A. and R.K. Stocker. 2000. Control of non-native plants in natural areas of Florida. Available at http://edis.ifas.ufl.edu. [Accessed 12 June 2006].

LaPolla, J.S., P.G. Hawkes, and J.N. Fisher. 2013. Taxonomic review of the ant genus Paratrechina, with a description of a new species from Africa. Journal of Hymenoptera Research 35: 71. DOI: 10.3897/JHR.35.5628.

LaRosa, A.M. 1984. The biology and ecology of Passiflora mollissima in Hawai`i. Technical Report 50. University of Hawai`i, Honolulu, USA: Cooperative National Park Resources Studies Unit.

Locascio, S.J. and W.M. Stall. 1983. Weed control in snap beans. Proceedings of the Florida State Horticultural Society, 96:90-92.

Loh, R.K. and C.C. Daehler. 2007. Influence of invasive tree kill rates on native and invasive plant establishment in a Hawai`ian forest. Restoration Ecology, 15(2):199-211. Available at http://www.blackwell-synergy.com/loi/rec.

MacDougal, J.M. 1994. Revision of Passiflora subgenus Decaloba Section Pseudodysosmia (Passifloraceae). The American Society of Plant Taxonomists. Systematic Botany Monographs, 41.

Malalavidhane, T.S., S.M.D.N. Wickramasinghe, and E.R. Jansz. 2000. Oral hypoglycaemic activity of Ipomoea aquatica. Journal of Ethnopharmacology, 72, 293-298.

Markin, G.P. 1970. Foraging behavior of the Argentine ant in a California citrus grove. Journal of Economic Entomolology, 63:740-744.

Markin, G.P. 2002. Proceedings of the Hawai`ian Entomological Society. January 2002. 67-76.

McConnell, J. and R. Muniappan. 1991. Introduced ornamental plants that have become weeds on Guam. Mironesica Supplement, 3:47-50.

McEwen, F.L., J.W. Beardsley, M. Hapai, and T.H. Su. 1979. Laboratory tests with candidate insecticides for control of the big-headed ant, Pheidole megacephala (Fabricius). Proceedings of the Hawai`ian Entomological Society, 23(1):119-123.

McGlynn, T.P. 1999. The Worldwide Transfer of Ants: Geographical Distribution and Ecological Invasions, Journal of Biogeography 26(3): 535-548.

McIntyre, G. and C. Barbe. 1994. Chemical v/s hand weeding in young citrus and mango orchards. Revue Agricole et Sucriere de l'Ile Maurice, 73:44-47.

Middleton, B. 1990. Effect of water depth and clipping frequency on the growth and survival of four wetland plant species. Aquatic Botany, 37(2):189-196.

Miller, S.E. 1994. Dispersal of Plant Pests into the Virgin Islands. Florida Entomologist 77(4):520.

Minden, V., K.J. Hennenberg, S. Porembski, and H.J. Boehmer. 2009. Invasion and management of alien Hedychium gardnerianum (kahili ginger, Zingiberaceae) alter plant species composition of a montane rainforest on the island of Hawai'i. Plant Ecol (2009) 206:321–333.

Monteiro, I. and F. Rocha. 1992. Study of a survey of weed biotypes resistant to atrazine. Proceedings of the 1992 Congress of the Spanish Weed Science Society., 315-319; 9 ref.

Morton, J.J. 1982. Plants poisonous to people in Florida and other warm areas. Plants poisonous to people in Florida and other warm areas. Stuart, Florida, USA: Southeastern Printing Co., Inc., unpaginated.

Morton, J.F. 1985. Indian Almond (Terminalia catappa), Salt-Tolerant, Useful, Tropical Tree with "Nut" Worthy of Improvement. Economic Botany, Vol. 39, No. 2 (Apr. - Jun., 1985), pp. 101-111.

Mortensen, H.S., Y.L. Dupont, and J.M. Olesen. 2008. A snake in paradise: Disturbance of plant reproduction following extirpation of bird flower-visitors on Guam. Biological Conservation 141(8): 2146-2154.

Motooka, P., L. Ching, G. Nagai. 2002. Herbicidal Weed Control Methods for Pasture and Natural Areas of Hawai`i. Hawai`i, USA: Cooperative Extension Service, College of Tropical Agriculture and Human Resources, University of Hawai'i. [CTAHR free publication WC-8.].

Motooka, P., L. Castro, D. Nelson, G. Nagai, and L. Ching. 2003. Weeds of Hawai`i's Pastures and Natural Areas; an identification and management guide. College of Tropical Agriculture and Human Resources, University of Hawai`i at Manoa.

Muensch, J.A., P.D. Leininger, D.E. Werth, A.M Fawks, and S.M. Thomas. 2006. The Anoles of Coconut Island, Kaneohe Bay, Oahu, Hawai`i. Iguana Volume 13 Number 3 September 2006. 199. Available at http://www.ircf.org/downloads/wwdigitalmembers/Iguana_13-3web.pdf#page=25. [Accessed 2 July 2010].

Munger, G.T. 2006. Fragaria vesca. In: Fire Effects Information System, [Online]. United States Department of Agriculture, Forest Service, Rocky Mountain Research Station, Fire Sciences Laboratory (Producer). Available at http://www.fs.fed.us/database/feis/. [Accessed 30 December 2013].

Muniappan, R., G.V.P. Reddy, and A. Raman. 2009. Coccinia grandis (L.) Voigt (Cucurbitaceae). In: Biological Control of Tropical Weeds using Arthropods [ed. by Muniappan, R. \Reddy, G. V. P. \Raman, A.]. Cambridge, UK: Cambridge University Press, 175-18.

Murray, D.A.H. 1982. Effects of sticky banding of custard apple tree trunks on ants and citrus mealybug, Planococcus citri (Risso) (Pseudococcidae (Hem)) in south-east Queensland. Queensland Journal of Agricultural and Animal Sciences, 39(2):141-146.

Nagata, R.F. and G.P. Markin. 1986. Status of insects introduced into Hawai'i for the biological control of the wild blackberry Rubus argutus link. In: Proceedings of the Sixth Conference in Natural Sciences Hawai`i Volcanoes National Park. In: Status of insects introduced into Hawai'i for the biological control of the wild blackberry Rubus argutus link [ed. by Smith, C. W. \Stone, C. P.]. Honolulu, Hawai`i, USA: Department of Botany, University of Hawai`i at Manoa, 53-64.

Nakanishi, H. 1989. Dispersal ecology of the maritime plants in the Ryukyu Islands, Japan. Ecological Research, 3(2):163-173; 12 ref.

Napompeth, B. 1982. Biological control research and development in Thailand. In: Heong KL, Lee BS, Lim TM, Teoh CH, Ibrahim Y, ed. Proceedings of the International Conference on Plant Protection in the Tropics. Malaysian Plant Protection Society Kuala Lumpur Malaysia, 301-323.

National Animal Pest Alert. 2011. Pacific Rat. Animal Pest Alert, 10. Western Australia, Australia: Department of Agriculture and Food, Government of Western Australia, 4 pp.

Ness, J.H. and J.L. Bronstein. 2004. The Effects of Invasive Ants on Prospective Ant Mutualists, Biological Invasions 6: 445-461.

Newbould, S. 1998. Caltrop (*Tribulus cistoides*). Agnote, Darwin, Australia, No. 582.

Newell, W. and T.C. Barber. 1913. The Argentine Ant. U.S. Dept. Agric. Bureau of Entomology Bulletin., 98 pp.

Newman, Y.C. and L.E. Sollenberger. 2005 . Grazing management and nitrogen fertilization effects on vaseygrass persistence in limpograss pastures. Crop Science, 45(5):2038-2043.

New Zealand's Biosecurity System. 2008. Mexican Daisy: Erigeron karvinskianus. Available at http://www.biosecurity.govt.nz/pests/mexican-daisy.

Nickerson, J.C. and K.A. Barbara. 2000. Crazy ant: scientific name: Paratrechina longicornis (Latreille) (Insecta: Hymenoptera: Formicidae). Featured Creatures: University of Florida Institute of Food and Agricultural Sciences. Available at http://entomology.ifas.ufl.edu/creatures/urban/ants/crazy_ant.htm. [Accessed 17 March 2009].

Nicol, J, S. Muston, P. D'Santos, B. McCarthy, S. Zukowski. 2007. Impact of sheep grazing on the soil seed bank of a managed ephemeral wetland: implications for management. Australian Journal of Botany, 55(2):103-109. Available at http://www.publish.csiro.au/?nid/66.

Ninomiya, K., Y. Oogami, M. Kino-Oka, and M. Taya. 2003. Assessment of herbicidal toxicity based on non-destructive measurement of local chlorophyll content in photoautotrophic hairy roots. Journal of Bioscience and Bioengineering, 95, 3, 264-270.

Nishimoto, R.K., R.T. Hirano, F.D. Rauch, K.L. Hibbard. 1980. Herbicide evaluation studies with special emphasis on oxadiazon 2G in container-grown ornamentals in Hawai`i. Research Report 199. Honolulu, Hawai`i, USA: University of Hawai`i College of Tropical Agriculture and Human Resources.

National Pesticide Information Center (NPIC). 2002. Hydramethylnon General Fact Sheet. Available at http://npic.orst.edu/factsheets/hydragen.pdf. [Accessed 13 January 2013].

National Pesticide Information Center (NPIC). 2009. Fipronil General Fact Sheet. Available at http://npic.orst.edu/factsheets/fipronil.pdf. [Accessed 13 January 2013].

National Pesticide Information Center (NPIC). 2013. Boric Acid General Fact Sheet. Available at http://npic.orst.edu/factsheets/boricgen.html. [Accessed 13 January 2013].

O'Connor, S. Pers. comm. Undated. Coordinator, Pacific Ant Prevention Programme Secretariat of the Pacific Community New Zealand

O'Dowd, D.J., P.T. Green, P.S. Lake. 1999. Status, Impact, and Recommendations for Research and Management of Exotic Invasive Ants in Christmas Island National Park. Report to Environment Australia.

Olifintoye, J.A. and A.A. Adesiyun. 1989. Weed control in cowpea (Vigna unguiculata) with sethoxydim and Galex. Nigerian Journal of Weed Science, 2(1-2):29-34.

Pacific Island Ecosystems at Risk (PIER). 2002. Passiflora foetida. Available at http://www.hear.org/pier/passiflora_foetida.htm. [Accessed 8 April 2003].

Pacific Island Ecosystems at Risk (PIER). 2004. Institute of Pacific Islands Forestry. Available at http://www.hear.org/pier/.

Pacific Island Ecosystems at Risk (PIER). 2005. Ricinus communis L., Euphorbiaceae. Available at http://www.hear.org/pier/species/ricinus_communis.htm. [Accessed 30 December 2005].

Pacific Island Ecosystems at Risk (PIER). 2007. USA: Institute of Pacific Islands Forestry. Available at http://www.hear.org/pier/index.html.

Pacific Island Ecosystems at Risk (PIER). 2008. Setaria verticillata (L.) P. Beauv., Poaceae. Available at http://www.hear.org/pier/species/setaria_verticillata.htm. [Accessed 20 June 2008].

Pacific Island Ecosystems at Risk (PIER). 2010. Cenchrus echinatus L., Poaceae. Available at http://www.hear.org/pier/species/cenchrus_echinatus.htm. [Accessed 23 September 2010].

Pacific Island Ecosystems at Risk (PIER). 2012. Honolulu, USA: HEAR, University of Hawai`i. Available at http://www.hear.org/pier/index.html

Pacific Island Ecosystems at Risk (PIER). 2013. United States Forest Service, Online resource. Available at http://www.hear.org/pier/. [Accessed 16 December 2013].

Pacific Rim Conservation (PRC). 2011. *Wake Island Biological Monitoring*. Final Report March 2011. Prepared for Chugach Support Services Inc. and USAF 611 CES/CEA. March.

Palmer, W.A., T.A. Heard, and A.W. Sheppard. 2010. A review of Australian classical biological control of weeds programs and research activities over the past 12 years. Biological Control 52 (2010) 271–287.

Parker, C. 1992. Weeds of Bhutan. Weeds of Bhutan., vi + 236 pp.

Parker, C. and C.R. Riches. 1993. Parasitic weeds of the world: biology and control. Wallingford, UK; CAB International, xx + 332 pp.

Parsons, W.T. and E.G. Cuthbertson. 1992. Noxious Weeds of Australia. Melbourne, Australia: Inkata Press.

Peng, C., C. Chen, W. Leu, and H. Yen. 1998. Pluchea Cass. (Asteraceae: Inuleae) in Taiwan. Bot. Bull. Acad. Sin. (1998) 39: 287-297.

Petty, G.J. and B.Q. Manicom. 1995. Control of the big-headed ant, Pheidole megacephala, in pineapple plantations with the proprietary bait Amdro. Fruits (Paris), 50(5):343-346; 11 ref.

Pernas, T., G. Wheeler, K. Langeland, E. Golden, M. Purcell, J. Taylor, K. Brown, D.S. Taylor, and E. Allen. 2013. Australian Pine Management Plan for Florida. Florida Exotic Pest Plant Council. Available at www.fleppc.org. [Accessed 30 December 2013].

Perry, G., E.W. Campbell, G.H. Rodda, and T.H. Fritts. 1998. Managing Island Biotas: Brown Tree Snake Control Using Barrier Technology, Proc. 18th Vertebr. Pest Conf. (R.O. Baker & A.C. Crabb, Eds.). Univ. of Calf.

Perry, G., G.H. Rodda, T.H. Fritts, and F.J. Qualls. 2004. Snake control using barrier technology: a summary of work conducted 1995-2001. Micronesica 37: 177.

Peters, H.A. 2001. Clidemia hirta Invasion at the Pasoh Forest Reserve: An Unexpected Plant Invasion in an Undisturbed Tropical Forest, Biotropica 33(1): 60 - 68.

Phillips, P.A., R.S. Bekey, and G.E. Goodall. 1987. Argentine ant management in cherimoyas. California Agriculture, 41(3-4):8-9.

Pokhriyal, T.C., H.C.S. Bhandari, D.S. Negi, S.P. Chaukiyal, and B.B. Gupta. 1990. Identification of some fast growing leguminous tree species for nitrogen fixation studies. Indian Forester 116(6): 504-507.

Prado, R.D.E, E. Romero, J. Menéndez, and M. Tena. 1992. Mechanism of resistance to atrazine in Setaria verticillata and Setaria faberi. IXe Colloque international sur la biologie des mauvaises herbes, 16-18 September 1992, Dijon, France. 457-463; 5 ref.

Prasad, G.S., D.R. Singh, S. Senani, and R.P. Medhi. 2004. Eco-friendly way to keep away pestiferous Giant African snail, Achatina fulica Bowdich from nursery beds, Current Science 87(12).

Prasad, T.V.R., N. Narasimha, N. Dwarakanath, and K. Krishnamurthy. 1987. Efficacy of oxyfluorfen for weed control in irrigated groundnut. International Arachis Newsletter, No.2:9-11.

Prieur-Richard, A.H., S. Lavorel, A. Dos Santos, and K. Grigulis. 2002. Mechanisms of resistance of Mediterranean annual communities to invasion by Conyza bonariensis: effects of native functional composition. Oikos, 99(2):338-346; 37 ref.

Pyon, J.Y. 1976. Germination and growth of sourgrass and its competition with forage grasses. Journal of the Korean Society of Crop Science, 21(1):15-19.

Quinones, V.M. Undated. Effect of herbicides on weed control in cotton (Gossypium hirsutum L.) in Barinas, Venezuela. Abstracts of the XIV Brazilian congress on herbicides and herbaceous weeds (SBHED) and the VI congress of the Latin American Weed Association (ALAM), Campinas, 1982 Campinas, Sao Paulo, Brazil, 126-127.

Rajamani, K., S. Thamburaj, T. Thangaraj, and S. Murugesan. 1992. Studies on the effect of certain herbicides in rose cv. Happiness. South Indian Horticulture, 40(2):121-122.

Randall, R.P. 2002. A Global Compendium of Weeds. Melbourne, Australia: RG & FJ Richardson.

Raut, S.K., and G.M. Barker. 2002. Achatina fulica Bowdich and Other Achatinidae as Pests in Tropical Agriculture. In: Barker (Ed.) Molluscs as Crop Pests. CABI.

Rice, P.M. and J.C. Toney. 1996. Plant population responses to broadcast herbicide applications for spotted knapweed control. Down to Earth. 51(2): 14-19. [27754].

Richard, A. and V. Ramey. 2007. Invasive and Non-Native Plants You Should Know, Recognition Cards. Florida, USA: UF/IFAS Center for Aquatic and Invasive Plants. [UF/IFAS Center for Aquatic and Invasive Plants, Publication No. SP 431.]

Reimer, N.J. and J.W. Beardsley Jr. 1990. Effectiveness of hydramethylnon and fenoxycarb for control of bigheaded ant (Hymenoptera: Formicidae), an ant associated with mealybug wilt of pineapple in Hawai`i. Journal of Economic Entomology, 83(1):74-80.

Reimer, N.J., B.M. Glancey, and J.W. Beardsley. 1991. Development of Pheidole megacephala (Hymenoptera: Formicidae) colonies following ingestion of fenoxycarb and pyriproxyfen. Journal of Economic Entomology, 84(1):56-60.

Rodda, G.H., T.H. Fritts, and P.J. Conroy. 1992. Origin and population growth of the brown tree snake, Boiga irregularis, on Guam. Pacific Science 46: 46-57.

Rodda, G.H., T.H. Fritts, G. Perry, and E.W. Campbell III. 1998. Managing island biotas: can indigenous species be protected from introduced predators such as the brown treesnake? Transactions of the 63rd North American Wildlife Natural Resources Conference: 95-108.

Rust, M.K. 2001. Insecticides and their use in urban structural pest control. In: Handbook of pesticide toxicology [ed. by Krieger R] San Diego, USA: Academic Press, 243-250.

Rust, M.K. and R.L. Knight. 1990. Controlling Argentine ants in urban situations. In: Applied Myrmecology: A world perspective [ed. by Meer Van der RK, Jaffe K, Cedeno A] Boulder CO, USA: Westview Press, 663-670.

Samways, M.J. 1985. Appraisal of the proprietary bait 'Amdro' for control of ants in South African citrus. Citrus and Subtropical Fruit Journal, No. 621:14-17.

Sarpe, N., C. Dinu, and I. Lungulescu. 1992. Efficacy of the butylate, bentazone and imazethapyr herbicides in the control of dodder and other weeds in seedling alfalfa, in first year of vegetation. Mededelingen van de Faculteit Landbouwwetenschappen, Universiteit Gent, 57(3b):1117-1126.

Savannah River Ecology Laboratory. Undated. Species profile: Green Anole (Anolis carolinensis). Savannah River Ecology Laboratory Herpetology Program. Available at http://srelherp.uga.edu/lizards/anocar.htm. [Accessed 6 January 2014].

Savarie, P.J.; W.S. Wood, G.H. Rodda, R.L. Bruggers, and R.M. Engeman. 2005. Effectiveness of methyl bromide as a cargo fumigant for brown treesnakes International Biodeterioration & Biodegradation. 56(1) 40-44.

Savidge, J.A. 1987. Extinction of an island forest avifauna by an introduced snake. Ecology 68: 660-668.

Sheley, R. and J. Petroff (eds.). 1999. Biology and management of noxious rangeland weeds. Oregon State University Press, Corvallis, Oregon. 438 pp.

Shelton, H.M. and J.L. Brewbaker. 1994. Leucaena leucocephala - the most widely used forage tree legume. Forage tree legumes in tropical agriculture. 15-29; 23 ref.

Shorey, H.H., L.K. Gaston, R.G. Gerber, P.A. Phillips, and D.L. Wood. 1992. Disruption of foraging by Argentine ants, Iridomyrmex humilis (Mayr) (Hymenoptera: Formicidae), in citrus trees through the use of semiochemicals and related chemicals. Journal of Chemical Ecology, 18(1):2131-2142.

Shorey, H.H., L.K. Gaston, R.G. Gerber, C.B. Sisk, and P.A. Phillips. 1996. Formulating farnesol and other ant-repellent semiochemicals for exclusion of Argentine ants

(Hymenoptera: Formicidae) from citrus trees. Environmental Entomology, 25(1):114-119.

Silverman, J. and D. Liang. 2001. Colony disassociation following diet partitioning in a unicolonial ant. Naturwissenschaften, 88(2):73-77.

Simberloff, D. and L. Gibbons. 2004. Now you see them, now you don't! – Population crashes of established introduced species, Journal Biological Invasions 6(2): 161-172.

Singh, D.P., S.K. Tomar, and R.D. Vaishya. 1994. Weed control in white jute (Corchorus capsularis). Indian Journal of Agronomy, 39(3):437-441

Smith, A.C. 1979. Flora Vitiensis nova: a new flora of Fiji. National Tropical Botanical Garden, Lawai, Kauai, Hawai`i. Volume 1. 494 pp.

Smith, A.C. 1981. Flora Vitiensis nova: a new flora of Fiji. National Tropical Botanical Garden, Lawai, Kauai, Hawai`i. Volume 2. 810 pp.

Smith, C.W. 1985. Impact of alien plants on Hawai`i's native biota. In: Stone CP, Scott JM, eds. Hawai`i's Terrestrial Ecosystems: Preservation and Management. Honolulu, Hawai`i, USA: University of Hawai`i Press, 180-250.

Smith, C.W., J. Denslow, and S. Hight. 2002. Proceedings of workshop on biological control of native ecosystems in Hawai‘i. Pacific Cooperative Studies Unit (University of Hawai`i at Manoa, Department of Botany) Technical Report 129. 122 pages.

Smith, C.W. 2002. Forest pest biological control programe in Hawai'i. In: Smith C, W, Denslow J, Hight S, Eds. Proceedings of a workshop on biological control of invasive plants in native Hawai`ian Ecosystems. Honolulu, Hawai`i, USA: University of Hawai`i Cooperative Extension Service Studies Unit, Technical Report, 129:91-102.

Smith, C.W. Undated. Distribution, Status, Phenology, Rate of Spread, and Management of Clidemia in Hawai`i. Available at http://www.botany.Hawai`i.edu/faculty/duffy/book/1992_chap/11.pdf. [Accessed 19 April 2006].

Smith, N.M. 2002. Weeds of the wet/dry tropics of Australia - a field guide. Environment Centre NT, Inc. 112 pp.

Snyder, S.A. 1992. Casuarina spp. In: Fire Effects Information System, [Online]. U.S. Department of Agriculture, Forest Service, Rocky Mountain Research Station, Fire Sciences Laboratory (Producer). Available at http://www.fs.fed.us/database/feis/.

Soeprono, A.M. and M.K. Rust. 2004. Strategies for controlling Argentine ants (Hymenoptera: Formicidae). Sociobiology, 44(3):669-682. Available at http://www.csuchico.edu/biol/Sociobiology/volume/sociobiologyv44n32004.html#2.

Soerjani, M., A.J.G.H. Kostermans, G. Tjitrosoepomo. 1987. Weeds of Indonesia. Jakarta, Indonesia: Balai Pustaka, 716 pp.

Space and Missile Defense Command (SMDC). 1999. *Supplemental Environmental Assessment – Wake Island Launch Center*. Final. October 1999.

Sperry, M.L. Undated. K.R.C.P.'s Most Wanted: The top 10 most invasive plant species in Koke'e. Koke'e Resource Conservation Program. Available at https://sites.google.com/site/krcpmostwanted/. [Accessed 13 January 2014]

Stanley, M.C. 2004. Review of the Efficacy of Baits Used for Ant Control and Eradication (Landcare Research Contract Report: LC0405/044). Available at http://www.landcareresearch.co.nz/research/biocons/invertebrates/ants/BaitEfficacyReport.pdf. [Accessed 29 March 2007].

Stanley, M.C. and W.A. Robinson. 2007. Relative attractiveness of baits to Paratrechina longicornis (Hymenoptera: Formicidae). Journal of Economic Entomology 100 (2): 509-516.

Staples, G.W. and D.R. Herbst. 2005. A tropical garden flora: plants cultivated in the Hawaiian Islands and other tropical places. Bishop Museum Press, Honolulu. 908 pp.

State of Queensland Department of Agriculture, Fisheries and Forestry. 2012. Molasses grass: Melinis minutiflora Fact Sheet. Available at http://www.daff.qld.gov.au/__data/assets/pdf_file/0004/58333/IPA-Molasses-Grass-PP88.pdf. [Accessed 20 December 2013].

Stone, B.C. 1970. The flora of Guam. Micronesica 6:1-659.

Stone, C., C. Smith, and J. Tunison (eds). 1992. Alien plant invasions in native ecosystems of Hawai'i: Management and Research. Manoa, USA: Cooperative National Park Resources Studies Unit, University of Hawai'i, 887 pp.

Stow, S.J.C. 2008. Non-native plant distribution in Montserrat: Conservation and Ecological aspects. A thesis submitted in partial fulfillment of the requirements for the degree of Master of Science and the Diploma of Imperial College of London. Available at http://www.iccs.org.uk/thesis/consci/msc08-stow,sarah.pdf. [Accessed 20 April 2010].

Strecker, R.L. and W.B. Jackson. 1962. Habitats and habits. In: Storer TI, ed, 1962. Pacific Island Rat Ecology: Report of a Study made on Ponape and Adjacent Islands 1955-1958. Hawai`i: Bernice P Bishop Museum Bulletin, 225:64-73.

Suarez, A.V., D.A. Holway, and T.J. Case. 2001. Patterns of spread in biological invasions dominated by long-distance jump dispersal: insights from Argentine ants. Proceedings of the National Academy of Sciences of the USA, 98:1095-1100.

Suarez, A.V., N.D. Tsutsui, D.A. Holway, and T.J. Case. 1999. Behavioral and genetic differentiation between native and introduced populations of the Argentine ant. Biological Invasions, 1(1):43-53.

Swarbrick, J.T. 1997. Weeds of the Pacific Islands. Technical paper no. 209. South Pacific Commission, Noumea, New Caledonia. 124 pp.

Swearingen, J.M. 1997. Australian Pine. Washington, D.C.: National Park Service, Plant Conservation Alliance, Alien Plant Working Group.

Teig, D., Lt Col USAF. 2013. Trip Report – Wake Island. 29 March 2013.

Terry, P.J. 1983. Some common crop weeds of West Africa and their control. USAID Regional Food Crop Protection Project Dakar Senegal, 132 pp.

Thiengo, S.C., F.A. Faraco, N.C. Salgado, R.H. Cowie, and M.A. Fernandez. 2007. Rapid spread of an invasive snail in South America: the giant African snail, Achatina fulica, in Brasil, Biol Invasions 9: 693-702.

Thompson, J.D. and R. Turkington. 1988. The biology of Canadian weeds. 82. Holcus lanatus L. Canadian Journal of Plant Science, 68(1):131-147.

Timmins, S.M. and I.W. Mackenzie. 1995. Weeds in New Zealand protected natural areas database. Wellington, New Zealand. Department of Conservation, Technical Series No. 8. 287 pp.

Toda, M., H. Takahashi, N. Nakagawa, N. Sukigara. 2010. Ecology and Control of the Green Anole (Anolis carolinensis), an Invasive Alien Species on the Ogasawara Islands. In Restoring the Oceanic Island Ecosystem.

Troup, R.S. and H.B. Joshi. 1984. Troup's The Silviculture of Indian Trees. Volume V. Delhi, India: Controller of Publications.

Tsutsui, N.D. and A.V. Suarez. 2003. The colony structure and population biology of invasive ants. Conservation Biology, 17(1):48-58.

Tunison, T. 1991. Element Stewardship Abstract for Rubus argutus, prickly Florida blackberry. Rubus argutus, prickly Florida blackberry. The Nature Conservancy (online). Available at http://www.invasive.org/gist/esadocs/documnts/rubuarg.pdf.

United States Air Force (USAF). 2007. Integrated Natural Resources Management Plan. Prepared by Argonne National Laboratory for Hickam Air Force Base, 15th Civil Engineering Squadron, Environmental Planning Element.

United States Air Force (USAF). 2008. Integrated Natural Resources Management Plan for Wake Atoll. Prepared by Argonne National Laboratory for Hickam Air Force Base, 15th Civil Engineering Squadron, Environmental Planning Element. September.

United States Air Force (USAF). 2011. Wake Island Air Field Facility Standard Operating Procedures: Invasive Species Prevention and Control. Prepared by Chugach Federal Solutions, Inc.

United States Air Force (USAF). 2012. Wake Island Biosecurity Management Plan.

United States Air Force (USAF). 2012. 611th ASG Wake Island Ironwood Control.

United States Air Force (USAF). 2013a. *Trip Report – Wake Island – Biological Assessment*. Memorandum for: 611 CES/CEAN. From: 757AS/DOS. Department of the Air Force, Youngstown Air Reserve Station, Aerial Spray Unit, Vienna, Ohio. June.

United States Air Force (USAF). 2013b. Installation Support Services for Geographically Separated Locations: Invasive Species Management. Prepared by Chugach Federal Solutions, Inc.

United States Air Force (USAF). 2013c. Pest Control and Pesticide/Herbicide Management Plan: Wake Island. Prepared by Chugach Federal Solutions, Inc.

United States Air Force (USAF). Undated. Invasive Species Protocol for Wake Island. Prepared by Chugach Federal Solutions, Inc.

United States Department of Agriculture (USDA). 2011. Brown Treesnake Containment Plan for Guam. Prepared by United States Department of Agriculture, Animal and Plant Health Inspection Service, Wildlife Services.

United States Department of Agriculture (USDA)-Animal and Plant Health Inspection Services (APHIS). 2001. The Brown Tree Snake Factsheet. Available at http://www.aphis.usda.gov/publications/wildlife_damage/content/printable_version/fs_wsbtsnake.pdf. [Accessed 16 December 2009].

United States Department of Agriculture (USDA)-Animal and Plant Health Inspection Services (APHIS), Plant Protection and Quarantine (PPQ). 2012. Federal noxious weed list (1 February 2012).

United States Department of Agriculture (USDA)-Agricultural Research Service (ARS). 2008. Germplasm Resources Information Network (GRIN). Online Database. Beltsville, USA: National Germplasm Resources Laboratory. Available at http://www.ars-grin.gov/cgi-bin/npgs/html/tax_search.pl.

United States Department of Agriculture (USDA)-Agricultural Research Service (ARS). 2012. Germplasm Resources Information Network (GRIN). Online Database. Beltsville, USA: National Germplasm Resources Laboratory. Available at http://www.ars-grin.gov/.

United States Department of Agriculture (USDA)-Natural Resources Conservation Service (NRCS). 2013. The PLANTS Database. National Plant Data Team, Greensboro, North

Carolina 27401-4901 USA. Available at http://plants.usda.gov. [Accessed 13 December 2013].

United States Department of Interior (DOI). 1999. Terrestrial Resources Survey, Wake Atoll, Mid-Pacific Ocean, 18-29 June 1998. Report prepared for the Department of the Army, U.S. Space and Missile Defense Command SMDC-EN-V, Huntsville, AL. Prepared by Chip Demarest, U.S. Department of the Interior, Office of Environmental Policy and Compliance, San Francisco, CA.

United States Fish and Wildlife Service (USFWS). 2010. Formal Section 7 Consultation for the Continuing Operations of the Kōke`e Air Force Station and Kōke`e Microwave Antenna Site and Installation of U.S. Coast Guard Rescue 21 Monopole at Kōke`e Air Force Station, Kauai.

United States Forest Service. 2013. Washington, DC, USA: USDA (online). Available at http://www.fs.fed.us/.

Vega, S.Y. and M.K. Rust. 2003. Determining the foraging range and origin of resurgence after treatment of Argentine ant (Hymenoptera: Formicidae) in urban areas. Journal of Economic Entomology, 96(3):844-849

Venette, R.C. and M. Larson. 2004. Mini Risk Assessment Giant African Snail, Achatina fulica Bowdich [Gastropoda: Achatinidae]. Available at http://www.aphis.usda.gov/plant_health/plant_pest_info/pest_detection/downloads/pra/afulicapra.pdf. [Accessed 17 February 2010].

Vernier, P. 1985. Development of rice culture on aquifers in North Cameroon. An example of technology transfer. Agronomie Tropicale, 40(4):323-336.

Wagner, W.L., D.R. Herbst, and S.H. Sohmer. 1999. Manual of the flowering plants of Hawai`i. Revised edition. Bernice P. Bishop Museum special publication. University of Hawai‘i Press/Bishop Museum Press, Honolulu. 1919 pp. (two volumes).

Waterhouse, D.F. 1993. Biological control: Pacific prospects. Supplement 2. Australian Centre for International Agricultural Research, Canberra. 138 pp.

Waterhouse, D.F. 1993. The major arthropod pests and weeds of agriculture in Southeast Asia. The Australian Centre for International Agricultural Research, Canberra. 141 pp.

Waterhouse, D.F. 1994. Biological control of weeds: Southeast Asian prospects. Australian Centre for International Agricultural Research, Canberra. 302 pp.

Waterhouse, D.F. and K.R. Norris. 1987. Biological control: Pacific prospects. Inkata Press, Melbourne. 454 pp.

Watson, M. 1986. Notes on the control of foxtail grass (Pennisetum polystachion (L.) cv. Schult). Tea Bulletin, 6(2):10-11.

Weber, E. 2003. Invasive plants of the World. CABI Publishing, CAB International, Wallingford, UK. 548 pp.

Webster, T.M. 2005. Patch Expansion of Purple Nutsedge (Cyperus rotundus) and Yellow Nutsedge (Cyperus esculentus) with and without Polyethylene Mulch, Weed Science 53(6): 839-845.

Webster, T.M., T.L. Grey, J.W. Davis, and A.S. Culpepper. 2008. Glyphosate Hinders Purple Nutsedge (Cyperus rotundus) and Yellow Nutsedge (Cyperus esculentus) Tuber Production, Weed Science 56: 735-742.

Weedbusters, 2012. Weedbusters (online). Matangi, New Zealand. Available at http://www.weedbusters.org.nz/.

Wehner, D.J., J.E. Haley, A.K. Yust. 1981. Control of plantains and clover in turf with post-em. herbicides. Proceedings North Central Weed Control Conference, Volume 36:36-37.

Wersal, R.M. and J.D. Madsen. 2010. Combinations of penoxsulam and diquat as foliar applications for control of waterhyacinth and common salvinia: evidence of herbicide antagonism. Journal of Aquatic Plant Management, 48:21-25. Available at http://www.apms.org/japm/vol48/vol48p21.pdf.

Westbrook, C. and K. Ramos. 2005. Under Siege: Invasive Species on Military Bases. National Wildlife Federation.

Whistler, W.A. 1983. The flora and vegetation of Swains Island. Atoll Research Bulletin No. 262. Smithsonian Institution, Washington. 25 pp.

Whistler, W.A. 1988. Checklist of the weed flora of western Polynesia. Technical Paper No. 194, South Pacific Commission, Noumea, New Caledonia. 69 pp.

Whistler, W.A. 1995. Wayside plants of the Islands. Everbest Printing Company, Ltd. Hong Kong.

Whistler, W.A. and O. Steele. 1999. Botanical survey of the United States of America Kwajalein Atoll (USAKA) Islands. Prepared for Oak Ridge Institute for Science and Education and the U. S. Army Environmental Center. 111 pp.

Wiggins, I.L. and D.M. Porter. 1971. Flora of the Galapágos Islands. Stanford University Press. 998 pp.

Wild, A.L. 2004. Taxonomy and distribution of the Argentine ant, Linepithema humile (Hymenoptera: Formicidae). Annals of the Entomological Society of America, 97(6):1204-1215.

Wiles, G.J. and J.P. Guerrero. 1996. Relative abundance of lizards and marine toads on Saipan, Mariana Islands. Pacific Science. 50(3). 1996. 274-284. Available at

http://scholarspace.manoa.Hawai`i.edu/bitstream/10125/2900/1/v50n3-274-284.pdf. [Accessed 2 July 2010].

THIS PAGE INTENTIONALLY LEFT BLANK

Appendix A: Comprehensive Plant Lists for Wake Atoll, Kōke`e AFS, and Mt. Ka`ala AFS

THIS PAGE INTENTIONALLY LEFT BLANK

Table A-1. Vegetation Species Found on Wake Atoll

Scientific Name	**Common Name**
Abutilon albescens	Sweet monkeybush
Abutilon asiaticum var. albescens	Indian mallow
Agave americana	American century plant
Agave angustifolia	century plant
Agave sisalana	Sisal
Agave sp.	agave sp.
Aglaonema commutatum	Aglaonema
Allium cepa	Onion
Allium fistulosum	Green onion
Allium sp.	Onion sp.
Allium tuberosum	Chinese chive
Aloe vera	Aloe
Alpinia galanga	Greater galangal
Alpinia purpurata	Pink ginger; Jungle Queen
Amaranthus dubius	Spleen amaranth
Amaranthus graecizans	Tumbleweed
Amaranthus tricolor	Joseph′s coat
Amaranthus viridis	Slender amaranth
Ananas comosus	Pineapple
Anethum graveolens	Dill
Annona muricata	Soursop
Annona squamosa	Sweetsop
Apium petroselinum	Garden parsley
Araucaria heterophylla	Norfolk Island pine
Asparagus densiflorus	Sprenger asparagus fern
Asplenium nidus	Bird’s-nest fern
Barringtonia asiatica	Fish poison tree
Bauhinia sp.	Camel’s foot tree
Bidens alba	white beggar-ticks
Bidens pilosa var. minor	Beggar-ticks
Boerhavia albiflora var. powelliae	--
Boerhavia diffusa	Red Spiderling
Boerhavia repens	anena
Boerhavia sp.	Spiderling sp.
Bothriochloa pertusa	Indian blue grass
Bougainvillea spectabilis	bougainvillea
Brassica nigra	Mustard
Brassica oleracea var. italica	Brocolli
Caesalpinia bonduc	Grey nickers
Caladium bicolor	Caladium
Calotropis gigantea	Crown flower
Capsicum frutescens	Cayenne pepper
Capsicum annuum	chili pepper

Table A-1. Vegetation Species Found on Wake Atoll

Scientific Name	**Common Name**
Carica papaya	Papaya
Casuarina equisetifolia	Casuarina
Catharanthus roseus	periwinkle
Cenchrus brownii	Brown's sandbur
Cenchrus echinatus	Sandbur
Chamaesyce hirta	hairy spurge
Chamaesyce hypericifolia	Graceful spurge
Chamaesyce prostrata	Prostrate spurge
Chamaesyce thymifolia	Gulf sandmat
Chloris barbata	swollen fingergrass
Chlorophytum comosum	Spider plant
Chrysophyllum cainito	Star apple
Citrus hystrix	Kaffir lime
Citrus sp.	Citrus
Cleome gynandra	wild spider flower
Coccinia grandis	Ivy gourd
Coccoloba uvifera	Sea grapes
Cocos nucifera	coconut palm
Codiaeum variegatum	Croton
Coleus scutellarioides	Common coleus
Colocasia esculenta	Taro
Conyza bonariensis	Hairy horseweed
Conyza canadensis var. pusilla	Canada horseweed
Cordia subcordata	Cordia
Cordyline fruticosa	Ti
Cordyline terminalis	Coco yam
Coriandrum sativum	Chinese parsley
Corymbia citriodora	Lemon-scented gum
Crassula ovata	Jade plant
Crinum amabile	Sumatran giant-lily
Crinum angustum	Queen Emma-lily
Crinum sp.	Lily sp.
Crinum asiaticum	Giant lily
Cucumis melo	Cantaloupe
Cucumis sativus	Cucumber
Cucurbita pepo	Squash
Cuscuta pentagona	Fiveangled dodder
Cymbopogon citratus	lemon grass
Cynodon dactylon	Bermuda grass
Cyperus pumilus	Low flatsedge
Cyperus rotundus	nutgrass
Cyperus involucratus	Umbrella plant
Dactyloctenium aegyptium	crowfoot grass

Table A-1. Vegetation Species Found on Wake Atoll

Scientific Name	**Common Name**
Delonix regia	royal poinciana
Desmanthus pernambucanus	slender mimosa
Dieffenbachia seguine	Dumb cane
Digitaria ciliaris	Henry's crabgrass
Digitaria gaudichaudii	--
Digitaria insularis	Sourgrass
Digitaria setigera	Itchy crabgrass
Digitaria sp.	crabgrass species
Digitaria bicornis	Asian crabgrass
Dracaena marginata	Money tree
Eichhornia crassipes	Water hyacinth
Eleusine indica	goosegrass
Epipremnum pinnatum	Taro vine
Eragrostis amabilis	Japanese love grass
Eragrostis minor	little lovegrass
Eragrostis scabriflora	Fijian lovegrass
Eryngium foetidum	False Chinese parsley
Erythrina variegata var. orientalis	Indian coral tree
Euphorbia cyathophora	wild poinsettia
Euphorbia lactea	Mottled candlestick tree
Euphorbia milii	Crown of thorns
Euphorbia pulcherrima	Poinsettia
Euphorbia tirucalli	Pencil tree
Eustachys petraea	Pinewoods fingergrass
Ficus carica	Edible fig
Ficus microcarpa	Chinese banyan
Ficus rubiginosa	Port Jackson fig
Ficus sp	fig sp.
Fimbristylis cymosa	button sedge
Fimbristylis dichotoma	Forked fimbry
Gardenia taitensis	Tahitian gardenia
Gomphrena globosa	Globe amaranth
Gossypium hirsutum	Cotton
Gossypium hirsutum	upland cotton
Hedychium coronarium	White ginger
Helianthus annuus	Common sunflower
Heliotropium anomalum	Hinahina
Heliotropium procumbens var. depressum	four-spike heliotrope
Hibiscus sp	hibiscus sp..
Hibiscus tiliaceus	Hau
Hymenocallis littoralis	Beach spider lily
Hymenocallis pedalis	Spider lily

Table A-1. Vegetation Species Found on Wake Atoll

Scientific Name	**Common Name**
Ipomoea aquatica	Swamp morning-glory
Ipomoea batatas	Sweet potato
Ipomoea pes-caprae spp. brasiliensis	beach morning glory
Ipomoea tuba	moon flower
Ipomoea violacea	beach moonflower
Ixora sp.	Ixora
Jasminum sambac	Arabian jasmine
Jatropha integerrima	Rose-flowered Jatropha
Kalanchoe pinnata	Cathedral bells
Kalanchoe daigremontiana	Kalanchoe
Kalanchoe delagoensis	Chandelier plant
Kalanchoe pinnata	Air plant
Lactuca sativa	Lettuce
Lepidium bidentatum	Kunana pepperwort
Lepturus gasparricensis	--
Lepturus repens	Pacific Island thintail
Leucaena leucocephala	Tangantangan
Lobularia maritima	Sweet alyssum
Mangifera indica	Mango
Manilkara zapota	Chicle
Momordica charantia	bitter melon
Morella faya	Fire tree
Morinda citrifolia	Indian mulberry
Moringa oleifera	Horseradish tree
Musa acuminata	Banana
Nerium oleander	Oleander
Nicotiana tabacum	Tobacco
Nidularium sp.	Nest bromeliad
Noronhia emarginata	Madagascar olive
Nymphaea sp.	Waterlily
Ocimum basilicum	sweet basil
Ocimum tenuiflorum	holy basil
Opuntia littoralis	coastal pricklypear
Opuntia cochenillifera	Cochineal nopal cactus
Pandanus tectorius	Screwpine
Pandanus tectorius - variegated form	Variegated screwpine
Paspalum setaceum	thin pasplum
Paspalum vaginatum	seashore pasplum
Paspalum scrobiculatum	Knotgrass
Passiflora foetida var. hispida	Passion fruit
Passiflora sp.	Passion fruit
Pedilanthus bracteatus	Candelilla Slipper
Pedilanthus tithymaloides	Redbird flower

Table A-1. Vegetation Species Found on Wake Atoll

Scientific Name	**Common Name**
Pemphis acidula	Pemphis
Pennisetum polystachion	Feathery pennisetum
Petroselinum crispum	Parsley
Phaseolus coccineus	Scarlet runner bean
Phaseolus lunatus	Lima bean
Phaseolus vulgaris	String bean
Philodendron undulatum	Philodendron
Philodendron hederaceum var. oxycardium	Philodendron
Phoenix sp.	Date palm
Phyllanthus acidus	Otaheite gooseberry
Phyllanthus amarus	carry me seed
Phymatosorus scolopendria	Laua'e fern
Pilea microphylla	Artillery plant
Piper lolot	Lolot
Pisonia grandis	Pisonia
Pithecellobium dulce	Manila tamarind
Pluchea carolinensis	Sour bush
Pluchea odorata	Sweetscent
Plumeria obtusa	Singapore Plumeria
Plumeria rubra	Red Plumeria
Plumeria sp.	plumeria sp.
Polyscias fruticosa	Ming aralia, Elegans
Polyscias guilfoylei	Wild coffee
Polyscias scutellaria	Balfour aralia, Balfourniana
Portulaca australis	Purslane
Portulaca cv.	Wildfire
Portulaca lutea	yellow purslane
Portulaca oleracea	Common purslane
Portulaca pilosa	Akulikuli
Portulaca samoensis	--
Portulaca sp	purslane sp.
Pseuderanthemum carruthersii var. atropurpure	Purple false eranthemum
Pseuderanthemum carruthersii var. carruthersii	Eldorado
Psidium guajava	Guava
Psophocarpus tetragonolobus	Wing bean
Raphanus sativus	Daikon
Raphanus sativus	Radish

Table A-1. Vegetation Species Found on Wake Atoll

Scientific Name	**Common Name**
Ricinus communis	Castor bean
Rosa hybrid	Rose
Sansevieria trifasciata	Bowstring hemp
Sansevieria roxburghiana	--
Scaevola sericea var. taccada	scaevola
Schefflera actinophylla	Octopus tree
Sedum sp.	stonecrop sp.
Sempervivum tectorum	Common houseleek
Sesbania grandiflora	Sesban
Sesuvium portulacastrum	seaside purslane
Setaria verticillata	Bristly foxtail
Sida fallax	ilima
Solanum lycopersicum	Tomato
Solanum torvum	Wild tomato
Solanum melongena	eggplant
Solenostemon scutellarioides	Coleus
Sonchus oleraceus	thistle Aztec
Sorghum bicolor	Sweet sorghum
Spondias pinnata	Amra
Stachytarpheta cayennensis	Nettle-leaved vervain
Stachytarpheta jamaicensis	Jamaican vervain
Strelitzia reginae	Bird-of-paradise
Syngonium auritum	Syngonium
Tagetes erecta	marigold
Tagetes patula	French marigold
Tamarindus indica	Tamarind
Terminalia catappa	Indian almond
Thespesia populnea	Milo
Tournefortia argentea	tournefortia
Tradescantia pallida	Purple Tradescantia
Tradescantia spathacea	Oyster plant
Tribulus cistoides	Puncture vine
Tribulus terrestris	Puncture vine
Tridax procumbens	coatbuttons
Vigna unguiculata ssp. sesquipedalis	Yard-long bean
Vitex trifolia	Blue vitex
Waltheria indica	uhaloa
Zea mays	Corn
Zinnia violacea	Zinnia
Ziziphus mauritiana	Indian jujube
Zoysia matrella	Manila grass

Sources: Fosberg 1959, USAF 2008a

Table A-2. Vegetation Species Found on Koke`e Air Force Station

Scientific Name	**Common Name**
Acacia koa	Koa
Acacia mearnsii	black wattle
Adenophorus tamariscinus	wahine noho mauna
Alyxia stellata	maile
Antidesma platyphyllum var. hillebrandii	hame, ha`a
Astelia argyrocoma	pa`iniu
Axonopus fissifolius	narrow-leaved carpetgrass
Bobea brevipes	ahakea lau li` i
Carex meyenii	Meyen's sedge
Carex wahuensis ssp. wahuensis	Oahu sedge
Cheirodendron trigynum	olapa
Claoxylon sandwicense	po`ola
Coprosma kauensis	koi
Crocosmia crocosmiiflora	montbretia crocosmia
Cuphea carthagenensis	Tar weed
Cyrtandra longifolia	ha`iwale
Deparia petersenii	Petersen's spleenwort
Dianella sandwicensis	`uki`uk
Dicranopteris linearis	uluhe
Digitaria eriantha ssp. pentzii	pangola grass
Diplazium sandwichianum	ho`i`o
Dodonaea viscosa	`a`ali`i
Dryopteris wallichiana	laukahi, `i`o nui
Elaeocarpus bifidus	kalia
Elaphoglossum aemulum	laukahi
Elaphoglossum hirtum	maku`e, laukahi
Emilia fosbergii	Florida tasselflower
Erigeron karvinskianus	Daisy fleabane
Fragaria vesca	Woodland Strawberry
Fuchsia magellanica	hardy fuschia earring flower, kulapepeiao
Grammitis tenella	kolokolo mahina lua
Grevillea robusta	silk oak
Hedychium flavescens	Yellow ginger
Hedychium gardnerianum	Kahili ginger
Hedyotis centranthoides	manono
Hedyotis terminalis	ko iko
Holcus lanatus	common velvet grass
Hydrangea macrophylla	hydrangea
Hypochaeris glabra	smooth cat`s ear
Ilex anomala	Hawaii holly
Kalanchoe pinnata	Cathedral bells
Kyllinga brevifolia	shortleaf spikesedge
Lantana camara	Lantana
Melicope anisata	fragrant mokihana

Table A-2. Vegetation Species Found on Koke`e Air Force Station

Scientific Name	**Common Name**
Melinis minutiflora	Molassesgrass
Metrosideros polymorpha	`ohi`a
Microlepia strigosa	palapala`i
Mimosa pudica	Sensitive plant
Morella faya	Firetree
Myrsine alyxifolia	kolea
Nestegis sandwicensis	olopua
Odontosoria chinensis	pala`a
Paspalum urvillei	Vasey's grass
Passiflora tarminiana	banana poka
Pennisetum clandestinum	Kikuyugrass
Perrottetia sandwicensis	olomea
Persea americana	avocado, alligator pear
Pinus sp	pine
Plantago lanceolata	Narrowleaf plantain
Pouteria sandwicensis	`aulu
Prunus cerasifera	methley plum
Psidium cattleianum	Strawberry guava
Psidium sp.	guava
Pyrus communis	common pear
Pyrus malus	apple
Rubus argutus	Sawtooth blackberry
Sadleria cyatheoides	`ama`u
Scaevola gaudichaudiana	naupaka kuahiwi
Sechium edule	Chayote
Setaria palmifolia	Palm grass
Setaria parviflora	yellow foxtail
Sophora chrysophylla	mamane mamani
Sporobolus indicus var. capensis	African dropseed
Stenogyne purpurea	Purplefruit stenogyne
Styphelia tameiameiae	Pukiawe
Syzygium cumini	Java plum
Syzygium sandwicensis	`ohi`a ha
Taraxacum officinale	common dandelion
Tetraplasandra sp.	`ohe sp.
Thelypteris parasitica	wood-fern
Vaccinium calycinum	tree ohelo, `ohelo kau la`au
Vicia sativa	common vetch
Vinca major	trailing periwinkle
Zantedeschia aethiopica	Calla lily

Source: USAF 2007, Kinsla undated a

Table A-3. Vegetation Species Found on Mt. Ka`ala Air Force Station

Scientific Name	**Common Name**
Adenophorus tamariscinus	wahine noho mauna
Ageratina adenophora	Maui pamakani
Araucaria columnaris	Cook pine
Argyranthemum sp.	Dill daisy
Asplenium contiguum	Forest spleenwort
Astelia menziesiana	kalusha, pa`iniu
Athyrium microphyllum	`akolea
Axonopus fissifolius	narrow-leaved carpetgrass
Broussaisia arguta	kanawa`o
Buddleja asiatica	Dogtail
Casuarina equisetifolia	Casuarina
Cerastium fontanum	chickweed
Cheirodendron platyphyllum	lapalapa
Cheirodendron trigynum	`olapa
Cibotium chamissoi	hapu`u `i`i
Cibotium glaucum	hapu`u pulu
Clidemia hirta	Koster's curse
Coprosma granadensis	heads makole
Coprosma ochracea	Maui mirrorplant
Crocosmia x crocosmiiflora	montbretia, crocosmia
Cynodon dactylon	Bermuda grass
Cyperus javanicus	`ahu`awa
Cyperus polystachyos var. polystachyos	manyspike flatsedge
Dianella sandwicensis	`uki uki
Dicranopteris linearis	false staghorn fern, uluhe
Diplazium sandwichianum	Hawai`i teinsorus fern
Drymaria cordata	drymaria, pipili
Dubautia laxa ssp. hirsuta	na`ena`e pua melemele
Elaeocarpus angustifolius	blue marble tree
Freycinetia arborea	`ie`ie
Gunnera petaloidea	`ape`ape
Hedychium flavescens	Yellow ginger
Hedychium gardnerianum	Kahili ginger
Hedyotis terminalis	manono
Hydrangea macrophylla	Hydrangea, popo-hau
Hymenophyllum lanceolatum	palai hinahina
Ilex anomala	Hawaii holly
Impatiens walleriana	impatiens
Juncus bufonius	common toad rush
Juncus planifolius	rush
Kyllinga brevifolia	Green kyllinga, kili`o`opu
Labordia waiolani	kamakahala lau li`i
Lellingeria saffordii	kihi

Table A-3. Vegetation Species Found on Mt. Ka`ala Air Force Station

Scientific Name	**Common Name**
Lepisorus thunbergianus	pakahakaha
Lycopodium cernuum	wawae-`iole
Lythrum maritimum	pukamole
Machaerina angustifolia	`uki
Melicope clusiifolia	anise-scented alani
Metrosideros polymorpha	`ohi`a
Myrsine lessertiana	kolea lau nui
Nasturtium microphyllum	watercress, leko
Odontosoria chinensis	pala`a, pala- ala`a
Paspalum conjugatum	hilo grass
Paspalum urvillei	Vasey's grass
Pennisetum clandestinum	Kikuyugrass
Peperomia membranacea	`ala`ala wai nui
Perrottetia sandwicensis	olomea
Phyllostegia grandiflora	kapana
Pipturus albidus	mamaki
Pityrogramma calomelanos	gold fern
Plantago lanceolata	Narrowleaf plantain
Plantago major	common plantain
Pluchea carolinensis	sourbush
Poa annua	annual bluegrass
Poa sp.	grass sp.
Polypodium pellucidum	`ae
Prunus cerasifera	Methley plum
Psidium cattleianum	Strawberry guava
Rubus argutus	Sawtooth blackberry
Sacciolepis indica	glenwood grass
Sadleria cyatheoides	ama`u
Smilax melastomifolia	hoi kuahiwi, aka`awa
Sporobolus indicus	West Indian dropseed
Styphelia tameiameiae	pukiawe
Syzygium sandwicensis	`ohi`a ha
Thelypteris cyatheoides	kikawaio
Thelypteris parasitica	wood-fern
Trematolobelia macrostachys	koli`i
Vaccinium calycinum	`ohelo kau la`au
Youngia japonica	oriental hawksbeard

Source: USAF 2007, Kinsla undated b

Appendix B: Herbicide and Pesticide Labels

THIS PAGE INTENTIONALLY LEFT BLANK

Specimen Label

Dow AgroSciences

Garlon* 3A

Specialty Herbicide

*Trademark of Dow AgroSciences LLC

For the control of woody plants, broadleaf weeds and vines in forests and industrial non-crop areas, including manufacturing and storage sites, rights-of-way such as electrical power lines, communication lines, pipelines, roadsides, railroads, fence rows, non-irrigation ditch banks, and around farm buildings; including application to grazed areas, and establishment and maintenance of wildlife openings on these sites, and in Christmas tree plantations. Use within production forests and industrial non-crop sites may include applications to control target vegetation in and around standing water sites, such as marshes, wetlands, and the banks of ponds and lakes.

Active Ingredient:	
triclopyr: 3,5,6-trichloro-2-pyridinyloxyacetic acid, triethylamine salt	44.4%
Inert Ingredients	55.6%
Total	100.0%

Acid equivalent: triclopyr - 31.8% - 3 lb/gal

EPA Reg. No. 62719-37

Keep Out of Reach of Children

DANGER PELIGRO

Si usted no entiende la etiqueta, busque a alguien para que se la explique a usted en detalle. (If you do not understand the label, find someone to explain it to you in detail.)

Precautionary Statements

Hazard to Humans and Domestic Animals

Corrosive • Causes Irreversible Eye Damage • Harmful If Swallowed Or Absorbed Through Skin • Prolonged Or Frequently Repeated Skin Contact May Cause Allergic Reaction In Some Individuals

Do not get in eyes or on skin or clothing.

Personal Protective Equipment (PPE)

Applicators and other handlers must wear:

- Long-sleeved shirt and long pants
- Shoes plus socks
- Protective eyewear
- Chemical resistant gloves (≥ 14 mils) such as butyl rubber, natural rubber, neoprene rubber or nitrile rubber

Discard clothing and other absorbent materials that have been drenched or heavily contaminated with this product's concentrate. Do not reuse them. Follow manufacturer's instructions for cleaning/maintaining PPE. If no such instructions for washables, use detergent and hot water. Keep and wash PPE separately from other laundry.

Engineering Controls

When handlers use closed systems, enclosed cabs, or aircraft in a manner that meets the requirements listed in the WPS (40 CFR 170.240(d)(4-6), the handler PPE requirements may be reduced or modified as specified in the WPS.

User Safety Recommendations

Users should:

- Wash hands before eating, drinking, chewing gum, using tobacco, or using the toilet.
- Remove clothing immediately if pesticide gets inside. Then wash thoroughly and put on clean clothing.
- Remove PPE immediately after handling this product. Wash the outside of gloves before removing. As soon as possible, wash thoroughly and change into clean clothing.

First Aid

If in eyes: Hold eye open and rinse slowly and gently with water for 15-20 minutes. Remove contact lenses, if present, after the first 5 minutes, then continue rinsing eye. Call a poison control center or doctor for treatment advice.

If on skin or clothing: Take off contaminated clothing. Rinse skin immediately with plenty of water for 15-20 minutes. Call a poison control center or doctor for treatment advice.

If swallowed: Call a poison control center or doctor immediately for treatment advice. Have person sip a glass of water if able to swallow. Do not induce vomiting unless told to do so by a poison control center or doctor. Do not give anything by mouth to an unconscious person. Have the product container or label with you when calling a poison control center or doctor, or going for treatment. You may also contact 1-800-992-5994 for emergency medical treatment information.

Note to Applicator: Allergic skin reaction is not expected from exposure to spray mixtures of Garlon 3A herbicide when used as directed.

Note to Physician: Probable mucosal damage may contraindicate the use of gastric lavage.

Environmental Hazards

Do not contaminate water when cleaning equipment or disposing of equipment washwaters. Under certain conditions, treatment of aquatic weeds can result in oxygen depletion or loss due to decomposition of dead plants, which may contribute to fish suffocation. This loss can cause fish suffocation. Therefore, to minimize this hazard, do not treat more than one-third to one-half of the water area in a single operation and wait at least 10 to 14 days between treatments. Begin treatment along the shore and proceed outwards in bands to allow fish to move into untreated areas. Consult with the State agency for fish and game before applying to public water to determine if a permit is needed.

This chemical has properties and characteristics associated with chemicals detected in groundwater. The use of this chemical in areas where soils are permeable, particularly where the water table is shallow, may result in groundwater contamination.

Physical or Chemical Hazards

Combustible. Do not use or store the product near heat or open flame.

Notice: Read the entire label. Use only according to label directions. **Before using this product, read Warranty Disclaimer, Inherent Risks of Use, and Limitation of Remedies elsewhere on this label. If terms are unacceptable, return at once unopened.**

In case of emergency endangering health or the environment involving this product, call 1-800-992-5994. If you wish to obtain additional product information, visit our web site at www.dowagro.com.

Agricultural Chemical: Do not ship or store with food, feeds, drugs or clothing.

Directions for Use

It is a violation of Federal law to use this product in a manner inconsistent with its labeling.
Read all Directions for Use carefully before applying.

Do not apply this product in a way that will contact workers or other persons, either directly or through drift. Only protected handlers may be in the area during application. For any requirements specific to your state or tribe, consult the agency responsible for pesticide regulation

Agricultural Use Requirements

Use this product only in accordance with its labeling and with the Worker Protection Standard, 40 CFR part 170. This Standard contains requirements for the protection of agricultural workers on farms, forests, nurseries, and greenhouses, and handlers of agricultural pesticides. It contains requirements for training, decontamination, notification, and emergency assistance. It also contains specific instructions and exceptions pertaining to the statements on this label about personal protective equipment (PPE), and restricted-entry interval. The requirements in this box only apply to uses of this product that are covered by the Worker Protection Standard.

Do not enter or allow worker entry into treated areas during the restricted entry interval (REI) of 48 hours.

PPE required for early entry to treated areas that is permitted under the Worker Protection Standard and that involves contact with anything that has been treated, such as plants, soil, or water, is:

- Coveralls
- Shoes plus socks
- Protective eyewear
- Chemical-resistant gloves (≥ 14 mils) such as butyl rubber, natural rubber, neoprene rubber or nitrile rubber

Non-Agricultural Use Requirements

The requirements in this box apply to uses of this product that are NOT within the scope of the Worker Protection Standard for Agricultural Pesticides (40 CFR Part 170). The WPS applies when this product is used to produce agricultural plants on farms, forests, nurseries, or greenhouses.

Entry Restrictions for Non-WPS Uses: For applications to non-cropland areas, do not allow entry into areas until sprays have dried, unless applicator and other handler PPE is worn.

Storage and Disposal

Do not contaminate water, food, or feed by storage and disposal.
Open dumping is prohibited.
Pesticide Storage: Store above 28°F or agitate before use.
Pesticide Disposal: Wastes resulting from the use of this product may be disposed of on site or at an approved waste disposal facility.
Container Disposal for Refillable Containers: Seal all openings which have been opened during use. Return the empty container to a collection site designated by Dow AgroSciences. If the container has been damaged and cannot be returned according to the recommended procedures, contact Dow AgroSciences Customer Service Center at 1-800-258-1470 to obtain proper handling instructions.
Container Disposal (Metal): Do not reuse container. Triple rinse (or equivalent). Then offer for recycling or reconditioning, or puncture and dispose of in a sanitary landfill, or by other procedures approved by state and local authorities.
Container Disposal (Plastic): Do not reuse container. Triple rinse (or equivalent). Then offer for recycling or reconditioning, or puncture and dispose of in a sanitary landfill, or by incineration, or, if allowed by state and local authorities, by burning. If burned, stay out of smoke.
General: Consult federal, state, or local disposal authorities for approved alternative procedures.

General Information for Production Forests and Industrial Non-Crop Areas

Garlon* 3A specialty herbicide is recommended for the control of woody plants, broadleaf weeds and vines in forests and industrial non-crop areas including manufacturing and storage sites, rights-of-way such as electrical power lines, communication lines, pipelines, roadsides, railroads, fence rows, non-irrigation ditch banks, and around farm buildings, including application to grazed areas, and establishment and maintenance of wildlife openings on these sites, and in Christmas tree plantations. Use within production forests and industrial non-crop sites may include applications to control target vegetation in and around standing water sites, such as marshes, wetlands, and the banks of ponds and lakes.

Obtain Required Permits: Consult with appropriate state or local water authorities before applying this product to public waters. State or local public agencies may require permits.

General Use Precautions and Restrictions

In Arizona: The state of Arizona has not approved Garlon 3A for use on plants grown for commercial production, specifically forests grown for commercial timber production, or on designated grazing areas.

When applying this product in tank mix combination, follow all applicable use directions, precautions and limitations on each manufacturer's label.

Chemigation: Do not apply this product through any type of irrigation system.

Do not apply Garlon 3A directly to, or otherwise permit it to come into direct contact with grapes, tobacco, vegetable crops, flowers, or other desirable broadleaf plants, and do not permit spray mists containing it to drift into them.

It is permissible to treat non-irrigation ditch banks, seasonally dry wetlands (such as flood plains, deltas, marshes, swamps, or bogs) and transitional areas between upland and lowland sites.

- **Do not** apply to salt water bays or estuaries.
- **Do not** apply directly to un-impounded rivers or streams.
- **Do not** apply on ditches or canals used to transport irrigation water. It is permissible to treat non-irrigation ditch banks.
- **Do not** apply where runoff water may flow onto agricultural land as injury to crops may result.
- When making applications to control unwanted plants on banks or shorelines of moving water sites, minimize overspray to open water.
- The use of a mistblower is not recommended.
- Apply no more than 2 lb ae of triclopyr (2/3 gallon of Garlon 3A) per acre per growing season on range and pasture sites, including rights-of-way, fence rows or any area where grazing or harvesting is allowed.
- On forestry sites, Garlon 3A may be used at rates up to 6 lb ae of triclopyr (2 gallons of Garlon 3A) per acre per year.
- For all terrestrial use sites other than range, pasture, forestry sites, and grazed areas, the maximum application rate is 9 lb ae of triclopyr (3 gallons of Garlon 3A) per acre per year.

Precautions for Potable Water Intakes for Emerged Aquatic Weed Control

See chart below for specific setback distances near functioning potable water intakes. **Note:** Existing potable water intakes which are no longer in use, such as those replaced by potable water wells or connections to a municipal water system, are not considered to be functioning potable water intakes. These setback restrictions do not apply to terrestrial applications made adjacent to potable water intakes.

	Garlon 3A Application Rate, qt/acre			
Area Treated	2 qt/acre	4 qt/acre	6 qt/acre	8 qt/acre
(acres)	Setback Distance (ft)			
4	0	200	400	500
>4 - 8	0	200	700	900
>8 - 16	0	200	700	1000
>16	0	200	900	1300

To apply Garlon 3A around and within the distances noted above from a functioning potable water intake, the intake must be turned off until the triclopyr level in the intake water is determined to be 0.4 parts per million (ppm) or less by laboratory analysis or immunoassay.

- **Recreational Use of Water in Treatment Area:** There are no restrictions on use of water in the treatment area for recreational purposes, including swimming and fishing.
- **Livestock Use of Water from Treatment Area:** There are no restrictions on livestock consumption of water from the treatment area.

Grazing and Haying Restrictions

Except for lactating dairy animals, there are no grazing restrictions following application of this product.

- **Grazing Lactating Dairy Animals:** Do not allow lactating dairy animals to graze treated areas until the next growing season following application of this product.
- Do not harvest hay for 14 days after application.
- Grazed areas of non-cropland and forestry sites may be spot treated if they comprise no more than 10% of the total grazable area.

Slaughter Restrictions: During the season of application, withdraw livestock from grazing treated grass at least 3 days before slaughter.

Avoiding Injurious Spray Drift

Applications should be made only when there is little or no hazard from spray drift. Very small quantities of spray, which may not be visible, may seriously injure susceptible plants. Do not spray when wind is blowing toward susceptible crops or ornamental plants near enough to be injured. It is suggested that a continuous smoke column at or near the spray site or a smoke generator on the spray equipment be used to detect air movement, lapse conditions, or temperature inversions (stable air). If the smoke layers or indicates a potential of hazardous spray drift, do not spray.

Aerial Application: For aerial application on rights-of-way or other areas near susceptible crops, apply through a Microfoil† or Thru-Valve boom†, or use an agriculturally labeled drift control additive. Other drift reducing systems or thickened sprays prepared by using high viscosity inverting systems may be used if they are made as drift-free as mixtures containing agriculturally labeled thickening agents or applications made with the Microfoil or Thru-Valve boom. Keep spray pressures low enough to provide coarse spray droplets. Spray boom should be no longer than 3/4 of the rotor length. Do not use a thickening agent with the Microfoil or Thru-Valve booms, or other systems that cannot accommodate thick sprays. Spray only when the wind velocity is low (follow state regulations). Avoid application during air inversions. If a spray thickening agent is used, follow all use recommendations and precautions on the product label.

† Reference within this label to a particular piece of equipment produced by or available from other parties is provided without consideration for use by the reader at its discretion and subject to the reader's independent circumstances, evaluation, and expertise. Such reference by Dow AgroSciences is not intended as an endorsement of such equipment, shall not constitute a warranty (express or implied) of such equipment, and is not intended to imply that other equipment is not available and equally suitable. Any discussion of methods of use of such equipment does not imply that the reader should use the equipment other than is advised in directions available from the equipment's manufacturer. The reader is responsible for exercising its own judgment and expertise, or consulting with sources other than Dow AgroSciences, in selecting and determining how to use its equipment.

Spray Drift Management

Avoiding spray drift at the application site is the responsibility of the applicator. The interaction of many equipment and weather related factors determine the potential for spray drift. The applicator and the grower are responsible for considering all these factors when making decisions.

The following drift management requirements must be followed to avoid off-target drift movement from aerial applications:

1. The distance of the outer most operating nozzles on the boom must not exceed 3/4 the length of the rotor.
2. Nozzles must always point backward parallel with the air stream and never be pointed downwards more than 45 degrees.

Where states have more stringent regulations, they should be observed.

The applicator should be familiar with and take into account the information covered in the following Aerial Drift Reduction Advisory. [This information is advisory in nature and does not supersede mandatory label requirements.]

Aerial Drift Reduction Advisory

Information on Droplet Size: The most effective way to reduce drift potential is to apply large droplets. The best drift management strategy is to apply the largest droplets that provide sufficient coverage and control. Applying larger droplets reduces drift potential, but will not prevent drift if applications are made improperly, or under unfavorable environmental conditions (see Wind, Temperature and Humidity, and Temperature Inversions).

Controlling Droplet Size:

- **Volume** - Use high flow rate nozzles to apply the highest practical spray volume. Nozzles with higher rated flows produce larger droplets.
- **Pressure** - Do not exceed the nozzle manufacturer's recommended pressures. For many nozzle types, lower pressure produces larger droplets. When higher flow rates are needed, use higher flow rate nozzles instead of increasing pressure.
- **Number of Nozzles** - Use the minimum number of nozzles that provide uniform coverage.
- **Nozzle Orientation** - Orienting nozzles so that the spray is released parallel to the airstream produces larger droplets than other orientations and is the recommended practice. Significant deflection from horizontal will reduce droplet size and increase drift potential.
- **Nozzle Type** - Use a nozzle type that is designed for the intended application. With most nozzle types, narrower spray angles produce larger droplets. Consider using low-drift nozzles. Solid stream nozzles oriented straight back produce the largest droplets and the lowest drift.

Boom Length: For some use patterns, reducing the effective boom length to less than 3/4 of the wingspan or rotor length may further reduce drift without reducing swath width.

Application Height: Applications should not be made at a height greater than 10 feet above the top of the largest plants unless a greater height is required for aircraft safety. Making applications at the lowest height that is safe reduces exposure of droplets to evaporation and wind.

Swath Adjustment: When applications are made with a crosswind, the swath will be displaced downwind. Therefore, on the up and downwind edges of the field, the applicator must compensate for this displacement by adjusting the path of the aircraft upwind. Swath adjustment distance should increase, with increasing drift potential (higher wind, smaller drops, etc.).

Wind: Drift potential is lowest between wind speeds of 2-10 mph. However, many factors, including droplet size and equipment type, determine drift potential at any given speed. Application should be avoided below 2 mph due to variable wind direction and high inversion potential. **Note:** Local terrain can influence wind patterns. Every applicator should be familiar with local wind patterns and how they affect spray drift.

Temperature and Humidity: When making applications in low relative humidity, set up equipment to produce larger droplets to compensate for evaporation. Droplet evaporation is most severe when conditions are both hot and dry.

Temperature Inversions: Applications should not occur during a local, low level temperature inversion because drift potential is high. Temperature inversions restrict vertical air mixing, which causes small suspended droplets to remain in a concentrated cloud. This cloud can move in unpredictable directions due to the light variable winds common during inversions. Temperature inversions are characterized by increasing temperatures with altitude and are common on nights with limited cloud cover and light to no wind. They begin to form as the sun sets and often continue into the morning. Their presence can be indicated by ground fog; however, if fog is not present, inversions can also be identified by the movement of the smoke from a ground source or an aircraft smoke generator. Smoke that layers and moves laterally in a concentrated cloud (under low wind conditions) indicates an inversion, while smoke that moves upward and rapidly dissipates indicates good vertical air mixing.

Sensitive Areas: The pesticide should only be applied when the potential for drift to adjacent sensitive areas (e.g., residential areas, bodies of water, known habitat for threatened or endangered species, non-target crops) is minimal (e.g., when wind is blowing away from the sensitive areas).

Ground Equipment: To aid in reducing spray drift, Garlon 3A should be used in thickened (high viscosity) spray mixtures using an agriculturally labeled drift control additive, high viscosity invert system, or equivalent as directed by the manufacturer. With ground equipment, spray drift can be reduced by keeping the spray boom as low as possible; by applying 20 gallons or more of spray per acre; by keeping the operating spray pressures at the lower end of the manufacturer's recommended pressures for the specific nozzle type used (low pressure nozzles are available from spray equipment manufacturers); and by spraying when wind velocity is low (follow state regulations). In hand-gun applications, select the minimum spray pressure that will provide adequate plant coverage (without forming a mist). Do not apply with nozzles that produce a fine-droplet spray.

High Volume Leaf-Stem Treatment: To minimize spray drift, do not use pressure exceeding 50 psi at the spray nozzle and keep sprays no higher than brush tops. An agriculturally labeled thickening agent may be used to reduce drift.

Plants Controlled by Garlon 3A

Woody Plant Species

alder	Douglas-fir	poplar
arrowwood	dogwood	salt-bush *(Baccharis* spp.)
ash	elderberry	sassafras
aspen	elm	scotch broom
bear clover (bearmat)	gallberry	sumac
beech	hazel	sweetbay magnolia
birch	hornbean	sweetgum
blackberry	kudzu†	sycamore
blackgum	locust	tanoak
Brazilian pepper	madrone	thimbleberry
cascara	maples	tulip poplar
ceanothus	mulberry	waxmyrtle
cherry	oaks	western hemlock
chinquapin	persimmon	wild rose
choke cherry	pine	willow
cottonwood	poison ivy	winged elm
crataegus (hawthorn)	poison oak	salmonberry

†For complete control, retreatment may be necessary.

Annual and Perennial Broadleaf Weeds

bindweed	dandelion	ragweed
burdock	field bindweed	smartweed
Canada thistle	lambsquarter	tansy ragwort
chicory	plantain	vetch
curly dock	Purple loosestrife	wild lettuce

Application Methods

Use Garlon 3A at rates of 3/4 to 9 lb ae of triclopyr (1/4 to 3 gallons of Garlon 3A) per acre to control broadleaf weeds and woody plants. In all cases use the amount specified in enough water to give uniform and complete coverage of the plants to be controlled. Use only water suitable for spraying. Use of an agriculturally labeled non-ionic surfactant is recommended for all foliar applications. When using surfactants, follow the use directions and precautions listed on the surfactant manufacturer's label. Use the higher recommended concentrations of surfactant in the spray mixture when applying lower spray volumes per acre. The recommended order of addition to the spray tank is water, spray thickening agent (if used), additional herbicide (if used), and Garlon 3A. Surfactant should be added to the spray tank last or as recommended on the product label. If combined with emulsifiable concentrate herbicides, moderate continuous adequate agitation is required.

Before using any recommended tank mixtures, read the directions and all use precautions on both labels.

For best results, applications should be made when woody plants and weeds are actively growing. When hard to control species such as ash, blackgum, choke cherry, elm, maples, oaks, pines, or winged elm are prevalent and during applications made in late summer when the plants are mature and during drought conditions, use the higher rates of Garlon 3A alone or in combinations with Tordon* 101 Mixture herbicide. (Tordon 101 Mixture is a restricted use pesticide. See product label.)

When using Garlon 3A in combination with 2,4-D 3.8 lb amine, like DMA 4 IVM, or low volatile ester herbicides, generally the higher rates should be used for satisfactory brush control.

Use the higher dosage rates when brush approaches an average of 15 feet in height or when the brush covers more than 60% of the area to be treated. If lower rates are used on hard to control species, resprouting may occur the year following treatment.

On sites where easy to control brush species dominate, rates less than those recommended may be effective. Consult State or Local Extension personnel for such information.

Foliage Treatment With Ground Equipment

High Volume Foliage Treatment

For control of woody plants, use Garlon 3A at the rate of 3 to 9 lb ae of triclopyr (1 to 3 gallons of Garlon 3A) per 100 gallons of spray solution, or Garlon 3A at 3/4 to 3 lb ae of triclopyr (1 to 4 quarts of Garlon 3A) may be tank mixed with 1/4 to 1/2 gallons of 2,4-D 3.8 lb amine, like DMA 4 IVM, or low volatile ester or Tordon 101 Mixture and diluted to make 100 gallons of spray solution. Apply at a volume of 100 to 400 gallons of total spray per acre depending on size and density of woody plants. Coverage should be thorough to wet all leaves, stems, and root collars. (See General Use Precautions and Restrictions.) Do not exceed maximum allowable use rates per acre (see table below).

Maximum Labeled Rate versus Spray Volume per Acre

Total Spray Volume (gal/acre)	Maximum Rate of Garlon 3A		
	Rangeland and Pasture Sites† (gal/100 gal of spray)	Forestry Sites†† (gal/100 gal of spray)	Other Non-Cropland Sites††† (gal/100 gal of spray)
400	Do not use	0.5	0.75
300	Do not use	0.67	1
200	Do not use	1	1.5
100	0.67	2	3
50	1.33	4	6
40	1.67	5	7.5
30	2.33	6.65	10
20	3.33	10	15
10	6.67	20	30

† Do not exceed the maximum use rate of 2 lb ae of triclopyr (2/3 gal of Garlon 3A)/acre/year.

†† Do not exceed the maximum use rate of 6 lb ae of triclopyr (2 gal of Garlon 3A)/acre/year.

††† Do not exceed the maximum use rate of 9 lb ae of triclopyr (3 gal of Garlon 3A)/acre/year on non-cropland use sites other than rangeland, pasture, forestry, and grazed areas.

Low Volume Foliage Treatment

To control susceptible woody plants, apply up to 15 lb ae of triclopyr (5 gallons of Garlon 3A) in 10 to 100 gallons of finished spray. The spray concentration of Garlon 3A and total spray volume per acre may be adjusted according to the size and density of target woody plants and kind of spray equipment used. With low volume sprays, use sufficient spray volume to obtain uniform coverage of target plants including the surfaces of all foliage, stems, and root collars (see General Use Precautions and Restrictions). For best results, a surfactant should be added to all spray mixtures. Match equipment and delivery rate of spray nozzles to height and density of woody plants. When treating tall, dense brush, a truck mounted spray gun with spray tips that deliver up to 2 gallons per minute at 40 to 60 psi may be required. Backpack or other types of specialized spray equipment with spray tips that deliver less than 1 gallon of spray per minute may be appropriate for short, low to moderate density brush.

Tank Mixing: As a low volume foliar spray, up to 9 lb ae of triclopyr (3 gallons of Garlon 3A) may be applied in tank mix combination with 1/2 to 1 gallon of Tordon K or 1 to 2 gallons of Tordon 101 Mixture in 10 to 100 gallons of finished spray.

Broadcast Applications With Ground Equipment

Make application using equipment that will assure uniform coverage of the spray volumes applied. To improve spray coverage, add an agriculturally labeled non-ionic surfactant as described later under Directions for Use. See Maximum Labeled Rate versus Spray Volume per Acre table above for relationship between mixing rate, spray volume and maximum application rate.

Woody Plant Control

Foliage Treatment: Use 6 to 9 lb ae of triclopyr (2 to 3 gallons of Garlon 3A) in enough water to make 20 to 100 gallons of total spray per acre or 1 1/2 to 3 lb ae of triclopyr (1/2 to 1 gallon of Garlon 3A) may be combined with 1 to 2 gallons of 2,4-D 3.8 lb amine, like DMA 4 IVM, or low volatile esters or Tordon 101 Mixture in sufficient water to make 20 to 100 gallons of total spray per acre.

Broadleaf Weed Control

Use Garlon 3A at rates of 1 to 4 1/2 lb ae of triclopyr (1/3 to 1 1/2 gallons of Garlon 3A) in a total volume of 20 to 100 gallons of water per acre. Apply any time during the growing season. Garlon 3A at 1 to 3 lb ae of triclopyr (1/3 to 1 gallon of Garlon 3A) may be tank mixed with 1/2 to 1 gallon of Tordon K, Tordon 101 Mixture or 2,4-D 3.8 lb amine, like DMA 4 IVM, or low volatile herbicides to improve the spectrum of activity.

Aerial Application (Helicopter Only)

Aerial sprays should be applied using suitable drift control. (See General Use Precautions and Restrictions.) Add an agriculturally labeled non-ionic surfactant as described under Directions for Use. See Maximum Labeled Rate versus Spray Volume per Acre table above for relationship between mixing rate, spray volume and maximum application rate.

Foliage Treatment (Non-Grazed Rights-of-Way)

Non-grazed areas: Use 6 to 9 lb ae of triclopyr (2 to 3 gallons of Garlon 3A) or 3 to 4 1/2 lb ae of triclopyr (1 to 1 1/2 gallons of Garlon 3A) in a tank mix combination with 1 to 2 gallons of 2,4-D 3.8 lb amine, like DMA 4 IVM, or low volatile esters or Tordon 101 Mixture, and apply in a total spray volume of 10 to 30 gallons per acre. Use the higher rates and volumes when plants are dense or under drought conditions.

Interspersed areas in non-grazed rights-of-ways that may be subject to grazing may be spot treated if the treated area comprises no more than 10% of the total grazable area.

Forest Management Applications

For best control from broadcast applications of Garlon 3A, use a spray volume which will provide thorough plant coverage. Recommended spray volumes are usually 10 to 25 gallons per acre by air or 10 to 100 gallons per acre by ground. To improve spray coverage of spray volumes less than 50 gallons per acre, add an agriculturally labeled non-ionic surfactant as described under Directions for Use. Application systems should be used to prevent hazardous drift to off-target sites. Nozzles or additives that produce larger droplets of spray may require higher spray volumes to maintain brush control.

Forest Site Preparation (Not for Conifer Release)

Use up to 6 lb ae of triclopyr (2 gallons of Garlon 3A) and apply in a total spray volume of 10 to 30 gallons per acre or Garlon 3A at 3 to 4 1/2 lb ae of triclopyr (1 to 1 1/2 gallons of Garlon 3A) may be used with 1 to 2 gallons of Tordon 101 Mixture or 2,4-D 3.8 lb low volatile ester in a tank mix combination in a total spray volume of 10 to 30 gallons per acre. Use of a non-ionic agricultural surfactant is recommended for all foliar applications as described under Directions for Use.

Note: Conifers planted sooner than one month after treatment with Garlon 3A at less than 4 lb ae of triclopyr (1 1/3 gallons of Garlon 3A) per acre or sooner than two months after treatment at 4 to 9 lb ae of triclopyr (1 1/3 to 3 gallons of Garlon 3A) per acre may be injured. When tank mixtures of herbicides are used for forest site preparation, labels for all products in the mixture should be consulted and the longest recommended waiting period before planting observed.

Directed Spray Applications for Conifer Release

To release conifers from competing hardwoods such as red maple, sugar maple, striped maple, sweetgum, red and white oaks, ash, hickory, alder, birch, aspen, and pin cherry, mix 3 to 6 lb ae triclopyr (1 to 2 gallons of Garlon 3A) in enough water to make 100 gallons of spray mixture. To improve spray coverage, add an agriculturally labeled non-ionic surfactant as described under Directions for Use. The spray mixture should be directed onto foliage of competitive hardwoods using knapsack or backpack sprayers with flat fan nozzles or equivalent any time after hardwoods have reached full leaf size, but before autumn coloration. The majority of treated hardwoods should be less than 6 feet in height to ensure adequate spray coverage. Care should be taken to direct spray away from contact with conifer foliage, particularly foliage of desirable pines.

Note: Spray may cause temporary damage and growth suppression where contact with conifers occurs; however, injured conifers should recover and grow normally. Over-the-top spray applications can kill pines.

Broadcast Application for Conifer Release in the Northeastern United States

To release spruce, fir, red pine and white pine from competing hardwoods, such as red maple, sugar maple, striped maple, alder, birch (white, yellow or gray), aspen, ash, pin cherry and *Rubus* spp. and perennial and annual broadleaf weeds, use Garlon 3A at rates of 1 1/2 to 3 lb ae triclopyr (2 to 4 quarts of Garlon 3A) per acre alone or plus 2,4-D amine, like DMA 4 IVM, or 2,4-D ester to provide no more than 4 pounds acid equivalent per acre from both products. Applications should be made in late summer or early fall after conifers have formed their over wintering buds and hardwoods are in full leaf and prior to autumn coloration.

Broadcast Applications for Douglas Fir Release in the Pacific Northwest and California

To release Douglas fir from susceptible competing vegetation such as broadleaf weeds, alder, blackberry or Scotch broom, apply Garlon 3A at 1 to 1 1/2 lb ae triclopyr (1 1/3 to 2 quarts of Garlon 3A) per acre alone or in combination with 4 lb per acre of atrazine. Mix all sprays in a water carrier with a non-ionic surfactant. Applications should be made in early spring after hardwoods begin growth and before Douglas fir bud break ("early foliar" hardwood stage) or after Douglas fir seasonal growth has "hardened off" (set winter buds) in late summer, but while hardwoods are still actively growing. When treating after Douglas fir bud set, apply prior to onset of autumn coloration in hardwood foliage. **Note:** Treatments applied during active Douglas fir shoot growth (after spring bud break and prior to bud set) may cause injury to Douglas fir trees.

Cut Surface Treatments

To control unwanted trees of hardwood species such as elm, maple, oak and conifers in rights-of-way and other non-crop areas, apply Garlon 3A, either undiluted or diluted in a 1 to 1 ratio with water, as directed below.

With Tree Injector Method

Applications should be made by injecting 1/2 milliliter of undiluted Garlon 3A or 1 milliliter of the diluted solution through the bark at intervals of 3 to 4 inches between centers of the injector wound. The injections should completely surround the tree at any convenient height. **Note: No Worker Protection Standard worker entry restrictions or worker notification requirements apply when this product is injected directly into plants.**

With Hack and Squirt Method

Make cuts with a hatchet or similar equipment at intervals of 3 to 4 inches between centers at a convenient height around the tree trunk. Spray 1/2 milliliter of undiluted Garlon 3A or 1 milliliter of the diluted solution into each cut.

With Frill or Girdle Method

Make a single girdle through the bark completely around the tree at a convenient height. Wet the cut surface with undiluted or diluted solution.

Both of the above methods may be used successfully at any season except during periods of heavy sap flow of certain species - for example, maples.

Stump Treatment

Spray or paint the cut surfaces of freshly cut stumps and stubs with undiluted Garlon 3A. The cambium area next to the bark is the most vital area to wet.

Christmas Tree Plantations

Garlon 3A is recommended for the control of woody plants and annual and perennial broadleaf weeds in established Christmas tree plantations. For best results, applications should be made when woody plants and weeds are actively growing. Garlon 3A does not control weeds which have not emerged at the time of application. If lower rates are used on hard to control woody species, resprouting may occur the year following treatment. Brush over 8 feet tall is difficult to treat efficiently using hand equipment such as backpack or knapsack sprayers. When treating large brush or trees or hard to control species such as ash, blackgum, choke cherry, elm, hazel, madrone, maples, oaks or sweetgum, and for applications made during drought conditions or in late summer when the leaves are mature, use the higher rates of Garlon 3A or use cut surface application methods. For foliar applications, apply in enough water to give uniform and complete coverage of the plants to be controlled. Applications made under drought conditions may provide less than desirable results.

Use Precautions

- Do not use on newly seeded grass until well established as indicated by vigorous growth and development of secondary root system and tillering
- Newly seeded turf (alleyways, etc.) should be mowed two or three times before any treatment with Garlon 3A.
- Do not reseed Christmas tree areas treated with Garlon 3A for a minimum of three weeks after application.
- Do not use Garlon 3A if legumes, such as clover, are present and injury cannot be tolerated.

Spray Preparation

The recommended order of addition to the spray tank is water, drift control agent (if used), non-ionic agricultural surfactant and Garlon 3A. Continue moderate agitation while mixing and spraying. Use of a non-ionic agricultural surfactant is recommended for all applications. When using surfactants, follow use directions and precautions listed on the manufacturer's label. Use the higher recommended concentrations of surfactant in the spray mixture when applying lower spray volumes per acre.

Application

Make applications in late summer or early autumn after terminal growth of Christmas trees has hardened of, but before leaf drop of, target weeds. Apply at a rate of 3/4 to 1 3/4 lb ae triclopyr (2 to 5 pints of Garlon 3A) per acre as a foliar spray directed toward the base of Christmas trees. Use sufficient spray volume to provide uniform coverage of target plants (20 to 100 gallons per acre). **Do not apply with 2,4-D.** Application rates of Garlon 3A recommended for Christmas trees will only suppress some well established woody plants that are greater than 2 to 3 years old (see table below). Broadcast sprays may also be applied in bands between the rows of planted trees. Use spray equipment that will assure uniform coverage of the desired spray volume.

Spray solution from Garlon 3A can cause needle and branch injury to Christmas trees. To minimize injury to Christmas trees, it is recommended that sprays be directed so as to minimize contact with foliage. Blue spruce, white spruce, balsam fir and Frasier fir are less susceptible to injury than white pine and Douglas fir.

Restriction: Apply Garlon 3A only to established Christmas trees that were planted at least one full year prior to application.

Application Rates and Species Controlled:

Garlon 3A		
2 pints/acre (3/4 lb ae triclopyr)	3 to 4 pints/acre (1 1/2 lb ae triclopyr)	5 pints/acre (1 3/4 lb ae triclopyr)
clover dandelion dock, curly lambsquarters lespedeza plantain, broadleaf plantain, buckhorn ragweed, common vetch	bindweed, field (TG) blackberry† chicory (s) fireweed ivy, ground lettuce, wild oxalis poison ivy smartweed (TG) thistle, Canada (TG) violet, wild Virginia creeper†	arrowwood (SDL) aspen beech (SDL) birch (SDL) chinquapin cottonwood (SDL) elderberry grape, wild mulberry (SDL) poplar (SDL) sassafras (SDL) sumac (SDL) sycamore (SDL)

(TG) Top growth control, retreatment may be necessary
(S) Suppression
(SDL) Seedlings less than 2-3 years old
†Use 4 pint per acre rate

Directed Applications

To control hardwoods such as red maple, sugar maple, striped maple, sweetgum, red and white oaks, ash, alder, birch, aspen, and pin cherry mix 4 to 20 fluid ounces of Garlon 3A in enough water to make 3 gallons of spray mixture. For directed applications, do not exceed 6 lb ae triclopyr (2 gallons of Garlon 3A) per acre per year. To improve coverage, add a non-ionic agricultural surfactant to the spray. This spray mixture should be directed onto foliage of competitive hardwoods using knapsack or backpack sprayers with flat fan nozzles or equivalent any time after hardwoods have reached full leaf size, but before autumn coloration (when plants are actively growing). The majority of treated hardwoods should be less than 8 feet in height to ensure adequate spray coverage. **Note:** To prevent Christmas tree injury, care should be taken to direct spray away from contact with Christmas tree foliage.

Cut Surface Treatments

When treating large brush or trees or hard to control species such as ash, blackgum, choke cherry, elm, hazel, madrone, maples, oaks or sweetgum, and for applications made during drought conditions or in late summer when the leaves are mature, use cut surface treatments. (See directions for Cut Surface Treatments in preceding section of this label.)

Wetland Sites in Production Forests and Industrial Non-Crop Areas

Garlon 3A may be used within production forests and industrial non-crop sites to control target vegetation in and around standing water sites, such as marshes, wetlands, and the banks of ponds and lakes and transition areas between upland and lowland sites.

For control of woody plants and broadleaf weeds in these sites, follow use directions and application methods on this label for forestry and terrestrial non-cropland sites.

Use Precautions

Minimize overspray to open water when treating target vegetation in and around non-flowing, quiescent or transient water. When making applications to control unwanted plants on banks or shorelines of flowing water, minimize overspray to open water. **Note:** Consult local public water control authorities before applying this product in and around public water. Permits may be required to treat such areas.

Terms and Conditions of Use

If terms of the following Warranty Disclaimer, Inherent Risks of Use, and Limitation of Remedies are not acceptable, return unopened package at once to the seller for a full refund of purchase price paid. Otherwise, use by the buyer or any other user constitutes acceptance of the terms under Warranty Disclaimer, Inherent Risks of Use and Limitations of Remedies.

Warranty Disclaimer

Dow AgroSciences warrants that this product conforms to the chemical description on the label and is reasonably fit for the purposes stated on the label when used in strict accordance with the directions, subject to the inherent risks set forth below. Dow AgroSciences MAKES NO OTHER EXPRESS OR IMPLIED WARRANTY OF MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE OR ANY OTHER EXPRESS OR IMPLIED WARRANTY.

Inherent Risks of Use

It is impossible to eliminate all risks associated with use of this product. Plant injury, lack of performance, or other unintended consequences may result because of such factors as use of the product contrary to label instructions (including conditions noted on the label, such as unfavorable temperature, soil conditions, etc.), abnormal conditions (such as excessive rainfall, drought, tornadoes, hurricanes), presence of other materials, the manner of application, or other factors, all of which are beyond the control of Dow AgroSciences or the seller. All such risks shall be assumed by buyer.

Limitation of Remedies

The exclusive remedy for losses or damages resulting from this product (including claims based on contract, negligence, strict liability, or other legal theories), shall be limited to, at Dow AgroSciences' election, one of the following:

1. Refund of purchase price paid by buyer or user for product bought, or
2. Replacement of amount of product used.

Dow AgroSciences shall not be liable for losses or damages resulting from handling or use of this product unless Dow AgroSciences is promptly notified of such loss or damage in writing. In no case shall Dow AgroSciences be liable for consequential or incidental damages or losses.

The terms of the Warranty Disclaimer, Inherent Risks of Use, and this Limitation of Remedies cannot be varied by any written or verbal statements or agreements. No employee or sales agent of Dow AgroSciences or the seller is authorized to vary or exceed the terms of the Warranty Disclaimer or this Limitation of Remedies in any manner.

*Trademark of Dow AgroSciences LLC
Dow AgroSciences LLC • Indianapolis, IN 46268 U.S.A.

Label Code: D02-101-037
Replaces Label: D02-101-036
LOES Number: 010-00084

EPA-Accepted 12/03/02

Revisions:

1. Corrected Example Calculation 2 on page 10: = (800 x 3.912) – 160/3.33.

ARSENAL®
herbicide

SPECIMEN

APPLICATORS CONCENTRATE

ACTIVE INGREDIENT: Isopropylamine salt of Imazapyr (2-[4,5-dihydro-4-methyl-4-(1-methylethyl)-5-oxo-1*H*-imidazol-2-yl]-3-pyridinecarboxylic acid)*	53.1%
INERT INGREDIENT	46.9%
TOTAL	100.0%

*Equivalent to 43.3% 2-[4,5-dihydro-4-methyl-4-(1-methylethyl)-5-oxo-1*H*-imidazol-2-yl]-3-pyridinecarboxylic acid or 4 pounds acid per gallon.

U.S. Patent No. 4,798,619 **EPA Reg. No. 241-299**

KEEP OUT OF REACH OF CHILDREN
CAUTION/PRECAUCION

Si usted no entiende la etiqueta, busque a alguien para que se la explique a usted en detalle. (If you do not understand this label, find someone to explain it to you in detail.)

STATEMENT OF PRACTICAL TREATMENT

IF INHALED: Move person to fresh air. If person is not breathing, call 911 or an ambulance, then give artificial respiration, preferably mouth-to-mouth if possible. Call a poison control center or doctor for further treatment advice.

IF IN EYES: Hold eye open and rinse slowly and gently with water for 15-20 minutes. Remove contact lenses, if present, after the first 5 minutes, then continue rinsing. Call poison control center or doctor for treatment advice.

IF ON SKIN: Take off contaminated clothing. Rinse skin immediately with plenty of water for 15-20 minutes. Call a poison control center or doctor for treatment advice.

Have the product label with you when calling a poison control center or doctor or going for treatment.

In case of emergency endangering life or property involving this product, call day or night 800-832-HELP.

See next page for Additional Precautionary Statements

12/00

BASF Corporation
26 Davis Drive
Research Triangle Park, NC 27709

BASF

PRECAUTIONARY STATEMENTS

HAZARDS TO HUMANS

CAUTION!

Harmful if inhaled. Avoid contact with skin, eyes, or clothing. Avoid breathing spray mist.

Personal Protective Equipment (PPE):

Applicators and other handlers must wear:

- long-sleeved shirt and long pants
- shoes plus socks

Follow manufacturer's instructions for cleaning and maintaining PPE. If no such instructions for washables, use detergent and hot water. Keep and wash PPE separately from other laundry.

USER SAFETY RECOMMENDATIONS

Users should:

1. Wash hands before eating, drinking, chewing gum, using tobacco, or using the toilet.
2. Remove clothing immediately if pesticide gets inside. Then wash thoroughly and put on clean clothing.

ENVIRONMENTAL HAZARDS

For terrestrial uses, DO NOT apply directly to water or to areas where surface water is present or to intertidal areas below the mean high water mark. DO NOT contaminate water when disposing of equipment washwaters. This herbicide is phytotoxic at extremely low concentrations. Nontarget plants may be adversely affected from drift.

PHYSICAL AND CHEMICAL HAZARDS

Spray solutions of ARSENAL herbicide APPLICATORS CONCENTRATE should be mixed, stored, and applied only in stainless steel, fiberglass, plastic, and plastic-lined steel containers.

DO NOT mix, store, or apply ARSENAL herbicide APPLICATORS CONCENTRATE or spray solutions of ARSENAL herbicide APPLICATORS CONCENTRATE in unlined steel (except stainless steel) containers or spray tanks.

DIRECTIONS FOR USE

It is a violation of Federal law to use this product in a manner inconsistent with its labeling.

Do not apply this product in a way that will contact workers or other persons, either directly or through drift. Only protected handlers may be in the area during application.

For any requirements specific to your State or Tribe, consult the agency responsible for pesticide regulation.

ARSENAL herbicide APPLICATORS CONCENTRATE should be used only in accordance with recommendations on the booklet label. Keep containers closed to avoid spills and contamination.

ARSENAL herbicide APPLICATORS CONCENTRATE may be applied using helicopters, ground operated sprayers, low-volume hand-operated spray equipment such as back-pack and pump-up sprayers, and tree injection equipment.

Observe all cautions and limitations in the package labels of products used in combination with ARSENAL herbicide APPLICATORS CONCENTRATE.

AGRICULTURAL USE REQUIREMENTS

Use this product only in accordance with its labeling and with the Worker Protection Standard, 40 CFR part 170. This Standard contains requirements for the protection of agricultural workers on farms, forests, nurseries, and greenhouses, and handlers of agricultural pesticides. It contains requirements for training, decontamination, notification, and emergency assistance. It also contains specific instructions and exceptions pertaining to the statements on this label about personal protective equipment (PPE) and restricted entry interval. The requirements in this box only apply to uses of this product that are covered by the Worker Protection Standard.

Do not enter or allow worker entry into treated areas during the restricted entry interval (REI) of 12 hours.

PPE required for early entry to treated areas that is permitted under the Worker Protection Standard and that involves contact with anything that has been treated, such as plants, soil, or water, is:

• coveralls • shoes plus socks

STORAGE AND DISPOSAL

PROHIBITIONS: DO NOT store below 10°F. DO NOT contaminate water, food, or feed by storage or disposal.

PESTICIDE DISPOSAL: Wastes resulting from the use of this product may be disposed of on site or at an approved waste disposal facility.

CONTAINER DISPOSAL: Triple rinse (or equivalent). Then offer for recycling or reconditioning, or puncture and dispose of in an approved sanitary landfill, or incineration, or, if allowed by state and local authorities, by burning. If burned, stay out of smoke.

IMPORTANT

DO NOT use on food or feed crops. DO NOT use on Christmas trees. DO NOT treat irrigation ditches, or water used for crop irrigation or for domestic uses. Keep from contact with fertilizers, insecticides, fungicides, and seeds to prevent unintentional exposure of desirable vegetation to ARSENAL herbicide APPLICATORS CONCENTRATE. DO NOT apply or drain or flush equipment on or near sensitive desirable plants, or on areas where their roots may extend, or in locations where the chemical may be washed or moved into contact with their roots. DO NOT side trim desirable vegetation with this product. Prevent drift of spray to desirable plants.

Clean application equipment after using this product by thoroughly flushing with water.

GENERAL INFORMATION

ARSENAL herbicide APPLICATORS CONCENTRATE is a surfactant free aqueous solution to be mixed in water and generally applied as a post-emergent spray for control of most annual and perennial grasses, broadleaf weeds, vines and brambles, and hardwood brush and trees for forestry site preparation and release of conifers from woody and herbaceous competition. ARSENAL herbicide APPLICATORS CONCENTRATE may be used for selective woody and herbaceous weed control in natural regeneration of certain conifers (see pine release). ARSENAL herbicide APPLICATORS CONCENTRATE may also be mixed in water and used for stump and cut-stem treatment for control of unwanted woody vegetation.

ARSENAL herbicide APPLICATORS CONCENTRATE may be applied in forestry sites (land managed for timber production) on areas defined as puddles, potholes, berms of ditches, drainage ditches, intermittent drainage, intermittently flooded low lying sites, seasonally dry flood plains, and transitional areas between upland and lowland sites except in the states of California and New York. It is permissible to treat marshes, swamps, and bogs after water has receded, as well as seasonally dry flood deltas except in the states of California and New York.

ARSENAL herbicide APPLICATORS CONCENTRATE is also recommended for control of undesirable vegetation along forest roads, non-irrigation ditchbanks, and the establishment and maintenance of wildlife openings except in the state of California.

SYMPTOMOLOGY:

ARSENAL herbicide APPLICATORS CONCENTRATE is readily absorbed through foliage and roots and is translocated rapidly throughout the plant, with accumulation in the meristematic regions. Treated plants stop growing soon after spray application. Chlorosis first appears in the youngest leaf tissue. In perennials, the herbicide is translocated into the roots, thus preventing most resprouting. Chlorosis and tissue necrosis may not be apparent in some plant species for several weeks after application. Woody plants, brush, and trees normally do not display the full extent of herbicide control until several months following application.

MIXING AND APPLICATION INSTRUCTIONS

HELICOPTER SPRAY EQUIPMENT:

Thoroughly mix the recommended amount of ARSENAL herbicide APPLICATORS CONCENTRATE in 5 to 30 gallons of water per acre and uniformly apply with properly calibrated aerial equipment. A suitable nonionic surfactant may be added to the spray solution to enhance control of undesirable vegetation. All precautions should be taken to minimize or eliminate spray drift. Applications should not be made under windy or gusty conditions. The use of controlled droplet booms and nozzle configurations is recommended. A drift control agent may be added at the recommended label rate except when applying with a MICROFOIL[1] boom, THRU-VALVE BOOM[2] or other similar equipment. A foam reducing agent may be added at the recommended label rate, if needed.

IMPORTANT: DO NOT make applications by fixed wing aircraft. Maintain adequate buffer zones. Thoroughly clean application and mixing

[1] Trademark of Rhone Poulenc Ag. Company

[2] Trademark of Waldrum Specialties

equipment, including landing gear, immediately after use. Prolonged exposure of this product to uncoated steel (except stainless steel) surfaces may result in corrosion and failure of the exposed part.

GROUND OPERATED SPRAY EQUIPMENT:

Thoroughly mix and apply the recommended amount of ARSENAL herbicide APPLICATORS CONCENTRATE in 5 to 100 gallons of water per acre. A suitable nonionic surfactant may be added to the spray solution to enhance control of undesirable vegetation. A drift control agent and a foam reducing agent may be added at the recommended label rates, if needed. If desired, a spray pattern indicator may be added at the recommended label rate.

For best results, uniformly cover the foliage of the vegetation to be controlled with the spray solution.

IMPORTANT: DO NOT spray under windy or gusty conditions. Maintain adequate buffer zones. HIGH VOLUME (75 to 100 gallons per acre) APPLICATIONS ARE RECOMMENDED FOR KUDZU WEED CONTROL PROGRAMS. Clean application and mixing equipment after using this product by thoroughly flushing with water.

DIRECTED FOLIAR OR SPOT SPRAY EQUIPMENT:

When making directed or spot spray applications with helicopter or ground spray equipment, or low-volume hand-operated spray equipment, thoroughly mix a solution of 1 to 5 percent by volume of ARSENAL herbicide APPLICATORS CONCENTRATE and a minimum of 1/4 percent by volume nonionic surfactant in water.

To mix the spray solution, add the volume of ARSENAL herbicide APPLICATORS CONCENTRATE and nonionic surfactant indicated in the table below to the desired amount of water.

SPRAY SOLUTION MIXING GUIDE

SOLUTION VOLUME	ARSENAL herbicide APPLICATORS CONCENTRATE (%)			SURFACTANT
	1	2.5	5	
1 gallon	1 - 1/3 oz.	3 - 1/3 oz.	6 - 2/3 oz.	1/3 oz.
5 gallons	6 - 2/3 oz.	1 pint	2 pints	1 - 2/3 oz.
10 gallons	13 - 1/3 oz.	2 pints	4 pints	3 - 1/3 oz.
25 gallons	2 pints	5 pints	10 pints	8 oz.
100 gallons	1 gal.	2.5 gal.	5 gal.	2 pints

2 tablespoons = 1 fluid ounce

For best results, uniformly cover the foliage of the vegetation to be controlled with the spray solution. Avoid making applications directly to desirable conifers. BIGLEAF MAPLE REQUIRES AT LEAST A 5% SPRAY SOLUTION CONCENTRATION.

IMPORTANT: DO NOT over apply causing runoff from the treated foliage. Avoid direct application to desired plant species as injury may occur. DO NOT exceed recommended dosage rate per acre.

STUMP AND CUT STEM TREATMENTS

ARSENAL herbicide APPLICATORS CONCENTRATE may be used to control undesirable woody vegetation in forest management by applying a solution of the herbicide in water to the cambium area of freshly-cut stump surfaces or to cuts on the stem of the target woody vegetation. Applications can be made at any time of the year except during periods of heavy sap flow in the spring. Tree injection and cut stem treatments are most effective in late summer and early fall.

MIXING

ARSENAL herbicide APPLICATORS CONCENTRATE may be mixed as either a concentrated or dilute solution for stump and cut stem treatments. The dilute solution may be used for applications to the surface of the stump or to cuts on the stem of the target woody vegetation. Concentrated solutions may be used for applications to cuts on the stem. Use of the concentrated solution permits application to fewer cuts on the stem, especially for large diameter trees. Follow the application instructions to determine proper application techniques for each type of solution.

APPLICATION WITH DILUTE SOLUTIONS

To prepare a dilute solution, mix 6 fluid ounces of ARSENAL herbicide APPLICATORS CONCENTRATE with one gallon of water.

For cut stump treatments: Spray or brush the solution onto the cambium area of the freshly cut stump surface. Insure that the solution thoroughly wets the entire cambium area (the wood next to the bark of the stump).

For tree injection treatments: Using standard injection equipment, apply 1 milliliter of solution at each injection site around the tree with no more than one inch intervals between cut edges. Insure that the injector completely penetrates the bark at each injection site.

For frill or girdle treatments: Using a hatchet, machete, or similar device, make cuts through the bark at intervals around the tree with no more than two inch intervals between cut edges. Spray or brush the solution into each cut until thoroughly wet.

APPLICATION WITH CONCENTRATED SOLUTIONS

To prepare a concentrated solution, use undiluted product or mix with up to 75% water, by volume.

For tree injection treatments: Using standard injection equipment, apply 1 milliliter of solution at each injection site. Make at least one injection cut for every three inches of diameter at breast height (dbh) on the target tree. For example, a three inch dbh tree will receive 1 injection cut and a six inch dbh tree will receive 2 injection cuts. On trees requiring more than one injection site, place the injection cuts at approximately equal intervals around the tree.

For hack and squirt treatments: Using a hatchet, or similar device, make cuts at a downward angle completely through the bark and cambium at approximately equal intervals around the tree. Make at least one cut for every three inches of diameter at breast height (dbh) on the target tree. For example, a three inch dbh tree will receive 1 cut and a six inch dbh tree will receive 2 cuts. Using a squirt bottle, syringe, or similar device apply 1 milliliter of the concentrated mix into each cut, ensuring that the solution does not run out of the cut.

NOTE: Injury may occur to non-target or desirable woody plants if they extend from the same root system or their root systems are grafted to those of the treated tree.

SITE PREPARATION TREATMENTS

ARSENAL herbicide APPLICATORS CONCENTRATE may be used to control labeled grasses, broadleaf weeds, vines and brambles, and woody brush and trees on forest sites in advance of regeneration for the following conifer crop species:

Crop Species	Rate (oz/A)
Loblolly Pine *(Pinus taeda)*	24 - 40
Loblolly X Pitch Hybrid	24 - 40
Longleaf Pine *(Pinus palustris)*	24 - 40
Shortleaf Pine *(Pinus echinata)*	24 - 40
Virginia Pine *(Pinus virginiana)*	24 - 40
Slash Pine *(Pinus elliottii)*	20 - 32
Douglas-Fir *(Pseudotsuga menziesii)*	12 - 24
California Red Fir *(Abies magnifica)*	12 - 20
California White Fir *(Abies concolor)*	12 - 20
Jack Pine *(Pinus banksiana)*	12 - 16
Lodgepole Pine *(Pinus contorta)*	12 - 16
Pitch Pine *(Pinus rigida)*	12 - 16
Ponderosa Pine *(Pinus ponderosa)*	12 - 16
Sugar Pine *(Pinus lambertiana)*	12 - 16
White Pine *(Pinus strobus)*	12 - 16
Black Spruce *(Picea mariana)*	12 - 16
Red Spruce *(Picea rubens)*	12 - 16
White Spruce *(Picea glauca)*	12 - 16

Use the recommended rate of ARSENAL herbicide APPLICATORS CONCENTRATE per acre applied as a broadcast foliar spray for long-term control of labeled woody plants and residual control of herbaceous weeds. Within 4 to 6 weeks of treatment, grasses and other herbaceous weeds will be controlled and may provide fuel to facilitate a site preparation burn, if desired, to control conifers or other species tolerant to the herbicide.

Apply the recommended rate of ARSENAL herbicide APPLICATORS CONCENTRATE per acre in 10 to 20 gallons total spray solution for helicopter applications or 5 to 40 gallons total spray solution for mechanical ground spray and backpack applications. Use a minimum of 1/2 percent by volume nonionic surfactant. Use the higher label rates of ARSENAL herbicide APPLICATORS CONCENTRATE and higher spray volumes when controlling particularly dense or multi-layered canopies of hardwood stands, or difficult to control species.

Tank mixes may be necessary for chemical control of conifers and other species tolerant to ARSENAL herbicide APPLICATORS CONCENTRATE in certain cases. Observe all precautions and restrictions on the product labels. Always follow the most restrictive label. Combinations with other products labeled for forest site preparation may kill certain plants such as legumes and blackberry which are desirable for wildlife habitat.

Where quick initial brown out (deadening of foliage) is desired for burning, apply a tank mixture of 16 to 32 oz. ARSENAL herbicide APPLICATORS CONCENTRATE with 16 to 64 oz. Accord[3] or 16 to 48 oz. Garlon 4[4] per acre. For control of seedling pines, apply 16 to 32 oz. ARSENAL herbicide APPLICATORS CONCENTRATE with 3 to 4 quarts Accord. For site preparation, rates less than 24 oz. ARSENAL herbicide APPLICATORS CONCENTRATE will provide suppression of hardwood brush and trees, and some resprouting may occur.

Do not plant seedlings of black spruce *(Picea mariana)* or white spruce *(Picea glauca)* on sites that have been broadcast treated with ARSENAL herbicide APPLICATORS CONCENTRATE or into the treated zone of spot or banded applications for three months following application or injury may occur.

HERBACEOUS WEED CONTROL

Use ARSENAL herbicide APPLICATORS CONCENTRATE for selective weeding in the following conifers:

Crop Species	Rate (fl.oz./A)
Loblolly Pine *(Pinus taeda)*	6 - 10
Loblolly X Pitch Hybrid	6 - 10
Virginia Pine *(Pinus virginiana)*	6 - 10
Longleaf Pine *(Pinus palustris)*[1]	4 - 6
Slash Pine *(Pinus elliottii)*[1]	4 - 6
Douglas-Fir *(Pseudotsuga menziesii)*[1]	4 - 6

[1] Use of surfactant is not recommended.

ARSENAL herbicide APPLICATORS CONCENTRATE may be applied as a broadcast treatment, banded over tree rows, or as a directed spray for release of young conifers from herbaceous weeds. To prevent possibility of conifer injury, do not apply ARSENAL herbicide APPLICATORS CONCENTRATE when conifers are under stress from drought, diseases, animal or winter injury, planting shock, or other stresses reducing conifer vigor. Broadcast applications may be made by helicopter, ground, or backpack sprayer. For best results, applications should be made to newly emerged weeds. For difficult to control weeds, use the higher labeled rates. Where herbaceous weeds have overtopped conifer seedlings, a nonionic surfactant may be added to improve weed control (except for slash pine, longleaf pine, and Douglas-fir), at a rate not to exceed 1/4 percent of spray solution volume. Some minor conifer growth inhibition may be observed when herbaceous weed control treatments are made during periods of active conifer growth.

ARSENAL herbicide APPLICATORS CONCENTRATE may also be applied using backpack or hand-held sprayers to control herbaceous weeds around individual conifer seedlings. Mix 0.4 to 0.6 oz. ARSENAL herbicide APPLICATORS CONCENTRATE and 0.2 oz. nonionic surfactant per gallon of water. Direct the spray to the weeds and minimize the amount applied to conifer foliage for best conifer tolerance. Ensure that maximum labeled rates per acre listed for crop species above are not exceeded.

ARSENAL herbicide APPLICATORS CONCENTRATE may be tank mixed with Oust[5] to broaden the spectrum of weeds controlled. For loblolly pine only, apply 4 to 6 oz. ARSENAL herbicide APPLICATORS CONCENTRATE plus 1-2 oz. Oust (product) per acre.

CONIFER RELEASE TREATMENTS

ARSENAL herbicide APPLICATORS CONCENTRATE may be applied as a broadcast or directed spray application for suppression of labeled brush, tree, and herbaceous weed species. Directed spray applications may be made with low-volume applications in conifer stands of all ages by targeting the unwanted vegetation and avoiding direct application to the conifer. Ensure that maximum labeled rates per acre listed for crop species below are not exceeded.

Use broadcast applications of ARSENAL herbicide APPLICATORS CONCENTRATE for release of the following conifers from hardwood competition:

Crop Species	Rate (fl. oz./Acre)
Loblolly Pine *(Pinus taeda)*[3]	12 - 20
Loblolly X Pitch Hybrid[3]	12 - 20
Virginia Pine *(Pinus virginiana)*[3]	12 - 20
Longleaf Pine *(Pinus palustris)*	12 - 16
Pitch Pine *(Pinus rigida)*	12 - 16
Shortleaf Pine *(Pinus echinata)*	12 - 16
Slash Pine *(Pinus elliottii)*	12 - 16
White Pine *(Pinus strobus)*[1]	8 - 16
Lodgepole Pine *(Pinus contorta)*[2]	8 - 12
Douglas-Fir *(Pseudotsuga menziesii)*[2]	8 - 12
Jack Pine *(Pinus banksiana)*[2]	6 - 12
Black Spruce *(Picea mariana)*[2]	6 - 12
Red Spruce *(Picea rubens)*[2]	6 - 12
White Spruce *(Picea glauca)*[2]	6 - 12

[1] DO NOT make applications to white pine stands younger than three years old. To minimize potential white pine injury, release treatments should not be made prior to July 15.

[2] Applications should be made after formation of final conifer resting buds in the fall or height growth inhibition may occur.

[3] Mid-rotation release: For broadcast applications below the pine canopy in established stands of loblolly pine, loblolly X pitch hybrid, and Virginia pine use 16-32 oz product per acre. For mid-rotation release of other species use rates listed above.

For slash pine and longleaf pine, broadcast release treatments over the top of pines for the purpose of woody plant control must be made after August 15 and only in stands 2 through 5 years old. For applications over the top of slash pine and longleaf pine, do not add surfactant and use lower labeled rates on sandy soils.

Apply the recommended rate of ARSENAL herbicide APPLICATORS CONCENTRATE per acre when making broadcast applications with helicopter or ground spray equipment. Refer to mixing and application instructions for proper spray volumes. A nonionic surfactant may be added at no more than 1/4 percent by volume. Use the higher label rates of ARSENAL herbicide APPLICATORS CONCENTRATE when controlling particularly dense stands or difficult to control species.

Some minor conifer growth inhibition may be observed when release treatments are made during periods of active conifer growth. To minimize potential conifer height growth inhibition, do not make broadcast applications to conifer stands, except loblolly pine, before the end of the second growing season. To minimize potential conifer height growth inhibition, broadcast release treatments may be made late in the growing season. To prevent possibility of conifer injury, do not apply ARSENAL herbicide APPLICATORS CONCENTRATE when conifers are under stress from drought, diseases, animal or winter injury, or other stresses reducing conifer vigor.

ARSENAL herbicide APPLICATORS CONCENTRATE may be used to release loblolly pine seedlings during the first growing season following planting or for one-year-old natural loblolly pine regeneration. For one-year-old loblolly pine release, apply 12-20 oz./A ARSENAL herbicide APPLICATORS CONCENTRATE after July 15. The use of rates below 16 oz./A is intended for hardwood growth suppression and some hardwood resprouting should be expected.

Use ARSENAL herbicide APPLICATORS CONCENTRATE for spot treatment of undesirable hardwood vegetation:

ARSENAL herbicide APPLICATORS CONCENTRATE may be used as a directed foliar or cut stem application to control undesirable brush and hardwoods in the management of stands of all ages for the conifer species listed in the broadcast application section above. Refer to mixing and application instructions in the directed foliar or cut stem sections above for proper use rates, equipment, and application techniques. Ensure that the maximum labeled rates per acre listed for crop species are not exceeded. Cut stem applications may be used for spot treatment of undesirable hardwoods in Ponderosa pine stands using 12 oz. or less of product per acre.

Avoid direct application to desired plant species as injury may occur. Injury may occur to non-target or desirable hardwoods or conifers if they extend from the same root system or their root systems are grafted to those of the treated tree or if their roots extend into the treated zone.

[3] Trademark of Monsanto Company

[4] Trademark of Dow-Agrosciences Company

[5] Trademark of E.I. duPont de Nemours & Company

WEEDS CONTROLLED

ARSENAL herbicide APPLICATORS CONCENTRATE will provide postemergence control and some residual control of the following target vegetation species. Degree of control is both species and rate dependent. ARSENAL herbicide APPLICATORS CONCENTRATE should be used only in accordance with the recommendations on this label.

GRASSES

The species of annual and perennial grasses controlled by ARSENAL herbicide APPLICATORS CONCENTRATE include the following:

Annual bluegrass *(Poa annua)*
Bahiagrass *(Paspalum notatum)*
Barnyardgrass *(Echinochloa crus-galli)*
Beardgrass *(Andropogon* spp.*)*
Bermudagrass *(Cynodon dactylon)*[1]
Big bluestem *(Andropogon gerardii)*
Broadleaf signalgrass *(Brachiaria platyphylla)*
Canada bluegrass *(Poa compressa)*
Cattail *(Typha* spp.*)*
Cheat *(Bromus secalinus)*
Cogongrass *(Imperata cylindrica)*[2]
Crabgrass *(Digitaria* spp.*)*
Crowfootgrass *(Dactyloctenium aegyptium)*
Dallisgrass *(Paspalum dilatatum)*
Downy brome *(Bromus tectorum)*
Fall panicum *(Panicum dichotomiflorum)*
Feathertop *(Pennisetum villosum)*
Fescue *(Festuca* spp.*)*
Foxtail *(Setaria* spp.*)*
Giant reed *(Arundo donax)*
Goosegrass *(Eleusine indica)*
Guineagrass *(Panicum maximum)*
Italian ryegrass *(Lolium multiflorum)*
Itchgrass *(Rottboellia exaltata)*
Johnsongrass *(Sorghum halepense)*[1]
Junglerice *(Echinochloa colonum)*
Kentucky bluegrass *(Poa pratensis)*
Lovegrass *(Eragrostis* spp.*)*[1]
Orchardgrass *(Dactylis glomerata)*
Panicum spp.
Paragrass *(Brachiaria mutica)*
Phragmites *(Phragmites australis)*
Prairie cordgrass *(Spartina pectinata)*
Prairie threeawn *(Aristida oligantha)*
Quackgrass *(Agropyron repens)*
Reed canary grass *(Phalaris arundinacea)*
Saltgrass *(Distichlis stricta)*
Sand dropseed *(Sporobolus cryptandrus)*
Sandbur *(Cenchrus* spp.*)*
Smooth brome *(Bromus inermis)*
Sprangletop *(Leptochloa* spp.*)*
Timothy *(Phleum pratense)*
Torpedograss *(Panicum repens)*
Vaseygrass *(Paspalum urvillei)*
Wild barley *(Hordeum* spp.*)*
Wild oats *(Avena fatua)*
Wirestem muhly *(Muhlenbergia frondosa)*
Witchgrass *(Panicum capillare)*
Woolly cupgrass *(Eriochloa villosa)*

[1] Use higher labeled rates.
[2] Use minimum of 24 oz per acre.

BROADLEAF WEEDS

The species of annual and perennial broadleaf weeds controlled by ARSENAL herbicide APPLICATORS CONCENTRATE include the following:

Arrowwood *(Pluchea sericea)*
Broom snakeweed *(Gutierrezia sarothrae)*
Bull thistle *(Cirsium vulgare)*
Burclover *(Medicago* spp.*)*
Burdock *(Arctium* spp.*)*
Camphorweed *(Heterotheca subaxillaris)*
Canada thistle *(Cirsium arvense)*
Carolina geranium *(Geranium carolinianum)*
Carpetweed *(Mullugo verticillata)*
Chickweed, mouseear *(Cerastium vulgatum)*
Clover *(Trifolium* spp.*)*
Cocklebur *(Xanthium strumarium)*
Common chickweed *(Stellaria media)*
Common ragweed *(Ambrosia artemisiifolia)*
Cudweed *(Gnaphalium* spp.*)*
Dandelion *(Taraxacum officinale)*
Desert camelthorn *(Alhagi pseudalhagi)*
Diffuse knapweed *(Centaurea diffusa)*
Dock *(Rumex* spp.*)*
Dogfennel *(Eupatorium capillifolium)*
Fiddleneck *(Amsinckia intermedia)*
Filaree *(Erodium* spp.*)*
Fleabane *(Erigeron* spp.*)*
Giant ragweed *(Ambrosia trifida)*
Goldenrod *(Solidago* spp.*)*
Gray rabbitbrush *(Chrysothamnus nauseosus)*
Henbit *(Lamium aplexicaule)*
Hoary vervain *(Verbena stricta)*
Horseweed *(Conyza canadensis)*
Indian mustard *(Brassica juncea)*
Japanese bamboo/knotweed *(Polygonum cuspidatum)*
Knotweed, prostrate *(Polygonum aviculare)*
Kochia *(Kochia scoparia)*
Lambsquarters *(Chenopodium album)*
Little mallow *(Malva parviflora)*
Milkweed *(Asclepias* spp.*)*
Miners lettuce *(Montia perfoliata)*
Mullein *(Verbascum* spp.*)*
Nettleleaf goosefoot *(Chenopodium murale)*
Oxeye daisy *(Chrysanthemum leucanthemum)*
Pepperweed *(Lepidium* spp.*)*
Pigweed *(Amaranthus* spp.*)*
Plantain *(Plantago* spp.*)*
Pokeweed *(Phytolacca americana)*
Primrose *(Oenothera kunthiana)*
Puncturevine *(Tribulus terrestris)*
Purple loosestrife *(Lythrum salicaria)*
Purslane *(Portulaca* spp.*)*
Pusley, Florida *(Richardia scabra)*
Rocket, London *(Sisymbrium irio)*
Rush skeletonweed *(Chondrilla juncea)*
Russian knapweed *(Centaurea repens)*
Russian thistle *(Salsola kali)*
Saltbush *(Atriplex* spp.*)*
Shepherd's purse *(Capsella bursa-pastoris)*
Silverleaf nightshade *(Solanum elaeagnifolium)*
Smartweed *(Polygonum* spp.*)*
Sorrell *(Rumex* spp.*)*
Sowthistle *(Sonchus* spp.*)*
Spurge, annual *(Euphorbia* spp.*)*
Stinging nettle *(Urtica dioica)*
Sunflower *(Helianthus* spp.*)*
Sweet clover *(Melilotus* spp.*)*
Tansymustard *(Descurainia pinnata)*
Texas thistle *(Cirsium texanum)*
Velvetleaf *(Abutilon theophrasti)*
Western ragweed *(Ambrosia psilostachya)*
Wild carrot *(Daucus carota)*
Wild lettuce *(Lactuca* spp.*)*
Wild parsnip *(Pastinaca sativa)*
Wild turnip *(Brassica campestris)*
Woollyleaf bursage *(Ambrosia grayi)*
Yellow starthistle *(Centaurea solstitialis)*
Yellow woodsorrel *(Oxalis stricta)*

VINES AND BRAMBLES

The species of vines and brambles controlled by ARSENAL herbicide APPLICATORS CONCENTRATE include the following:

Field bindweed *(Convolvulus arvensis)*
Hedge bindweed *(Calystegia sequium)*
Honeysuckle *(Lonicera* spp.*)*
Morningglory *(Ipomoea* spp.*)*
Poison ivy *(Rhus radicans)*
Redvine *(Brunnichia cirrhosa)*
Trumpetcreeper *(Campsis radicans)*
Virginia creeper *(Parthenocissus quinquefolia)*
Wild buckwheat *(Polygonum convolvulus)*
Wild grape *(Vitis* spp.*)*
Wild rose *(Rosa* spp.*)*[1]
Including: Multiflora rose *(Rosa multiflora)*
Macartney rose *(Rosa bracteata)*

[1] Use higher labeled rates.

WEEDS CONTROLLED

ARSENAL herbicide APPLICATORS CONCENTRATE will provide postemergence control and some residual control of the following target vegetation species. Degree of control is both species and rate dependent. ARSENAL herbicide APPLICATORS CONCENTRATE should be used only in accordance with the recommendations on this label.

WOODY BRUSH AND TREES

The species of woody brush and trees controlled by ARSENAL herbicide APPLICATORS CONCENTRATE include the following:

Alder *(Alnus* spp.*)*
American beech *(Fagus grandifolia)*
Ash *(Fraxinus* spp.*)*[1]
Aspen *(Populus* spp.*)*
Autumn olive *(Elaeagnus umbellata)*
Bald cypress *(Taxodium distichum)*
Bigleaf maple *(Acer macrophyllum)*
Birch *(Betula* spp.*)*[1]
Black oak *(Quercus kelloggii)*
Blackgum *(Nyssa sylvatica)*[2]
Boxelder *(Acer negundo)*
Brazilian peppertree *(Schinus terebinthifolius)*
Ceanothis *(Ceanothis* spp.*)*
Cherry *(Prunus* spp.*)*[1,2]
Chinaberry *(Melia azedarach)*
Chinese tallow-tree *(Sapium sebiferum)*
Chinquapin *(Castanopsis chrysophylla)*
Cottonwood *(Populus trichocarpa* and *Populus deltoides)*
Cypress *(Taxodium* spp.*)*
Dogwood *(Cornus* spp.*)*[1]
Eucalyptus *(Eucalyptus* spp.*)*
Hawthorn *(Crataegus* spp.*)*
Hickory *(Carya* spp.*)*[1]
Huckleberry *(Gaylussacia* spp.*)*
Lyonia spp.
Including: Fetterbush *(Lyonia lucida)*
Staggerbush *(Lyonia mariana)*
Madrone *(Arbutus menziesii)*
Maple *(Acer* spp.*)*
Melaleuca *(Melaleuca quinquenervia)*
Mulberry *(Morus* spp.*)*[1,3]
Oak *(Quercus* spp.*)*[4]
Persimmon *(Diospyros virginiana)*[2]
Poison oak *(Rhus diversiloba)*
Popcorn-tree *(Sapium sebiferum)*
Poplar *(Populus* spp.*)*
Privet *(Ligustrum vulgare)*
Red alder *(Alnus rubra)*
Red maple *(Acer rubrum)*
Saltcedar *(Tamarix pentandra)*
Sassafras *(Sassafras albidum)*
Sourwood *(Oxydendrum arboreum)*[2]
Sumac *(Rhus* spp.*)*
Sweetgum *(Liquidambar styraciflua)*
Sycamore *(Platanus occidentalis)*
Tanoak *(Lithocarpus densiflorus)*[1]
TiTi *(Cyrilla racemiflora)*[1]
Tree of heaven *(Ailanthus altissima)*
Vaccinium spp.
Including: Blueberry *(Vaccinium* spp.*)*
Sparkleberry *(Vaccinium arboreum)*
Willow *(Salix* spp.*)*
Yellow-poplar *(Liriodendron tulipifera)*

[1] Use higher labeled rates.
[2] Best control with applications prior to formation of fall leaf color.
[3] The degree of control may be species dependent.
[4] For Water oak *(Quercus nigra)*, Laurel oak *(Q. laurifloria)*, Willow oak *(Q. phellos)* and Live oak *(Q. virginiana)* use higher labeled rates.

DISCLAIMER

The label instructions for the use of this product reflect the opinion of experts based on field use and tests. The directions are believed to be reliable and should be followed carefully. However, it is impossible to eliminate all risks inherently associated with use of this product. Ineffectiveness or other unintended consequences may result because of such factors as weather conditions, presence of other materials, or the use or application of the product contrary to label instructions, all of which are beyond the control of BASF Corporation. All such risks shall be assumed by the user.

BASF warrants only that the material contained herein conforms to the chemical description on the label and is reasonably fit for the use therein described when used in accordance with the directions for use, subject to the risks referred to above.

Any damages arising from a breach of this warranty shall be limited to direct damages and shall not include consequential commercial damages such as loss of profits or values or any other special or indirect damages.

BASF makes no other express or implied warranty, including other express or implied warranty of FITNESS or of MERCHANTABILITY.

5500

BASF Corporation
26 Davis Drive
Research Triangle Park, NC 27709

PE-11072 12/00

NVA 2001-04-104-0002

Approved Banvel II Label (Incorporation of Supplemental & Addition of Size Range), Sep. 12, 2006

GROUP	4	HERBICIDE

BANVEL® II HERBICIDE

COMMERCIAL (AGRICULTURAL)

GUARANTEE: Dicamba ..... 480 g/L
(present as diglycolamine salt)

REGISTRATION NO. 23957 **PEST CONTROL PRODUCTS ACT**

CAUTION **POISON**

WARNING - EYE IRRITANT

IN CASE OF EMERGENCY ENDANGERING LIFE OR PROPERTY INVOLVING THIS PRODUCT, CALL DAY OR NIGHT 1-800-454-2673

NET CONTENTS: 1 to 1000 L

E.P.A. Est. No. 55947-TX-1

READ THE LABEL AND THE BROCHURE BEFORE USING.
KEEP OUT OF REACH OF CHILDREN.

BASF Canada Inc.
100 Milverton Drive
5th Floor
Mississauga, Ontario
L5R 4H1

BANVEL® II is a registered trademark of BASF Corporation, used under license by BASF Canada Inc.

ABOUT BANVEL II

Banvel II Herbicide controls broadleaf weeds in cereals, corn, reduced tillage (prior to seeding and reduced tillage fallow), pastures and rangeland grasses, crop-free land (summerfallow and stubble), red fescue, canary grass, seedling grasses grown for seed and forage, and low bush blueberries.

GENERAL PRECAUTIONS

1. **Banvel II** should not be applied on or near desirable trees or plants.

2. Apply **Banvel II** when air temperature is between 10 and 25°C. Do not apply when there is a risk of severe fall in night temperature after use.

3. Do not contaminate domestic or irrigation water. Thoroughly clean application equipment.

4. Do not treat areas where movement of the chemical into the soil or surface washing may bring **Banvel II** into contact with roots of desirable plants.

5. Crop damage can occur if the chemical is applied at any time other than the recommended crop stage.

   NOTE: Crops growing under stress from adverse environmental conditions such as excess moisture, drought, disease, etc., may suffer a further setback and exhibit more pronounced injury symptoms if **Banvel II** is applied. However, the crop injury that may occur is usually offset by the weed control obtained.

6. Unless otherwise specified, do not use additives such as oil, wetting agents, emulsifiers, detergents, spreaders, sticking agents, or dispersing agents with **Banvel II** on crops.

7. For information on feeding and grazing of beef and dairy cattle on treated vegetation and for recommendations on treatment/harvest intervals, refer to the Table on Grazing Restrictions.

8. If **Banvel II** is tank-mixed with another product, such as 2,4-D, consult that product's label for additional safety precautions, restrictions, application rates, timings and additional weeds controlled.

9. Ensure that spray equipment used to apply **Banvel II** is properly cleaned before re-using to apply any other chemicals. See section on suggested procedure for cleaning spray equipment.

SPRAY DRIFT PRECAUTIONS

Banvel II may cause injury to desirable trees and plants, particularly soybeans, flowers, fruit trees, grapes, ornamentals, peas, potatoes, tomatoes, tobacco, and other broadleaf plants especially in their developmental and growing stage. Follow these precautions when spraying in the vicinity of sensitive crops:

1. Treat when wind is 3 to 15 km/hr. Do not apply during periods of dead calm or when weather conditions may cause drift from target areas to adjacent sensitive crops. Leave an adequate buffer zone between treatment areas and sensitive plants.

2. Use coarse sprays since they are less likely to drift than fine sprays. Select nozzles which minimize amounts of the fine spray particles. Keep the spray pressure below 150 kPa and the spray volume above 220 L/ha unless otherwise required by the nozzle manufacturer.

3. Do not spray when the temperature is expected to exceed 30°C.

4. Avoid spraying under conditions of high humidity or fog.

DIRECTIONS FOR USE

CEREALS (not underseeded to legumes)

Treatment Notes

1. For best performance, spray when weeds are in the 2 to 3 leaf stage and rosettes are less than 5 cm across.

2. Use the higher level of listed rate ranges when treating more mature weeds or dense vegetative growth.

3. Crop damage can occur if application is made at any time other than the recommended crop stage.

4. Do not apply **Banvel II** or **Banvel II** tank-mixes if crop is under-seeded to legumes.

APPLICATION DIRECTIONS

Ground Application

Apply **Banvel II** or **Banvel II** tank-mixes in at least 110 litres of water/ha.

Aerial Application (Western Canada Only)

Apply only by fixed-wing or rotary aircraft equipment which has been functionally and operationally calibrated for the atmospheric conditions of the area and the application rates and conditions of this label.

Label rates, conditions and precautions are product specific. Read and understand the entire label before opening this product. Apply only at the rate recommended for aerial application on this label. Where no rate for aerial application appears for the specific use, this product cannot be applied by any type of aerial equipment.

Ensure uniform application. To avoid streaked, uneven or overlapped application, use appropriate marking devices.

Use Precautions
Apply only when meteorological conditions at the treatment site allow for complete and even crop coverage. Apply only under conditions of good practice specific to aerial application as outlined in the *Basic Knowledge Requirements for Pesticide Education in Canada: Applicator Core* and *Aerial Module*, developed by CAPCO.

Do not apply to any body of water. Avoid drifting of spray onto any body of water or other non-target areas. Specified buffer zones should be observed.

Coarse sprays are less likely to drift, therefore, avoid combinations of pressure and nozzle type that will result in fine particles (mist). Do not apply during periods of dead calm or when wind velocity and direction pose a risk of spray drift. Do not spray when the wind is blowing towards a nearby sensitive crop, garden, terrestrial habitat (such as shelter-belt) or aquatic habitat.

Operator Precautions
Do not allow the pilot to mix chemicals to be loaded onto the aircraft. Loading of premixed chemicals with a closed system is permitted.

It is desirable that the pilot have communication capabilities at each treatment site at the time of application.

The field crew and the mixer/loaders must wear chemical resistant gloves, coveralls and goggles or face shield during mixing/loading, cleanup and repair. Follow the more stringent label precautions in cases where the operator precautions exceed the generic label recommendations on the existing ground boom label.

All personnel on the job site must wash hands and face thoroughly before eating and drinking. Protective clothing, aircraft cockpit and vehicle cabs must be decontaminated regularly.

Product Specific Precautions
Read and understand the entire label before opening this product. If you have questions, call the manufacturer at 1-877-371-BASF (2273) or obtain technical advice from the distributor or your provincial agricultural representative. Application of this specific product must meet and/or conform to the following:

1. **Banvel II** or **Banvel II** phenoxy herbicide tank-mixes may be aerially applied in not less than 20 litres of water/ha.

2. Apply **Banvel II** alone at 230 mL/ha or tank mix **Banvel II** at 230 mL/ha with the recommended rate of the phenoxy herbicides specified on this label.

3. Treat when wind is 3 to 15 km/hr. Do not apply during periods of dead calm or when weather conditions may cause drift from target areas to adjacent sensitive crops.

4. Do not use nozzle pressure above 200 kPa.

5. Do not spray when the wind is blowing towards a nearby sensitive crop, garden, or shelterbelt.

6. Unless otherwise specified, do not use any additives with **Banvel II**.

Weeds Controlled

Weeds Controlled	Banvel II Rate	Tank Mix
Buckwheat, *Tartary* buckwheat, *wild* cockle, *cow* Cleavers **(higher rate only)** lady's thumb sow-thistle, *perennial* **(top growth only)** smartweed, *green* spurry, *corn* thistle, *Canada* **(top growth only)**	**Banvel II** alone at 230-290 mL/ha	None
All of the above plus: Burdock **(young seedlings)** canola, *volunteer* * cocklebur flixweed hemp-nettle** kochia pigweed, *redroot* pigweed, *Russian* radish, *wild* shepherd's-purse sunflower, *volunteer* *** thistle, *Russian*	**Banvel II** at 230 mL/ha +	2, 4-D amine **OR** MCPA amine **OR** MCPA K
All of the above plus: Chickweed; Hemp-nettle** Spurry, *corn;* stinkweed; Sunflower, volunteer***	**Banvel II** at 230 mL/ha +	Sencor **OR** Lexone
All of the above plus: Buckwheat, *wild;* canola, *volunteer;** sow-thistle, *perennial* **(top growth only)**	**Banvel II** at 230 mL/ha +	Ally

* *Best results will be obtained if application is made prior to bolting of canola, when this weed is at the 2 to 4 leaf stage.*

** *Use **Banvel II** + MCPA K for hemp-nettle control. Apply at the 2 to 3 leaf stage of weed for best control. Hemp-nettle may not be controlled if application is made at a more advanced stage of crops and weeds.*

*** *Depending on the growing conditions, control may be slightly delayed.*

APPLICATION DIRECTIONS

Banvel II may be applied to:

- Spring Wheat
- Spring Barley
- Winter Wheat
- Oats
- Spring Rye

The following sections describe application directions for these crops.

Spring Wheat

Herbicide Mix	Rate/ha	Crop Stage
Banvel II alone	230-290 mL/ha	2-5 leaf
+ 2,4-D amine	850 mL/ha (500 g/L formulation)	2-5 leaf
or MCPA amine	850 mL/ha (500 g/L formulation)	2-5 leaf
or MCPA K	1.1 L/ha (400 g/L formulation)	2-5 leaf
or Sencor 500*	275-425 mL/ha**	2-3 leaf
or Lexone DF*	275 g/ha	2-3 leaf
or Ally***	5 g/ha	2-5 leaf

* *Sencor/Lexone tank-mixes apply to Western Canada only. Application may be delayed until the 4-leaf stage of the crop, however, crop tolerance may be reduced. Apply* ***Banvel II*** *at 230 mL/ha with Sencor/Lexone.*

** *Use the higher rate of Sencor 500 for control of volunteer sunflowers.*

*** *Ally tank-mixes apply to Western Canada only. Apply* ***Banvel II*** *at 230 mL/ha with Ally. Ensure that Ally is completely in suspension in the spray tank before adding* ***Banvel II****. Do not add a surfactant.*

Spring Rye

Herbicide Mix	Rate/ha	Crop Stage
Banvel II alone	230-290 mL/ha	2-3 leaf
+ 2,4-D amine	850 mL/ha (500 g/L formulation)	2-3 leaf

Spring Barley

Herbicide Mix	Rate/ha	Crop Stage
Banvel II alone	230-290 mL/ha	2-5 leaf
+2,4-D amine	850 mL/ha (500 g/L formulation)	2-5 leaf
or MCPA amine	850 mL/ha (500 g/L formulation)	2-5 leaf
or MCPA K	1.1 L/ha (400 g/L formulation)	2-5 leaf
or Sencor 500*	275-425 mL/ha**	2-3 leaf
or Lexone DF*	275 g/ha	2-3 leaf
or Ally***	5 g/ha	2-5 leaf

* *Sencor/Lexone tank-mixes apply to Western Canada only.* **NOTE:** *Do not use on Klondike barley.*

** *Use the higher rate of Sencor 500 for control of volunteer sunflowers.*

*** *Ally tank-mixes apply to Western Canada only. Apply* ***Banvel II*** *at 230 mL/ha with Ally. Ensure that Ally is completely in suspension in the spray tank before adding* ***Banvel II****. Do not add a surfactant.*

Winter Wheat

Herbicide Mix	Rate/ha	Crop Stage
Banvel II alone	230-290 mL/ha	15-25 cm tall or before shot- blade stage
+ 2,4-D amine	850 mL/ha (500 g/L formulation)	15-25 cm tall or before shot- blade stage
or MCPA amine	850 mL/ha (500 g/L formulation)	
or MCPA K	1.1 L/ha (400 g/L formulation)	

Oats

Herbicide Mix	Rate/ha	Crop Stage
Banvel II alone	230-290 mL/ha	2-5 leaf
+ MCPA amine	850 mL/ha (500 g/L formulation)	2-5 leaf
or MCPA K	1.1 L/ha (400 g/L formulation)	2-5 leaf

Grazing Restrictions

1. Following treatment with **Banvel II** plus any other herbicide tank-mix: Do not graze or harvest for livestock feed prior to crop maturity; sufficient data are not available to support such use.

2. Following treatment with **Banvel II** or **Banvel II** plus 2,4-D, follow the grazing restrictions below:

Hay Making And Grazing Restrictions For Dairy Cattle

Rate/ha	Delay Between Treatment & Hay-Making/Grazing
Up to 1.25 L **Banvel II**	0 days

Hay Making, Grazing and Slaughter Restrictions For Meat Animals

Number of Days Between Banvel II Application & Hay- Making or Consumption	Slaughter Restrictions
Vegetation consumed *within 30 days* of treatment	feed animal untreated diet for 30 days before slaughter
Vegetation consumed *30 days after* treatment	no restrictions on slaughter

FIELD CORN

Treatment Notes

DO NOT APPLY BY AIR.

1. Apply **Banvel II** or **Banvel II** tank-mixes in 220 to 350 litres of water/ha at a pressure of 150 to 275 kPa. Use coarse sprays.

2. Keep spray mixture in suspension at all times. If mixture is allowed to settle, thoroughly agitate the mixture before spraying.

3. Do not apply to sweet corn.

4. Unless otherwise specified, do not use additives such as oil, wetting agents, emulsifiers, detergents, spreaders, sticking agents, or dispersing agents on corn with **Banvel II**.

5. Corn height refers to the crop as it stands, not leaf-extended.

6. When using drop pipes (drop nozzles), direct the spray beneath the lower leaves of the corn and onto the weeds and soil. Do not apply to corn over 50 cm in height.

7. Apply no later than 2 weeks prior to tassel emergence when using **Banvel II** alone up to 50 cm.

8. For the best control of annuals, spray when they are actively growing and in the seedling stage. Poor results may occur if weeds are well advanced at the time of application.

9. When applying **Banvel II** herbicide adjacent to sensitive crops, apply as a pre-emergent or early post-emergent treatment to avoid potential drift onto these sensitive crops.

10. When applied as a tank-mix combination, read and observe all label directions, including rates, restrictions and grazing limitations for each product used in the tank-mix. Follow the more stringent label precautionary and PPE measures for mixing/loading/applying, and label statements pertaining to environmental protection, such as buffer zones, stated on all tank-mix product labels.

BANVEL II/LIQUID NITROGEN

Pre-emergent applications of **Banvel II** are generally compatible with most liquid nitrogen fertilizers. To determine compatibility, mix all components of the finished spray in proportionate quantities in a small jar before mixing in the spray tank. If the herbicides do not ball-up or form flakes, sludge, jelly, oily films or layers, or other precipitates within 5 minutes after mixing, the tested spray-mix is compatible.

Weeds Controlled

Weeds Controlled	Banvel II Rate	Tank Mix
bindweed, *field***	**Banvel II** alone at 600 mL – 1.25 L/ha	none
buckwheat, *Tartary*		
buckwheat, *wild*		
cleavers		
cockle, *cow*		
fleabane, *Canada****		
lady's-thumb		
lamb's-quarters*		
mustard, *hare's-ear*		
mustard, *Indian*		
mustard, *tumble*		
mustard, *wild*		
mustard, *wormseed*		
pigweed, *redroot**		
pigweed, *Russian*		
ragweed, *common**		
ragweed, *false*		
ragweed, *giant*		
sow-thistle, *perennial***		
spurry, *corn*		
smartweed, *green*		
thistle, *Canada***		
velvetleaf		

* *Including atrazine-resistant species.*

** *Apply **Banvel II** annually for three years at the flowering stage of bindweed and the budding stage of thistles.*

*** *Post-emergence application only.*

PRE-EMERGENCE TREATMENT

Eastern Canada Only

Banvel II can be used alone at 1.25 L/ha or in tank-mixes with the following herbicides for additional broadleaf and grassy weed control.

Herbicide	Rate/ha
Dual	2.0 - 2.75 L
Dual II	2.0 - 2.75 L
Frontier	1.1 - 1.4 L
Primextra II Magnum	3.0 - 4.0 L
Atrazine 480*	2.10 L
Prowl 400**	4.20 L
Atrazine 480* + Dual II	2.10 L + 2.0 L

* *Other atrazine formulations will require a rate calculation adjustment according to percent active ingredient*

** *Other pendimethalin formulations will require a rate calculation adjustment according to percent active ingredient.*

Pre-Emergence Treatment Notes

- Apply **Banvel II** tank-mixes as broadcast ground treatments after planting but before weeds and corn emerge.
- Apply to medium to fine textured soils containing more than 2.5% organic matter.
- Do not use on sandy or sandy loam soils.
- Avoid direct chemical contact with the corn seed. If you plan to apply **Banvel II** prior to corn emergence, be sure to place the corn seeds 4 cm or more below the soil surface. If seeds are planted less than 4 cm below the soil surface, delay application of **Banvel II** until the spike stage
- Do not incorporate. If applications are made during planting, apply **Banvel II** far enough behind the planting equipment to avoid incorporation by the planter wheel or other covering device. If soil crusting makes it necessary to use a rotary hoe after a pre-emergence treatment, delay hoeing the soil more than 1.3 cm deep.
- Always consult the tank mix partner label for further limitations and restrictions (especially re: soil type).

POST-EMERGENCE TREATMENT

Banvel II or **Banvel II** tank-mixes can be applied as "overlay" to corn previously treated with any other broadleaf or grass herbicide. The 1.25 L rate of **Banvel II** as "overlay" is particularly effective in controlling velvetleaf and providing extended residual control of other late germinating, deep rooted annuals. ***Note:*** Unless otherwise specified, do not use additives such as oils, wetting agents, or sticking agents.

Banvel II alone
Spike to 5-leaf corn
Eastern and Western Canada

Herbicide	Rate/ha	Corn Stage	Weed Stage
Banvel II alone	1.25 L/ha	Spike to 5-leaf	Pre-emergence to 2-leaf[1]

[1]*For best performance, spray when the broadleaf weeds are emerged and up to the 2-leaf stage of their development.*

Banvel II Tank-mixes
Western Canada (Prairie Provinces only)*

Herbicide	Rate/ha	Corn Stage	Weed Stage
Banvel II + Accent + non-ionic surfactant such as Agral®, Agsurf® or Citowett® Plus	0.6 L (288 g ai/ha) + 33 g (25 g ai/ha) + 0.2% v/v	Spike to 6-leaf	Post-emergence to 6-leaf

**Single post-emergent spray; ground application only; do not apply this tank mix within 30 days of harvest.*

Banvel II tank-mixes
Eastern Canada only

Herbicide	Rate/ha	Corn Stage	Weed Stage
Banvel II + Frontier	1.25 L + 1.1 - 1.4 L	Spike to 3-leaf	Pre-emergence to 2-leaf***
Banvel II + Atrazine 480*	1.25 L + 2.10 L	Spike to 5-leaf	Pre-emergence to 2-leaf
Banvel II + Atrazine 480* + Dual II	0.6 - 1.25 L + 2.3 L + 2.0 - 2.75 L	Spike to 2-leaf	Emergence to 2-leaf
Banvel II + Primextra II Magnum	0.6 -1.25 L + 3.0 - 4.0 L	Spike to 2-leaf	Emergence to 2-leaf
Banvel II + Prowl 400**	0.6 -1.25 L + 4.20 L	Spike to 4-leaf	Pre-emergence to 2-leaf
Banvel II + Ultim 75% DF + non-ionic surfactant	0.60 L + 1 bag + 0.2% v/v	Spike to 6-leaf	Emergence to 6-leaf
Banvel II + Elim EP + non-ionic surfactant	0.60 L + 60 g + 0.2% v/v	Spike to 3-leaf	Emergence to 4-leaf
Banvel II + Dual II	0.6 -1.25 L + 2.0 - 2.75 L	Spike to 2-leaf	Emergence to 2-leaf
Banvel II + Prowl 400** + Elim EP + non-ionic surfactant	0.625 L + 2.5 L + 50 g + 0.2% v/v	Spike to 3-leaf	Emergence to 4-leaf

* *Other atrazine formulations will require a rate calculation adjustment according to percent active ingredient*

** *Other pendimethalin formulations will require a rate calculation adjustment according to percent active ingredient.*

*** *For annuals, apply before 2-leaf stage.*

Banvel II tank-mixes
Eastern Canada and the Province of Manitoba*

Banvel II can be tank mixed with Option 35 DF herbicide and applied as a post-emergence application to field corn grown in Eastern Canada and the province of Manitoba. Tank mixing **Banvel II** with Option 35 DF will provide enhanced control of annual broadleaf weeds.

Option 35 DF herbicide is to be used in conjunction with Hasten spray additive at 1.75 L/ha plus liquid nitrogen fertilizer (28% UAN) at a rate of 2.5 L/ha. Use of a spray-grade liquid nitrogen fertilizer is recommended.

Herbicide	Rate/ha	Corn Stage	Weed Stage	Weeds Controlled
Banvel II + Option 35 DF + Hasten spray additive + liquid nitrogen fertilizer (28% UAN)	0.3 L + 100 g + 1.75 L + 2.5 L/ha	1 to 8-leaf	Consult the Option 35 DF label for the recommended leaf stage of weeds at application. For best results, apply to emerged, young, actively growing weeds.	**Perennials** quackgrass **Annual Grasses** foxtail, bristly foxtail, green foxtail, yellow grass, barnyard grass, large crab millet, proso panicum, fall witchgrass **Annual Broadleaf Weeds** chickweed, common lamb's-quarters mustard, wild mustard, wormseed nightshade, Eastern black pigweed, redroot ragweed, common (suppression only) velvetleaf

**Ground application only. Do not apply by air. Make only one application per season. Apply in a minimum of 220 L/ha of water and at a pressure of 175 – 275 kPa.*

Spike to 50 cm standing corn
Eastern and Western Canada

Herbicide	Rate/ha	Corn Stage	Weed Stage
Banvel II alone	600 mL	Emergence to 50 cm (drop nozzles from 20-50 cm corn)	Pre-emergence to 2-leaf
Banvel II + 2,4-D amine	290 mL + 850 mL	Emergence to 50 cm (drop nozzles from 20-50 cm corn)	Pre-emergence to 2-leaf

Sequential Banvel II Applications
Eastern and Western Canada
Banvel II may be applied sequentially to a **Banvel II** application to control late-emerging weeds such as field bindweed, Canada thistle and velvetleaf. Follow application directions as outlined for the **Banvel II** alone post-emergence treatments up to 50 cm tall corn.

Grazing Restrictions
Do not graze cattle on treated crop, or harvest for silage until 7 days following the application of **Banvel II** alone and at least 12 weeks following treatment with **Banvel II** tank-mixes.

WEED CONTROL IN REDUCED TILLAGE (prior to seeding)

Treatment Notes
1. **Banvel II** + Roundup applications may be applied to emerged annual grass and annual broadleaf weeds in reduced tillage systems prior to seeding of wheat, barley, rye, oats, and field corn only.

2. Do not apply prior to seeding sweet corn.

3. Planting should follow soon after application since this tank-mix does not provide residual weed control.

4. Delayed planting following chemical application will allow weeds to emerge between application and crop emergence.

5. For field corn, apply to medium to fine textured soils containing more than 2.5% organic matter. Do not use on sandy or sandy loam soil.

6. Certain broadleaf crops such as sweet corn, lentils, peas, canola and flax can be injured by a pre-seeding application of this tank-mix and should not be planted after the use of this tank-mix.

7. Under certain stress conditions, such as drought, cool temperatures or where extremely hard water (> 700 ppm Ca + Mg) will be used, use 50 L/ha of water with this tank-mix to help improve results.

APPLICATION DIRECTIONS

Weeds Controlled	Banvel II Rate	Tank Mix
Annual Grasses *(Apply any time between emergence and heading)* brome, *downy* cereals, *volunteer* darnel, *Persian* foxtail, *green* oats, *wild*	**Banvel II** at 315 mL/ha +	Roundup at 935 mL/ha + 0.5 L of a non-ionic surfactant in 100 L of water
Annual Broadleaves *(Apply up to 15 cm height)* buckwheat, *wild** canola, *volunteer**** cockle, *cow* flixweed** kochia lady's-thumb lamb's-quarters mustard, *wild* pigweed, *redroot* smartweed, *green* stinkweed** thistle, *Russian* cleavers (1-4 whorls) **(suppression only)**	**Banvel II** at 315 mL/ha +	Roundup at 935 mL/ha + 0.5 L of a non-ionic surfactant in 100 L of water
Perennials *(Apply before initiation of seed head or browning of lower leaves)* barley, *foxtail* (suppression only)	**Banvel II** at 315 mL/ha +	Roundup at 935 mL/ha + 0.5 L of a non-ionic surfactant in 100 L of water

* *Apply at the 1 to 4-leaf stage.*

** *For optimal control of winter annual broadleaf weeds such as flixweed and stinkweed, 2,4-D should be applied to emerged, actively growing weeds in the fall the year prior to the* ***Banvel II*** *+ Roundup spring pre-seeding tank-mix. Refer to the 2,4-D product label for appropriate rates.*

*** *Not including glyphosate tolerant canola, i.e. Roundup Ready Canola.*

WEED CONTROL IN REDUCED TILLAGE FALLOW

Treatment Notes

1. Apply **Banvel II** tank-mixes in the spring to fallow land when seedling weeds have emerged, and are actively growing at the 2 to 4-leaf stage.

2. Reduced control may occur if applications are made at an advanced stage of weed development.

DO NOT APPLY BY AIR.

APPLICATION DIRECTIONS

Weeds Controlled	Banvel II Rate	Tank Mix
buckwheat, *wild* buckwheat, *Tartary* cockle, *cow* flixweed kochia lady's-thumb lamb's-quarters mustard, *wild* pigweed, *redroot* shepherd's-purse smartweed, *green* sow-thistle, *perennial* **(top growth)** stinkweed thistle, *Canada* **(top growth)** thistle, *Russian*	230 – 290 mL/ha +	1.1 L/ha of 2,4-D amine 500 **OR** 920 mL/ha of 2,4-D L.V. ester 600 in 50-100 L of water
barley, *foxtail*** buckwheat, *wild*** cereals, *volunteer* cockle, *cow* flixweed* foxtail, *green* kochia lady's-thumb lamb's-quarters mustard, *wild* oats, *wild* pigweed, *redroot*** canola, *volunteer**** stinkweed thistle, *Russian*	290 mL/ha +	750 mL - 1.0 L/ha Roundup plus 350 mL of a non- ionic surfactant registered for this use in 50-100 L of water
Buckwheat, *wild*	600 mL/ha +	750 mL - 1.0 L/ha Roundup + 350 mL of an approved non-ionic surfactant in 50-100 L of water

* *For control of flixweed use 1.0 L/ha of Roundup.*

** *Suppression only.*

*** *Not including glyphosate tolerant canola, i.e. Roundup Ready Canola.*

Banvel II / Roundup Application Notes

1. These tank-mixes should be applied to emerged actively growing annual weeds from 8-15 cm in height.

2. Use the higher rate of Roundup when weeds are at a more advanced stage of growth.

3. For perennial weed control, refer to the appropriate section of this label for proper stages of growth and recommended stages of application.

4. Reduced control may occur if muddy water is used, such as water from dug-outs, ponds and unlined ditches.

PERENNIAL WEED CONTROL IN SUMMERFALLOW AND STUBBLE

Treatment Notes

1. Apply **Banvel II** in 110-220 litres of water/ha.

2. For the most effective control of Canada thistle, follow a long-term approach that includes in crop, post-harvest, and summerfallow treatments, in conjunction with tillage operations.

3. If application is made after September 1st, or if soil moisture levels are extremely low after application, crop injury may occur in the spring following application.

DO NOT APPLY BY AIR.

Weeds Controlled

Weeds Controlled	Rate	Recropping in Year Following
bindweed, *field* daisy, *English* dock, *curled* **(top growth)** goldenrod ragwort, *tansy* sow thistle, *perennial* thistle, *Canada*	**Banvel II** alone at 2.5 L/ha	cereals soybeans field corn white beans sweet corn
thistle, *Canada* sow-thistle, *perennial*	**Banvel II** at 1.25 L/ha + Roundup at 1.7 L/ha + 350 mL of a non-ionic surfactant	*All of the above plus:* canola

Application Directions

Summerfallow Treatment Notes

1. Cultivate in the spring and apply **Banvel II** when:

Weed	Weed Stage
thistles	the majority of thistles are up and before the early bud stage (15-25 cm tall)
field bindweed	in the flowering stage
other weeds	in the early bud stage of growth

2. Cultivate three weeks after application.

Stubble Treatment Notes

Apply to regrowth after harvest and at least 2 weeks prior to a killing frost.

PERENNIAL ROSETTE CONTROL IN SUMMERFALLOW

Treatment Notes

1. For the most effective control of Canada thistle, follow a long-term approach that includes in crop, post-harvest, and summerfallow treatments, in conjunction with tillage operations.

2. Commence early spring cultivation and continue as required throughout the summer. ***Note:*** The final cultivation must occur by the end of July between July 15-August 1 and the final cultivation should cut the thistle off 5 to 7.5 cm below the soil surface.

3. Spray in 110-220 L of water/ha when the majority of thistles have emerged as low growing rosettes 15 to 25 cm across.

4. Apply at least two weeks prior to a killing frost.

5. Cultivate three weeks after application.

DO NOT APPLY BY AIR.

Weeds Controlled

Weeds Controlled	Banvel II Rate	Recropping in Year Following
thistle, *Canada*	1.25 L/ha	cereals field corn white beans canola soybeans

PASTURES, RANGELAND AND NON-CROP AREAS

Treatment Notes

For Broadleaf Weed Control

1. Apply **Banvel II** or **Banvel II** tank-mixes in 110-220 L of water/ha when weeds are actively growing. Thorough coverage of foliage is necessary to control weeds.

2. Do not apply **Banvel II** or **Banvel II** tank-mixes if pasture is underseeded to legumes.

DO NOT APPLY BY AIR.

Weeds Controlled	Banvel II Rate	Tank Mix
bindweed, *field* daisy, *English* dock, *curled* **(top growth)** goldenrod ragwort, *tansy* sow-thistle, *perennial* thistle, *Canada*	**Banvel II** alone at 2.1 L/ha	none
beard, *goat's* cherry, *ground* knapweed, *diffuse* sage, *pasture* sorrel, *sheep* spurge, *thyme-leafed* weed, *poverty*	**Banvel II** alone at 4.6 L/ha	none
poison ivy	**Banvel II** at 1.65 L/ha +	2.2 L/ha of 2,4-D amine (500 g/L formulation) in 560 L of water/ha
wild carrot *plus* additional weeds found on the 2,4-D amine label	**Banvel II** at 2.1 L/ha +	2.2 L/ha of 2,4-D amine (500 g/L formulation)
All of the above plus additional weeds found on the 2,4-D amine label	**Banvel II** at 2.1 L/ha +	1.83 L of 2,4-D L.V. ester (600 g/L formulation)

For Brush Weed Control

1. **Banvel II** is effective in controlling many deciduous brush species that are found growing along fence rows and in other areas around the farm where they may be undesirable.

2. Apply **Banvel II** tank-mixes in spring or early summer to deciduous species (leaves should be fully expanded) either as a leaf stem treatment or as a broadcast ground application.

3. Brush and trees over 2 meters tall should be cut and regrowth treated when it develops.

4. Do not apply **Banvel II** tank-mixes if pasture or rangeland is underseeded to legumes.

5. For Stem Foliage Treatment, apply to all foliage and stems to the point of runoff. The volume of spray mix applied per hectare will vary according to the height and density of the woody species present.

6. For Broadcast Ground Treatment, apply **Banvel II** tank-mixes in sufficient dilution to wet all foliage. Normally, 220-230 litres of water/ha is recommended for brush stands.

DO NOT APPLY BY AIR.

Weeds Controlled	Banvel II Rate	Tank Mix
alder aspen poplar cherry western snowberry (buckbrush) wolf willow (silverwillow) wild rose	**Banvel II** at 2.1 L /1000 L of water +	4.0 L of 2,4-D amine (500 g/L formulation) **OR** 3.3 L of 2,4-D L.V. (600 g/L formulation)
aspen poplar	**Banvel II** at 3.25 L/ha +	4.4 L/ha of 2,4-D amine (500 g/L formulation) **OR** 3.75 L/ha of 2,4-D L.V. ester (600 g/L formulation)
prickly rose	**Banvel II** at 3.65 L/ha +	4.4 L/ha of 2,4-D amine (500 g/L formulation) **OR** 3.75 L/ha of 2,4-D L.V. ester (600 g/L formulation)
western snowberry	**Banvel II** at 3.65 L/ha +	3.75 L/ha of 2,4-D L.V. ester (600 g/L formulation)

Grazing Restrictions

Hay Making and Grazing Restrictions for Dairy Cattle

Rate/ha	Delay Between Treatment & Hay Making/Grazing
Up to 1.25 L **Banvel II**	0 days
> 1.25 L to 2.3 L **Banvel II**	7 days
> 2.3 L to 4.6 L **Banvel II**	14 days
> 4.6 L to 7.1 L **Banvel II**	30 days

Hay Making and Grazing Restrictions for Meat Animals

Number of Days Between Banvel II Application & Hay Making or Consumption	Slaughter Restrictions
vegetation consumed *within 30 days* of treatment	feed animal untreated diet for 30 days *before* slaughter
vegetation consumed *30 days after* treatment	no restrictions on slaughter

SEED PRODUCTION

Treatment Notes
For New/Established Stands of Red Fescue

1. Apply **Banvel II** or **Banvel II** tank-mixes in at least 110 litres of water/ha.

2. Applications to new seedling stands may be made when the crop is 5 cm tall.

3. Application to established stands may be made up to the shot-blade stage of the crop.

4. For dandelion control, apply **Banvel II** plus 2,4-D amine in the fall when weeds are in the rosette or early bud stage.

DO NOT APPLY BY AIR.

Weeds Controlled	Banvel II Rate	Tank Mix
buckwheat, *wild* buckwheat, *Tartary* cockle, *cow* clover lady's-thumb sow-thistle, *perennial* **(top growth)** spurry, *corn* smartweed, *green* thistle, *Canada* **(top growth)**	**Banvel II** alone at 600 mL/ha	none
All of the above plus: additional weeds found on the 2,4-D amine label	**Banvel II** at 600 mL/ha +	1.5 L/ha of 2,4-D amine (500 g/L formulation)

For Canary Grass

1. The canary grass should only be used as bird seed.

2. For specific weeds controlled, refer to the **Banvel II** + MCPA amine weed spectrum list under "Cereals".

Herbicide	Rate	Canary Grass Stage
Banvel II alone	290 mL/ha	3 - 5 leaf stage
Banvel II + MCPA amine	290 mL/ha + 850 mL/ha (500 g/L formulation)	3 - 5 leaf stage

For Seedling Grasses (seeded alone or underseeded with cereals)

For seed and forage production of the following seedling grasses

bromegrass, *smooth*
fescue, *meadow*
fescue, *tall*
foxtail, *meadow*
orchard grass
red fescue, *creeping*
timothy
wheatgrass, *crested*
wheatgrass, *Intermediate*
wheatgrass, *pubescent*
wheatgrass, *slender*
wheatgrass, *streambank*
wheatgrass, *tall*

1. Apply **Banvel II** or **Banvel II** + tank-mixes in at least 110 litres of water/ha.

2. Application to new seedling grasses may be made when they are in the 2 to 4-leaf stage. If the seedling grass is under seeded with a cereal crop, refer to "Cereals" for additional restrictions pertaining to application type and rate.

3. If the crops are to be used as feed or pasture following treatment with **Banvel II**, **Banvel II** plus 2,4-D amine or MCPA, refer to "Grazing Restrictions".

Weeds Controlled	Banvel II Rate	Tank Mix
buckwheat, *Tartary* buckwheat, *wild* cockle, *cow* cleavers **(higher rate only)** lady's-thumb sow-thistle, *perennial* **(top growth)** smartweed, *green* spurry, *corn* thistle, *Canada* **(top growth)**	**Banvel II** alone at 230 - 290 mL/ha	none
All of the above plus: burdock **(young seedlings)** canola, *volunteer** cocklebur flixweed hemp-nettle** kochia pigweed, *redroot* pigweed, *Russian* radish, *wild* shepherd's-purse sunflower, *volunteer**** thistle, *Russian*	**Banvel II** at 230 - 290 mL/ha +	850 mL/ha of 2,4-D amine (500 g/L formulation) **OR** 850 mL/ha of MCPA amine (500 g/L formulation) **OR** 1.1 L/ha of MCPA K (400 g/L formulation)

* *Best results will be obtained if application is made prior to bolting of canola, when this weed is at the 2 to 4 leaf stage.*

** *Use **Banvel II** + MCPA K for hemp-nettle control. Apply at the 2 to 3 leaf stage of weed for best control. Hemp-nettle may not be controlled if application is made at a more advanced stage of crops and weeds.*

*** *Depending on the growing conditions, control may be delayed slightly.*

For Established Grass Pasture

1. Apply **Banvel II** at 600 mL/ha with 1.5 L/ha of 2,4-D amine (500 g/L formulation) to suppress volunteer alfalfa.

2. Apply **Banvel II** + 2,4-D amine in 110-220 L/ha in the spring to actively growing alfalfa at greater than 5 cm in height.

LOW-BUSH BLUEBERRIES

Treatment Notes

1. **Banvel II** can be used alone or in a tank-mix with 2,4-D L.V. ester.

2. Apply **Banvel II** or the **Banvel II** tank-mix in 550 litres of water per hectare.

3. Apply in the fall while the sweet-fern is still moderately green after 90% of the blueberries have dropped their leaves. This should be done before the area is burned. Fall burning or cutting should be carried out 4 to 5 weeks after spraying. If spring burning or cutting is planned, it should be done as early as possible in the spring to reduce injury to the blueberries.

DO NOT APPLY BY AIR.

Weeds Controlled

Weeds Controlled	Banvel II Rate	Tank Mix
fern, *sweet* lambkill (sheep laurel)	4.6 - 7.1 L/ha	none
additional broadleaf control	2.3 L/ha +	5.7 L of 2,4-D L.V. ester (600 g/L formulation)

RESISTANCE-MANAGEMENT RECOMMENDATIONS

For resistance management, **Banvel II** is a Group 4 herbicide. Any weed population may contain or develop plants naturally resistant to **Banvel II** and other Group 4 herbicides. The resistant biotypes may dominate the weed population if these herbicides are used repeatedly in the same field. Other resistance mechanisms that are not linked to site of action, but specific for individual chemicals, such as enhanced metabolism, may also exist. Appropriate resistance-management strategies should be followed.

To delay herbicide resistance:

- Where possible, rotate the use of **Banvel II** or other Group 4 herbicides with different herbicide groups that control the same weeds in a field.
- Use tank mixtures with herbicides from a different group when such use is permitted.
- Herbicide use should be based on an IPM program that includes scouting, historical information related to herbicide use and crop rotation, and considers tillage (or other mechanical), cultural, biological and other chemical control practices.
- Monitor treated weed populations for resistance development.

- Prevent movement of resistant weed seeds to other fields by cleaning harvesting and tillage equipment and planting clean seed.
- Contact your local extension specialist or certified crop advisors for any additional pesticide resistance-management and/or integrated weed-management recommendations for specific crops and weed biotypes.
- For further information or to report suspected resistance, contact BASF at 1-877-371-2273.

PRECAUTIONS

1. **KEEP OUT OF REACH OF CHILDREN.**

2. Harmful if swallowed or absorbed through the skin.

3. Avoid contact with skin, eyes, and clothing.

4. Thaw if frozen. Shake before use.

If this pest control product is to be used on a commodity that may be exported to the U.S. and you require information on acceptable residue levels in the U.S., visit CropLife Canada's web site at www.croplife.ca.

FIRST AID INSTRUCTIONS

IN CASE OF SKIN CONTACT: Wash with plenty of soap and water.

IN CASE OF EYE CONTACT: Flush with plenty of water for at least 15 minutes. Contact a physician or poison control centre IMMEDIATELY.

IF SWALLOWED: Contact a physician or poison control centre IMMEDIATELY. Take container, label or product name and Pest Control Product Registration Number with you when seeking medical attention.

IF INHALED: Remove person to fresh air. Assist breathing if necessary. Contact a physician or poison control centre IMMEDIATELY.

TOXICOLOGICAL INFORMATION

Treat symptomatically.

DISPOSAL

Do not reuse this container for any purpose. This is a recyclable container, and it is to be disposed of at a container collection site. Contact your local distributor/dealer or municipality for the location of the nearest collection site. Before taking the container to the collection site:

1. Triple- or pressure-rinse the empty container. Add the rinsings to spray mixture in the tank.
2. Make the empty, rinsed container unsuitable for further use.

If there is no container collection site in your area, dispose of the container in accordance with provincial requirements.

For information on disposal of unused, unwanted product, contact the manufacturer or the provincial regulatory agency. Contact the manufacturer and the provincial regulatory agency in case of a spill, and for clean-up of spills.

Cleaning Spray Equipment

Banvel II alone or with 2,4-D or MCPA
If you have used **Banvel II** alone or **Banvel II** in a tank-mix with 2,4-D or MCPA, to clean the spray equipment follow these steps:

1. Thoroughly hose down the inside and outside of equipment surfaces while filling the spray tank half-full with water. Flush by operating the sprayer until the system is purged of the rinse water.

2. Fill the tank with water, adding 1 L of household ammonia for every 100 L of water. Operate the spray pump to circulate the ammonia solution through the sprayer solution for 15-20 minutes and discharge a small amount of the ammonia solution through the spray boom and nozzles.

3. Flush the solution out of the spray tank through the boom.

4. Remove the nozzles and screens and flush the system with two tanks full of water.

Banvel II with other Herbicides
To clean spray equipment used to apply **Banvel II** as a tank-mix with wettable powders (WP), emulsifiable concentrates (EC) or other types of water-dispersible formulations, follow these steps: (Note that if you use **Banvel II** tank-mixes with water-dispersible formulation, you must add detergent to the rinse water.)

1. Thoroughly hose down the inside and outside of equipment surfaces while filling the spray tank half-full with water. Flush by operating the sprayer until the system is purged of the rinse water.
2. Fill tank with water while adding 1 kg of detergent for every 150 litres of water. Operate the pump to circulate the detergent solution through the sprayer system for 5-10 minutes and discharge a small amount of the solution through the boom and nozzles. Let the solution stand for several hours, preferably overnight.

3. Flush the detergent solution out of the spray tank through the boom.

4. Repeat step 1 and follow steps 2 and 3.

Bulk Container Refilling

1. The container is to be refilled only with **Banvel II**.

2. Reseal and return to an authorized BASF bulk site.

3. Prior to refilling, inspect thoroughly for damage such as cracks, punctures, bulges, dents, abrasions and damaged or worn threads on closure devices.

4. Check for leaks after refilling and before transportation.

5. Do not refill or transport damaged or leaking containers.

6. For disposal, this container may be returned to the point of purchase (dealer/distributor). It must be refilled by the distributor/dealer with the same product. Do not reuse this container for any other purpose.

7. If the container is not being refilled, refer to Section on "Disposal".

STORAGE

1. Store **Banvel II** in its original container only, away from other pesticides, fertilizer, food, or feed.

2. Keep the container closed to prevent spills and contamination.

3. Keep packages dry at all times.

NOTICE TO USER

This pest control product is to be used only in accordance with the directions on the label. It is an offence under the *Pest Control Products Act* to use this product in a way that is inconsistent with the directions on the label. The user assumes the risk to persons or property that arises from any such use of this product.

SAFETY DATA SHEET

Dow AgroSciences

Emergency Phone: 0800 243 622
Dow AgroSciences (N Z) Ltd.
89 Paritutu Road, New Plymouth

TORDON* Brushkiller Herbicide

Effective Date: 09-Dec-05
Product Code: 11612

1. PRODUCT AND COMPANY IDENTIFICATION:

PRODUCT: TORDON* Brushkiller Herbicide

RECOMMENDED USES: Controls a range of brush weeds as specified on the label.

COMPANY IDENTIFICATION:
Dow AgroSciences (NZ) Ltd.
Registration No. 169964
89 Paritutu Road, New Plymouth

Customer Service Toll Free Number:
0800 803 939
(Mon-Fri, 8am–4.30 pm)
www.dowagrosciences.co.nz

Emergency Telephone Number:
0800 CHEMCALL (0800 243 622)
(24 hours) (EMERGENCIES ONLY)

Transport Emergency Only Dial 111

This SDS may not provide exhaustive guidance for all the HSNO controls assigned to this substance. The ERMA website www.ermanz.govt.nz should be consulted for a full list of triggered controls and cited regulations

2. HAZARDOUS IDENTIFICATIONS:

EMERGENCY OVERVIEW

ERMA New Zealand Approval Code: HSR000553
HSNO Hazard Classification: 3.1D, 6.1D, 6.3B, 6.4A, 6.5B, 6.9B, 9.1A, 9.2A, 9.3C

RISK PHRASES

R36/37/38	Irritating to eyes, respiratory system and skin.
R43	May cause sensitisation by skin contact.
R50	Very toxic to aquatic organisms.
R54	Toxic to Flora.

SAFETY PHRASES

S2	Keep out of the reach of children.
S3/7	Keep container tightly closed in a cool place.
S23	Do not breathe vapour or spray.
S36/37/39	Wear suitable protective clothing, gloves and eye/face protection.
S20/21	When using do not eat, drink or smoke.
S45	In case of accident or if you feel unwell, seek medical advice immediately (show that the label where possible).
S29	Do not empty into drains.

3. COMPOSITION/INFORMATION ON INGREDIENTS:

Ingredient	CAS #	Content
Triclopyr butoxyethyl ester	064700-56-7	36.5%
Picloram	001918-02-1	8.8%
Oxirane, methyl,- polymer with oxirane, monobutyl ether	9038-95-3	5-10%
Balance Ingredients not contributing to a hazard		40-50%

4. FIRST AID:

Consult the National Poisons Information Centre (0800 POISON (0800 764 766) or a doctor in every case of suspected chemical poisoning. Never give fluids or induce vomiting if a patient is unconscious or convulsing regardless of cause of injury. If breathing difficulties occur seek medical attention immediately.

EYES: Hold eyes open and rinse slowly and gently with water for 15-20 minutes. Remove contact lenses, if present, after the first 5 minutes, and then continue rinsing eyes. Call a poison control center or doctor for treatment advice.

SKIN: Take off contaminated clothing. Rinse skin immediately with plenty of water for 15-20 minutes. Call a poison control center or doctor for treatment advice.

INGESTION: Immediately call a poison control center or doctor. Do not induce vomiting unless told to do so by a poison control center or doctor. Do not give any liquid to the person. Do not give anything by mouth to an unconscious person.

INHALATION: Move person to fresh air; if effects occur, consult a physician.

NOTE TO PHYSICIAN: The decision of whether to induce vomiting or not should be made by a physician. If lavage is performed, suggest endotracheal and/or esophageal control. Danger from lung aspiration must b weighed against toxicity when considering emptying the stomach. No specific antidote. Treatment of exposure should be directed at the control of symptoms and the clinical condition of the patient.

5. FIRE FIGHTING MEASURES:

FLASH POINT: 82°C

FLAMMABLE LIMITS
LFL: Not available
UFL: Not available

EXTINGUISHING MEDIA: Water fog, foam, CO_2, dry chemical.

FIRE & EXPLOSION HAZARDS: Keep unnecessary people away; isolate hazard area and deny unnecessary entry. Highly toxic and irritating fumes are released in fire situations. Do not allow material or run-of to enter waterways. Stay upwind; keep out of low areas.

FIRE-FIGHTING EQUIPMENT: Use approved positive-pressure, self-contained breathing apparatus and special protective clothing, including heavy neoprene or rubber boots and neoprene gloves.

HAZCHEM: 2X

6. ACCIDENTAL RELEASE MEASURES:

ACTION TO TAKE FOR SPILLS/LEAKS: Absorb with material such as sand, sawdust or Zorball. Dike area in case of large spills. Do not use water for cleanup. Report large spills to Dow AgroSciences Emergency Services at 0800 CHEMCALL (0800 243 622).

7. HANDLING AND STORAGE:

PRECAUTIONS TO BE TAKEN IN HANDLING AND STORAGE:

HANDLING: Keep out of reach of children. Harmful if swallowed. Causes skin irritation and sensitivity. Avoid contact with skin and clothing. After work, remove protective clothing and equipment, wash hands before eating, drinking, chewing gum, using tobacco, or using the toilet.
Clean up spilled material immediately, and wash clothes, equipment and work area after use.

STORAGE: Store in tightly closed original container in a cool, dry well-ventilated area out of direct sunlight and away from sources of ignition when not in use. This product can be stored in an unheated building. Do not store with food, feedstuffs, fertilizers and seeds. See product label for further handling/storage precautions relative to the end use of this product.

This substance is subject to a requirement for an emergency management plan, secondary containment and signage, whenever it is held in quantities of 100 litres or more, either alone on in aggregate with other hazardous substances. See Hazardous Substances Emergency Management and Identification Regulations.

8. EXPOSURE CONTROLS/PERSONAL PROTECTION:

These precautions are suggested for conditions where the potential for exposure exists. Emergency conditions may require additional precautions.

EXPOSURE GUIDELINE(S):
Picloram Acid: OSH WES is 10 mg/m^3
Triclopyr Acid: Dow AgroSciences Industrial Hygiene Guide is 2 mg/m^3, Skin

A "skin" notation following the exposure guideline refers to the potential for dermal absorption of the material including mucous membranes and the eyes either by contact with vapors or by direct skin contact. It is intended to alert the reader that inhalation may not be the only route of exposure and that measures to minimize dermal exposures should be considered.

ENGINEERING CONTROLS: Provide general and/or local exhaust ventilation to control airborne levels below the exposure guidelines.

RECOMMENDATIONS FOR MANUFACTURING, COMMERCIAL BLENDING, AND PACKAGING WORKERS:

RESPIRATORY PROTECTION: Atmospheric levels should be maintained below the exposure guideline. When respiratory protection is required for certain operations, use an approved air-purifying respirator. The following should be an effective type of air-purifying respirator: organic vapor cartridge.

SKIN PROTECTION: When prolonged or frequently repeated contact could occur, use protective clothing chemically resistant to this material. Selection of specific items such as face shield, boots, apron, or full-body suit will depend on the task.

EYE PROTECTION: Use chemical goggles.

APPLICATORS AND ALL OTHER HANDLERS: Refer to the product label for personal protective clothing and equipment.

9. PHYSICAL AND CHEMICAL PROPERTIES:

APPEARANCE: Brown
ODOUR: Ester
BOILING POINT: ~200°C
VAPOR PRESSURE: Not available for substance (triclopyr BE = 3.60×10^{-6} mmHg @ 25 °C ; Picloram acid = 6.16×10^{-7} mm Hg at 35 °C)
SOLUBILITY IN WATER: Emulsifiable
SPECIFIC GRAVITY: 1.15 g/mL @ 20°C
pH: 6.65 – 8.5 (5% v/v water emulsion)

10. STABILITY AND REACTIVITY:

STABILITY: (CONDITIONS TO AVOID) Combustible. Keep away from heat, open flames and sparks.

INCOMPATIBILITY: (SPECIFIC MATERIALS TO AVOID) None under normal use conditions. Under abnormal conditions, avoid oxidizing materials and strong acids.

HAZARDOUS DECOMPOSITION PRODUCTS: Hydrogen chloride and nitrogen oxides may be formed if product is involved in fire.

HAZARDOUS POLYMERIZATION: Not known to occur.

11. TOXICOLOGICAL INFORMATION:

POTENTIAL HEALTH EFFECTS: This section includes possible adverse effects, which could occur if this material is not handled in the recommended manner.

EYE: May cause moderate eye irritation. Corneal injury is unlikely. Effects are likely to heal readily. HSNO Classification: 6.4A (irritating to the eye).

SKIN: Prolonged contact may cause skin irritation with local redness. Prolonged skin contact is unlikely to result in absorption of harmful amounts. Prolonged or frequently repeated skin contact may cause allergic skin reactions in some individuals. The dermal LD_{50} for rabbits is >2,000 mg/kg. HSNO Classification: 6.3B (irritating to the skin); 6.5B (contact sensitiser)

INGESTION: Low toxicity if swallowed. Aspiration into the lungs may occur during ingestion or vomiting, causing lung damage or even death due to chemical pneumonia. The LD_{50} for rats is 2,525 mg/kg (female) and 3,383 mg/kg (male). HSNO Classification 6.1D (acutely toxic).

INHALATION: Excessive exposure may cause irritation to upper respiratory tract (nose and throat). The aerosol LC_{50} for rats is >5.0 mg/L for 4 hours.

SYSTEMIC (OTHER TARGET ORGAN) EFFECTS: In animals, effects have been reported on the following organs: liver, kidney, blood. Symptoms of excessive exposure may be anesthetic or narcotic effects, dizziness and drowsiness may be observed. HSNO Classification 6.9B (harmful to organs or systems).

CANCER INFORMATION: The active ingredient(s) did not cause cancer in laboratory animals.

TERATOLOGY (BIRTH DEFECTS): The active ingredient(s) did not cause birth defects in laboratory animals. Has been toxic to the fetus in laboratory animals at doses toxic to the mother.

REPRODUCTIVE EFFECTS: For triclopyr, in laboratory animal studies, effects on reproduction have been seen only at doses that produced significant toxicity to the parent animals. Picloram did not interfere with reproduction in laboratory animal studies.

MUTAGENICITY (EFFECTS ON GENETIC MATERIAL): The preponderance of data shows picloram to be non-mutagenic in 'in-vitro' (test tube) tests and in animal test systems. For triclopyr, in-vitro and animal genetic toxicity studies were negative.

12. ECOLOGICAL INFORMATION:

ENVIRONMENTAL FATE:
Based largely or completely on information for the active ingredient(s).

MOVEMENT AND PARTITIONING:
Bioconcentration potential is moderate (BCF is between 100 and 3000 or Log Pow between 3 and 5).

DEGRADATION AND PERSISTENCE:
Based on stringent OECD test guidelines, this material cannot be considered as readily biodegradable; however, these results do not necessarily mean that the material is not biodegradable under environmental conditions.

ECOTOXICOLOGY:
Based largely or completely on information for the active ingredient(s).

Material is:
Highly toxic to aquatic organisms on an acute basis (The LC_{50} or EC_{50} is between 0.1 and 1 mg/L in the most sensitive species tested).
Highly toxic to plants.
Harmful to birds and mammals (Triclopyr BE bird LD_{50} = 735 mg/kg) See Part 11 ingestion for mammals.
HSNO Classification: 9.1A (very ecotoxic in the aquatic environment); 9.2A (very ecotoxic in the soil environment); 9.3C. (harmful to terrestrial vertebrates).

13. DISPOSAL CONSIDERATIONS:

DISPOSAL METHOD: If wastes and/or containers cannot be disposed of according to the product label directions, disposal of this material must be in accordance with your local or area regulatory authorities. This information presented below only applies to the material as supplied. The identification based on characteristic(s) or listing may not apply if the material has been used or otherwise contaminated. It is the responsibility of the waste generator to determine the toxicity and physical properties of the material generated to determine the proper waste identification and disposal methods in compliance with applicable regulations. If the material as supplied becomes a waste, follow all applicable regional, national and local laws and regulations.

14. TRANSPORT INFORMATION:

PUBLIC PASSENGER VEHICLE TRANSPORT: Do not transport in a public passenger vehicle.

DANGEROUS GOODS CLASSIFICATION

UN No: 3082
Class: 9
Packing group: III
SHIPPING NAME: ENVIRONMENTALLY HAZARDOUS SUBSTANCE, LIQUID, N.O.S (TRICLPOYR, PICLORAM).

Compliance with the above requirements is deemed to comply with the applicable requirements of the Hazardous Substances Identification and Emergency Management Regulations and.

15. REGULATORY INFORMATION:

ACVMG APPROVAL NUMBER: P003737
ERMA New Zealand Approval Code: HSR000555

16. OTHER INFORMATION:

Glossary
ACGIH: American Conference of Governmental Industrial Hygienists.

Dow AgroSciences

Emergency Phone: 0800 243 622
Dow AgroSciences (N Z) Ltd.
89 Paritutu Road, New Plymouth

TORDON* Brushkiller Herbicide

Effective Date: 09-Dec-05
Product Code: 11612

BCF: Bioconcentration Factor - a measure for the characterization of the accumulation of a chemical in an organism. It is defined as the concentration of a chemical in an organism (plants, microorganisms, animals) divided by the concentration in a reference compartment (e.g. food, surrounding water).
EC_{50}: median effective concentration. Statistically derived concentration of a substance in an environmental medium expected to produce a certain effect in 50% of test organisms in a given population under a defined set of conditions.
EEL: Environmental exposure standard set by ERMA
Explosive Limits: The range of concentrations (% by volume in air) of a flammable gas or vapour that can result in an explosion for ignition in a confined space.
ERMA: The Environmental Risk Management Authority of New Zealand.
K_{oc}: the organic carbon partition coefficient (mL soil water /g organic carbon).
K_{ow}: See P_{ow}
LC_{50}: Lethal Concentration 50%. A concentration of chemical in air or water that will kill 50% of the test organisms.
LD_{50}: Lethal Dose-50%. The doses of a chemical that will kill 50% of the test animals receiving it.
NIOSH: American national Institute of Occupational Safety and Health, a federal agency which conducts research on occupational safety and health questions and recommends new standards.
OSH: Occupational Safety and Health Service of Nea Zealand.
OSHA: American Occupational Safety and Health Administration.
PEL: Permissible Exposure Level, a maximum allowable exposure level by law.
pH: Measure of how acidic or alkaline a material is using a 1 - 14 scale. pH 1 is strongly acidic and pH 14 strongly alkaline.
Polymerisation: a chemical reaction in which small molecules (monomers) combine to form much larger molecules (polymers). A hazardous polymerisation reaction is one that occurs at a fast rate and releases large amounts of energy.
P_{ow}: The octanol-water partition coefficient is the ratio of the concentration of a chemical in octanol and in water at equilibrium and at a specified temperature. Octanol is an organic solvent that is used as a surrogate for natural organic matter. This parameter is used in many environmental studies to help determine the fate of chemicals in the environment.
STEL: Short-Term Exposure Limit. A term used to indicate the maximum average concentration allowed for a continuous 15 minute exposure period.
TEL: Tolerable Exposure Limit set by ERMA
TVL: Threshold Limit Value, an exposure limit set by a competent authority
TWA: Time Weighted Average. The average concentration of a chemical in air over the total exposure time - usually an 8-hour workday.
WES: Work place exposure standard set by ERMA or OSH.

References

AS/NZS 1715-1994 Selection Use and Maintenance of Respiratory Protective Devices.
ASNZS 1716 - 1994 Respiratory protective devices.
A guide to Respiratory Protection (published by the Occupational Safety and Health Service with support of NZ Safety Ltd 1999
Guidelines for Personal Protection for Agrichemical Users NZ Safety Limited.
Environmental Risk Management Authority Decision for ERMA Approval Code (Refer to Section 15).
The Land Transport Rule 45001: Dangerous Goods 2005.
International Maritime dangerous goods code (IMDG)
Maritime Rule 20A: Carriage of Cargoes-Dangerous Goods.
International Air Transport Association (IATA) Dangerous Goods Regulation.

FOR FURTHER PRODUCT INFORMATION CALL DOW AGROSCIENCES CUSTOMER SERVICE REPRESENTATIVES TOLL FREE 0800 803 939 DURING BUSINESS HOURS.

PLATEAU®

herbicide

FOR WEED CONTROL, NATIVE GRASS ESTABLISHMENT AND TURF GROWTH SUPPRESSION ON PASTURES, RANGELAND AND NONCROP AREAS

ACTIVE INGREDIENT:	
Ammonium salt of imazapic (±)-2-[4,5-dihydro-4-methyl-4-(1-methylethyl)-5-oxo-1*H*-imidazol-2-yl]-5-methyl-3-pyridinecarboxylic acid*	23.6%
INERT INGREDIENTS	76.4%
TOTAL	100.0%

*Equivalent to 22.2% (±)-2-[4,5-dihydro-4-methyl-4-(1-methylethyl)-5-oxo-1*H*-imidazol-2-yl]-5-methyl-3-pyridinecarboxylic acid
(1 gallon contains 2.0 pounds of active ingredient as the free acid)

U.S. Patent No. 4,798,619
EPA Reg. No. 241-365

KEEP OUT OF REACH OF CHILDREN

CAUTION!/PRECAUCION!

Si usted no entiende la etiqueta, busque a alguien para que se la explique a usted en detalle. (If you do not understand the label, find someone to explain it to you in detail.)

In case of an emergency endangering life or property involving this product, call day or night, 800-832-HELP.

See inside for Additional First Aid, Precautionary Statements, Directions for Use and Conditions of Sale and Warranty

BASF Corporation
26 Davis Drive
Research Triangle Park, NC 27709

BASF

FIRST AID	
If inhaled	• Move person to fresh air. If person is not breathing, call 911 or an ambulance, then give artificial respiration, preferably mouth-to-mouth if possible. • Call a poison control center or doctor for further treatment advice.
If on skin or clothing	• Take off contaminated clothing. • Rinse skin immediately with plenty of water for 15-20 minutes. • Call a poison control center or doctor for treatment advice.
If in eyes	• Hold eye open and rinse slowly and gently with water for 15-20 minutes. • Remove contact lenses, if present, after the first 5 minutes, then continue rinsing. • Call a poison control center for treatment advice.
HOTLINE NUMBER	
Have the product container or label with you when calling a poison control center or doctor or going for treatment. You may also contact BASF Corporation for emergency medical treatment information: 1-800-832-HELP (4357).	

PRECAUTIONARY STATEMENTS

HAZARDS TO HUMANS AND DOMESTIC ANIMALS

CAUTION!

Avoid breathing spray mist. Avoid contact with skin, eyes or clothing. Wash thoroughly with soap and water after handling.

Personal Protective Equipment (PPE):

Applicators and other handlers must wear:

- Long-sleeve shirt and long pants
- Chemical-resistant gloves made of waterproof material
- shoes plus socks

Follow manufacturer's instructions for cleaning and maintaining PPE. If no such instructions for washables, use detergent and hot water. Keep and wash PPE separately from other laundry.

User Safety Recommendations:

Users Should:

- Wash hands before eating, chewing gum, using tobacco or using the toilet.
- Remove clothing immediately if pesticide gets inside. Then wash thoroughly and put on clean clothing.

ENVIRONMENTAL HAZARDS

For terrestrial use only. DO NOT apply directly to water, or to areas where surface water is present, or to intertidal areas below the mean high water mark.

DO NOT contaminate water when disposing of equipment wash-waters or rinsate.

This chemical demonstrates the properties and characteristics associated with chemicals detected in ground water. The use of this chemical in areas where soils are permeable, particularly where the water table is shallow, may result in ground-water contamination.

This product may contaminate water through drift of spray in wind. This product has a high potential for runoff for several months or more after application. Poorly draining soils and soils with shallow watertables are more prone to produce runoff that contains this product. A level, well maintained vegetative buffer strip between areas to which this product is applied and surface water features such as ponds, streams, and springs will reduce the potential for contamination of water from rainfall-runoff. Runoff of this product will be reduced by avoiding applications when rainfall is forecasted to occur within 48 hours.

IMPORTANT

PLATEAU® herbicide may be applied to non-irrigation ditches and low lying areas when water has drained, but may be isolated in pockets due to uneven or unlevel conditions. DO NOT treat the inside of irrigation ditches. DO NOT rinse equipment on or near desirable trees or ornamental plants, or on areas where their roots may extend, or in locations where the chemical may be washed or moved into contact with their roots. DO NOT use on residential lawns.

DIRECTIONS FOR USE

It is a violation of Federal law to use this product in a manner inconsistent with its labeling.

Do not apply this product in a way that will contact workers or other persons, either directly or through drift. Only protected handlers may be in the area during application. For any requirements specific to your State or Tribe, consult the agency responsible for pesticide regulation.

This labeling must be in the possession of the user at the time of pesticide application.

DO NOT use **PLATEAU** on food or feed crops except as recommended by this label or supplemental labeling.

DO NOT cut treated area for hay within seven days after treatment.

DO NOT use organophosphate insecticides on newly seeded areas treated with **PLATEAU** unless severe injury or loss of stand can be tolerated.

Observe all cautions and limitations on this label and on the labels of products used in combination with **PLATEAU**. Do not use **PLATEAU** other than in accordance with the instructions set forth on this label. The use of **PLATEAU** not consistent with this label may result in injury to desired vegetation. Keep containers closed to avoid spills and contamination.

When making new plantings of prairiegrass or wildflowers, carry-over from persistent herbicides such as sulfonyl-urea, imidazolinone, triazine, substituted urea, dinitroanaline, and other herbicides applied the previous year may result in compounded injury or death of desirable vegetation when treated with **PLATEAU**.

When making applications around desirable trees or ornamental plants, small areas should be tested to determine the tolerance of a particular species to soil and/or foliar applications of **PLATEAU**. See "TOLERANCE OF TREES AND BRUSH TO **PLATEAU** HERBICIDE" section of this label.

DO NOT apply this product through any type of irrigation system.

DO NOT exceed 12 ounces of **PLATEAU** per acre in one year.

AGRICULTURAL USE REQUIREMENTS

Use this product only in accordance with its labeling and with the Worker Protection Standard, 40 CFR part 170. This Standard contains requirements for the protection of agricultural workers on farms, forests, nurseries, and greenhouses, and handlers of agricultural pesticides. It contains requirements for training, decontamination, notification, and emergency assistance. It also contains specific instructions and exceptions pertaining to the statements on this label about personal protective equipment (PPE) and restricted entry interval. The requirements in this box only apply to uses of this product that are covered by the Worker Protection Standard.

Do not enter or allow worker entry into treated areas during the restricted entry interval (REI) of 12 hours.

PPE required for early entry to treated areas that is permitted under the Worker Protection Standard and that involves contact with anything that has been treated, such as plants, soil, or water, is:

- coveralls
- chemical-resistant gloves made of any waterproof material
- shoes plus socks

NON-AGRICULTURAL USE REQUIREMENTS

The requirements in this box apply to uses of this product that are NOT within the scope of the Worker Protection Standard (WPS) for agricultural pesticides (40 CFR Part 170). The WPS applies when this product is used to produce agricultural plants on farms, forests, nurseries, or greenhouses.

Noncrop weed control is not within the scope of the Worker Protection Standard. See the GENERAL INFORMATION section of this label for a description of noncrop sites.

Do not enter treated areas without protective clothing until sprays have dried.

STORAGE AND DISPOSAL

DO NOT contaminate water, food or feed by storage or disposal.

PESTICIDE STORAGE: KEEP FROM FREEZING. DO NOT store below 20°F.

PESTICIDE DISPOSAL: Wastes resulting from the use of this product may be disposed of on site or at an approved waste disposal facility.

CONTAINER DISPOSAL: Triple rinse (or equivalent). Then offer for recycling or reconditioning, or puncture and dispose of in a sanitary landfill, by incineration or, if allowed by State and local authorities by burning. If burned, stay out of smoke.

DISCLAIMER

The label instructions for the use of this product reflect the opinion of experts based on research and field use. The directions are believed to be reliable and should be followed carefully. However, it is impossible to eliminate all risks inherently associated with use of this product. Turf injury, ineffectiveness or other unintended consequences may result because of such factors as weather conditions, presence of other materials, or the use of, or application of the product contrary to label instructions, all of which are beyond the control of BASF Corporation (BASF). All such risks shall be assumed by the user.

BASF shall not be responsible for losses or damages resulting from use of this product in any manner not set forth on this label. User assumes all risks associated with the use of this product in any manner not specifically set forth on this label.

BASF warrants only that the material contained herein conforms to the chemical description on the label and is reasonably fit for the use therein described when used in accordance with the directions for use, subject to the risks referred to above. BASF DOES NOT MAKE OR AUTHORIZE ANY AGENT OR REPRESENTATIVE TO MAKE ANY OTHER WARRANTIES, EXPRESS OR IMPLIED AND EXPRESSLY EXCLUDES AND DISCLAIMS ALL IMPLIED WARRANTIES OF MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE. BUYER'S EXCLUSIVE REMEDY AND BASF'S EXCLUSIVE LIABILITY, WHETHER IN CONTRACT, TORT, NEGLIGENCE, STRICT LIABILITY OR OTHERWISE, SHALL BE LIMITED TO REPAYMENT OF THE PURCHASE PRICE OF **PLATEAU® herbicide**. In no case shall BASF or the seller be liable for consequential, special or indirect damages resulting from the use or handling of this product.

BASF makes no other express or implied warranty, including other express or implied warranty of FITNESS or of MERCHANTABILITY. User assumes the risk of any use contrary to label instructions, or under abnormal conditions, or under conditions not reasonably foreseeable by BASF.

USES WITH OTHER PRODUCTS (TANK-MIXES)

If this product is used in combination with any other product except as specifically recommended in writing by BASF Corporation then BASF Corporation shall have no liability for any loss, damage, or injury arising out of its use in any such combination not so specifically recommended. If used in combination recommended by BASF Corporation, the liability of BASF Corporation shall in no manner extend to any damage, loss or injury not directly caused by the inclusion of the BASF Corporation product in such combination use, and in any event shall be limited to return of the amount of the purchase price of the BASF Corporation product.

GENERAL INFORMATION

PLATEAU is an aqueous solution to be mixed with water and an adjuvant and applied as a spray solution to provide weed control and/or turf height suppression on pastures, rangeland (see "GUIDELINES FOR RANGELAND USE" section), Federal Conservation Reserve Program (CRP) land and noncropland areas including noncropland areas that may be grazed or cut for hay. Examples of noncropland areas include, but are not limited to railroad, utility, pipeline and highway rights-of-way, railroad crossings, utility plant sites, petroleum tank farms, pumping installations, non-agricultural fence rows, storage areas, non-irrigation ditchbanks, prairie sites, airports, industrial turf, golf courses, recreational and non-residential turf and other similar areas. **PLATEAU** may be used for the release of bermudagrass, bahiagrass, smooth bromegrass, wheatgrass, "wildtype" common Kentucky bluegrass, native prairiegrass, wildflowers, crown vetch, other grasses and certain legumes. **PLATEAU** can also be used for weed control during the establishment of native prairiegrasses and other grasses (see "REVEGETATION WITH PRAIRIEGRASSES AND OTHER FORAGE GRASSES" section).

PLATEAU is readily absorbed through leaves, stems, and roots and is translocated rapidly throughout the plant, with accumulation in the meristematic regions. Treated plants stop growing soon after spray application. Chlorosis appears first in the newest leaves, and necrosis spreads from this point. In perennials, the herbicide is translocated into, and kills, underground storage organs which prevents regrowth. Chlorosis and tissue necrosis may not be apparent in some plant species for several weeks after application. Complete kill of plants may not occur for several weeks after application. Adequate soil moisture is important for optimum **PLATEAU** activity. When adequate soil moisture is present, **PLATEAU** will provide residual control of susceptible germinating weeds. Activity on established weeds will depend on the weed species and rooting depth. **PLATEAU** is rainfast one hour after application.

PLATEAU will control annual and perennial grasses and broadleaf weeds and vine species. **PLATEAU** will provide residual control of labeled weeds which germinate in the treated area. Certain brush species and ornamentals may be injured by direct application of **PLATEAU** to their foliage. This product may be applied either preemergence or postemergence to the weeds. However, postemergence application is the method of choice in most situations, particularly for perennial species. For maximum activity, weeds should be growing vigorously at the time of postemergence applications and the spray solution should include an adjuvant (see "SPRAY ADJUVANTS FOR POSTEMERGENCE APPLICATIONS" section). These solutions may be applied as a broadcast or as a spot treatment using backpack, or ground equipment.

PLATEAU may be applied in the dormant or growing season for weed control.

Tolerance of desirable grass species to **PLATEAU® herbicide** may be reduced when grasses are stressed due to insect damage,

disease, environmental conditions, shade, poorly drained soils or other causes.

Depending on the turf type being treated, some yellowing of turf may occur with applications during the growing season. Depending on weather conditions, yellowing will usually disappear in 2 to 4 weeks.

PLATEAU®herbicide should not be applied to newly seeded or sprigged grass stands, unless otherwise stated in this label (see "REVEGETATION WITH PRAIRIEGRASSES AND OTHER FORAGE GRASSES" section).

MANAGING OFF-TARGET MOVEMENT

Spray Drift: Avoiding spray drift at the application site is the responsibility of the applicator. The interaction of many equipment-and-weather-related factors determine the potential for spray drift. The applicator and the grower are responsible for considering all these factors when making decisions.

Spray drift from applying this product may result in damage to sensitive plants adjacent to the treatment area. Only apply this product when the potential for drift to these and other adjacent sensitive areas (e.g. residential areas, bodies of water, known habitat for threatened or endangered species, or non-target crops) is minimal. Do not apply when the following conditions exist that increase the likelihood of spray drift from intended targets: high or gusty winds, high temperatures, low humidity, temperature inversions.

To minimize spray drift, the applicator should be familiar with and take into account the following drift reduction advisory information. Additional information may be available from state enforcement agencies or the Cooperative Extension on the application of this product.

The best drift management strategy and most effective way to reduce drift potential are to apply large droplets that provide sufficient coverage and control. Applying larger droplets reduces drift potential, but will not prevent drift if applications are made improperly, or under unfavorable environmental conditions (see **Wind, Tmperature and Humidity and Temperature Inversions**).

Controlling Droplet Size:

·Volume - Use high flow rate nozzles to apply the highest practical spray volume. Nozzles with higher rated flows produce larger droplets.

·Pressure - Do not exceed the nozzle manufacturer's recommended pressures. For many nozzle types, lower pressure produces larger droplets. When higher flow rates are needed, use higher flow rate nozzles instead of increasing pressure.

·Number of Nozzles - Use the minimum number of nozzles that provide uniform coverage.

·Nozzle Orientation - Orienting nozzles so that the spray is released parallel to the airstream produces larger droplets than other orientations and is recommended practice. Significant deflection from the horizontal will reduce droplet size and increase drift potential.

·Nozzle Type - Use a nozzle type that is designed for the intended application. With most nozzle types, narrower spray angles produce larger droplets. Consider using low-drift nozzles. Solid stream nozzles oriented straight back produce the largest droplets and the lowest drift. Do not use nozzles producing a mist droplet spray.

Application Height: Making applications at the lowest possible height (aircraft, ground driven spray boom) that is safe and practical reduces exposure of droplets to evaporation and wind.

Swath Adjustment: When applications are made with a crosswind, the swath will be displaced downwind. Therefore, on the up and downwind edges of the field, the applicator must compensate for this displacement by adjusting the path of the application equipment (e.g. aircraft, ground) upwind. Swath adjustment distance should increase with increasing drift potential (higher wind, smaller droplets, etc.).

Wind: Drift potential is lowest between wind speeds of 3-10 mph. However, many factors, including droplet size and equipment type, determine drift potential at any given speed. Application should be avoided below 3 mph due to variable wind direction and high inversion potential. NOTE: Local terrain can influence wind patterns. Every applicator should be familiar with local wind patterns and how they affect spray drift.

Temperature and Humidity: When making applications in low relative humidity, set up equipment to produce larger droplets to compensate for evaporation. Droplet evaporation is most severe when conditions are both hot and dry.

Temperature Inversions: Drift potential is high during a temperature inversion. Temperature inversions restrict vertical air mixing, which causes small suspended droplets to remain in a concentrated cloud, which can move in unpredictable directions due to the light variable winds common during inversions. Temperature inversions are characterized by increasing temperatures with altitude and are common on nights with limited cloud cover and light to no wind. They begin to form as the sun sets and often continue into the morning. Their presence can be indicated by ground fog; however, if fog is not present, inversions can also be identified by the movement of smoke from a ground source or an aircraft smoke generator. Smoke that layers and moves laterally in a concentrated cloud (under low wind conditions) indicates an inversion, while smoke that moves upward and rapidly dissipates indicates good vertical air mixing.

Wind Erosion: Avoid treating powdery dry or light sandy soils when conditions are favorable for wind erosion. Under these conditions, the soil surface should first be settled by rainfall or irrigation.

Aerial Application Methods and Equipment: Use 2 or more gallons of water per acre. The actual minimum spray volume per acre is determined by the spray equipment used. Use adequate spray volume to provide accurate and uniform distribution of spray particles over the treated area and to avoid spray drift.

Managing spray drift from aerial applications: Applicators must follow these requirements to avoid off-target drift movement: 1) boom length - the distance of the outermost nozzles on the boom must not exceed ¾ the length of the wingspan or rotor, 2) nozzle orientation - nozzles must always point backward parallel with the air stream and never be pointed downwards more than 45 degrees, and 3) application height - without compromising aircraft safety, applications should made at a height of 10 feet or less above the crop canopy or tallest plants. Applicators must follow the most restrictive use cautions to avoid drift hazards, including those found in this labeling as well as applicable state and local regulations and ordinances.

Ground Application (Broadcast): Use 5 or more gallons of water per acre. The actual minimum spray volume per acre is determined by the spray equipment used. Use adequate spray volume to provide accurate and uniform distribution of spray particles over the treated area and to avoid spray drift.

MIXING INSTRUCTIONS

Fill the spray tank one-half to three-quarters full with clean water. Use a calibrated measuring device to measure the required amount of **PLATEAU**. Add **PLATEAU** to the spray tank while agitating. Fill the remainder of the tank with water.

For postemergence applications, add a surfactant to the spray tank (see "SPRAY ADJUVANTS FOR POSTEMERGENCE APPLICATIONS" section of this label for specific recommendations). Maintain agitation while spraying to ensure a uniform spray mixture. An antifoaming agent may be added to the tank if needed.

When tank-mixing **PLATEAU** with recommended herbicides, add wettable powders, dispersible granules or other dry formulations first, then EC's, then **PLATEAU**, and then an adjuvant.

SPRAYING INSTRUCTIONS

DO NOT apply during windy or gusty conditions unless applications are being made with a drift control agent and/or an enclosed or shielded spray system. DO NOT apply if rainfall is threatening. Rainfall within 1 hour after **PLATEAU** application may reduce weed control.

GROUND APPLICATIONS:

Uniformly apply with properly calibrated ground equipment in 2 or more gallons of water per acre. Application equipment, specially designed to make low volume application should be used when making applications using less than 10 gallons of water per acre. A spray pressure of 20 to 40 psi is recommended.

To achieve acceptable control of the target vegetation, good spray coverage of the weed foliage (postemergence) or soil surface

(preemergence) is required. To achieve good spray coverage the sprayer must be calibrated to deliver the recommended spray volume and pressure and adjust the spray boom height to ensure proper coverage of weed foliage or soil surface (according to the manufacturer's recommendation). Avoid overlaps when spraying.

SPOT TREATMENTS:

To prepare the spray solution, thoroughly mix in water 0.25 to 1.5% (0.3 to 1.9 oz/gallon water) **PLATEAU® herbicide** plus an adjuvant (see "SPRAY ADJUVANTS FOR POSTEMERGENCE APPLICATIONS" section). A methylated seed oil at 1% v/v is the recommended spray adjuvant except when treating seedling prairiegrasses and wildflowers. When making spot applications, spray coverage should be sufficient to moisten the leaves of the target vegetation, but not to the point of run-off. See section on desired species and do not exceed the recommended **PLATEAU** rate per acre. Also see "WEEDS CONTROLLED" and "SPECIAL WEED CONTROL" sections for specific rate and/or tank-mix recommendations.

AERIAL APPLICATION:

All precautions should be taken to minimize or eliminate spray drift. Fixed wing aircraft and helicopters can be used to apply **PLATEAU**, however, when making applications by fixed wing aircraft maintain appropriate buffer zones to prevent spray drift out of the target area. Aerial equipment designed to minimize spray drift such as a helicopter equipped with a MICROFOIL™ boom, or THRU-VALVE™ boom or raindrop nozzles, must be used and calibrated. Except when applying with a MICROFOIL boom, a drift control agent may be added at the recommended label rate. To avoid drift, applications should not be made during inversion conditions, when winds are gusty, or under any other conditions that promote spray drift.

Uniformly apply recommended amount of **PLATEAU**, using enough water volume to provide adequate coverage of target area or foliage. Include an adjuvant in the spray solution (see "SPRAY ADJUVANTS FOR POSTEMERGENCE APPLICATIONS" section). A foam reducing agent may be added at the recommended rate, if needed. Aerial application to target species growing under the canopy of trees and brush may not receive sufficient spray coverage for effective control. For weed species with a recommended fall application timing (see "SPECIAL WEED CONTROL" section), delaying the aerial application until trees and brush have dropped their leaves can improve weed control and reduce the potential for tree and brush injury (see "TOLERANCE OF TREES AND BRUSH TO **PLATEAU** HERBICIDE" section).

IMPORTANT: Thoroughly clean application equipment, including landing gear, immediately after use of this product. Prolonged exposure of this product to uncoated steel (except stainless steel) surfaces may result in corrosion and failure of the exposed part. The maintenance of an organic coating (paint) may prevent corrosion.

Avoid overlaps when spraying.

SPRAY ADJUVANTS FOR POSTEMERGENCE APPLICATIONS

Postemergence applications of **PLATEAU** require a spray adjuvant. See "SPECIAL WEED CONTROL" section. Due to variations in surfactant contents, certain surfactants containing high amounts of alcohols, paraffin based petroleum oils, and other compounds which can increase phytotoxicity to desirable vegetation, it is recommended to choose a low phytotoxic surfactant.

Methylated Seed Oils or Vegetable Oil Concentrates: Instead of a surfactant, a methylated vegetable-based seed oil concentrate containing 5 to 20% surfactant and the remainder methylated vegetable oil is the preferred adjuvant for use with PLATEAU herbicide and may be used at the rate of 1.5 to 2 pints per acre. Methylated seed oils provide their greatest effects at 30 GPA or less. At spray volumes above 50 GPA, their advantage appears negated. When using spray volumes greater than 30 gallons per acre methylated seed oil or vegetable based seed oil concentrates should be mixed at a rate of 1% of the total spray volume or alternatively use a nonionic surfactant as described below. Research indicates these oils may aid in deposition and uptake of **PLATEAU** for hard-to-control perennials, waxy leaf species or when plants are under moisture or temperature stress. **DO NOT** use a methylated seed oil or vegetable oil concentrate when making applications to newly emerged seedling prairiegrasses or wildflowers as injury may occur.

Nonionic Surfactants: Use a nonionic surfactant at the rate of 0.25% v/v or higher (see manufacturer's label) of the spray solution (0.25% v/v is equivalent to 1 quart in 100 gallons). For best results, select a nonionic surfactant with a HLB (hydrophilic to lipophilic balance) ratio between 12 and 17 and having at least 60% surfactant in the formulated product (alcohols, fatty acids, oils, ethylene glycol or diethylene glycol should not be considered as surfactants to meet the above requirements). Nonionic surfactants are the preferred adjuvant for use with PLATEAU herbicide in bermudagrass pastures and hay meadows.

Silicone-Based Surfactants: See manufacturer's label for specific rate recommendations. Silicone-based surfactants may reduce the surface tension of the spray droplet allowing greater spreading on the leaf surface as compared to conventional nonionic surfactants. However, some silicone-based surfactants may dry too quickly, limiting herbicide uptake and higher spray volumes may exhibit "run-off".

Fertilizer/Surfactant Blends: Nitrogen-based liquid fertilizers such as 28%N, 32%N, 10-34-0, or ammonium sulfate, may be added at the rate of 2 to 3 pints per acre in combination with the recommended rate of nonionic surfactant or methylated seed oil. Research indicates that nitrogen based fertilizers aid in the burndown of annual weeds and increase **PLATEAU** uptake through waxy leaf species. However, fertilizers may increase phytotoxicity to desired species and newly emerged seedling prairiegrasses and wildflowers. The use of liquid fertilizers at a rate of 2 to 3 pints per acre in a tank-mix without a nonionic surfactant or a methylated seed oil is not recommended and may result in herbicide failure. Only when liquid fertilizer is used as the spray carrier is no additional spray adjuvant required.

TANK MIXES

For use in noncrop areas, **PLATEAU** may be tank-mixed with PENDULUM® herbicide for additional control of late season annual grasses and certain broadleaves. For additional weed control in noncrop areas, **PLATEAU** may be tank-mixed with ACCORD®, ROUNDUP® PRO, glyphosate, ARSENAL® herbicide, SAHARA® DG herbicide, diuron, CAMPAIGN®, FINALE®, GARLON™ 3A, MSMA, VANQUISH®, OUST®, ESCORT®, TORDON®, or other labeled products. A compatibility test is advised for products not listed. 2,4-D and other phenoxy type herbicides have resulted in reduced control of perennial grass weeds.

For tank mix recommendations for use in bermudagrass pastures, refer to the "DIRECTIONS FOR USE IN BERMUDAGRASS PASTURES AND HAY MEADOWS" section.

DO NOT tank mix with organophosphate insecticides or use the same year as **PLATEAU** when making applications to newly planted areas.

Consult manufacturer's labels for specific rates and weeds controlled. Always follow the more restrictive label when making an application involving tank-mixes.

FOR WEED CONTROL IN PASTURE AND RANGELAND

For the control of undesirable weeds in pasture and rangeland (see "GUIDELINES FOR RANGELAND USE" section), apply **PLATEAU** at 2 to 12 oz. per acre as a broadcast treatment or as a 0.25% to 1% solution with 1.0% MSO for spot treatments. See appropriate sections of this label for specific use directions.

GUIDELINES FOR RANGELAND USE

PLATEAU may be applied to rangeland for the control of undesirable vegetation in order to achieve one or more of the following vegetation management objectives:

1. The control of undesirable (non-native, invasive and noxious) plant species.
2. The control of undesirable vegetation in order to aid in the establishment of desirable rangeland plant species.
3. The control of undesirable vegetation in order to aid in the establishment of desirable rangeland vegetation following a fire.
4. The control of undesirable vegetation for purposes of wildfire fuel reduction.
5. The release of existing desirable rangeland plant communities from the competitive pressure of undesirable plant species.

6. The control of undesirable vegetation for purposes of wildlife habitat improvement.

To ensure the protection of threatened and endangered plants when applying **PLATEAU® herbicide** to rangeland:

1. Federal agencies must follow NEPA regulations to ensure protection of threatened and endangered plants.
2. State agencies must work with the Fish and Wildlife Service or the Service's designated state conservation agency to ensure protection of threatened and endangered plants.
3. Other organizations or individuals must operate under a Habitat Conservation Plan if threatened or endangered plants are known to be present on the land to be treated.

Please see the appropriate section(s) of this label for specific use directions for the desired rangeland vegetation management objective.

PLATEAU should only be applied to a given rangeland acre as specific weed problems arise. For the control of annual weed species such as cheatgrass, downy brome and medusahead rye, a single application of **PLATEAU** that coincides with the successful establishment and/or release of desirable rangeland vegetation and the use of available IPM can provide effective, sustainable control of the annual weed problem. For difficult to control perennial weed species such as leafy spurge, dalmatian toadflax and Russian knapweed, a single broadcast application of **PLATEAU** should be effective in most cases. If needed, spot treatments with **PLATEAU** can be used to control any remnant plants or new seedlings that may emerge. Long term control of undesirable weed species ultimately depends on the successful use of land management practices that promote the growth and sustainability of desirable rangeland plant species.

DIRECTIONS FOR USE IN BERMUDAGRASS PASTURES AND HAY MEADOWS

PLATEAU may be used postemergence at a rate of 4 to 12 oz per acre for control of undesirable winter and summer annual and perennial grasses in bermudagrass pastures and hay meadows (see rate and timing recommendations below). **PLATEAU** may be used on common and coastal varieties of bermudagrass including, but not restricted to Tifton 44, 78 and 85, Alicia and Russell. Suppression of bermudagrass growth for 30 to 45 days or longer may occur, depending upon growth conditions after application. Jiggs bermudagrass in particular has shown greater sensitivity to **PLATEAU**. Do not use **PLATEAU** if this growth response is not acceptable.

In bermudagrass pastures and hay meadows, even and thorough spray coverage is necessary to achieve the desired level of weed control. To ensure proper spray coverage, the sprayer must be calibrated to deliver the recommended spray volume and pressure and the spray boom height adjusted to ensure proper coverage of weed foliage (according to the manufacturer's recommendation). The use of boomless or flood type nozzles is not recommended and may result in decreased weed control.

DO NOT apply **PLATEAU** to drought stressed bermudagrass.

DO NOT use **PLATEAU** for the establishment of sprigged or seeded bermudagrass.

DO NOT use **PLATEAU** on World Feeder varieties of bermudagrass.

DO NOT apply **PLATEAU** during transition from dormancy to full green-up.

AVOID applications of **PLATEAU** to newly aerated fields for 30 days after aeration.

Spring Applications and Bermudagrass Tolerance: Spring application of **PLATEAU** should only be made after bermudagrass has reached 100% green-up. **PLATEAU** applications to bermudagrass during transition from winter dormancy to 100% green-up will significantly delay green-up and growth of bermudagrass, resulting in the potential loss of one or more cuttings. Bermudagrass can be considered to have reached 100% green-up only when all stolons (runners) have developed new active growth. Partial green-up may be characterized by the green appearance of new bermudagrass growth in the field, but upon close inspection some of the stolons may not have begun to grow. **PLATEAU** applications made at this time can still cause significant reductions in bermudagrass growth and development and should be delayed until 100% green-up. To minimize bermudagrass response from spring applications, all applications should be made postemergence to the targeted summer annual or perennial weeds. See specific use directions below for appropriate postemergence timing for targeted weed species.

General rate recommendations: Most annual and some perennial weeds in bermudagrass pastures and hay meadows can be controlled with postemergent application of PLATEAU herbicide at 4 to 6 oz per acre. For early applications when target weeds are small and have not been subjected to multiple cuttings, the lower recommended rate should be used. For later applications as target weeds become older, larger or have been subjected to multiple cuttings, then the higher recommended rate should be used. Read and follow the specific rate recommendations below for the individual weed species.

Postemergent Control of Summer Annual and Perennial Grass Weeds: Apply **PLATEAU** after bermudagrass has reached full green-up and target grass weeds are at the desired growth stage (see recommended rates and growth stages below). Early Spring applications made during transition from dormancy to green-up will delay bermudagrass green-up and subsequent bermudagrass growth. Recommended **PLATEAU** applications may cause some stolon internode shortening and yellowing of the bermudagrass. The use of a nitrogen fertilizer (32-0-0 or 28-0-0) as the spray carrier will shorten recovery time.

For summer annual grass control apply 4 to 6 oz per acre of **PLATEAU** early postemergence (2 to 4 leaf stage) following full bermudagrass green-up. If target weeds are at or above boot stage, apply 6 to 8 oz per acre for control. Always add a surfactant when applying **PLATEAU** unless liquid fertilizer is being used as the spray carrier. **PLATEAU** will provide some preemergence annual grass control, however initial applications need to be made postemergence to target weed species.

For summer perennial grass control apply 6 to 12 oz per acre of **PLATEAU** postemergence following bermudagrass green-up. If higher rates (8 to 12 oz per acre) are needed for control of target species, **PLATEAU** can be applied in the fall before killing frost occurs. When making a fall application, if bermudagrass has been cut for hay, allow sufficient regrowth of target species before making application. Always add a surfactant when applying **PLATEAU** unless liquid fertilizer is being used as the spray carrier.

Postemergent Control of Winter Annual and Perennial Grass Weeds: Apply PLATEAU herbicide when bermudagrass is dormant prior to green-up. If bermudagrass has green tissue at the root crown or stolons, applications of PLATEAU may delay green-up of bermudagrass and subsequent bermudagrass growth. During mild winters, bermudagrass in the deep South may not be completely dormant. Applications in these areas should be avoided if delayed green-up cannot be tolerated.

For winter annual and perennial grass control, apply 6 to 12 oz per acre of PLATEAU postemergent, when bermudagrass is dormant. The addition of 16 to 24 oz per acre of ROUNDUP® ULTRA or glyphosate equivalent will increase control of larger winter annual and cool season perennial grasses. Always add a surfactant when applying PLATEAU herbicide unless liquid fertilizer is being used as the spray carrier.

Recommended PLATEAU Herbicide Rates for Postemergent Summer Annual Grass Control

Common Name	Genus Species	Weed Height (inches)[1]	Rate per Acre (fluid oz)
Large Crabgrass	*Digitaria sanguinalis*	≤4	4
		>4	6
Southern Crabgrass	*Digitaria ciliaris*	≤4	4
		>4	6
Smooth Crabgrass	*Digitaria ischaemum*	≤4	4
		>4	6
Giant Foxtail	*Setaria faberi*		6
Green Foxtail	*Setaria viridis*	≤4	4
		>4	6

Recommended PLATEAU® Herbicide Rates for Postemergent Summer Annual Grass Control (CONT:)

Common Name	Genus Species	Weed Height (inches)[1]	Rate per Acre (fluid oz)
Yellow Foxtail	*Setaria glauca*	≤4	4
		>4	6
Texas Panicum	*Panicum texanum*		6
Fall Panicum	*Panicum dichotomiflorum*		6
Broadleaf Signalgrass	*Bracharia platyphylla*	≤4	4
		>4	6
Annual Jewgrass	*Microstegium vimineum*	≤4	4
		>4	6
Barnyardgrass	*Echinchloa crus-galli*	≤4	4
		>4	6
Sandbur	*Cenchrus* spp.	≤4	4
		>4	6

[1] Summer annual grasses that are older, larger or have been subjected to multiple cuttings should be treated with the higher rate.

Applications made to summer annual grasses should be done after bermudagrass green-up. Applications of **PLATEAU® herbicide** made during bermudagrass transition will delay green up and subsequent bermudagrass growth. Avoid applications to bermudagrass during green-up transition if delayed green-up cannot be tolerated.

Recommended PLATEAU Herbicide Rates for Postemergent Summer Perennial Grass Control

Common Name	Genus Species	Weed Height (inches)[1]	Rate per Acre (fluid oz)
Johnsongrass	*Sorgham halepense*	18-24	8
		>24	12
Vaseygrass	*Paspalum urvillei*	4-8	6-8
Nutsedge	*Cyperus* spp.	≤4	4
		>4	6
Bahiagrass	*Paspalum notatum*	4-8	6-8
Dallisgrass[2]	*Paspalum dilatatum*	4-8	8-12
Smutgrass[2]	*Sporobolus indicus*	4-8	8-12

[1] Summer annual grasses that are older, larger or have been subjected to multiple cuttings should be treated with the higher rate.

[2] Suppression

Recommended PLATEAU Herbicide Rates for Postemergent Winter Annual and Cool Season Perennial Grass Control

Common Name	Genus Species	Weed Height (inches)[1]	Rate per Acre (fluid oz)
Annual Ryegrass*	*Lolium multifloru*	≤6	6
		>6	10
Tall Fescue	*Festuca arundinacea*	-	12
Wild Oats	*Avena fatua*	≤6	6
		>6	10
Little Barley	*Hordeim pusilium*	≤6	4
		>6	6

*AHAS and ALS resistant annual ryegrass has been documented across the Southeastern United States. To minimize this problem, tank mix 16 to 24 oz per acre of ROUNDUP® ULTRA or glyphosate equivalent when making applications to annual ryegrass.

Spray Adjuvants: The addition of 10 to 20 gallons per acre of 32-0-0 or 28-0-0 liquid fertilizer as part of the spray carrier will promote the recovery of the bermudagrass from any growth reduction caused by the herbicide application. No additional spray adjuvant is required if liquid fertilizer is used as the spray carrier.

See "SPRAY ADJUVANTS FOR POSTEMERGENCE APPLICATIONS" section for additional spray adjuvant recommendations.

DO NOT use crop oil concentrates (COC) as spray adjuvant for control of weeds with **PLATEAU**.

Tank Mixtures: For broadleaf weed control the addition of a broadleaf herbicide such as WEEDMASTER® is recommended. **PLATEAU** may also be tank mixed with GRAZON® , REMEDY® , REDEEM® , ALLY® , 2,4-D and ROUNDUP® ULTRA or glyphosate equivalent. Applications with tank mixes of 2,4-D that exceed 1 pound active ingredient per acre and applications with tank mixes of triclopyr amine that exceed 1.5 pounds active ingredient per acre may reduce efficacy on target grass weed species.

USE OF PLATEAU HERBICIDE ON FEDERAL CONSERVATION RESERVE PROGRAM (CRP) LAND

PLATEAU may be used on Federal Conservation Reserve Program (CRP) land at rates up to 12 oz. per acre per year (see minimum plant-back intervals below). See appropriate section of this label for specific instructions for the intended use.

ROTATIONAL CROP RESTRICTIONS

The following rotational crops may be planted after applying **PLATEAU**. Planting rotational crops earlier than the recommended interval may result in crop injury.

Plateau Use Rate (oz/A)	Minimum Plant Back Interval (Months After PLATEAU Herbicide Application)				
≤4	12	12	18	26	40
5-8	12	14	22	30	44
9-12	12	18	24	36	48
Rotational Crops	Bahiagrass CLEARFIELD® corn hybrids Peanuts Rye Wheat	Snapbeans Southern peas Soybeans Tobacco	Barley Cotton[1] Grain sorghum Oats	Field corn[2] All crops not otherwise listed or included for use on this label[2]	Canola[2] Potatoes[2] Red table beets[2] Sugar beets[2]

[1] **For Arizona, New Mexico, Oklahoma, and Texas only:** Depending on the **PLATEAU** use rate, cotton may be planted 18 to 24 months after **PLATEAU** application in the states of Arizona, New Mexico, Oklahoma, and Texas unless drought conditions develop the year of **PLATEAU** application. DO NOT rotate to cotton at 18 to 24 months after **PLATEAU** application if less than 15 inches of rainfall or irrigation is received from the time of **PLATEAU** application through November 1 of the same year. If drought conditions develop the year of **PLATEAU** application, cotton may be planted 26, 30 and 40 months after **PLATEAU** application.

[2] After the recommended rotational interval listed for these selected crops and for all crops not otherwise listed or included for use on this label, a successful field bioassay must be completed. The field bioassay consists of a test strip of the intended rotational crop planted across the previously treated field and grown to maturity. The test strip should include low areas and knolls, and include variations in soil such as type and pH. If no crop injury is evident in the test strip, then the intended rotational crop may be planted the following year.

Use of **PLATEAU** in accordance with label directions is expected to result in normal growth of plant-back crops in most situations; however, various environmental and agronomic factors make it impossible to eliminate all risks associated with the use of this product and, therefore, plant-back crop injury is always possible. If crop injury is a concern then a bioassay with the desired crop is recommended prior to planting.

FOR FOLIAR AND SEEDHEAD SUPPRESSION OF BAHIAGRASS, COOL SEASON GRASSES AND SUPPRESSION OF SOME ANNUAL WEEDS

Bahiagrass: PLATEAU may be used at the rate of 2 to 6 oz per acre to suppress growth and seedhead development of bahiagrass in

unimproved areas. In North and South Carolina it is recommended to use **PLATEAU ® herbicide** at the rate of 2 oz per acre as higher rates may cause turf thinning. Depending on rate of **PLATEAU** used, surfactant and environmental conditions, temporary turf discoloration may occur. For optimum performance, application should be made after green-up. Applications may be made before or after mowing. If applied prior to mowing, raise mowing height to leave adequate existing foliage as new growth will be suppressed. If applied after mowing, allow adequate foliage to remain by increasing mower height or allowing time for foliar regrowth prior to application. **DO NOT** apply to turf under stress (drought, cold, insect, disease, etc.) or severe injury may occur. **DO NOT** use a methylated seed oil adjuvant.

PLATEAU	PHYTOTOXICITY	LENGTH OF SUPPRESSION
2 oz	none to low	partial to season long
3 to 6 oz	low to moderate	season long

For winter annual weed control, apply 8 oz of **PLATEAU** when bahiagrass is dormant, but when weeds are actively growing. This can be followed by 3 to 4 oz of **PLATEAU** in the spring after bahiagrass green-up for the suppression of seedheads and foliage.

Cool Season Grasses:

KY31 Tall Fescue and "Wildtype Common" Kentucky Bluegrass: Apply **PLATEAU** at 2 to 4 oz per acre for foliar and seedhead suppression of certain cool season grasses such as "KY31" tall fescue and "wildtype common" Kentucky bluegrass. Do not use a methylated seed oil adjuvant. Add a surfactant to the 2 oz rate of **PLATEAU** for optimum performance. The addition of a surfactant to 4 oz of **PLATEAU** may cause excessive turf injury or mortality of tall fescue. Application to turf type tall fescue or Kentucky bluegrass may result in severe injury or loss of stand.

Wheatgrass: Apply **PLATEAU** at 6 to 10 oz. per acre for foliar and seedhead suppression of crested wheatgrass, and 6 to 12 oz. per acre for foliar and seedhead suppression of intermediate wheatgrass. Other wheatgrass species may also be suppressed, however, apply **PLATEAU** to a limited area to determine effectiveness. Tank-mixes with 2,4-D or products containing 2,4-D may decrease the effectiveness of **PLATEAU**. Tank-mixes with GARLON®, TORDON®, TRANSLINE™ and VANQUISH® may decrease the potential of turf injury. DO NOT apply to turf under stress or severe injury may occur.

FOR THE CONTROL OF UNDESIRABLE WEEDS IN BERMUDAGRASS NOT BEING GROWN FOR FORAGE OR HAY

PLATEAU may be used on bermudagrass turf such as roadsides, utility rights-of-way, railroad crossings, airports, non-irrigation drainage ditches and other noncropland sites. There is a differential tolerance between bermudagrass types (see below paragraphs). Depending on bermudagrass type, timing of application, and **PLATEAU** rate, some foliar, stolon, and seedhead suppression may occur. IMPORTANT: Apply **PLATEAU** after bermudagrass has reached full green-up. Spring applications made prior to full green-up may delay green-up. Always add a surfactant when applying **PLATEAU**. DO NOT apply to grass under stress from drought, disease, insects or other causes. Simultaneous mow/spray operations may suppress internode development. After mowing, allow adequate foliage regrowth prior to **PLATEAU** application as some internode suppression may prevent bermudagrass from quickly recovering from mowing.

Common Bermudagrass: Common bermudagrass is the most tolerant bermudagrass to **PLATEAU**. Tank-mixes with ROUNDUP PRO, ACCORD or glyphosate will improve the weed control spectrum, but may increase turf phytotoxicity. Some stolon internode shortening and seedhead suppression may occur for the first 8 weeks.

Established Coastal Bermudagrass: PLATEAU at 2 to 12 oz per acre will provide control of labeled weeds as well as foliar and seed head suppression of established coastal bermudagrass. Do not use on World Feeder varieties of bermudagrass. Depending on environmental conditions and weed pressure, the longevity of suppression and weed control increases as the **PLATEAU** rate increases. Tank-mixes with ROUNDUP PRO, ACCORD, or glyphosate may result in death or excessive injury of coastal bermudagrass.

Turf Type Bermudagrass: Turf type bermudagrass varieties show a high degree of variation in tolerance to **PLATEAU**. **PLATEAU** at rates of 2 to 6 oz per acre will provide some annual weed control and foliar & seedhead suppression. Rates above 6 oz per acre may result in excessive injury or death of turf type bermudagrass.

SEE ABOVE SECTIONS FOR PLATEAU HERBICIDE RATES AND TIMINGS FOR SPECIFIC BERMUDAGRASS TYPES WITH REGARD TO WEED CONTROL AND TURF TOLERANCE.

Winter Annual Weed Control: Apply **PLATEAU® herbicide** at the rate of 4 to 12 oz. per acre prior to winter weed germination or while winter weeds are actively growing. Early spring applications may delay green-up of bermudagrass turf.

Summer Annual Weeds: For best results, apply **PLATEAU** at the rate of 4 to 12 oz per acre preemergence or early postemergence before weeds have reached 6 inches in height. Larger weeds may be controlled depending on susceptibility, growing conditions, tank-mix partner and adjuvant selection.

Perennial Weeds: Apply **PLATEAU** at the rate of 8 to 12 oz per acre postemergence after weeds have produced adequate foliage for herbicide uptake. For a particular weed see "SPECIAL WEED CONTROL" section below. The addition of ACCORD or ROUNDUP PRO herbicide may increase control.

Bahiagrass Control: Apply **PLATEAU** at the rate of 8 to 12 oz per acre postemergence. See "SPECIAL WEED CONTROL" section below for recommendations. The addition of ROUNDUP PRO or ACCORD herbicide at 12 to 16 oz per acre may increase control.

FOR THE CONTROL OF UNDESIRABLE WEEDS IN UNIMPROVED CENTIPEDE GRASS

PLATEAU may be applied at a rate of 4 to 8 oz per acre to established centipede grass for the control of annual broadleaf and grass weeds. Apply **PLATEAU** after centipede grass has reached full green-up. Spring applications made prior to full green-up may delay green-up. Always add a surfactant when applying **PLATEAU**. DO NOT apply to grass under stress from drought, disease, insects or other causes. Simultaneous mow/spray operations may suppress internode development. After mowing, allow adequate foliage regrowth prior to **PLATEAU** application as some internode suppression may prevent centipede grass from quickly recovering from mowing.

FOR CONTROL OF UNDESIRABLE WEEDS IN SMOOTH BROMEGRASS, WILDTYPE COMMON KENTUCKY BLUEGRASS AND WHEATGRASSES

PLATEAU may be used on smooth bromegrass, "wildtype" common Kentucky bluegrass and wheatgrass. **PLATEAU** provides control of labeled grass and broadleaf weeds (see "WEEDS CONTROLLED" and "SPECIAL WEED CONTROL" sections). Treatment of smooth bromegrass and wheatgrass with **PLATEAU** may result in foliar height and seedhead suppression.

Smooth Bromegrass and "Wildtype" Common Kentucky Bluegrass: Use **PLATEAU** at 4 to 8 oz per acre in the spring for weed control and growth suppression after smooth bromegrass and "wildtype" common Kentucky bluegrass have reached 100% green-up. Applications prior to 100% green-up may delay green-up. Rates from 8 to 12 oz per acre may be applied in the spring but may result in excessive growth suppression. For fall applications (see "SPECIAL WEED CONTROL" section), **PLATEAU** may be used at 8 to 12 oz per acre for control of perennial weeds.

Wheatgrass: To control undesirable weeds in wheatgrasses apply **PLATEAU** at 4 to 12 oz. per acre.

FOR CONTROL OF UNDESIRABLE WEEDS IN CROWN VETCH

PLATEAU may be applied at the rate of 4 oz per acre to newly seeded crown vetch beds to aid in the establishment of vetch and reduce weed competition.

PLATEAU at 8 to 12 oz per acre may be used on unimproved established crown vetch in noncropland areas. **PLATEAU** provides control of labeled grass and broadleaf weeds (refer to the "WEEDS CONTROLLED" and "SPECIAL WEED CONTROL" sections for specific rates). Treatment of crown vetch beds with **PLATEAU** may

cause internode shortening and some minor tip chlorosis depending on timing of application.

PLATEAU® herbicide should be applied during winter dormancy or early spring to reduce potential injury. Applications made after May, may result in increased injury or defoliation. Addition of surfactants such as dilimenene based or crop oil concentrates will increase injury. Fall applications during the period of active crown vetch growth may result in severe injury or loss of stand.

PLATEAU may be applied at the rate of 2 to 12 oz per acre to newly established or existing stands of labeled species (see below for details) in such areas as pasture, rangeland (see "GUIDELINES FOR RANGELAND USE" section), Conservation Reserve Program (CRP) land and noncropland sites such as roadsides, industrial sites, prairie restoration sites, drainage ditch banks, and other similar areas. Certain local ecotypes or varieties may be suppressed by **PLATEAU**. Many factors such as poor seedling vigor, cool temperatures, poor soil, planting depth, excessive moisture, disease, insects and dry weather after emergence can all result in poor stands. Additional stress of herbicide residue, poor soils and other factors contributing to poor seedling vigor can also increase injury and could result in mortality. BASF can not be held responsible for such unforeseen factors. It is suggested to try **PLATEAU** on a small area if tolerance is not known. **PLATEAU** controls many annual and perennial grass and broadleaf weeds. Weed competition is reduced allowing grass seedlings to establish. **PLATEAU** is also effective for control of noxious weeds in established grass stands and must be applied postemergence as a foliar treatment to perennial weeds. IMPORTANT: ALWAYS ADD AN ADJUVANT when applying **PLATEAU**. To maximize weed control always use a methylated seed oil when treating established grass stands. Use a nonionic surfactant when treating newly emerged seedling grasses. The addition of liquid fertilizer will decrease grass tolerance and should not be used when treating newly emerged seedling grasses.

PLATEAU may be applied at a rate of up to 12 oz per acre to Federal Conservation Reserve Program (CRP) land for the establishment or release of certain grass species (see "TOLERANT GRASS SPECIES" table).

Establishment: For optimum results in establishing mixed grass stands with **PLATEAU**, make application at planting before grass seedlings emerge. Newly emerged grasses can be sensitive to **PLATEAU** and/or the adjuvant used. If grasses have begun to emerge, it is best to wait until they have reached the five leaf stage to make a **PLATEAU** application and use a nonionic or silicone surfactant. Do not use a methylated seed oil at this time as some grass species tolerance will be lost. **PLATEAU** will control annual weeds preemergence or early postemergence. See "WEEDS CONTROLLED" section for maximum height of weeds and see below for more details on best rate and timing for grass and wildflower species. Postemergence applications may result in stand thinning due to variability in seedling grass tolerance to the use of spray adjuvants. Seedling grasses are generally more tolerant to the use of spray adjuvants after they have reached the five leaf stage. When planting into a field which was row cropped the previous year, compounded injury may occur from herbicide carry-over (see "DIRECTIONS FOR USE" section).

Rates and Control: Apply **PLATEAU** at 2 to 6 oz per acre to fields cropped the previous year, when annual weeds are the target and/or if grass/forb mixtures are used. **PLATEAU** at 2 to 6 oz per acre will provide control and/or suppression of many annual grass and broadleaf weeds. Use lower rates when in the northern most U.S., dry climates or for late season plantings into clean seedbeds. **PLATEAU** rates as low as 2 oz. per acre may be used on soils with a pH > 7, a low CEC and a course texture containing a minimum of clay and organic matter. Use higher rates in heavy weed pressure, heavy residue, high organic matter, high rainfall and long growing season (southern portions of Illinois, Indiana, Missouri and Ohio, etc.). Apply **PLATEAU** at 8 to 12 oz per acre for giant ragweed or for perennial weed control/suppression. **PLATEAU** rates of 8 to 12 oz per acre may result in stunting or stand thinning. The duration and intensity of suppression are directly related to weed pressure, chemical residue, soil type and environmental conditions. See below for details for particular grass tolerances and timings.

Established Stands: For optimum results, apply **PLATEAU** as an early postemergence application to annual grasses and broadleaf weeds. For perennial weed control, see "SPECIAL WEED CONTROL" section. The use of high rates may result in foliar and/or seed head height suppression of established grass stands. This effect is more likely to occur under conditions of light soils, low weed pressure, low rainfall, and short growing seasons. Use the lower rates for light weed infestations or when applying to grass stands containing desirable wildflowers and legumes (see "WILDFLOWER ESTABLISHMENT AND MAINTENANCE" section for rate tolerance). Use higher rates to broaden and lengthen weed control spectrum.

Big Bluestem, Little Bluestem and Indiangrass: PLATEAU® herbicide may be applied at the rate of 2 to 12 oz per acre at planting, or any time thereafter, including after seedling grasses have emerged or to perennial stands (dormant or actively growing). See "WEEDS CONTROLLED" section for desired rate. Use the lower rates in Wisconsin, Michigan, Minnesota, South Dakota, North Dakota, Kansas, Oklahoma, Texas and Nebraska and higher rates as rainfall and/or growing season increases.

Switchgrass (*Panicum virgatum*): PLATEAU is not recommended for the establishment of pure switchgrass stands as severe injury or death may result. **PLATEAU** may be applied at a rate of 2 to 4 oz per acre if switchgrass is planted in mixed stands with tolerant species, but only if some stand thinning or loss of stand can be tolerated. Mature switchgrass planting can be reclaimed from certain perennial weeds such as tall fescue, leafy spurge, johnsongrass, etc., with **PLATEAU** at rates of 10 to 12 oz per acre. However, severe stunting and injury is imminent. DO NOT apply **PLATEAU** to switchgrass if such severe injury can not be tolerated.

Sideoats and Blue Grama: Apply **PLATEAU** to monoculture stands of sideoats and blue grama only if some stand thinning or loss of stand can be tolerated. **PLATEAU** may be applied at the rate of 2 to 4 oz/A plus an adjuvant to aid in the establishment of sideoats and blue grama after new seedlings have emerged and reached the five (5) leaf stage. When using **PLATEAU** at 4 oz per acre it is not recommended to use in combination with a methylated seed oil adjuvant as stand thinning may occur. The lower rates may provide adequate weed suppression in early summer plantings in the states of Wisconsin, Michigan, Minnesota, South Dakota, North Dakota, Kansas, Oklahoma, Texas and Nebraska and other states where growing degree days are short. Sideoats and blue grama have shown tolerance to **PLATEAU** at 2 to 4 oz/A, applied preemergence at planting, however, some stand thinning may occur. For weed control in established stands use 4 to 10 oz/A of **PLATEAU**. Up to 12 oz/A of **PLATEAU** may be applied, but may result in foliar and/or seedhead suppression, or in the injury of sideoats and blue grama, depending on surfactant choice, soil type, variety, weed pressure and environmental conditions.

Buffalograss: Apply **PLATEAU** at the rate of 2 to 4 oz/A for control or suppression of labeled weeds and to aid in the establishment of newly sprigged buffalograss. Apply **PLATEAU** immediately after planting prior to spring growth or seed germination. New growth and small seedlings can be severely injured or killed. If applying after emergence it is best to wait until buffalograss has at least five true leaves and use a nonionic or silicone surfactant. Do not use a methylated seed oil. For established stands, **PLATEAU** may be applied at the rate of 2 to 8 oz/A for weed control. Higher rates may cause some turf discoloration and stunting. **PLATEAU** may be applied to dormant buffalograss to control winter annual weeds. Turf type buffalograss may express different tolerance level to **PLATEAU** than wild type buffalograss. Some turf types can tolerate low rates of **PLATEAU** at seeding. Consult seed dealer for details.

Eastern Gamagrass: PLATEAU should only be used for the establishment or maintenance of eastern gamagrass if some stand thinning or loss can be tolerated. Apply **PLATEAU** at 2 to 6 oz per acre at planting prior to gamagrass emergence. Stand thinning and stunting is imminent. Adverse conditions, poor soils, or added stress to the gamagrass could result in stand mortality. Postemergence application to seedlings will cause mortality. On established eastern gamagrass, apply **PLATEAU** at 2 to 8 oz per acre prior to gamagrass breaking dormancy. Some stunting will occur and increases as the **PLATEAU** rate increases. Applications made during or after green-up may result in foliar and seedhead suppression and possible mortality of weak plants.

Tall Fescue Control: Tall fescue can be controlled by using **PLATEAU** at the rate of 12 oz per acre plus methylated seed oil at 2 pints per acre in established stands of or to prepare a seed bed for big bluestem, little bluestem, and indiangrass. The addition of nitrogen fertilizer (see "SPRAY ADJUVANTS FOR POSTEMERGENCE APPLICATIONS" section) to the above mix will aid in control. Tall fescue must be actively growing for optimum control. If tall fescue has reached the boot stage or has reached summer dormancy, control may be poor. For improved control of tall fescue, **PLATEAU** may be tank mixed with ACCORD®, ROUNDUP® PRO, or glyphosate. Fall

applications of **PLATEAU® herbicide** at 8 to12 oz/A plus 24 to 64 oz/A ACCORD® or ROUNDUP® PRO will result in best control of existing tall fescue and new germinating seedlings. With spring applications of **PLATEAU** at 6 to 12 oz/A, plus a ACCORD® or ROUNDUP® PRO at 32 to 64 oz/A, use higher rates for older, mature fescue stands and lower **PLATEAU** rates when planting forbs. When using 8 oz/A of **PLATEAU** in the fall with a glyphosate product, it is recommended to apply 4 oz/A **PLATEAU** in the spring at planting for annual weed and seedling fescue control. Burning the fescue stand, where permitted, the following spring, just prior to green-up, will aid in control and provide a better seedbed for planting. Mowing the fescue several times the summer before fall application will weaken the fescue root system, making it more susceptible to herbicides. Always allow for at least 10 inches of regrowth, following the last mowing before spraying, as both **PLATEAU** and glyphosate products need foliage present for herbicide uptake and satisfactory control.

TOLERANT GRASS SPECIES[1]

Prairiegrass

Common Name	Genus species	Plateau herbicide Rate (oz/A)[2] New Seeding	Established
Big Bluestem	*Andropogon gerardii*	2-12	2-12
Little Bluestem	*Schizachyrium scoparium*	2-12	2-12
Indiangrass	*Sorghastrum nutans*	2-12	2-12
Bushy Bluestem	*Andropogon glomeratus*	—*	2-12
King Ranch Bluestem	*Bothriochloa ischaemum*	—	2-12
Silver Beard Bluestem	*Bothriochloa saccharoides*	—	2-12
Broomsedge	*Andropogon virginicus*	—	2-12
Fingergrass, Rhodes grass	*Choris* spp.	—	2-12
Needlegrass	*Stipa* spp.	—	2-12
Needleandthread	*Stipa comata*	—	2-12
Kearny (Plains) Threeawn	*Aristida longespica*	—	2-12
Prairie Threeawn	*Aristida oligantha*	—	2-12
Prairie Sandreed	*Calamovilfa longifolia*	—	2-12
Smooth Bromegrass	*Bromus inermis*	—	2-12
Kentucky Bluegrass	*Poa pratensis*	—	2-12[4]
Sandberg's Bluegrass	*Poa sandbergii*	—	2-12
Wheatgrasses	*Agropyron* spp.	—	2-12
Bottlebrush Squirreltail	*Sitanian hystrix*	—	2-12
Russian Wild Ryegrass	*Elymus junceus*	2-6[2]	2-12
Sideoats Grama	*Bouteloua curtipendula*	2-8[3]	2-8
Blue Grama	*Bouteloua gracilis*	2-8[3]	2-8
Buffalograss	*Buchloe dactyloides*	2-4	2-8
Eastern Gamagrass	*Tripsacum dactyloides*	2-6[3]	2-8

[1] See individual grass sections for application timing.

[2] High rates may result in stunting and growth suppression.

[3] **PLATEAU** preemergence applications to newly seeded sideoats, blue grama and Eastern gamagrass may result in thinning or loss of stand.

[4] Some bluegrass varieties are sensitive to PLATEAU herbicide. Drought can delay recovery and may result in overgrazing of treated area.

* Tolerance unknown

TOLERANCE OF ESTABLISHED GRASSES TO 8 TO 12 OZ/A OF PLATEAU APPLIED IN THE FALL

Grass Species[1]	Tolerant	Suppressed[2]	Not Tolerant	Tolerance Unknown
Bermudagrass	X			
Bluegrass, Kentucky		X		
Bluegrass, Sandberg's	X			
Bluestem, big	X			
Bluestem, bushy	X			
Bluestem, King Ranch	X			
Bluestem, little	X			
Bluestem, silver beard	X			
Bromegrass, meadow		X	X	

TOLERANCE OF ESTABLISHED GRASSES TO 8 TO 12 OZ/A OF PLATEAU APPLIED IN THE FALL (CONT):

Grass Species[1]	Tolerant	Suppressed[2]	Not Tolerant	Tolerance Unknown
Bromegrass, smooth		X		
Broomsedge	X			
Buffalograss	X	X		
Cheatgrass			X	
Creeping foxtail, Garrison				X
Downey brome			X	
Fescue, Idaho	X			
Fescue, tall			X	
Gamagrass, eastern		X		
Grama, blue	X	X		
Grama, sideoats	X	X		
Indiangrass	X			
Medusahead			X	
Needleandthread	X			
Needlegrass, green	X			
Orchardgrass		X		
Prairie cordgrass		X		
Prairie dropseed				X
Praire sandreed	X			
Praire threeawn	X			
Quackgrass		X		
Redtop		X	X	
Reed canarygrass		X	X	
Rhodes grass/Fingergrass	X			
Ryegrass, annual or Italian			X	
Ryegrass, perennial		X	X	
Squirreltail, bottlebrush	X			
Switchgrass		X	X	
Timothy			X	
Wheatgrass, bluebunch	X	X		
Wheatgrass, crested	X	X		
Wheatgrass, intermediate	X	X		
Wheatgrass, pubescent	X	X		
Wheatgrass, siberian	X			
Wheatgrass, slender	X	X		
Wheatgrass, stream-bank	X	X		
Wheatgrass, western	X	X		
Wild ryegrass, Basin	X			
Wild ryegrass, Canada		X		
Wild ryegrass, Russian	X			
Wild ryegrass, Virginia		X		

[1] Species with an X in more than one column means tolerance will vary depending on variety, use rate and environmental conditions.

[2] Suppression may be expressed as reduction in number of seedheads, seedhead height suppression or foliage height reduction; however, full recovery of the grass can be expected.

WILDFLOWER ESTABLISHMENT AND MAINTENANCE

Due to high degree of variation in genotypes, ecotypes and varieties of wildflowers, tolerances to **PLATEAU** can vary dramatically and may be reduced under certain soil types and environmental conditions. Apply **PLATEAU** only if some stand thinning or loss can be tolerated. Preemergence applications of low use rates (2 oz/A) to tolerant species, result in the least amount of injury, but may not eliminate it. Postemergence applications of **PLATEAU** can result in injury or death of some genotypes, and should be used only as a rescue treatment when weed competition threatens the stand. Use of certain spray adjuvants can also increase wildflower injury and loss of stand. Although most legumes listed in the tolerance table are tolerant to 4 oz/A of **PLATEAU** preemergence, some stand thinning

may occur. Legumes are more tolerant to post applications, but chlorosis or stunting is possible. Recommendations listed in the tables below are designed for mixed grass/wildflower stands. Less than satisfactory results may occur from applications to monoculture stands. It is recommended to try on a small scale to determine degree of satisfaction on monoculture stands.

For prairiegrass/wildflower mixtures: Where some wildflower injury (phytotoxicity, height suppression) can be tolerated, apply **PLATEAU® herbicide** at the rate to achieve desired weed control, but not to exceed tolerance rate listed in the table below. Wildflower injury can be reduced or eliminated with preemergence applications. To minimize injury, apply **PLATEAU** at 2 to 4 oz per acre at planting to tolerant species listed below. Use the 2 oz per acre rate under cool dry conditions and in low rainfall areas. If postemergence application is made to established prairiegrass/wildflower mixtures, use the lowest rate of **PLATEAU** necessary to achieve desired weed control (see "WEEDS CONTROLLED" section). Postemergence application can result in stand thinning or death due to vast variation in seed sources, varieties and genotypes. It is recommended that a small area be tested prior to full application for tolerance of desired species. The rates listed below are for those species in which acceptable tolerance has been confirmed on the varieties/genotypes being treated.

Application of **PLATEAU** in conjunction with an organophosphate insecticide may cause an increase in wildflower injury.

Seedling Wildflower and Legume Tolerance to PLATEAU (4 oz/A)[1] in Mixed Grass/Forb Stands.

Common Name	Genus Species	PRE	POST
Alfalfa	*Medicago sativa*	No	Yes
Aster, New England	*Aster novae angliae*	No	Yes
Aster, Prairie	*Aster tanacetifolius*	No	Yes
Baby Blue Eyes	*Nemophila menziestii*	No	Yes
Beggar ticks	*Bidens frondosa*	No	Yes
Bird's Eyes	*Gilia tricolor*	No	Yes
Bishop's Flower	*Anuni majus*	No	Yes
Blackeyed Susan	*Rudbeckia hirta*	Yes	Yes
Blanketflower	*Gaillardia aristata*	No	Yes
Bundleflower, Illinois	*Desmanthus illinoensis*	Yes	Yes
Catchfly	*Silene armeria*	No	Yes
Chicory	*Cichorium intybus*	Yes	Yes
Clover, Crimson	*Trifolium incarnatum*	Yes	Yes
Clover, White	*Trifolium repens*	No	Yes
Coneflower, Purple	*Echinacea purpurea*	Yes	Yes
Coneflower, Upright Prairie	*Ratibida columnifera*	Yes	Yes
Coreopsis, Dwarf Red Plains	*Coreopsis tinctoria* var. Gay Feather	Yes	Yes
Coreopsis, Lance Leaved	*Coreopsis lanceolata*	Yes	Yes
Coreopsis, Plains	*Coreopsis tinctoria*	Yes	Yes
Cornflower	*Centaurea cyanus*	No	Yes
Cosmos, Garden	*Cosmos bipinnatus*	Yes	Yes
Cosmos, Yellow	*Cosmos sulphureus*	Yes	Yes
Daisy, Ox-eye	*Chrysanthemum leucanthermum*	Yes	Yes
Daisy, Shasta	*Chrysanthemum maximum*	Yes	Yes
Five Spot	*Nemophila maculata*	No	Yes
Flax, Blue	*Linum perenne*	No	Yes
Indian Blanket	*Gaillardia pulchella*	No	Yes
Indigo, Blue False	*Baptisia australis*	Yes	No
Johnny Jump-ups	*Viola cornuta*	Yes	Yes
Lemon Mint	*Monarda citriodora*	No	Yes
Lespedeza, Bicolor	*Lespedeza*	Yes	Yes
Lespedeza, Korean	*Lespedeza stipulacea*	No	Yes
Lespedeza, Sericea	*Lespedeza cuneata*	No	Yes
Lupine, Perennial	*Lupinus perennis*	Yes	Yes
Mexican Hat	*Ratibida columnifera*	Yes	Yes
Partridgepea	*Cassia fasciculata*	Yes	Yes
Pea, Calico	*Pisum viganasinensis*	Yes	Yes

Seedling Wildflower and Legume Tolerance to PLATEAU (4 oz/A)[1] in Mixed Grass/Forb Stands.(CONT):

Common Name	Genus Species	PRE	POST
Pea, Flat	*Lathyrus sylvestris*	Yes	Yes
Pea, Perennial	*Lathyrus latifolius*	Yes	Yes
Phlox, Drummond	*Phlox drummondii*	Yes	No
Poppy, California	*Eschscholzia californica*	Yes	No
Poppy, Corn	*Papaver rhoeas*	Yes	Yes
Poppy, Red Corn	*Papaver* sp.	Yes	Yes
Prairieclover, Purple	*Dalea purpurea*	Yes	Yes
Prairieclover, White	*Dalea candidum*	Yes	Yes
Tick-trefoil, Showy	*Desmodium canadense*	No	Yes
Trefoil, Birdsfoot	*Lotus corniculatus*	No	Yes
Vetch, Crown	*Coronilla varia*	Yes	—
Vetch, Hairy	*Vicia villosa*	Yes	—
Yarrow, Gold	*Achillea filipendulina*	No	Yes

[1] For legumes, at least three true leaves should be present before a postemergence application.

Established Wildflower and Legume Tolerance to PLATEAU (maximum rate[1], oz/A) in Mixed Grass/Forb Stands.

Common Name	Genus Species	PRE	POST[2]
Flax, Blue	*Linum perenne*	0	6
Indian Blanket	*Gaillardia pulchella*	0	6
Blanketflower	*Gaillardia aristata*	0	8
Chickory	*Cichorium intybus*	4	6
Daisy, Shasta	*Chrysanthemum maximum*	4	8
Prairieclover, Purple	*Dalea purpurea*	4	12
Coneflower, Upright Prairie	*Ratibida columnifera*	6	6
Mexican Hat	*Ratibida columnifera*	6	6
Poorjoe	*Diodia teres*	8	—
Lupine, Perennial[4]	*Lupinus perennis*	8	12
Coneflower, Purple	*Echinacea purpurea*	8	8
Daisy, Ox-eye[3]	*Chrysanthemum leucanthermum*	8	8
Leadplant	*Amorpha canescens*	8	8
Lespedeza, Bicolor	*Lespedeza*	8	8
Milkweed, Common	*Asclepias syriaca*	8	—
Pea, Prairie Scurf	*Psoralea esculenta*	8	8
Yarrow, Gold[3]	*Achillea filipendulina*	8	8
Blackeyed Susan	*Rudbeckia hirta*	8	10
Johnny Jump-ups	*Viola cornuta*	8	12
Sweetclover	*Melilotus* sp.	12	8
Alfalfa	*Medicago sativa*	12	12
Bundleflower, Illinois	*Desmanthus illinoensis*	12	12
Lespedeza, Sericea	*Lespedeza cuneata*	12	12
Partridgepea	*Cassia fasciculata*	12	12
Sensitive vine	*Mimosa strigillosa*	12	12
Vetch, Crown	*Coronilla varia*	12	12
Violet, Wild	*Viola* spp.	12	12

[1] Height suppression or stand reduction may occur at maximum use rate. For legumes, some yellowing and stunting can occur at higher use rates.

[2] Postemergence application should be made early post on the flowers to reduce injury and increase flower set.

[3] Will not flower.

[4] Most native rangeland lupines are tolerant to PLATEAU herbicide at 12 oz/A postemergence.

Wildflower Establishment with PLATEAU 4 oz/A + PENDULUM herbicide 2 lbs a.i./A[1]

Common Name	Genus Species	PRE[2]	POST[3]
Blackeyed Susan	*Rudbeckia hirta*	Yes	Yes
Blanketflower	*Gaillardia pulchella*	No	Yes

Wildflower Establishment with PLATEAU® herbicide 4 oz/A + PENDULUM® herbicide 2 lbs a.i./A[1]

Common Name	Genus Species	PRE[2]	POST[3]
Bundleflower, Illinois	*Desmanthus illinoensis*	>50% thinning	Yes
Clover, Crimson	*Trifolium incarnatum*	>50% thinning	Yes
Coneflower, Clasping	*Dracopsis amplexicaulis*	Yes	Yes
Coneflower, Upright Prairie	*Ratibida columnifera*	No	OK
Coneflower, Purple	*Echinacea purpurea*	Yes	Yes
Coreopsis, Dwarf Red Plains	*Coreopsis tinctoria* var. Gay Feather	OK stunting	OK stunting
Coreopsis, Plains	*Coreopsis tinctoria*	OK stunting	Yes
Coreopsis, Lance Leaved	*Coreopsis lanceolata*	25% thinning	Yes
Cornflower	*Centaurea cyanus*	No	OK 20% thinning
Cosmos, Garden	*Cosmos bipinnatus*	OK 10% thinning	OK stunting
Cosmos, Yellow	*Cosmos sulphureus*	Yes	Yes
Daisy, Ox-eye	*Chrysanthemum leucanthermum*	25% thinning	Yes
Daisy, Shasta	*Chrysanthemum maximum*	marginal-OK 20% thinning	Yes
Lupine, Perennial	*Lupinus perennis*	Yes	≤50% thinning
Partridgepea	*Cassia fasciculata*	25% thinning	Yes
Poppy, California	*Eschscholzia californica*	Yes	25% injury stunting, thinning
Yarrow, Gold	*Achillea filipendulina*	OK thinning	OK

[1] 2 lbs ai/A = 2.4 qts of PENDULUM herbicide 3.3 EC or 3.3 lbs of PENDULUM herbicide WDG

[2] Preemergence at planting

[3] Postemergence to seedlings

Yes = no injury

No = results in no wildflower germination or unacceptable injury to seedling flowers.

OK = can be used if thinning and/or stunting can be tolerated or if establishment is threatened by weed competition.

Due to the diversity of species and varieties that exist in areas where wildflowers are grown, the response to **PLATEAU** may vary greatly. Careful testing on desirable species is recommended to determine if area-wide applications can be made. Try on a limited area to verify tolerance in a specific area.

The suitability of **PLATEAU** use on wildflower species not listed, should be determined by treating a small number of such wild flowers at an appropriate rate, not to exceed 12 oz per acre per year. Treated wildflowers should be evaluated 1 to 2 months following application for possible injury. THE USER ASSUMES RESPONSIBILITY FOR ANY DAMAGE OR OTHER LIABILITY.

SPECIAL WEED CONTROL

ALWAYS ADD AN ADJUVANT to **PLATEAU** (see "SPRAY ADJUVANTS FOR POSTEMERGENCE APPLICATIONS" section). Research has shown Methylated Seed Oil (MSO) surfactants provide **PLATEAU** with superior control of perennial weeds. This effect is not always observed and is most prevalent on waxy leaf species, perennials and weeds under stress conditions. For the weeds listed below, it is recommended to use a MSO for best results. The use of nonionic surfactants or silicone based surfactants may result in less than acceptable control.

Johnsongrass & Itchgrass: For best results, apply **PLATEAU** at the rate of 8 to 12 oz per acre after johnsongrass or itchgrass has reached 18 to 24 inches in height at the whorl. The addition of ACCORD® or ROUNDUP® PRO at the rate of 8 to 16 oz per acre may improve control after culm elongation or in dense stands. Use higher herbicide rates as density increases. Larger grass than specified above can be controlled.

Dallisgrass, Bahiagrass, Vaseygrass, *Paspalum* spp., Smutgrass: For dallisgrass, bahiagrass and smutgrass control, apply **PLATEAU** postemergence at the rate of 10 to 12 oz per acre, after grass has reached 100% green-up. For dallisgrass and smutgrass, activity may range from suppression to control depending upon grass growth stage and growing conditions at the time of application. For vaseygrass apply **PLATEAU** at the rate of 4 to 6 oz per acre postemergence after grass has reached 100% green-up and is from 3 to 8 inches in height. The addition of ACCORD® or ROUNDUP® PRO at the rate of 12 to 16 oz per acre will improve efficacy. Use higher herbicide rates as target grass weed densities and/or maturity increase. The addition of PENDULUM® will provide increased preemergence control of these grasses from seed.

Leafy Spurge: For best results, apply **PLATEAU** at 8 to 12 oz per acre in late summer or fall (August through October, but timing may vary by state and/or altitude). Consecutive year applications will optimize long term control. **PLATEAU** at 12 oz/A applied spring or fall, or 4 oz/A in the spring following an 8 oz/A fall treatment may result in excessive injury to cool season grasses in some areas. For best results, always use a methylated seed oil at 2 pints per acre. Two pints per acre of nitrogen fertilizer (see "SPRAY ADJUVANTS FOR POSTEMERGENCE APPLICATIONS" section) may also be added to the spray tank to increase leafy spurge control, however, this may increase injury to desired species of grasses and forbs. The use of nonionic and silicone based surfactants have resulted in little or no control of leafy spurge. Approximate dates for fall timing in North and South Dakota is late August through September; for Nebraska and Iowa is mid-September through mid-October. This application should be made after good soil moisture is present but prior to the leafy spurge losing its milky sap flow due to a killing frost. To check and see if the milky sap flow has been affected by a frost simply break the main stem of the leafy spurge and if milky sap flows from the break then **PLATEAU** can still be applied.

Tall Fescue Control: Tall fescue can be controlled by using **PLATEAU** at the rate of 12 oz plus Methylated Seed Oil at 2 pints per acre. The addition of ACCORD, glyphosate or ROUNDUP PRO and/or nitrogen fertilizer (see "SPRAY ADJUVANTS FOR POSTEMERGENCE APPLICATIONS" section) to the above mix will aid in control. Tall fescue must be actively growing for optimum control. If tall fescue has reached summer dormancy, control may be poor.

Fall applications of **PLATEAU** at 8 to12 oz/A plus a ACCORD® or ROUNDUP® PRO at 24 to 64 oz/A will result in best control of existing tall fescue and new germinating seedlings. With spring applications of **PLATEAU** at 6 to 12 oz/A, plus ACCORD or ROUNDUP PRO at 32 to 64 oz/A, use higher rates for older, mature fescue stands and lower **PLATEAU** rates when planting forbs. When using 8 oz/A of **PLATEAU** in the fall with ACCORD or ROUNDUP PRO, it is recommended to apply 4 oz/A **PLATEAU** in the spring at planting for annual weed and seedling fescue control. Burning the fescue stand, where permitted, the following spring, just prior to green-up, will aid in control and provide a better seedbed for planting. Mowing the fescue several times the summer before fall application, will weaken the fescue root system, making it more susceptible to herbicides. Always allow for at least 10 inches of regrowth, following the last mowing before spraying, as both **PLATEAU** and ROUNDUP products need foliage present for herbicide uptake and satisfactory control.

Russian Knapweed: Apply 12 oz/A of **PLATEAU** plus 1 quart per acre of methylated seed oil during Russian knapweed senescence in the fall . Control improves as senescence progresses and may still be obtained with applications made after full senescence. Applications made prior to the initiation of senescence will result in reduced control.

Dalmatian Toadflax: Apply 12 oz/A of **PLATEAU** plus 1 quart per acre of methylated seed oil in the fall when the top 25% of the plant is necrotic, usually after a hard frost (late October through November). The addition of ammonium sulfate at a rate of 2 to 3 pints per acre may improve control. As long as there is some green stem and/or leaf tissue remaining, good control can be achieved. This timing usually corresponds to fall basal growth. Applications made prior to this will result in poor control.

Resistant Biotypes: Naturally occurring biotypes (a plant within a given species that has a slightly different, but distinct genetic makeup from other plants of the same species) of some weeds listed on this label may not be effectively controlled by this and/or other herbicides (OUST®) with the ALS/AHAS enzyme inhibiting mode of action. If naturally occurring ALS/AHAS resistant biotypes are present in an area, **PLATEAU** should be tank-mixed or applied sequentially with an appropriate registered herbicide having a different mode of action to ensure control.

For sensitive areas and use around desirable vegetation **PLATEAU® herbicide** at 12 ounces per acre may be tank mixed with PENDULUM® herbicide, ROUNDUP® PRO, ESCORT®, KARMEX®, 2,4-D, diuron, ENDURANCE® or other labeled products to provide total vegetation control. For other bareground areas **PLATEAU** at 12 oz per acre may be tank mixed with ARSENAL® herbicide, SAHARA® DG herbicide, KROVAR®, OUST®, TORDON®, VANQUISH® or other labeled products to provide total bareground weed control. For maximum weed control, use 2 pints per acre of methylated seed oil as an adjuvant.

Spot Treatments: PLATEAU may be used to control weed encroachment in bareground or total vegetation control situations. To prepare the spray solution, thoroughly mix in each gallon of water 0.25 to 5% volume/volume (0.3 oz to 5.4 oz per gallon) **PLATEAU** plus a methylated seed oil adjuvant.

USE UNDER PAVED SURFACES

Applications should be made to the soil surface only when final grade is established. DO NOT move soil following **PLATEAU** application. Apply **PLATEAU** in sufficient water to ensure thorough and uniform wetting of the soil surface, including the shoulder area. Add **PLATEAU** at a rate of 12 oz. per acre to clean water in the spray tank during the filling operation. Agitate before spraying. If soil is not moist prior to treatment, incorporation of **PLATEAU** will improve control. **PLATEAU** can be incorporated into the soil to a depth of two inches using a rototiller or disc. Rainfall or irrigation totaling one inch is also sufficient to incorporate **PLATEAU** into the soil surface. DO NOT allow treated soil to wash or move into untreated area.

TOLERANCE OF TREES AND BRUSH TO PLATEAU

The following tolerance information is provided as a general guideline when it is desirable or necessary to make **PLATEAU** applications in and around desirable tree and brush species. DO NOT use **PLATEAU** on nursery, orchard, ornamental plantings, new plantings, seedling trees or fiber farms except as specified on supplemental labeling. It is suggested that **PLATEAU** be tried on a limited basis to determine tolerance in your area. **PLATEAU** may be used at rates up to 12 oz per acre for weed control in and around established trees on pasture, rangeland (see "GUIDELINES FOR RANGELAND USE" section) and noncropland areas such as roadsides, prairies and similar areas used for wildlife cover, erosion control, wind breaks, etc. Tree and brush species known to have acceptable tolerance to **PLATEAU** when applied under the canopy and/or to the foliage are listed below. Tolerance is based upon trees with a minimum of 2 inch DBH. Application to tree and brush species that are under stress due to drought, disease, insect damage or other factors may be more susceptible to injury from **PLATEAU** and may result in severe injury or death. Some species may exhibit tip chlorosis and minor necrosis. Foliar contact may increase injury to include defoliation and terminal death. Application methods that minimize foliar contact with desirable tree and brush species can improve tolerance.

When making fall applications of **PLATEAU**, potential injury to tree and brush species from foliar contact may be minimized by making the application after the leaves have begun to senesce (fall color) or after leaf drop. Conifer species are generally tolerant to fall applications. **PLATEAU** applications in and around tree and brush species should be made at the recommended timing for the target weed species.

Brush and Tree Species Tolerance to PLATEAU at 12 oz per Acre[1]

		Tolerance by Application Method[2]	
Common Name	**Genus Species**	**Directed Below Foliage**	**To Foliage**
Apple (Var. Winesap)[3]	*Malus sylvestris*	Yes	NR
Ash, Blue	*Fraxinus quadrangulata*	Yes	NR
Ash, Green	*Fraxinus pennsylvanica*	No	No
Azalea	*Rhododendron* spp.	No	No
Basswood	*Tilia hetrophylla*	No	No
Boxelder	*Acer negundo*	Yes	Injury[5]

Brush and Tree Species Tolerance to PLATEAU at 12 oz per Acre[1]

		Tolerance by Application Method[2]	
Common Name	**Genus Species**	**Directed Below Foliage**	**To Foliage**
Buckeye, Ohio	*Aesculus glabra*	Yes	NR
Cedar-juniper, Western	*Thuja plicata*	Yes	Yes
Cherry, Black[3]	*Prunus serotina*	No	No
Cherry, Choke	*Prunus virginiana*	No	No
Cherry, Sweet[3]	*Prunus avium*	No	NR
Cottonwood	*Populus deltoides*	Yes	Injury[5]
Cottonwood, narrow leaf	*Populus* spp.	Yes	Injury[5]
Currant species	*Ribes* spp.	Injury[5]	No
Dogwood, Flowering	*Cornus* spp.	Yes	Yes
Dogwood, Grey	*Cornus racemosa*	Yes	Injury[5]
Dogwood, Red Trig	*Cornus* spp.	Yes	Yes
Douglas Fir	*Pseudotsuga menziesii*	Yes	Yes[4]
Elm, American	*Ulmus americana*	Yes	Yes
Elm,Siberian	*Ulmus pumila*	Yes	No
Elm, Slippery	*Ulmus rubra*	Yes	Yes
Gooseberry	*Ribes* spp.	Injury[5]	Injury[5]
Hackberry	*Celtis occidentalis*	Yes	Yes
Hawthorn	*Crataegus* spp.	Yes	Injury[5]
Juniper, Chinese	*Juniperus chinensis*	Yes	Yes
Juniper, Western	*Juniperus osteosperma*	Yes	Yes
Lilac	*Syringa* spp.	No	No
Linden, American	*Tilia americana*	No	No
Locust, Black	*Robinia pseudoacacia*	Yes	Yes
Locust, Honey	*Gleditsia triacanthos*	Yes	Yes
Maple, Red	*Acer rubrum*	Yes	Yes
Maple, Sugar	*Acer saccharum*	Yes	Yes
Mulberry, Red	*Morus rubra*	Yes	NR
Mulberry, White	*Morus alba*	Yes	NR
Oak, Black	*Quercus velutina*	Yes	NR
Oak, Live	*Quercus virginiana*	Yes	Yes
Oak, Southern Red	*Quercus falcata*	Yes	NR
Oak, White	*Quercus alba*	Yes	NR
Olive, Russian	*Elaeagnus angustifolia*	Yes	No
Osage Orange	*Maclura pomifera*	Yes	NR
Peach (Var. Elberta)[3]	*Prunus persica*	Yes	NR
Photinia, Red Tip	*Photinia fraseri*	Yes	Yes
Pine, Lodgepole	*Pinus contorta*	Yes	Injury[4]
Pine, White[4]	*Pinus strobus*	Yes	Yes
Pittosporum, Japanese	*Pittosporum tobira*	Yes	Yes
Plum species	*Prunus* spp.	Yes	No
Poplar, Yellow (Tulip)	*Liriodendron tulipfera*	Yes	NR
Privet, Common	*Ligustrum vulgare*	Yes	Yes
Rabbitbrush species	*Chrysothamnus* spp.	Yes	Yes
Redbud	*Cercis canadenis*	Yes	Yes
Redcedar, Eastern	*Juniperus virginiana*	Yes	Yes
Rose, Multiflora	*Rosa multiflora*	Yes[5]	No
Sage, Big	*Artemisia tridentata*	Yes	Yes
Sage, Fringe	*Artemisis frigida*	Yes	Yes
Sage, Silver	*Artemisia cana*	Yes	Yes
Sagebrush, Big	*Artemisia tridentata*	Yes	Yes
Sagebrush, Fringed	*Artemisia frigida*	Yes	Yes
Saltcedar	*Tamarix* spp.	Yes	No
Serviceberry	*Amelanchier alnifolia*	Yes	NR
Snowberry, Western	*Symphoricarpos occidentalis*	Yes	Injury[5]

Brush and Tree Species Tolerance to PLATEAU® herbicide at 12 oz per Acre[1] (CONT):

Common Name	Genus Species	Tolerance by Application Method[2] Directed Below Foliage	To Foliage
Spruce species	*Picea* spp.	Yes[4]	Yes[4]
Sugarberry	*Celtis laevigata*	Yes	Yes
Sweetgum	*Liquidambar styraciflua*	Yes	Yes[6]
Sycamore	*Plantanus occidentalis*	Yes	No
Tree-of-Heaven	*Ailanthus altissima*	Yes	Yes
Walnut, American Black	*Juglans nigra*	Yes	No
Willow	*Salix* spp.	Yes	Injury[5]

[1] Not intended for nursery, orchard, ornamental plantings, new plantings or seedling trees.

[2] Yes = Tolerant
No = Not Tolerant, Severe injury or death
NR = Not Recommended due to insufficient tolerance data

[3] Not for use on ornamental or fruit bearing trees.

[4] Applications made just before or during candling may cause candle injury or death.

[5] Possible defoliation and/or death. Some species may exhibit tip chlorosis and minor necrosis. If spray contacts foliage then defoliation and terminal death may occur. Injury can be reduced or eliminated if applied in fall after color change or leaf drop.

[6] See supplemental label, "For Use In Sweetgum *(Liquidambar styraciflua)* Grown on Fiber Farms."

WEEDS CONTROLLED

PLATEAU, 4 to 6 oz per acre

Common Name	Genus Species	PRE[1]	POST[2]	Annual/ Biennial/ Perennial[3]
BROADLEAVES				
Bedstraw, Catchweed	*Galium aparine*	C	4	WA
Beggarweed, Florida	*Desmodium tortuosum*	C	2	SA
Buffalobur	*Solanum rostratum*	—	C	SA
Buttercup, Bur	*Ranunculus testiculatus*	C	C	WA
Cocklebur, Common	*Xanthium strumarium*	S	6	SA
Lambsquarters, Common	*Chenopodium album*	C	2	SA
Halogeton	*Halogeton glomeratus*	C	C	SA
Morningglory				
Entireleaf	*Ipomoea hederacea*	S	3	SA
Ivyleaf	*Ipomoea hederacea*	S	3	SA
Tall	*Ipomoea purpurea*	S	3	SA
Mustard, Wild	*Brassica kaber*	C	C	WA
Pigweed	*Amaranthus* sp.	C	6	SA
Queen Anne's Lace	*Daucus carota*	—	4	B
Radish, Wild	*Raphanus raphanistrum*	S	4	WA
Yellow Rocket	*Barbarea vulgaris*	C	4	WA
Sicklepod	*Senna obtusifolia*	C	4	SA
Sida, Prickly	*Sida spinosa*	C	2	SA
Smartweed				
Ladysthumb	*Polygonum persicaria*	C	C	SA
Pennsylvania	*Polygonum pensylvanicum*	C	C	SA
Swamp	*Polygonum coccineum*	C	C	SA
Starbur, Bristly	*Acanthospermum hispidum*	C	2	SA
Velvetleaf	*Abutilon theophrasti*	C	6	SA
GRASS WEEDS				
Brome, Downy	*Bromus tectorum*	C	2	WA
Cheat	*Bromus secalinus*	C	2	WA
Crabgrass				
Large (Hairy)	*Digitaria sanguinalis*	C	4	SA
Smooth	*Digitaria ischaemum*	C	4	SA
GRASS WEEDS (CONT):				
Foxtail,				
Giant	*Setaria faberi*	C	6	SA
Green	*Setaria viridis*	C	4	SA
Yellow	*Setaria glauca*	C	4	SA
Goatgrass, Jointed	*Aegilops cylindrica*	C	C	WA
Goosegrass	*Elusine indica*	S	2	SA
Johnsongrass (Seedling)	*Sorghum halepense*	C	12	SA
Medusahead	*Taeniatherum caput-medusae*	C	2	WA
Panicum, Fall	*Panicum dichotomiflorum*	S	6	SA
Sandbur	*Cenchrus* sp.	S	C	A/P
Shattercane	*Sorghum bicolor*	C	12	SA
Signalgrass, Broadleaf	*Brachiaria platyphylla*	C	C	SA
Stiltgrass, Japanese	*Microstegium vimineum*	C	4	A
Vaseygrass	*Paspalum urvillei*	—	8	P
SEDGES				
Nutsedge				
Yellow	*Cyperus esculentus*	S	4S	P
Purple	*Cyperus rotundus*	S	4S	P
Sedge	*Juncus* sp.	S	4S	A/P

[1] C = control, S = suppression in northern United States only

[2] Maximum plant height in inches at time of application

[3] Growth habit: A=Annual, SA=Summer Annual, WA=Winter Annual, B=Biennial P=Perennial

PLATEAU, 8 to 12 oz per acre

Common Name	Genus Species	PRE[1]	POST[2]	Annual /Biennial/ Perennial[3]
BROADLEAVES:				
Anoda, Spurred	*Anoda cristata*	C	6	SA
Baby's Breath[5]	*Gypsophila paniculata*	—	C	P
Bedstraw, Catchweed	*Galium aparine*	C	C	WA
Bedstraw, Marsh	*Galium* spp.	C	C	WA
Beggarweed, Florida	*Desmodium tortuosum*	C	6	SA
Bindweed, Field	*Convolvulus arvensis*	—	C	P
Buffalobur	*Solanum rostratum*	—	C	SA
Burclover	*Medicago* sp.	—	4	SA
Chickweed, Common	*Stellaria media*	C	6	SA
Cocklebur, Common	*Xanthium strumarium*	C	6	SA
Cornsalad, Common	*Valerianella locusta*	—	C	WA
Crownbeard, Golden	*Verbisina encelioides*	C	2	SA
Dandelion	*Taraxacum officinale*	—	C	P
Dock, Curly	*Rumex crispus*	C	6	B
Fiddleneck	*Amsinckia* sp.	—	C	SA
Flax, Spurge	*Thymelaea passerina*	C	C	A
Fleabane, Annual	*Erigeron annuus*	—	C	A
Geranium, Carolina	*Geranium carolinianum*	—	C	WA/B
Geranium, Cranesbill	*Geranium maculatum*	C	C	WA/B
Ground Cherry	*Physalis heterophylla*	—	C	P
Hemlock, Poison	*Conium maculatum*	C	6	B
Henbit	*Lamium amplexicaule*	C	3	WA/B
Hoary Cress	*Cardaria* spp.	—	C	P
Houndstongue, Bristly	*Cynoglossum officinale*	C	C	B
Indigo, Hairy	*Indigofera hirsuta*	C	2	P
Jimsonweed	*Datura stramonium*	C	6	SA
Knapweed, Russian[6]	*Centaurea repens*	—	C*	P
Knotweed, Prostrate	*Polygonum aviculare*	C	C	SA
Kochia*	*Kochia scoparia*	C	3	SA
Lambsquarters, Common	*Chenopodium album*	C	3	SA

PLATEAU® herbicide, 8 to 12 oz per acre (CONT):

Common Name	Genus Species	PRE[1]	POST[2]	Annual /Biennial/ Perennial[3]
BROADLEAVES:				
Morningglory				
Cypressvine	*Ipomoea quamoclit*	C	6	SA
Entireleaf	*Ipomoea hederacea*	C	6	SA
Ivyleaf	*Ipomoea hederacea*	C	6	SA
Pitted	*Ipomoea lacunosa*	C	6	SA
Smallflower	*Jacquemontia tamnifolia*	C	6	SA
Tall	*Ipomoea purpurea*	C	6	SA
Mustard, Wild	*Brassica kaber*	C	C	WA
Onion, Wild	*Allium canadense*	C	C	P
Pepperweed, Perennial	*Lepidium latifolium*	—	C	P
Pigweed[4]	*Amaranthus* sp.	C	6	SA
Plantain, Narrowleaf	*Plantago lanceolata*	C	C	B
Poinsettia, Wild	*Euphorbia heterophylla*	C	6	SA
Puncture Vine	*Tribulus terrestris*	—	C	SA
Purslane, Common	*Portulaca oleracea*	C	4	SA
Pusley, Florida	*Richardia scapra*	C	4	SA
Queen Anne's Lace	*Daucus carota*	C	C	B
Ragweed				
Common	*Ambrosia artemisiifolia*	C	3	SA
Giant	*Ambrosia trifida*	S	6	SA
Western	*Ambrosia psilostachya*	—	C	A/P
Rocket, Yellow	*Barbarea vulgaris*	C	C	WA
Senna, Coffee	*Cassia occidentalis*	C	4	SA
Sicklepod	*Senna obtusifolia*	C	6	SA
Sida, Prickly	*Sida spinosa*	C	6	SA
Smartweed				
Ladysthumb	*Polygonum persicaria*	C	C	SA
Pennsylvania	*Polygonum pensylvanicum*	C	C	SA
Swamp	*Polygonum coccineum*	C	C	SA
Spurge				
Leafy	*Euphorbia esula*	—	FALL*	P
Spotted	*Euphorbia maculata*	C	4	SA
Toothed	*Euphorbia dentata*	C	4	SA
Starbur, Bristly	*Acanthospermum hispidum*	—	6	SA
Sunflower	*Helianthus annuus*	—	18	SA
Tansymustard	*Descurainia pinnata*	C	C	WA
Teasel, Common	*Dipsacus fullonum*	—	C	B
Thistle				
Bull	*Cirsium vulgare*	S	C	WA/B
Musk	*Carduus nutans*	S	C	B
Platt	*Cirsium canescens*	S	C	P
Russian*	*Salsola iberica*	C	3	A
Toadflax, Dalmatian	*Linaria dalmatica*	—	C*	P
Velvetleaf	*Abutilon theophrasti*	C	C	A
Vervain, Blue	*Verbena hastata*	—	S	WA
Vervain, prostrate	*Verbena bracteata*	—	C	P
Whitetop	*Cardaria* spp.	—	C	P
Willowherb	*Epilobium* spp.	—	C	P
Woodsorrel, Yellow	*Oxalis stricta*	C	C	P
GRASS				
Bahiagrass	*Paspalum nutatum*	S	C*	P
Barley, Little	*Hordeum pusillum*	C	4	WA
Barley, Squirrel Tail	*Hordeum jubatum*	—	C	P
Barnyardgrass	*Echinochloa crus-galli*	C	6	SA
Cheat	*Bromus secalinus*	C	C	WA
Crabgrass	*Digitaria* sp.	C	6	SA
Crowfootgrass	*Dactyloctenium aegyptiium*	C	C	SA
Dallisgrass	*Paspalum dilatatum*	S	C*	P
Downy Brome	*Bromus tectorum*	C	C	WA
Dropseed, Tall	*Sporobolus cryptandrus*	S	C	A/P
Fescue, Tall	*Festuca arundinacea*	C	C*	P
Foxtail				
Giant	*Setaria faberi*	C	C	SA
Green	*Setaria viridis*	C	C	SA
Knotroot	*Setaria geniculatus*	S	6	SA
Purple Robust	*Setaria viridis*	S	S	SA
Yellow	*Setaria glauca*	C	4	SA
Garlic, Wild	*Allium vineale*	C	C	P
Goosegrass	*Elusine indica*	C	3S	SA
Itchgrass	*Rottboellia cochinchinensis*	—	C*	SA
Johnsongrass				
Seedling	*Sorghum halepense*	C	C	SA
Rhizome	*Sorghum halepense*	—	C*	P
Medusahead	*Taeniatherum caput-medusae*	C	C	WA
Panicum				
Fall	*Panicum dichotomiflorum*	C	C	SA
Texas	*Panicum texanum*	C	C	SA
Ryegrass, Annual (Italian)	*Lolium multiflorum*	C	C	WA
Ryegrass, Perennial	*Lolium perenne*	—	C	P
Sandbur	*Cenchrus* sp.	S	C	A/P
Shattercane	*Sorghum bicolor*	C	C	SA
Signalgrass, Broadleaf	*Brachiaria platyphylla*	C	C	SA
Smutgrass	*Sporobolus indicus*	—	C	P
Stiltgrass, Japanese	*Microstegium vimineum*	C	C	A
Stinkgrass, Annual	*Eragrostis cilianensis*	C	2	SA
Torpedograss	*Panicum repens*	—	C	P
Vaseygrass	*Paspalum urvillei*	C		P
Wild Oats	*Avena fatua*	—	C	WA
SEDGES/RUSHES				
Nutsedge				
Yellow	*Cyperus esculentus*	C	C	P
Purple	*Cyperus rotundus*	C	C	P
Rush	*Juncus* sp.	S	4	A/P

[1] C = control, S = suppression

[2] Maximum plant height in inches at time of application

[3] Growth habit: A=Annual, SA=Summer Annual, WA=Winter Annual, B=Biennial P=Perennial

[4] Some species are tolerant and resistant biotypes are possible.

[5] For annual control. The addition of 1-2 pints of 2,4-D will aid in burndown.

[6] For best control apply in the fall.

*See "SPECIAL WEED CONTROL" section

0241365-030141.20031003.pdf
NVA 2003-04-126-0143
Supersedes NVA 2001-04-126-0261

BASF Corporation
26 Davis Drive
Research Triangle Park, NC 27709

Agricultural Products

Specimen Label

Dow AgroSciences

Pathfinder* II

Specialty Herbicide

*Trademark of Dow AgroSciences LLC

A ready-to-use herbicide for the control of woody plants on:

- **Forests**
- **Non-crop areas including: Industrial manufacturing and storage sites, rights-of-way, non-irrigation ditch banks**
- **Rangeland and permanent pastures**
- **Grazed areas and maintenance of wildlife openings on those sites**

Active Ingredient:	
triclopyr: 3,5,6-trichloro-2-pyridinyloxyacetic acid, butoxyethyl ester	13.6%
Inert Ingredients	86.4%
Total	100.0%

Acid Equivalent: triclopyr – 9.81% – 0.75 lb/gal

EPA Reg. No. 62719-176

Keep Out of Reach of Children

CAUTION PRECAUCION

Si usted no entiende la etiqueta, busque a alguien para que se la explique a usted en detalle. (If you do not understand the label, find someone to explain it to you in detail.)

Precautionary Statements

Hazards to Humans and Domestic Animals

Harmful If Swallowed, Inhaled Or Absorbed Through The Skin

Avoid contact with skin, eyes or clothing. Avoid breathing vapor or spray mist. Prolonged or frequently repeated skin contact may cause allergic reactions in some individuals.

Personal Protective Equipment (PPE)

Some materials that are chemical-resistant to this product are listed below. If you want more options, follow the instructions for category E on an EPA chemical resistance category selections chart.

Applicators and other handlers must wear:

- Long-sleeved shirt and long pants
- Chemical-resistant gloves such as Barrier Laminate, Nitrile Rubber, Neoprene Rubber, or Viton
- Shoes plus socks

Follow manufacturer's instructions for cleaning/maintaining PPE. If no such instructions for washables, use detergent and hot water. Keep and wash PPE separately from other laundry.

User Safety Recommendations

Users should:

- Wash hands before eating, drinking, chewing gum, using tobacco or using the toilet.
- Remove clothing immediately if pesticide gets inside. Then wash thoroughly and put on clean clothing.

First Aid

If on skin: Wash with plenty of soap and water. Get medical attention.
If inhaled: Remove victim to fresh air. If not breathing, give artificial respiration, preferably mouth-to-mouth. Get medical attention.
If swallowed: Call a physician or Poison Control Center. Drink 1 or 2 glasses of water and induce vomiting by touching back of throat with finger. Do not induce vomiting or give anything by mouth to an unconscious person.

Environmental Hazards

This pesticide is toxic to fish. Keep out of lakes, ponds or streams. Do not apply directly to water, to areas where surface water is present or to intertidal areas below the mean high water mark. Do not contaminate water when disposing of equipment washwaters.

Physical or Chemical Hazards

Combustible - Do not use or store near heat or open flame. Do not cut or weld container.

Notice: Read the entire label. Use only according to label directions. **Before buying or using this product, read "Warranty Disclaimer" and "Limitation of Remedies" elsewhere on this label.**

In case of emergency endangering health or the environment involving this product, call 1-800-992-5994. If you wish to obtain additional product information, visit our web site at www.dowagro.com.

Agricultural Chemical: Do not ship or store with food, feeds, drugs or clothing.

Directions for Use

It is a violation of Federal law to use this product in a manner inconsistent with its labeling.
Read all Directions for Use carefully before applying.

Ready-To-Use, No Mixing Required.

Do not apply this product in a way that will contact workers or other persons, either directly or through drift. Only protected handlers may be in the area during application. For any requirements specific to your state or tribe, consult the agency responsible for pesticide regulation.

Agricultural Use Requirements

Use this product only in accordance with its labeling and with the Worker Protection Standard, 40 CFR part 170. This Standard contains requirements for the protection of agricultural workers on farms, forests, nurseries, and greenhouses, and handlers of agricultural pesticides. It contains requirements for training, decontamination, notification, and emergency assistance. It also contains specific instructions and exceptions pertaining to the statements on this label about personal protective equipment (PPE) and restricted-entry interval. The requirements in this box only apply to uses of this product that are covered by the Worker Protection Standard.

Do not enter or allow worker entry into treated areas during the restricted entry interval (REI) of 12 hours.

PPE required for early entry to treated areas that is permitted under the Worker Protection Standard and that involves contact with anything that has been treated, such as plants, soil, or water, is:

- Coveralls
- Chemical-resistant gloves such as Barrier Laminate, Nitrile Rubber, Neoprene Rubber, or Viton
- Shoes plus socks

Storage and Disposal

Do not contaminate water, food or feed by storage or disposal. Open dumping is prohibited.
Storage: Store above 28°F or agitate before use.
Pesticide Disposal: Pesticide, spray mixture, or rinsate that cannot be used according to label instructions must be disposed of according to applicable federal, state, or local procedures.
Container Disposal: Triple rinse (or equivalent) with 10 drops or more of a liquid hand soap and water or an oil basal product such as kerosene or diesel fuel and spray rinsate on undesirable vegetation, in target area. Offer containers for recycling or reconditioning where allowed, or puncture and dispose of in a sanitary landfill, or by incineration if approved by state and local procedures.
Container Disposal for Refillable Containers: Close all openings which have been opened during use and replace all caps. Return the empty container to a collection site designated by Dow AgroSciences. If the container has been damaged and cannot be returned according to the recommended procedures, contact the Dow AgroSciences Customer Service Center at 1-800-258-1470 to obtain proper handling instructions.
General: Consult federal, state, or local disposal authorities for approved alternative procedures.

General Information

Pathfinder II herbicide is a ready-to-use product which is recommended for the control of unwanted woody plants through the use of basal bark application techniques in forests, rangeland and permanent pastures, and on non-crop areas including industrial manufacturing and storage sites, rights-of-way such as electrical power lines, communication lines, pipelines, road sides and railroads, fence rows, non-irrigation ditch banks and around farm buildings. Use on these sites may include application to grazed areas as well as establishment and maintenance of wildlife openings.

General Use Precautions

The state of Arizona has not approved Pathfinder II for use on plants grown for commercial production; specifically forests grown for commercial timber production, or on designated grazing areas.

Apply this product only as specified on this label.

Do not apply this product through any type of irrigation system.

It is permissible to treat non-irrigation ditch banks, seasonally dry wetlands, flood plains, deltas, marshes, swamps, bogs, and transitional areas between upland and lowland sites. Do not apply to open water (such as lakes, reservoirs, rivers, streams, creeks, salt water bays or estuaries) nor to water present in fresh water wetlands, deltas, marshes, swamps, bogs or potholes, or to salt water marshes below the mean high water mark.

Do not apply Pathfinder II herbicide directly to, or otherwise permit it to come into direct contact with grapes, tobacco, vegetable crops, flowers or other desirable broadleaf plants, and do not permit spray mists containing it to drift onto them.

Avoid Injurious Spray Drift: Applications should be made only when there is little or no hazard from spray drift. Very small quantities of spray, which may not be visible, may seriously injure susceptible plants. Do not spray when wind is blowing toward susceptible crops or ornamental plants near enough to be injured.

With ground equipment, spray drift can be reduced by using spray pressures no greater than are required to obtain adequate coverage; by using large droplet producing nozzle tips; and by spraying when wind velocity is low. Do not apply with nozzles that produce a fine droplet spray. Do not apply with an orchard type mist blower.

Do not apply on snow or frozen ground.

Untreated trees occasionally can be affected by movement of the herbicide through root grafting with the treated trees.

Since this herbicide moves within the treated plant, do not use Pathfinder II on parts of a multiple stem plant if injury to the untreated portions (cut or standing stems) cannot be tolerated.

Do not apply on ditches used to transport irrigation water. Do not apply where runoff or irrigation water may flow onto agricultural land as injury to crops may result.

Be sure that use of this product conforms to all applicable regulations.

Grazing and Haying Restrictions

Grazing or harvesting green forage:

1) Lactating dairy animals
   - 2.5 gallons/acre or less: Do not graze or harvest green forage from treated area for 14 days after treatment.
   - Greater than 2.5 gallons/acre: Do not graze or harvest green forage until the next growing season.
2) Other Livestock
   - 2.5 gallons/acre or less: No grazing restrictions.
   - Greater than 2.5 to 7.5 gallons/acre: Do not graze or harvest green forage from treated area for 14 days after treatment. **Note:** If less than 25% of a grazed area is treated, there is no grazing restriction.

Haying (harvesting of dried forage):

1) Lactating dairy animals
   - Do not harvest hay until the next growing season.
2) Other Livestock
   - 2.5 gallons/acre or less: Do not harvest hay for 7 days after treatment.
   - Greater than 2.5 to 5 gallons/acre: Do not harvest hay for 14 days after treatment.
   - Greater than 5 gallons/acre: Do not harvest hay until the next growing season.

Slaughter Restrictions: Withdraw livestock from grazing treated grass or consumption of treated hay at least 3 days before slaughter. This restriction applies to grazing during the season following treatment or hay harvested during the season following treatment.

Among The Woody Plant Species Controlled Are:

ailanthus	hackberry	oak, water
alder, red	hazel	oak, white
alder, speckled	hercules club	olive, autumn
ash, green	hickory, mockernut	olive, Russian
ash, white	hickory, pignut	persimmon, common
aspen†	honeylocust	pine, jack
Australian pine	hornbeam (blue beach)	pine, loblolly
basswood	locust, black†	pine, ponderosa
beech, American	madrone, Pacific	pine, red
birch, black	manzanita, greenleaf	pine, white
birch, gray	maple, bigleaf†	poison ivy
birch, paper	maple, mountain	poison oak
blackberry	maple, red	poplar, balsam
black locust	maple, silver	redcedar, eastern
blackgum	maple, striped	salt cedar†
boxelder	maple, sugar	sassafras†
Brazilian pepper	maple, vine	sumac, smooth†
cherry, black†	mesquite†/†††	sumac, staghorn†
cherry, choke	mountain-laurel	sweetgum
cherry, pin	oak, black††	sycamore
cottonwood	oak, blackjack††	tamarack
dogwood, flowering	oak, chestnut	tanoak
dogwood, red-osier	oak, post††	walnut
elm, American	tanoak	waxmyrtle
elm, winged†	walnut	willow
gallberry	oak, red	yaupon
guava	oak, scarlet	yellow poplar

† Some resprouting may occur.
†† Not recommended for streamline basal treatment.
††† Suppression only with streamline basal bark treatment.

Approved Uses

Forest Uses

Agricultural Use Requirements for Forest Use: For the following crop and forestry uses, follow PPE and Reentry instructions in the "Agricultural Use Requirements" section of this label.

Non-crop Uses Such As Rights-of-Way, Industrial Sites, Rangeland and Permanent Pastures, Non-irrigation Ditch Banks and Wildlife Openings.

Use Requirements for Non-cropland Areas: No Worker Protection Standard worker entry restrictions or worker notification requirements apply when this product is applied to non-cropland areas.

Low Volume Basal Bark Treatment

To control susceptible woody plants with stems less than 6 inches in basal diameter, apply Pathfinder II with a backpack or knapsack sprayer using low pressure and a solid cone or flat fan nozzle. Spray the basal parts of brush and tree trunks in a manner which thoroughly wets the lower 12 to 15 inches of stems, including the root collar area, but not to the point of runoff. Herbicide concentration should vary with size and susceptibility of species treated. Apply at any time, including the winter months, except when snow or water prevent spraying to the ground line.

Treatment of Cut Stumps

To control resprouting, apply undiluted Pathfinder II to wet the area adjacent to the cambium and bark around the entire circumference and the sides of cut stumps. Sides of stumps should be thoroughly wetted down to the root collar area, but not to the point of runoff. Treatments may be applied throughout the year, except when snow or water prevent spraying to the ground line. Control may be reduced with treatment during periods of moisture stress as in late summer.

Streamline Basal Bark Treatment (Southern States)

To control or suppress susceptible woody plants for conifer release or in rangeland and pasture, apply Pathfinder II with a backpack or knapsack sprayer using equipment which provides a directed straight-stream spray. Apply sufficient spray to one side of stems less than 3 inches in basal diameter to form a treated zone that is 6 inches in height. When the optimum amount of spray mixture is applied, the treated zone should widen to encircle the stem within approximately 30 minutes. Treat both sides of stems which are 3 to 4 inches in basal diameter. Direct the spray at bark that is approximately 12 to 24 inches above ground. Pines (loblolly, slash, shortleaf, and Virginia) up to 2 inches in diameter breast height (dbh) can be controlled by directing the spray at the point approximately 4 feet above ground. Best results are achieved when applications are made to young vigorously growing stems which have not developed the thicker bark characteristic of slower growing, understory trees in older stands. This technique is not recommended for scrub and live oak species, including blackjack, turkey, post, live, bluejack and laurel oaks. Apply from approximately 6 weeks prior to hardwood leaf expansion in the spring until approximately 2 months after leaf expansion is completed. Do not apply when snow or water prevent spraying at the desired height above ground level.

Warranty Disclaimer

Dow AgroSciences warrants that this product conforms to the chemical description on the label and is reasonably fit for the purposes stated on the label when used in strict accordance with the directions, subject to the inherent risks set forth below. Dow AgroSciences MAKES NO OTHER EXPRESS OR IMPLIED WARRANTY OF MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE OR ANY OTHER EXPRESS OR IMPLIED WARRANTY.

Inherent Risks of Use

It is impossible to eliminate all risks associated with use of this product. Plant injury, lack of performance, or other unintended consequences may result because of such factors as use of the product contrary to label instructions (including conditions noted on the label, such as unfavorable temperature, soil conditions, etc.), abnormal conditions (such as excessive rainfall, drought, tornadoes, hurricanes), presence of other materials, the manner of application, or other factors, all of which are beyond the control of Dow AgroSciences or the seller. All such risks shall be assumed by buyer.

Limitation of Remedies

The exclusive remedy for losses or damages resulting from this product (including claims based on contract, negligence, strict liability, or other legal theories), shall be limited to, at Dow AgroSciences' election, one of the following:

1. Refund of purchase price paid by buyer or user for product bought, or
2. Replacement of amount of product used

Dow AgroSciences shall not be liable for losses or damages resulting from handling or use of this product unless Dow AgroSciences is promptly notified of such loss or damage in writing. In no case shall Dow AgroSciences be liable for consequential or incidental damages or losses.

The terms of the "Warranty Disclaimer" above and this "Limitation of Remedies" cannot be varied by any written or verbal statements or agreements. No employee or sales agent of Dow AgroSciences or the seller is authorized to vary or exceed the terms of the "Warranty Disclaimer" or this "Limitation of Remedies" in any manner.

*Trademark of Dow AgroSciences LLC
Dow AgroSciences LLC • Indianapolis, IN 46268 U.S.A.

Label Code: D02-104-007
Replaces Label: D02-104-006

EPA Accepted 05/17/94

Revisions:

1. General Use Precautions (The following statement was deleted from this section): "Do not use for manufacturing or formulating."

This sample label is current as of October 5, 2000. The product descriptions and recommendations provided in this sample label are for background information only. Always refer to the label on the product before using Monsanto or any other agrichemical product.

21203Z1-1/CG

Roundup PRO Concentrate

The Complete Broad Spectrum Postemergence Professional Herbicide for Industrial, Turf and Ornamental Weed Control.

Complete Directions for Use

EPA Reg. No. 524-529

AVOID CONTACT OF HERBICIDE WITH FOLIAGE, GREEN STEMS, EXPOSED NON-WOODY ROOTS OR FRUIT OF CROPS, DESIRABLE PLANTS AND TREES, BECAUSE SEVERE INJURY OR DESTRUCTION IS LIKELY TO RESULT.

Roundup Pro Concentrate is a trademark of Monsanto Technology LLC.

2001-1

Read the entire label before using this product.

Use only according to label instructions.

It is a violation of Federal law to use this product in any manner inconsistent with its labeling.

Not all products recommended on this label are registered for use in California. Check the registration status of each product in California before using.

Read the "LIMIT OF WARRANTY AND LIABILITY" statement at the end of the label before buying or using. If terms are not acceptable, return at once unopened.

THIS IS AN END-USE PRODUCT. MONSANTO DOES NOT INTEND AND HAS NOT REGISTERED IT FOR REFORMULATION. SEE INDIVIDUAL CONTAINER LABEL FOR REPACKAGING LIMITATIONS.

1.0 INGREDIENTS

ACTIVE INGREDIENT:	
*Glyphosate, N-(phosphonomethyl)glycine, in the form of its isopropylamine salt	50.2%
OTHER INGREDIENTS:	49.8%
	100.0%

*Contains 600 grams per litre or 5 pounds per U.S. gallon of the active ingredient glyphosate, in the form of its isopropylamine salt.

This product is protected by U.S. Patent Nos. 5,683,958; 5,703,015; 6,063,733; 6,121,199; and 6,121,200. No license granted under any non-U.S. patent(s).

2.0 IMPORTANT PHONE NUMBERS

1. FOR PRODUCT INFORMATION OR ASSISTANCE IN USING THIS PRODUCT, CALL TOLL-FREE, 1-800-332-3111.
2. IN CASE OF AN EMERGENCY INVOLVING THIS PRODUCT, OR FOR MEDICAL ASSISTANCE, CALL COLLECT, DAY OR NIGHT, 1-(314)-694-4000.

3.0 PRECAUTIONARY STATEMENTS

3.1 Hazards to Humans and Domestic Animals

Keep out of reach of children.

CAUTION!

CAUSES MODERATE EYE IRRITATION.
Avoid contact with eyes or clothing.

FIRST AID	
IF IN EYES	Hold eye open and rinse slowly and gently with water for 15-20 minutes. Remove contact lenses, if present, after the first 5 minutes, then continue rinsing eye. Call a poison control center or doctor for treatment advice.
HOT LINE NUMBER	
Have the product container or label with you when calling a poison control center or doctor, or going for treatment. This product is identified as Roundup Pro Concentrate™, EPA Registration No. 524-529. You may also contact (314) 694-4000, collect day or night, for emergency medical treatment information.	

DOMESTIC ANIMALS: This product is considered to be relatively nontoxic to dogs and other domestic animals; however, ingestion of this product or large amounts of freshly sprayed vegetation may result in temporary gastrointestinal irritation (vomiting, diarrhea, colic, etc.). If such symptoms are observed, provide the animal with plenty of fluids to prevent dehydration. Call a veterinarian if symptoms persist for more than 24 hours.

Personal Protective Equipment (PPE)

Applicators and other handlers must wear: long-sleeved shirt and long pants, shoes plus socks. Follow manufacturer's instructions for cleaning/maintaining Personal Protective Equipment (PPE). If there are no such instructions for washables, use detergent and hot water. Keep and wash PPE separately from other laundry.

When handlers use closed systems, enclosed cabs or aircraft in a manner that meets the requirements listed in Worker Protection Standard (WPS) for agricultural pesticides [40 CFR 170.240 (d) (4-6)], the handler PPE requirements may be reduced or modified as specified in the WPS.

User Safety Recommendations

Users should:

- Wash hands before eating, drinking, chewing gum, using tobacco or using the toilet.
- Remove clothing immediately if pesticide gets inside. Then wash thoroughly and put on clean clothing.

3.2 Environmental Hazards

Do not apply directly to water, to areas where surface water is present or to intertidal areas below the mean high water mark. Do not contaminate water when disposing of equipment washwaters.

3.3 Physical or Chemical Hazards

Spray solutions of this product should be mixed, stored and applied using only stainless steel, aluminum, fiberglass, plastic or plastic-lined steel containers.

DO NOT MIX, STORE OR APPLY THIS PRODUCT OR SPRAY SOLUTIONS OF THIS PRODUCT IN GALVANIZED STEEL OR UNLINED STEEL (EXCEPT STAINLESS STEEL) CONTAINERS OR SPRAY TANKS. This product or spray solutions of this product react with such containers and tanks to produce hydrogen gas which may form a highly combustible gas mixture. This gas mixture could flash or

explode, causing serious personal injury, if ignited by open flame, spark, welder's torch, lighted cigarette or other ignition source.

DIRECTIONS FOR USE

It is a violation of Federal law to use this product in any manner inconsistent with its labeling. Do not apply this product in a way that will contact workers or other persons, either directly or through drift. Only protected handlers may be in the area during application. For any requirements specific to your State or Tribe, consult the agency responsible for pesticide regulations.

Agricultural Use Requirements

Use this product only in accordance with its labeling and with the Worker Protection Standard, 40 CFR part 170. This Standard contains requirements for the protection of agricultural workers on farms, forests, nurseries, and greenhouses, and handlers of agricultural pesticides. It contains requirements for training, decontamination, notification and emergency assistance. It also contains specific instructions and exceptions pertaining to the statements on this label about Personal Protective Equipment (PPE) and restricted entry interval. The requirements in this box only apply to uses of this product that are covered by the Worker Protection Standard.

Do not enter or allow worker entry into treated areas during the restricted entry interval (REI) of 4 hours.

PPE required for early entry to treated areas that is permitted under the Worker Protection Standard and that involves contact with anything that has been treated, such as plants, soil or water, is: coveralls, shoes plus socks and waterproof gloves.

Non-Agricultural Use Requirements

The requirements in this box apply to uses of this product that are NOT within the scope of the Worker Protection Standard (40 CFR Part 170) for agricultural pesticides. The WPS applies when this product is used to produce agricultural plants on farms, forests, nurseries or greenhouses.

Keep people and pets off treated areas until spray solution has dried to prevent transfer of this product onto desirable vegetation.

4.0 STORAGE AND DISPOSAL

Do not contaminate water, foodstuffs, feed or seed by storage or disposal.

Keep container closed to prevent spills and contamination.

DISPOSAL: Wastes resulting from the use of this product that cannot be used or chemically reprocessed should be disposed of in a landfill approved for pesticide disposal or in accordance with applicable Federal, state, or local procedures.

Emptied container retains vapor and product residue. Observe all labeled safeguards until container is cleaned, reconditioned, or destroyed.

FOR REFILLABLE PORTABLE CONTAINERS: Do not reuse this container except for refill in accordance with a valid Monsanto Repackaging or Toll Repackaging Agreement. If not refilled or returned to the authorized repackaging facility, triple rinse container, then puncture and dispose of in a sanitary landfill, or by incineration, or, if allowed by state and local authorities, by burning. If burned, stay out of smoke.

FOR METAL CONTAINERS (non-aerosol): Triple rinse (or equivalent). Then offer for recycling or reconditioning, or puncture and dispose of in a sanitary landfill, or by other procedures approved by state and local authorities.

FOR BULK CONTAINERS: Triple rinse emptied bulk container. Then offer for recycling or reconditioning, or dispose of in a manner approved by state and local authorities.

FOR PLASTIC 1-WAY CONTAINERS & BOTTLES: Do not reuse container. Triple rinse container, then puncture and dispose of in a sanitary landfill, or by incineration, or, if allowed by state and local authorities, by burning. If burned, stay out of smoke.

FOR DRUMS: Do not reuse container. Return container per the Monsanto container return program. If not returned, triple rinse container, then puncture and dispose of in a sanitary landfill, or by incineration, or, if allowed by state and local authorities, by burning. If burned, stay out of smoke.

5.0 GENERAL INFORMATION

Product Description: This product is a postemergent, systemic herbicide with no soil residual activity. It gives broad spectrum control of many annual weeds, perennial weeds, woody brush and trees. It is formulated as a water-soluble liquid containing surfactant.

Environmental Fate: When this product comes in contact with the soil it is bound to soil particles. When used in accordance with label directions, once this product is bound it is not available for plant uptake and will not harm off-site vegetation where roots grow into the treatment area or if the soil is transported off-site. The strong affinity of this product to soil particles prevents this product from leaching out of the soil profile and entering ground water. The affinity between this product and soil particles remains until this product is degraded, which is primarily a biological degradation process carried out under both aerobic and anaerobic conditions by soil microflora.

Time to Symptoms: This product moves through the plant from the point of foliage contact to and into the root system. Visible effects on most annual weeds occur within 2 to 4 days, but on most perennial weeds may not occur for 7 days or more. Extremely cool or cloudy weather following treatment may slow activity of this product and delay development of visual symptoms. Visible effects are a gradual wilting and yellowing of the plant which advances to complete browning of aboveground growth and deterioration of underground plant parts.

Mode of Action in Plants: The active ingredient in this product inhibits an enzyme found only in plants that is essential to formation of specific amino acids.

Cultural Considerations: Reduced control may result when applications are made to annual or perennial weeds that have been mowed, grazed or cut, and have not been allowed to regrow to the recommended stage for treatment.

Rainfastness: Heavy rainfall soon after application may wash this product off of the foliage and a repeat application may be required for adequate control.

No Soil Activity: Weeds must be emerged at the time of application to be controlled by this product. Weeds germinating from seed after application will not be controlled. Unemerged plants arising from unattached underground rhizomes or root stocks of perennials will not be affected by the herbicide.

Volatility: Roundup Pro Concentrate herbicide is nonvolatile. Therefore, it cannot move as a vapor after application to affect nearby vegetation.

Toxicology: Exposure to workers and other applicators generally is expected to pose minimal risks based on results of short-term toxicity studies. Glyphosate has been thoroughly tested and determined not to cause cancer or other adverse long-term health effects.

Tank Mixing: This product does not provide residual weed control. For subsequent residual weed control, follow a label-approved herbicide program. Read and carefully observe the cautionary statements and all other information appearing on the labels of all herbicides used. Use according to the most restrictive label directions for each product in the mixture.

Buyer and all users are responsible for all loss or damage in connection with the use or handling of mixtures of this product with herbicides or other materials that are not expressly recommended in this label. Mixing this product with herbicides or other materials not recommended on this label may result in reduced performance.

Grazing Restrictions for Utility Rights-of-Way: This product may be used to treat undesirable vegetation in rights-of-way that pass through pastures and rangeland and on forestry sites that are being grazed. For tank-mix applications, comply with all restrictions appearing on the tank-mix product label.

There are no grazing restrictions for the following applications of this product:

- Where the spray can be directed onto undesirable

weeds, woody brush and trees, such as in handgun, spray-to-wet or low volume directed spray treatments.

- For tree injection or frill application and for cut stump treatments.

For broadcast applications, observe the following restrictions:

- For application rates of greater than 4 3/4 quarts but not to exceed 8 quarts per acre, no more than 15 percent of the available grazing area may be treated.
- For application rates that do not exceed 4 3/4 quarts per acre, no more than 25 percent of the available grazing area may be treated.
- All restrictions apply to lactating dairy animals. No other restrictions apply to lactating dairy animals.

These recommendations do not apply to rangeland outside of utility rights-of-way.

Annual Maximum Use Rate: The combined total of all treatments must not exceed 8.5 quarts of this product per acre per year.

ATTENTION

AVOID CONTACT OF HERBICIDE WITH FOLIAGE, GREEN STEMS, EXPOSED NON-WOODY ROOTS OR FRUIT OF CROPS, DESIRABLE PLANTS AND TREES, BECAUSE SEVERE INJURY OR DESTRUCTION MAY RESULT.

AVOID DRIFT. EXTREME CARE MUST BE USED WHEN APPLYING THIS PRODUCT TO PREVENT INJURY TO DESIRABLE PLANTS AND CROPS.

Do not allow the herbicide solution to mist, drip, drift or splash onto desirable vegetation since minute quantities of this product can cause severe damage or destruction to the crop, plants or other areas on which treatment was not intended. The likelihood of injury occurring from the use of this product increases when winds are gusty, as wind velocity increases, when wind direction is constantly changing or when there are other meteorological conditions that favor spray drift. When spraying, avoid combinations of pressure and nozzle type that will result in splatter or fine particles (mist) which are likely to drift. AVOID APPLYING AT EXCESSIVE SPEED OR PRESSURE.

NOTE: Use of this product in any manner not consistent with this label may result in injury to persons, animals or crops, or other unintended consequences. Keep container closed to prevent spills and contamination.

6.0 MIXING

Clean sprayer parts immediately after using this product by thoroughly flushing with water.

NOTE: REDUCED RESULTS MAY OCCUR IF WATER CONTAINING SOIL IS USED, SUCH AS VISIBLY MUDDY WATER OR WATER FROM PONDS AND DITCHES THAT IS NOT CLEAR.

Now More Concentrated

Use the following conversion table to help determine application rates of Roundup Pro Concentrate herbicide based on commonly used rates of Roundup Pro® herbicide:

Roundup Pro Concentrate (Ounces)	Roundup Pro (Ounces)	Roundup Pro (Pints)
20	24	1.5
26	32	2.0
32	40	2.5

6.1 Mixing With Water

This product mixes readily with water. Mix spray solutions of this product as follows: Fill the mixing or spray tank with the required amount of water. Add the recommended amount of this product near the end of the filling process and mix well. Use caution to avoid siphoning back into the carrier source. Use approved anti-backsiphoning devices where required by state or local regulations. During mixing and application, foaming of the spray solution may occur. To prevent or minimize foam, avoid the use of mechanical agitators, terminate by-pass and return lines at the bottom of the tank and, if needed, use an approved anti-foam or defoaming agent.

6.2 Tank Mixing Procedure

When tank mixing, read and carefully observe label directions, cautionary statements and all information on the labels of all products used. Add the tank-mix product to the tank as directed by the label. Maintain agitation and add the recommended amount of this product.

Maintain good agitation at all times until the contents of the tank are sprayed. If the spray mixture is allowed to settle, thorough agitation may be required to resuspend the mixture before spraying is resumed.

Keep by-pass line on or near the bottom of the tank to minimize foaming. Screen size in nozzle or line strainers should be no finer than 50 mesh.

Always predetermine the compatibility of labeled tank mixtures of this product with water carrier by mixing small proportional quantities in advance.

Refer to the **"Tank Mixing"** section of "GENERAL INFORMATION" for additional precautions.

6.3 Mixing for Hand-Held Sprayers

Prepare the desired volume of spray solution by mixing the amount of this product in water as shown in the following table:

Spray Solution

Desired Volume	Amount of Roundup Pro Concentrate herbicide					
	0.4%	0.8%	1.2%	1.6%	4%	8%
1 Gallon	0.5 oz	1 oz	1.6 oz	2.1 oz	5.2 oz	10.5 oz
25 Gallon	13 oz	0.8 qt	1.2 qt	1.6 qt	4 qt	8 qt
100 Gallon	1.6 qt	0.8 gal	1.2 gal	1.6 gal	4 gal	8 gal

2 tablespoons = 1 fluid ounce

For use in backpack, knapsack or pump-up sprayers, it is suggested that the recommended amount of this product be mixed with water in a larger container. Fill sprayer with the mixed solution.

6.4 Colorants or Dyes

Agriculturally approved colorants or marking dyes may be added to this product. Colorants or dyes used in spray solutions of this product may reduce performance, especially at lower rates or dilution. Use colorants or dyes according to the manufacturer's recommendations.

7.0 APPLICATION EQUIPMENT AND TECHNIQUES

SPRAY DRIFT MANAGEMENT

AVOID DRIFT. EXTREME CARE MUST BE USED WHEN APPLYING THIS PRODUCT TO PREVENT INJURY TO DESIRABLE PLANTS AND CROPS.

Avoiding spray drift at the application site is the responsibility of the applicator. The interaction of many equipment- and weather-related factors determine the potential for spray drift. The applicator and the grower are responsible for considering all these factors when making decisions.

Do not apply this product through any type of irrigation system.

Apply these spray solutions in properly maintained and calibrated equipment capable of delivering desired volumes.

Do not allow the herbicide solution to mist, drip, drift or splash onto desirable vegetation since minute quantities of this product can cause severe damage or destruction to the crop, plants or other areas on which treatment was not intended.

7.1 Aerial Equipment

DO NOT APPLY THIS PRODUCT USING AERIAL SPRAY EQUIPMENT EXCEPT UNDER CONDITIONS AS SPECIFIED WITHIN THIS LABEL.

For aerial broadcast applications, unless otherwise specified, use this product at the rate of 0.8 to 1.6 quarts per acre for annual weeds, 1.6 to 4 quarts per acre for perennial weeds and 4 to 8 quarts per acre for woody brush and trees. Use the recommended rates of this herbicide in 3 to 25 gallons of water per acre. When used according

to label directions this product will give control or partial control of herbaceous weeds, woody brush and trees listed in the "WEEDS CONTROLLED" section of this label.

FOR AERIAL APPLICATION IN CALIFORNIA, REFER TO THE FEDERAL SUPPLEMENTAL LABEL FOR AERIAL APPLICATIONS IN THAT STATE FOR SPECIFIC INSTRUCTIONS, RESTRICTIONS AND REQUIREMENTS. This product plus Banvel™ tank mixtures may not be applied by air in California.

AERIAL SPRAY DRIFT MANAGEMENT

The following drift management requirements must be followed to avoid off-target drift movement from aerial applications to agricultural field crops. These requirements do not apply to forestry applications or to public health uses.

1. The distance of the outermost nozzles on the boom must not exceed 3/4 the length of the wingspan or rotor.
2. Nozzles must always point backward parallel with the airstream and never be pointed downwards more than 45 degrees. Where states have more stringent regulations, they should be observed.

Importance of droplet size

The most effective way to reduce drift potential is to apply large droplets. The best drift management strategy is to apply the largest droplets that provide sufficient coverage and control. Applying larger droplets reduces drift potential, but will not prevent drift if applications are made improperly, or under unfavorable environmental conditions (see the **"Wind"**, **"Temperature and Humidity"**, and **"Temperature Inversion"** sections of this label).

Controlling droplet size

- **Volume:** Use high flow rate nozzles to apply the highest practical spray volume. Nozzles with the higher rated flows produce larger droplets.
- **Pressure:** Use the lower spray pressures recommended for the nozzle. Higher pressure reduces droplet size and does not improve canopy penetration. When higher flow rates are needed, use higher flow rate nozzles instead of increasing pressure.
- **Number of nozzles:** Use the minimum number of nozzles that provide uniform coverage.
- **Nozzle orientation:** Orienting nozzles so that the spray is released backwards, parallel to the airstream, will produce larger droplets than other orientations. Significant deflection from the horizontal will reduce droplet size and increase drift potential.
- **Nozzle type:** Use a nozzle type that is designed for the intended application. With most nozzle types, narrower spray angles produce larger droplets. Consider using low-drift nozzles. Solid stream nozzles oriented straight back produce larger droplets than other nozzle types.
- **Boom length:** For some use patterns, reducing the effective boom length to less than 3/4 of the wingspan or rotor length may further reduce drift without reducing swath width.
- **Application height:** Applications should not be made at a height greater than 10 feet above the top of the largest plants unless a greater height is required for aircraft safety. Making applications at the lowest height that is safe reduces the exposure of the droplets to evaporation and wind.

Swath Adjustment

When applications are made with a crosswind, the swath will be displaced downward. Therefore, on the up and downwind edges of the field, the applicator must compensate for this displacement by adjusting the path of the aircraft upwind. Swath adjustment distance should increase, with increasing drift potential (higher wind, smaller droplets, etc.).

Wind

Drift potential is lowest between wind speeds of 2 to 10 mph. However, many factors, including droplet size and equipment type determine drift potential at any given speed. Application should be avoided below 2 mph due to variable wind direction and high inversion potential. **NOTE:** Local terrain can influence wind patterns. Every applicator should be familiar with local wind patterns and how they affect drift.

Temperature and Humidity

When making applications in low relative humidity, set up equipment to produce larger droplets to compensate for evaporation. Droplet evaporation is most severe when conditions are both hot and dry.

Temperature Inversions

Applications should not occur during a temperature inversion because drift potential is high. Temperature inversions restrict vertical air mixing, which causes small, suspended droplets to remain in a concentrated cloud. This cloud can move in unpredictable directions due to the light variable winds common during inversions. Temperature inversions are characterized by increasing temperatures with altitude and are common on nights with limited cloud cover and light to no wind. They begin to form as the sun sets and often continue into the morning. Their presence can be indicated by ground fog; however, if fog is not present, inversions can also be identified by the movement of smoke from a ground source or an aircraft smoke generator. Smoke that layers and moves laterally in a concentrated cloud (under low wind conditions) indicates an inversion, while smoke that moves upward and rapidly dissipates indicates good vertical air mixing.

Sensitive Areas

The pesticide should only be applied when the potential for drift to adjacent sensitive areas (e.g., residential areas, bodies of water, known habitat for threatened or endangered species, non-target crops) is minimal (e.g., when wind is blowing away from the sensitive areas).

Avoid direct application to any body of water.

Drift control additives may be used. When a drift control additive is used, read and carefully observe the cautionary statements and all other information appearing on the additive label.

Ensure uniform application—To avoid streaked, uneven or overlapped application, use appropriate marking devices.

PROLONGED EXPOSURE OF THIS PRODUCT TO UNCOATED STEEL SURFACES MAY RESULT IN CORROSION AND POSSIBLE FAILURE OF THE PART. The maintenance of an organic coating (paint) which meets aerospace specification MIL-C-38413 may prevent corrosion. To prevent corrosion of exposed parts, thoroughly wash aircraft after each day of spraying to remove residues of this product accumulated during spraying or from spills. Landing gear are most susceptible.

7.2 Ground Broadcast Equipment

For broadcast ground applications, unless otherwise specified use this product at the rate of 0.8 to 1.6 quarts per acre for annual weeds, 1.6 to 4 quarts per acre for perennial weeds and 4 to 8 quarts per acre for woody brush and trees. When used according to label directions this product will give control or partial control of herbaceous weeds, woody brush and trees listed in the "WEEDS CONTROLLED" section of this label.

Use the recommended rates of this product in 3 to 40 gallons of water per acre as a broadcast spray unless otherwise specified. As density of weeds increases, spray volume should be increased within the recommended range to ensure complete coverage. Carefully select proper nozzles to avoid spraying a fine mist. For best results with ground application equipment, use flat-fan nozzles. Check for even distribution of spray droplets.

7.3 Hand-Held and High-Volume Equipment

Apply to foliage of vegetation to be controlled. For applications made on a spray-to-wet basis, spray coverage should be uniform and complete. Do not spray to the point of runoff. Use coarse sprays only.

For control of weeds listed in the **"Annual Weeds"** section of "WEEDS CONTROLLED", apply a 0.4 percent solution of this product to weeds less than 6 inches in height or runner length. For annual weeds over 6 inches tall, or unless otherwise specified, use a 0.8 percent solution. Apply prior to seedhead formation in grass or bud formation in broadleaf weeds.

For best results, use a 1.6 percent solution on harder-to-control perennials, such as bermudagrass, dock, field bindweed, hemp dogbane, milkweed and Canada thistle.

For low volume directed spray applications, use a 4 to 8 percent solution of this product for control or partial control of annual weeds, perennial weeds, or woody brush and trees. Spray coverage should be uniform with at least 50 percent of the foliage contacted. Coverage of the top one-half of the plant is important for best results. To ensure adequate spray coverage, spray both sides of large or tall woody brush and trees, when foliage is thick and dense, or where there are multiple sprouts.

7.4 Selective Equipment

This product may be applied through recirculating spray systems, shielded applicators, hooded sprayers, wiper applicators or sponge bars after dilution and thorough mixing with water to listed weeds growing in any noncrop site specified on this label.

A recirculating spray system directs the spray solution onto weeds growing above desirable vegetation, while spray solution not intercepted by weeds is collected and returned to the spray tank for reuse.

A shielded or hooded applicator directs the herbicide solution onto weeds, while shielding desirable vegetation from the herbicide.

A wiper or sponge applicator applies the herbicide solution onto weeds by rubbing the weed with an absorbent material containing the herbicide solution.

AVOID CONTACT OF HERBICIDE WITH DESIRABLE VEGETATION.

Applicators used above desired vegetation should be adjusted so that the lowest spray stream or wiper contact point is at least 2 inches above the desirable vegetation. Droplets, mist, foam or splatter of the herbicide solution settling on desirable vegetation is likely to result in discoloration, stunting or destruction.

Better results may be obtained when more of the weed is exposed to the herbicide solution. Weeds not contacted by the herbicide solution will not be affected. This may occur in dense clumps, severe infestations or when the height of the weeds varies so that not all weeds are contacted. In these instances, repeat treatment may be necessary.

Shielded and Hooded Applicators

Use nozzles that provide uniform coverage within the treated area. Keep shields on these sprayers adjusted to protect desirable vegetation. EXTREME CARE MUST BE EXERCISED TO AVOID CONTACT OF HERBICIDE WITH DESIRABLE VEGETATION.

Wiper Applicators and Sponge Bars

Equipment must be designed, maintained and operated to prevent the herbicide solution from contacting desirable vegetation. Operate this equipment at ground speeds no greater than 5 mph. Performance may be improved by reducing speed in areas of heavy weed infestations to ensure adequate wiper saturation. Better results may be obtained if 2 applications are made in opposite directions.

Avoid leakage or dripping onto desirable vegetation. Adjust height of applicator to ensure adequate contact with weeds. Keep wiping surfaces clean. Be aware that, on sloping ground, the herbicide solution may migrate, causing dripping on the lower end and drying of the wicks on the upper end of a wiper applicator.

Do not use wiper equipment when weeds are wet.

Mix only the amount of solution to be used during a 1-day period, as reduced activity may result from use of leftover solutions. Clean wiper parts immediately after using this product by thoroughly flushing with water.

For Rope or Sponge Wick Applicators—Solutions ranging from 33 to 75 percent of this product in water may be used.

For Porous-Plastic Applicators and Pressure-Feed Systems—Solutions ranging from 33 to 100 percent of this product in water may be used.

When applied as recommended, this product CONTROLS the following weeds:

Corn, volunteer	Sicklepod
Panicum, Texas	Spanishneedles
Rye, common	Starbur, bristly
Shattercane	

When applied as recommended, this product SUPPRESSES the following weeds:

Beggarweed, Florida	Ragweed, common
Bermudagrass	Ragweed, giant
Dogbane, hemp	Smutgrass
Dogfennel	Sunflower
Guineagrass	Thistle, Canada
Johnsongrass	Thistle, musk
Milkweed	Vaseygrass
Nightshade, silverleaf	Velvetleaf
Pigweed, redroot	

7.5 Injection Systems

This product may be used in aerial or ground injection spray systems. It may be used as a liquid concentrate or diluted prior to injecting into the spray stream. Do not mix this product with the undiluted concentrate of other products when using injection systems unless specifically recommended.

7.6 CDA Equipment

The rate of this product applied per acre by controlled droplet application (CDA) equipment must not be less than the amount recommended in this label when applied by conventional broadcast equipment. For vehicle-mounted CDA equipment, apply 3 to 15 gallons of water per acre.

CDA equipment produces a spray pattern which is not easily visible. Extreme care must be exercised to avoid spray or drift contacting the foliage or any other green tissue of desirable vegetation, as damage or destruction is likely to result.

8.0 SITE AND USE RECOMMENDATIONS

Detailed instructions follow alphabetically, by site.

Unless otherwise specified, applications may be made to control any weeds listed in the annual, perennial and woody brush tables. Refer also to the **"Selective Equipment"** section.

8.1 Cut Stumps

Cut stump treatments may be made on any site listed on this label. This product will control many types of woody brush and tree species, some of which are listed below. Apply this product using suitable equipment to ensure coverage of the entire cambium. Cut trees or resprouts close to the soil surface. Apply a 50 to 100 percent solution of this product to the freshly-cut surface **immediately** after cutting. Delays in application may result in reduced performance. For best results, applications should be made during periods of active growth and full leaf expansion.

Alder	Saltcedar
Eucalyptus	Sweetgum
Madrone	Tan oak
Oak	Willow
Reed, giant	

DO NOT MAKE CUT STUMP APPLICATIONS WHEN THE ROOTS OF DESIRABLE WOODY BRUSH OR TREES MAY BE GRAFTED TO THE ROOTS OF THE CUT STUMP. INJURY RESULTING FROM ROOT GRAFTING IS LIKELY TO OCCUR IN ADJACENT WOODY BRUSH OR TREES.

8.2 General Noncrop Areas and Industrial Sites

Use in areas such as airports, ditch banks, dry ditches, dry canals, fencerows, industrial sites, lumber yards, ornamental nurseries, parking areas, petroleum tank farms and pumping installations, railroads, roadsides, sod and turf farms, storage areas, warehouse areas, and similar industrial and noncrop sites.

General Weed Control, Trim-and-Edge and Bare Ground

This product may be used in general noncrop areas. It

may be applied with any application equipment described in this label. This product may be used to trim-and-edge around objects in noncrop sites. This product may be used prior to laying asphalt or beginning construction projects.

Repeated applications of this product may be used, as weeds emerge, to maintain bare ground.

This product may be tank mixed with the following products. Refer to these products' labels for approved noncrop sites and application rates.

ARSENAL™	DIURON
BANVEL	ENDURANCE™
BARRICADE™ 65WG	ESCORT™
GARLON™ 3A	PRINCEP™ DF
GARLON 4	PRINCEP LIQUID
KARMEX™ DF	RONSTAR™ 50WP
KROVAR™ I DF	SAHARA™
MANAGE®	SIMAZINE
OUST™	SURFLAN™
PENDULUM™ 3.3 EC	TELAR™
PENDULUM WDG	VANQUISH™
PLATEAU™	2,4-D

Banvel tank mixtures may not be applied by air in California.

When applied as a tank mixture for bare ground, this product provides control of the emerged annual weeds and control or partial control of emerged perennial weeds, woody brush and trees.

For control or partial control of the following perennial weeds, apply 0.8 to 1.6 quarts of this product plus 2 to 4 ounces of Oust per acre.

Bahiagrass	Fescue, tall
Bermudagrass	Johnsongrass
Broomsedge	Poorjoe
Dallisgrass	Quackgrass
Dock, curly	Vaseygrass
Dogfennel	Vervain, blue

Chemical Mowing—Perennials

This product will suppress perennial grasses listed in this section to serve as a substitute for mowing. Use 6.4 fluid ounces of this product per acre when treating tall fescue, fine fescue, orchardgrass or quackgrass covers. Use 5 fluid ounces of this product per acre when treating Kentucky bluegrass. Apply treatments in 10 to 40 gallons of spray solution per acre.

Use only in areas where some temporary injury or discoloration of perennial grasses can be tolerated.

Chemical Mowing—Annuals

For growth suppression of some annual grasses, such as annual ryegrass, wild barley and wild oats growing in coarse turf on roadsides or other industrial areas, apply 3 to 4 fluid ounces of this product in 10 to 40 gallons of spray solution per acre. Applications should be made when annual grasses are actively growing and before the seedheads are in the boot stage of development. Treatments may cause injury to the desired grasses.

8.3 Habitat Management

Habitat Restoration and Management

This product may be used to control exotic and other undesirable vegetation in habitat management and natural areas, including rangeland and wildlife refuges. Applications can be made to allow recovery of native plant species, prior to planting desirable native species, and for similar broad spectrum vegetation control requirements. Spot treatments can be made to selectively remove unwanted plants for habitat management and enhancement.

Wildlife Food Plots

This product may be used as a site preparation treatment prior to planting wildlife food plots. Any wildlife food species may be planted after applying this product, or native species may be allowed to repopulate the area. If tillage is needed to prepare a seedbed, wait 7 days after application before tillage to allow translocation into underground plant parts.

8.4 Injection and Frill (Woody Brush and Trees)

This product may be used to control woody brush and trees by injection or frill applications. Apply this product using suitable equipment which must penetrate into the living tissue. Apply the equivalent of 1 milliliter of this product per each 2 to 3 inches of trunk diameter at breast height (DBH). This is best achieved by applying a 50 to 100 percent concentration of this product either to a continuous frill around the tree or as cuts evenly spaced around the tree below all branches. As tree diameter increases in size, better results are achieved by applying diluted material to a continuous frill or more closely spaced cuttings. Avoid application techniques that allow runoff to occur from frilled or cut areas in species that exude sap freely. In species such as this, make the frill or cuts at an oblique angle to produce a cupping effect and use a 100 percent concentration of this product. For best results, application should be made during periods of active growth and after full leaf expansion. This product will control many species, some of which are listed below:

Control	Partial Control
Oak	Black gum
Poplar	Dogwood
Sweetgum	Hickory
Sycamore	Maple, red

8.5 Ornamental and Plant Nurseries, Christmas Trees

Post-Directed, Trim-and-Edge

This product may be used as a post-directed spray around established woody ornamental species such as arborvitae, azalea, boxwood, crabapple, euonymus, fir, douglas fir, jojoba, hollies, lilac, magnolia, maple, oak, privet, pine, spruce and yew. This product may also be used to trim-and-edge around trees, buildings, sidewalks and roads, potted plants and other objects in a nursery setting.

Desirable plants may be protected from the spray solution by using shields or coverings made of cardboard or other impermeable material. THIS PRODUCT IS NOT RECOMMENDED FOR USE AS AN OVER-THE-TOP BROADCAST SPRAY IN ORNAMENTALS AND CHRISTMAS TREES. Care must be exercised to avoid contact of spray, drift or mist with foliage or green bark of established ornamental species.

Site Preparation

This product may be used prior to planting any ornamental, nursery or Christmas tree species.

Greenhouse/Shadehouse

This product may be used to control weeds growing in and around greenhouses and shadehouses. Desirable vegetation must not be present during application and air circulation fans must be turned off.

8.6 Railroads

All of the instructions in the **"General Noncrop Areas and Industrial Sites"** section apply to railroads.

Bare Ground, Ballast and Shoulders, Crossings, and Spot treatment

This product may be used to maintain bare ground on railroad ballast and shoulders. Repeat applications of this product may be used, as weeds emerge, to maintain bare ground. This product may be used to control tall-growing weeds to improve line-of-sight at railroad crossings and reduce the need for mowing along rights-of-way. For crossing applications, up to 80 gallons of spray solution per acre may be used. This product may be tank-mixed with the following products for ballast, shoulder, spot, bare ground and crossing treatments:

ARSENAL	KROVAR I DF
BANVEL	OUST
DIURON	SAHARA
ESCORT	SPIKE™
GARLON 3A	TELAR
GARLON 4	VANQUISH
HYVAR™ X	2,4-D

Brush Control

This product may be used to control woody brush and trees on railroad rights-of-way. Apply 3 to 8 quarts of this product per acre as a broadcast spray, using boom-type or boomless nozzles. Up to 80 gallons of spray solution per acre may be used. Apply a 2/3 to 1.6 percent solution of this product when using high-volume spray-to-wet applications. Apply a 4 to 8 percent solution of this product when using low volume directed sprays for spot treatment. This product may be mixed with the following products for enhanced control of woody brush and trees:

ARSENAL	GARLON 4
ESCOR	TORDON™ K
GARLON 3A	

Bermudagrass Release

This product may be used to control or partially control many annual and perennial weeds for effective release of actively growing bermudagrass. Apply 13 to 38 fluid ounces of this product in up to 80 gallons of spray solution per acre. Use the lower rate when treating annual weeds below 6 inches in height (or runner length). Use the higher rate as weeds increase in size or as they approach flower or seedhead formation. These rates will also provide partial control of the following perennial species:

Bahiagrass	Johnsongrass
Bluestem, silver	Trumpetcreeper
Fescue, tall	Vaseygrass

This product may be tank-mixed with Oust. If tank-mixed, use no more than 13 to 38 fluid ounces of this product with 1 to 2 ounces of Oust per acre. Use the lower rates of each product to control annual weeds less than 6 inches in height (or runner length) that are listed in this label and the Oust label. Use the higher rates as annual weeds increase in size and approach the flower or seedhead stages. These rates will also provide partial control of the following perennial weeds:

Bahiagrass	Fescue, tall
Blackberry	Johnsongrass
Bluestem, silver	Poorjoe
Broomsedge	Raspberry
Dallisgrass	Trumpetcreeper
Dewberry	Vaseygrass
Dock, curly	Vervain, blue
Dogfennel	

Use only on well-established bermudagrass. Bermudagrass injury may result from the treatment, but regrowth will occur under moist conditions. Repeat applications in the same season are not recommended, since severe injury may occur.

8.7 Roadsides

All of the instructions in the "**General Noncrop Areas and Industrial Sites**" section apply to roadsides.

Shoulder Treatments

This product may be used on road shoulders. It may be applied with boom sprayers, shielded boom sprayers, high-volume off-center nozzles, hand-held equipment, and similar equipment.

Guardrails and Other Obstacles to Mowing

This product may be used to control weeds growing under guardrails and around signposts and other objects along the roadside.

Spot Treatment

This product may be used as a spot treatment to control unwanted vegetation growing along roadsides.

Tank Mixtures

This product may be tank-mixed with the following products for shoulder, guardrail, spot and bare ground treatments:

BANVEL	PRINCEP DF
DIURON	PRINCEP LIQUID
ENDURANCE	RONSTAR 50WP
ESCORT	SAHARA
KROVAR I DF	SIMAZINE
OUTRIDER®	SURFLAN
OUST	TELAR
PENDULUM 3.3 EC	VANQUISH
PENDULUM WDG	2,4-D

See the "**General Noncrop Areas and Industrial Sites**" section of this label for general instructions for tank mixing.

Release of Bermudagrass or Bahiagrass

Dormant Applications

This product may be used to control or partially control many winter annual weeds and tall fescue for effective release of dormant bermudagrass or bahiagrass. Treat only when turf is dormant and prior to spring greenup. This product may also be tank-mixed with Outrider herbicide or Oust for residual control. Tank mixtures of this product with Oust may delay greenup.

For best results on winter annuals, treat when plants are in an early growth stage (below 6 inches in height) after most have germinated. For best results on tall fescue, treat when fescue is at or beyond the 4- to 6-leaf stage.

Apply 6.4 to 51 fluid ounces of this product in a tank mixture with 3/4 to 1 1/3 ounces Outrider herbicide per acre. Read and follow all label directions for Outrider herbicide.

Apply 6.4 to 51 fluid ounces of this product per acre alone or in a tank mixture with 1/4 to 1 ounce per acre of Oust. Apply the recommended rates in 10 to 40 gallons of water per acre. Use only in areas where bermudagrass or bahiagrass are desirable ground covers and where some temporary injury or discoloration can be tolerated. To avoid delays in greenup and minimize injury, add no more than 1 ounce of Oust per acre on bermudagrass and no more than 0.5 ounce of Oust per acre on bahiagrass and avoid treatments when these grasses are in a semi-dormant condition.

Actively Growing Bermudagrass

This product may be used to control or partially control many annual and perennial weeds for effective release of actively growing bermudagrass. Apply 13 to 38 fluid ounces of this product in 10 to 40 gallons of spray solution per acre. Use the lower rate when treating annual weeds below 6 inches in height (or runner length). Use the higher rate as weeds increase in size or as they approach flower or seedhead formation. These rates will also provide partial control of the following perennial species:

Bahiagrass	Johnsongrass
Bluestem, silver	Trumpetcreeper
Fescue, tall	Vaseygrass

This product may be tank mixed with Outrider herbicide for control or partial control of Johnsongrass and other weeds listed in the Outrider herbicide label. Use 6.4 to 26 fluid ounces of this product with 3/4 to 1 1/3 ounces of Outrider herbicide. Use the higher rates of both products for control of perennial weeds or annual weeds greater than 6 inches in height.

This product may be tank-mixed with Oust. If tank-mixed, use no more than 13 to 26 fluid ounces of this product with 1 to 2 ounces of Oust per acre. Use the lower rates of each product to control annual weeds less than 6 inches in height (or runner length) that are listed in this label and the Oust label. Use the higher rates as annual weeds increase in size and approach the flower or seedhead stages. These rates will also provide partial control of the following perennial weeds:

Bahiagrass	Fescue, tall
Bluestem, silver	Johnsongrass
Broomsedge	Poorjoe
Dallisgrass	Trumpetcreeper
Dock, curly	Vaseygrass
Dogfennel	Vervain, blue

Use only on well-established bermudagrass. Bermudagrass injury may result from the treatment, but regrowth will occur under moist conditions. Repeat applications of the tank-mix in the same season are not recommended, since severe injury may occur.

Actively Growing Bahiagrass

For suppression of vegetative growth and seedhead inhibition of bahiagrass for approximately 45 days, apply 5 fluid ounces of this product in 10 to 40 gallons of water per acre. Apply 1 to 2 weeks after full greenup or after mowing to a uniform height of 3 to 4 inches. This application must be made prior to seedhead emergence.

For suppression up to 120 days, apply 3 fluid ounces of this product per acre, followed by an application of 1.5 to 3 fluid ounces per acre about 45 days later. Make no more than 2 applications per year.

This product may be used for control or partial control of Johnsongrass and other weeds listed on the Outrider herbicide label in actively growing bahiagrass. Apply 1 1/4 to 4 ounces of this product with 3/4 to 1 1/3 ounces of Outrider herbicide per acre. Use the higher rates for control of perennial weeds or annual weeds greater than 6 inches in height. Use only on well-established bahiagrass.

A tank mixture of this product plus Oust may be used. Apply 5 fluid ounces of this product plus 0.25 ounce of Oust per acre 1 to 2 weeks following an initial spring mowing. Make only one application per year.

9.0 WEEDS CONTROLLED

Always use the higher rate of this product per acre within the recommended range when weed growth is heavy or dense or weeds are growing in an undisturbed (noncultivated) area.

Reduced results may occur when treating weeds heavily covered with dust. For weeds that have been mowed, grazed or cut, allow regrowth to occur prior to treatment.

Refer to the following label sections for recommended rates for the control of annual and perennial weeds and woody brush and trees. For difficult to control perennial weeds and woody brush and trees, where plants are growing under stressed conditions, or where infestations are dense, this product may be used at 4 to 8 quarts per acre for enhanced results.

9.1 Annual Weeds

Use 26 fluid ounces per acre if weeds are less than 6 inches in height or runner length and 1.2 to 3.2 quarts per acre if weeds are over 6 inches in height or runner length or when weeds are growing under stressed conditions.

For spray-to-wet applications, apply a 0.4 percent solution of this product to weeds less than 6 inches in height or runner length. Apply prior to seedhead formation in grass or bud formation in broadleaf weeds. For annual weeds over 6 inches tall, or for smaller weeds growing under stressed conditions, use a 0.8 to 1.6 percent solution. Use the higher rate for tough-to-control species or for weeds over 24 inches tall.

WEED SPECIES

Annoda, spurred
Barley*
Barnyardgrass*
Bittercress*
Black nightshade*
Bluegrass, annual*
Bluegrass, bulbous*
Bassia, fivehook
Brome, downy*
Brome, Japanese*
Browntop panicum*
Buttercup*
Carolina foxtail*
Carolina geranium
Castor bean
Cheatgrass*
Cheeseweed
(Malva parviflora)
Chervil*
Chickweed*
Cocklebur*
Copperleaf, hophornbeam
Corn*
Corn speedwell*
Crabgrass*
Dwarfdandelion*
Eastern mannagrass*
Eclipta*
Fall panicum*
Falsedandelion*
Falseflax, smallseed*
Fiddleneck
Field pennycress*
Filaree
Fleabane, annual*
Fleabane, hairy
*(Conyza bonariensis)**
Fleabane, rough*
Florida pusley
Foxtail*
Goatgrass, jointed*
Goosegrass
Grain sorghum (milo)*
Groundsel, common*
Hemp sesbania
Henbit
Horseweed/Marestail
(Conyza canadensis)
Itchgrass*
Johnsongrass, seedling
Junglerice
Knotweed
Kochia
Lambsquarters*
Little barley*
London rocket*
Mayweed
Medusahead*
Morninglory
(Ipomoea spp.)
Mustard, blue*
Mustard, tansy*
Mustard, tumble*
Mustard, wild*
Oats
Pigweed*
Plains/Tickseed
coreopsis*
Prickly lettuce*
Puncturevine
Purslane, common
Ragweed, common*
Ragweed, giant
Red rice
Russian thistle
Rye*
Ryegrass*
Sandbur, field*
Shattercane*
Shepherd's-purse*
Sicklepod
Signalgrass, broadleaf*
Smartweed, ladysthumb*
Smartweed,
Pennsylvania*
Sowthistle, annual
Spanishneedles
Speedwell, purslane*
Sprangletop*
Spurge, annual
Spurge, prostrate*
Spurge, spotted*
Spurry, umbrella*
Starthistle, yellow
Stinkgrass*
Sunflower*
Teaweed/Prickly sida
Texas panicum*
Velvetleaf
Virginia copperleaf
Virginia pepperweed*
Wheat*
Wild oats*
Witchgrass*
Woolly cupgrass*
Yellow rocket

*When using field broadcast equipment (aerial applications or boom sprayers using flat-fan nozzles) these species will be controlled or partially controlled using 13 fluid ounces of this product per acre. Applications must be made using 3 to 10 gallons of carrier volume per acre. Use nozzles that ensure thorough coverage of foliage and treat when weeds are in an early growth stage.

9.2 Perennial Weeds

Best results are obtained when perennial weeds are treated after they reach the reproductive stage of growth (seedhead initiation in grasses and bud formation in broadleaves). For non-flowering plants, best results are obtained when the plants reach a mature stage of growth. In many situations, treatments are required prior to these growth stages. Under these conditions, use the higher application rate within the recommended range.

Ensure thorough coverage when using spray-to-wet treatments using hand-held equipment. When using hand-held equipment for low volume directed spot treatments, apply a 4 to 8 percent solution of this product.

Allow 7 or more days after application before tillage.

WEED SPECIES	RATE (QT/A)	HAND-HELD % SOLUTION
Alfalfa*	0.8	1.6
Alligatorweed*	3.2	1.2
Anise (fennel)	1.6-3.2	0.8-1.6
Bahiagrass	2.4-4	1.6
Beachgrass, European *(Ammophila arenaria)*	—	4
Bentgrass*	1.2	1.6
Bermudagrass	4	1.6
Bermudagrass, water (knotgrass)	1.2	1.6
Bindweed, field	3.2-4	1.6
Bluegrass, Kentucky	1.6	1.6
Blueweed, Texas	3.2-4	1.6
Brackenfern	2.4-3.2	0.8-1.2
Bromegrass, smooth	1.6	1.6
Bursage, woolly-leaf	—	1.6
Canarygrass, reed	1.6-2.4	1.6
Cattail	2.4-4	1.6
Clover; red, white	2.4-4	1.6
Cogongrass	2.4-4	1.6
Dallisgrass	2.4-4	1.6
Dandelion	2.4-4	1.6
Dock, curly	2.4-4	1.6
Dogbane, hemp	3.2	1.6
Fescue (except tall)	2.4-4	1.6
Fescue, tall	0.8-2.4	1.6
German ivy	1.6-3.2	0.8-1.6
Guineagrass	2.4	0.8
Horsenettle	2.4-4	1.6
Horseradish	3.2	1.6
Iceplant	1.6	1.2-1.6
Jerusalem artichoke	2.4-4	1.6
Johnsongrass	1.6-2.4	0.8
Kikuyugrass	1.6-2.4	1.6
Knapweed	3.2	1.6
Lantana	—	0.8-1
Lespedeza	2.4-4	1.6
Milkweed, common	2.4	1.6
Muhly, wirestem	1.6	1.6
Mullein, common	2.4-4	1.6
Napiergrass	2.4-4	1.6
Nightshade, silverleaf	1.6	1.6
Nutsedge; purple, yellow	2.4	0.8-1.6
Orchardgrass	1.6	1.6
Pampasgrass	2.4-4	1.2-1.6

WEED SPECIES	RATE (QT/A)	HAND-HELD % SOLUTION
Paragrass	2.4-4	1.6
Pepperweed, perennial	3.2	1.6
Phragmites*	2.4-4	0.8-1.6
Poison hemlock	1.6-3.2	0.8-1.6
Quackgrass	1.6-2.4	1.6
Redvine*	1.6	1.6
Reed, giant	3.2-4	1.6
Ryegrass, perennial	1.6-2.4	0.8
Smartweed, swamp	2.4-4	1.6
Spurge, leafy*	—	1.6
Sweet potato, wild*	—	1.6
Thistle, artichoke	1.6-2.4	0.8-1.6
Thistle, Canada	1.6-2.4	1.6
Timothy	1.6-2.4	1.6
Torpedograss*	3.2-4	1.6
Trumpetcreeper*	1.6-2.4	1.6
Vaseygrass	2.4-4	1.6
Velvetgrass	2.4-4	1.6
Wheatgrass, western	1.6-2.4	1.6

*Partial control

9.3 Woody Brush and Trees

Apply this product after full leaf expansion, unless otherwise directed. Use the higher rate for larger plants and/or dense areas of growth. On vines, use the higher rate for plants that have reached the woody stage of growth. Best results are obtained when application is made in late summer or fall after fruit formation.

In arid areas, best results are obtained when applications are made in the spring to early summer when brush species are at high moisture content and are flowering.

Ensure thorough coverage when using spray-to-wet treatments using hand-held equipment. When using hand-held equipment for low volume directed-spray spot treatments, apply a 4 to 8 percent solution of this product.

Symptoms may not appear prior to frost or senescence with fall treatments.

Allow 7 or more days after application before tillage, mowing or removal. Repeat treatments may be necessary to control plants regenerating from underground parts or seed. Some autumn colors on undesirable deciduous species are acceptable provided no major leaf drop has occurred. Reduced performance may result if fall treatments are made following a frost.

WEED SPECIES	BROADCAST RATE (QT/A)	HAND-HELD SPRAY-TO-WET % SOLUTION
Alder	2.4-3.2	0.8-1.2
Ash*	1.6-4	0.8-1.6
Aspen, quaking	1.6-2.4	0.8-1.2
Bearclover (Bearmat)*	1.6-4	0.8-1.6
Beech*	1.6-4	0.8-1.6
Birch	1.6	0.8
Blackberry	2.4-3.2	0.8-1.2
Blackgum	1.6-4	0.8-1.6
Bracken	1.6-4	0.8-1.6
Broom; French, Scotch	1.6-4	1.2-1.6
Buckwheat, California*	1.6-3.2	0.8-1.6
Cascara*	1.6-4	0.8-1.6
Catsclaw*	—	0.8-1.2
Ceanothus*	1.6-4	0.8-1.6
Chamise*	1.6-4	0.8
Cherry; bitter, black, pin	1.6-2.4	0.8-1.2
Coyote brush	2.4-3.2	1.2-1.6
Deerweed	1.6-4	0.8
Dogwood*	1.6-4	0.8-1.6
Elderberry	1.6	0.8
Elm*	1.6-4	0.8-1.6
Eucalyptus	—	1.6
Gorse*	1.6-4	0.8-1.6
Hasardia*	1.6-3.2	0.8-1.6
Hawthorn	1.6-2.4	0.8-1.2
Hazel	1.6	0.8
Hickory*	1.6-4	0.8-1.6
Honeysuckle	2.4-3.2	0.8-1.2
Hornbeam, American*	1.6-4	0.8-1.6
Kudzu	3.2	1.6
Locust, black*	1.6-3.2	0.8-1.6
Madrone resprouts*	—	1.6
Manzanita*	1.6-4	0.8-1.6
Maple, red	1.6-3.2	0.8-1.2
Maple, sugar	—	0.8-1.2
Monkey flower*	1.6-3.2	0.8-1.6
Oak; black, white*	1.6-3.2	0.8-1.6
Oak, post	2.4-3.2	0.8-1.2
Oak; northern, pin	1.6-3.2	0.8-1.2
Oak, Scrub*	1.6-3.2	0.8-1.2
Oak; southern red	1.6-2.4	0.8-1.2
Peppertree, Brazilian (Florida holly)*	1.6-4	0.8-1.6
Persimmon*	1.6-4	0.8-1.6
Pine	1.6-4	0.8-1.6
Poison ivy	3.2-4	1.6
Poison oak	3.2-4	1.6
Poplar, yellow*	1.6-4	0.8-1.6
Redbud, eastern	1.6-4	0.8-1.6
Rose, multiflora	1.6	0.8
Russian olive*	1.6-4	0.8-1.6
Sage, black	1.6-3.2	0.8
Sage, white*	1.6-3.2	0.8-1.6
Sage brush, California	1.6-3.2	0.8
Salmonberry	1.6	0.8
Saltcedar*	1.6-4	0.8-1.6
Sassafras*	1.6-4	0.8-1.6
Sourwood*	1.6-4	0.8-1.6
Sumac; laurel, poison, smooth, sugarbush, winged*	1.6-3.2	0.8-1.6
Sweetgum	1.6-2.4	0.8-1.2
Swordfern*	1.6-4	0.8-1.6
Tallowtree, Chinese	—	0.8
Tan oak resprouts*	—	1.6
Thimbleberry	1.6	0.8
Tobacco, tree*	1.6-3.2	0.8-1.6
Toyon*	—	1.6
Trumpetcreeper	1.6-2.4	0.8-1.2
Vine maple*	1.6-4	0.8-1.6
Virginia creeper	1.6-4	0.8-1.6
Waxmyrtle, southern*	1.6-4	0.8-1.6
Willow	2.4	0.8
Yerbasenta*	—	1.6

*Partial control

10.0 LIMIT OF WARRANTY AND LIABILITY

Monsanto Company warrants that this product conforms to the chemical description on the label and is reasonably fit for the purposes set forth in the Complete Directions for Use label booklet ("Directions") when used in accordance with those Directions under the conditions described therein. NO OTHER EXPRESS WARRANTY OR IMPLIED WARRANTY OF FITNESS FOR PARTICULAR PURPOSE OR MERCHANTABILITY IS MADE. This warranty is also subject to the conditions and limitations stated herein.

Buyer and all users shall promptly notify this Company of any claims whether based in contract, negligence, strict liability, other tort or otherwise.

Buyer and all users are responsible for all loss or damage from use or handling which results from conditions beyond the control of this Company, including, but not limited to, incompatibility with products other than those set forth in the Directions, application to or contact with desirable vegetation, unusual weather, weather conditions which are outside the range considered normal at the application site and for the time period when the product is applied, as well as weather conditions which are outside the application ranges set forth in the Directions, application in any manner not explicitly set forth in the Directions, moisture conditions outside the moisture range specified in the Directions, or the presence of products other than those set forth in the Directions in or on the soil, crop or treated vegetation.

This Company does not warrant any product reformulated or repackaged from this product except in accordance with this Company's stewardship requirements and with express written permission from this Company.

THE EXCLUSIVE REMEDY OF THE USER OR BUYER, AND THE LIMIT OF THE LIABILITY OF THIS COMPANY OR ANY OTHER SELLER FOR ANY AND ALL LOSSES, INJURIES OR DAMAGES RESULTING FROM THE USE OR HANDLING OF THIS PRODUCT (INCLUDING CLAIMS BASED IN CONTRACT, NEGLIGENCE, STRICT LIABILITY, OTHER TORT OR OTHERWISE) SHALL BE THE PURCHASE PRICE PAID BY THE USER OR BUYER FOR THE QUANTITY OF THIS PRODUCT INVOLVED, OR, AT THE ELECTION OF THIS COMPANY OR ANY OTHER SELLER, THE REPLACEMENT OF SUCH QUANTITY, OR, IF NOT ACQUIRED BY PURCHASE, REPLACEMENT OF SUCH QUANTITY. IN NO EVENT SHALL THIS COMPANY OR ANY OTHER SELLER BE LIABLE FOR ANY INCIDENTAL, CONSEQUENTIAL OR SPECIAL DAMAGES.

Upon opening and using this product, buyer and all users are deemed to have accepted the terms of this LIMIT OF WARRANTY AND LIABILITY which may not be varied by any verbal or written agreement. If terms are not acceptable, return at once unopened.

This product is protected by U.S. Patent Nos. 5,683,958; 5,703,015; 6,063,733; 6,121,199; and 6,121,200. No license granted under any non-U.S. patent(s).

EPA Reg. No. 524-529

In case of an emergency involving this product,
Call Collect, day or night, (314) 694-4000.

MONSANTO™

This sample label is current as of 1/13/99. The product descriptions and recommendations provided in this sample label are for background information only. Always refer to the label on the product before using Monsanto or any other agrichemical product.

21061Y6-1/CG

RODEO®

EMERGED AQUATIC WEED AND BRUSH HERBICIDE

by Monsanto

Complete Directions for Use in Aquatic and Other Noncrop Sites.

EPA Reg. No. 524-343

AVOID CONTACT OF HERBICIDE WITH FOLIAGE, GREEN STEMS, EXPOSED NON-WOODY ROOTS OR FRUIT OF CROPS, DESIRABLE PLANTS AND TREES, BECAUSE SEVERE INJURY OR DESTRUCTION IS LIKELY TO RESULT.

2000-1

Read the entire label before using this product.

Use only according to label instructions.

It is a violation of Federal law to use this product in any manner inconsistent with its labeling.

Not all products recommended on this label are registered for use in California. Check the registration status of each product in California before using.

Read the "LIMIT OF WARRANTY AND LIABILITY" statement at the end of the label before buying or using. If terms are not acceptable, return at once unopened.

THIS IS AN END-USE PRODUCT. MONSANTO DOES NOT INTEND AND HAS NOT REGISTERED IT FOR REFORMULATION OR REPACKAGING. SEE INDIVIDUAL CONTAINER LABEL FOR REPACKAGING LIMITATIONS.

1.0 INGREDIENTS

ACTIVE INGREDIENT:	
*Glyphosate, N-(phosphonomethyl)glycine, in the form of its isopropylamine salt	53.8%
OTHER INGREDIENTS:	46.2%
	100.0%

*Contains 648 grams per litre or 5.4 pounds per U.S. gallon of the active ingredient, glyphosate, in the form of its isopropylamine salt. Equivalent to 480 grams per litre or 4 pounds per U.S. gallon of the acid, glyphosate.

This product is protected by U.S. Patent No. 4,405,531. Other patents pending. No license granted under any non-U.S. patent(s).

2.0 IMPORTANT PHONE NUMBERS

1. FOR PRODUCT INFORMATION OR ASSISTANCE IN USING THIS PRODUCT, CALL TOLL-FREE,

   1-800-332-3111

2. IN CASE OF AN EMERGENCY INVOLVING THIS PRODUCT, OR FOR MEDICAL ASSISTANCE, CALL COLLECT, DAY OR NIGHT,

   (314)-694-4000

3.0 PRECAUTIONARY STATEMENTS

3.1 Hazards to Humans and Domestic Animals

Keep out of reach of children.

CAUTION!

Remove contaminated clothing and wash clothing before reuse.

Wash thoroughly with soap and water after handling.

3.2 Environmental Hazards

Do not contaminate water when disposing of equipment washwaters. Treatment of aquatic weeds can result in oxygen depletion or loss due to decomposition of dead plants. This oxygen loss can cause fish suffocation.

In case of: SPILL or LEAK, soak up and remove to a landfill.

3.3 Physical or Chemical Hazards

Spray solutions of this product should be mixed, stored and applied using only stainless steel, aluminum, fiberglass, plastic or plastic-lined steel containers.

DO NOT MIX, STORE OR APPLY THIS PRODUCT OR SPRAY SOLUTIONS OF THIS PRODUCT IN GALVANIZED STEEL OR UNLINED STEEL (EXCEPT STAINLESS STEEL) CONTAINERS OR SPRAY TANKS. This product or spray solutions of this product react with such containers and tanks to produce hydrogen gas which may form a highly combustible gas mixture. This gas mixture could flash or explode, causing serious personal injury, if ignited by open flame, spark, welder's torch, lighted cigarette or other ignition source.

DIRECTIONS FOR USE

It is a violation of Federal law to use this product in any manner inconsistent with its labeling. For any requirements specific to your State or Tribe, consult the agency responsible for pesticide regulations.

4.0 STORAGE AND DISPOSAL

Do not contaminate water, foodstuffs, feed or seed by storage or disposal.

STORAGE: STORE ABOVE 10°F (-12°C) TO KEEP PRODUCT FROM CRYSTALLIZING. Crystals will settle to the bottom. If allowed to crystallize, place in a warm room 68°F (20°C) for several days to redissolve and roll or shake container or recirculate in mini-bulk containers to mix well before using.

DISPOSAL:
Wastes resulting from the use of this product that cannot be used or chemically reprocessed should be disposed of in a landfill approved for pesticide disposal or in accordance with applicable Federal, state, or local procedures.

Emptied container retains vapor and product residue. Observe all labeled safeguards until container is cleaned, reconditioned, or destroyed.

FOR REFILLABLE PORTABLE CONTAINERS: Do not reuse this container except for refill in accordance with a valid Monsanto Repackaging or Toll Repackaging Agreement. If not refilled or returned to the authorized repackaging facility, triple rinse container, then puncture and dispose of in a sanitary landfill, or by incineration, or, if allowed by state and local authorities, by burning. If burned, stay out of smoke.

FOR METAL CONTAINERS (non-aerosol): Triple rinse (or equivalent). Then offer for recycling or reconditioning, or puncture and dispose of in a sanitary landfill, or by other procedures approved by state and local authorities.

FOR BULK CONTAINERS: Triple rinse emptied bulk container. Then offer for recycling or reconditioning, or dispose of in a manner approved by state and local authorities.

FOR PLASTIC 1-WAY CONTAINERS & BOTTLES: Do not reuse container. Triple rinse container, then puncture and dispose of in a sanitary landfill, or by incineration, or, if allowed by state and local authorities, by burning. If burned, stay out of smoke.

FOR DRUMS: Do not reuse container. Return container per the Monsanto container return program. If not returned, triple rinse container, then puncture and dispose of in a sanitary landfill, or by incineration, or, if allowed by state and local authorities, by burning. If burned, stay out of smoke.

5.0 GENERAL INFORMATION

This product, a water-soluble liquid, mixes readily with water and nonionic surfactant to be applied as a foliar spray for the control or destruction of many herbaceous and woody plants.

This product moves through the plant from the point of foliage contact to and into the root system. Visible effects on most annual weeds occur within 2 to 4 days but on most perennial brush species may not occur for 7 days or more. Extremely cool or cloudy weather following treatment may slow the activity of this product and delay visual effects of control. Visible effects are a gradual wilting and yellowing of the plant which advances to complete browning of aboveground growth and deterioration of underground plant parts.

Unless otherwise directed on this label, delay application until vegetation has emerged and reached the stages described for control of such vegetation under the "WEEDS CONTROLLED" section of this label.

Unemerged plants arising from unattached underground rhizomes or root stocks of perennials or brush will not be affected by the spray and will continue to grow. For this reason best control of most perennial weeds or brush is obtained when treatment is made at late growth stages approaching maturity.

Always use the higher rate of this product per acre within the recommended range when vegetation is heavy or dense.

Do not treat weeds or brush under poor growing conditions such as drought stress, disease or insect damage, as reduced control may result. Reduced results may also occur when treating weeds or brush heavily covered with dust.

Reduced control may result when applications are made to any weed or brush species that have been mowed, grazed or cut, and have not been allowed to regrow to the recommended stage for treatment.

Rainfall or irrigation occurring within 6 hours after application may reduce effectiveness. Heavy rainfall or irrigation within 2 hours after application may wash the product off the foliage and a repeat treatment may be required.

When this product comes in contact with soil (on the soil surface or as suspended soil or sediment in water) it is bound to soil particles. Under recommended use situations, once this product is bound to soil particles, it is not available for plant uptake and will not harm off-site vegetation where roots grow into the treatment area or if the soil is transported off-site. Under recommended use conditions, the strong affinity of this product to soil particles prevents this product from leaching out of the soil profile and entering ground water. The affinity between this product and soil particles remains until this product is degraded, which is primarily a biological degradation process carried out under both aerobic and anaerobic conditions by soil microflora.

This product does not provide residual weed control. For subsequent residual weed control, follow a label-approved herbicide program. Read and carefully observe the cautionary statements and all other information appearing on the labels of all herbicides used.

Buyer and all users are responsible for all loss or damage in connection with the use or handling of mixtures of this product or other materials that are not expressly recommended in this label. Mixing this product with herbicides or other materials not recommended in this label may result in reduced performance.

ATTENTION

AVOID DRIFT. EXTREME CARE MUST BE USED WHEN APPLYING THIS PRODUCT TO PREVENT INJURY TO DESIRABLE PLANTS AND CROPS.

Do not allow the herbicide solution to mist, drip, drift or splash onto desirable vegetation since minute quantities of this product can cause severe damage or destruction to the crop, plants or other areas on which treatment was not intended. The likelihood of plant or crop injury occurring from the use of this product is greatest when winds are gusty or in excess of 5 miles per hour or when other conditions, including lesser wind velocities, will allow spray drift to occur. When spraying, avoid combinations of pressure and nozzle type that will result in splatter or fine particles (mist) which are likely to drift. AVOID APPLYING AT EXCESSIVE SPEED OR PRESSURE.

NOTE: Use of this product in any manner not consistent with this label may result in injury to persons, animals or crops, or other unintended consequences. When not in use, keep container closed to prevent spills and contamination.

6.0 MIXING

Clean sprayer parts immediately after using this product by thoroughly flushing with water.

NOTE: REDUCED RESULTS MAY OCCUR IF WATER CONTAINING SOIL IS USED, SUCH AS VISIBLY MUDDY WATER OR WATER FROM PONDS AND DITCHES THAT IS NOT CLEAR.

6.1 Mixing with Water and Surfactant

This product mixes readily with water. Mix spray solutions of this product as follows: Fill the mixing or spray tank with the required amount of water. Add the recommended amount of this product and the required surfactant near the end of the filling process and mix well. Use caution to avoid siphoning back into the carrier source. Use approved anti-back-siphoning devices where required by state or local regulations. During mixing and application, foaming of the spray solution may occur. To prevent or minimize foam, avoid the use of mechanical agitators, terminate by-pass and return lines at the bottom of the tank and, if needed, use an approved antifoam or defoaming agent.

Maintain good agitation at all times until the contents of the tank are sprayed. If the spray mixture is allowed to settle, thorough agitation may be required to resuspend the mixture before spraying is resumed.

Keep by-pass line on or near the bottom of the tank to minimize foaming. Screen size in nozzle or line strainers should be no finer than 50 mesh.

When using this product, mix 2 or more quarts of a nonionic surfactant per 100 gallons of spray solution. Use a nonionic surfactant labeled for use with herbicides. The surfactant must contain 50 percent or more active ingredient.

These surfactants should not be used in excess of 1 quart per acre when making **broadcast** applications.

Always read and follow the manufacturer's surfactant label recommendations for best results. Carefully observe all cautionary statements and other information appearing in the surfactant label.

6.2 Mixing for Hand-held Sprayers

Prepare the desired volume of spray solution by mixing the amount of this product in water as shown in the following table:

Spray Solution

Desired Volume	Amount of Rodeo©					
	3/4%	1%	1 1/4%	1 1/2%	5%	8%
1 Gal	1 oz	1 1/3 oz	1 2/3 oz	2 oz	6 oz	10 1/4 oz
25 Gal	1 1/2 pt	1 qt	1 1/4 qt	1 1/2 qt	5 qt	2 gal
100 Gal	3 qt	1 gal	1 1/4 gal	1 1/2 gal	5 gal	8 gal

2 tablespoons = 1 fluid ounce

For use in backpack, knapsack or pump-up sprayers, it is suggested that the recommended amount of this product be mixed with water in a larger container. Fill sprayer with the mixed solution and add the correct amount of surfactant.

6.3 Colorants or Dyes

Agriculturally-approved colorants or marking dyes may be added to this product. Colorants or dyes used in spray solutions of this product may reduce performance, especially at lower rates or dilution. Use colorants or dyes according to the manufacturer's recommendations.

7.0 APPLICATION EQUIPMENT AND TECHNIQUES

Do not apply this product through any type of irrigation system.

APPLY THESE SPRAY SOLUTIONS IN PROPERLY MAINTAINED AND CALIBRATED EQUIPMENT CAPABLE OF DELIVERING DESIRED VOLUMES.

SPRAY DRIFT MANAGEMENT

AVOID DRIFT. EXTREME CARE MUST BE USED WHEN APPLYING THIS PRODUCT TO PREVENT INJURY TO DESIRABLE PLANTS AND CROPS.

Do not allow the herbicide solution to mist, drip, drift or splash onto desirable vegetation since minute quantities of this product can cause severe damage or destruction to the crop, plants or other areas on which treatment was not intended.

Avoiding spray drift at the application site is the responsibility of the applicator. The interaction of many equipment-and-weather-related factors determine the potential for spray drift. The applicator and the grower are responsible for considering all these factors when making decisions.

AERIAL SPRAY DRIFT MANAGEMENT

The following drift management requirements must be followed to avoid off-target drift movement from aerial applications to agricultural field crops. These requirements do not apply to forestry applications or to public health uses.

1. The distance of the outermost nozzles on the boom must not exceed 3/4 the length of the wingspan or rotor.
2. Nozzles must always point backward parallel with the air stream and never be pointed downwards more than 45 degrees. Where states have more stringent regulations, they should be observed.

Importance of Droplet Size

The most effective way to reduce drift potential is to apply large droplets. The best drift management strategy is to apply the largest droplets that provide sufficient coverage and control. Applying larger droplets reduces drift potential, but will not prevent drift if applications are made improperly, or under unfavorable environmental conditions (see the **"Wind"**, **"Temperature and Humidity"**, and **"Temperature Inversion"** sections of this label).

Controlling Droplet Size

- **Volume:** Use high flow rate nozzles to apply the highest practical spray volume. Nozzles with the higher rated flows produce larger droplets.
- **Pressure:** Use the lower spray pressures recommended for the nozzle. Higher pressure reduces droplet size and does not improve canopy protection. When higher flow rates are needed, use higher flow rate nozzles instead of increasing pressure.
- **Number of Nozzles:** Use the minimum number of nozzles that provide uniform coverage.
- **Nozzle Orientation:** Orienting nozzles so that the spray is released backwards, parallel to the airstream, will produce larger droplets than other orientations. Significant deflection from the horizontal will reduce droplet size and increase drift potential.
- **Nozzle Type:** Use a nozzle type that is designed for the intended application. With most nozzle types, narrower spray angles produce larger droplets. Consider using low-drift nozzles. Solid stream nozzles oriented straight back produce larger droplets than other nozzle types.
- **Boom Length:** For some use patterns, reducing the effective boom length to less than 3/4 of the wingspan or rotor length may further reduce drift without reducing swath width.
- **Application Height:** Applications should not be made at a height greater than 10 feet above the top of the largest plants unless a greater height is required for aircraft safety. Making applications at the lowest height that is safe reduces the exposure of the droplets to evaporation and wind.

Swath Adjustment

When applications are made with a crosswind, the swath will be displaced downward. Therefore, on the up and downwind edges of the field, the applicator must compensate for this displacement by adjusting the path of the aircraft upwind. Swath adjustment distance should increase, with increasing drift potential (higher wind, smaller droplets, etc.).

Wind

Drift potential is lowest between wind speeds of 2 to 10 mph. However, many factors, including droplet size and equipment type determine drift potential at any given speed. Application should be avoided below 2 mph due to variable wind direction and high inversion potential. **NOTE**: Local terrain can influence wind patterns. Every applicator should be familiar with local wind patterns and how they affect drift.

Temperature and Humidity

When making applications in low relative humidity, set up equipment to produce larger droplets to compensate for evaporation. Droplet evaporation is most severe when conditions are both hot and dry.

Temperature Inversions

Applications should not occur during a temperature inversion because drift potential is high. Temperature inversions restrict vertical air mixing, which causes small suspended droplets to remain in a concentrated cloud. This cloud can move in unpredictable directions due to the light variable winds common during inversions. Temperature inversions are characterized by increasing temperatures with altitude and are common on nights with limited cloud cover and light to no wind. They begin to form as the sun sets and often continue into the morning. Their presence can be indicated by ground fog; however, if fog is not present, inversions can also be identified by the movement of smoke from a ground source or an aircraft smoke generator. Smoke that layers and moves laterally in a concentrated cloud (under low wind conditions) indicates an inversion, while smoke that moves upward and rapidly dissipates indicates good vertical air mixing.

Sensitive Areas

The pesticide should only be applied when the potential for drift to adjacent sensitive areas (e.g., residential areas, bodies of water, known habitat for threatened or endangered species, non-target crops) is minimal (e.g., when wind is blowing away from the sensitive areas).

7.1 Aerial Equipment

DO NOT APPLY THIS PRODUCT USING AERIAL SPRAY EQUIPMENT EXCEPT UNDER CONDITIONS AS SPECIFIED WITHIN THIS LABEL.

FOR AERIAL APPLICATION IN CALIFORNIA, REFER TO THE FEDERAL SUPPLEMENTAL LABEL FOR AERIAL APPLICATIONS IN THAT STATE FOR SPECIFIC INSTRUCTIONS, RESTRICTIONS AND REQUIREMENTS.

AVOID DRIFT—DO NOT APPLY DURING LOW-LEVEL INVERSION CONDITIONS, WHEN WINDS ARE GUSTY OR UNDER ANY OTHER CONDITION WHICH FAVORS DRIFT. DRIFT IS LIKELY TO CAUSE DAMAGE TO ANY VEGETATION CONTACTED TO WHICH TREATMENT IS NOT INTENDED. TO PREVENT INJURY TO ADJACENT DESIRABLE VEGETATION, APPROPRIATE BUFFER ZONES MUST BE MAINTAINED.

Use the recommended rates of this product and surfactant in 3 to 20 gallons of water per acre as a broadcast spray, unless otherwise specified.

Coarse sprays are less likely to drift; therefore, do not use nozzles or nozzle configurations which dispense spray as fine spray droplets. Do not angle nozzles forward into the airstream and do not increase spray volume by increasing nozzle pressure.

Drift control additives may be used. When a drift control additive is used, read and carefully observe the cautionary statements and all other information appearing on the additive label.

Ensure uniform application—To avoid streaked, uneven or overlapped application, use appropriate marking devices.

PROLONGED EXPOSURE OF THIS PRODUCT TO UNCOATED STEEL SURFACES MAY RESULT IN CORROSION AND POSSIBLE FAILURE OF THE PART. The maintenance of an organic coating (paint) which meets aerospace specification MIL-C-38413 may prevent corrosion. To prevent corrosion of exposed parts, thoroughly wash aircraft after each day of spraying to remove residues of this product accumulated during spraying or from spills. Landing gear are most susceptible.

7.2 Ground Broadcast Equipment

Use the recommended rates of this product in 3 to 40 gallons of water per acre as a broadcast spray unless otherwise specified. See the "WEEDS CONTROLLED" section of this label for specific rates. As density of weeds increases, spray volume should be increased within the recommended range to ensure complete coverage. Carefully select proper nozzles to avoid spraying a fine mist. For best results with ground application equipment, use flat fan nozzles. Check for even distribution of spray droplets.

7.3 Hand-Held and High-Volume Equipment

Use Coarse Sprays Only

For control of weeds listed in this label using backpack or knapsack sprayers or high-volume spraying equipment utilizing handguns or other suitable nozzle arrangements. Prepare a 3/4 to 2 percent solution of this product in water, add a nonionic surfactant and apply to foliage of vegetation to be controlled. For specific rates of application and instructions for control of various annual and perennial weeds, see the "WEEDS CONTROLLED" section in this label.

Applications should be made on a spray-to-wet basis. Spray coverage should be uniform and complete. Do not spray to point of runoff.

This product may be used as a 5 to 8 percent solution for low-volume directed sprays for spot treatment of trees and brush. It is most effective in areas where there is a low density of undesirable trees or brush. If a straight stream nozzle is used, start the application at the top of the targeted vegetation and spray from top to bottom in a lateral zig-zag motion. Ensure that at least 50 percent of the leaves are contacted by the spray solution. For flat fan and cone nozzles and with hand-directed mist blowers, mist the application over the foliage of the targeted vegetation. Small, open-branched trees need only be treated from one side. If the foliage is thick or there are multiple root sprouts, applications must be made from several sides to ensure adequate spray coverage.

7.4 Selective Equipment (Wiper Applications)

A wiper or sponge applicator applies the herbicide solution onto weeds by rubbing the weed with an absorbent material containing the herbicide solution.

Wiper applications can be used to control or suppress annual and perennial weeds listed on this label. In heavy weed stands, a double application in opposite directions may improve results. See the "WEEDS CONTROLLED" section in this label for recommended timing, growth stage and other instructions for achieving optimum results.

AVOID CONTACT OF HERBICIDE WITH DESIRABLE VEGETATION AS SERIOUS INJURY OR DEATH IS LIKELY TO OCCUR.

For wick or wiper applications, mix 2 1/2 gallons of this product plus 1 quart of a nonionic surfactant with 7 1/4 gallons of clean water to prepare a 25 percent solution.

Mix only the amount of solution to be used during a 1-day period, as reduced activity may result from use of leftover solutions. Clean wiper parts immediately after using this product by thoroughly flushing with water.

8.0 SITE AND USE RECOMMENDATIONS

Detailed instructions follow alphabetically, by site.

Unless otherwise specified, applications may be made to control any weeds listed in the annual, perennial and woody brush tables. Refer also to the "SELECTIVE EQUIPMENT" section.

8.1 Aquatic and Other Noncrop Sites

When applied as directed and under the conditions described in the "WEEDS CONTROLLED" section in this label, this product will control or partially control the labeled weeds growing in the following industrial, recreational and public areas or other similar aquatic and terrestrial sites.

Aquatic Sites

This product may be applied to emerged weeds in all bodies of fresh and brackish water which may be flowing, nonflowing or transient. This includes lakes, rivers, streams, ponds, estuaries, rice levees, seeps, irrigation and drainage ditches, canals, reservoirs, wastewater treatment facilities, wildlife habitat restoration and management areas, and similar sites.

If aquatic sites are present in the noncrop area and are part of the intended treatment, read and observe the following directions:

This product does not control plants which are completely submerged or have a majority of their foliage under water.

There is no restriction on the use of treated water for irrigation, recreation or domestic purposes.

Consult local state fish and game agency and water control authorities before applying this product to public water. Permits may be required to treat such water.

NOTE: Do not apply this product **directly to water** within 1/2 mile up-stream of an active potable water intake in flowing water (i.e., river, stream, etc.) or within 1/2 mile of an active potable water intake in a standing body of water such as lake, pond or reservoir. To make aquatic applications around and within 1/2 mile of active potable water intakes, the water intake must be turned off for a minimum period of 48 hours after the application. The water intake may be turned on prior to 48 hours if the glyphosate level in the intake water is below 0.7 part per million as determined by laboratory analysis. These aquatic applications may be made ONLY in those cases where there are alternative water sources or holding ponds which would permit the turning off of an active potable water intake for a minimum period of 48 hours after the applications. This restriction does **NOT** apply to intermittent inadvertent overspray of water in terrestrial use sites.

For treatments after drawdown of water or in dry ditches, allow 7 or more days after treatment before reintroduction of water to achieve maximum weed control. Apply this product within 1 day after drawdown to ensure application to actively growing weeds.

Floating mats of vegetation may require retreatment. Avoid wash-off of sprayed foliage by spray boat or recreational boat backwash or by rainfall within 6 hours of application. Do not re-treat within 24 hours following the initial treatment.

Applications made to moving bodies of water must be made while traveling upstream to prevent concentration of this herbicide in water. When making any bankside applications, do not overlap more than 1 foot into open water. Do not spray in bodies of water where weeds do not exist. The maximum application rate of 7 1/2 pints per acre must not be exceeded in any single broadcast application that is being made over water.

When emerged infestations require treatment of the total surface area of impounded water, treating the area in strips may avoid oxygen depletion due to decaying vegetation. Oxygen depletion may result in fish kill.

Other Noncrop-Type Sites—This product may be used to control the listed weeds in terrestrial noncrop sites and/or in aquatic sites within these areas.

- Airports
- Golf Courses
- Habitat Restoration & Management Areas
- Highways
- Industrial Plant Sites
- Lumberyards
- Natural Areas
- Parking Areas
- Parks
- Petroleum Tank Farms
- Pipeline, Power, Telephone & Utility Rights-of-Way
- Pumping Installations
- Railroads
- Roadsides
- Schools
- Storage Areas
- Similar Industrial and Non-crop Sites

8.2 Cut Stump Application

Cut stump treatments may be made on any site listed on this label. This product will control many types of woody brush and tree species, some of which are listed below. Apply this product using suitable equipment to ensure coverage of the entire cambium. Cut trees or resprouts close to the soil surface. **Apply a 50 to 100 percent solution of this product to the freshly-cut surface immediately after cutting.** Delays in application may result in reduced performance. For best results, applications should be made during periods of active growth and full leaf expansion.

When used according to directions for cut stump application, this product will CONTROL, PARTIALLY CONTROL or SUPPRESS most woody brush and tree species, some of which are listed below:

Alder
Alnus spp.

Coyote brush*
Baccharis consanguinea

Dogwood*
Cornus spp.

Eucalyptus
Eucalyptus spp.

Hickory*
Carya spp.

Madrone
Arbutus menziesii

Maple*
Acer spp.

Oak
Quercus spp.

Poplar*
Populus spp.

Reed, giant
Arundo donax

Salt cedar
Tamarix spp.

Sweet gum*
Liquidambar styraciflua

Sycamore*
Platanus occidentalis

Tan oak
Lithocarpus densiflorus

Willow
Salix spp.

*This product is not approved for this use on these species in the State of California.

DO NOT MAKE CUT STUMP APPLICATIONS WHEN THE ROOTS OF DESIRABLE WOODY BRUSH OR TREES MAY BE GRAFTED TO THE ROOTS OF THE CUT STUMP. INJURY RESULTING FROM ROOT GRAFTING IS LIKELY TO OCCUR IN ADJACENT WOODY BRUSH OR TREES.

8.3 Habitat Restoration and Management

This product is recommended for the restoration and/or maintenance of native habitat and in wildlife management areas.

Habitat Restoration and Management

This product may be used to control exotic, alien and other undesirable vegetation in habitat management and natural areas, including riparian and estuarine areas, and wildlife refuges. Applications can be made to allow recovery of native plant species, prior to planting desirable native species, and for similar broad spectrum vegetation control requirements. Spot treatments can be made to selectively remove unwanted plants for habitat management and enhancement.

Wildlife Food Plots

This product may be used as a site preparation treatment prior to planting wildlife food plots. Any wildlife food species, including natives, may be planted after applying this product, or native species may be allowed to repopulate the area. If tillage is needed to prepare a seedbed, wait 7 days after application before tillage to allow translocation into underground plant parts.

8.4 Injection and Frill Applications

Woody vegetation may be controlled by injection or frill application of this product. Apply this product using suitable equipment which must penetrate into living tissue. Apply the equivalent of 1 ml of this product per 2 to 3 inches of trunk diameter. This is best achieved by applying 25 to 100 percent concentration of this product either to a continuous frill around the tree or as cuts evenly spaced around the tree below all branches. As tree diameter increases in size, better results are achieved by applying dilute material to a continuous frill or more closely spaced cuttings. Avoid application techniques that allow runoff to occur from frill or cut areas in species that exude sap freely after frills or cutting. In species such as these, make frill or cut at an oblique angle so as to produce a cupping effect and use undiluted material. For best results, applications should be made during periods of active growth and full leaf expansion.

This treatment WILL CONTROL the following woody species:

Oak
Quercus spp.

Poplar
Populus spp.

Sweet gum
Liquidambar styraciflua

Sycamore
Platanus occidentalis

This treatment WILL SUPPRESS the following woody species:

Black gum*
Nyssa sylvatica

Dogwood
Cornus spp.

Hickory
Carya spp.

Maple, red
Acer rubrum

*This product is not approved for this use on this species in the State of California.

DO NOT MAKE INJECTION OR FRILL APPLICATIONS WHEN THE ROOTS OF DESIRABLE WOODY BRUSH OR TREES MAY BE GRAFTED TO THE ROOTS OF THE TREATED TREES. INJURY RESULTING FROM ROOT GRAFTING IS LIKELY TO OCCUR IN ADJACENT WOODY BRUSH OR TREES.

8.5 Roadsides

RELEASE OF DORMANT BERMUDAGRASS AND BAHIAGRASS

When applied as directed, this product will provide control or suppression of many winter annual weeds and tall fescue for effective release of dormant bermudagrass or bahiagrass. Make applications to dormant bermudagrass or bahiagrass.

For best results on winter annuals, treat when weeds are in an early growth stage (below 6 inches in height) after most have germinated. For best results on tall fescue, treat when fescue is in or beyond the 4- to 6-leaf stage.

WEEDS CONTROLLED

Rate recommendations for control or suppression of winter annuals and tall fescue are listed below.

Apply the recommended rates of this product in 10 to 25 gallons of water per acre plus 2 quarts nonionic surfactant per 100 gallons of total spray volume.

WEEDS CONTROLLED OR SUPPRESSED*

NOTE: C = Control
S = Suppression

	RODEO FLUID OZ/ACRE					
WEED SPECIES	**6**	**9**	**12**	**18**	**24**	**48**
Barley, little *Hordeum pusillum*	S	C	C	C	C	C
Bedstraw, catchweed *Galium aparine*	S	C	C	C	C	C
Bluegrass, annual *Poa annua*	S	C	C	C	C	C
Chervil *Chaerophyllum tainturieri*	S	C	C	C	C	C
Chickweed, common *Stellaria media*	S	C	C	C	C	C
Clover, crimson *Trifolium incarnatum*	•	S	S	C	C	C
Clover, large hop *Trifolium campestre*	•	S	S	C	C	C
Speedwell, corn *Veronica arvensis*	S	C	C	C	C	C
Fescue, tall *Festuca arundinacea*	•	•	•	•	S	S
Geranium, Carolina *Geranium carolinianum*	•	•	S	S	C	C
Henbit *Lamium amplexicaule*	•	S	C	C	C	C
Ryegrass, Italian *Lolium multiflorum*	•	•	S	C	C	C
Vetch, common *Vicia sativa*	•	•	S	C	C	C

*These rates apply only to sites where an established competitive turf is present.

RELEASE OF ACTIVELY GROWING BERMUDAGRASS

NOTE: USE ONLY ON SITES WHERE BAHIAGRASS OR BERMUDAGRASS ARE DESIRED FOR GROUND COVER AND SOME TEMPORARY INJURY OR YELLOWING OF THE GRASSES CAN BE TOLERATED.

When applied as directed, this product will aid in the release of bermudagrass by providing control of annual species listed in the "WEEDS CONTROLLED" section in this label, and suppression or partial control of certain perennial weeds.

For control or suppression of those annual species listed in this label, use 3/4 to 2 1/4 pints of this product as a broadcast spray in 10 to 25 gallons of spray solution per acre, plus 2 quarts of a nonionic surfactant per 100 gallons of total spray volume. Use the lower rate when treating annual weeds below 6 inches in height (or length of runner in annual vines). Use the higher rate as size of plants increases or as they approach flower or seedhead formation.

Use the higher rate for partial control or longer-term suppression of the following perennial species. Use lower rates for shorter-term suppression of growth.

Bahiagrass	Johnsongrass**
Dallisgrass	Trumpetcreeper*
Fescue (tall)	Vaseygrass

*Suppression at the higher rate only.

**Johnsongrass is controlled at the higher rate.

Use only on well-established bermudagrass. Bermudagrass injury may result from the treatment but regrowth will occur under moist conditions. Repeat applications in the same season are not recommended, since severe injury may result.

BAHIAGRASS SEEDHEAD AND VEGETATIVE SUPPRESSION

When applied as directed in the "NONCROP SITES" section in this label, this product will provide significant inhibition of seedhead emergence and will suppress vegetative growth for a period of approximately 45 days with single applications and approximately 120 days with sequential applications.

Apply this product 1 to 2 weeks after full green-up of bahiagrass or after the bahiagrass has been mowed to a uniform height of 3 to 4 inches. Applications must be made prior to seedhead emergence. Apply 5 fluid ounces per acre of this product, plus 2 quarts of an approved nonionic surfactant per 100 gallons of total spray volume in 10 to 25 gallons of water per acre.

Sequential applications of this product plus nonionic surfactant may be made at approximately 45-day intervals to extend the period of seedhead and vegetative growth suppression. For continued vegetative growth suppression, sequential applications must be made prior to seedhead emergence.

Apply no more than 2 sequential applications per year. As a first sequential application, apply 3 fluid ounces of this product per acre plus nonionic surfactant. A second sequential application of 2 to 3 fluid ounces per acre plus nonionic surfactant may be made approximately 45 days after the last application.

ANNUAL GRASS GROWTH SUPPRESSION

For growth suppression of some annual grasses, such as annual ryegrass, wild barley and wild oats growing in coarse turf on roadsides or other industrial areas, apply 3 to 4 ounces of this product in 10 to 40 gallons of spray solution per acre. Mix 2 quarts of a nonionic surfactant per 100 gallons of spray solution. Applications should be made when annual grasses are actively growing and before the seedheads are in the boot stage of development. Treatments made after seedhead emergence may cause injury to the desired grasses.

9.0 WEEDS CONTROLLED

9.1 Annual Weeds

Apply to actively growing annual grasses and broadleaf weeds.

Allow at least 3 days after application before disturbing treated vegetation. After this period the weeds may be mowed, tilled or burned. See "DIRECTIONS FOR USE," "GENERAL INFORMATION" and "MIXING AND APPLICATION INSTRUCTIONS" for labeled uses and specific application instructions.

Broadcast Application—Use 1 1/2 pints of this product per acre plus 2 or more quarts of a nonionic surfactant per 100 gallons of spray solution if weeds are less than 6 inches tall. If weeds are greater than 6 inches tall, use 2 1/2 pints of this product per acre plus 2 or more quarts of an approved nonionic surfactant per 100 gallons of spray solution.

Hand-Held, High-Volume Application—Use a 3/4 to 1 1/2 percent solution of this product in water plus 2 or more quarts of a nonionic surfactant per 100 gallons of spray solution and apply to foliage of vegetation to be controlled. Use the higher rate for tough-to-control species or for weeds over 24 inches tall.

When applied as directed under the conditions described in this label, this product plus nonionic surfactant WILL CONTROL the following ANNUAL WEEDS:

Balsamapple**
Momordica charantia

Barley
Hordeum vulgare

Barnyardgrass
Echinochloa crus-galli

Bassia, fivehook
Bassia hyssopifolia

Bluegrass, annual
Poa annua

Bluegrass, bulbous
Poa bulbosa

Brome
Bromus spp.

Buttercup
Ranunculus spp.

Cheat
Bromus secalinus

Cheeseweed
Malva parviflora

Chickweed, mouseear
Cerastium vulgatum

Cocklebur
Xanthium strumarium

Corn, volunteer
Zea mays

Crabgrass
Digitaria spp.

Dwarfdandelion
Krigia cespitosa

Falseflax, smallseed
Camelina microcarpa

Fiddleneck
Amsinckia spp.

Flaxleaf fleabane
Conyza bonariensis

Fleabane
Erigeron spp.

Foxtail
Setaria spp.

Foxtail, Carolina
Alopecurus carolinianus

Groundsel, common
Senecio vulgaris

Horseweed/Marestail
Conyza canadensis

Kochia
Kochia scoparia

Lambsquarters, common
Chenopodium album

Lettuce, prickly
Lactuca serriola

Morningglory
Ipomoea spp.

Mustard, blue
Chorispora tenella

Mustard, tansy
Descurainia pinnata

Mustard, tumble
Sisymbrium altissimum

Mustard, wild
Sinapis arvensis

Oats, wild
Avena fatua

Panicum
Panicum spp.

Pennycress, field
Thlaspi arvense

Pigweed, redroot
Amaranthus retroflexus

Pigweed, smooth
Amaranthus hybridus

Puncturevine
Tribulus terrestris

Ragweed, common
Ambrosia artemisiifolia

Ragweed, giant
Ambrosia trifida

Rocket, London
Sisymbrium irio

Rye
Secale cereale

Ryegrass, Italian*
Lolium multiflorum

Sandbur, field
Cenchrus spp.

Shattercane
Sorghum bicolor

Shepherd's-purse
Capsella bursa-pastoris

Signalgrass, broadleaf
Brachiaria platyphylla

Smartweed, Pennsylvania
Polygonum pensylvanicum

Sowthistle, annual
Sonchus oleraceus

Spanishneedles*
Bidens bipinnata

Stinkgrass
Eragrostis cilianensis

Sunflower
Helianthus annuus

Thistle, Russian
Salsola kali

Spurry, umbrella
Holosteum umbellatum

Velvetleaf
Abutilon theophrasti

Wheat
Triticum aestivum

Witchgrass
Panicum capillare

*Apply 3 pints of this product per acre.

**Apply with hand-held equipment only.

Annual weeds will generally continue to germinate from seed throughout the growing season. Repeat treatments will be necessary to control later germinating weeds.

9.2 Perennial Weeds

Apply a 3/4 to 1 1/2 percent solution of this product to control or destroy most vigorously growing perennial weeds. Add 2 or more quarts of a nonionic surfactant per 100 gallons of spray solution to the rates of this product given in this list. See the "GENERAL INFORMATION," "DIRECTIONS FOR USE" and "MIXING AND APPLICATION" sections in this label for specific uses and application instructions.

Ensure thorough coverage when using spray-to-wet treatments using hand-held equipment. When using hand-held equipment for low volume directed spot treatments, apply a 5 to 8 percent solution of this product.

Unless otherwise directed, allow at least 7 days after application before disturbing vegetation. If weeds have been mowed or tilled, do not treat until regrowth has reached the recommended stages. Fall treatments must be applied before a killing frost.

Repeat treatments may be necessary to control weeds regenerating from underground parts or seed.

When applied as recommended under the conditions described, this product plus surfactant WILL CONTROL the following PERENNIAL WEEDS:

Alfalfa
Medicago sativa

Alligatorweed*
Alternanthera philoxeroides

Anise/Fennel
Foeniculum vulgare

Artichoke, Jerusalem
Helianthus tuberosus

Bahiagrass
Paspalum notatum

Beachgrass, European
Ammophila arenaria

Bermudagrass
Cynodon dactylon

Bindweed, field
Convolvulus arvensis

Bluegrass, Kentucky
Poa pratensis

Blueweed, Texas
Helianthus ciliaris

Brackenfern
Pteridium spp.

Bromegrass, smooth
Bromus inermis

Canarygrass, reed
Phalaris arundinacea

Cattail
Typha spp.

Clover, red
Trifolium pratense

Clover, white
Trifolium repens

Cogongrass
Imperata cylindrica

Cordgrass
Spartina spp.

Cutgrass, giant*
Zizaniopsis miliacea

Dallisgrass
Paspalum dilatatum

Dandelion
Taraxacum officinale

Dock, curly
Rumex crispus

Dogbane, hemp
Apocynum cannabinum

Fescue
Festuca spp.

Fescue, tall
Festuca arundinacea

Guineagrass
Panicum maximum

Hemlock, poison
Conium maculatum

Horsenettle
Solanum carolinense

Horseradish
Armoracia rusticana

Ice Plant
Carprobrotus edulis

Ivy, German, cape
Senecio mikanoides
Delairea odorata

Johnsongrass
Sorghum halepense

Kikuyugrass
Pennisetum clandestinum

Knapweed, Russian
Centaurea repens

Lantana
Lantana camara

Lespedeza: common, serices
Lespedeza striata
Lespedeza cuneata

Loosestrife, purple
Lythrum salicaria

Lotus, American
Nelumbo lutea

Maidencane
Panicum hematomon

Milkweed
Asclepias spp.

Muhly, wirestem
Muhlenbergia frondosa

Mullein, common
Verbascum thapsus

Napiergrass
Pennisetum purpureum

Nightshade, silverleaf
Solanum elaeagnifolium

Nutsedge:
purple
Cyperus rotundus
yellow
Cyperus esculentus

Orchardgrass
Dactylis glomerata

Pampasgrass
Cortaderia jubata

Paragrass
Brachiaria mutica

Pepperweed, perennial
Lepidium latifolium

Phragmites**
Phragmites spp.

Quackgrass
Agropyron repens

Reed, giant
Arundo donax

Ryegrass, perennial
Lolium perenne

Smartweed, swamp
Polygonum coccineum

Spatterdock
Nuphar luteum

Starthistle, yellow
Centaurea solstitialis

Sweet potato, wild*
Ipomoea pandurata

Thistle, artichoke
Cynara cardunculus

Thistle, Canada
Cirsium arvense

Timothy
Phleum pratense

Torpedograss*
Panicum repens

Tules, common
Scirpus acutus

Vaseygrass
Paspalum urvillei

Velvetgrass
Holcus spp.

Waterhyacinth
Eichornia crassipes

Waterlettuce
Pistia stratiotes

Waterprimrose
Ludwigia spp.

Wheatgrass, western
Agropyron smithii

*Partial control.

**Partial control in southeastern states. See specific recommendations below.

Alligatorweed—Apply 6 pints of this product per acre as a broadcast spray or as a 1 1/4 percent solution with hand-held equipment to provide partial control of alligatorweed. Apply when most of the target plants are in bloom. Repeat applications will be required to maintain such control.

Bermudagrass—Apply 7 1/2 pints of this product per acre as a broadcast spray or as a 1 1/2 percent solution with hand-held equipment. Apply when target plants are actively growing and when seed heads appear.

Bindweed, field / Silverleaf Nightshade / Texas Blueweed—Apply 6 to 7 1/2 pints of this product per acre as a broadcast spray west of the Mississippi River and 4 1/2 to 6 pints of this product per acre east of the Mississippi River. With hand-held equipment, use a 1 1/2 percent solution. Apply when target plants are actively growing and are at or beyond full bloom. For silverleaf nightshade, best results can be obtained when application is made after berries are formed. Do not treat when weeds are under drought stress. New leaf development indicates active growth. For best results apply in late summer or fall.

Brackenfern—Apply 4 1/2 to 6 pints of this product per acre as a broadcast spray or as a 3/4 to 1 percent solution with hand-held equipment. Apply to fully expanded fronds which are at least 18 inches long.

Cattail—Apply 4 1/2 to 6 pints of this product per acre as a broadcast spray or as a 3/4 percent solution with hand-held equipment. Apply when target plants are actively growing and are at or beyond the early-to-full bloom stage of growth. Best results are achieved when application is made during the summer or fall months.

Cogongrass—Apply 4 1/2 to 7 1/2 pints of this product per acre as a broadcast spray. Apply when cogongrass is at least 18 inches tall and actively growing in late summer or fall. Allow 7 or more days after application before tillage or mowing. Due to uneven stages of growth and the dense nature of vegetation preventing good spray coverage, repeat treatments may be necessary to maintain control.

Cordgrass—Apply 4 1/2 to 7 1/2 pints of this product per acre as a broadcast spray or as a 1 to 2 percent solution with hand-held equipment. Schedule applications in order to allow 6 hours before treated plants are covered by tidewater. The presence of debris and silt on the cordgrass plants will reduce performance. It may be necessary to wash targeted plants prior to application to improve uptake of this product into the plant.

Cutgrass, giant—Apply 6 pints of this product per acre as a broadcast spray or as a 1 percent solution with hand-held equipment to provide partial control of giant cutgrass. Repeat applications will be required to maintain such control, especially where vegetation is partially submerged in water. Allow for substantial regrowth to the 7- to 10-leaf stage prior to retreatment.

Dogbane, hemp / Knapweed / Horseradish—Apply 6 pints of this product per acre as a broadcast spray or as a 1 1/2 percent solution with hand-held equipment. Apply when target plants are actively growing and most have reached the late bud-to-flower stage of growth. For best results, apply in late summer or fall.

Fescue, tall—Apply 4 1/2 pints of this product per acre as a broadcast spray or as a 1 percent solution with hand-held equipment. Apply when target plants are actively growing and most have reached the boot-to-head stage of growth. When applied prior to the boot stage, less desirable control may be obtained.

Guineagrass—Apply 4 1/2 pints of this product per acre as a broadcast spray or as a 3/4 percent solution with hand-held equipment. Apply when target plants are actively growing and when most have reached at least the 7-leaf stage of growth.

Johnsongrass / Bluegrass, Kentucky / Bromegrass, smooth / Canarygrass, reed / Orchardgrass / Ryegrass, perennial / Timothy / Wheatgrass, western—Apply 3 to 4 1/2 pints of this product per acre as a broadcast spray or as a 3/4 percent solution with hand-held equipment. Apply when target plants are actively growing and most have reached the boot-to-head stage of growth. When applied prior to the boot stage, less desirable control may be obtained. In the fall, apply before plants have turned brown.

Lantana—Apply this product as a 3/4 to 1 percent solution with hand-held equipment. Apply to actively growing lantana at or beyond the bloom stage of growth. Use the higher application rate for plants that have reached the woody stage of growth.

Loosestrife, purple—Apply 4 pints of this product per acre as a broadcast spray or as a 1 to 1 1/2 percent solution using hand-held equipment. Treat when plants are actively growing at or beyond the bloom stage of growth. Best results are achieved when application is made during summer or fall months. Fall treatments must be applied before a killing frost.

Lotus, American—Apply 4 pints of this product per acre as a broadcast spray or as a 3/4 percent solution with hand-held equipment. Treat when plants are actively growing at or beyond the bloom stage of growth. Best results are achieved when application is made during summer or fall months. Fall treatments must be applied before a killing frost. Repeat treatment may be necessary to control regrowth from underground parts and seeds.

Maidencane / Paragrass—Apply 6 pints of this product per acre as a broadcast spray or as a 3/4 percent solution with hand-held equipment. Repeat treatments will be required, especially to vegetation partially submerged in water. Under these conditions, allow for regrowth to the 7- to 10-leaf stage prior to retreatment.

Milkweed, common—Apply 4 1/2 pints of this product per acre as a broadcast spray or as a 1 1/2 percent solution with hand-held equipment. Apply when target plants are actively growing and most have reached the late bud-to-flower stage of growth.

Nutsedge: purple, yellow—Apply 4 1/2 pints of this product per acre as a broadcast spray, or as a 3/4 percent solution with hand-held equipment to control existing nutsedge plants and immature nutlets attached to treated plants. Apply when target plants are in flower or when new nutlets can be found at rhizome tips. Nutlets which have not germinated will not be controlled and may germinate following treatment. Repeat treatments will be required for long-term control.

Pampasgrass—Apply a 1 1/2 percent solution of this product with hand-held equipment when plants are actively growing.

Phragmites—For partial control of phragmites in Florida and the counties of other states bordering the Gulf of Mexico, apply 7 1/2 pints per acre as a broadcast spray or apply a 1 1/2 percent solution with hand-held equipment. In other areas of the U.S., apply 4 to 6 pints per acre as a broadcast spray or apply a 3/4 percent solution with hand-held equipment for partial control. For best results, treat during late summer of fall months when plants are actively growing and in full bloom. Due to the dense nature of the vegetation, which may prevent good spray coverage and uneven stages of growth, repeat treatments may be necessary to maintain control. Visual control symptoms will be slow to develop.

Quackgrass / Kikuyugrass / Muhly, wirestem—Apply 3 to 4 1/2 pints of this product per acre as a broadcast spray or as a 3/4 percent solution with hand-held equipment when most quackgrass or wirestem muhly is at least 8 inches in height (3- to 4-leaf stage of growth) and actively growing. Allow 3 or more days after application before tillage.

Reed, giant / Ice Plant—For control of giant reed and ice plant, apply a 1 1/2 percent solution of this product with hand-held equipment when plants are actively growing. For giant reed, best results are obtained when applications are made in late summer to fall.

Spatterdock—Apply 6 pints of this product per acre as a broadcast spray or as a 3/4 percent solution with hand-held equipment. Apply when most plants are in full bloom. For best results, apply during the summer or fall months.

Sweet potato, wild—Apply this product as a 1 1/2 percent solution using hand-held equipment. Apply to actively growing weeds that are at or beyond the bloom stage of growth. Repeat applications will be required. Allow the plant to reach the recommended stage of growth before retreatment.

Thistle: Canada, artichoke—Apply 3 to 4 1/2 pints of this product per acre as a broadcast spray or as a 1 1/2 percent solution with hand-held equipment for Canada thistle. To control artichoke thistle, apply a 2 percent solution as a spray-to-wet application. Apply when target plants are actively growing and are at or beyond the bud stage of growth.

Torpedograss—Apply 6 to 7 1/2 pints of this product per acre as a broadcast spray or as a 3/4 to 1 1/2 percent solution with hand-held equipment to provide partial control of torpedograss. Use the lower rates under terrestrial conditions, and the higher rates under partially submerged or a floating mat condition. Repeat treatments will be required to maintain such control.

Tules, common—Apply this product as a 1 1/2 percent solution with hand-held equipment. Apply to actively growing plants at or beyond the seedhead stage of growth. After application, visual symptoms will be slow to appear and may not occur for 3 or more weeks.

Waterhyacinth—Apply 5 to 6 pints of this product per acre as a broadcast spray or apply a 3/4 to 1 percent solution with hand-held equipment. Apply when target plants are actively growing and at or beyond the early bloom stage of growth. After application, visual symptoms may require 3 or more weeks to appear with complete necrosis and decomposition usually occurring within 60 to 90 days. Use the higher rates when more rapid visual effects are desired.

Waterlettuce—For control, apply a 3/4 to 1 percent solution of this product with hand-held equipment to actively growing plants. Use higher rates where infestations are heavy. Best results are obtained from mid-summer through winter applications. Spring applications may require retreatment.

Waterprimrose—Apply this product as a 3/4 percent solution using hand-held equipment. Apply to plants that are actively growing at or beyond the bloom stage of growth, but before fall color changes occur. Thorough coverage is necessary for best control.

Other perennials listed on this label—Apply 4 1/2 to 7 1/2 pints of this product per acre as a broadcast spray or as a 3/4 to 1 1/2 percent solution with hand-held equipment. Apply when target plants are actively growing and most have reached early head or early bud stage of growth.

9.3 Woody Brush and Trees

Apply a 1 to 2 percent solution of this product to control or partially control the woody brush and tree species listed below. Add 2 or more quarts of a nonionic surfactant per 100 gallons of spray solution to the rates of this product given in this list. See the "GENERAL INFORMATION," "DIRECTIONS FOR USE" and "MIXING AND APPLICATION" sections in this label for specific uses and application instructions.

Ensure thorough coverage when using spray-to-wet treatments using hand-held equipment. When using hand-held equipment for low volume directed spot treatments, apply a 5 to 8 percent solution of this product.

When applied as recommended under the conditions described, this product plus surfactant CONTROLS or PARTIALLY CONTROLS the following woody brush plants and trees:

Alder
Alnus spp.

Ash*
Fraxinus spp.

Aspen, quaking
Populus tremuloides

Bearclover, Bearmat
Chamaebatia foliolosa

Birch
Betula spp.

Blackberry
Rubus spp.

Broom:
French
Cytisus monspessulanus
Scotch
Cytisus scoparius

Buckwheat, California*
Eriogonum fasciculatum

Cascara*
Rhamnus purshiana

Castorbean
Ricinus communis

Catsclaw*
Acacia greggi

Ceanothus
Ceanothus spp.

Chamise
Adenostoma fasciculatum

Cherry:
Bitter
Prunus emarginata
Black
Prunus serotina
Pin
Prunus pensylvanica

Cottonwood, eastern
Populus deltoides

Coyote brush
Baccharis consanguinea

Creeper, Virginia*
Parthenocissus quinquefolia

Cypress, swamp, bald
Taxodium distichum

Deerweed
Lotus scoparius

Dewberry
Rubus trivialis

Dogwood
Cornus spp.

Elderberry
Sambucus spp.

Elm*
Ulmus spp.

Eucalyptus, bluegum
Eucalyptus globulus

Gallberry
Ilex glabra

Hackberry, western
Celtis occidentalis

Hasardia*
Haplopappus squamosus

Hawthorn
Crataegus spp.

Hazel
Corylus spp.

Hickory
Carya spp.

Honeysuckle
Lonicera spp.

Hornbeam, American
Carpinus caroliniana

Huckleberry
Vaccinium spp.

Kudzu
Pueraria lobata

Locust, black*
Robinia pseudoacacia

Magnolia, sweetbay
Magnolia virginiana

Manzanita
Arctostaphylos spp.

Maple:
Red**
Acer rubrum
Sugar
Acer saccharum
Vine*
Acer circinatum

Monkey Flower*
Mimulus guttatus

Oak:
Black*
Quercus velutina
Northern pine
Quercus palustris
Post
Quercus stellata
Red
Quercus rubra
Southern red
Quercus falcata
White*
Quercus alba

Orange, Osage
Maclura pomifera

Peppertree, Brazilian (Florida Holly)
Schinus terebinthifolius

Persimmon*
Diospyros spp.

Poison Ivy
Rhus radicans

Poison Oak
Rhus toxicodendron

Poplar, yellow*
Liriodendron tulipifera

Prunus
Prunus spp.

Raspberry
Rubus spp.

Redbud, eastern
Cercis canadensis

Redcedar, eastern
Juniperus virginiana

Rose, multiflora
Rosa multiflora

Russian-olive
Elaeagnus angustifolia

Sage: black, white
Salvia spp.

Sagebrush, California
Artemisia californica

Salmonberry
Rubus spectabilis

Saltcedar, tamarisk*
Tamarix spp.

Saltbush, Sea myrtle
Baccharis halimifolia

Sassafras
Sassafras albidum

Sourwood*
Oxydendrum arboreum

Sumac:
Laurel*
Rhus toxicodendron
Poison*
Rhus vernix
Smooth*
Rhus glabra
Sugarbush*
Rhus ovata
Winged*
Rhus copallina

Sweet gum
Liquidambar styraciflua

Swordfern*
Polystichum munitum

Tallowtree, Chinese
Sapium sebiferum

Thimbleberry
Rubus parviflorus

Tobacco, tree*
Nicotiana glauca

Toyon*
Heteromeles arbutifolia

Trumpetcreeper
Campsis radicans

Waxmyrtle, southern*
Myrica cerifera

Willow
Salix spp.

Yerbasenta, California
Eriodictylon californicum

*Partial control
**See below for control or partial control instruction.

NOTE: If brush has been mowed or tilled or trees have been cut, do not treat until regrowth has reached the recommended stage of growth.

Apply the recommended rate of this product plus 2 or more quarts of a nonionic surfactant per 100 gallons of spray solution when plants are actively growing and, unless otherwise directed, after full-leaf expansion. Use the higher rate for larger plants and/or dense areas of growth. On vines, use the higher rate for plants that have reached the woody stage of growth. Best results are obtained when application is made in late summer or fall after fruit formation.

In arid areas, best results are obtained when application is made in the spring or early summer when brush species are at high moisture content and are flowering. Ensure thorough coverage when using hand-held equipment. Symptoms may not appear prior to frost or senescence with fall treatments.

Allow 7 or more days after application before tillage, mowing or removal. Repeat treatments may be necessary to control plants regenerating from underground parts or seed. Some autumn colors on undesirable deciduous species are acceptable provided no major leaf drop has occurred. Reduced performance may result if fall treatments are made following a frost.

See the "DIRECTIONS FOR USE" and "MIXING AND APPLICATION INSTRUCTIONS" sections in this label for labeled use and specific application instructions.

Applied as a 5 to 8 percent solution as a directed application as described in the "HAND-HELD AND HIGH-VOLUME EQUIPMENT" section, this product will control or partially control all species listed in this section of this label. Use the higher rate of application for dense stands and larger woody brush and trees.

Apply the product as follows to control or partially control the following woody brush and trees.

Alder / Blackberry / Dewberry / Honeysuckle / Oak, Post / Raspberry—For control, apply 4 1/2 to 6 pints per acre as a broadcast spray or as a 3/4 to 1 1/4 percent solution with hand-held equipment.

Aspen, quaking / Hawthorn / Trumpetcreeper—For control, apply 3 to 4 1/4 pints of this product per acre as a broadcast spray or as a 3/4 to 1 1/4 percent solution with hand-held equipment.

Birch / Elderberry / Hazel / Salmonberry / Thimbleberry—For control, apply 3 pints per acre of this product as a broadcast spray or as a 3/4 percent solution with hand-held equipment.

Broom: French, Scotch—For control, apply a 1 1/4 to 1 1/2 percent solution with hand-held equipment.

Buckwheat, California / Hasardia / Monkey Flower / Tobacco, tree—For partial control of these species, apply a 3/4 to 1 1/2 percent solution of this product as a foliar spray with hand-held equipment. Thorough coverage of foliage is necessary for best results.

Castorbean—For control, apply a 1 1/2 percent solution of this product with hand-held equipment.

Catsclaw—For partial control, apply a 1 1/4 to 1 1/2 percent solution with hand-held equipment when at least 50 percent of the new leaves are fully developed.

Cherry: Bitter, Black, Pin / Oak, Southern Red / Sweet gum / Prunus—For control, apply 3 to 7 1/2 pints of this product per acre as a broadcast spray or as a 1 to 1 1/2 percent solution with hand-held equipment.

Coyote brush—For control, apply a 1 1/4 to 1 1/2 percent solution with hand-held equipment when at least 50 percent of the new leaves are fully developed.

Dogwood / Hickory / Saltcedar, tamarisk—For partial control, apply a 1 to 2 percent solution of this product with hand-held equipment or 6 to 7 1/2 pints per acre as a broadcast spray.

Eucalyptus, bluegum—For control of eucalyptus resprouts, apply a 1 1/2 percent solution of this product with hand-held equipment when resprouts are 6- to 12-feet tall. Ensure complete coverage. Apply when plants are actively growing. Avoid application to drought-stressed plants.

Kudzu—For control, apply 6 pints of this product per acre as a broadcast spray or as a 1 1/2 percent solution with hand-held equipment. Repeat applications will be required to maintain control.

Maple, Red—For control, apply as a 3/4 to 1 1/4 percent solution with hand-held equipment when leaves are fully developed. For partial control, apply 2 to 7 1/2 pints of this product per acre as a broadcast spray.

Maple, Sugar / Oak: Northern Pin, Red—For control, apply as a 3/4 to 11/4 percent solution with hand-held equipment when at least 50 percent of the new leaves are fully developed.

Peppertree, Brazilian (Holly, Florida) / Waxmyrtle, southern—For partial control, apply this product as a 1 1/2 percent solution with hand-held equipment.

Poison Ivy / Poison Oak—For control, apply 6 to 7 1/2 pints of this product per acre as a broadcast spray or as a 1 1/2 percent solution with hand-held equipment. Repeat applications may be required to maintain control. Fall treatments must be applied before leaves lose green color.

Rose, multiflora—For control, apply 3 pints of this product per acre as a broadcast spray or as a 3/4 percent solution with hand-held equipment. Treatments should be made prior to leaf deterioration by leaf-feeding insects.

Sage, black / Sagebrush, California / Chamise / Tallowtree, Chinese—For control of these species, apply a 3/4 percent solution of this product as a foliar spray with hand-held equipment. Thorough coverage of foliage is necessary for best results.

Saltbush, Sea myrtle—For control, apply this product as a 1 percent solution with hand-held equipment.

Willow—For control, apply 4 1/2 pints of this product per acre as a broadcast spray or as a 3/4 percent solution with hand-held equipment.

Other woody brush and trees listed in this label—For partial control, apply 3 to 7 1/2 pints of this product per acre as a broadcast spray or as a 3/4 to 1 1/2 percent solution with hand-held equipment.

10.0 LIMIT OF WARRANTY AND LIABILITY

Monsanto Company warrants that this product conforms to the chemical description on the label and is reasonably fit for the purposes set forth in the Complete Directions for Use label booklet ("Directions") when used in accordance with those Directions under the conditions described therein. NO OTHER EXPRESS WARRANTY OR IMPLIED WARRANTY OF FITNESS FOR PARTICULAR PURPOSE OR MERCHANTABILITY IS MADE. This warranty is also subject to the conditions and limitations stated herein.

Buyer and all users shall promptly notify this Company of any claims whether based in contract, negligence, strict liability, other tort or otherwise.

Buyer and all users are responsible for all loss or damage from use or handling which results from conditions beyond the control of this Company, including, but not limited to, incompatibility with products other than those set forth in the Directions, application to or contact with desirable vegetation, unusual weather, weather conditions which are outside the range considered normal at the application site and for the time period when the product is applied, as well as weather conditions which are outside the application ranges set forth in the Directions, application in any manner not explicitly set forth in the Directions, moisture conditions outside the moisture range specified in the Directions, or the presence of products other than those set forth in the Directions in or on the soil, crop or treated vegetation.

This Company does not warrant any product reformulated or repackaged from this product except in accordance with this Company's stewardship requirements and with express written permission of this Company.

THE EXCLUSIVE REMEDY OF THE USER OR BUYER, AND THE LIMIT OF THE LIABILITY OF THIS COMPANY OR ANY OTHER SELLER FOR ANY AND ALL LOSSES, INJURIES OR DAMAGES RESULTING FROM THE USE OR HANDLING OF THIS PRODUCT (INCLUDING CLAIMS BASED IN CONTRACT, NEGLIGENCE, STRICT LIABILITY, OTHER TORT OR OTHERWISE) SHALL BE THE PURCHASE PRICE PAID BY THE USER OR BUYER FOR THE QUANTITY OF THIS PRODUCT INVOLVED, OR, AT THE ELECTION OF THIS COMPANY OR ANY OTHER SELLER, THE REPLACEMENT OF SUCH QUANTITY, OR, IF NOT ACQUIRED BY PURCHASE, REPLACEMENT OF SUCH QUANTITY. IN NO EVENT SHALL THIS COMPANY OR ANY OTHER SELLER BE LIABLE FOR ANY INCIDENTAL, CONSEQUENTIAL OR SPECIAL DAMAGES.

Upon opening and using this product, buyer and all users are deemed to have accepted the terms of this LIMIT OF WARRANTY AND LIABILITY which may not be varied by any verbal or written agreement. If terms are not acceptable, return at once unopened.

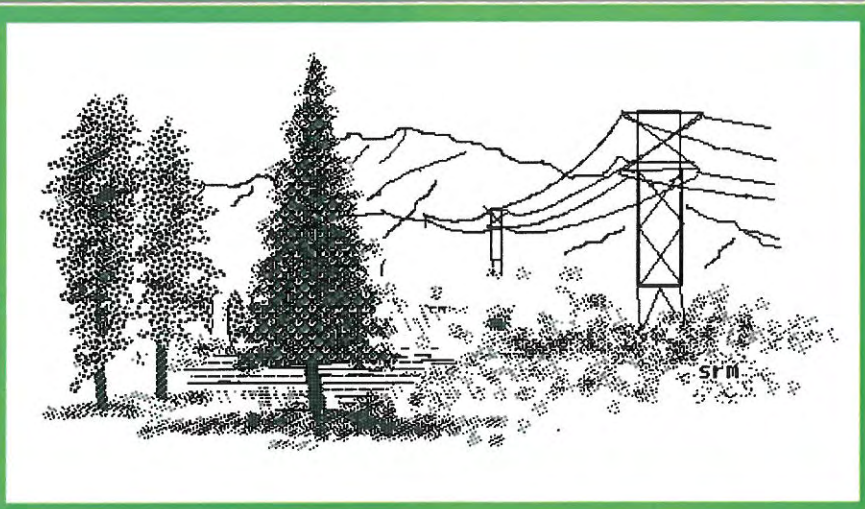
EPA Reg. No. 524-343

In case of an emergency involving this product,
Call Collect, day or night, (314) 694-4000.

21061Y6-1/CG

Imazapyr

Pesticide Fact Sheet



Prepared for the U.S. Department of Agriculture, Forest Service by Information Ventures, Inc.

This fact sheet is one of a series issued by the Forest Service, the Bureau of Land Management, and the Bonneville Power Administration for their workers and the general public. It provides information on forest and land management uses, environmental and human health effects, and safety precautions for the herbicide imazapyr and its formulations. Unless otherwise stated, the toxicity data presented in this fact sheet refer to the active ingredient, imazapyr. When included, data on formulated products will be specifically identified. A list of definitions is included in Section VIII of the fact sheet.

I. Basic Information

Common name: Imazapyr

Chemical name: 2-(4,5-dihydro-4-methyl-4-(1-methylethyl)-5-oxo-1H-imidazol-2-yl)-3-pyridinecarboxylic acid

Common Product names: Arsenal®, Chopper®, Contain®

Pesticide classification: herbicide

Registered Use Status: "General Use"

Formulations: Commercial imazapyr products generally contain one or more inert ingredients. An inert ingredient is anything added to the product other than an active ingredient. Because of concern for

human health and the environment, the U.S. Environmental Protection Agency (EPA) announced its policy on toxic inert ingredients in the Federal Register on April 22, 1987 (52 FR 13305). The intent of this policy is the regulation of inert ingredients. EPA's strategy for the implementation of this policy included the development of four lists of inerts based on toxicological concerns. Inerts of toxicological concern were placed on List 1. Potentially toxic inerts/high priority for testing were placed on List 2. Inerts of unknown toxicity were placed on List 3 and inerts of minimal concern were placed on List 4.

For pesticides containing List 1 inerts, the EPA has given the pesticide registrant the opportunity to reformulate the product to remove the List 1 inerts. If the registrant chooses not to reformulate the product, then the List 1 inerts must be identified on the product label. For List 2 inerts, the EPA is monitoring ongoing testing and gathering existing information on the potential adverse effects of these chemicals to determine if further regulatory action is required. The EPA has no particular regulatory plans for List 3 and List 4 inerts. The Forest Service will incorporate new data on inerts into updated fact sheets as it becomes available.

The contents of three imazapyr formulations are listed below.

Chopper®: imazapyr (22.6%), isopropylamine (5.4%), and other inert ingredients (72%)

Arsenal®: imazapyr (27.6%), and inert ingredients (72.4%)

Chopper® RTU: isopropylamine salt of imazapyr (3.6%), propylene glycol (30%), isopropanol (5.0%), and other inert ingredients (61.4%)

Residue assay methods: Information on residue assay methods is not available.

II. Herbicide Uses

Registered forestry, rangeland, right-of-way uses: non-cropland use for rights-of-way, forestry site preparation and conifer release

Operational details:

Target Plants: Imazapyr is used to control annual and perennial grass and broadleaved weeds, brush, vines, and many deciduous trees.

Mode of action: Imazapyr is absorbed by the leaves and roots, and moves rapidly through the plant. It

accumulates in the meristem region (active growth region) of the plant. In plants, imazapyr disrupts protein synthesis, and interferes with cell growth and DNA synthesis. Sensitive plants die slowly.

Method of application: aerial methods, low-volume hand-held spray equipment, high-volume spray equipment, boom equipment, basal treatment, cut stump treatment, tree injection, and frill treatment

Use rates: Use at 2 to 6 pints/acre

Special Precautions:

Always read all of the information on the product label before using any pesticide. Read the label for application restrictions.

Timing Of Application: Imazapyr can be applied either before or after weeds emerge. After weeds emerge, imazapyr should be applied during active weed growth. For hardwoods, imazapyr can be applied between leaf emergence and leaf drop.

Drift Control: Do not spray under windy or gusty conditions. Select proper spray nozzles to avoid fine mist. Do not apply near desirable plants or where their roots may extend.

III. Environmental Effects/Fate

Soil:

- **Residual Soil Activity:** Imazapyr can remain active in the soil for 6 months to 2 years.
- **Adsorption:** Imazapyr is strongly adsorbed by soils. It is usually found only in the top few inches of soil.
- **Persistence and Agents of Degradation:** Imazapyr may be broken down by exposure to sunlight. Soil microorganisms contribute to the break-down of imazapyr. Very little imazapyr is lost by evaporation.
- **Metabolites/Degradation Products and Potential Environmental Effects:** No information available.

Water:

- **Solubility:** Imazapyr is soluble in water.
- **Potential For Leaching Into Ground-Water:** Imazapyr has a low potential for leaching into ground-water.
- **Surface Waters:** Imazapyr may move from treated areas in streams. Most movement of imazapyr was found in runoff from storms. Use of a streamside management zone can significantly reduce the amount of offsite movement of imazapyr in stormflow. The half-life of imazapyr in water is about 4 days.

  Do not apply on irrigation ditches. Do not apply where runoff water may flow onto agricultural land. Do not apply to water or wetlands.

Air:

- **Volatilization:** Imazapyr does not evaporate easily.
- **Potential For By-Products From Burning of Treated Vegetation:** No information available.

IV. Ecological Effects

Non-Target Toxicity:

- **Soil Microorganisms:** Imazapyr has very little effect on microorganisms.
- **Plants:** Imazapyr is non-toxic to conifers. It is toxic to many other non-target plants.
- **Aquatic Animals:** Imazapyr and its formulations are low in toxicity to invertebrates and practically non-toxic to fish. Imazapyr is not expected to accumulate or build up in aquatic animals. Imazapyr and its formulations have not been tested for chronic effects in aquatic animals. Acute toxic level:

species	LC50	Source Table
fish	<100 mg/l	(Table II, Aquatic)
water flea	<100 mg/l	(Table II, Aquatic)

- **Terrestrial Animals:** Imazapyr is practically non-toxic to mammals and birds. It is of low

toxicity to bees. Imazapyr is rapidly excreted by mammals. Imazapyr and its formulations have not been tested for chronic effects in terrestrial animals. Acute toxic level:

species	LD50	Source Table
birds	<2150 mg/kg	(Table II, Avian)
mammals	4800 to <5000 mg/kg	(Table II, Mammalian)
bee	<100 micrograms/bee	---

- **Threatened and Endangered Species:** Imazapyr could be a hazard to endangered plants if applied to areas where they grow. It would probably not be a hazard to most endangered animals because of its low toxicity.

V. Toxicology Data

Acute toxicity:

- **Acute oral toxicity:** In tests in rats, the acute oral LD50 was greater than 5,000 mg/kg. (Toxicity Category IV, Table I, Oral)

  Acute dermal toxicity: The acute dermal (skin) LD50 was greater than 2,000 mg/kg in rabbits. (Toxicity Category III, Table I, Dermal)

- **Primary irritation score:** The acute dermal (skin) LD50 was greater than 2,000 mg/kg in rabbits. (Toxicity Category III, Table I, Dermal)
- **Primary eye irritation:** In laboratory tests in rabbits, imazapyr was an eye irritant. (Toxicity Category III, Table I, Eye irritation)
- **Acute inhalation:** In laboratory tests in rats, the acute inhalation LC50 was greater than 5.1 milligrams/liter. (Toxicity Category III, Table I, Inhalation)

Chronic toxicity:

- **Carcinogenicity:** The potential for causing tumors (oncogenicity) has not been determined at this time. Laboratory studies are being carried out to determined oncogenicity.
- **Developmental:** Laboratory studies with imazapyr in rats (at dose levels up to 1,000 mg/kg per day) and rabbits (at up to 400 mg/kg per day) indicated no evidence of teratology (birth defects).
- **Reproduction:** The potential for causing adverse effects on fertility or reproduction has not been determined at this time. Laboratory studies are being carried out to determined the potential for reproductive effects.
- **Mutagenicity:** Imazapyr was negative in all tests for mutagenicity (the ability to cause genetic damage).

The data reported above are results of animal studies which have been evaluated by the Forest Service. These data are used to make inferences relative to human health.

HAZARD: Based on the results of animal studies, imazapyr does not cause genetic damage or birth defects. There is not enough information available at this time to determined whether imazapyr causes cancer, or adverse effects on reproduction or fertility.

VI. Human Health Effects

Acute toxicity (poisoning):

Reported effects: No reports of poisoning in humans were found.

Chronic toxicity:

Reported effects: No reports of long term health effects in humans were found.

Potential for adverse health effects from contacting or consuming treated vegetation, water or animals: The exposure levels a person could receive from these sources, as a result of routine operations, are below levels shown to cause harmful effects in laboratory studies.

Potential for adverse health effects from inert ingredients contained in the formulated product: Inert ingredients found in imazapyr include propylene glycol, isopropanol, water, and surfactant. Water is not toxic. Propylene glycol is low in toxicity. Very large doses can cause hypoglycemia, lactic acidosis and seizures in some sensitive people. Surfactants are generally low in toxicity. Isopropanol may be a toxic hazard if a large amount is swallowed.

Health effects of exposure to formulated products: The formulated products are approximately as toxic as imazapyr alone.

Health effects associated with contaminants: No reported contaminants.

Health effects associated with other formulations: No imazapyr formulations contain other herbicides.

Health risk management procedures: The Forest Service has evaluated health effects data in the development of both pesticide background statement documents and environmental impact statements for pesticide use on forest lands. These health effects evaluations have taken into consideration the potential for both worker and public exposure from Forest Service operations. This information has been used in assessing health risks and consequently in formulating protective measures to reduce risk to forest workers and to the public. Section VII of this fact sheet, Safety Precautions, provides guidance for the safe handling and use of imazapyr.

VII. Safety precautions:

Signal word and definition:

Chopper® RTU - **CAUTION** - HARMFUL IF INHALED OR ABSORBED THROUGH SKIN.
Chopper® - **CAUTION** - MAY BE A SKIN SENSITIZER.
Arsenal® - **CAUTION**

Protective Precautions for Workers: Avoid contact with skin, eyes or clothing. Avoid breathing imazapyr spray mist. Wash thoroughly with soap and water after handling imazapyr. Remove and wash clothing before reuse.

Medical Treatment Procedures (Antidotes): There is no antidote: treat symptoms. If on skin, wash with plenty of soap and water. For exposure to the eyes, flush with plenty of water. Get medical attention if irritation persists. **In case of emergency, call your local poison control center for advice.**

Handling, Storage, And Disposal: Imazapyr is stable at room temperature for at least 2 years. At higher temperatures, it is stable for shorter periods. Do not store below 10 degrees Fahrenheit. Keep imazapyr products away from flames and sparks; protect from exposure to fire and heat. Wear chemical splash goggles and/or face shield when handling imazapyr. Wear rubber gloves and apron. Do not mix, store or apply in unlined steel containers or spray tanks. Do not contaminate water, food, or animal feed by storage or disposal. Wastes from the use of imazapyr can be disposed of on site or at an approved

waste disposal facility.

Emergency (Spill) Hazards And Procedures: Absorb liquid spills with an inert material such as clay or sawdust. Place material in a closed container for later disposal. **In case of a large spill, call CHEMTREC at 1-800-424-9300 for advice.**

VIII. Definitions

---

adsorption - the process of attaching to a surface
avian - of, or related to, birds
basal treatment - applied to the stem of a plant just above the soil
carcinogenicity - ability to cause cancer
ecotoxicology - the study of the effects of environmental toxicants on populations of organisms originating, being produced, growing, or living naturally in a particular region or environment.
ecotoxicological - related to the study of the effects of environmental toxicants on populations of organisms originating, being produced, growing, or living naturally in a particular region or environment.
formulation - the form in which the pesticide is supplied by the manufacturer for use
frill treatment - a frill of overlapping axe cuts is made through the bark of a tree, and the injured surface is painted or sprayed with herbicide
half-life - the time required for half the amount of substance to be reduced by natural processes
herbicide - a substance used to destroy plants or to slow down their growth
LC50 - the concentration in air, water, or food which will kill approximately 50% of the subjects
LD50 - the dose which will kill approximately 50% of the subjects
leach - to dissolve out by the action of water
mg/kg - milligrams of the substance per kilogram of body weight
microorganisms - living things too small to be seen without a micro-scope
mutagenicity - ability to cause genetic changes
non-target - animals or plants other than the ones which the pesticide is intended to kill
persistence - tendency of a pesticide to remain active after it is applied
ppm - parts per million
residual activity - the remaining amount of activity as a pesticide
volatility - the tendency to become a vapor at relatively low temperature

---

IX. Additional Reading

---

1. Final Environmental Impact Statement for Managing Competing and Unwanted Vegetation. Pacific Northwest Region. Forest Service, U.S. Department of Agriculture, Portland, Oregon. 1988.
2. Final Environmental Impact Statement. Vegetation Management in the Coastal Plain/Piedmont. Forest Service, U.S. Department of Agriculture, Atlanta, Georgia. Management Bulletin R8-MB-23, 1989.
3. Final Environmental Impact Statement. Vegetation Management for Reforestation. Forest Service, U.S. Department of Agriculture, San Francisco, California. 1989.
4. Imazapyr. A Review of Its Toxic Properties and Environmental Fate Characteristics. R.S. Jagan, T.E. McManus, G.H. Drendel, P.J. Sczerzenie, and J.A. Weeks. Labat-Anderson Incorporated, Arlington, Virginia. 1987.

X. Toxicity Categories

Tables of Categories of Toxicity

Table I: Human Hazards

		Route of Administration			Hazard	
Category	**Signal word**	**Oral (mg/kg)**	**Dermal (mg/kg)**	**Inhalation (mg/L)**	**Eye Irritation**	**Skin Irritation**
I	DANGER Poison	0-50	0-200	0-0.2	corrosive: corneal opacity not reversible within 7 days	corrosive
II	WARNING	>50-500	>200-2000	>0.2-20	corneal opacity reversible within 7 days; irritation persisting for 7 days	severe irritation at 72 hours
III	CAUTION	>500-5000	>2000-20,000	>2.0-20	no corneal opacity; irritation reversible within 7 days	moderate irritation at 72 hours

IV	none	>5000	>20,000	>20	no irritation	mild or slight irritation at 72 hours

40 CFR 162.10 (h) (1), July 3, 1975

Table II: Ecotoxicological Categories

Toxicity Category	Mammalian (Acute Oral)* mg/kg	Avian (Acute Oral)* mg/kg	Avian (Dietary)_ ppm	Aquatic Organisms‡ ppm
very highly toxic	<10	<10	<50	<0.1
highly toxic	10-50	10-50	50-500	0.1-1
moderately toxic	51-500	51-500	501-1000	>1-10
slightly toxic	501-2000	501-2000	1000-5000	>10-100
practically non-toxic	>2000	>2000	>5000	>100

* Reflects dose given to test animals and is based on body weight of the test animal.
_Concentration in the diet. Unrelated to body weight of the test animal. Measure of environmental exposure.
‡Concentration in water. Unrelated to body weight of test animal. Measure of environmental exposure.

Adapted from Insecticides, Brooks, H.L. et al. (1973) Cooperative Extension, Kansas State University, Manhattan, Kansas
For more information on Imazapyr contact your local Forest Service, Bureau of Land Management, or Bonneville Power Administration office.
Prepared by Information Ventures, Inc. under U.S. Forest Service Contract. November 1995

IVI Home ▪ E'Health Home ▪ Search ▪ Comment

Mail us at: Customer-Service@infoventures.com
http://infoventures.com/e-hlth/

Specimen Label

Dow AgroSciences

Garlon* 4

Specialty Herbicide

*Trademark of Dow AgroSciences LLC

For the control of woody plants and broadleaf weeds on rights-of-way, industrial sites, non-crop areas, non-irrigation ditch banks, forests, and wildlife openings, including grazed areas on these sites.

Active Ingredient:	
triclopyr: 3,5,6-trichloro-2-pyridinyloxyacetic acid, butoxyethyl ester	61.6%
Inert Ingredients	38.4%
Total	100.0%

Contains petroleum distillates
Acid Equivalent:
triclopyr - 44.3% - 4 lb/gal

EPA Reg. No. 62719-40

Precautionary Statements

Hazards to Humans and Domestic Animals

Keep Out of Reach of Children

CAUTION PRECAUCION

Si usted no entiende la etiqueta, busque a alguien para que se la explique a usted en detalle. (If you do not understand the label, find someone to explain it to you in detail.)

Harmful If Swallowed, Inhaled, Or Absorbed Through Skin

Avoid contact with eyes, skin, or clothing. Avoid breathing mists or vapors. Avoid contamination of food.

Personal Protective Equipment (PPE)

Some materials that are chemical-resistant to this product are listed below. If you want more options, follow the instructions for category E on an EPA chemical resistance category selections chart.

WPS Uses: Applicators and other handlers who handle this pesticide for any use covered by the Worker Protection Standard (40 CFR Part 170) -- in general, agricultural-plant uses are covered -- must wear:

- Long-sleeved shirt and long pants
- Chemical-resistant gloves such as Barrier Laminate, Nitrile Rubber, Neoprene Rubber, or Viton
- Shoes plus socks

Non-WPS Uses: Applicators and other handlers who handle this pesticide for any use NOT covered by the Worker Protection Standard (40 CFR Part 170) -- in general, only agricultural-plant uses are covered by the WPS -- must wear:

- Long-sleeved shirt and long pants
- Shoes plus socks

Follow manufacturer's instructions for cleaning/maintaining PPE. If no such instructions for washables, use detergent and hot water. Keep and wash PPE separately from other laundry.

User Safety Recommendations

Users should:

- Wash hands before eating, drinking, chewing gum, using tobacco, or using the toilet.
- Remove clothing immediately if pesticide gets inside. Then wash thoroughly and put on clean clothing.

First Aid

If on skin: Flush skin with plenty of water. Get medical attention if irritation persists.
If swallowed: Do not induce vomiting. Call a physician.

Environmental Hazards

This pesticide is toxic to fish. Do not apply directly to water, to areas where surface water is present, or to intertidal areas below the mean high water mark. Do not contaminate water when disposing of equipment washwaters.

Physical or Chemical Hazards

Do not use or store near heat or open flame. Do not cut or weld container.

Notice: Read the entire label. Use only according to label directions. **Before buying or using this product, read "Warranty Disclaimer" and "Limitation of Remedies" elsewhere on this label.**

In case of emergency endangering health or the environment involving this product, call 1-800-992-5994. If you wish to obtain additional product information, visit our web site at www.dowagro.com.

Agricultural Chemical: Do not ship or store with food, feeds, drugs or clothing.

Directions for Use

It is a violation of Federal law to use this product in a manner inconsistent with its labeling.
Read all Directions for Use carefully before applying.

Do not use for manufacturing or formulating.

Do not apply this product in a way that will contact workers or other persons, either directly or through drift. Only protected handlers may be in the area during application. For any requirements specific to your state or tribe, consult the agency responsible for pesticide regulation.

Agricultural Use Requirements

Use this product only in accordance with its labeling and with the Worker Protection Standard, 40 CFR part 170. This standard contains requirements for the protection of agricultural workers on farms, forests, nurseries, and greenhouses, and handlers of agricultural pesticides. It contains requirements for training, decontamination, notification, and emergency assistance. It also contains specific instructions and exceptions pertaining to the statements on this label about personal protective equipment (PPE) and restricted-entry interval. The requirements in this box only apply to uses of this product that are covered by the Worker Protection Standard.

Do not enter or allow worker entry into treated areas during the restricted entry interval (REI) of 12 hours.

PPE required for early entry to treated areas that is permitted under the Worker Protection Standard and that involves contact with anything that has been treated, such as plants, soil, or water, is:

- Coveralls
- Chemical-resistant gloves such as Barrier Laminate, Nitrile Rubber, Neoprene Rubber, or Viton
- Shoes plus socks

Storage and Disposal

Do not contaminate water, food, or feed by storage or disposal. Open dumping is prohibited.

Storage: Store above 28°F or agitate before use.

Pesticide Disposal: Pesticide, spray mixture, or rinse water that cannot be used according to label instructions must be disposed of according to applicable federal, state, or local procedures.

Plastic Container Disposal: Triple rinse (or equivalent). Then offer for recycling or reconditioning, or puncture and dispose of in a sanitary landfill, or by incineration, or, if allowed by state and local authorities, by burning. If burned, stay out of smoke.

Metal Container Disposal: Triple rinse (or equivalent). Then offer for recycling or reconditioning, or puncture and dispose of in a sanitary landfill, or by other procedures approved by state and local authorities.

Container Disposal for Refillable Containers: Replace the dry disconnect cap, if applicable, and seal all openings which have been opened during use. Return the empty container to a collection site designated by Dow AgroSciences. If the container has been damaged and cannot be returned according to the recommended procedures, contact the Dow AgroSciences Customer Service Center at 1-800-258-1470 to obtain proper handling instructions.

General: Consult federal, state, or local disposal authorities for approved alternative procedures.

General Information

Garlon* 4 herbicide is recommended for the control of unwanted woody plants and annual and perennial broadleaf weeds in forests, and on non-crop areas including industrial manufacturing and storage sites, rights-of-way such as electrical power lines, communication lines, pipelines, roadsides and railroads, fence rows, non-irrigation ditch banks, and around farm buildings. Use on these sites may include application to grazed areas as well as establishment and maintenance of wildlife openings.

General Use Precautions

Agricultural Use Requirements for Forestry Uses: For use of this product on forestry sites, follow PPE and Reentry restrictions in the Agricultural Use Requirements section of this label.

Use Requirements for Non-cropland Areas: No Worker Protection Standard worker entry restrictions or worker notification requirements apply when this product is applied to non-cropland.

In Arizona: The state of Arizona has not approved Garlon 4 for use on plants grown for commercial production; specifically forests grown for commercial timber production, or on designated grazing areas.

Chemigation: Do not apply this product through any type of irrigation system.

Other Precautions:

- When applying this product in tank mix combination, follow all applicable use directions and precautions on each manufacturer's label.
- Do not apply on ditches used to transport irrigation water. Do not apply where runoff or irrigation water may flow onto agricultural land as injury to crops may result.
- Do not apply this product using mist blowers unless a drift control additive, high viscosity inverting system, or equivalent is used to control spray drift.
- Sprays applied directly to Christmas trees may result in conifer injury. When treating unwanted vegetation in Christmas tree plantations, care should be taken to direct sprays away from conifers.
- Do not apply Garlon 4 directly to, or otherwise permit it to come into direct contact with grapes, tobacco, vegetable crops, flowers, or other desirable broadleaf plants and do not permit spray mists containing it to drift onto them.
- It is permissible to treat non-irrigation ditch banks, seasonally dry wetlands, flood plains, deltas, marshes, swamps, bogs, and transitional areas between upland and lowland sites. Do not apply to open water such as lakes, reservoirs, rivers, streams, creeks, salt water bays, or estuaries.

Avoid Injurious Spray Drift

Applications should be made only when there is little or no hazard from spray drift. Very small quantities of spray, which may not be visible may seriously injure susceptible plants. Do not spray when wind is blowing toward susceptible crops or ornamental plants near enough to be injured. It is suggested that a continuous smoke column at or near the spray site or a smoke generator on the spray equipment be used to detect air movement, lapse conditions, or temperature inversions (stable air). If the smoke layers or indicates a potential of hazardous spray drift, do not spray.

Aerial Application (Helicopter Only): For aerial application on rights-of-way or other areas near susceptible crops, use an agriculturally registered spray thickening drift control additive as recommended by the manufacturer or apply through the Microfoil† boom, Thru-Valve boom, or equivalent drift control system. Thickened sprays prepared by using high viscosity invert systems or other drift reducing systems may be utilized if they are made as drift-free as are mixtures containing an agriculturally registered thickening agent or applications made with the Microfoil boom or Thru Valve boom. If a spray thickening agent is used, follow all use recommendations and precautions on the product label. Do not use a thickening agent with the Microfoil boom, Thru Valve boom, or other systems that cannot accommodate thick sprays.

†Reference within this label to a particular piece of equipment produced by or available form other parties is provided without consideration for use by the reader at its discretion and subject to the reader's independent circumstances, evaluation, and expertise. Such reference by Dow AgroSciences is not intended as an endorsement of such equipment, shall not constitute a warranty (express or implied) of such equipment, and is not intended to imply that other equipment is not available and equally suitable. Any discussion of methods of use of such equipment does not imply that the reader should use the equipment other than is advised in directions available from the equipment's manufacturer. The reader is responsible for exercising its own judgment and expertise, or consulting with sources other than Dow AgroSciences, in selecting and determining how to use its equipment.

With aircraft, drift can be lessened by applying a coarse spray; by using a spray boom no longer than 3/4 the rotor length; by spraying only when wind velocities are low; or by using an approved drift control system. Keep operating spray pressures at the lower end of the manufacturer's recommended pressures for the specific nozzle type used. Low pressure nozzles are available from spray equipment manufacturers. Select nozzles and pressures which provide adequate plant coverage, but minimize the production of fine spray particles.

Ground Equipment: To aid in reducing spray drift potential when making ground applications near susceptible crops or other desirable broadleaf plants, Garlon 4 should be applied through large droplet producing equipment, such as the Radiarc sprayer or in thickened spray mixtures using an agriculturally registered drift control additive, or high viscosity invert systems. When using a spray thickening or inverting additive, follow all use directions and precautions on the product label. With ground equipment, spray drift can be reduced by keeping the spray boom as low as possible; by applying 20 gallons or more of spray per acre; and by spraying when wind velocity is low. Do not apply with nozzles that produce a fine droplet spray. Keep operating spray pressures at the lower end of the manufacturer's recommended pressures for the specific nozzle type used. Low pressure nozzles are available from spray equipment manufacturers. Select nozzles and pressures which provide adequate plant coverage, but minimize the production of fine spray particles.

High Volume Leaf-Stem Treatment: To minimize spray drift, keep sprays no higher than brush tops and keep spray pressures low enough to provide coarse spray droplets. A spray thickening agent may be used to reduce spray drift.

Grazing and Haying Restrictions

Grazing or harvesting green forage:

1) Lactating dairy animals
   Two quarts per acre or less: Do not graze or harvest green forage from treated area for 14 days after treatment.
   Greater than 2 to 6 quarts per acre: Do not graze or harvest green forage until the next growing season.
2) Other Livestock
   Two quarts per acre or less: No grazing restrictions.
   Greater than 2 to 6 quarts per acre: Do not graze or harvest green forage from treated area for 14 days after treatment. **Note:** If less than 25% of a grazed area is treated, there is no grazing restriction.

Haying (harvesting of dried forage):

1) Lactating dairy animals
   Do not harvest hay until the next growing season.
2) Other Livestock
   Two quarts per acre or less: Do not harvest hay for 7 days after treatment.
   Greater than 2 to 4 quarts per acre: Do not harvest hay for 14 days after treatment.
   Greater than 4 quarts per acre: Do not harvest hay until the next growing season.

Slaughter Restrictions:
Withdraw livestock from grazing treated grass or consumption of treated hay at least 3 days before slaughter. This restriction applies to grazing during the season following treatment or hay harvested during the season following treatment.

Plants Controlled by Garlon 4

Woody Plants Controlled

alder	chinquapin	madrone	scotch broom
arrowwood	choke cherry	maples	sumac
ash	cottonwood	mulberry	sweetbay magnolia
aspen	Crataegus (hawthorn)	oaks	sweetgum
bear clover (bearmat)	dogwood	persimmon	sycamore
beech	Douglas-fir	pine	tanoak
birch	elderberry	poison ivy	thimbleberry
blackberry	elm	poison oak	tree-of-heaven (*Ailanthus*)†
blackgum	gallberry	poplar	tulip poplar
boxelder†	gorse	salmonberry	wax myrtle
Brazilian pepper	hazel	salt-bush	wild rose
buckthorn	hickory	(*Braccharis* spp.)	willow
cascara	hornbeam	salt-cedar†	winged elm
Ceanothus	kudzu††	sassafras	
cherry	locust		

†For best control, use either a basal bark or cut stump treatment.
††For complete control, retreatment may be necessary.

Annual and Perennial Broadleaf Weeds Controlled

black medic	curly dock	matchweed	sweet clover
bull thistle	dandelion	mustard	vetch
burdock	field bindweed	Oxalis	wild carrot (Queen Anne's lace)
Canada thistle	goldenrod	plantain	wild lettuce
chicory	ground ivy	purple loosestrife	wild violet
clover	lambsquarters	ragweed	yarrow
creeping beggarweed	lespedeza	smartweed	

Table 1 (Maximum Application Rate): The following table is provided as a guide to the user to achieve the proper rate of Garlon 4 without exceeding the maximum use rate of 8 quarts per acre:

Spray Volume Per Acre	Quarts of Garlon 4 Per 100 Gallons of Spray (Not to Exceed 8 qt/Acre)
400	2
300	2.7
200	4
100	8
50	16
20	40
10	80

Approved Uses

Foliar Applications

Use Garlon 4 at rates of 1 to 8 quarts per acre to control broadleaf weeds and woody plants. In all cases use the amount specified in enough water to give uniform and complete coverage of the plants to be controlled. The recommended order of addition to the spray tank is water, spray thickening agent (if used), surfactant (if used), additional herbicide (if used), and Garlon 4. If a standard agricultural surfactant is used, use at a rate of 1 to 2 quarts per acre. Use continuous adequate agitation.

Before using any recommended tank mixtures, read the directions and all precautions on both labels.

For best results applications should be made when woody plants and weeds are actively growing. When hard-to-control species such as ash, blackgum, choke cherry, elm, maples (other than vine or big leaf), oaks, pines, or winged elm are prevalent, and during applications made during late summer when the plants are mature, or during drought conditions, use the higher rates of Garlon 4 alone or in combination with Tordon* 101 Mixture herbicide.

When using Garlon 4 in combination with 3.8 pounds per gallon 2,4-D low volatile ester herbicide generally the higher rates should be used for satisfactory brush control.

Use the higher dosage rates when brush approaches an average of 15 feet in height or when the brush covers more than 60% of the area to be treated. If lower rates are used on hard-to-control species, resprouting may occur the year following treatment.

On sites where easy to control brush species dominate, rates less than those recommended may be effective. Consult state or local extension personnel for such information.

Foliar Treatment With Ground Equipment

High Volume Foliar Treatment

For control of woody plants, use Garlon 4 at the rate of 1 to 3 quarts per 100 gallons of spray mixture, or Garlon 4 at 1 to 3 quarts may be tank mixed with labeled rates of 2,4-D low volatile ester herbicide, Tordon 101 Mixture herbicide, or Tordon K herbicide and diluted to make 100 gallons of spray. Apply at a volume of 100 to 400 gallons of total spray per acre depending on size and density of woody plants. Coverage should be thorough to wet all leaves, stems, and root collars. See Table 1 for relationship between spray volume and maximum application rate. When tank mixing, follow applicable use directions and precautions on each manufacturer's label.

Low Volume Foliar Treatment

To control susceptible woody plants, mix up to 20 quarts of Garlon 4 in 10 to 100 gallons of finished spray. The spray concentration of Garlon 4 and total spray volume per acre should be adjusted according to the size and density of target woody plants and kind of spray equipment used. With low volume sprays, use sufficient spray volume to obtain uniform coverage of target plants including the surfaces of all foliage, stems, and root collars (See General Use Precautions). For best results, a surfactant should be added to all spray mixtures. Match equipment and delivery rate of spray nozzles to height and density of woody plants. When treating tall, dense brush, a truck mounted spray gun with spray tips that deliver up to 2 gallons per minute at 40 to 60 psi may be required. Backpack or other types of specialized spray equipment with spray tips that deliver less than 1 gallon of spray per minute may be appropriate for short, low to moderate density brush. See Table 1 for relationship between mixing rate, spray volume and maximum application rate.

Tank Mixing: As a low volume foliar spray, up to 12 quarts of Garlon 4 may be applied in tank mix combination with labeled rates of Tordon K or Tordon 101 Mixture in 10 to 100 gallons of finished spray.

Broadcast Applications With Ground Equipment

Make application using equipment that will assure thorough and uniform coverage at spray volumes applied.

Woody Plant Control

Foliage Treatment: Use 4 to 8 quarts of Garlon 4 in enough water to make 5 or more gallons per acre of total spray, or Garlon 4 at 1 1/2 to 3 quarts may be combined with labeled rates of 2,4-D low volatile ester, Tordon 101 Mixture, or Tordon K in sufficient water to make 5 or more gallons per acre of total spray.

Broadleaf Weed Control

Use Garlon 4 at rates of 1 to 4 quarts in a total volume of 5 or more gallons per acre as a water spray mixture. Apply at any time weeds are actively growing. Garlon 4 at 0.25 to 3 quarts may be tank mixed with labeled rates of 2,4-D amine or low volatile ester, Tordon K, or Tordon 101 Mixture to improve the spectrum of activity. For thickened (high viscosity) spray mixtures, Garlon 4 can be mixed with diesel oil or other inverting agent. When using an inverting agent, read and follow the use directions and precautions on the product label.

Aerial Application (Helicopter Only)

Aerial sprays should be applied using suitable drift control (See "General Use Precautions").

Foliage Treatment (Utility and Pipeline Rights-of-Way)

Use 4 to 8 quarts of Garlon 4 alone, or 3 to 4 quarts Garlon 4 in a tank mix combination with labeled rates of 2,4-D low volatile ester Tordon 101 Mixture or Tordon K and apply in a total spray volume of 10 to 30 gallons per acre. Use the higher rates and volumes when plants are dense or under drought conditions.

Basal Bark and Dormant Brush Treatments

To control susceptible woody plants in rights-of-way, and other non-crop areas, and in forests, use Garlon 4 in oil or oil-water mixtures prepared and applied as described below. When preparing mixtures, use as oils either a commercially available basal oil, diesel fuel, No. 1 or No. 2 fuel oil, or kerosene. Substitute other oils or diluents only as recommended by the oil or diluent's manufacturer. When mixing with a basal oil or other oils or diluents, read and follow the use directions and precautions on the product label prepared by the oil or diluent's manufacturer.

Oil Mixture Sprays
Add Garlon 4 to the required amount of oil in the spray tank or mixing tank and mix thoroughly. If the mixture stands over 4 hours, reagitation is required.

Oil Mixtures of Garlon 4 and Tordon K: Tordon K and Garlon 4 may be used in tank mix combination for basal bark treatment of woody plants. These herbicides are incompatible and will not form a stable mixture when mixed together directly in oil. Stable tank mixtures for basal bark application can be made if each product is first combined with a compatibility agent prior to final mixing in the desired ratio.
(See product bulletin for mixing instructions.)

Oil-Water Mixture Sprays
First, premix the Garlon 4, oil and surfactant in a separate container. Do not allow any water or mixtures containing water to get into the Garlon 4 or the premix. Fill the spray tank about half full with water, then slowly add the premix with continuous agitation and complete filling the tank with water. Continue moderate agitation.

Note: If the premix is put in the tank without any water, the first water added may form a thick "invert" (water in oil) emulsion which will be hard to break.

Basal Bark Treatment
To control susceptible woody plants with stems less than 6 inches in basal diameter, mix 1 to 5 gallons of Garlon 4 in enough oil to make 100 gallons of spray mixture. Apply with knapsack sprayer or power spraying equipment using low pressure (20-40 psi). Spray the basal parts of brush and tree trunks to a height of 12 to 15 inches from the ground. Thorough wetting of the indicated area is necessary for good control. Spray until runoff at the ground line is noticeable. Old or rough bark requires more spray than smooth young bark. Apply at any time, including the winter months, except when snow or water prevent spraying to the ground line.

Low Volume Basal Bark Treatment
To control susceptible woody plants with stems less than 6 inches in basal diameter, mix 20 to 30 gallons of Garlon 4 in enough oil to make 100 gallons of spray mixture. Apply with a backpack or knapsack sprayer using low pressure and a solid cone or flat fan nozzle. Spray the basal parts of brush and tree trunks in a manner which thoroughly wets the lower stems, including the root collar area, but not to the point of runoff. Herbicide concentration should vary with size and susceptibility of species treated. Apply at any time, including the winter months, except when snow or water prevent spraying to the ground line or when stem surfaces are saturated with water.

Garlon 4 Plus Tordon K in Oil Tank Mix: Garlon 4 and Tordon K may be applied as a low volume basal bark treatment to improve control of certain woody species such as ash, elm, maple, poplar, aspen, hackberry, oak, oceanspray, birch, hickory, pine, tanoak, cherry, locust, sassafras, and multiflora rose. (See product bulletin for mixing instructions.)

Streamline Basal Bark Treatment (Southern States)
To control or suppress susceptible woody plants for conifer release, mix 20 to 30 gallons of Garlon 4 in enough oil to make 100 gallons of spray mixture. Apply with a backpack or knapsack sprayer using equipment which provides a directed straight stream spray. Apply sufficient spray to one side of stems less than 3 inches in basal diameter to form a treated zone that is 6 inches in height. When the optimum amount of spray mixture is applied, the treated zone should widen to encircle the stem within approximately 30 minutes. Treat both sides of stems which are 3 to 4 inches in basal diameter. Direct the spray at bark that is approximately 12 to 24 inches above ground. Pines (loblolly, slash, shortleaf, and Virginia) up to 2 inches in diameter breast height (dbh) can be controlled by directing the spray at a point approximately 4 feet above ground. Vary spray mixture concentration with size and susceptibility of the species being treated. Best results are achieved when applications are made to young vigorously growing stems which have not developed the thicker bark characteristic of slower growing, understory trees in older stands. This technique is not recommended for scrub and live oak species, including blackjack, turkey, post, live, bluejack and laurel oaks, or bigleaf maple. Apply from approximately 6 weeks prior to hardwood leaf expansion in the spring until approximately 2 months after leaf expansion is completed. Do not apply when snow or water prevent spraying at the desired height above ground level.

Low Volume Stem Bark Band Treatment (North Central and Lake States)
To control susceptible woody plants with stems less than 6 inches in basal diameter, mix 20 to 30 gallons of Garlon 4 in enough oil to make 100 gallons of spray mixture. Apply with a backpack or knapsack sprayer using low pressure and a solid cone or flat fan nozzle. Apply the spray in a 6 to 10 inch wide band that completely encircles the stem. Spray in a manner that completely wets the bark, but not to the point of runoff. The treatment band may be positioned at any height up to the first major branch. For best results apply the band as low as possible. Spray mixture concentration should vary with size and susceptibility of species to be treated. Applications may be made at any time, including winter months.

Thinline Basal Bark Treatment
To control susceptible woody plants with stems less than 6 inches in diameter, apply Garlon 4 either undiluted or mixed at 50-75% v/v with oil in a thin stream to all sides of the lower stems. The stream should be directed horizontally to apply a narrow band around each stem or clump. Use a minimum of 2 to 15 milliliters of Garlon 4 or oil mixture with Garlon 4 to treat single stems and from 25 to 100 milliliters to treat clumps of stems. Use an applicator metered or calibrated to deliver the small amounts required.

Dormant Stem Treatment
Dormant stem treatments will control susceptible woody plants and vines with stems less than 2 inches in diameter. Plants with stems greater than 2 inches in diameter may not be controlled and resprouting may occur. This treatment method is best suited for sites with dense, small diameter brush. Dormant stem treatments of Garlon 4 can also be used as a chemical side-trim for controlling lateral branches of larger trees that encroach onto roadside, utility, or other rights-of-way.

Mix 4 to 8 quarts of Garlon 4 in 2 to 3 gallons of crop oil concentrate or other recommended oil and add this mixture to enough water to make 100 gallons of spray solution. Use continuous adequate agitation. Apply with Radiarc, OC or equivalent nozzles, or handgun using 70 to 100 gallons of spray per acre to ensure uniform coverage of stems. Garlon 4 may be mixed with 4 quarts of Weedone 170 herbicide to improve the control of black cherry and broaden the spectrum of herbicidal activity. In western states, apply anytime after woody plants are dormant. In other areas apply anytime within 10 weeks of budbreak, generally February through April. Do not apply to wet or saturated bark as poor control may result.

Cut Stump Treatment
To control resprouting of cut stumps of susceptible species, mix 20 to 30 gallons of Garlon 4 in enough oil to make 100 gallons of spray mixture. Apply with a backpack or knapsack sprayer using low pressures and a solid cone or flat fan nozzle. Spray the root collar area, sides of the stump, and the outer portion of the cut surface including the cambium until thoroughly wet, but not to the point of runoff. Spray mixture concentration should vary with size and susceptibility of species treated. Apply at any time, including in winter months, except when snow or water prevent spraying to the ground line.

Treatment of Cut Stumps in Western States
To control resprouting of salt-cedar and other *Tamarix* species, bigleaf maple, tanoak, Oregon myrtle, and other susceptible species, apply undiluted

Garlon 4 to wet the cambium and adjacent wood around the entire circumference of the cut stump. Treatments may be applied throughout the year; however, control may be reduced with treatment during periods of moisture stress as in late summer. Use an applicator which can be calibrated to deliver the small amounts of material required.

Note: All basal bark and dormant brush treatment methods may be used to treat susceptible woody species on range and permanent pasture land provided that no more than 1.5 quarts of Garlon 4 are applied per acre. Large plants or species requiring higher rates of Garlon 4 may not be completely controlled.

Forest Management Applications

For broadcast applications apply the recommended rate of Garlon 4 in a total spray volume of 5 to 25 gallons per acre by air or 10 to 100 gallons per acre by ground. Use spray volumes sufficient to provide thorough coverage of treated foliage. Use application systems designed to prevent spray drift to off-target sites. Nozzles or additives that produce larger droplets may require higher spray volumes to provide adequate coverage.

Plant Back Interval for Conifers: Conifers planted sooner than 1 month after treatment with Garlon 4 at less than 4 quarts per acre or sooner than 2 months after treatment at 4 to 8 quarts per acre may be injured. When tank mixtures of herbicides are used for forest site preparation, labels for all products in the mixture should be consulted and the longest recommended waiting period observed.

Broadcast Treatments for Forest Site Preparation (Not For Conifer Release)

Southern States Including Alabama, Arkansas, Delaware, Florida, Georgia, Louisiana, Maryland, Mississippi, North Carolina, Oklahoma, South Carolina, Tennessee, Texas, and Virginia: To control susceptible woody plants and broadleaf weeds, apply Garlon 4 at a rate of 4 to 8 quarts per acre. To broaden the spectrum of woody plants and broadleaf weeds controlled, apply 2 to 4 quarts per acre of Garlon 4 in tank mix combination with labeled rates of Tordon 101 Mixture or Tordon K. Tordon 101 Mixture and Tordon K are not registered for use in the states of California and Florida. Where grass control is also desired, Garlon 4, alone or in combination with Tordon K or Tordon 101 Mixture, may be tank mixed with labeled rates of other herbicides registered for grass control in forests. Use of tank mix products must be in accordance with the most restrictive of label limitations and precautions. No label application rates should be exceeded. Garlon 4 cannot be tank mixed with any product containing a label prohibition against such mixing.

In Western, Northeastern, North Central, and Lake States (States Not Listed Above As Southern States): To control susceptible woody plants and broadleaf weeds, apply Garlon 4 at a rate of 3 to 6 quarts per acre. To broaden the spectrum of woody plants and broadleaf weeds controlled, apply 1.5 to 3.0 quarts per acre of Garlon 4 in tank mix combination with labeled rates of Tordon 101 Mixture, Tordon K, or 2,4-D low volatile ester. Tordon 101 Mixture and Tordon K are not registered for use in the states of California and Florida. Where grass control is also desired, Garlon 4, alone or in tank mix combination with Tordon 101 Mixture or Tordon K, may be applied with labeled rates of other herbicides registered for grass control in forests. When applying tank mixes, follow applicable use directions and precautions on each product label.

Applications for Site Preparation in Southern Coastal Flatwoods: To control susceptible broadleaf weeds and woody species such as gallberry and wax-myrtle, and for partial control of saw-palmetto, apply 2 to 4 quarts per acre of Garlon 4. To broaden the spectrum of species controlled to include fetterbush, staggerbush, titi, and grasses, apply 2 to 3 quarts per acre of Garlon 4 in tank mix combination with labeled rates of Arsenal Applicator's Concentrate herbicide. Where control of gallberry, wax-myrtle, broadleaf weeds, and grasses is desired, 2 to 3 quarts per acre of Garlon 4 may be applied in tank mix combination with labeled rates of Accord herbicide.

These treatments may be broadcast during site preparation of flat planted or bedded sites or, on bedded sites, applied in bands over the top of beds. For best results, make applications in late summer or fall. Efficacy may not be satisfactory when applications are made in early season prior to August. **Note: Do not apply after planting pines.**

Applications for Conifer Release

Note: Applications for conifer release may cause temporary damage and growth suppression where contact with conifers occurs; however, injured conifers should recover and grow normally. Over-the-top spray applications can kill pines.

Directed Sprays

To release conifers from competing hardwoods and brush such as red maple, sugar maple, striped maple, sweetgum, red and white oaks, ash, hickory, alder, birch, aspen, pin cherry, *Ceanothus* spp., blackberry, chinquapin, and poison oak, mix 4 to 20 quarts of Garlon 4 in enough water to make 100 gallons of spray mixture. This spray should be directed onto foliage of competitive hardwoods using knapsack or backpack sprayers with flat fan nozzles or equivalent any time after the hardwoods and brush have reached full leaf size, but before autumn coloration. The majority of treated hardwoods and brush should be less than 6 feet in height to ensure adequate spray coverage. Care should be taken to direct spray solutions away from conifer foliage, particularly foliage of desirable pines. See Table 1 for relationship between mixing rate, spray volume and maximum application rate.

Broadcast Applications for Mid-Rotation Understory Brush Control in Southern Coastal Flatwoods Pine Stands (Ground Equipment Only)

For control of susceptible species such as gallberry and wax-myrtle and broadleaf weeds, apply 2 to 4 quarts per acre of Garlon 4. To broaden the spectrum of woody plants controlled to include fetterbush, staggerbush, and titi, apply 2 to 3 quarts per acre of Garlon 4 in tank mix combination with labeled rates of Arsenal Applicator's Concentrate. Saw-palmetto will be partially controlled by use of Garlon 4 at 4 quarts per acre or by mixtures of Garlon 4 at 2 to 3 quarts per acre in tank mix combination with either Arsenal Applicator's Concentrate or Escort herbicide.

These mixtures should be broadcast applied over target understory brush species, **but to prevent injury to pines, make applications underneath the foliage of pines.** It is recommended that sprays be applied in 30 or more gallons per acre of total volume. For best results, make applications in late summer or fall. Efficacy may not be satisfactory when applications are made in early season prior to August.

Broadcast Applications for Conifer Release in the Pacific Northwest and California

On Dormant Conifers Before Bud Swell (Excluding Pines): To control or suppress deciduous hardwoods such as vine maple, bigleaf maple, alder, scotch broom, or willow **before leaf-out** or evergreen hardwoods such as madrone, chinquapin, and *Ceanothus* spp., use Garlon 4 at 1 to 2 quarts per acre. Diluents used may be diesel or fuel oil. Or, water plus 1 to 2 gallons per acre of diesel oil or a suitable surfactant or oil substitute at manufacturer's recommended rates may be used.

On Conifer Plantations (Excluding Pines) After Hardwoods Begin Growth and Before Conifer Bud Break ("Early Foliar" Hardwood Stage): Use Garlon 4 at 1.0 to 1.5 quarts alone or plus 2,4-D low volatile ester herbicide in water carrier to provide no more than 3 pounds acid

equivalent per acre from both products. After conifer bud break, these sprays may cause more serious injury to the crop trees. Use of a surfactant may cause unacceptable injury to conifers especially after bud break.

On Conifer Plantations (Excluding Pines) After Conifers Harden Off In Late Summer and While Hardwoods Are Still Growing Actively: Use Garlon 4 at rates of 1.0 to 1.5 quarts per acre alone or plus 2,4-D low volatile ester to provide no more than 3 pounds acid equivalent per acre from both products. Treat as soon after conifer bud hardening as possible so that hardwoods and brush are actively growing. Use of oil, oil substitute, or surfactant may cause unacceptable injury to the conifers.

Broadcast Applications for Conifer Release in the Eastern United States
To release spruce, fir, red pine, and white pine from competing hardwoods such as red maple, sugar maple, striped maple, alder, birch (white, yellow, and grey), aspen, ash, pin cherry, and *Rubus* spp. and perennial and annual broadleaf weeds, use Garlon 4 at rates of 1.5 to 3.0 quarts per acre alone or plus 2,4-D amine or low volatile ester to provide no more than 4 pounds acid equivalent per acre from both products. Applications should be made in late summer or early fall after conifers have formed their overwintering buds and hardwoods are in full leaf and prior to autumn coloration.

Broadcast Applications for Conifer Release in the Lake States Region
To release spruce, fir, and red pine from competing hardwoods such as aspen, birch, maple, cherry, willow, oak, hazel, and *Rubus* spp. and perennial and annual broadleaf weeds, use Garlon 4 at rates of 1.5 to 3.0 quarts per acre. Applications should be made in late summer or early fall after conifers have formed their overwintering buds and hardwoods are in full leaf and prior to autumn coloration.

Warranty Disclaimer

Dow AgroSciences warrants that this product conforms to the chemical description on the label and is reasonably fit for the purposes stated on the label when used in strict accordance with the directions, subject to the inherent risks set forth below. Dow AgroSciences MAKES NO OTHER EXPRESS OR IMPLIED WARRANTY OF MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE OR ANY OTHER EXPRESS OR IMPLIED WARRANTY.

Inherent Risks of Use

It is impossible to eliminate all risks associated with use of this product. Plant injury, lack of performance, or other unintended consequences may result because of such factors as use of the product contrary to label instructions (including conditions noted on the label, such as unfavorable temperature, soil conditions, etc.), abnormal conditions (such as excessive rainfall, drought, tornadoes, hurricanes), presence of other materials, the manner of application, or other factors, all of which are beyond the control of Dow AgroSciences or the seller. All such risks shall be assumed by buyer.

Limitation of Remedies

The exclusive remedy for losses or damages resulting from this product (including claims based on contract, negligence, strict liability, or other legal theories), shall be limited to, at Dow AgroSciences' election, one of the following:

1. Refund of purchase price paid by buyer or user for product bought, or
2. Replacement of amount of product used

Dow AgroSciences shall not be liable for losses or damages resulting from handling or use of this product unless Dow AgroSciences is promptly notified of such loss or damage in writing. In no case shall Dow AgroSciences be liable for consequential or incidental damages or losses.

The terms of the "Warranty Disclaimer" above and this "Limitation of Remedies" cannot be varied by any written or verbal statements or agreements. No employee or sales agent of Dow AgroSciences or the seller is authorized to vary or exceed the terms of the "Warranty Disclaimer" or this "Limitation of Remedies" in any manner.

*Trademark of Dow AgroSciences LLC
Dow AgroSciences LLC • Indianapolis, IN 46268 U.S.A.

Label Code: D02-102-023
Replaces Label: D02-102-022

EPA-Accepted 07/22/97

Revisions:
Minor corrections to EPA accepted text dated 7-22-97

QUINTOX® Mouse Seed Pacs

Material Safety Data Sheet
DATE ISSUED: 27 January 2006

SECTION 1 - CHEMICAL PRODUCT AND COMPANY IDENTIFICATION

Company Name:	**BELL LABORATORIES, INC.** 3699 Kinsman Blvd. Madison, WI 53704 U.S.A.		
Company Phone No.:	(608) 241-0202	**Emergency Phone No.:**	952-852-4636
Product Name:	QUINTOX® MOUSE SEED PACS (Domestic)	**Product Use:** Acute Rodenticide	**Formulation:** Formulated Dry Bait
WHMIS Classification:	This product is not regulated under WHMIS.	**Pest Control Products (PCP) Registration No.:**	20383

SECTION 2 - HAZARDOUS INGREDIENTS

Identity:	**Typical % w/w:**	**Other Information:**
Cholecalciferol (CAS No. 67-97-0)	0.075%	Not Applicable

Other ingredients not identified are not considered hazardous

SECTION 3 - PHYSICAL DATA

Physical State: Meal	**Colour:** Blue	**Odour:** Sweet, Grain-like	**Boiling Point:** Not Applicable
Melting Point: Not Applicable	**Freezing Point:** Not Applicable	**Vapour Pressure:** Not Applicable	**Evaporation Rate (water=1):** Greater than 1.0
Vapor Density (air = 1): Greater than 1.0	**Bulk Density:** Not Applicable	**Specific Gravity:** Not Applicable	**Solubility:** Not Soluble in Water
PH: Not Applicable	**Water/Oil Part. Coeff.:** Not Applicable	**Threshold Odour:** Not Determined	**Sensitivity to Mechnical Impact:** None

SECTION 4 - FIRE AND EXPLOSION DATA

Flammability: Yes [ ] No [X] Will not support combustion	**Means of Extinction:** Surround fire with water, foam or inert gas.
Flash Point (°C) (method): Non-flammable	**Special Firefighting Procedures:** Firefighters must be equipped with protective clothing and self-contained breathing apparatus.
Autoignition Temperature: Not Applicable	**Explosion Limits (% by Volume):** **Upper Limit:** Not Applicable **Lower Limit:** Not Applicable

Hazardous Combustion Products:	**Sensitivity to Impact:**	**Sensitivity to Static Discharge:**
Oxides of Carbon and Irritating Gasses	Not Sensitive	Not Sensitive

SECTION 5 - REACTIVITY DATA

Chemical Stability: Yes [X] No [ ] Product is Stable	**Incompatibility with Other Substances (If yes, which ones):** Avoid Contact with Strongly Alkaline Materials
Reactivity, and Under What Conditions: Not Applicable	**Hazardous Decomposition Products:** Not Applicable

SECTION 6-TOXICOLOGICAL PROPERTIES (HEALTH HAZARDS INFORMATION)

Routes of Entry:	[X] - Ingestion	[ ] - Skin Absorption	[ ] - Eye Contact
	[ ] - Inhalation	[ ] - Inhalation Chronic	[ ] - Skin Contact

Effects of Acute Exposure to Material:	**Effects of Chronic Exposure to Material:**	
Hypercalcemia, anorexia, nausea, vomiting, loss of appetite, extreme thirst lethargy, diarrhea, profuse sweating, headache	Not Applicable.	
Lethal Dose Concentration (Specify Species/Route):	**Irritancy (rabbits):**	**Synergistic Materials:**
LD50: >5000 mg/kg (rats, oral) **LC50:** Not Applicable	Non-irritating	Not Applicable

Exposure Limits:	**TWA** = Non Assigned	**STEL** = None Assigned	**IDLH** = None Assigned

Sensitizing Capability:	**Carcinogenicity:**	**Reproductive Effects:**
Not a Sensitizer	No Evidence	No Evidence

SECTION 7 - PREVENTATIVE MEASURES

Personal Protective Equipment:	**Engineering Controls:**
Rubber gloves when handling bait.	Not Required
Handling and Storage Requirements:	**Disposal Instructions:**
Use normal good hygiene and housekeeping practices. Store in a dry place at room temperature. Avoid prolonged exposure to light and humidity. Keep container tightly closed when not in use. Keep away from children and away from food.	Dispose of waste either on-site or at an approved waste disposal facility in accordance with all applicable regulations. Avoid contamination of surface water by use or disposal.
Leak and Spill Procedure:	**Special Shipping Information:**
Sweep up spilled material. Place in a properly labeled container for disposal or reuse.	Not considered hazardous under Transportation Canada Dangerous Goods Regulations (TDG).

SECTION 8 - FIRST AID INSTRUCTIONS

Ingestion:	**Eye Contact:**
Call physician, Poison Control Centre or emergency phone number immediately. Do not give anything by mouth or induce vomiting unless instructed by physician.	Flush eyes and under eyelids with copious amounts of cool water for 15 minutes. If irritation develops, obtain medical assistance.
Skin Contact:	**Inhalation:**
Wash skin and hands with soap and water.	Not Applicable
Note to Physician:	**Antidote:**
If serum calcium levels are elevated, treatment with calcitonin is effective in reducing calcium to normal levels. Continue to monitor serum calcium and treat as necessary.	Calcitonin (thyrocalcitonin, TCA , TCT) infusion leads to a significant decrease in plasma calcium (together with a corresponding fall in plasma phosphate).

SECTION 9 - PREPARATION DATA

Prepared By:	**Date of Preparation:**	**Phone Number:**
Bell Laboratories, Inc. (PSM/CAR)	27 January 2006	(608) 241-0202

SIEGE®

gel insecticide

SPECIMEN

RECOMMENDED FOR USE BY COMMERCIAL APPLICATORS

Syringe packaging is for use as a syringe or with other bait devices.
Cartridge packaging is for use with XACTADOSE® Precision Baiting System.

FOR USE IN AND AROUND HOMES, COMMERCIAL, INDUSTRIAL, OR INSTITUTIONAL AREAS

ACTIVE INGREDIENT:	
Hydramethylnon [tetrahydro-5,5-dimethyl-2(1*H*)-pyrimidinone (3-[4-(trifluoromethyl)phenyl]-1-(2-[4-(trifluoromethyl)phenyl] ethenyl)-2-propenylidene)hydrazone]	2.0%
INERT INGREDIENTS	98.0%
TOTAL	100.0%

EPA Reg. No. 241-313-9444

KEEP OUT OF REACH OF CHILDREN

CAUTION!

See Back Panel For Additional Precautionary Statements
Use only in areas not easily accessible to children and pets.

Distributed by:

CB® **Professional Products Division**
A Division of Waterbury Companies, Inc.
Waterbury, CT 06722

5/01

PRECAUTIONARY STATEMENTS

HAZARDS TO HUMANS AND DOMESTIC ANIMALS

CAUTION!

May be harmful if swallowed. Avoid contact with skin and clothing. Wash hands thoroughly after handling.

STATEMENT OF PRACTICAL TREATMENT

If swallowed, drink two glasses of water and induce vomiting by touching back of throat with finger. Do not induce vomiting or give anything by mouth to an unconscious person. Get medical attention. In case of emergency, call day or night, 800-832-HELP.

STORAGE AND DISPOSAL

Do not contaminate water, food or feed by storage or disposal. Wrap used cartridge and place in a trash can.

DIRECTIONS FOR USE

It is a violation of Federal law to use this product in a manner inconsistent with its labeling. Do not apply this product by any method not specified on this label.

Do not apply this product in a way that will contact any person or pet.

SIEGE gel insecticide may be used as a spot or crack and crevice treatment for the control of cockroaches (including carbamate, organophosphate and pyrethroid resistant strains) in and around homes and the non-food/feed areas of institutional, warehousing and commercial establishments (such as groceries and supermarkets; meat, poultry and shell egg grading plants; hotels and motels; hospitals and nursing homes; schools; laboratories; computer facilities; sewers; buses, boats, ships, trains, and planes; pet shops; and zoos).

Nonfood areas are areas such as garbage rooms, lavatories, floor drains (to sewers), entries, and vestibules, offices, locker rooms, machine rooms, boiler rooms, garages, mop closets and storage (after canning or bottling).

SIEGE gel insecticide may be used only as a crack and crevice treatment in food/feed areas of restaurants and other commercial or institutional food handling establishments, and food manufacturing, processing, storage and warehousing facilities. Food areas include areas for receiving, storage, packing (canning, bottling, wrapping, boxing), preparing, edible waste storage and enclosed processing systems (mills, dairies, edible oils, syrups) and distribution facilities. Serving areas (when food is exposed and facility is in operation) are also considered food areas. Serving areas are areas where prepared foods are served, such as dining rooms, but excluding areas where foods may be prepared or held.

APPLICATIONS OF THIS PRODUCT IN THE FOOD/FEED AREAS OF FOOD/FEED-HANDLING ESTABLISHMENTS OTHER THAN AS A CRACK AND CREVICE TREATMENT ARE NOT PERMITTED.

Keep exposed gel away from open food and food contact surfaces. Do not place treatments in locations where routine cleansing operations may transfer diluted bait to food or food preparation surfaces. Do not apply gel to areas where food, food utensils or food processing/food preparation surfaces may become contaminated. Do not apply to areas that are routinely washed such as: cracks and crevices in tops of tables, food preparation, and prepared food holding surfaces, as gel may be removed by washing. Do not apply to surfaces where the temperature exceeds 130°F. Examples include, but are not limited to, portions of stoves, ovens, grills, fume hoods, heat lamps, coffee urns, steam tables, toasters, fryers, dishwashers and hot water pipes. Care should be taken to avoid depositing gel onto exposed surfaces. If gel contacts an exposed surface, remove gel and wash exposed surface promptly. Do not apply gel to areas which have been recently sprayed with insecticide, and do not spray insecticide over gel as it may cause the bait to become repellent.

Application rate is dependent on level of infestation and species to be controlled. Numerous smaller placements will provide faster control than few larger spots, especially for German cockroach control. Pest population reduction will be apparent within a week or less. Cockroaches become lethargic after ingesting the bait and some may be seen during daylight hours.

Cockroach Species	Application Rate (g/m^2 infested surface areas)	Application Method
Small, such as German or brown-banded	0.25 - 0.50	Thin film or small spots
Large, such as American, smokybrown or Oriental	0.5 - 1.0	Larger spots

The lower application rate should be used for low to moderate infestations and the higher rate for more severe infestations. Gel placements should be at or near harborages or aggregation areas, such as cracks and crevices, corners, or areas of movement.

Outdoor Use Directions: For use outdoors to control smokybrown, American, oriental, woods, and other outdoor cockroach species. Apply bait to likely points of entry or harborage sites, such as: the cracks and crevices around windows, doors, porches, sills and screens; holes where pipes or utilities enter a structure; expansion joints; beneath siding or shingles; around firewood piles; eaves; attic or soffit vents; weep holes in masonry; and similar sites. Also, apply bait in likely breeding areas, such as tree holes, behind palm fronds, basements, crawlspaces, attics, garages, or similar sites.

Priority treatment areas may be identified by visual inspection of such areas listed above or aided by trapping techniques or spot flushings.

To apply gel, remove the cap on nozzle, touch the application tip to surface, and apply. Recapping the application tip after treatment is completed is recommended to preserve bait freshness. The bait will adhere to non-greasy or non-dusty surfaces and will remain palatable to cockroaches for at least 6 months. Repeat treatments as necessary to maintain adequate control.

DISCLAIMER

The label instructions for the use of this product reflect the opinion of experts based on field use and tests. The directions are believed to be reliable and should be followed carefully. However, it is impossible to eliminate all risks inherently associated with use of this product. Reduced performance or other unintended consequences may result from external factors such as environmental conditions, presence of other materials, or the use or application of the product contrary to label instructions all of which are beyond the control of CB Professional Products. All such risks shall be assumed by the user. CB Professional Products warrants only that the material contained herein conforms to the chemical description on the label and is reasonably fit for the use therein described when used in accordance with the directions for use, subject to the risks referred to above.

Any damages arising from a breach of this warranty shall be limited to direct damages and shall not include consequential commercial damages such as loss of profits or values or any other special or indirect damages.

CB Professional Products makes no other express or implied warranty, including any other express or implied warranty of FITNESS or of MERCHANTABILITY.

RESTRICTED USE PESTICIDE

DUE TO TOXICITY TO AQUATIC INVERTEBRATES

For retail sale to and use only by Certified Applicators or persons under their direct supervision and only for those uses covered by the Certified Applicator's certification.

QUALI-PRO

Fipronil 0.0143G Broadcast

Insecticide

COMMERCIAL USE ONLY • FOR APPLICATION BY PEST CONTROL OPERATORS

For Turfgrass and Landscape Beds

- Contains the active ingredient Fipronil
- One application controls Imported Fire Ants, *Solenopsis* spp., All Season Long
- Application is Quick and Easy

ACTIVE INGREDIENT:	**% BY WT.**
Fipronil:5-amino-1-(2,6-dichloro-4-(trifluoromethyl) phenyl)-4-((1,R,S)-(trifluoromethyl)sulfinyl) -1H-pyrazole-3-carbonitrile	0.0143%
OTHER INGREDIENTS:	99.9857%
TOTAL:	100.0000%

EPA Reg. No. 53883-272-66222

KEEP OUT OF REACH OF CHILDREN

CAUTION - PRECAUCION

Si usted no entiende la etiqueta, busque a alguien para que se la explique a usted en detalle. (If you do not understand this label, find someone to explain it to you in detail).

For additional precautionary, handling, and use statements, see inside of this booklet.

Distributed By:
Makhteshim Agan of North America, Inc.
4515 Falls of Neuse Rd., Suite 300
Raleigh, NC 27609

FG# 14187

FIRST AID	
IF ON SKIN OR CLOTHING:	• Take off contaminated clothing. • Rinse skin immediately with plenty of water for 15-20 minutes. • Call a poison control center or doctor for treatment advice.
IF SWALLOWED:	• Call a poison control center or doctor immediately for treatment advice. • Have person sip a glass of water if able to swallow. • Do not induce vomiting unless told to do so by a poison control center or doctor. • Do not give anything by mouth to an unconscious person.
IF IN EYES:	• Hold eye open and rinse slowly and gently with water for 15-20 minutes. • Remove contact lenses, if present, after the first 5 minutes, then continue rinsing eye. • Call a poison control center or doctor for treatment advice.
Have the product container or label with you when calling a poison control center or doctor or going for treatment. You may also contact Prosar at 1-877-250-9291 for emergency medical treatment information.	
NOTE TO PHYSICIAN: There is no specific antidote. All treatment should be based on observed signs and symptoms of distress in the patient. **Symptoms of Poisoning:** In severe cases of overexposure by oral ingestion, lethargy, muscle tremors, and in extreme cases, possible convulsions may occur.	

EPA 041210/Rev A

PEEL BACK BOOK HERE

EPA Est. No. 67572-GA-1

Net Weight: 30 lbs.

RESTRICTED USE PESTICIDE

DUE TO TOXICITY TO AQUATIC INVERTEBRATES

For retail sale to and use only by Certified Applicators or persons under their direct supervision and only for those uses covered by the Certified Applicator's certification.

QUALI-PRO®

Fipronil 0.0143G Broadcast

Insecticide

COMMERCIAL USE ONLY • FOR APPLICATION BY PEST CONTROL OPERATORS

For Turfgrass and Landscape Beds

- Contains the active ingredient Fipronil
- One application controls Imported Fire Ants, *Solenopsis* spp., All Season Long
- Application is Quick and Easy

ACTIVE INGREDIENT:	**% BY WT.**
Fipronil:5-amino-1-(2,6-dichloro-4-(trifluoromethyl) phenyl)-4-((1,R,S)-(trifluoromethyl)sulfinyl) -1H-pyrazole-3-carbonitrile	0.0143%
OTHER INGREDIENTS:	99.9857%
TOTAL:	100.0000%

EPA Reg. No. 53883-272-66222

KEEP OUT OF REACH OF CHILDREN

CAUTION - PRECAUCION

Si usted no entiende la etiqueta, busque a alguien para que se la explique a usted en detalle. (If you do not understand this label, find someone to explain it to you in detail).

For additional precautionary, handling, and use statements, see inside of this booklet.

Distributed By:
Makhteshim Agan of North America, Inc.
4515 Falls of Neuse Rd., Suite 300
Raleigh, NC 27609

FG# 14187

FIRST AID	
IF ON SKIN OR CLOTHING:	• Take off contaminated clothing. • Rinse skin immediately with plenty of water for 15-20 minutes. • Call a poison control center or doctor for treatment advice.
IF SWALLOWED:	• Call a poison control center or doctor immediately for treatment advice. • Have person sip a glass of water if able to swallow. • Do not induce vomiting unless told to do so by a poison control center or doctor. • Do not give anything by mouth to an unconscious person.
IF IN EYES:	• Hold eye open and rinse slowly and gently with water for 15-20 minutes. • Remove contact lenses, if present, after the first 5 minutes; then continue rinsing eye. • Call a poison control center or doctor for treatment advice.
Have the product container or label with you when calling a poison control center or doctor or going for treatment. You may also contact Prosar at 1-877-250-9291 for emergency medical treatment information.	
NOTE TO PHYSICIAN: There is no specific antidote. All treatment should be based on observed signs and symptoms of distress in the patient. **Symptoms of Poisoning:** In severe cases of overexposure by oral ingestion, lethargy, muscle tremors, and in extreme cases, possible convulsions may occur.	

EPA 041210/Rev A

PRECAUTIONARY STATEMENTS
HAZARD TO HUMANS AND DOMESTIC ANIMALS

Caution. Harmful if absorbed through the skin. Causes eye irritation. Avoid contact with skin, eyes, or clothing. Wash thoroughly with soap and water after handling.

PERSONAL PROTECTIVE EQUIPMENT (PPE)

Applicators, mixers, loaders, and persons cleaning application equipment must wear:

- Long-sleeved shirt and long pants
- Waterproof gloves
- Shoes plus socks

Follow manufacturer's instructions for cleaning and maintaining PPE. If no such instructions exist, use detergent and hot water. Keep and wash PPE separately from other laundry.

ENGINEERING CONTROLS STATEMENT

When handlers use closed systems or enclosed cabs in a manner that meets the requirements listed in the Worker Protection Standard (WPS) for agricultural practices (40 CFR 170.240 (d) (4-6), the handler PPE requirements may be reduced or modified as specified in the WPS. Important: When reduced PPE is worn because a closed system is being used, handlers must be provided all PPE specified above for applicators and other handlers, and have such PPE available for use in an emergency, such as a spill or equipment breakdown.

USER SAFETY RECOMMENDATIONS

Users should:

- Wash hands before eating, drinking, chewing gum, using tobacco, or using the toilet.
- Remove clothing/PPE immediately if pesticide gets inside. Then wash thoroughly and put on clean clothing.
- Remove PPE immediately after handling this product. Wash the outside of gloves before removing. As soon as possible, wash thoroughly and change into clean clothing.

ENVIRONMENTAL HAZARDS

This pesticide is toxic to birds, fish, aquatic and estuarine (tidewater dwelling) invertebrates. Do not apply directly to water or to areas where surface water is present or to intertidal areas below the mean high water mark. Runoff from treated areas may be hazardous to aquatic organisms in neighboring areas. Cover, incorporate, or clean up granules that are spilled. Do not contaminate water when disposing of equipment washwater or rinsate. Do not apply within 15 feet of bodies of fresh water, lakes, reservoirs, rivers, permanent streams, marshes, natural ponds, and commercial fish ponds. A 15-foot buffer of uniform groundcover must exist between application zone and bodies of freshwater (uniform ground cover is defined as land which supports vegetation of greater than 2 inches throughout).

Do not apply within 60 feet of estuarine bodies of water. Estuarine water bodies are brackish tidal water such as bays, mouths of rivers, salt marshes, and lagoons.

In order to reduce risk to birds, ensure that the application is spread evenly over the treatment area.

In Florida: Do not use this product within 500 feet of areas occupied by the threatened Florida scrub jay, bluetail mole skink, or sand skink. In addition, for the protection of the threatened bluetail mole skink and sand skink, apply only to turfgrass and allow at least a 30-foot untreated buffer of turfgrass when adjacent to scrub habitat (i.e., xeric upland) in the following counties: Highlands, Lake, Marion, Orange, Osceola, Polk, and Putnam. For guidance, consult the Florida Department of Agriculture and Consumer Services.

For application to urban turf or lawns in Florida, follow the Best Management Practices for Protection of Water Resources in Florida, June 2002, Florida Green Industries, available on the internet at http://www.flaes.org/pdf/BMP_Book_final.pdf.

DIRECTIONS FOR USE

It is a violation of Federal law to use this product in a manner inconsistent with its labeling.

RESTRICTED USE PESTICIDE

Read entire label before using this product.

Do not apply this product in a way that will contact workers or other persons, either directly or through drift. Only protected handlers may be in the area during application. For any requirements specific to your State or Tribe, consult the agency responsible for pesticide regulation.

AGRICULTURAL USE REQUIREMENTS

Use this product in accordance with its labeling and with the Worker Protection Standard, 40 CFR 170. This Standard contains requirements for the protection of agricultural workers on farms, forests, nurseries, and greenhouses, and handlers of agricultural pesticides. It contains requirements for training, decontamination, notification, and emergency assistance. It also contains specific instructions and exceptions pertaining to the statements on this label about personal protective equipment (PPE), notifications to workers, and restricted-entry intervals. The requirements in this box only apply to sodfarm uses of this product that are covered by the Worker Protection Standard.

Do not enter or allow worker entry into treated areas during the restricted-entry interval (REI) of 24 hours.

PPE required for entry to treated areas that is permitted under the Worker Protection Standard and that involves contact with anything that has been treated such as plants, soil, or water is:

- Coveralls
- Waterproof gloves
- Shoes plus socks

NON-AGRICULTURAL USE REQUIREMENTS

The requirements in this box apply to uses of this product that are not within the scope of the Worker Protection Standard (WPS) for agricultural pesticides (40 CFR Part 170). The WPS applies when this product is used to produce agricultural plants on farms, forests, nurseries, or greenhouses.

Always wear protective clothing and use appropriate equipment during application and handling. Avoid breathing dust.

TURFGRASS AND LANDSCAPE BEDS

QUALI-PRO FIPRONIL 0.0143G BROADCAST is for use to control imported fire ants, *Solenopsis* spp., on turfgrass and landscape beds. Additional insects such as fleas, ticks, mole crickets, and nuisance ants may be controlled for a limited time after application.

GENERAL PRECAUTIONS AND RESTRICTIONS:
Always wear protective clothing and use appropriate equipment during application and handling. Avoid contact with granules. Avoid breathing dust. Apply this pesticide when the potential for drift to nearby bodies of water is minimal (wind speed is 10 mph or less and the wind is blowing away from the body of water). Do not apply to pastures or grazing lands. Do not apply in a combination with other products (pesticides, fertilizers, etc.) since comprehensive compatibility studies have not been performed on all products.

State Specific Restrictions:
- The state of Arizona has not approved this product for use on agricultural sites. Do not use this product on uses considered by the Arizona statutes to be agricultural uses.

APPLICATION INSTRUCTIONS

QUALI-PRO FIPRONIL 0.0143G BROADCAST is for use on Turfgrass, Landscape Beds, and Outdoor Nursery Sites for Containerized Ornamental Pants as a broadcast treatment.

To control Imported Fire Ants, *Solenopsis* spp., or for established colonies, QUALI-PRO FIPRONIL 0.0143G BROADCAST should be applied evenly to the entire area to be treated with broadcast equipment.

This product can be used only in the USDA APHIS Fire Ant Quarantine area in the following states including Puerto Rico:

Alabama	Georgia	Oklahoma
Arkansas	Louisiana	South Carolina
California (Coachella Valley Only)*	Mississippi	Tennessee
	New Mexico	Texas
Florida	North Carolina	Virginia

* Applications can only be made from April through September.

Restrictions:
- Before using this product refer to the USDA APHIS Imported Fire Ant Quarantine web site: http://www/aphis.usda.gov/plant_health/plant_pest_info/fireants/downloads/fireant.pdf or search the APHIS web site by zip code to determine if the area to be treated is located within the APHIS Imported Fire Ant Quarantine area: http://www.aphis.usda.gov/plant_health/plant_pest_info/fireants?fireantquery.php. If the zip code for the area to be treated does not appear in the APHIS Imported Fire Ant Quarantine zone, you must notify and consult with the county's extension agent prior to treating.
- Consult your State or Federal plant protection inspector or your county agent for assistance regarding exact areas under regulation and requirements for moving regulated articles.
- For all areas except sodfarms within the USDA APHIS Quarantine area, do not apply more than 1 application per year of 87 lbs. (0.0125 lbs. ai) per acre.
- For sodfarms within the USDA APHIS Quarantine area, 2 applications of 87 lbs. (0.0125 lbs. ai) per acre per application may be made.
- Do not broadcast over impervious surfaces such as paved or concrete roads, sidewalks, driveways, and walkways.
- Do not broadcast near any storm drains.
- Calibrate and adjust equipment prior to application to ensure that the proper rate of product will be applied.

WHERE TO APPLY: Turfgrass areas including golf courses; lawns in commercial and residential areas; cemeteries; recreational areas including parks, campsites; around schools and sports fields; and on sodfarms; and **Landscape beds**.

HOW TO USE: Apply QUALI-PRO FIPRONIL 0.0143G BROADCAST with broadcast equipment. Before each use, calibrate and adjust the equipment to ensure accurate application rates. Ensure thorough and even coverage of the granules. Water in immediately after application.

HOW MUCH TO APPLY: Apply 87 lbs. of QUALI-PRO FIPRONIL 0.0143G BROADCAST per acre (2 pounds of QUALI-PRO FIPRONIL 0.0143G BROADCAST per 1000 sq. ft.).

CONTAINERIZED ORNAMENTAL PLANTS IN OUTDOOR NURSERY SITES

To control Imported Fire Ants, *Solenopsis* spp., for up to 1 year, apply to outdoor nursery sites before placement of the containerized plants into the treated area.

Restrictions:
- Do not apply to field-grown nursery stock.
- Do not apply to bare ground or other impervious surfaces such as concrete, asphalt, compacted soil surfaces, plastic film, or wood surfaces.
- Do not apply to areas where plants grown for food will be placed.

HOW MUCH TO APPLY: Apply 87 lbs. of QUALI-PRO FIPRONIL 0.0143G BROADCAST per acre (2 pounds of QUALI-PRO FIPRONIL 0.0143G BROADCAST per 1000 sq. ft.).

The primary purpose of this product is for Imported Fire Ants, *Solenopsis* spp., control. When treating for Imported Fire Ants, *Solenopsis* spp., the following pests will be controlled for a limited time:
Fleas [*Ctenacephalides* spp.] and Ticks [*Dermacentor* spp., *Rhipicephalus* spp., *Ixodes* spp.], 1 month; Nuisance ants [*Lasius neoniger*], 3 months; Mole crickets [*Scapteriscus* spp.], 4 months.

STORAGE AND DISPOSAL

Do not contaminate water, food, or feed by storage or disposal.

PESTICIDE STORAGE: Do not store in or around the home. Store unused product in original container only, out of the reach of children and animals. NEVER TRANSFER THIS PRODUCT TO ANOTHER CONTAINER FOR STORAGE.

PESTICIDE DISPOSAL: Pesticide wastes are acutely hazardous. Improper disposal of excess pesticide is a violation of Federal law. Contamination with this product will render water, food, or feed unfit for human consumption. Wastes resulting from the use of this product may be disposed of on site or at an approved waste disposal facility.

IN CASE OF SPILL: Sweep up spilled granules, transfer to a marked container, and dispose of wastes on site or at a waste disposal facility.

CONTAINER DISPOSAL: Nonrefillable container. Do not reuse or refill container. Offer for recycling, if available. Completely empty bag into application equipment. Then dispose of empty bag in a sanitary landfill or by incineration or, if allowed by State and local authorities, by burning. If burned, stay out of smoke.

WARRANTY STATEMENT

Makhteshim Agan of North America, Inc. warrants that this product conforms to the chemical description on the label thereof and is reasonably fit for purposes stated on such label only when used in accordance with directions under normal use conditions. It is impossible to eliminate all risks inherently associated with use of this product. Crop injury, ineffectiveness, or other unintended consequences may result because of such factors as weather conditions, presence of other materials, or the manner of use or application, all of which are beyond the control of Makhteshim Agan of North America, Inc. To the extent consistent with applicable law, Makhteshim Agan of North America, Inc. shall in no event be liable for consequential, special, or indirect damages resulting from the use or handling of this product. All such risks shall be assumed by the Buyer. Except, as expressly provided herein, Makhteshim Agan of North America, Inc. makes no warranties, guarantees, or representations of any kind, either expressed or implied, or by usage of trade, statutory or otherwise, with regard to the product sold, including, but not limited to merchantability, fitness for a particular purpose, use or eligibility of the product for any particular trade usage. To the extent consistent with applicable law, the exclusive remedy of any buyer or user of this product for any and all losses, injuries, or damage resulting from or in any way arising from the use, handling, or application of this product, whether in contract, warranty, tort, negligence, strict liability, or otherwise, shall be damages not exceeding the purchase price paid for this product or, at Makhteshim Agan of North America, Inc.'s election, the replacement of this product.

Quali-Pro is a registered trademark of Makhteshim Agan of North America, Inc.

EXTINGUISH®
Professional Fire Ant Bait

- **ELIMINATES FIRE AND PAVEMENT ANT COLONIES**
- **STOPS THE DEVELOPMENT OF NEW MOUNDS**
- **NO WITHDRAWAL PERIOD OR GRAZING RESTRICTIONS ON TREATED AREAS**
- **CAN BE USED AROUND FLOWERS, SHRUBS, AND TREES**
- **WITH PRECOR® INSECT GROWTH REGULATOR**

SPECIMEN LABEL

ACTIVE INGREDIENT:	
(S)-Methoprene (CAS #65733-16-6)	0.5%
OTHER INGREDIENTS:	99.5%
Total. . . .	100.0%

EPA Reg No. 2724-475

KEEP OUT OF REACH OF CHILDREN

CAUTION

See additional Precautionary Statements

PRECAUTIONARY STATEMENTS
HAZARDS TO HUMANS AND DOMESTIC ANIMALS – CAUTION

Causes moderate eye irritation. Avoid contact with eyes or clothing. Wash thoroughly with soap and water after handling.

FIRST AID	
If in eyes	• Hold eye open and rinse slowly and gently with water for 15-20 minutes. • Remove contact lenses, if present, after the first 5 minutes, then continue rinsing eye. • Call a poison control center or doctor for treatment advice.

Have the product container or label with you when calling a poison control center or doctor, or going for treatment. You may also contact 1-800-347-8272 for emergency medical treatment information.

PERSONAL PROTECTIVE EQUIPMENT (PPE):
WPS USES:

Applicators and other handlers who handle this pesticide for any use covered by the Worker Protection Standard (40 CFR Part 170) - in general, agricultural-plant uses are covered – must wear:

- Long-sleeved shirt and long pants
- Chemical-resistant gloves
- Shoes plus socks

Follow manufacturer's instructions for cleaning/ J3 maintaining PPE. If no such instructions for washables, use detergent and hot water. Keep and wash PPE separately from other laundry.

ENGINEERING CONTROLS STATEMENTS

When handlers use closed systems, enclosed cabs, or aircraft in a manner that meets the requirements listed in the Worker Protection Standard (WPS) for agricultural pesticides [40 CFR 170.240 (d)(4-6)], the handler PPE requirements may be reduced or modified as specified in the WPS.

USER SAFETY RECOMMENDATIONS:

Users should:

- Wash hands before eating, drinking, chewing gum, using tobacco, or using the toilet.
- Remove clothing immediately if pesticide gets inside. Then wash thoroughly and put on clean clothing.
- After handling this product, immediately wash the outside of gloves before removing them, then remove gloves and all other PPE. Immediately wash thoroughly and change into clean clothing.

ENVIRONMENTAL HAZARDS

Do not apply directly to water, or to areas where surface water is present or to intertidal areas below the mean high water mark. Do not contaminate water when disposing of rinsate or equipment washwaters.

GENERAL INFORMATION

EXTINGUISH® PROFESSIONAL FIRE ANT BAIT (EXTINGUISH®) contains an insect growth regulator (IGR) with specific activity to fire and pavement ants. The IGR is contained in an attractive bait that foraging fire and pavement ant workers take back to the mound to feed to the queen. IGR's are different from conventional products which provide a direct kill to fire and pavement ants. IGR's work by affecting queen reproduction. The effects of the treatment may not be immediately evident. IGR's are slower in activity than conventional products. Though slower in action, control is complete without the concern of rebounding or movement of the colony to another location. Reduction in colony size can be seen beginning at 3 weeks with colony elimination within 8 to 10 weeks. When existing workers die, replacement workers are not produced resulting in starvation and elimination of the queen and colony.

DIRECTIONS FOR USE

It is a violation of Federal Law to use this product in a manner inconsistent with its labeling.

Do not apply this product in a way that will contact workers or other persons, either directly or through drift. Only protected handlers may be in the area during application. For any requirements specific to your State or Tribe, consult the agency responsible for pesticide regulation.

AGRICULTURAL USE REQUIREMENTS

Use this product only in accordance with its labeling and with the Worker Protection Standard, 40 CFR Part 170. This Standard contains requirements for the protection of agricultural workers on farms, forests, nurseries, and greenhouses, and handlers of agricultural pesticides. It contains requirements for training, decontamination, notification, and emergency assistance. It also contains specific instructions and exceptions pertaining to the statements on this label about personal protective equipment (PPE) and restricted-entry interval. The requirements in this box only apply to uses of this product that are covered by the Worker Protection Standard.

Do not enter or allow worker entry into treated areas during the restricted-entry interval (REI) of 4 hours.

PPE required for early entry to treated areas that is permitted under the Worker Protection Standard and that involves contact with anything that has been treated, such as plants, soil, or water is: • Coveralls • Chemical-resistant gloves • Shoes plus socks

APPLICATION SITES
OUTDOOR USE

EXTINGUISH® may be applied to, but not limited to, the following areas:

- Residential Turf & Landscapes (around flowers, shrubs, and trees)
- Perimeter Areas of Buildings, Homes, Sheds, Kennels, Barns, Poultry Houses, Swine Operations, Dairies, Electrical & Phone Boxes, Pump Houses and other Associated Areas
- Parks
- Sports Fields
- Golf Courses
- Zoos
- Cemeteries
- Airports
- Roadsides
- School Grounds
- Citrus Groves
- Pastures
- Rangeland
- Cropland
- Sod Farms
- Commercial Nurseries including Field Grown and Container Stock
- Forestry Sites

METHODS OF APPLICATION

GENERAL

Application during heat of the day or when rain is expected within 6 hours of application will reduce the effectiveness of this product. Moisture reduces the attractiveness of the bait in wet areas. In areas of heavy infestation, repeat applications may be necessary 10 to 12 weeks following the initial application.

1. **Individual Mound Treatments** - Treat all visible mounds with 3 to 5 tablespoons of **EXTINGUISH®** per mound. To treat the mounds, sprinkle the adjacent areas of the mound, applying evenly in a manner to encompass the mound to a perimeter of 4 feet. Do not disturb the mound during application. Worker ants will locate the bait quickly and begin taking it back to the mound.
2. **Broadcast Applications** - Apply **EXTINGUISH®** to areas at the rate of 1 to 1.5 pounds of product per acre (3.5 tablespoons/1000 ft^2) using suitable application equipment. Backpack, hand, or motorized mechanical equipment may be used. No withdrawal or grazing restrictions are necessary on treated areas.

EXTINGUISH® may be used as a preventative application to reduce the buildup of fire and pavement ants into unwanted areas. Two to three broadcast applications per year are recommended to prevent the encroachment and subsequent development of new mounds into an area.

Repeat applications may be made as often as fire and pavement ants are observed.

3. **Hopper Blend** - Blend **EXTINGUISH®** with other fire and pavement ant bait products such as ProBait®*, Amdro Pro™, or other bait products labeled for fire and pavement ant control. When blending products, the more restrictive label will apply. Use a 50/50 mix to blend **EXTINGUISH®** and other bait. For broadcast applications, mix the required amount of bait so that the application is made using 0.75 lbs. **EXTINGUISH®** and 0.75 lbs. of other bait for a total of 1.5 lbs. of total bait per acre. For mound treatments, blend a 50/50 mix of **EXTINGUISH®** and other bait and apply at the rate of 3–5 tablespoons per mound.

RATES AND TIMING

Treatment	Rate	Comments
Broadcast Treatment	0.75 lbs. **EXTINGUISH®** plus 0.75 lbs. other bait product per acre	Mix bait products together thoroughly prior to application; distribute bait uniformly with ground equipment (granular spreaders) or aerial equipment.
Individual Mound Treatment	50/50 mix of **EXTINGUISH®** plus other bait. Apply blended product at 3-5 tablespoons per mound.	Mix thoroughly and apply product around and on the mound.

Observe all restrictions and precautions which appear on all product labels.

4. **Refillable Bait Stations** - **EXTINGUISH®** may be used in refillable bait stations. Place up to 1 oz of **EXTINGUISH®** per refillable bait station. Locate stations along the perimeter of a structure or fence line with 1 station every 15-30 linear feet. Locate stations near potential ant entry points of a structure or near locations where ants are a problem. Examples include: weep holes, foundation vents, stairs, decks, patios, picnic areas, utility areas, and other areas frequented by ants. Inspect stations frequently and replenish bait if soiled or wet. Affix a sticker to bait station indicating the contents.

INDOOR USE

Use **EXTINGUISH®** indoors in homes, residences (apartments, nursing homes), commercial buildings and warehouses, and any other structures where ants may enter. Also for use in non-food/feed areas of institutions, restaurants, commercial food processing areas, including poultry and livestock operations. Apply bait to cracks, crevices, and voids or to areas that are inaccessible such as attics, crawlspaces, and wall voids. Apply 0.25 – 0.50 oz per crack, crevice, or void. For use in attics or crawlspaces, use 0.25 oz per 100 square feet in those areas that are inaccessible to children or pets.

STORAGE AND DISPOSAL

STORAGE

Do not contaminate water, food, or feed by storage and disposal.

PESTICIDE DISPOSAL

Wastes resulting from the use of this product may be disposed of on site or at an approved waste disposal facility.

CONTAINER DISPOSAL

Nonrefillable container. Do not reuse or refill this container. Completely empty bag into application equipment. Then offer for recycling if available or dispose of empty bag in a sanitary landfill or by incineration, or if allowed by State and Local authorities, by burning. If burned, stay out of smoke.

Seller makes no warranty, expressed or implied, concerning the use and handling of this product other than indicated on the label. Buyer assumes all risks of use and handling of this material when such use and handling are not in accordance with directions.

For information call 1-800-347-8272.

www.extinguishfireants.com

www.zoecon.com

www.starbarproducts.com

Wellmark International
1501 East Woodfield Road 200W
Schaumburg, Illinois 60173

ZOËCON™ Professional Products

300505183

October, 2009
Schaumburg, IL

MATERIAL SAFETY DATA SHEET
MSDS Y-117 REVISION 3

SECTION 1: PRODUCT AND COMPANY IDENTIFICATION

COMBAT INSECT CONTROL SYSTEMS
C/O The Dial Corporation
19001 N. Scottsdale Road
Scottsdale, Arizona 85255-9672

Medical Emergencies: 1-888-689-9082
Chemtrec: 1-800-424-9300 (24 Hours Daily)
Other Information: 1-888-468-6673

PRODUCT:	COMBAT®	DATE OF ISSUE: March 3, 2009
TRADE NAMES/SYNONYMS:	Combat Source Kill 4 Combat Ant Killing System	
CHEMICAL FAMILY:	Insecticides	
EPA REG. NUMBER:	64240-3	

SECTION 2: HAZARD IDENTIFICATION

EMERGENCY OVERVIEW

CAUTION: This product is a food bait in a child resistant plastic station. Direct contact with eyes can cause irritation. Harmful if absorbed through skin. Prolonged contact with skin can cause mild irritation. Refer to product label for additional precautions during product use. Keep out of reach of children. This product is toxic to fish and aquatic invertebrates. Not a fire hazard. Product is stable.

This product is labeled in accordance with guidelines set forth in the Federal Insecticide, Fungicide and Rodenticide Act. The use pattern and exposure in the workplace are generally not consistent with those experienced by consumers. The requirements of the Occupational Safety and Health Administration applicable to this Material Safety Data Sheet may differ from the requirements of the FD & C Act and as a result, this MSDS may contain additional health hazard information not pertinent to consumer use and not found on the product label.

REGULATORY STATUS

This material is considered to be hazardous under OSHA's Hazard Communication Standard (29 CFR 1900.1200). This MSDS should be retained and available for employees and other users of this product.

POTENTIAL HEALTH EFFECTS

INHALATION:	Not a likely route of exposure. Irritating, in high concentration, to the respiratory tract (nose, throat, and lungs).
SKIN CONTACT:	Harmful if absorbed through skin. Can cause mild skin irritation with prolonged contact.
EYE CONTACT:	Can cause mild-to-moderate eye irritation..
INGESTION:	Not a likely route of exposure. Ingestion of large amounts may cause some gastrointestinal discomfort including nausea, vomiting, abdominal pain, diarrhea, and lethargy.

CHRONIC HEALTH EFFECTS: Due to the nature and composition of this product no chronic health effects are anticipated.

MEDICAL CONDITIONS GENERALLY RECOGNIZED AS BEING AGGRAVATED BY EXPOSURE: No known health conditions are aggravated by exposure to this product.

POTENTIAL ENVIRONMENTAL EFFECTS

See Section 12: Ecological Information.

SECTION 3: COMPOSITION / INFORMATION ON INGREDIENTS

Based on our hazard evaluation, the following chemical substance(s) in this product have been identified as hazardous.

INGREDIENT	CAS NUMBER	PERCENT (w/w)
Hydramethylnon	67485-29-4	1.0 %

SECTION 4: FIRST AID MEASURES

Call poison control center or doctor immediately for treatment advice. Have the product container or label with you when calling a poison control center or doctor or going for treatment.

INHALATION: Remove from exposure area to fresh air immediately. Keep affected person warm and at rest. Treat symptomatically and supportively. Contact physician or local poison control center. If breathing has stopped, give artificial respiration, and get medical attention immediately.

IF ON SKIN OR CLOTHING: Take off contaminated clothing. Rinse skin immediately with plenty of water for 15-20 minutes. Call a poison control center or doctor for treatment advice.

EYE CONTACT: Immediately rinse eyes with plenty of water, occasionally lifting upper and lower lids, until no evidence of product remains. Get medical attention if pain or irritation persists.

INGESTION: Treat symptomatically and supportively. Maintain airway and respiration. If vomiting occurs, keep head below hips to prevent aspiration. Dilution by rinsing the mouth and giving water or milk to drink is generally recommended. If unconscious, the victim should not be given anything to drink. Contact physician or local poison control center.

NOTE TO PHYSICIAN: The physician's judgement should be used to control symptoms and clinical condition based on the individual reactions of the patient.

SECTION 5: FIRE FIGHTING MEASURES

FLAMMABLE PROPERTIES

OSHA FLAMMABILITY CLASSIFICATION: Not available

FLASH POINT: > 200°C (TCC)

UPPER FLAMMABILITY LIMIT: Not applicable

LOWER FLAMMABILITY LIMIT: Not applicable

AUTO-IGNITION TEMPERATURE: Not applicable

FLAME PROJECTION: Not applicable

FIRE AND EXPLOSION HAZARD: Negligible fire hazard when exposed to heat or flame.

HAZARDOUS DECOMPOSITION PRODUCTS: Oxides of carbon and oxides of nitrogen.

EXTINGUISHING MEDIA

Dry chemical, carbon dioxide (CO_2) foam or water spray.

PROTECTION OF FIREFIGHTERS

In case of fire, wear a full face positive-pressure self contained breathing apparatus and protective suit. Move container from fire area if you can do it without risk. Do not scatter spilled material with high-pressure water streams. Dike fire-control water for later disposal. Use agents suitable for type of surrounding fire. Avoid breathing hazardous vapors, keep upwind.

SECTION 6: ACCIDENTAL RELEASE MEASURES

PERSONAL PRECAUTIONS :
Ventilate spill area if possible. Do not touch spilled material. Stop or reduce any leaks if it is safe to do so. Use personal protective equipment recommended in Section 8. Notify appropriate government, occupational health and safety and environmental authorities. Keep unnecessary people away; isolate hazard area and restrict entry. Ensure clean-up is conducted by trained personnel only.

ENVIRONMENTAL PRECAUTIONS:
This product is toxic to fish and aquatic invertebrates. This product should not be directly discharged into lakes,streams, ponds, estuaries, oceans, public water supplies, or other waters. Do not contaminate surface or ground water by cleaning equipment or disposal of wastes, including equipment washwater.

METHODS FOR CONTAINMENT AND CLEAN UP

SMALL SPILLS: Sweep or scoop up and place into suitable clean, dry containers for reclamation or later disposal. Wash site of spillage thoroughly with water. LARGE SPILLS: Sweep or scoop up. Recover in suitable containers for later disposal. Keep unnecessary people away from spill.

SECTION 7: HANDLING AND STORAGE

HANDLING:
Do not get in eyes, on skin, on clothing. Do not take internally. Wash thoroughly with soap and water after handling bait stations. Use with adequate ventilation. Avoid generating aerosols and mists. Keep the containers closed when not in use. Have emergency equipment (for fires, spills, leaks, etc.) readily available.

STORAGE:
Store in a cool, dry, ventilated area out of reach of children and away from sources of heat, moisture, and incompatible substances. Store in suitable labeled containers. Store the containers tightly closed.

SECTION 8: EXPOSURE CONTROLS / PERSONAL PROTECTION

WORKER EXPOSURE LIMITS:
The following exposure limits exist for the ingredients listed below. The PEL-TWA is the Permissible Exposure Limit – Time Weighted Average from American Cyanamid.

INGREDIENT	CAS NUMBER	EXPOSURE LIMIT
Hydramethylnon	67485-29-4	TLV-TWA 1.4 mg/m^3

ENGINEERING CONTROLS: Provide local exhaust or general dilution ventilation to keep potential exposure to airborne contaminants as low as possible.

RESPIRATOR: None required under normal use conditions. Use general ventilization to minimize exposure. Air contamination monitoring should be carried out where generation of vapors is likely to occur, to assure that the employees are not exposed to harmful concentrations of any of the above mentioned components. If respiratory protection is required, it must be based on the contamination levels found in the workplace, must not exceed the working limits of the respirator and be jointly approved by the National Institute for Occupational Safety and Health and the Mine Safety and Health Administration (NIOSH-MSHA).

FOR FIRE FIGHTING AND OTHER IMMEDIATELY DANGEROUS TO LIFE OR HEALTH CONDITIONS: Any self-contained breathing apparatus that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode. Any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary self-contained breathing apparatus operated in pressure demand or other positive-pressure mode.

CLOTHING: Protective clothing (impervious to liquids) is required where splashing of product may occur.

GLOVES: Chemical-resistant gloves are required where repeated or prolonged skin contact may occur.

EYE/fFACE PROTECTION: Splash-proof safety glasses are required to prevent eye contact where splashing of product may occur.

SECTION 9: PHYSICAL AND CHEMICAL PROPERTIES

APPEARANCE:	Hydramethylnon based food bait in a child resistant plastic station.		
ODOR/ODOR THRESHOLD:	Not available	PHYSICAL STATE:	Solid
pH (@ 25°C):	Not available	VAPOR DENSITY:	Not available
BOILING POINT:	Not available	VAPOR PRESSURE:	Not available
MELTING/FREEZING POINT:	60° C	FLASH POINT:	See Section 5.
FLAMMABLE PROPERTIES:	See Section 5.	SOLUBILITY IN WATER:	Insoluble
DENSITY/SPECIFIC GRAVITY:	1.25 g/ml	EVAPORATION RATE:	Not available

OCTANOL/WATER PARTITION COEFFICIENT (K_{ow}): Not available

VISCOSITY (Dynamic): Not applicable

SECTION 10: STABILITY AND REACTIVITY

CHEMICAL STABILITY: Stable under normal ambient temperature (70°F, 21°C) and pressure (1 atm).

CONDITIONS TO AVOID: Avoid storing in direct sunlight, avoid extremes of temperature.

INCOMPATIBLE MATERIALS: Strong oxidizers and reducing agents.

HAZARDOUS DECOMPOSITION PRODUCTS: Thermal decomposition products may include oxides of carbon.

POSSIBILITY OF HAZARDOUS REACTIONS: Hazardous reactions do not occur under normal temperatures and pressures.

SECTION 11: TOXICOLOGICAL INFORMATION

PRODUCT INFORMATION SUMMARY: The use of this product by consumers is safe under normal and reasonable foreseen use. Direct contact with eyes can cause irritation. Harmful if absorbed through skin. Prolonged contact with skin can cause mild irritation.

COMPONENT ANALYSIS: The following toxicity information is available for the product and/or for the hazardous ingredients when used as technical grade.

PRODUCT / INGREDIENT	LD50 / DRAIZE SCORE	TOXICITY / IRRITATION RATING
ACUTE ORAL TOXICITY		
Combat Ant Bait F1	> 5,000 mg/kg (rat)	Non-hazardous
Hydramethylnon (active ingredient)	1,193 mg/kg (rat)	Moderately Toxic
ACUTE DERMAL TOXICITY		
Combat Ant Bait F1	> 2,000 mg/kg (rabbit)	Practically Non-Toxic
Hydramethylnon (active ingredient)	> 5,000 mg/kg (rat)	Non-Hazardous
ACUTE INHALATION TOXICITY		
Combat Ant Bait F1	> 20.0 mg/l	Non-Hazardous
Hydramethylnon (active ingredient)	> 5.0 mg/l	Slightly Toxic
EYE IRRITATION		
Combat Ant Bait F1		Slightly Irritating
Hydramethylnon (active ingredient)		Moderately Irritating
SKIN IRRITATION		
Combat Ant Bait F1		Practically Non-Irritating
Hydramethylnon (active ingredient)		Slightly Irritating

SENSITIZATION: This product is not considered a skin or respiratory sensitizer.

CARCINOGENICITY: None of the ingredients in this product are listed as carcinogens by the International Agency for Research on Cancer (IARC), the National Toxicology Program (NTP) or the Occupational Safety and Health Administration (OSHA).

MUTAGENICITY: None of the ingredients in this product are known to cause mutagenicity.

REPRODUCTIVE/FETAL/DEVELOPMENTAL TOXICITY: Hydramethylnon is currently listed under California Proposition 65 for developmental effects in males.

TARGET ORGAN TOXICITY: None of the ingredients in this product are known to have target organ toxicity.

EPIDEMIOLOGICAL INFORMATION: None of the ingredients in this product are known to have health-related information in working populations.

SECTION 12: ECOLOGICAL INFORMATION

The environmental toxicity of this product has not been evaluated. This product could be toxic to fish. Do not apply directly to water. Do not contaminate water by cleaning of equipment or disposal of equipment washwaters.

ENVIRONMENTAL FATE:
No environmental fate exists for the product.

PERSISTENCE AND DEGRADABILITY:
The persistence and degradability of this product has not been determined. Hydramethylnon degrades rapidly in sunlight with a half-life of 1 hour in water and 6 days in soil.

Water: In water, Hydramethylnon undergoes photolysis with a half-life of 0.0291-0.0417 days (0.25 mg/l at pH 7 and 25-27°C). The degradates under these conditions are 4H-pyrimido-[2-1,C] as-triazio-4-one-1,6,7,8-tetrahydro-7,7-dimethyl-3-[p-(trifluoro-methyl)-styryl and 1,5-bis(alpha, alpha, alpha-tri-fluoro-p-tolyl)-1,4,-pentadiene-3-one. Hydramethylnon is also metabolized in water under anaerobic conditions with half-lives of 455-552 days.

Soil: In loam soil (51.2% sand, 12.3% clay, 36% silt) containing 1.87% organic matter, Hydramethylnon undergoes biphasic photolysis with a half-life of 4 and 35 days for the first and second phase, respectively (pH 5.8 and 25°C). Hydramethylnon is also metabolized in soil under aerobic conditions with half-lives of 375-391 days in sandy loam (54% sand, 18% clay, 28% silt) containing 2.1% organic matter (pH 6.1 and 25°C).

BIOACCUMULATION POTENTIAL:
The bioaccumulation potential of this product has not been determined.

MOBILITY:
The mobility of this product (in soil and water) has not been determined.

SECTION 13: DISPOSAL CONSIDERATIONS

Pesticide wastes can be acutely hazardous. Improper disposal of excess pesticide, spray mixture, or rinsate is a violation of Federal Law. If these wastes cannot be disposed of by use according to label instructions, contact your State Pestice or Environmental Control Agency, or the hazardous waste representative at the nearest EPA Regional Office for guidance.

WASTE NUMBER AND DESCRIPTION: Not Applicable, not regulated.

DISPOSAL CONSIDERATIONS: This product is not a RCRA hazardous waste and can be disposed of in accordance with federal, state and local regulations.

SECTION 14: TRANSPORT INFORMATION

GROUND TRANSPORT
DOT Hazard Class: Not regulated
DOT Proper Shipping Name: Insecticide, non-toxic, solid – Not Restricted.
UN/NA Number: Not applicable
Packing Group: Not applicable
Shipping Label Information: Not applicable

AIR TRANSPORT (ICAO/IATA)

ICAO/IATA Hazard Class:	Not regulated
ICAO/IATA Proper Shipping Name:	Not applicable

MARINE TRANSPORT (IMDG/IMO)

IMDG/IMO Hazard Class:	Not regulated
IMDG/IMO Proper Shipping Name:	Not applicable

SECTION 15: REGULATORY INFORMATION

UNITED STATES:
OSHA HAZARD COMMUNICATION RULE, 29 CFR 1910.1200:
The Occupational Safety and Health Administration requires Material Safety Data Sheets to provide any hazards that may be associated with the product, and make this information available in the workplace. Since the use pattern and exposure in the workplace are generally not consistent with those experienced by consumers, this MSDS may contain additional health hazard information not pertinent to consumer use.

EPA - SARA TITLE III SECTION 313: Not applicable - Consumer product.

EPA CERCLA/SARA TITLE III SUPERFUND AMENDMENT AND REAUTHORIZATION ACT:
This product contains no CERCLA/SARA Title III materials.

TSCA: This product is a registered pesticide and is exempted from listing on the U.S. Toxic Substances Control Act (TSCA) chemical substance inventory.

FIFRA: EPA Registration Number 64240-3
EPA Establishment Number 071106-GA-001

STATE REGULATIONS
CALIFORNIA PROPOSITION 65: Hydramethylnon is currently listed under California Proposition 65.

SECTION 16: OTHER INFORMATION

DISCLAIMER: The information contained herein is provided in good faith and is believed to be correct as of the date hereof. However, The Dial Corporation makes no representation as to the comprehensiveness or accuracy of the information. It is expected that individuals receiving the information will exercise their independent judgment in determining its appropriateness for a particular purpose. Accordingly, The Dial Corporation will not be responsible for damages of any kind resulting from the use of or reliance upon such information. No representations, or warranties, either expressed or implied of merchantability, fitness for a particular purpose or of any other nature is made hereunder with respect to the information set forth herein or to the product to which the information refers.

NFPA RATINGS (Scale 0-4, where 4=high degree of hazard):	HEALTH=1	FLAMMABILITY=1	REACTIVITY=0
HMIS RATINGS (Scale 0-4, where 4=severe hazard):	HEALTH=1	FLAMMABILITY=1	REACTIVITY=0

MSDS CREATION DATE: 11/14/04
SUPERSEDES: 07/26/07, Ver. 2
REVISION DATE: 03/03/09
REVISION: Update Company Information.

How AMDRO® Fire Ant Bait Works:

1. **AMDRO® is a bait. Worker ants carry it into the mound as food for the colony.**
2. **They eat it and feed it to the queen. AMDRO® starts to kill ants immediately.**
3. **In about a week the queen is dead, which destroys the mound.**

PRECAUTIONARY STATEMENTS
ENVIRONMENTAL HAZARDS

This product is toxic to fish. Do not apply directly to water. Do not contaminate water when cleaning equipment or disposing of equipment washwaters.

NOTICE: To the extent consistent with applicable law, seller makes no warranty, expressed or implied, concerning the use of this product other than indicated on the label. To the extent consistent with applicable law, buyer assumes all risk of use and/or handling of this material when such use and/or handling is contrary to label instructions.

In case of an emergency endangering life or property involving this product, call 1-800-265-0761.

For more information, please visit our website at www.amdro.com

Amdro and Central Garden & Pet with design are trademarks of Central Garden & Pet Company.

Manufactured for **AMBRANDS**
2030 Powers Ferry Road, Suite 370
Atlanta, GA 30339
EPA Reg. No. 73342-1
EPA Est. No. 5905-AR-1a, 5905-GA-1a
Subscript used is first letter of run code on container.

CENTRAL

*Kills the Queen, Fast**

AMDRO
FIRE ANT BAIT
Kills Fire Ants

Destroys the Mound**

KEEP OUT OF REACH OF CHILDREN
CAUTION See Side Panels for Additional Precautionary Statements

*ELIMINA A LA REINA RÁPIDAMENTE

MANTENER FUERA DEL ALCANCE DE LOS NIÑOS
PRECAUCION Consulte los paneles laterales para conocer las frases de precaución adicionales

**DESTRUYE A LA COLONIA

ACTIVE INGREDIENT:	By Wt.
Hydramethylnon (CAS No. 67485-29-4)	0.73%
OTHER INGREDIENTS:	99.27%

NET WT/PESO NETO
1 LB (.454 kg)

Cómo funciona el cebo para hormigas de fuego AMDRO®:

1. **AMDRO® es un cebo. Las hormigas obreras lo transportan a su hormiguero como alimento para la colonia.**
2. **Las hormigas lo comen y alimentan a la reina con el cebo. AMDRO® comienza a eliminar a las hormigas de inmediato.**
3. **La reina muere en aproximadamente una semana, lo cual destruye el hormiguero.**

DECLARACIONES DE PRECAUCIÓN
RIESGOS AMBIENTALES

Este producto es tóxico para los peces. No aplique directamente en el agua. No contamine el agua cuando limpie el equipo ni cuando elimine las aguas con que lavó el equipo.

NOTA: Hasta donde la ley lo permita, el vendedor no garantiza expresa ni implícitamente el uso de este producto distinto al indicado en la etiqueta. Hasta donde la ley lo permita, el comprador asume el riesgo del uso y/o manejo de este material cuando tal uso y/o manejo es contrario a las instrucciones de la etiqueta.

En caso de emergencia que ponga en riesgo la vida o las propiedades debido a este producto, llame al 1-800-265-0761.

Para mayor información, sírvase visitar nuestro sitio Web **www.amdro.com**

FPO

8 13576 00416 3

3005124S5-09/12

DIRECTIONS FOR USE

It is a violation of Federal law to use this product in a manner inconsistent with its labeling.

This product is not for use on vegetable or other food crops, timber or plants grown for sale or other commercial use, or for commercial seed production, or for research purposes.

Application Restrictions: Do not apply this product in a way that will contact any person or pet, either directly or through drift. Keep people and pets out of the area during application.

Outdoor Use

For individual mounds: Sprinkle 2 to 5 level tablespoons of AMDRO® around the mound. Do not disturb the mound. Use a disposable scoop (do not use a kitchen utensil).

For large, infested areas: Using a hand-held granular spreader, broadcast AMDRO® at 2 to 4 ounces per 5,000 square feet (1 to 2 pounds per acre).

For best results, apply AMDRO® when ants are active. Repeat application as needed.

AMDRO® fire ant bait controls imported and native fire ants and other ants, such as harvester ants, bigheaded ants and Argentine ants. AMDRO® fire ant bait is for use ONLY on lawns, landscaped areas, golf courses, commercial grounds, parks and other noncropland areas, as well as on grounds surrounding poultry houses (excluding runs and ranges) or corrals and other animal holding areas. Do not graze or feed treated lawn or sod clippings to livestock. Avoid direct exposure of animals to AMDRO® granules.

Application Tips:

- For best results, apply in early morning or late afternoon when ants are most active.
- Do not apply when ground is soaking wet or when heavy rains are expected. Do not water-in after application.

STORAGE AND DISPOSAL

Pesticide Storage: Store in cool, dry, secure place and keep container closed. Store container away from pets. When properly stored, this product will retain its effectiveness for up to 3 months after the package has been opened.

Pesticide Disposal: If partially filled – Call your local solid waste agency for disposal instructions. Never place unused product down any indoor or outdoor drain.

Container Disposal: If empty – Nonrefillable container. Do not reuse or refill this container. Place in trash or offer for recycling if available.

INSTRUCCIONES

Usar este producto de modo inconsistente con las indicaciones de su etiqueta constituye una violación de la ley Federal.

No se debe usar este producto en cultivos de vegetales u otros cultivos, madera o plantas cultivados para la venta u otro uso comercial, ni para la producción comercial de semillas ni fines de investigación.

Restricciones de la aplicación: No aplique este producto de modo que tenga contacto con alguna persona o mascota, ya sea de modo directo o por esparcirse en el aire. Mantenga a las personas y mascotas fuera del área durante la aplicación.

Uso en exteriores

Para hormiguero individuales: Vierta de 2 a 5 cucharadas rasas de AMDRO® alrededor de el hormiguero. No perturbe el hormiguero. Use una cuchara desechable (no utilice un utensilio de cocina).

Para las zonas grandes e infestadas: Mediante el uso de un esparcidor granular manual, disemine AMDRO® a 2-4 onzas por 5,000 pies cuadrados (1-2 libras por acre).

Para obtener los mejores resultados, aplique AMDRO® cuando las hormigas estén activas. Repita la aplicación según sea necesario.

El cebo para hormigas de fuego AMDRO® controla a las hormigas de fuego importadas y oriundas y otros tipos de hormigas, tales como las hormigas cosechadoras, hormigas cabezonas y hormigas argentinas. El cebo para hormigas de fuego AMDRO® se utiliza SOLO en el césped, paisajes, campos de golf, terrenos comerciales, parques y otras zonas que no sean para el cultivo, así como en los terrenos que rodean a los gallineros (excluyendo los pastizales) o corrales y otras zonas que encierren animales. No apaciente ni alimente al ganado con el césped tratado o los restos de su poda. Evite la exposición directa de los gránulos AMDRO® a los animales.

Consejos de la aplicación:

- Para mejores resultados, aplique temprano en la mañana o por la tarde cuando las hormigas se encuentran más activas.
- No aplique cuando el terreno se encuentre muy mojado o si se esperan fuertes lluvias. No riegue después de la aplicación.

ALMACENAMIENTO Y ELIMINACIÓN

Almacenamiento del pesticida: Almacene en un lugar fresco, seco y seguro, y mantenga el envase cerrado. Guarde el envase fuera del alcance de las mascotas. El producto conservará su efectividad hasta por 3 meses después de abrir el empaque cuando se almacena adecuadamente.

Eliminación del pesticida: Si está parcialmente lleno – Llame a su agencia local de desechos sólidos para obtener instrucciones sobre cómo eliminarlo. Nunca elimine el producto no utilizado en ningún drenaje interior o exterior.

Eliminación del envase: Si está vacío – Envase que no se puede rellenar. No vuelva a usar o rellenar este envase. Tírelo a la basura o, si está disponible, obtenga para reciclaje.

MRI

3.00"
6.50"
14.75"
15.25"

File Path / Date / Time	Central Garden JOBS/Central Garden Jobs WIP/077222/077222_A/050_Production Art/MPLS_077222_A_Label_K.ai 09/12/2012 8:55:22 AM
Component #:	3005124S5
Description:	Kills Fire Ants, Ant Bait, 1lb Label
UPC #:	813576004163
Consumer Unit Size:	W: 15.25 IN H: 6.0 IN.
Program:	Adobe Illustrator CS5
Printer:	HA
Creation Date:	07.17.2012
Rev. Date:	09.12.2012

Ink Colors: Yellow, Magenta, Cyan, Black, PMS 186, Line Black

UPC Check | Proofread/QC

SCHAWK!

The color on this copy will not match the final printed package.
Schawk Minneapolis has checked this artwork for accuracy. Final approval is the client's responsibility.
Please double check for errors before reproduction.

241-371 10/17/2003 1/11

SENSIBLE™ /SUBTERFUGE® termite bait

For use in the control of subterranean termite infestations

For sale to, use and storage by individuals/firms licensed or registered by the state to apply termiticide and general pest control products. States may have more restrictive requirements regarding qualifications of persons using this product. Consult the structural pest control regulatory agency of your state prior to use of this product.

Active Ingredient:

Hydramethylnon: Tetrahydro-5,5-dimethyl-2(1*H*)-pyrimidinone (3-[4-(trifluoromethyl)phenyl]-1-(2-[4-[(trifluoromethyl)phenyl]-ethenyl)-2-propenylidene)hydrazone 0.3%

Inert Ingredients 99.7%

Total 100.0%

EPA Reg. No. 241-371 **EPA Est. No.**

KEEP OUT OF REACH OF CHILDREN

CAUTION/PRECAUCION!

Si usted no entiende la etiqueta, busque a alguien para que se la explique a usted en detalle. (If you do not understand this label, find someone to explain it to you in detail.)

See Back Panel for Additional Precautionary Statements

ACCEPTED
OCT 17 2003
Under the Federal Insecticide, Fungicide, and Rodenticide Act, as amended, for the pesticide registered under EPA Reg. No. 241-371

Net Weight:

™/®Trademark of BASF

BASF Corporation
26 Davis Drive
Research Triangle Park, NC 27709

BASF

PRECAUTIONARY STATEMENTS

HAZARDS TO HUMANS AND DOMESTIC ANIMALS

CAUTION!

MAY BE HARMFUL IF SWALLOWED

Harmful if absorbed through the skin. Causes moderate eye injury. Avoid contact with skin, eyes or clothing. Wash thoroughly with soap and water after handling.

FIRST AID

IF ON SKIN OR CLOTHING: Take off contaminated clothing. Rinse skin immediately with plenty of water for 15-20 minutes. Call a poison control center or doctor for treatment advice.

IF IN EYES: Hold eye open and rinse slowly and gently with water for 15-20 minutes. Remove contact lenses, if present, after the first 5 minutes, then continue rinsing eye. Call a poison control center or doctor for treatment advice.

Have the product container or label with you when calling a poison control center or doctor, or going for treatment.

In case of an emergency endangering life or property involving this product, call day or night 800-832-HELP.

ENVIRONMENTAL HAZARDS

This product is toxic to fish. Do not apply directly to water. Do not use this product in locations where the bait or its hydramethylnon contents may be washed out of the bait station into ponds, streams, springs, or other natural water sources.

DIRECTIONS FOR USE

It is a violation of Federal law to use this product in a manner inconsistent with its labeling. Do not apply this product by any method not specified on this label.

STORAGE AND DISPOSAL	
Do not contaminate water, food or feed by storage or disposal.	
Storage:	Store in original container in a dry storage area. Keep bait cartridges wrapped until ready to be used.
Pesticide Disposal:	Wrap used bait cartridge containing any unused bait with paper and place in trash can.
General:	Consult Federal, State, or local disposal authorities for approved alternative procedures.

General Information

SENSIBLE/SUBTERFUGE termite bait is intended for use as a supplement (for an integrated pest management approach), or alternative, to conventional methods for controlling termite infestations in and around areas such as, but not limited to, buildings, wooden structures, or landscape timbers. **SENSIBLE/SUBTERFUGE** contains a bait matrix that has been shown to be a preferred food source. The active ingredient in **SENSIBLE/SUBTERFUGE**, hydramethylnon, has been shown to be effective in controlling communal or social insects. Foraging workers from subterranean termite colonies (e.g., *Reticulitermes* spp., *Coptotermes* spp., or *Heterotermes* spp.) that discover and feed on **SENSIBLE/SUBTERFUGE** will recruit other foragers to the bait. Continued feeding upon **SENSIBLE/SUBTERFUGE termite bait** will result in population suppression and control of the infestations within the structure. The speed of infestation decline and the subsequent control is dependent upon the speed of the termite's interception of the bait and the amount of bait consumed.

SENSIBLE/SUBTERFUGE termite bait must be used in conjunction with a regularly scheduled inspection and monitoring program. The frequency of inspection and monitoring necessary to achieve effective control will vary depending on the level of termite activity, the size of the termite colony, and the conditions conducive to termite infestation present at the structure being protected.

General Use Instructions

Before placements of **SENSIBLE/SUBTERFUGE termite bait** can be established, an inspection of the structure to be protected (and outbuildings or landscaping on the property) is recommended to identify those sites in and around the structure where termite activity can be confirmed [e.g., mud tubes from the soil to the structure; live termites under mulch, or in construction scraps or landscape timbers], to identify other sites where termite activity is suspected [e.g., active feeding site in structural timbers, with no evident soil activity adjacent to this feeding site] and to identify areas conducive for termite activity such as areas where the soil remains damp (e.g. near sprinkler heads or gutter downspouts) or areas where wood is in contact with soil. **SENSIBLE/SUBTERFUGE termite bait** is to be applied from bait stations that are installed around the building(s) or structure(s), or in a localized area(s), where termite activity is confirmed or suspected.

SENSIBLE/SUBTERFUGE Termite Bait Is For Use Under One Or More Of The Following Treatment Strategies

Supplemental Treatment

In conjunction with the application of soil termiticides, placements of **SENSIBLE/SUBTERFUGE termite bait** can be established around the building or structure* to be protected, concentrating bait placement in areas where termite activity is known or suspected to exist. **SENSIBLE/SUBTERFUGE** may also be established in the soil beneath concrete slabs, asphalt, paving stones, or other ground coverings. As a supplemental treatment, **SENSIBLE/SUBTERFUGE** can be used to control termite activity in localized areas where environmental conditions, structural design, or other situations may preclude the use or effectiveness of conventional soil termiticides. Inspect bait within one month following installation. Following the initial inspection monitor and service bait placements at least once every three months. During winter months in geographic areas north of U.S. Interstate 80, monitoring and servicing of bait placements can be extended to at least once every 4 months. If active termite feeding is found upon either the initial or subsequent inspections then it is recommended that at least one additional termite bait be placed within 12 inches of each bait found to have termites present, where soil access is not restricted, otherwise place as close as possible, and continue to follow the monitoring schedule previously described. If after 2 consecutive monitoring periods, no termite activity is detected in **SENSIBLE/SUBTERFUGE termite bait,** then the bait may be replaced with monitoring devices. Once termite activity on a monitoring device is detected, replace the monitoring device with **SENSIBLE/SUBTERFUGE termite bait.** Install an additional **SENSIBLE/SUBTERFUGE termite bait** station within 12 inches of any station with active termites.

NOTE: Liquid termiticides that act as repellents may reduce the chances that termites will discover and feed on the bait if SENSIBLE/SUBTERFUGE termite bait is placed directly in the treated soil. Bait placement should be approximately 18 inches away from soil treated with repellent barrier termiticides.

Remedial Treatment

For control of subterranean termites infesting buildings or structures*, placements of **SENSIBLE/SUBTERFUGE termite bait** can be established around the building or structure. For remedial treatments, install at least one bait station for every 10 linear feet along the foundation, or if soil access is restricted by paving or similar hard surface, place as close as possible to adjacent bait station. Concentrate bait placement in areas where termite activity is known or suspected to exist. **SENSIBLE/SUBTERFUGE** may also be established in the soil beneath concrete slabs, asphalt, paving stones, or other ground coverings. Inspect bait within one month following installation. Following the initial inspection monitor and service bait placements at least once every three months. During winter months in geographic areas north of U.S. Interstate 80, monitoring and servicing of bait placements can be extended to at least once every 4 months. If active termite feeding is found upon either the initial or subsequent inspections then it is recommended that at least one additional termite bait be placed within 12 inches of each bait found to have termites present, where soil access is not restricted, otherwise place as close as possible, and continue to follow the monitoring schedule previously described. If after 2 consecutive monitoring periods, no termite activity is detected in **SENSIBLE/SUBTERFUGE termite bait,** then the bait may be replaced with monitoring devices. Once termite activity on a monitoring device is detected, replace the monitoring device with **SENSIBLE/SUBTERFUGE termite bait**. Install an additional **SENSIBLE/SUBTERFUGE termite bait** station within 12 inches of any station with active termites.

Note: When used as a supplemental or remedial treatment where termite activity is confirmed, install **SENSIBLE/SUBTERFUGE termite bait** within 12 inches of the site of termite activity; where soil access is not restricted. If access is restricted by paving or similar ground covering, locate bait stations as close to the site of termite activity as possible. Where termite activity is only known from feeding sites in the structure, it is recommended to install **SENSIBLE/SUBTERFUGE termite bait** in the soil beneath these feeding sites.

Preventive Treatment

As an aid to the prevention from attack by subterranean termites, placements of **SENSIBLE/SUBTERFUGE termite bait** can be established in the soil around the exterior of the building or structure* to be protected. For preventative treatments, install at least one bait station for every 10 linear feet along the foundation, or if soil access is restricted by paving or similar hard surface, place as close as possible to adjacent bait station. **SENSIBLE/SUBTERFUGE** may also be established in the soil beneath concrete slabs, asphalt, paving stones, or other ground coverings. Inspect bait within one month following installation. Following the initial inspection monitor and service bait placements at least once every three months. During winter months in geographic areas north of U.S. Interstate 80, monitoring and servicing of bait placements can be extended to at least once every 4 months. If active termite feeding is found upon either the initial or subsequent inspections then it is recommended that at least one additional termite bait be placed within 12 inches of each bait found to have termites present, where soil access is not restricted, otherwise place as close as possible, and continue to follow the monitoring schedule previously described. If after 2 consecutive monitoring periods, no termite activity is detected in **SENSIBLE/SUBTERFUGE termite bait,** then the bait may be replaced with monitoring devices. Once termite activity on a monitoring device is detected, replace the monitoring device with **SENSIBLE/SUBTERFUGE termite bait**. Install an additional **SENSIBLE/SUBTERFUGE termite bait** station within 12 inches of any station with active termites.

* Application sites for **SENSIBLE/SUBTERFUGE termite bait** include, but are not limited to, areas near structures (houses, condominiums, apartments, commercial properties, garages, barns and other buildings), decks, wells, fences, utility poles, retaining walls, trees, landscape plantings, wood piles, or other wood which could be attacked, or is actively being attacked, by subterranean termites.

Do not apply repellent type liquid termiticides around the perimeter of SENSIBLE/SUBTERFUGE termite bait that has been previously installed. Applications of this type with repellent liquid termiticides can prevent termites from discovering and feeding on the bait.

SENSIBLE/SUBTERFUGE termite bait may also be used in areas conducive to termite foraging activity such as areas where the soil remains damp (e.g. near sprinkler heads or gutter downspouts) or areas where wood is in contact with soil.

After baiting the sites above, additional baits may be located in areas of likely termite activity where no termites were detected.

Install as many **SENSIBLE/SUBTERFUGE termite baits** as needed to thoroughly cover all sites of known or suspected termite activity around the structure to be protected.

SENSIBLE/SUBTERFUGE termite bait can be applied in the in-ground bait delivery stations provided with this termite bait or in other compatible in-ground termite bait delivery stations. Termatrol[1] termite bait stations are compatible for use with SENSIBLE/SUBTERFUGE termite bait. Other termite bait delivery stations must be tested by the Pest Management Professional for compatibility prior to use to confirm that termites have direct access to the SENSIBLE/SUBTERFUGE termite bait from the soil through the delivery station. Read and understand the manufacturer's instructions for installing and operating their termite bait station. If SENSIBLE/SUBTERFUGE is to be installed through cored openings in paved or similar hard surfaces the bait cartridge may be placed into the ground with or without an in-ground bait delivery station as long as the cored opening is securely covered to prevent unauthorized access. If no station is used then the cartridge must be installed so that the outside surface of the bait cartridge is flush with the soil allowing for termite access to the bait.

Monitoring and Servicing Instructions

It is important to maintain the supply of **SENSIBLE/SUBTERFUGE termite bait** in the bait stations at all times. For this reason it is recommended to inspect each termite bait within one month following installation. Following the initial inspection, monitor and service bait placements at least once every three months. During winter months in geographic areas north of U.S. Interstate 80, monitoring and servicing of bait placements can be extended to at least once every 4 months. This is done to assess the level of termite activity and consumption of **SENSIBLE/SUBTERFUGE termite bait.** If active termite feeding is found upon either the initial or subsequent inspections then it is recommended that at least one additional termite bait be placed within 12 inches of each bait found to have termites present, where soil access is not restricted, otherwise place as close as possible, and continue to follow the monitoring schedule previously described. In areas of high termite activity, bait availability may need to be monitored more frequently as termites can rapidly deplete the bait supply when recruitment is high. If after 2 consecutive monitoring periods, no termite activity is detected in **SENSIBLE/SUBTERFUGE termite bait,** then the bait may be replaced with monitoring devices. Once termite activity on a monitoring device is detected, replace the monitoring device with **SENSIBLE/SUBTERFUGE termite bait.** Install an additional **SENSIBLE/SUBTERFUGE termite bait** station within 12 inches of any station with active termites.

When inspecting the bait installations for termite activity, visually estimate the amount of bait that has been consumed since the previous inspection. When termites have consumed approximately 50% or more of the **SENSIBLE/SUBTERFUGE termite bait** in any installation, that bait must be replaced with a new **SENSIBLE/SUBTERFUGE termite bait.** It may be desirable to increase the number of bait installations in the immediate vicinity of baits which are being heavily fed upon; this will increase the amount of bait available to the colony and can hasten control.

After no new evidence of activity has been observed during 2 consecutive monitoring periods, either **SENSIBLE/SUBTERFUGE termite bait** or monitoring devices can remain in place to preserve long-term population control, or to detect the presence of new or persistent infestations in an on-going monitoring program. Inspections should follow the preventative treatment instructions outlined in this label. In a long-term preventative

program, fresh baits may be installed at approximately seven months following installation or when the bait has been compromised by other insects or normal decay. If termite activity is discovered in the structure being protected during the long-term monitoring, then the instructions for use as a supplemental or remedial treatment and/or other control measures must be initiated.

DISCLAIMER

The label instructions for the use of this product reflect the opinion of experts based on field use and tests. The directions are believed to be reliable and should be followed carefully. However, it is impossible to eliminate all risks inherently associated with use of this product. Ineffectiveness or other unintended consequences may result because of such factors as weather conditions, presence of other materials, or the use or application of the product contrary to label instructions all of which are beyond the control of BASF Corporation (BASF). All such risks shall be assumed by the user. BASF warrants only that the material contained herein conforms to the chemical description on the label and is reasonably fit for the use therein described when used in accordance with the directions for use, subject to the risks referred to above.

Any damages arising from a breach of this warranty shall be limited to direct damages and shall not include consequential commercial damages such as loss of profits or values or any other special or indirect damages.

BASF makes no other express or implied warranty, including any other express or implied warranty of FITNESS or of MERCHANTABILITY.

BASF Corporation
26 Davis Drive
Research Triangle Park, NC 27709

BASF

™ Trademark of BASF

[1] Trademark of Sector Diagnostics and the Whitmire Micro-Gen

NVA 2003-04-161-0152

4/7

NOTIFICATION

JUN 19 2009

Drexel

Boric Acid

Powder Technical

NOT FOR FOOD OR DRUG USE
FOR MANUFACTURING USE ONLY

ACTIVE INGREDIENT:

Boric acid 100.00%

KEEP OUT OF REACH OF CHILDREN

CAUTION

See FIRST AID Below

EPA Reg. No. 19713-519
EPA Est. No. 19713-XX-XXX **Net Content:** _____

FIRST AID

IF SWALLOWED:
- Call a poison control center or doctor immediately for treatment advice.
- Have person sip a glass of water if able to swallow.
- Do not induce vomiting unless told to do so by a poison control center or doctor
- Do not give anything by mouth to an unconscious or convulsing person.

IF IN EYES:
- Hold eye open and rinse slowly and gently with water for 15 to 20 minutes.
- Remove contact lenses, if present, after the first 5 minutes, then continue rinsing eye.
- Call a poison control center or doctor for treatment advice.

IF ON SKIN OR CLOTHING:
- Take off contaminated clothing.
- Rinse skin immediately with plenty of water for 15 to 20 minutes.
- Call a poison control center or doctor for treatment advice.

IF INHALED:
- Move person to fresh air.
- If person is not breathing, call 911 or an ambulance, then give artificial respiration, preferably mouth-to-mouth, if possible.
- Call a poison control center or doctor for further treatment advice.

Have the product container or label with you when calling a poison control center or doctor, or going for treatment. For information on this pesticide product (including health concerns, medical emergencies or pesticide incidents), call the National Pesticide Information Center at 1-800-858-7378.

PRECAUTIONARY STATEMENTS

Hazards to Humans and Domestic Animals

CAUTION: Causes irritation. Harmful if swallowed or absorbed through damaged skin. Avoid contact with eyes, skin and clothing. Avoid breathing dust. Use with adequate ventilation. Keep container closed. Wash thoroughly after handling. Avoid contamination of feed and food. Good housekeeping practices are important. Product should not be allowed to accumulate in equipment.

ENVIRONMENTAL HAZARDS

Do not discharge effluent containing this product into lakes, streams, ponds, estuaries, oceans or other waters unless in accordance with the requirements of a National Pollutant Discharge Elimination System (NPDES) permit and the permitting authority has been notified in writing prior to discharge. Do not discharge effluent containing this product to sewer systems without previously notifying the local sewage treatment plant authority.

For guidance, contact your State Water Board or Regional Office of the EPA.

USE INFORMATION

Formulators and repackagers using this product are responsible for obtaining Environmental Protection Agency (EPA) registration for their products.

DIRECTIONS FOR USE

It is a violation of Federal law to use this product in a manner inconsistent with its labeling.

This product is a soluble inorganic powder which may be used for the formulation of products for the following registered end-use patterns:
- Algaecides for water treatment in swimming pools;
- Bacteriostats for use in impregnating absorbent material to inhibit the growth of odor-causing bacteria when applied at a rate of approximately equivalent to 0.036% w/w equivalent boron;
- Insecticides for mop, spot, crack and crevice treatment in homes, residential, industrial, institutional and commercial buildings and in transportation equipment;
- Insecticides/fungicides for wood treatment.

This product may be used to formulate products for specific use(s) not listed on this label if the formulator, user group, or grower has complied with U.S. EPA data submission requirements regarding the support of such use(s).

STORAGE AND DISPOSAL

Do not contaminate water, food or feed by storage and disposal.

PESTICIDE STORAGE: Store in cool, dry area away from heat.

PESTICIDE DISPOSAL: Wastes resulting from the use of this product may be disposed of on site or at an approved waste disposal facility.

CONTAINER DISPOSAL:

Nonrefillable Container (flexible-bag-all weights): Nonrefillable container. Do not reuse or refill this container. Offer for recycling, if available. Dispose of empty container in a sanitary landfill or by incineration, or, if allowed by State and local authorities, by burning. If burned, stay out of smoke.

Nonrefillable Container (rigid-fifty lbs. or less): Nonrefillable container. Do not reuse or refill this container. Offer for recycling, if available. Clean container promptly after emptying. Triple rinse as follows: Empty the remaining contents into a mix tank. Fill the container one-fourth full with water and recap. Shake for 10 seconds. Pour rinsate into a mix tank or store rinsate for later use or disposal. Drain for 10 seconds after the flow begins to drip. Repeat this procedure two more times. Dispose of empty container in a sanitary landfill or by incineration, or, if allowed by State and local authorities, by burning. If burned, stay out of smoke.

(Continued)

STORAGE AND DISPOSAL *(Cont'd.)*

Nonrefillable Container (rigid-greater than fifty lbs.): Nonrefillable container. Do not reuse or refill this container. Offer for recycling, if available. Clean container promptly after emptying. Triple rinse as follows: Empty the remaining contents into a mix tank. Fill the container one-fourth full with water. Replace and tighten closures. Tip container on its side and roll it back and forth, ensuring at least one complete revolution, for 30 seconds. Stand the container on its end and tip it back and forth several times. Turn the container over onto its other end and tip it back and forth several times. Empty the rinsate into a mix tank or store rinsate for later use or disposal. Repeat this procedure two more times. Dispose of empty container in a sanitary landfill or by incineration, or, if allowed by State and local authorities, by burning. If burned, stay out of smoke.

Refillable Container: Refillable container. Refill this container with this product only. Do not reuse this container for any other purpose. Cleaning the container before final disposal is the responsibility of the person disposing of the container. Cleaning before refilling is the responsibility of the refiller. To clean the container before final disposal, empty the remaining contents from this container into a mix tank. Fill the container about 10 percent full with water. Agitate vigorously or recirculate water with the pump for 2 minutes. Pour or pump rinsate into a mix tank or rinsate collection system. Repeat this rinsing procedure two more times.

WARRANTY—CONDITIONS OF SALE

Manufacturer warrants that this product conforms to its chemical description and is reasonably fit for the purposes referred to in the directions for use. Manufacturer makes no other warranties, express or implied, including FITNESS or MERCHANTABILITY. To the extent consistent with applicable law, in no case shall Manufacturer or the Seller be liable for consequential, special or indirect damages resulting from the use or handling of this product. To the extent consistent with applicable law, the foregoing is a condition of sale and is accepted as such by the Buyer.

Manufactured By:
Drexel Chemical Company
P.O. BOX 13327, MEMPHIS, TN 38113-0327
SINCE 1972

NOTIFICATION
JUN 19 2009

SPECIMEN LABEL

MAXFORCE®

PROFESSIONAL INSECT CONTROL® GRANULAR INSECT BAIT

SPECIMEN LABEL

GRANULAR INSECT BAIT (10 oz.)

FOR CONTROL OF ANTS, ROACHES[1] AND CRICKETS
FOR USE IN AND AROUND STRUCTURES AND RESIDENTIAL AREAS
RECOMMENDED FOR USE BY COMMERCIAL APPLICATORS

ACTIVE INGREDIENT:

Hydramethylnon [Tetrahydro-5,5-dimethyl-2(1*H*)-pyrimidinone, (3-(4-(trifluoromethyl) phenyl)-1-(2-(4-(trifluoromethyl) phenyl) ethenyl)-2-propenylidene)hydrazone]	1.0%
Other Ingredients:	99.0%
TOTAL:	100%

KEEP OUT OF REACH OF CHILDREN

CAUTION: SEE BELOW FOR ADDITIONAL PRECAUTIONARY STATEMENTS

For more information, call: 1-800-331-2867.

PRECAUTIONARY STATEMENTS:

CAUTION: HAZARDS TO HUMANS: May be harmful if swallowed. Avoid contact with skin or eyes. Applicator should wear gloves and wash hands thoroughly after handling.

FIRST AID: If swallowed, drink one or two glasses of water and induce vomiting by touching back of throat with finger. Do not induce vomiting or give anything by mouth to an unconscious person. Get medical attention. For more information, call: 1-800-334-7577.

HAZARDS TO ANIMALS: Store in a secure place. Pets may be attracted to this product. Keep pets away from treated areas for at least 24 hours after application.

ENVIRONMENTAL HAZARDS

This product is toxic to fish. Do not apply directly to water. Do not contaminate water by cleaning of equipment or disposal of equipment washwaters.

STORAGE AND DISPOSAL: Store in a cool, dry, secure place. Keep container closed when not in use. Avoid contamination from other insecticides. Do not contaminate water, food or feed by storage or disposal. Do not reuse empty container for any use other than this product. Wrap empty container and place in trash can.

-or-

STORAGE AND DISPOSAL

Do not contaminate water, food or feed by storage and disposal. **Storage:** Store in a cool, dry area out of reach of children or domestic animals. Keep container closed when not in use. Avoid contamination from other insecticides. **Disposal:** Triple rinse (or equivalent). Then offer for recycling or reconditioning, or puncture and dispose of in a sanitary landfill, or incineration, or if allowed by state and local authorities, by burning. If burned, stay out of smoke.

GENERAL INFORMATION

This product is a ready-to-use product for use indoors and outdoors; around buildings, on lawns, and other non-crop areas* such as residential areas, the non-food/non-feed areas of institutional and commercial establishments including warehouses, restaurants, food processing plants, supermarkets, hospitals, nursing homes, motels, hotels, apartment buildings, schools, laboratories, computer facilities, pet shops, zoos, sewers, highway rights-of-way and medians, traffic islands, utility rights-of-way (including: powerlines, pipelines, aqueducts), managed turf areas (non-crop*) (including: school yards, playgrounds, athletic fields, amusement parks, picnic areas, recreation areas, office parks, industrial grounds, airports, shopping centers, public parks, arboretums, public gardens, monument sites, cemeteries and mausoleums, golf courses, race tracks, fairgrounds, outdoor amphitheaters, sod farms, and ornamental nurseries). The use of this product on pasture and rangeland is unlawful. Do not graze or feed lawn or sod clippings to livestock. This patented formula contains a special blend of foods, combined with the delayed-action stomach poison, hydramethylnon. The delayed action of the active ingredient allows foraging ants to bring the bait back to the nest so that the entire colony, including the queen, is destroyed. When properly used, this bait will control many of the following insects, including ants, cockroaches, crickets, silverfish, before they can enter a structure. Do not apply other insecticides (such as aerosols, sprays, etc.) on top of or in close proximity to this product, as it will reduce the effectiveness. You should -or- Expect to see fewer ants -or- insects -or- roaches -or- crickets within a week.

This product's bulk container may be used on the job site or to refill the MAXFORCE Granular Insect Bait 10 oz service container. The bulk container will refill approximately 10 service containers. Reuse only those service containers with current and legible labels.

DIRECTIONS FOR USE:

It is a violation of Federal law to use this product in a manner inconsistent with its labeling.

FOR OUTDOOR USE:

1. AROUND STRUCTURES: This product may be sprinkled around structures and/or applied to refillable/serviceable bait stations as outlined below. Note: Around structures the total application should not exceed 4-8 oz per 200-400 linear feet (or 0.5 oz per 25 linear feet). Sprinkle evenly in a 1-2 foot wide band adjacent to the structure at a rate of 0.5 oz (one tablespoon) of bait per 25 linear feet. A typical application would be 4-8 oz adjacent to an average sized home of 200-400 linear feet. Be sure to treat areas such as porches, patios, driveways, sidewalks, flower gardens, landscape timbers and around trees, wood piles, air conditioning units and garbage receptacles. DO NOT USE ON EDIBLE FOOD CROPS OR ON AREAS INTENDED FOR EDIBLE FOOD CROP PRODUCTION. Treat visible ant trails, as well as cracks or crevices, where insects (ants, roaches, crickets) may enter a structure.

   Refillable Stations: This product may be used in the Maxforce Refillable Bait Stations or B&G Perimeter Patrol Station. Place 1 to 3 oz (2 to 6 Tbsp.) of granular bait per station. Refillable stations should be placed every 20 to 30 feet around the perimeter of a structure. Use approximately 2 stations per side of a typical single family home.

   For best results, place stations near: air conditioning units, water faucets, foundation vents and weep holes, decks, utility entryways (e.g. electrical, cable TV) and wherever target pests are frequently found. Stations may also be placed along fence lines and property lines to intercept foraging pests.

   Regularly inspect all stations and replace bait as needed for continual control.

   Position Refillable Bait Stations in areas where they will not be damaged by lawn equipment such as mowers and trimmers. When placing the station in turf remove sod layer and place station base plate against the soil. Screw the anchor tube into the ground and lock station lid so bait is not easily accessible to children and pets. If the station is not equipped with a sticker to identify the contents, apply a sticker to the outside or inside of the station.
2. **BROADCAST APPLICATION:** Broadcast this product uniformly at a rate of up to 1 oz per 1800 square feet.
3. **FIRE ANTS AND OTHER MOUND BUILDING ANTS (Pavement, Fire, Harvester, Field and Cornfield):** Sprinkle approximately two tablespoons (1 oz) of bait around each mound. For best results, do not apply bait directly in or on the mound. Do not disturb the mound. Ants that are agitated may not feed on the bait.

FOR INDOOR USE: AVOID CONTAMINATION OF FOOD, FOOD CONTACT SURFACES AND FEEDSTUFFS.

NOTE: Indoor applications are limited to areas that are inaccessible to children or pets, such as cracks, crevices, wall voids, unfinished attics, crawl spaces and behind electrical switch plates, within residential and non-residential buildings or structures and within non-food/non-feed areas of industrial, institutional, and commercial buildings as outlined below.

Apply up to 0.5 oz (one tablespoon) of bait per crack, crevice or other inaccessible areas where insects may hide or live. Apply product using suitable application equipment (such as the Centro BaitMaster). Recover -or- Clean up -or- Wipe up any loose or excess granules. Apply evenly in unfinished attics and crawl spaces at a rate of 0.5 ounces per 100 square feet only if the space is secured or otherwise inaccessible to children and domestic animals

TOTAL NET WEIGHT 10 OZ. (283.5 kg.)

Bayer Environmental Science
A Business Group of Bayer CropScience LP
95 Chestnut Ridge Road, Montvale, New Jersey 07645

EPA Reg. No. 432-1255
EPA Est. No. 39578-TX-01

* Do not use on other non-crop areas in California.

[1] German, American, Oriental, and Smokybrown roaches
[2] Native and Imported.
[3] Pavement, Field, Cornfield, and Harvester ants

MAXFORCE

U.S. Patent Nos. 4,353,907; 4,657,912 and other patents pending.

Revised 1/03

Appendix C: Invasive and Nonnative Plant Management Actions by HMU on Wake Atoll

THIS PAGE INTENTIONALLY LEFT BLANK

Wake Atoll Invasive and Nonnative Plants Management Actions by HMU

HMU	Invasive Vegetation Species	Approximate Percent Cover	Recommended Management Action	Approximate Labor Hours	Approximate Labor and Cost	Priority
HMU-1	-					
HMU-2	*Casuarina equisetifolia*	20% (approx. 10% previously treated) of 26.58 acres	Frill-girdle (hack and squirt) application of triclopyr ester mixture (Garlon 4 mixture*) in new untreated areas. Re-application of chemical treatment (frill-girdle application of Garlon 4 mixture*) where needed in previously treated areas. Foliar application of the triclopyr ester mixture (Garlon 4 mixture*) on seedlings/saplings as needed following the initial treatment. Hand removal of seedlings where appropriate.	6 hours for chemical treatment. 3 hours for chemical treatment in previously treated area. 4 hours at 6-12 months to control seedlings/ saplings.	Chem Labor: $180.00 Chemical: $1,963.50 Chem Labor (at 6-12 months for seedlings): $80.00 Chemical: $491.00 Total: $2,714.50	0
HMU-3	*Casuarina equisetifolia*	10% of 22.02 acres	Frill-girdle (hack and squirt) application of triclopyr ester mixture (Garlon 4 mixture*). Foliar application of the triclopyr ester mixture (Garlon 4 mixture*) on seedlings/saplings as needed following the initial treatment. Hand removal of seedlings where appropriate.	5 hours for chemical treatment. 2.5 hours at 6-12 months to control seedlings/ saplings.	Chem Labor: $100.00 Chemical: $785.40 Chem Labor (at 6–12 months for seedlings): $50.00 Chemical: $197.00 Total: $1,133.00	0

Wake Atoll Invasive and Nonnative Plants Management Actions by HMU

HMU	Invasive Vegetation Species	Approximate Percent Cover	Recommended Management Action	Approximate Labor Hours	Approximate Labor and Cost	Priority
HMU-4	*Casuarina equisetifolia*	30% of 18.66 acres	See HMU-3.	14 hours for chemical treatment. 7 hours at 6-12 months to control seedlings/ saplings.	Chem Labor: $280.00 Chemical: $2,142.00 Chem Labor (at 6-12 months for seedlings): $140.00 Chemical: $536.00 Total: $3,098.00	0
HMU-5	*Casuarina equisetifolia*	70% of 21.14 acres	See HMU-3.	30 hours for chemical treatment. 15 hours at 6-12 months to control seedlings/ saplings.	Chem Labor: $600.00 Chemical: $5,355.00 Chem Labor (at 6-12 months for seedlings): $300.00 Chemical: $1,339.00 Total: $7,594.00	0
HMU-6	*Casuarina equisetifolia*	75% of 13.31 acres	See HMU-3.	20 hours for chemical treatment. 10 hours at 6-12 months to control seedlings/ saplings.	Chem Labor: $400.00 Chemical: $3,570.00 Chem Labor (at 6-12 months for seedlings): $200.00 Chemical: $893.00 Total: $5,063.00	0
HMU-7	-					

Wake Atoll Invasive and Nonnative Plants Management Actions by HMU

HMU	Invasive Vegetation Species	Approximate Percent Cover	Recommended Management Action	Approximate Labor Hours	Approximate Labor and Cost	Priority
HMU-8	*Casuarina equisetifolia*	65% of 5.61 acres	See HMU-3.	8 hours for chemical treatment. 4 hours at 6-12 months to control seedlings/ saplings.	Chem Labor: $160.00 Chemical: $1,428.00 Chem Labor (at 6-12 months for seedlings): $80.00 Chemical: $357.00 Total: $2,025.00	0
HMU-9	*Casuarina equisetifolia*	70% of 4.03 acres	See HMU-3.	6 hours for chemical treatment. 3 hours at 6-12 months to control seedlings/ saplings.	Chem Labor: $120.00 Chemical: $1,071.00 Chem Labor (at 6-12 months for seedlings): $60.00 Chemical: $268.00 Total: $1,519.00	0
	Leucaena leucocephala	15% of 4.03 acres	Foliar application of triclopyr, or basal bark applications of triclopyr ester mixture (Garlon 4 mixture*). Foliar application of triclopyr on seedlings/saplings as needed following the initial treatment. Hand removal of seedlings where appropriate.	2 hours for chemical treatment. 1 hour at 6-12 months to control seedlings/ saplings.	Chem Labor: $40.00 Chemical: $357.00 Chem Labor (at 6-12 months for seedlings): $20.00 Chemical: $90.00 Total: $507.00	0

Wake Atoll Invasive and Nonnative Plants Management Actions by HMU

HMU	Invasive Vegetation Species	Approximate Percent Cover	Recommended Management Action	Approximate Labor Hours	Approximate Labor and Cost	Priority
HMU-10	*Casuarina equisetifolia*	20% of 59.67 acres	See HMU-3.	24 hours for chemical treatment. 12 hours at 6-12 months to control seedlings/ saplings.	Chem Labor: $960.00 Chemical: $4,284.00 Chem Labor (at 6-12 months for seedlings): $480.00 Chemical: $1,071.00 Total: $6,795.00	0
	Leucaena leucocephala	10% of 59.67 acres	Foliar application of triclopyr, or basal bark applications of triclopyr ester mixture (Garlon 4 mixture*) on larger shrubs. Foliar application of triclopyr on seedlings/saplings as needed following the initial treatment. Continued regular mowing in clear zone and maintained mowed areas.	12 hours for chemical treatment. 6 hours at 6-12 months to control seedlings/ saplings. Regularly mowed areas are maintained by the BOS contractor. Mowing regime should be frequent enough to preclude seed development.	Chem Labor: $240.00 Chemical: $2,142.00 Chem Labor (at 6-12 months for seedlings): $120.00 Chemical: $536.00 Total: $3,038	0
HMU-11	*Casuarina equisetifolia*	2% of 32.23 acres	See HMU-3.	2 hours for chemical treatment. 1 hour at 6-12 months to control seedlings/ saplings.	Chem Labor: $40.00 Chemical: $357.00 Chem Labor (at 6-12 months for seedlings): $20.00 Chemical: $90.00 Total: $507.00	0

Wake Atoll Invasive and Nonnative Plants Management Actions by HMU

HMU	Invasive Vegetation Species	Approximate Percent Cover	Recommended Management Action	Approximate Labor Hours	Approximate Labor and Cost	Priority
HMU-12	*Leucaena leucocephala*	3% of 32.23 acres	See HMU-9.	2 hours for chemical treatment. 1 hour at 6-12 months to control seedlings/ saplings.	Chem Labor: $40.00 Chemical: $357.00 Chem Labor (at 6-12 months for seedlings): $20.00 Chemical: $90.00 Total: $507.00	0
	Casuarina equisetifolia	3% of 30.03 acres	See HMU-3.	2 hours for chemical treatment. 1 hour at 6-12 months to control seedlings/ saplings.	Chem Labor: $40.00 Chemical: $357.00 Chem Labor (at 6-12 months for seedlings): $20.00 Chemical: $90.00 Total: $507.00	0
	Leucaena leucocephala	3% of 30.03 acres	See HMU-9.	2 hours for chemical treatment. 1 hour at 6-12 months to control seedlings/ saplings.	Chem Labor: $40.00 Chemical: $357.00 Chem Labor (at 6-12 months for seedlings): $20.00 Chemical: $90.00 Total: $507.00	0

Wake Atoll Invasive and Nonnative Plants Management Actions by HMU

HMU	Invasive Vegetation Species	Approximate Percent Cover	Recommended Management Action	Approximate Labor Hours	Approximate Labor and Cost	Priority
HMU-13	*Casuarina equisetifolia*	30% of 18.43 acres	See HMU-3.	11 hours for chemical treatment. 6 hours at 6-12 months to control seedlings/ saplings.	Chem Labor: $220.00 Chemical: $1,964.00 Chem Labor (at 6-12 months for seedlings): $120.00 Chemical: $491.00 Total: $2,795.00	0
HMU-14	*Casuarina equisetifolia*	85% of 18.7 acres	See HMU-3.	32 hours for chemical treatment. 16 hours at 6-12 months to control seedlings/ saplings.	Chem Labor: $640.00 Chemical: $5,712.00 Chem Labor (at 6-12 months for seedlings): $320.00 Chemical: $1,428.00 Total: $8,100.00	0
HMU-15	*Casuarina equisetifolia*	25% of 12.4 acres	See HMU-3.	6 hours for chemical treatment. 3 hours at 6-12 months to control seedlings/ saplings.	Chem Labor: $120.00 Chemical: $1,071.00 Chem Labor (at 6-12 months for seedlings): $60.00 Chemical: $268.00 Total: $1,518.00	0

Wake Atoll Invasive and Nonnative Plants Management Actions by HMU

HMU	Invasive Vegetation Species	Approximate Percent Cover	Recommended Management Action	Approximate Labor Hours	Approximate Labor and Cost	Priority
HMU-16	*Casuarina equisetifolia*	65% of 36.17 acres	See HMU-3.	47 hours for chemical treatment. 24 hours at 6-12 months to control seedlings/ saplings.	Chem Labor: $940.00 Chemical: $8,390.00 Chem Labor (at 6-12 months for seedlings): $470.00 Chemical: $2,098.00 Total: $11,898.00	0
HMU-17	*Casuarina equisetifolia* (saplings)	2% of 5.4 acres	See HMU-3.	1 hour for chemical treatment. 1 hour at 6-12 months to control seedlings/ saplings.	Chem Labor: $20.00 Chemical: $357.00 Chem Labor (at 6-12 months for seedlings): $20.00 Chemical: $90.00 Total: $487.00	0
HMU-18	*Casuarina equisetifolia*	<1% of 12.49 acres	See HMU-3.	1 hour for chemical treatment. 1 hour at 6-12 months to control seedlings/ saplings.	Chem Labor: $20.00 Chemical: $357.00 Chem Labor (at 6-12 months for seedlings): $20.00 Chemical: $90.00 Total: $487.00	0

Wake Atoll Invasive and Nonnative Plants Management Actions by HMU

HMU	Invasive Vegetation Species	Approximate Percent Cover	Recommended Management Action	Approximate Labor Hours	Approximate Labor and Cost	Priority
HMU-19	*Casuarina equisetifolia*	20% of 10.82 acres	See HMU-3.	4 hours for chemical treatment. 2 hours at 6-12 months to control seedlings/ saplings.	Chem Labor: $80.00 Chemical: $1,428.00 Chem Labor (at 6-12 months for seedlings): $40.00 Chemical: $357.00 Total: $1,905.00	0
HMU-20	*Casuarina equisetifolia*	70% of 7.21 acres	See HMU-3.	11 hours for chemical treatment. 6 hours at 6-12 months to control seedlings/ saplings.	Chem Labor: $220.00 Chemical: $1,964.00 Chem Labor (at 6-12 months for seedlings): $120.00 Chemical: $491.00 Total: $2,795.00	0
HMU-21	*Casuarina equisetifolia*	30% of 21.97 acres	See HMU-3.	14 hours for chemical treatment. 7 hours at 6-12 months to control seedlings/ saplings.	Chem Labor: $280.00 Chemical: $2,499.00 Chem Labor (at 6-12 months for seedlings): $140.00 Chemical: $625.00 Total: $3,544.00	0
HMU-22	-					
HMU-23	-					

Wake Atoll Invasive and Nonnative Plants Management Actions by HMU

HMU	Invasive Vegetation Species	Approximate Percent Cover	Recommended Management Action	Approximate Labor Hours	Approximate Labor and Cost	Priority
HMU-24	*Casuarina equisetifolia*	30% of 12.42 acres	See HMU-3.	8 hours for chemical treatment. 4 hours at 6-12 months to control seedlings/ saplings.	Chem Labor: $160.00 Chemical: $1,428.00 Chem Labor (at 6-12 months for seedlings): $80.00 Chemical: $357.00 Total: $2,025.00	0
HMU-25	*Casuarina equisetifolia*	5% of 24.5 acres	See HMU-3.	3 hours for chemical treatment. 1.5 hours at 6-12 months to control seedlings/ saplings.	Chem Labor: $60.00 Chemical: $536.00 Chem Labor (at 6-12 months for seedlings): $30.00 Chemical: $134.00 Total: $760.00	0
HMU-26	-					
HMU-27	*Casuarina equisetifolia* (with tournefortia)	10% of 26.16 acres	See HMU-3.	6 hours for chemical treatment. 3 hours at 6-12 months to control seedlings/ saplings.	Chem Labor: $120.00 Chemical: $1,071.00 Chem Labor (at 6-12 months for seedlings): $60.00 Chemical: $268.00 Total: $1,518.00	0
HMU-28	-					

Wake Atoll Invasive and Nonnative Plants Management Actions by HMU

HMU	Invasive Vegetation Species	Approximate Percent Cover	Recommended Management Action	Approximate Labor Hours	Approximate Labor and Cost	Priority
HMU-29	*Casuarina equisetifolia* (saplings)	2% of 34.38 acres	See HMU-3.	2 hours for chemical treatment. 1 hour at 6-12 months to control seedlings/ saplings.	Chem Labor: $40.00 Chemical: $357.00 Chem Labor (at 6-12 months for seedlings): $20.00 Chemical: $90.00 Total: $507.00	0
HMU-30	*Casuarina equisetifolia*	10% of 16.82 acres	See HMU-3.	34 hours for chemical treatment. 17 hours at 6-12 months to control seedlings/ saplings.	Chem Labor: $680.00 Chemical: $6,069.00 Chem Labor (at 6-12 months for seedlings): $340.00 Chemical: $1,518.00 Total: $8,607.00	0
HMU-31	*Casuarina equisetifolia*	20% of 37.68 acres	See HMU-3.	15 hours for chemical treatment. 7.5 hours at 6-12 months to control seedlings/ saplings.	Chem Labor: $300.00 Chemical: $2,678.00 Chem Labor (at 6-12 months for seedlings): $150.00 Chemical: $670.00 Total: $3,798.00	0

Wake Atoll Invasive and Nonnative Plants Management Actions by HMU

HMU	Invasive Vegetation Species	Approximate Percent Cover	Recommended Management Action	Approximate Labor Hours	Approximate Labor and Cost	Priority
HMU-32	*Casuarina equisetifolia*	90% of 4.83 acres	See HMU-3.	9 hours for chemical treatment. 4.5 hours at 6-12 months to control seedlings/ saplings.	Chem Labor: $180.00 Chemical: $1,607.00 Chem Labor (at 6-12 months for seedlings): $90.00 Chemical: $402.00 Total: $2,279.00	0
HMU-33	*Casuarina equisetifolia*	10% of 30.37 acres	See HMU-3.	6 hours for chemical treatment. 3 hours at 6-12 months to control seedlings/ saplings.	Chem Labor: $120.00 Chemical: $1,071.00 Chem Labor (at 6-12 months for seedlings): $60.00 Chemical: $268.00 Total: $1,519.00	0
HMU-34	*Casuarina equisetifolia*	30% of 15.47 acres	See HMU-3.	10 hours for chemical treatment. 5 hours at 6-12 months to control seedlings/ saplings.	Chem Labor: $200.00 Chemical: $1,785.00 Chem Labor (at 6-12 months for seedlings): $100.00 Chemical: $447.00 Total: $2,532.00	0

Wake Atoll Invasive and Nonnative Plants Management Actions by HMU

HMU	Invasive Vegetation Species	Approximate Percent Cover	Recommended Management Action	Approximate Labor Hours	Approximate Labor and Cost	Priority
HMU-35	*Casuarina equisetifolia*	80% of 14.16 acres	See HMU-3.	23 hours for chemical treatment. 11.5 hours at 6-12 months to control seedlings/ saplings.	Chem Labor: $460.00 Chemical: $4,106.00 Chem Labor (at 6-12 months for seedlings): $230.00 Chemical: $1,027.00 Total: $5,823.00	0
HMU-36	*Casuarina equisetifolia*	75% of 3.01 acres	See HMU-3.	5 hours for chemical treatment. 2.5 hours at 6-12 months to control seedlings/ saplings.	Chem Labor: $100.00 Chemical: $893.00 Chem Labor (at 6-12 months for seedlings): $50.00 Chemical: $224.00 Total: $1,267.00	0
HMU-37	*Casuarina equisetifolia*	85% of 6.52	See HMU-3.	11hours for chemical treatment. 5.5 hours at 6-12 months to control seedlings/ saplings.	Chem Labor: $220.00 Chemical: $1,964.00 Chem Labor (at 6-12 months for seedlings): $110.00 Chemical: $491.00 Total: $2,785.00	0

Wake Atoll Invasive and Nonnative Plants Management Actions by HMU

HMU	Invasive Vegetation Species	Approximate Percent Cover	Recommended Management Action	Approximate Labor Hours	Approximate Labor and Cost	Priority
HMU-38	*Casuarina equisetifolia*	95% of 9.57 acres	See HMU-3.	18 hours for chemical treatment. 9 hours at 6-12 months to control seedlings/ saplings.	Chem Labor: $360.00 Chemical: $3,213.00 Chem Labor (at 6-12 months for seedlings): $180.00 Chemical: $804.00 Total: $4,557.00	0
HMU-39	*Casuarina equisetifolia*	75% of 18.31 acres	See HMU-3.	28 hours for chemical treatment. 14 hours at 6-12 months to control seedlings/ saplings.	Chem Labor: $560.00 Chemical: $4,998.00 Chem Labor (at 6-12 months for seedlings): $280.00 Chemical: $1,250.00 Total: $7,088.00	0
HMU-40	*Casuarina equisetifolia*	5% of 14.62 acres	See HMU-3.	2 hours for chemical treatment. 1 hour at 6-12 months to control seedlings/ saplings.	Chem Labor: $40.00 Chemical: $357.00 Chem Labor (at 6-12 months for seedlings): $20.00 Chemical: $90.00 Total: $507.00	0

Wake Atoll Invasive and Nonnative Plants Management Actions by HMU

HMU	Invasive Vegetation Species	Approximate Percent Cover	Recommended Management Action	Approximate Labor Hours	Approximate Labor and Cost	Priority
HMU-41	*Casuarina equisetifolia*	2% of 4.45 acres	See HMU-3.	1 hour for chemical treatment. 1 hour at 6-12 months to control seedlings/ saplings.	Chem Labor: $20.00 Chemical: $357.00 Chem Labor (at 6-12 months for seedlings): $20.00 Chemical: $90.00 Total: $487.00	0
	Leucaena leucocephala	2% of 4.45 acres	See HMU-9.	1 hour for chemical treatment. 1 hour at 6-12 months to control seedlings/ saplings.	Chem Labor: $20.00 Chemical: $357.00 Chem Labor (at 6-12 months for seedlings): $20.00 Chemical: $90.00 Total: $487.00	0
HMU-42	*Casuarina equisetifolia*	5% of 43.06 acres	See HMU-3.	4 hours for chemical treatment. 2 hours at 6-12 months to control seedlings/ saplings.	Chem Labor: $80.00 Chemical: $1,428.00 Chem Labor (at 6-12 months for seedlings): $40.00 Chemical: $357.00 Total: $1,905.00	0

Wake Atoll Invasive and Nonnative Plants Management Actions by HMU

HMU	Invasive Vegetation Species	Approximate Percent Cover	Recommended Management Action	Approximate Labor Hours	Approximate Labor and Cost	Priority
HMU-43	*Casuarina equisetifolia*	75% of 3.37 acres	See HMU-3.	5 hours for chemical treatment. 2.5 hours at 6-12 months to control seedlings/ saplings.	Chem Labor: $100.00 Chemical: $893.00 Chem Labor (at 6-12 months for seedlings): $50.00 Chemical: $224.00 Total: $1,267.00	0
HMU-44	*Casuarina equisetifolia*	50% of 3.41 acres	See HMU-3.	4 hours for chemical treatment. 2 hours at 6-12 months to control seedlings/ saplings.	Chem Labor: $80.00 Chemical: $1,428.00 Chem Labor (at 6-12 months for seedlings): $40.00 Chemical: $357.00 Total: $1,905.00	0
HMU-45	*Casuarina equisetifolia*	100% of 3.27 acres	See HMU-3.	7 hours for chemical treatment. 3.5 hours at 6-12 months to control seedlings/ saplings.	Chem Labor: $140.00 Chemical: $1,250.00 Chem Labor (at 6-12 months for seedlings): $70.00 Chemical: $313.00 Total: $1,773.00	0

Wake Atoll Invasive and Nonnative Plants Management Actions by HMU

HMU	Invasive Vegetation Species	Approximate Percent Cover	Recommended Management Action	Approximate Labor Hours	Approximate Labor and Cost	Priority
HMU-46	*Casuarina equisetifolia*	85% of 3.28 acres	See HMU-3.	6 hours for chemical treatment. 3 hours at 6-12 months to control seedlings/ saplings.	Chem Labor: $120.00 Chemical: $1,071.00 Chem Labor (at 6-12 months for seedlings): $60.00 Chemical: $268.00 Total: $1,519.00	0
HMU-47	*Casuarina equisetifolia* (mixed forest)	100% of 4.81 acres	See HMU-3.	10 hours for chemical treatment. 5 hours at 6-12 months to control seedlings/ saplings.	Chem Labor: $100.00 Chemical: $1,785.00 Chem Labor (at 6-12 months for seedlings): $50.00 Chemical: $447.00 Total: $2,382.00	0
HMU-48	*Casuarina equisetifolia*	85% of 5.22 acres	See HMU-3.	9 hours for chemical treatment. 4.5 hours at 6-12 months to control seedlings/ saplings.	Chem Labor: $180.00 Chemical: $1,607.00 Chem Labor (at 6-12 months for seedlings): $90.00 Chemical: $402.00 Total: $2,297.00	0

Wake Atoll Invasive and Nonnative Plants Management Actions by HMU

HMU	Invasive Vegetation Species	Approximate Percent Cover	Recommended Management Action	Approximate Labor Hours	Approximate Labor and Cost	Priority
HMU-49	*Casuarina equisetifolia*	65% of 13.96 acres	See HMU-3.	18 hours for chemical treatment. 9 hours at 6-12 months to control seedlings/ saplings.	Chem Labor: $360.00 Chemical: $3,213.00 Chem Labor (at 6-12 months for seedlings): $180.00 Chemical: $804.00 Total: $4,557.00	0
HMU-50	*Casuarina equisetifolia*	30% of 29.5 acres	See HMU-3.	18 hours for chemical treatment. 9 hours at 6-12 months to control seedlings/ saplings.	Chem Labor: $360.00 Chemical: $3,213.00 Chem Labor (at 6-12 months for seedlings): $180.00 Chemical: $804.00 Total: $4,557.00	0
HMU-51	*Casuarina equisetifolia*	35% of 43.24 acres	See HMU-3.	30 hours for chemical treatment. 15 hours at 6-12 months to control seedlings/ saplings.	Chem Labor: $600.00 Chemical: $5,355.00 Chem Labor (at 6-12 months for seedlings): $300.00 Chemical: $1,339.00 Total: $7,594.00	0

Wake Atoll Invasive and Nonnative Plants Management Actions by HMU

HMU	Invasive Vegetation Species	Approximate Percent Cover	Recommended Management Action	Approximate Labor Hours	Approximate Labor and Cost	Priority
	Leucaena leucocephala	5% of 43.24 acres	See HMU-9.	5 hours for chemical treatment. 2.5 hours at 6-12 months to control seedlings/ saplings.	Chem Labor: $100.00 Chemical: $893.00 Chem Labor (at 6-12 months for seedlings): $50.00 Chemical: $224.00 Total: $1,267.00	0
HMU-52	*Casuarina equisetifolia*	3% of 45.33 acres	See HMU-3.	3 hours for chemical treatment. 1.5 hours at 6-12 months to control seedlings/ saplings.	Chem Labor: $60.00 Chemical: $536.00 Chem Labor (at 6-12 months for seedlings): $30.00 Chemical: $134.00 Total: $760.00	0
HMU-53	*Casuarina equisetifolia* (mixed with tournefortia)	80% of 10.26 acres	See HMU-3.	17 hours for chemical treatment. 8.5 hours at 6-12 months to control seedlings/ saplings.	Chem Labor: $340.00 Chemical: $3,035.00 Chem Labor (at 6-12 months for seedlings): $170.00 Chemical: $759.00 Total: $4,304.00	0

Wake Atoll Invasive and Nonnative Plants Management Actions by HMU

HMU	Invasive Vegetation Species	Approximate Percent Cover	Recommended Management Action	Approximate Labor Hours	Approximate Labor and Cost	Priority
HMU-54	*Casuarina equisetifolia* (mixed with coastal ruderal scrub and tournefortia)	15% of 8.65 acres	See HMU-3.	3 hours for chemical treatment. 1.5 hours at 6-12 months to control seedlings/ saplings.	Chem Labor: $60.00 Chemical: $536.00 Chem Labor (at 6-12 months for seedlings): $30.00 Chemical: $134.00 Total: $760.00	0
HMU-55	*Casuarina equisetifolia*	35% of 13 acres	See HMU-3.	9 hours for chemical treatment. 4.5 hours at 6-12 months to control seedlings/ saplings.	Chem Labor: $180.00 Chemical: $1,607.00 Chem Labor (at 6-12 months for seedlings): $90.00 Chemical: $402.00 Total: $2,297.00	0
HMU-56	*Casuarina equisetifolia*	60% of 2.9 acres	See HMU-3.	4 hours for chemical treatment. 2 hours at 6-12 months to control seedlings/ saplings.	Chem Labor: $80.00 Chemical: $1,428.00 Chem Labor (at 6-12 months for seedlings): $40.00 Chemical: $357.00 Total: $1,905.00	0

Wake Atoll Invasive and Nonnative Plants Management Actions by HMU

HMU	Invasive Vegetation Species	Approximate Percent Cover	Recommended Management Action	Approximate Labor Hours	Approximate Labor and Cost	Priority
HMU-57	*Casuarina equisetifolia*	45% of 19.64 acres	See HMU-3.	18 hours for chemical treatment. 9 hours at 6-12 months to control seedlings/ saplings.	Chem Labor: $360.00 Chemical: $3,213.00 Chem Labor (at 6-12 months for seedlings): $180.00 Chemical: $804.00 Total: $4,557.00	0
	Leucaena leucocephala (within coastal ruderal scrub)	2% of 19.64 acres	See HMU-9.	1 hour for chemical treatment. 1 hour at 6-12 months to control seedlings/ saplings.	Chem Labor: $20.00 Chemical: $357.00 Chem Labor (at 6-12 months for seedlings): $20.00 Chemical: $90.00 Total: $487.00	0
HMU-58	*Casuarina equisetifolia*	10% of 61.73 acres	See HMU-3.	13 hours for chemical treatment. 6.5 hours at 6-12 months to control seedlings/ saplings.	Chem Labor: $260.00 Chemical: $2,321.00 Chem Labor (at 6-12 months for seedlings): $130.00 Chemical: $581.00 Total: $3,292.00	0

Wake Atoll Invasive and Nonnative Plants Management Actions by HMU

HMU	Invasive Vegetation Species	Approximate Percent Cover	Recommended Management Action	Approximate Labor Hours	Approximate Labor and Cost	Priority
	Leucaena leucocephala	3% of 61.73 acres	See HMU-9.	4 hours for chemical treatment. 2 hours at 6-12 months to control seedlings/ saplings.	Chem Labor: $80.00 Chemical: $1,428.00 Chem Labor (at 6-12 months for seedlings): $40.00 Chemical: $357.00 Total: $1,905.00	0
HMU-59	*Casuarina equisetifolia*	35% of 12.34 acres	See HMU-3.	9 hours for chemical treatment. 4.5 hours at 6-12 months to control seedlings/ saplings.	Chem Labor: $180.00 Chemical: $1,607.00 Chem Labor (at 6-12 months for seedlings): $90.00 Chemical: $402.00 Total: $2,297.00	0
HMU-60	*Casuarina equisetifolia*	15% of 58.18 acres	See HMU-3.	18 hours for chemical treatment. 9 hours at 6-12 months to control seedlings/ saplings.	Chem Labor: $360.00 Chemical: $3,213.00 Chem Labor (at 6-12 months for seedlings): $180.00 Chemical: $804.00 Total: $4,557.00	0

Wake Atoll Invasive and Nonnative Plants Management Actions by HMU

HMU	Invasive Vegetation Species	Approximate Percent Cover	Recommended Management Action	Approximate Labor Hours	Approximate Labor and Cost	Priority
HMU-61	*Leucaena leucocephala* (within tournefortia forest)	2% of 58.18 acres	See HMU-9.	3 hours for chemical treatment. 1.5 hours at 6-12 months to control seedlings/ saplings.	Chem Labor: $60.00 Chemical: $536.00 Chem Labor (at 6-12 months for seedlings): $30.00 Chemical: $134.00 Total: $760.00	0
	Casuarina equisetifolia	30% of 28.97 acres	See HMU-3.	18 hours for chemical treatment. 9 hours at 6-12 months to control seedlings/ saplings.	Chem Labor: $360.00 Chemical: $3,213.00 Chem Labor (at 6-12 months for seedlings): $180.00 Chemical: $804.00 Total: $4,557.00	0
	Leucaena leucocephala (within tournefortia/ cordia)	5% of 28.97 acres	See HMU-9.	3 hours for chemical treatment. 1.5 hours at 6-12 months to control seedlings/ saplings.	Chem Labor: $60.00 Chemical: $536.00 Chem Labor (at 6-12 months for seedlings): $30.00 Chemical: $134.00 Total: $760.00	0

Wake Atoll Invasive and Nonnative Plants Management Actions by HMU

HMU	Invasive Vegetation Species	Approximate Percent Cover	Recommended Management Action	Approximate Labor Hours	Approximate Labor and Cost	Priority
HMU-62	*Casuarina equisetifolia* (within tournefortia/ cordia forest)	15% of 41.49 acres	See HMU-3.	13 hours for chemical treatment. 6.5 hours at 6-12 months to control seedlings/ saplings.	Chem Labor: $260.00 Chemical: $2,321.00 Chem Labor (at 6-12 months for seedlings): $130.00 Chemical: $581.00 Total: $3,292.00	0
HMU-63	*Casuarina equisetifolia* (within tournefortia forest)	5% of 51.06 acres	See HMU-3.	5 hours for chemical treatment. 2.5 hours at 6-12 months to control seedlings/ saplings.	Chem Labor: $100.00 Chemical: $893.00 Chem Labor (at 6-12 months for seedlings): $50.00 Chemical: $224.00 Total: $1,267.00	0
	Leucaena leucocephala (within tournefortia forest)	2% of 51.06 acres	See HMU-9.	1 hour for chemical treatment. 1 hour at 6-12 months to control seedlings/ saplings.	Chem Labor: $20.00 Chemical: $357.00 Chem Labor (at 6-12 months for seedlings): $20.00 Chemical: $90.00 Total: $487.00	0

Wake Atoll Invasive and Nonnative Plants Management Actions by HMU

HMU	Invasive Vegetation Species	Approximate Percent Cover	Recommended Management Action	Approximate Labor Hours	Approximate Labor and Cost	Priority
HMU-64	*Casuarina equisetifolia* (within tournefortia forest/scrub)	8% of 18.76 acres	See HMU-3.	3 hours for chemical treatment. 1.5 hours at 6-12 months to control seedlings/ saplings.	Chem Labor: $60.00 Chemical: $536.00 Chem Labor (at 6-12 months for seedlings): $30.00 Chemical: $134.00 Total: $760.00	0
	Leucaena leucocephala (within tournefortia forest/scrub)	2% of 18.76 acres	See HMU-9.	1 hour for chemical treatment. 1 hour at 6-12 months to control seedlings/ saplings.	Chem Labor: $20.00 Chemical: $357.00 Chem Labor (at 6-12 months for seedlings): $20.00 Chemical: $90.00 Total: $487.00	0
HMU-65	*Casuarina equisetifolia* (seedlings)	1% of 357.39 acres	See HMU-3.	7 hours for chemical treatment. 7 hours at 6-12 months to control seedlings/ saplings	Chem Labor: $140.00 Chemical: $1,250.00 Chem Labor (at 6-12 months for seedlings): $70.00 Chemical: $313.00 Total: $1,773.00	0
	Leucaena leucocephala (mowed)	3% of 357.39 acres	-	Regularly mowed areas are maintained by the BOS contractor. Mowing regime should be frequent enough to preclude seed development.	-	0

Wake Atoll Invasive and Nonnative Plants Management Actions by HMU

HMU	Invasive Vegetation Species	Approximate Percent Cover	Recommended Management Action	Approximate Labor Hours	Approximate Labor and Cost	Priority
* Garlon 4 mixture = Garlon 4, Chopper Generation II, Cide-Kick II and Improved JB Oil Plus @ a cost of $357/acre for trees. Garlon 4 mixture @ a cost of $89.25 per acre for follow on treatment of seedlings.						

THIS PAGE INTENTIONALLY LEFT BLANK

COMPONENT PLAN C

BIRD AIRCRAFT STRIKE HAZARD REDUCTION PLAN FOR WAKE ISLAND

DEPARTMENT OF THE AIR FORCE
HEADQUARTERS ELEVENTH AIR FORCE (PACAF)
JOINT BASE ELMENDORF-RICHARDSON ALASKA

MEMORANDUM FOR INSTALLATION SUPPORT SERVICES (ISS) CONTRACTOR

FROM: PACAF REGIONAL SUPPORT CENTER (PRSC)/CC
9480 Pease Avenue, Suite 123
JBER AK 99506-2101

SUBJECT: Operational Instruction for Wake Island Bird Aircraft Strike Hazard (BASH) Reduction Plan

1. This instruction establishes a program to minimize wildlife strikes. It delineates Wake Island Airfield's Bird and Waterfowl Exclusion Zones for dispersal purposes and defines Vegetation Management Zones designed to make Wake Island Airfield unattractive to wildlife. Furthermore, it defines BASH responsibilities and outlines procedures for issuing bird conditions and reporting bird strikes.

2. The ISS contractor will manage the overall BASH program on site. The contractor is the Wake Island's Airfield's primary BASH detection and dispersal agent. They will be the primary dispersal team for all of the wildlife within the airfield security fence and birds within the exclusion zones following guidance in both the wildlife hazard management protocol and the Interagency Agreement. Furthermore, the contractor will be responsible for vegetation management and overall wildlife management outside the airfield Bird Exclusion Zone (BEZ). The PACAF Regional Support Center (PRSC) along with the 611 Civil Engineer Squadron (CES) Natural Resources Office Wildlife Biologist will serve as Wake Island Airfield BASH advisors and will be consulted as modifications to this plan are recommended. USFWS Permit applications, reporting and data gathering in concert with USFWS Airport Depredation Permit provisions shall be completed by the contractor.

3. Amendment Procedures

a. This plan will be subject to annual review and periodic amendments in order to ensure that the Bird Aircraft Strike Hazard (BASH) Reduction Plan reflects actual requirements. Prior to its implementation, and any amendment thereafter, it will be submitted to Eleventh Air Force Safety Office (11 AF/SE) & their office will coordinate with legal (11 AF/JA) for approval using the following email: v311AF.SE@us.af.mil
b. No "pen and ink" amendments will be made to this plan. Changes will be made by replacement of the applicable page(s). A change number and the issue date will identify each change in the plan. The first amendment will begin with number one (1).
c. The Record of Amendments will be updated by placing the change number and date in the amendment date column. Only 11 AF/SE personnel are authorized to make changes and be routed through PRSC personnel for implementation.
d. Any amendments to this plan will be submitted to the office of primary responsibility (OPR), 11 AF/SE, via email stated in 3.a above.

e. Amendments must be documented by annotating the chart below.

AMENDMENT NUMBER	AMEND DATE	DATE ENTERED	SIGNATURE OF PERSON ENTERING

f. Annual reviews must be documented by annotating the chart below. 11 AF/SE will ensure, (at a minimum) that the owning contracting office, PRSC, 611 CES, 11 AF JA, 611 ASUS/PM and a flight safety representative are coordinated with for each annual review. A representative from the contractor, PRSC and 11 AF/SE will sign off on each annual review.

Year	Contractor Representative	PRSC Representative	11 AF/SE Representative

Bird Aircraft Strike Hazard (BASH) Reduction Plan

For

Wake Island

Dated: 01 Sep 16

FOR OFFICIAL USE ONLY

Table of Contents

WAKE ISLAND AIRFIELD BIRD AIRCRAFT STRIKE HAZARD (BASH) REDUCTION PLAN

1. PLAN OVERVIEW

1.1. **PURPOSE:** To minimize aircraft and pilot exposure to potentially dangerous bird/animal wildlife strikes in the local flying area of Wake Island Airfield (PWAK). The program is developed using guidance from Air Force Instructions (AFI's) 91-202, 13-204, Air Force Pamphlet (AFPAM) 91-212, Federal Aviation Administration (FAA) Advisory Circular (AC's). Additional guidance, information and/or technical assistance may be obtained through the USAF BASH Team, HQ AFSEC/SEFW, U.S. Department of Agriculture (USDA) and/or U.S. Fish & Wildlife Service (USFWS) publications.

1.2. **CONDITIONS FOR EXECUTION**: This plan must be executed with a Full Time BASH Manager (FTBM) employee. This plan is based on hazards encountered at PWAK from resident and seasonal bird populations, and other animals. This plan is a living document, therefore implementation of some portions of this plan are designed to evolve over time, while other portions will be implemented as required, based on measurable (observed/recorded) bird/animal activity at PWAK, for lessons learned and continued process improvement.

1.3. **OPERATIONS TO BE CONDUCTED**:

1.3.1. Operations specific to the BASH Plan include:

1.3.2. Report and disseminate information regarding increased potential for aircraft/wildlife strikes to all base assigned and transient personnel affected, including real time airfield BASH updates as required to inbound aircraft.

1.3.3. Eliminate or reduce environmental conditions that attract birds to the airfield through habitat alterations.

1.3.4. Act to harass or depredate birds and other animals to reduce potential for aircraft/wildlife strikes.

1.3.5. Perform airfield/runway checks prior to planned aircraft arrivals for bird and other animal hazards, harassing or depredating as required to ensure safety of flight.

1.3.6. Perform airfield/runway checks for bird remains after a reported strike.

2. PLAN INTRODUCTION

2.1. To maintain overall situational awareness, Wake Island Airfield (PWAK) incorporates standardized Operational Risk Management (ORM) principles IAW Department of Defense (DoD) Instruction 6055.1 and FAA Safety System Handbook (chapter 15) to conduct/evaluate risk assessment according to a Five (5) step process:

2.1.1. Identify the Hazard
2.1.2. Assess the Hazard (severity)
2.1.3. Make Risk Decision (time critical)
2.1.4. Implement Controls
2.1.5. Supervise Effectiveness

Courtesy of AFPAM 90-803

2.2. This process allows PWAK management to properly identifying existing hazards, as they occur, based on operational need, to assess associated risks, identify “best practices” to minimize/control those risks and coordinate/advise local decision authorities and/or transient aircrews of current, real time bird/wildlife threats to aircraft operations, as well as any recommended actions (advisories/restrictions) to enhance overall flight safety and mission support.

2.3. The PWAK BASH Reduction Program has also adopted an integrated multi-discipline ORM preventive maintenance approach which involves four primary components:

2.3.1. Aircraft Avoidance
2.3.2. Hazard Response
2.3.3. Habitat Management
2.3.4. Monitoring and Research

2.4. The 11 AF/SE at Joint Base Elmendorf-Richardson (JBER) is the OPR for this program. Any proposed changes to this plan are provided to the Airfield Operations Manager (AOM) as Subject Matter Expert (SME) for review, concur/non-concur and incorporation, as deemed necessary. Any changes and/or recommendations must be sent to 11 AF/SE for review, validation and incorporation into this plan after proper approval. Contractor personnel are responsible for ensuring cooperation of this plan by all departments and all parts of this BASH Reduction Program. The Public Works Manager, Environmental Manager and QC/Safety Manager all have specific responsibilities within this plan to effect proper implementation, continuous compliance and safety of flight on PWAK and surrounding areas.

2.5. The Wake Island BASH Reduction Program Continuity Binder will be located in Base Operations, AOM Office. This Field Guide provides field reference materials (publications, web sites, etc.), tools and available resources, along with general information about different bird/animal species that frequent, or reside on PWAK, for use in conducting field observations, active/passive methods for bird/animal dispersal and options for making PWAK less attractive to wildlife. Additionally, this Program Binder is designed to be used as an orientation guide and local training tool for local Bird Dispersal Team (BDT) members. The BDT may recommend changes to this Field Guide as new information, dispersal techniques and training resources become available. Any changes/recommendations must be routed through the 11 AF/SE office at JBER via contact information as follows: v311AF.SE@us.af.mil or calling DSN: 317-552-3864/4730.

3. LOCAL CONDITIONS

3.1. Wake Atoll is one of the most isolated islands in the world. The total land area of Wake Atoll is approximately 2.85 square miles with 12 miles of coastline. Its three islands, Wilkes, Wake and Peale, form a “V” shaped atoll, open on the northwest side and surrounded by a barrier reef. A 9,844’ X 150’ runway, with associated taxiways and aircraft parking aprons covers much of Wake Island at the head of the lagoon. The runway is adjacent to man-made brackish drainage ponds in a few low-lying areas.

3.2. Extensive sand flats at the head of the lagoon also provide shorebird habitat. Due to the limited animal species currently on Wake Island, the threat of wildlife aircraft strikes is primarily associated with bird species. However, quarterly monitoring of the islands avifauna by the BOS has resulted in documentation of a diverse and dynamic bird/animal population which must be monitored and managed closely.

3.3. Most bird species on Wake Atoll (except for Rock Doves and Feral Pigeons) are protected under the Migratory Bird Treaty Act (MBTA), while currently no species have protections under the Endangered Species Act (ESA). To control the existing threat of bird/wildlife species that frequent PWAK, the USFWS has issued Wake Island Airfield Depredation Permit # MB077566-0, IAW 50 CFR 13 and 50 CFR 21.41. For specific instructions of this permit, see the permit, which is maintained in Base Operations/AOM Office, and at the Wake Island Environmental Office.

4. BASIC PLAN

4.1. SITUATION:

4.1.1. GENERAL: Bird Aircraft Strike Hazards (BASH) exist at Wake Island Airfield (PWAK) and the surrounding area due primarily to resident and migratory birds. This plan establishes procedures to minimize these hazards. No single solution exists to these BASH problems, so a variety of techniques are used and several organizations are tasked with execution of this program. This plan is designed to:

4.1.1.1. Establish a local Bird Dispersal Team (BDT), provide associated training, and designate responsibilities, to ensure seamless BASH execution. BDT membership and makeup are to be determined by the ISS contractor BASH OPR.

4.1.1.2. Establish Bird Watch Condition (BWC) codes to communicate bird activity, number and location to aircrew. These condition codes are established based on visual observations of bird activity in the vicinity of the airfield (BWC Guide, section 5).

4.1.1.3. Provide information to all aircrews, on bird hazards and procedures for bird avoidance.

4.1.1.4. Establish guidelines to decrease airfield attractiveness to birds.

4.1.1.5. Provide guidance and training for dispersing birds when they congregate on the airfield.

4.2. BIRD HAZARD WORKING GROUP (BHWG):

4.2.1. OPRs: The 11 AF BHWG is co-chaired by a senior representative of the PRSC and the 611 Air Operations Center (611 AOC). The 611 AOC/CC is the 11 AF Senior Airfield Authority, and will generally delegate AOC chair responsibilities to either 611 AOC/SPD or COD. The BHWG is facilitated by 11 AF/SE.

4.2.2. Group members include: AF/SE, 11 AF/JA, 611 CES, 611 ASUS, 176 WG, 517 AS/SE, 3 WG/SEF, 611 CES/CEI, 611 CES/CEO, 611 ASUS/ARS, 611

ASUS/PM, 611 ASUS/FOL, 611 ASUS/QAL, 3 CONS/LGCZ, 766 SCONS OL AA (ARS, EAS, WI), as well the Wake Island BASH OPR.

4.2.3. SCHEDULE: The BHWG meets semiannually, prior to major migration patterns (March/April and August/September) at the ALCOM building on JBER, AK. Outstations, including Wake Island members, attend via VTC or teleconference.

4.2.4. CONCEPT OF OPERATION: To help manage and mitigate BASH risks at all PRSC maintained sites, including Wake Island, via the collaboration of multiple agencies and experts from several base organizations. Birdstrike history, BASH objectives and trends, forecasts, dispersal and hazing methods, and depredation are discussed at these semi-annual conference calls.

4.2.4.1. Authority: The PWAK AOM and PRSC Det 1/CC (or designated representatives) shall attend all scheduled BHWG meetings. Implementation of on island activities associated with this plan is primarily accomplished through ISS Contractor IAW approved Performance Work Statement (PWS).

**Note: Technical assistance is available through the USAF BASH Team, HQ AFSC/SEFW, 9700 AVE G SE, Bldg. 24499, Kirtland AFB, NM 87117-5670. DSN: 312-246-5673/5674 or COMM: (505) 846-5673/5674.*

4.3. OVERVIEW OF CURRENT WAKE ISLAND AIRFIELD BIRD HAZARDS

4.3.1. The following is a summary of specific bird groupings and associated bird species that predominate in the Wake Atoll, along with general recommendations for reduction of each bird group as an existing hazard (threat) to flight operations; see photos following summary descriptions. More detailed information is provided in the following avian literature: The Sibley Guide to Birds, 2nd Edition by David Allen Sibley; National Geographic Field Guide to the Birds of North America, Sixth Edition by Jon L. Dunn and Jonathan Alderfer; Seabirds – An Identification Guide by Peter Harrison.

4.3.2. Pelagic Birds (Albatross, Petrels, Shearwaters, etc.)

4.3.2.1. Control of this bird species is difficult since natural predators are rare and these birds exhibit little fear of man or aircraft. Avoid flying near nesting sites during nesting seasons. These huge nesting colonies are located on steel, rocky coastlines or on islands where many thousands of birds may concentrate. Out at sea these large birds fly very close to the surface of the water gliding on small updrafts created by the ocean swells. Avoid flying low over the ocean or near low-lying wetland areas to minimize encounters with these soaring birds.

4.3.3. Seabirds (Great Frigate Birds, Brown Booby, Terns, etc.)

4.3.3.1. These are strictly fish eating birds common to coastal areas and along some major rivers and lakes. Avoid flying near areas where these birds may be active, such as nesting colonies or piers. Remove any localized nesting areas, eggs, food sources and/or fish-containment ponds to reduce their presence, which will significantly minimize this hazard.

4.3.4. Shorebirds (Sandpipers and Plovers)

4.3.4.1. The most significant hazard from these birds occurs when large migrating flocks traveling along the coastlines veer off and come into coastal areas near the airfield. Controlling or directing these large flocks is very difficult since pyrotechnics, bioacoustics, and depredation have minimal impact as an effective bird deterrent. The best option is to employ an aggressive land (habitat) management program that makes airfields less attractive to migrating flocks as a food/water source, roosting place and/or nesting area. Otherwise, the best procedure (active measure) is to continually update Air Traffic Control (ATC)/Base Ops as to approximate size, location and activity of existing flocks, to allow for aircrew situational awareness and proper execution of “see and avoid” operations. In addition, it is recommended that MARSA (Military Assumes Responsibility for Separation of Aircraft) operations be restricted when large flocks are observed, since these flocks tend to take flight and then return to the same location, thus presenting themselves as a hazard to remaining aircraft operating in close formation.

4.3.5. Photos of Common Birds Encountered at Wake Atoll

A - **Bristle-thighed Curlew** (*Numenius tahitiensis*)
B - **Wedge-tailed Shearwater** (*Puffinus pacificus*)
C - **White Tern** (*Gygis alba*)
D - **Red-tailed Tropicbird** (*Phaethon lepturus*)
E - **Laysan Albatross** (*Phoebastria immutabilis*)
F - **Masked Booby** (*Sula dactylatra*)

4.3.5. (Continued) – Photos of Common Bird Encountered at Wake Atoll

G – **Brown booby** (*Sula leucogaster*)
H – **Red footed booby** (*Sula sula*)
I – **Sooty tern** (*Onychoprion fuscatus*)
J – **Great frigatebird** (*Fregata minor*)
K – **Black noddy** (*Anous minutus*)
L – **White tailed tropicbird** (*Phaethon lepturus*)

4.4. Bird/Aircraft Strike Avoidance

4.4.1. Problematic BASH risk bird species that frequent PWAK, such as Sooty Terns, have been documented utilizing various part of the atoll by various avian researchers. Their life histories and habits have also displayed a preference for being active at different times of the day. In relation to these species, historical wildlife strike data reveals a majority of bird/animal strikes occur during the hours of dusk and dawn, when bird activity is normally at its peak. As such, during periods of peak bird/animal movement (commonly referred to as BASH Phase II), aircraft requesting a Prior Permission Required (PPR) Number should plan accordingly; schedule Estimated Times of Arrival or Departure (ETA/ETD) outside these key periods of activity, or operate over shorelines and designated bird sanctuaries (Wilkes Island) at altitudes sufficient to avoid contact with local bird populations and/or migrating shorebirds, which tend to fly low near the ground.

4.4.2. Published airfield operating hours for PWAK are Tuesday – Saturday, 0800-1600L. When scheduling aircraft operations outside published airfield hours, flying units and/or aircrews should take local bird/animal behavior into consideration when planning to transit PWAK. During peak wildlife movements, PWAK Full Time BASH Manager (FTBM) will inform aircrews of any potential flight hazards due to increased bird activity in the local area.

4.4.3. Through continuous observation, PWAK AOM updates the current Bird Watch Condition (BWC) as ***LOW, MODERATE*** *or* ***SEVERE****,* to correctly identify changes in bird/animal activity at or near the runway environment and respond to effectively mitigate any potential threats in an appropriate and timely manner.

4.4.4. The PWAK FTBM and/or designated alternate serve as primary authority to declare BWC for Wake Island Airfield. Aircraft Ground Equipment (AGE) handlers, Barrier Maintenance, Safety, Environmental and any other personnel may observe activity and are encouraged to report findings to the FTBM, AOM or Base Operations. If a transient aircrew member observes or encounters bird activity which could constitute a hazard, they must immediately report noted activity to Base Operations. The FTBM, or designated alternate, will respond and/or activate the Bird Dispersal Team (BDT) as is deemed necessary. BWC code changes will be announced over the Secondary Crash Net, Channel 7, then disseminated by Base Operations to base agencies IAW the BWC Change Quick Reaction Checklist (QRC) for notification. Field observations shall be recorded and tracked using ***PWAK the Bird/Wildlife Activity & Response Log,*** maintained in Base Operations.

4.4.4.1. BWCs elevated to *Moderate* or *Severe* are provided to inbound/outbound aircraft by Base Operations through Local Advisories, along with specific information relative to current BASH hazards/threats.

4.4.5. Current BWC is posted on the Airfield Status Board located in the Base Operations Flight Planning Room.

4.4.6. Limitations:

PWAK Base Operations cannot see birds/wildlife on the west end of the runway due to distance. Portions of the south ramp and the east end of the runway are also obscured due to the location of Base Operations in the terminal building. Therefore, it is necessary for the FTBM to visually inspect (usually via vehicle) the west and east ends of the runway, as well as the south ramp during planned arrivals and departures to assess the current BASH risk.

5. PWAK BIRD WATCH CONDITION (BWC) GUIDE

MASS:	**SMALL< .5lb**	**MEDIUM .5–2lbs**	**LARGE > 2 lbs**
BWC	Noddy, Tern, Plover, etc	Tropicbird, Shearwater, etc	Booby, Frigatebird, Albatross, etc
LOW	**< 10 birds**	**< 5 birds**	**1 bird**
MODERATE	**10 – 19 birds**	**5 – 10 birds**	**2 birds**
SEVERE	**> 19 birds**	**> 10 birds**	**3 + birds**

5.1. BWC codes are defined as:

5.1.1. SEVERE: Bird activity ***on or immediately above*** the active runway or other specific location represen*ting a high potential f*or bird/animal strikes. *Supervisors and aircrews must thoroughly evaluate mission need before conducting operations in areas under condition SEVERE.*

MODERATE: Bird activity ***near*** the active runway or other specific location representing increased potential for strikes. *BWC MODERATE requires increased vigilance (caution) by all aircrews, as well as base agencies and supervisors*

LOW: Bird activity on and around the airfield representing low potential for strikes.

6. TASKS AND RESPONSIBILITIES

6.1. The ISS contractor OPR will appoint, in writing, a designated Full Time BASH Manager (FTBM) and an Airfield Operations Manager (AOM), who both have authority to carry out the BASH Reduction Plan and the FTBM duties, as required.

6.2. FTBM shall:

6.2.1. Ensure all Wake Island tasked organizations comply and assist with this plan:

- ✓ Operations
- ✓ Civil Engineering
- ✓ Logistics
- ✓ Environmental
- ✓ Quality Control/Safety

6.2.2. Discuss all BDT recommendations for changes or enhancements to the PWAK BASH Program with the PRSC DET 1/CC, 11AF/SE, and the 611 CES Natural Resources Wildlife Biologist/ BASH Advisor at the semi-annual BHWG teleconference.

6.2.3. Report all bird-aircraft hazards.

6.2.4. Report all bird strikes on AF IMT 853, immediately forwarded to 11AF/SE (Safety), 611 ASUS/CES Natural Resources Wildlife Biologist/ BASH Advisor /Airfield Manager, DET 1/CC, Site Manager, contractor EV and contractor QC/Safety.

6.2.5. Define, develop, train, and manage the Bird Dispersal Team (BDT), utilizing available Wake Island personnel. Craft a BDT training program IAW Federal regulations and Air Force instructions, including AFPAM 91-212 BASH management techniques.

6.2.6. Ensure weapons safety training and Lautenberg Act requirements are met, and weapons maintenance and storage procedures are followed, per Det 1/CC policies.

6.2.7. Disseminate BASH data as required to the AOM, BDT and base operations.

6.2.8. Provide the BDT with current BASH guidance from the BHWG, Air Force, the USFWS and other agency records of confirmed bird/animal strikes on Wake Island Airfield.

6.2.9. Monitor bird activity and strike statistics, and attends all scheduled BHWG meetings.

6.2.10. Coordinate with aircrews and maintenance for collection of non-fleshy remains after bird/animal strikes; send any salvaged material, feather fragments, etc., to the Environmental Manager, who will forward to the Smithsonian National Museum of Natural History, for species identification. For additional guidance on where to send bird remains, refer to AFPAM 91-212 & AFI 91-204.

6.2.11. Establish and maintain a Continuity Binder in the FTBM or Airfield Manager's office with any pertinent BASH data, procedures, and information to assure breadth of knowledge with local agencies and personnel turnover.

6.2.12. Encourage aircrews using PWAK facilities to participate in the BASH Reduction Program by promptly reporting all bird strikes and hazardous conditions IAW this plan.

6.2.13. Ensure that an adequate supply of BASH report forms (AF Form 853) and bird activity maps, if necessary, are readily available to visiting aircrews.

6.2.14. Ensure aircrews operating from PWAK are briefed on seasonal bird Hazards, Phase I and II, during local safety briefings provided by the contractor QC Safety Technician and FTBM. The purpose of the phases is to raise awareness.

6.2.14.1. Phase I – (01 September-31 January)
Phase II – (01 February-31 August); Phase II represents heavier than normally observed bird activity, usually associated with migratory activity.

6.2.15. Establish a Bird Watch Condition (BWC) program to include information on local bird hazards and reporting procedures.

6.2.16. Initiate any change in the BWC as deemed necessary, with the AOM. Led by the FTBM, in coordination with Base Operations and/or the AOM, the Enroute Services Supervisor, QC Safety Technician, Environmental Manager, and/or other Trusted Agents may recommend BWC changes to the AOM or Base Ops, based on observed conditions.

6.2.16.1. Trusted Agents: IAW this plan, as defined, a "trusted agent" includes Air Operations supervisory personnel and BDT members, however, local bird/wildlife activity can be observed and reported by anyone operating on or near PWAK, which should be reported immediately to all of the following: FTBM/AOM and Base Operations.

6.2.17. As reported, the BWC will be upgraded and/or downgraded based on updated information, effectiveness of bird/wildlife dispersal techniques applied and/or observed conditions. Only the AOM or designee can upgrade or downgrade the BWC.

6.2.18. Disseminate current BWC to Base Operations for coordination with local agencies and all aircrews using PWAK.

6.2.19. Review and provide suggested changes to the BASH Plan to 11 AF/SE to ensure it remains viable, ensures continuity of knowledge, and meets the specific hazards encountered locally. This plan should inform new personnel of local hazards, and identify local conditions on the airfield attractive to wildlife and cite measures to reduce these attractions (e.g., long grass, insect reduction, water drainage).

6.2.19.1. Develop and run a BASH self-inspection checklist as a useful tool in identifying deficiencies in the BASH reduction plan.

6.2.19.2. Ensure proper documentation of Bird Dispersal Team training and assignment.

6.3. Enroute Services Supervisor will:

6.3.1. Notify the FTBM and AOM whenever significant bird activity is observed, to include recommendations for change in BWC codes.

6.3.2. Remove any dead or wounded birds/animals from the airfield and reports all findings to the following: FTBM or AOM, and Base Operations.

6.3.3. As required, conducts a runway sweep after a noted bird/wildlife strike.

6.3.4. When conducting supervisory responsibilities on the flight line, monitors bird populations, grass height, drainage ditches, etc. and reports all findings to the FTBM and AOM for further evaluation and/or disposition.

6.4. Base Operations will:

6.4.1. Collect and report observed bird activity, disseminate BWC changes and forward aircrew reports of bird/animal activity to the FTBM and AOM for further action.

6.4.1.1. For urgent or rapidly changing conditions, contact Air Force Flight Managers directly at both the Tanker and Airlift Control Center (TACC) (DSN 312-779-0301) and the 613th Air Mobility Division (AMD) (DSN 315-448-8888).

6.4.2. Post current bird activity data and BWC in the AF Form 3616, Events Log and Flight Planning Room so that it is properly documented and readily available to all aircrews.

6.4.3. Advise aircrews of BWC codes and/or local advisories.

6.4.4. Maintain bird activity logs and submits these logs monthly to the 611 CES Natural Resources Wildlife Biologist.

6.4.5. Approve Bird Dispersal Team (BDT) members access to the Controlled Movement Area (CMA) as required.

6.5. ISS Contractor Environmental Manager will:

6.5.1. Provide advice to the BHWG regarding environmental impact analysis as it relates to habitat control, designation of endangered species, known wetland areas and recommendations regarding long-term land management (passive measures) that make Wake Island Airfield and surrounding areas less attractive to bird/animal species.

6.5.2. Conduct periodic airfield BASH surveys and provides information on numbers, types, activities and location of bird activities and/or populations on PWAK to the U.S. Fish and Wildlife Service (USFWS). Also provides migratory bird activity and nesting information.

6.5.3. As a member of the BDT and as requested, assists the FTBM and AOM during bird dispersal activities, conducts BASH checks in and around the airfield to help provide a continuous presence, identify areas where there are increased bird/animal populations and provide SME to assist in development, procurement and/or application of initiatives designed to minimize or eliminate these threats.

6.6. Civil Engineer will:

6.6.1. In coordination with the FTBM, AOM and contractor Environmental Manager, develops procedures for removal or control of bird attractants in and around the airfield within existing resources.

6.6.2. Correct environmental conditions that increase BASH potential within the capabilities of the Contract Performance Work Statement (PWS) and available funding.

6.6.3. Use prescribed land management practices that reduce BASH potential.

6.6.4. Modifies airfield habitat consistent within established airfield imaginary surfaces (runway lateral & primary surface, taxiways, aprons, clear zone, etc.) and approach zones IAW Unified Facilities Criteria (UFC) 3-260-01, *Airfield & Heliport Planning & Design Criteria*.

6.6.5. Works with the 611 CES Natural Resources Wildlife Biologist/ BASH Advisor to ensure the following practices are incorporated into the base Integrated Natural Resource Management Plan (INRMP):

6.6.5.1. Airfield Grass Height Management: Maintain a uniform grass height between ***Seven to Fourteen (7-14) inches*** and establish a mowing frequency schedule to maintain standard height requirements. Coordinate mowing activities with the FTBM, AOM and Base Operations during periods of low flying activity, cutting grasses before they go to seed to discourage seed-eating birds/animals from using the airfield as a food source. Airfields with a variety of grass species may have strains that grow faster than others, which must be monitored closely. As is deemed appropriate, assistance in selection of herbicides for weed control, grass seed selection, fertilization and erosion control may be obtained from the U.S. Department of Agriculture (USDA), Natural Resources Conservation Service.

6.6.5.2. Broad-Leafed Weed Control: Keep broad-leafed weeds to a minimum on the airfield. Apply herbicides as necessary to minimize growth or spread. Broad-leafed weeds attract a variety of birds, and may produce seeds or berries, limit natural grass growth, and have the potential to damage airfield pavements (root growth).

6.6.5.3. Dead Vegetation: Brush piles and grass clippings should be removed as soon as possible to prevent provided cover for birds, nesting, etc.

6.6.5.4. Dead Birds/Animals: Must be removed from the airfield to avoid attracting carnivorous birds. Discovered remains that may have resulted from an aircraft collision will be delivered to the FTBM, AOM and Base Operations. Contract Environmental Manager will forward to proper authorities for identification. Any other remains found, thought to be the cause of natural selection, shall be removed and properly disposed of (buried).

6.6.5.5. Drainage Ditches: Inspect ditches regularly. These are to be kept clear and obstacle-free. Maintain ditch sides as steeply as possible (5:1 minimum slope ratio) to discourage wading birds and emergent vegetation. Remove vegetation as often as necessary to maintain water flow and discourage use by birds/animals. Reference the Integrated Natural Resources Management Plan for further procedures.

6.6.5.6. Standing Water: Eliminate standing water on or near the prepared surfaces of Aircraft Movement Areas (AMA). Eliminate small ponds, pebbles, low lying areas and large bodies of standing water to reduce attractiveness to birds.

6.6.5.7. Erosion Control: Vegetation should be used which is appropriate for the site characteristics and supports BASH reduction philosophy, i.e., do not control erosion using plants which produce bird attracting seeds or foliage.

6.6.5.8. Control Waste Disposal: Waste staging areas can be a significant attractant to hazardous bird species. Disposal sites should be operated IAW FAA Order 5200.5A, *Waste Disposal Sites On or Near Airports,* and must comply with Federal and State local laws. Solid waste dumpsters should be placed in hanger and/or terminal areas for aircrew use.

6.6.5.9. Consider the following methods:

- ✓ In coordination with FTBM/AOM and Base Operations, use pyrotechnics to frighten birds away
- ✓ Keep dumpster sliding doors and top lids closed at all times when not in use

6.6.5.10. Other Wildlife Hazards to Aircraft: PWAK currently has no other wildlife outside of birds, rats, amphibians, crabs and various insect species.

6.7. Tenant Unit(s):

6.7.1. Responsibilities within the unit will mirror the responsibilities assigned by this plan.

6.7.2. Issue specific guidance to maintenance personnel for the reporting of all discovered bird strikes on aircraft to the following: FTBM, AOM and Base Operations.

6.7.3. Issue procedures for the preservation of non-fleshy bird remains if discovered on the aircraft. Even the smallest feather (or down) remains should be forwarded to the FTBM, AOM and Base Operations for disposition and proper identification.

6.8. Bird Dispersal Team (BDT) Members:

6.8.1. Will be familiar with this plan and understand the basics of reducing the risk of a bird strike. The BDT will be comprised of the following: a FTBM, AOM, one (1) individual from Enroute Services, one (1) individual from the Fire Department, the Environmental Technician and the QC Safety Officer. As is applicable, Managers/Supervisors from each section will designate member(s) from their respective organization to serve on the BDT.

6.8.2. As approved by the FTBM, AOM and Site Manager, BDT members will be identified in writing in a BDT Charter or organizational chart.

6.8.3. Will be trained by the FTBM, AOM and/or appropriate designee in the use of firearms or pyrotechnic devices, as specified, before each BDT member is authorized to utilize this equipment. All training will be documented in the BASH Continuity Binder.

6.8.4. During normal or extended airfield operating hours, the FTBM and BDT members will monitor the Airfield Ramp Net (channel 7). When an ***immediate*** BASH threat is observed on the airfield (BWC is upgraded to ***MODERATE*** or ***SEVERE***), the following BDT members will respond as follows:

6.8.4.1. Primary First Responder: FTBM

6.8.4.2. Secondary Responder: AOM

6.8.4.3. Tertiary Responders: All other BDT members, as determined necessary by the FTBM and AOM, upon notification.

6.8.5. For immediate response situations, the primary consideration is to drive birds/wildlife away from the direct path of an aircraft as quickly as possible. In so doing, BDT members will first employ use of "active" measures (non-lethal techniques & resources) to frighten birds/wildlife away from the airfield. Active measures include, but may not be limited to the following, as are available:

6.8.5.1. Pyrotechnics: Non-lethal dispersal cartridges launched from a 15mm pyrotechnic pistol. Pyrotechnics are effective for temporary dispersal of most bird/wildlife species.

6.8.5.2. Bioacoustics: Recordings (by species) of mating or bird distress calls designed to ward-off or attract birds to/from a given location.

6.8.5.3. Vehicle Hazing: As equipped on authorized Airfield Response Vehicles, use of a Public Address (PA) system (voice), vehicle horn, light bar and/or siren may be used to disperse birds/wildlife.

6.8.5.4. Additional Methods: Use of other prescribed resources, such as Propane Gas Cannons, bird balls, paintball markers, etc., may be utilized as funding is available and considered value added.

6.8.5.5. When ALL non-lethal means have failed to mitigate the immediate BASH threat, consider use of lethal means (shotgun) as deemed appropriate IAW approved USFWS Depredation Permit, and as equipped/able.

6.8.6. In addition to activation during immediate response situations, BDT members are also required to assist the FTBM/AOM in performance of "passive" measures in and around the airfield to help reduce the overall BASH threat. Passive measures include, but may not be limited to, the following:

6.8.6.1. Airfield BASH Checks: The FTBM must conduct at least two (2) surveys in the morning and two (2) additional surveys in the afternoon (more frequent if needed) and must be documented on AF Form 3613-Daily Events Log. The surveys shall be implemented 5 days a week, and on days of aircraft arrivals and departures. These documents must be readily available for inspection/validation by AF authorized personnel. These surveys consist of the Bird Exclusion Zone (BEZ) and surrounding areas, providing a constant presence to deter bird/wildlife activity (loafing, nesting, feeding, etc.) on or near the airfield.

6.8.6.2. USFWS Depredation Permit Execution: As directed, assist in the "taking" and/or "re-location" of migratory birds, nests and eggs that pose a direct threat to human (flight) safety. Track the total number of eggs and bird which are taken in accordance with the USFWS Depredation Permit. On An annual basis, submit required USFWS annual report and application for permit renewal to USFWS Portland Regional Office. Provide 611th CES/CEIE Natural Resource management is provided copies of the application for renewal, newly issued permit, and annual reports for bird take.

6.8.6.3. Other BASH Prevention Initiatives: As required, provide the necessary manpower and/or assistance to effectively employ, observe and evaluate (record) on-going efforts to reduce overall BASH threats on the airfield.

6.9. Aircrew Members:

6.9.1. If an aircrew member observes and/or encounters bird activity at or near PWAK that constitutes, or could potentially cause a hazard to flight safety, he/she shall report said activity to Base Operations. As a minimum, the following information should be included:

- ✓ Call Sign
- ✓ Location
- ✓ Altitude
- ✓ Time of sighting
- ✓ Type of bird/waterfowl (if known)
- ✓ Approximate number of birds/waterfowl
- ✓ Bird/waterfowl behavior (soaring, feeding, flying to/from location, etc.)

6.9.2. Each Aircraft Commander (AC) is responsible to follow the guidance issued by his/her command during BWC ***MODERATE*** or ***SEVERE*** at Wake Island Airfield. AFPAM 91-212 states that supervisors and aircrews must use caution before conducting operations in areas under BWC ***MODERATE***, and/or thoroughly evaluate mission needs before conducting operations in areas under BWC ***SEVERE***.

7. BIRD STRIKE REPORTS AND FORMS

7.1. GENERAL

7.1.1. Wake Island Airfield (PWAK) has no base assigned aircraft. This annex outlines the procedures and/or forms required at PWAK for reporting bird strikes by transient aircrews IAW AFI 91-202, *U.S. Air Force Mishap Prevention Program*, 91-204, *Safety Investigations and Reports* and AFPAM 91-212, *Bird/Wildlife Aircraft Strike Hazard Management Techniques* to enhance our local BASH Prevention program here at PWAK.

7.2. BIRD STRIKE REPORTING

7.2.1. Report all wildlife strikes, both damaging and non-damaging, IAW AFI 91-204. The unit owning the mishap aircraft's flying hours must file the report. Additionally, any wildlife remains found on the runway at PWAK and believed to have been involved in a strike must be documented via AFSAS.

7.2.1.1. Contract personnel do not have direct access to the AFSAS. As such, IAW AFI 91-202, 11th AF Supplement, for any bird/wildlife remains found on the runway (airfield) believed to have been involved in an aircraft/bird/wildlife strike, the following reporting procedures apply:

7.2.1.1.1. The FTBM and (with the AOM as the alternate) will complete AF Form 853, *U.S. Air Force Bird Strike Report*, and forward to PRSC and the 611 CES, Environmental through the DET 1/CC.

7.2.1.1.2. Completed reports will be submitted to the PWAK QC Safety Officer for disposition.

7.2.1.1.3. The PWAK QC Safety Officer will forward completed reports pertaining to PRSC MSG installations to the 3rd WG/SE office for tracking through their hazard reporting program. In addition, all original reports will be forwarded to AFSC/SEFW, as confirmed and coordinated with the PRSC ASUS/QA on specifics of the hazard report.

7.2.2. To assist transient aircrews, the AF Form 853 or MAJCOM approved Bird Strike Report, will be made available to flying units using PWAK base facilities and/or base operations.

7.3. IDENTIFICATION OF BIRD/WILDLIFE REMAINS

7.3.1. Proper species identification of wildlife is an integral part of a BASH program. Feather fragments or fleshy remains from every bird strike, if available, must be sent to the Smithsonian Institution National Museum of Natural History for identification IAW AFPAM 91-212 and AFI 91-04.

7.4. TECHNICAL ASSISTANCE

7.4.1. The USAF Mishap Prevention Program outlines responsibilities for reducing bird strike hazards. Obtain additional information on BASH management from AFPAM 91-212, *Bird Aircraft Strike Hazard Management Techniques*.

7.4.1.1. Technical assistance is also available through the USAF BASH Team, HQ AFSC/SEFW, 9700 G Ave SE, Bldg. 24499, Kirtland AFB, NM 87117-5670. DSN: 312-246-5673/5674 or COMM: (505) 846-5673/5674. E-mail address; bash@kafb.saia.af.mil

7.4.2. USFWS MBTA experts from the Regional Portland Office and Honolulu Office provided technical advice to the USAF in order to assist with problematic nesting achieved by Sooty Terns in the summer of 2016. Given historical management issues with this species in relation to the airfield and BASH risk zone, a supplementary guide for dealing with this specific species has been created. Habitat management guidance, proven hazing techniques, and life history information for this specific species is available upon request from 611 CES/CN.

7.5. BIRD/WILDLIFE SIGHTING & ACTIVITY REPORT

7.5.1. When bird/wildlife activity is sighted on or near the airfield, as observed, any responsible party should immediately contact Base Operations (ext. 101/222 and/or by LMR, channel 7) and provide the following information, as a minimum:

- ✓ Number of birds/wildlife
- ✓ Type of birds/wildlife (if known)
- ✓ Location of birds/wildlife
- ✓ Activity of birds/wildlife

7.5.2. Base Operations will coordinate bird/wildlife observations with the FTBM for appropriate response (airfield or surrounding areas) and bird/wildlife dispersal, as deemed necessary. Once the bird/wildlife hazard has been mitigated, the

FTBM will advise Base Operations and the AOM of any bird/wildlife hazard dispersal actions taken.

7.5.3. IAW the approved ISS PWS, Section 1.7, *Airfield Management*, Sub-section 1.7.5., *Bird Aircraft Strike Hazard (BASH)*, Sub-paragraph d, Airfield Management will maintain on-site and provide the 611th Civil Engineering Squadron (611 CES) Environmental Quality Assurance (QA) Evaluator a copy during QA Evaluation visits a log of wildlife reduction actions to include the following:

- ✓ Date
- ✓ Bird location within the BEZ
- ✓ Dispersal method used
- ✓ Species
- ✓ Estimated numbers
- ✓ Number and species of birds taken lethally (if necessary)

7.5.4. Base Operations will archive BASH Log spreadsheets monthly and annually. As requested, Base Ops will forward logs to the ISS Environmental Technician and Manager for reporting/tracking PWAK BASH related data IAW USFWS requirements.

7.5.5. In accordance with ISS PWS, the contractor shall track the total number of eggs and bird which are taken over the course of the permitted period in accordance with the USFWS Depredation Permit. On An annual basis, the ISS shall submit required USFWS annual report and application for permit renewal to USFWS Portland Regional Office.

7.5.6. Base Operations will also annotate all required actions on AF Form 3616, *Daily Events Log*.

7.5.7. All data collected will be discussed during BHWG meetings. In addition, available data and any actions taken (methods, results, etc.) are provided by the FTBM and AOM to 11AF/SE, for inclusion as part of their semi-annual BHWG meetings.

8. MAPS AND CHARTS

8.1. GENERAL

8.1.1. This annex outlines the use and requirements for local maps and charts required to implement the PWAK BASH Reduction Program. Much of this information is also available in further detail within the Base Comprehensive Remediation Plan.

8.2. WAKE ISLAND AIRFIELD HABITAT MAP

8.2.1. The contractor will utilize the June 2015 Wake Atoll, Kokee AFS, and Mt Kaala INRMP habitat maps for portraying locations of problematic vegetation.

8.2.2. When a specific hazard is identified and the location of the activity is isolated, consult the habitat map to determine if a specific attractant exists that can be altered within the scope of this plan.

8.2.3. Engineering will use the habitat map as a guide for the long-range civil engineering program to reduce actual and potential hazardous environmental factors on Wake Island Airfield.

8.3. BIRD EXCLUSION ZONE (BEZ):

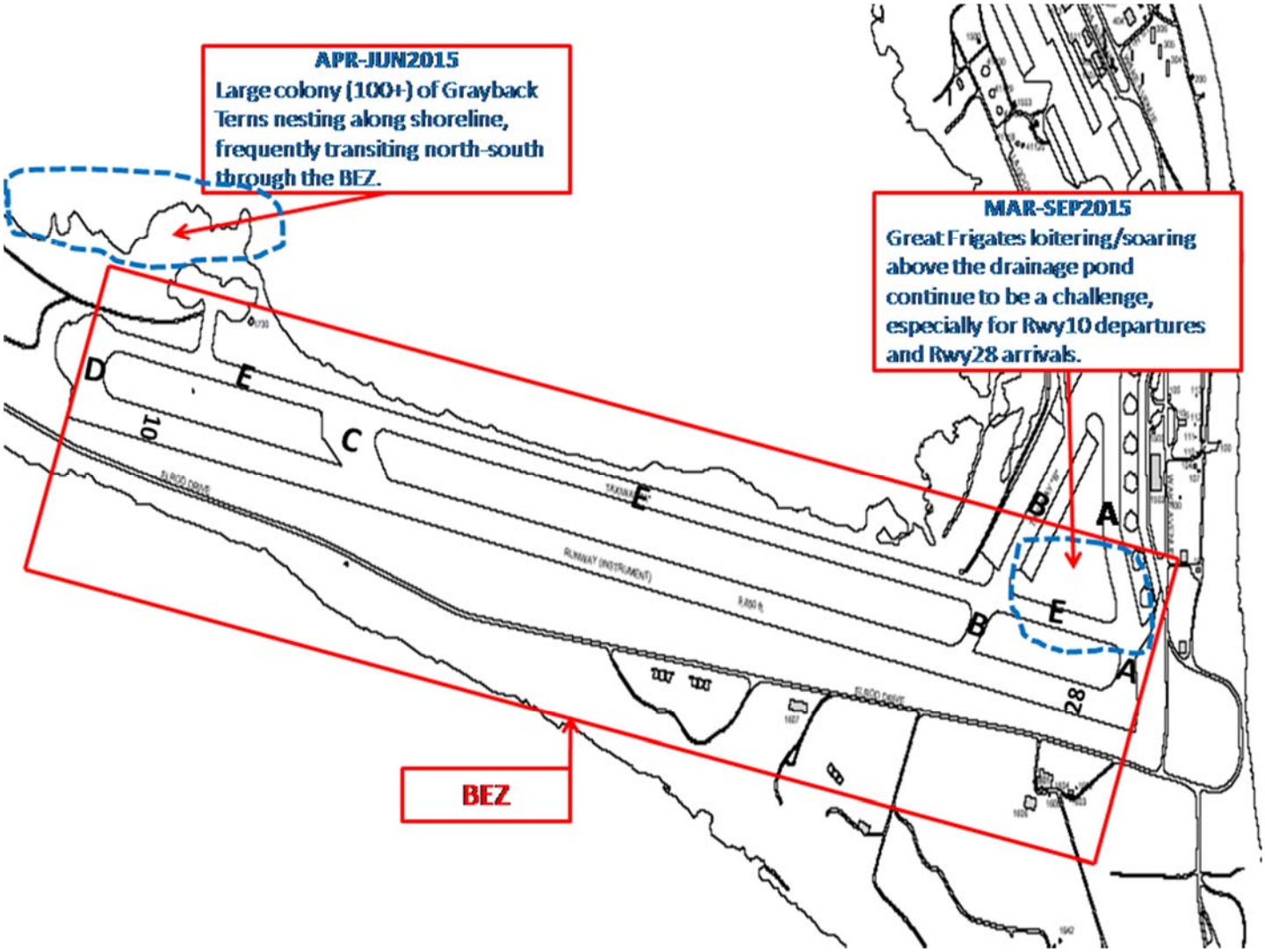
8.3.1. The BDT will operate within the Bird Exclusion Zone (BEZ) when activated by the AOM with the assistance from the FTBM during BWC ***MODERATE*** or ***SEVERE***. During aircraft operations (excluding emergency situations), when the AOM declares BWC MODERATE or SEVERE, the BDT will have priority access within the BEZ to conduct bird/wildlife dispersal.

8.3.2. As outlined within the 11th AF Supplement to AFI 91-202, the BEZ is defined as an area, 1,000' X 1,000' either side of centerline, over the entire length of the runway, to include the overruns.

8.3.3. The BDT will make every effort to eliminate all bird/wildlife hazards within the BEZ in a timely manner, as is both reasonable and prudent to sustain mission requirements and overall flight safety.

8.3.4. In addition to immediate response measures, the BDT will utilize historical data from previous years to identify, monitor and apply long term mitigation techniques to reduce attractiveness; minimize use as nesting, loafing or feeding areas. (***See Figure 1, PWAK BEZ and BASH Observed Habitat Map***).

FIGURE 1 - PWAK BEZ and BASH OBSERVED HABITAT MAP



9. PYROTECHNIC AND FIREARM USE

9.1. SAFETY

9.1.1. Pyrotechnic scare cartridges and launchers must only be used by properly trained staff who have a clear understanding and working knowledge of these devices.

9.1.2. Always purchase high-quality, purpose-built pyrotechnic launchers and cartridges. These devices provide a greater safety margin than modified products originally designed for other applications.

9.1.3. Operators must wear proper eye and ear protection at all times.

9.1.4. Check the barrel after firing each round. Clean barrel as needed.

9.1.5. Store pyrotechnics in cool, dry and secure places to prevent product degradation and restrict access to qualified personnel only IAW approved weapons safety plans.

9.1.6. Never fire into a wind. Fire in a manner and a direction to cause birds to fly away from aircraft movement areas.

9.1.7. Never fire towards vehicles, aircraft, people, buildings, dry fields or any other flammable materials or liquids.

9.1.8. Never fire pyrotechnics from inside vehicles.

9.1.9. Prevent Foreign Object Debris (FOD) by collecting all pyrotechnic debris from airside areas.

9.1.10. Wait 30 minutes before removing misfires or duds from launch devices. Ensure both the chamber and barrel is safely aimed when removing these cartridges.

9.1.11. Duds, misfires and damaged pyrotechnic cartridges should be soaked in water for 24 to 48 hours prior to disposal.

9.1.12. Ensure operating instructions accompany pyrotechnic launchers at all times.

9.1.13. Do not attempt to modify pyrotechnic cartridges.

9.2. LOADING AND FIRING PYROTECHNICS (SCREAMERS AND BANGERS)

9.2.1. Load and discharge all launchers according to manufacturers' instructions.

9.2.2. Insert a pyrotechnic device into the pistol according to instructions in the launcher's manual. Screamers load hollow end first; bangers load fuse end first. Check and be sure the pyro fits loosely into the muzzle end. If force is

required, remove the pyrotechnic cartridge and clean the muzzle, otherwise the device may not function properly.

9.2.3. Hold pistol away from the body and fire in the direction of birds. Screamers will normally travel more than 60 metres; bangers will normally travel more than 25 metres.

9.3. TRANSPORTING PYROTECHNICS SAFELY

9.3.1. Cartridges must be transported in closed, non-flammable containers away from any source of ignition. Use of open trays containing multiple pyrotechnic cartridges is not recommended.

9.3.2. Smoking is prohibited when transporting and deploying cartridges, and at all times when airside.

9.3.3. Never transport launchers loaded with crimped blanks or pyrotechnic cartridges.

9.4. GENERAL GUIDELINES FOR SAFE USE OF FIREARMS

9.4.1. Use of firearms should be undertaken only in close cooperation with the FTBM and Airfield Operations staff.

9.4.2. Never point loaded or unloaded firearms at anyone. Carry firearms pointed toward the ground.

9.4.3. Never keep a firearm loaded, even with the breech open.

9.4.4. Examine firearms and liners daily. If these appear faulty or defective, report immediately as unserviceable.

9.4.5. Handle cartridges carefully to ensure they don’t become distorted, damaged or wet.

9.4.6. Whenever using firearms, personnel must wear appropriate apparel which includes:

- ✓ effective eye and ear protection
- ✓ long-sleeved clothing to help prevent burns caused by misfires
- ✓ form-fitting gloves specifically designed for weapons use

9.4.7. Due to their relatively short lethal range, shotguns are safer than, and therefore preferred over, rifles for wildlife control.

9.4.8. Never fire across active runways.

9.4.9. Prevent FOD (Foreign Object Debris) by collecting all empty casings from airside areas.

9.4.10. Never load or discharge firearms while inside a vehicle.

9.5. GENERAL GUIDELINES FOR SAFE TRANSPORTATION AND STORAGE OF FIREARMS

9.5.1. Firearms may be transported only when they are unloaded and rendered inoperable by means of a secure locking device.

9.5.2. All firearms should be stored upright in racks.

9.5.3. Shotguns and rifles left in unattended vehicles must be locked in racks or other secure compartments.

9.5.4. Lock all unattended vehicles which contain firearms.

9.5.5. Firearms must be unloaded with the safety on when stored inside vehicles.

9.5.6. Do not hide firearms inside vehicles. Not only can firearms become dirty and unserviceable, they can also be forgotten when out of sight.

9.5.7. Operators must never load or discharge firearms while inside vehicles.

BASH REDUCTION MANAGEMENT PLAN
ATTACHMENT 1

RECOMMENDATIONS FOR MANAGING SOOTY TERNS NEAR ACTIVE RUNWAYS

Social Behavior of the Sooty Tern during Colony Initiation

Sooty Terns (*Onychoprion fuscatus*) nest on mammal-free islands in the tropics and subtropics around the world. They are long-lived, lay a single egg that both parents incubate and have a relatively long chick-rearing period for their size (200 grams) of approximately 10 weeks. They are exceedingly social, preferring to nest in dense aggregations with egg densities of 4 per square meter when the vegetation and terrain allows it. They prefer open windy sites with low or sparse vegetation perhaps because their thermoregulatory adaptations to high temperatures require wind speeds that allow for convective cooling. They enjoy the highest reproductive success when a pair is surrounded by other pairs that have laid their eggs at approximately the same time. Therefore much of their courtship and pre-laying behavior is aimed at breeding synchrony with other members of the group. Chicks that hatch earlier or later than the majority of young birds in their vicinity of the colony have lower survival rates.

The selection for synchrony with colony mates affects the process of colony formation. Sooty Terns do not stay in the area of the breeding colony when they are not breeding. A typical Sooty Tern breeding season begins with birds arriving at the island but just flying over and not landing. As the numbers of birds increases a noisy swirling kettle of calling birds forms every evening over the eventual breeding colony. The birds fly and call overhead into the middle of the night and then disperse during the day. This displaying without coming to land may go on for 1 or two months but finally the birds will start landing after dark and courting and displaying on the ground in the chosen area.

They will continue to leave in the early morning until the time has come to start laying eggs when they stay past dawn and the colony begins. Egg-laying takes place along an active front that is characterized by swirling and screaming birds. This activity signals to all the birds ready to lay that day where the best place to be is to end up with other birds at the same stage. The colony grows at these laying edges and maintains a consistent and tightly packed density until all the birds have laid their eggs and then they start quietly incubating for 30 days till hatching.

Methods to Discourage Sooty Terns from Choosing a Colony Site

1. Create attractive and suitable habitat available for the birds before they start arriving at the atoll or island. For instance at Wake, keeping the Wilkes Island colony area mowed or scraped with patches of grass and low ground cover interspersed with bare ground makes it very attractive. Keeping some openings in the shrubs around the perimeter would improve air flow and make it even more attractive. Due to other species nesting in that area it requires careful and selective mowing, weed-whacking, and shrub cutting so other nests are not compromised.

2. Monitor aerial displaying carefully and make sure that any birds landing in unacceptable sites are hazed immediately. This requires working at night and patience and persistence because the process of scaring the birds up from the ground causes them to call louder and the vocalizations are an attractant to other Sooty Terns in the area. Once there are too many birds landing, it is very difficult to stop them from laying. Early detection and constant attention is the best way to catch it and change their collective mind about a colony site. Riding back and forth through settling birds with a bicycle and strong flashlights until they disperse has been successful in the past. Once birds start landing at night there can be no break in vigilance or they will start laying eggs.

AVIAN MANAGEMENT PROJECTS TO IMPROVE BASH CONDITIONS AT WAKE ISLAND AIRFIELD

Project Title	Goal of Project	Implementor
Peale Island Avian Social Attraction	**Utilize Decoys and Vocalization tools to attract problematic seabird species to Peale Island.**	**611 CES/CEIE**
Native Plant Nursery Operations and Strategic Outplanting	**Erect and establish breeding program for native plant species; outplant in areas cleared of ironwood and/or other invasives.**	**611 CES/CEIE and BOS**
On Island BASH Specialist	**Utilize on site contract staff to perform hazing duties, collect data required by USFWS permit. In addition, manage the annual reporting, as well as renewal of the USFWS permit.**	**BOS**
Ironwood Control	**Utilize machinery, herbicide and manual pulling to remove ironwood from the atoll.**	**611 CES/CEIE and BOS**
Atoll Wide Quarterly Avian Monitoring	**Deploy avian experts to track the status of the atolls avifauna, using hsitoric index and census methodologies.**	**BOS**

COMPONENT PLAN D

WAKE ISLAND BIOSECURITY MANAGEMENT PLAN

WAKE ISLAND BIOSECURITY MANAGEMENT PLAN

Prepared For

The Department of Defense
United States Air Force
Pacific Air Forces Regional Support Center
611th Civil Engineer Squadron
Joint Base Elmendorf-Richardson, Alaska

Revised June 2015
Edition 4.0

Table of Contents

Appendices

FOREWARD

The 2012 version of the "Wake Island Biosecurity Management Plan" has been updated to reflect changes impacting the structure of the biosecurity program which is actively managed and implemented by a team of 611th Civil Engineer Squadron staff, remotely embedded support contract staff, and key government collaborators. The preceding version was a pre-requisite milestone associated with the 2012 rodent eradication, which took place in May of 2012. Even though the eradication attempt conducted only resulted in the removal of 1 of the 2 species impacting the atoll (*Rattus tanezumi*), the need for continued implementation of the biosecurity guidance contained within this document is warranted, as are intermittent updates of the plan. The revisions contained herein have been guided by a 30 day public review, internal USAF review, and external natural resource agency (NOAA, USFWS, State of Hawaii) review conducted during the spring of 2015. The processes and procedures detailed within this plan update are applicable to not only the USAF users of the atoll (active duty, civilian, and contract staff) but also to other tenants who use the property on a temporary or long term basis.

EXECUTIVE SUMMARY

A simple definition of biosecurity used by scientific professionals is as follows: protecting an island (or secure area) from a target pest (Browne 2005). Protection can be further divided into operational components such as prevention, detection, and incursion response (Russell 2008). Each of the three components previously mentioned consist of onshore and offshore practices, and when implemented appropriately, are highly likely to result in the successful protection of an island's resources.

The bioseucirty tools utilized during the prevention, detection, and incursion response stages are constantly evolving and researchers have experimented with numerous techniques in an effort to create barriers and inspection processes that are 100% impassable to a wide spectrum of organisms. Unfortunately, a valid biosecurity plan cannot be built upon one component or tool, but rather it must address invasion or re-invasion with an array of barriers and inspection processes that have displayed a high value of efficacy in other scenarios. Practitioners benefit from tailoring their biosecurity plans to the species most likely to re-invade, but in some cases predicting every potential invader is not possible (DON 2015). Given Wake's strong connection to other ports and airfields in the Pacific, in particular Guam and Oahu, the tracking of new incursions at these delivering depots becomes vital and in some cases justification for plan updates. Recent incursions to Oahu (e.g. discovery of Coconut Rhinocerus beetle on Oahu) have resulted in altered monitoring regimes at Wake Atoll, inclusive of the initiation of a trial Coconut Rhinocersus beetle monitoring program. Unfortunately, the discovery of a new invasive species on offshore installations or commercial ports in the Pacific does not result in a reduction of effort, but rather it becomes additive, requiring the biosecurity program to grow and address what management actions shall be implemented to address the new risk. By updating the document to address new risks and management apporoaches, the USAF continues to pledge its commitment to thwart future incursions of invasive species to Wake Atoll and any subsequent receiving installation or port.

The following plan will provide base personnel with a brief history of the island and its unique natural resources, the laws and internal USAF instruction governining biosecurity, applicable invasions routes, incursion prevention guidance, methods and guidance pertaining to interception, detection, and rapid response, and finally a list commonly used biosecurity terms and their definitions.

1.0 WAKE ISLAND BACKGROUND

1.1 Island Location

Wake Island (also commonly referred to as Wake Atoll) is a tiny island lying at approximately 19˚17' 1.854" North latitude and 166˚39' 4.566" East longitude (DATUM WGS 84). It is approximately 2,460 mi. (3956 km) west of Honolulu, 1590 mi. (2,545 km) east of Guam, and 690 mi. (1,140 km) north of Kwajalein Atoll.

1.2 Island History and Previous Management

The islands were first discovered in 1568 by Spanish explorers and then were forgotten for more than 200 years. They were rediscovered in 1796 by the British Captain William Wake and explored in 1841 by U.S. Navy Commander Charles Wilkes and naturalist Titian Peale. The islands were claimed by the United States in 1898, with formal possession established in 1899. In 1899 the United States utilized Wake Island as a cable station; today, Wake Island is an unorganized, unincorporated territory of the United States. Executive Order (E.O.) 11048, Part I (September 5, 1962), designated the Secretary of the Interior responsible for the civil administration of the island. The order gave the Secretary all executive, legislative, judicial authority necessary for that administration other than that of the U.S. District Court for the District of Hawaii (DOI 2015). Because of its unique jurisdictional setting, only federal natural resource and wildlife protection laws apply to Wake Atoll. No state, territorial, or commonwealth natural resource or wildlife protection laws apply (DOI 2015).

The U.S. Navy was given jurisdiction over the islands in 1934 by President Franklin Roosevelt. Development of the islands did not commence until the following year when Pan American Airlines (PAA) received permission to establish a seaplane refueling base on Peale Island. PAA subsequently built a single-story hotel, rainwater catchments, and several other support buildings and structures to support its weekly trans-Pacific flight service.

Plans were developed in 1938 for an outlying military base on Wake Island; however, construction on the atoll for a submarine and seaplane base by the U.S. Navy did not begin until January 1941. U.S. Marines arrived on the base in August 1941, along with a small naval contingent. The base was approximately 65 percent complete and supported a population of over 1,700 civilian and military personnel when the Japanese invaded and overran the island in December 1941. The island was occupied by Japanese forces for the remainder of World War II.

The Japanese continued the development of Wake Atoll during their occupation by constructing a runway, support buildings, and a defense system. Allied planes flew approximately 27 bombing missions on the islands during the occupation. Due to frequent bombing by the United States, many of the Japanese structures were constructed underground or embanked. The islands reverted back to American control in September 1945, after the Japanese surrender and the island was then again placed under the jurisdiction of the U.S. Navy.

In 1947, authority over the islands passed from the U.S. Navy to the Civil Aeronautics Administration, which later became the Federal Aviation Administration (FAA). During this time, contractors for the Military Air Transport Services and later the Military Airlift Command (MAC) provided service to transient USAF aircraft while at Wake Atoll. PAA, Trans-Ocean Airlines, British Overseas Airline Corporation, and others reestablished commercial airline services which lasted until 1972. A U.S. Coast Guard Station was established on Peale Island after the war and abandoned in 1971. Long-

Range Aid to Navigation radar facilities were also established by the Coast Guard on Wilkes Island. During the height of post-WW II use of Wake Atoll, the island population was nearly 2,000. An elementary school had been constructed. The school and many of the houses used by the families have since been torn down because of asbestos problems or have fallen into disrepair.

The development of long-range jet aircraft diminished the need for Wake Atoll as a refueling stop for commercial aircraft and, in 1972, the FAA transferred jurisdiction of its facilities on the islands to the USAF. In the agreement effective June 14, 1972, civil administration authority was transferred from the Federal Aviation Administration (FAA) to the U.S. Air Force. The Atoll was operated as Wake Island Airfield by Det 1, 15th Logistics Group, 15th Air Base Wing, Hickam Air Force Base. In 1993, the USAF terminated its operation of Wake Island but retained real property accountability. The U.S. Army operated the airfield from September 30, 1994 until October 1, 2002 when the USAF resumed direct responsibility for island operations.

Presently, the Pacific Air Forces Regional Support Center (PRSC) based out of Anchorage, Alaska supports Wake Atoll. The installation functions in support of contingency deployments, serves as an emergency landing facility, provides fuel storage, and supports the needs of the greater DoD community. The 611th Civil Engineer Squadron (CES) is responsible for the management of natural resources including biosecurity. The civilian contractor responsible for base operations at Wake Island, including biosecurity support, is Chugach Federal Solutions Inc. (CFSI), also referred to as the Base Operating Support (BOS) contractor. CFSI also participates and supports offshore biosecurity actions, in particular the loading of intercepting tools into containers bound for Wake atoll.

1.3 Current Island Management

The main mission of Wake Island is to support CORONET WEST missions. At present, the activities provided under the BOS contract include but are not limited to the following:

- Produce potable water and maintain the reverse osmosis systems.
- Maintain and operate the fuel systems.
- Maintain and operate electrical power generation and distribution.
- Maintain food inventory and consumables - provide 2,100 hot meals/wk with a surge capacity of 3,100 meals/wk.
- Provide temporary billeting services for 80 personnel with a surge capacity of 45 personnel.
- Provide fire protection and emergency services.
- Maintain grounds, building, equipment, and vehicles.
- Provide refuse collection operations where collected domestic/recycled waste is transported to the solid waste disposal site in the 1600-area.
- Maintain all heating, cooling, and air conditioning (HVAC) systems.
- Repair and maintain the electrical grid.
- Maintain channel buoys in the marina.
- Maintain long-range radios and other communications.
- Provide services of a full-time, board-certified medical physician.

The 9,850-ft. runway has recently been repaired and is capable of handling most aircraft. The aircraft ramp is configured with eight fueling hydrants fed from the fuel storage tanks in the 1500-area. Wake Atoll receives an AMC-chartered flight every other Friday from Joint Base Pearl Harbor Hickam carrying temporary contractors and supplies. Weekly chartered flights have been discontinued. Other supplies, large equipment, and JP-5 fuel are transported to Wake Atoll via ocean-going barges; the frequency of vessel arrivals to Wake is contingent on annual need and project composition. On an annual basis,

Wake is visited by at least one re-supply barge and fuel barge. Barges are towed via tug and the barges are loaded primarily with containerized equipment (both 20 and 40 foot sealed containers). Occasionally break bulk items (vehicles, large heavy construction equipment, and oddly shaped cargo) are shipped in addition to containerized cargo. Two transit routes are utilized by commercial barges to reach Wake. Often the barge will begin its voyage from Oahu and steam directly to Wake, however in some cases due to cost, shipping companies have directed barge traffic to Guam first, prior to final delivery at Wake.

Wake Island Airfield has three distinct areas of activity: the airport, the industrial area, and "downtown" (see Figure 1-1). The airport consists of a 9,850-foot runway, supporting taxiways, tarmacs, airport terminal, and various navigational aids. The industrial area includes aviation and airfield maintenance shops, fire and rescue, aircraft fueling support facilities, Civil Engineering, and supply and warehouse buildings. Other industrial facilities in the area include shops, water collection, and distribution centers. The downtown area supports housing, a cafeteria, a laundromat, medical clinic, chapel, and exercise facilities.

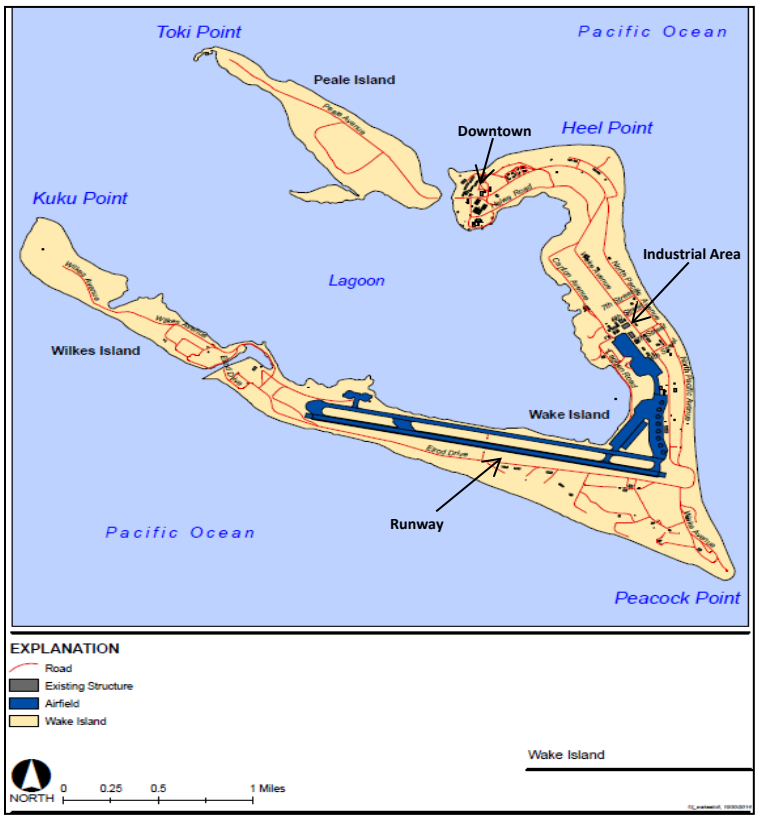


Figure 1-1. Layout of Wake Atoll (*Image Provided by MDA*)

2.0 NATURAL RESOURCES OF WAKE ATOLL

Wake Atoll is home to not only USAF and MDA missions, but also a rich mixture of marine and terrestrial species. Wilkes Island is the location of the atoll's primary seabird colonies, however nesting has been recorded for a variety of avian species on each island. Historical conservation actions have benefited the island's natural resources, in particular the seabirds. It was not until after the feral cats of Wake Island were eradicated that the seabird species richness and population sizes began to increase. In order to track the status and condition of the seabird populations, the USAF funds annual monitoring efforts. Biological surveys have been conducted by the Endangered Species Recovery Council (Ogden 1999), Rauzon and Gilardi (2007, 2008a, 2008b), Pacific Island Research Consortium (PICRA 2008, 2009, 2010), Pacific Rim Conservation (2010, 2011), USFWS (2012), Island Conservation (Pott et al. 2013) and United States Department of Agriculture (USDA) (2014 unpublished data). Survey efforts in some years have focused on biota other than avian species. Non avian monitoring and research has included the following foci: Sea turtle monitoring, intertidal organism population surveys, insect population surveys, invasive rodent eradication planning and research and plant control research (specifically ironwood control).

2.1 Marine Life

The waters surrounding wake have been inventoried by several agencies. The marine waters are home to more than 100 species of coral and a diverse assemblage of pelagic and near shore fishes. In-water survey efforts conducted in 1998 and 2005 provided results which serve as the primary databases for coral species present around the atoll (Kenyon 2013, USFWS 1999). Research efforts have also been extended to include fish and intertidal organisms. USDA fish collection efforts in 2015 assisted with slot size definitions for lagoon species, as well as further documentation regarding the absence or presence of specific compounds within fish tissues. Intertidal surveys conducted in 2009 revealed a diverse array of species and serves as a baseline for future comparisons, should rodents be removed in totality from the atoll (Zabin 2009). The results of the 2009 survey displayed a very rich and diverse array of organisms (see Figure 2-1 below). Marine survey efforts are forecasted in the future (specifically continued coral research and fish population surveys) and will tier off previous survey efforts, so as to ensure changes in population age structure, geography, health, and size are documented appropriately.

Figure 2-1. A sample of species discovered during 2009 Intertidal Surveys (*Image Provided by C. Zabin*)

2.2 Birds

The surveys performed within the previous 15 years have recorded a variety of avian species utilizing Wake Atoll. The shorelines and wetlands provide habitat for a variety of shorebirds and waterfowl, while interior portions of the islands provide refuge for nesting seabirds. Common birds encountered on the atoll are listed in Table 2-1.

TABLE 2-1 COMMON BIRDS OF WAKE ATOLL

Diomedeidae	
Laysan albatross	*Phosbastria immutabilis*
Black-footed albatross	*Phoebastria nigripes*
Procellariidae	
Wedge-tailed shearwater	*Puffinus pacificus*
Christmas shearwater	*Puffinus nativitatus*

TABLE 2-1 COMMON BIRDS OF WAKE ATOLL (CONTINUED)

Fregatidae	
Great frigatebird	*Fregeta minor*
Phaethontide	
White-tailed tropicbird	*Phaethon lepturus*
Red-tailed tropicbird	*Phaethon aethereus*
Sulidae	
Masked booby	*Sula dactylatra*
Brown booby	*Sula leucogaster*
Red-footed booby	*Sula sula*
Laridae	
Black noddy	*Anous minutus*
Brown noddy	*Anous stolidus*
White tern	*Gygis alba*
Sooty tern	*Sterna fuscata*
Grey-backed tern	*Sterna lunata*
Charadiriidae	
Pacific golden plover	*Pluvialis fulva*
Scolopacidae	
Ruddy turnstone	*Arenaria interpres*
Wandering tattler	*Heteroscelus incanus*
Grey-tailed tattler	*Heteroscelus brevipes*
Sanderling	*Calidris alba*
Dunlin	*Calidris alpine*
Sharp-tailed sandpiper	*Calidris acuminate*
Bristle-thighed curlew	*Numenius tahitiensis*
Anatidae	
Pintail Duck	*Anas acuta*

2.3 Other Wildlife

Within the terrestrial ecosystems of the atoll, several small reptiles can be encountered and they include the mourning gecko (*Lepidodactylus lugubris*), house gecko (*Hemidactylus frenatus*), stump-toed gecko (*Gehyra mutilata*), snake-eyed skink (*Cryptoblepharus boutonii*), and azure-tailed skink (*Emoia cyanura*). The snake-eyed skink and stumped toes gecko have not been sighted in recent years, however the remaining aforementioned reptiles are commonly seen.

Aside from two pet cats, the only other mammalian species present on the atoll is limited to the Polynesian Rat (*Rattus exulans*). Rodent eradication efforts in 2012 successfully removed the Asian House Rat (*Rattus tanezumi*) from the atoll, but the Polynesian Rat population survived the eradication effort and has rebounded. As of June 2015, rodents have not been document on Peale Island, suggesting both species have been eradicated from that specific island.

Terrestrial invertebrate populations on Wake Atoll are diverse. In 2009 PICRA completed an arthropod survey resulting in the collection and identification of 148 species (Hebshi et al. 2011). Subsets of the insects discovered in 2009 are considered invasive. For further information pertaining to the wildlife of Wake Atoll, please see "Chapter 5" of the 2015 Integrated Natural Resource Management Plan for Wake Island Airfield, Kokee AFS, and Mt Kaala AFS.

2.4 Threatened and Endangered Species

Federally protected terrestrial biota on Wake Atoll is limited to migratory seabirds and shorebirds. These birds are classified as "migratory" and protected under the Migratory Bird Treaty Act (MBTA) of 1916 (USAF 2012). There is no exclusively terrestrial biota federally listed as threatened or endangered under the Endangered Species Act (ESA), currently or reported from Wake Atoll (USFWS 1998). Sea turtles are present within the waters surrounding wake atoll, and are protected by the ESA, however a confirmed nesting attempt at Wake has never been documented, and thus the island is not considered a prime nesting location for nesting sea turtles.

3.0 IMPETUS FOR BIOSECURITY

The spread of invasive species is now recognized as one of the greatest threats to the ecological and the economic well-being of the planet (IMO 2015). An invasive species is defined by Executive Order (EO) 13112 as a species whose introduction has caused or may cause harm to environmental or human health (NISC 2008). Biosecurity is a concern to the United States government and the world. This plan has been created to help the Air Force carry out their responsibilities for the prevention, rapid response and control of non-native species on Wake Island. As global commerce, trade and travel continue to exist and evolve so will the need and policies of biosecurity management. This section provides a brief introduction to some of the policies and programs that are currently in place that directly or indirectly address non-native species issues on Wake Atoll.

3.1 Non-Native Species Laws, Policies and Protocols

INTERNATIONAL

- The Department of Defense Foreign Clearance Guide (DoD FCG) provides necessary information for aircraft and vessel international mission planning and execution, personnel travel to foreign

countries, as well as general information on foreign locations (including Wake Island). This DoD FCG is directive in nature for all DoD and DoD-sponsored travel abroad; travelers must ensure they comply with this Guide. It is accessible via website: https://www.fcg.pentagon.mil/. It was last updated on 16 March 2015 and is provided within Appendix A for further reading.

- US Pacific Command (USPACOM) Defense Transportation Regulation, (specifically chapter 511), identifies directives and establishes Customs/Border Clearance requirements and procedures and organizational points of contact. This regulation provides the most up to date overseas customs processes (although Wake Island is a US territory it is included within this regulation). A copy of the Wake Island section of the USPACOM Defense Transportation Regulation can be found in Appendix B. It was last updated 15 October 2014 and outlines several key biosecurity requirements shippers must complete prior to arriving to the atoll.

- The International Plant Protection Convention (IPPC) is an international agreement on plant heath with 177 current signatories (signed by the United States in 1951). The IPPC aims to protect cultivated and wild plants by preventing the introduction and spread of pests.

- The International Maritime Organization (IMO) has been at the front of the international effort by taking the lead on addressing the transfer of aquatic invasive species (AIS) through ship. IMO has done this through the adoption of "guidelines adopted in 1997 for the control and management of ships' ballast water to minimize the transfer of harmful aquatic organism and pathogens" (IMO 2011).

NATIONAL

- National Invasive Species Act of 1996 is a reauthorization and amendment to the 1990 Nonindigenous U.S. Aquatic Nuisance Prevention and Control Act of 1990 (P.L. 101-646) which authorized the National Oceanic and Atmospheric Administration and the U.S. Fish and Wildlife Service to address aquatic invaders. Section 1103 of the 1996 act states that the "Secretary of Defense shall implement a ballast water management program for seagoing vessels of the Department of Defense and Coast Guard.

- The Lacey Act combats trafficking in "illegal" wildlife, fish and plants. Amended by the 2008 Farm Bill, the Lacey Act makes it unlawful to import certain plants and plant product without an import declaration (USDA-APHIS 2015).

- The Endangered Species Act of 1973 permits the eradication of non-native species posing a threat to endangered species; furthermore, section 7 of the Endangered Species Act requires Federal agencies to insure that any action authorized, funded or carried out by them is not likely to jeopardize the continued existence of listed species or modify their critical habitat.

- EO 13112 which was established to prevent the introduction of invasive species; provide for their control; and minimize the economic, ecological and human health impacts that invasive species cause. This executive order defines invasive species, requires federal agencies to address invasive species concerns and to not authorize or carry out new actions that would cause or promote the introduction of invasive species, and also established the Invasive Species Council**.**

AIR FORCE INSTRUCTION (AFI)

- AFI 32-1053, Integrated Pest Management Program. This instruction implements Air Force policy directive (AFPD) 32-10, Installations and Facilities, 27 March 1995, and Department of Defense Instruction (DODI) 4150.7, DOD Pest Management Program, 29 May 2008. The objectives of the AF pest management programs are to meet or exceed DOD pest management Measures of Merit (MoM), and promote and support the following: Military readiness, installation program planning and maintenance, pollution prevention, conservation of natural/cultural resources and environmental compliance and integrated pest management.

- AFI 32-7064, 14.1. Invasive Species Management Policy. Executive Order 13112, *Invasive Species*, February 3, 1999 requires all federal agencies to prevent the introduction of invasive species, provide for their control and minimize their economic, ecological, and human health impacts. Under Executive Order 13112, installations will, to the extent practicable and permitted by law, not authorize, fund, or carry out management actions that are likely to cause the introduction or spread of invasive species. Furthermore, Title 7 U.S.C. §2814 states that each federal agency shall establish and adequately fund an undesirable plants management program through the agency's budgetary process.

- AFI 32-7064, 14.2. Invasive Species Management Program. Address invasive species management in the installation INRMP. Formulate and implement INRMP goals and objectives to detect, respond to, and control populations of invasive species in a cost-effective and environmentally sound manner whenever and wherever practical. INRMP goals should be consistent with the Federal Invasive Species Management Plan and other guidelines promulgated by the Federal Invasive Species Council. The invasive species management element of the INRMP will provide specific information on species to be controlled, recommended control methods, and appropriate level of control effort in consideration of available resources. Promote native habitats and the restoration of native species in ecosystems that have been invaded.

- AFI 32-7064, 14.3. Invasive Species Detection and Monitoring. The INRMP will include a current assessment of the presence and extent of exotic and invasive species on the installation. Conduct surveys to detect and map invasive species. Monitor invasive species populations and update inventory information as new species are discovered and known populations are controlled or eliminated.

- AFI 32-7064, 14.5. Control of Feral Animals. Installations will, to the extent practicable and permitted by law, not authorize, fund, or carry out activities that are likely to cause the introduction or spread of feral dogs, cats, pigs, goats or other non-native domesticated animals on AF-controlled lands. The INRMP will address the specific policies, programs and methods used to control feral animals on AF installations. Feeding or harboring of feral domesticated species is prohibited unless justified in the INRMP as necessary to achieve a specified natural resources management objective. (T-2).

- AFI 32-7064, 14.6. Interagency Cooperation. Title 7 U.S.C. §2814 authorizes cooperative agreements with state agencies for the control of undesirable plant species on federal lands. Partner with other federal, state, and local agencies and adjacent landowners in joint control strategies to collaborate efforts for the control of undesirable species and increase the effectiveness of control measures. (T-0). Installations are encouraged to participate in state or regional Exotic

Pest Plant Councils and Cooperative Invasive Species Management Areas at a level of effort that is commensurate with efforts by the partners and within the legal authority of the AF.

STATE

- Although Wake Atoll is not officially part of the State of Hawaii, it was previously managed by the 15th Air Wing based out of Hickam Air Force Base, Honolulu, Hawaii (as discussed in section 1.2 Island History and Previous Management); currently the Senior Airfield Authority (SAA) for Wake is the 611th Air Operation Center (AOC) with the large majority of access to Wake coming directly from Hawaii. Therefore many of the state laws and regulations that govern and manage invasive species in Hawaii are indirectly applicable to Wake Atoll. The AF currently uses the State of Hawaii list of Invasive and Noxious Weeds as the baseline to determine what is invasive on Wake Island (DPI 2003). The following website depicts a list of species considered to be state listed noxious weeds: http://plants.usda.gov/java/noxious?rptType=State&statefips=15 .

- In 2006, Act 85 amended by Act 109, Session Laws of Hawaii (SLH) 2006, became permanent law in Chapter 194-2, Hawaiian Revised Statues (HRS), and Invasive Species. This law establishes the interagency Hawaii Invasive Species Council (HISC), the purpose of this council is to coordinate and promote efforts to prevent, eradicate or control invasive species and maintain an overview of the issues related to invasive species in Hawaii. The Hawaii State Legislature authorized the creation of HISC under Act 85, SLH 2003, and stated "the silent invasion of Hawaii by alien invasive species is the single greatest threat to Hawaii's economy, natural environment, and the health and lifestyle of Hawaii's people and visitors."

- Invasive Species Committees of Hawai'i (ISCs) are island-based partnerships of government agencies, non-government organizations, and private businesses working to protect our Islands from the most threatening invasive pests, a total of 34 active targets (Hawaii Invasive Species Council, 2009).

3.2 Requirements of the 2009 Environmental Assessment (EA) for Addressing the Systematic Eradication of Non-Native Rodents From Wake Atoll

- The 2009 EA considered the implementation of a biosecurity plan a pre-requisite action. It further defined that should such a plan be implemented to no later than 6 months prior to the application of rodenticide.

- This 2009 EA also stated that the United States Fish and Wildlife Service (USFWS) would not engage in an operation without the existence of a biosecurity plan and more importantly, corresponding action on the ground which includes efficacy testing on a continual basis.

- Other milestones were embedded in the 2009 Operational Plan, which was a component of the EA. These milestones continue to be viewed as pre-requisite actions that shall be monitored for continued implementation. They include but are not limited to the following: the installation of an operational gasifier or incinerator to rid the island of accessible municipal waste which contained edible food items for commensal rodents, proper garden management, and proper waste containment prior to incineration or gasification. These items will remain pre-requisite actions, if a follow on eradication attempt were to be carried out in the future.

4.0 INVASION AND REINVASION ROUTES

The invasion and the reinvasion routes for invasive species accessing Wake Atoll can be described in three pathways: via air, contracted barge or stranded vessel. Cargo containers and break bulk cargo (goods that must be loaded individually, and not in intermodal containers) arriving to Wake via an annual barge departing the Fleet Industrial Supply Center (FISC) at Joint Base Pearl Harbor Hickam (JBPHH) are the biggest concern and threat. Sporadic vessel and air traffic from Guam, specifically Andersen Air Force Base and the Commercial Port of Guam, has resulted in the need to coordinate with USDA – WS to ensure canine teams (trained to detect Invasive Brown Treesnakes) inspect any goods and transportation platforms prior to departure.

4.1 Air

Air transportation guidelines have been created to ensure that all pilots, loadmasters, and flights transiting through Wake are aware of the biosecurity measures applicable to the installation. Guidelines nested within the Defense Transportation Regulations (DTR) and Foreign Clearance Guide (FCG) serve as a primer for crews to read prior to disembarking. Information possessed within the DTR addresses invasive species. The majority of air cargo destined for Wake via air originates at the AMC cargo facility at JBPHH, which is illuminated 24 hours a day for security reasons however this also helps in the detection and, in some cases, as a deterrent of invasive species. The USAF pest control operators issued a high density of traps and bait stations to this area in 2009 (n= 29 stations) in order to heighten the offshore defenses against potential rodent incursions. Pest control shops at JBPHH now fall under Navy control as a result of Joint Basing, thus NAVFAC HI and Navy Region Hawaii manage the financial limits as to what level of control and monitoring can take place on Navy properties.

4.2 Barge

Cargo containers and equipment destined for Wake usually arrive to the FISC in early April of each year and are further shipped to the island using tugs and open aired barges (no engines or quarters are on open aired barges). Rat deflectors, bait stations, traps, and indicators (wax chew blocks, ink cards, and visual inspections) are key elements of offshore prevention that are implemented at the FISC. FISC properties are kept free of weeds and other pest plants, in order to minimize the movement of invasive plants. Further, the FISC wearhouse is cleaned routinely, to ensure harborage for pests is minimized. In 2015, Goodnature traps were purchased in order to trial their efficacy as it pertains to controlling or detecting rodents in the areas.

Threat of invasive species movement via a ship or barge can take place via ballast water and fouled hulls. Ballast water is essential for safe and efficient modern shipping operations, unfortunately it also poses a serious ecological, economical and health threat due to the multitude of marine species being carried in the ballast water. These species may include bacteria, microbes, small invertebrates, eggs, cysts and larvae of various species. If transferred these species may survive to establish a reproductive population in the new host environment, becoming invasive, out-competing native species and multiplying into pest proportions (IMO, Ballast Water Management 2011). Ships and barges arrive at Wake on a more limited basis compared to aircraft, and with a barge comes an associated contract and or written agreement and that is where the AF has its opportunity to mitigate these potential barge threats to the Wake Island ecosystem. Section 5.2 discusses in further detail recommended verbiage for barge contracts.

4.3. Stranded Vessels

Wake also services as an emergency mooring site and harbor for small vessels in distress. Yachts or sailors in distress are required to request access to the installation prior to arrival via radio and rapid response teams will be required to inspect vessels moored to the docks. It is advised that the on-site pest control manager access the vessel, deploy interception tools (traps, bait stations, glue boards, as well as indicators blocks) in the event a rodent lives aboard. Bait stations are staged at the dock on Wake 365 days a year and will be baited appropriately prior to any vessel coming to Wake to target invasive species that may exist in the vicinity. It is advised that rat traps are also placed along travel corridors to increase the diligence of interception probability in the event of a stranded vessel is brought dockside.

5.0 PREVENTION

Prevention of a biosecurity breach is the first line of defense for averting an invasive species threat; other terms commonly used include “offshore biosecurity”. For Wake Island prevention efforts of the spread of invasive species can be broken down into two elements or tasks; Quarantine and Prescreening. Please refer to the most current Defense Transportation Regulation (DTR) part V for Wake Island specific prevention measures.

5.1 Quarantine

In the biosecurity world, quarantine consists of areas and or facilities that are utilized as staging areas for cargo that maintain a high level of pest management at all times. This involves deploying and managing a variety of preventative measures and detection devises that ensure an invasive-free environment. For aircraft this would include the terminal area and baggage holding facilities. The FISC would serve as the “quarantine area” for barge activities. To achieve a level of biosecurity necessary to consider these staging areas to be under “quarantine”, it is recommended that the following activities be conducted on a regular basis at the two aforementioned locales:

- Staging areas shall be illuminated 24 hours a day
- A high density of snap traps and or glue boards should be deployment in tamper resistant bait stations, these should be placed inside and outside of all buildings, (rats prefer to run along the perimeter of building walls rather than across wide gaps, bait stations should be placed along walls and in corners)
- All snap traps and glue boards inside the tamper resistant bait stations should be armed with a professional rat attractant
- If the staging area has a certified pesticide applicator on staff or contracted out, it is highly recommended that an EPA approved rodenticide (poison) be used to arm the tamper resistance bait stations. 2nd generation anticoagulant are suggested and compounds shall be alternated to reduce the occurrence of genetic resistance. Contrac (bromiadialone) is currently in use on JBPHH and is both a DOD and state certified pesticide if used according to the label
- Quality assurance inspections should occur at each staging facility quarterly
- Do not allow vegetation to grow within the confines of the quarantine area.
- Apply EPA approved insecticides to grounds or via stations to combat invasive insects.
- Utilize detection stations (cameras, tracking cards, glue boards) to detect cryptic insects, reptiles, amphibians, and other targets.

5.2 Pre-Screening

As containers baggage and cargo are being staged and prepared to be sent to Wake Island, a biosecurity prescreening inspection of all containers, baggage and cargo should occur. An example of the PRSC biosecurity prescreening inspection form is provided in Appendix C, this particular inspection form does not have to be used but it is recommended. If this USAF inspection biosecurity prescreening inspection checklist is not used, the proposed inspection checklist needs to be submitted to the PRSC, Natural Resources Program Manager for review and approval. All biosecurity prescreening inspection forms must be submitted for record to the PRSC's Natural Resource Program Manager. It is recommended that at a minimum the following biosecurity prescreening activities occur and are accounted for on an inspection form:

- Rat deflector shields or rat guards are to be deployed to every line used to secure the vessel to the dock both on departure and arrival legs (See Figure 5.1). Rat guards shall be placed by ship's company on all mooring lines and other connecting lines such as service lines between the ship, piers, and seawalls immediately upon berthing and during the entire time the vessel lies alongside a pier.

Figure 1-1. Rat Guard (*Image Provided by US Navy*)

- A high density of snap traps and or glue boards are deployment in tamper resistant bait stations along the dock where ships are tied off, in areas where cargo and containers are being staged, and along the inside and outside of all nearby buildings (rats prefer to run along the perimeter of building walls rather than across wide gaps, bait stations should be placed along walls and in corners)
- All closed containers (minus personal luggage) should be inspected for invasive species
- All closed containers must contain a sticky trap, rodent trap, and Dichlorvos-impregnated insect strips
- Inspection of cargo placed inside of each container for the presence of feces, urine stains, chewing, or other signs of incursion.
- Areas used to store equipment prior to departure will be lit 24 hrs a day and inspection strips will be maintained to deter rodents from traveling along preferred corridors.

5.3 Barge Contract Language

To ensure the above mentioned prevention measures are required and carried out, the following recommended verbiage is suggested for usage by Wake USAF project managers and military leaders when planning logistics.

Stipulation 1: Upon arrival at FISC or other loading dock, contracted tug(s) and barge(s) shall grant vessel access to a Government appointed pest control inspector to verify vessels awarded transport contracts do not show evident sign of invasive species infestation. Inspectors shall be appointed by the

611th Civil Engineer Squadron or Detachment 1 Commander. Inspectors shall be granted access to both the tug and barge any time the vessels are tied up to the dock at FISC or Wake Island in order to complete visual inspections.

Stipulation 2: Prior to entering port, equipment, supplies, cargo and waste on ships shall be inspected to avoid the introduction of invasive pests into Hawaii and or Wake Island. All vessels shall, prior to arrival to Hawaii or Wake, comply with DOD 4500.9-R, Defense Transportation Regulation Part V. Documentation of such inspection shall be provided upon arrival.

Stipulation 3: At Wake Island, contracted vessel inspectors should be on site at all times during the off loading activities. Inspectors shall conduct visual inspections to help ensure that items are free of any alien species, such as snakes, insects, lizards, rodents, etc., prior to being offloaded. No invasive species shall be brought ashore at any time.

Stipulation 4: State of Hawaii Department of Agriculture, USDA, Customs and Border Patrol (CBP), or Guam Port Authority inspectors shall be given the ability, if requested, to board US Flag vessels to assist with inspection of food stores, cargo, plants, animals, and garbage.

Stipulation 5: The intentional importation of invasive species that might cause damage to or be injurious or detrimental to agriculture, horticulture, forest of the State or to federally protected, endangered, or threatened species of Hawaii or Wake Island, shall be prohibited.

Stipulation 6: Discovery of invasive species or pest sign (feces, urine, carcass, hair, insect frass, plant seeds, dried vegetation; or an actual specimen) during inspections shall result in vessel delays and extended port stays. The delay period shall thus be referred to as the “emergency quarantine”. If pest sign or an actual specimen (dead or alive) is discovered aboard the barge or tug or external surface of container or cargo, the vessel operator or contractor awarded barge services shall, at their own cost, carry out a vessel wide emergency quarantine action to last at least four days. The Barge operator or awarded party shall incur all costs associated with delays or fees associated with late departure due to vessel operator inability to keep invasive species off their vessel. It is advised that vessels arriving to the FISC carry out invasive species control measures prior to arriving to the FISC so that delays and additional charges are not absorbed by the contracted party.

Stipulation 7: Emergency Quarantine shall consist of the following actions:

- Mandatory usage of bait stations armed with state and federally approved pesticide or trap, depending on the target in question. The Government shall direct barge operator as to which pesticide and trap is suitable for deployment based on the target in question. Barge operators shall submit their emergency quarantine plan to the Government pest control inspector for review and approval and at any time during the quarantine period the inspector shall be granted access to the vessel(s) to ensure the plan is indeed being completed as written. All applications shall abide by EPA approved label directions.
- Fumigants shall be used if the target in question cannot be eliminated via the usage of other tools.
- After completion of Emergency Quarantine actions, all unsealed cargo shall be inspected for fecal matter and incursions by Government appointed pest control inspectors prior to signing off on the success of emergency quarantine actions.
- On the fourth and final day of the quarantine period, Inspectors appointed by the 611th Civil Engineer Squadron or Detachment 1 Commander, shall inspect the vessel and document the efficacy of the treatment.

Stipulation 8: Contractor shall use deterrent devices to ensure vessel equipment does not provide access to the vessel while attached to dock. Vent and scupper openings shall be protected by backing them up with heavy gauge screening to prevent rats from building nests and or accessing vessel.

Stipulation 9: Vessel operators shall grant FISC, Base Operations Support contractor, and US Air Force personnel access to vessels at all times when docked, prior to departure to Wake Island.

Stipulation 10: Every container bound for wake atoll, regardless of original destination, shall possess one rat trap, one glue board, and one pest off strip (containing the active ingredient dichlorvos) prior to being loaded on any barge. Container exteriors shall be clean and free of vegetation or dirt. Power washers shall be utilized for containers which do not possess clean exteriors.

6.0 INTERCEPTION AND CONTROL

By mandating the deployment of container interception tools as described in Stipulation 10 of Section 5.3, interception of rodents, small reptiles, insects, and other invasive species is possible. The aforementioned interception tools are intended to address species which become stowed away in cargo, vessels, or planes. Given the lengthy voyage aboard the barge, interception tools will be enticing to invasive species which are not intercepted or detected at the FISC. USAF civilian and contracted personnel will need to have access to the Navy managed FISC areas, in order to manage interception tools and detection devices or materials.

7.0 EARLY DETECTION AND RAPID RESPONSE (EDRR)

The eradication records from international and domestic islands do indicate that even with a robust quarantine program (including ample deterrent deployment and efficacy monitoring) incursion (a breach; having got past a barrier) is possible and has occurred. The final stage of biosecurity which is used to eliminate an incursion or re-invasion is rapid response. A Rapid Response Team will need to be established and kept up to date to ensure the containment of an alien species once it has been detected. In some cases, the USAF will rely on already developed response programs for providing training and or guidance during response situations.

Often considered the “second line of defense” after prevention, EDRR is a critical component of any the USAF’s invasive species management program. When new invasive species incursions are detected, a prompt and coordinated contamination and eradication response can reduce the environmental and economic impacts (USDA-USFS 2015).

EDRR of new or a reinvasion of invasive species will not only make for a successful biosecurity plan, but will result in lower costs and the utilization of less resources. Properly written contracts for barges and quality assurance will also be key factors for ensuring compliance with a good biosecurity plan occurs; resulting in the most cost efficient program.

Monitoring is the most commonly carried out practice to discover whether or not an incursion has taken place, or a historic action was successful at eliminating the target in question. Track cards, traps, and glue boards also function as detectors and interception tools simultaneously. Wax blocks have been deemed successful for investigating the presence of invasive rodents. This tool has been highly successful for verifying the presence of rodents in both commensal and natural environments and paraffin is sold in 160 degree melting point formulations to allow for its usage in hot environments.

Other detection devices, such as CO2 operated Good-Nature traps were trialed in 2014 by USDA and Colorado State University biologists, but the traps were determined, due to hermit crab populations, to be less effective and not well suited for Wake's outdoor environment. New detection devices and survey methods, aimed at the detection of invasive insects, mammals, and reptiles shall be deployed in 2015, in order to detect the occurrence of species both at cargo and receiving locales.

It is the fear of every biologist to receive word that an incursion has occurred on an island "cleaned" of an invasive species. Rapid response teams must not only identify the incursion, but must act quickly to ensure the target does not give birth, move further away from the inception point, or introduce disease or foreign ectoparasites to an island free of such organisms. Studies have shown the effective nature of rapid response, but failed attempts have been documented which is why the establishment of quarantine, interception, and quality deterrent tools is so vital to a sound biosecurity program and plan. Trained canines have been documented to be effective in the discovery of incursions and elimination of target species. Other forms of rapid response include grid trapping, hand baiting (in accordance with EPA labels), and the establishment of secondary eradication actions (bait station grids). It is a cost exercise to cover large areas, but regardless of the action selected it is has become a standard in the eradication world to ensure that a minimum radial distance of 1 km be used to extend trapping or baiting efforts beyond the point of incursion (Russell 2008). This scale of treatment for trapping or baiting shall also be used for other observed targets, beyond just rodents.

Rapid response kits consist of traps, bait stations, snake sticks, aquariums, flagging and palatable toxic baits; these items are staged at wake atoll in a devoted connex box. The connex box is restricted to environmental staff, ensuring that equipment is not used for other needs. Rapid response training (and re-fresher training) for snakes shall continue to be identified as a requirement for biological staff both on island and sitting remotely in Hawaii. Wake continues to receive barge shipments from Guam, thus this element of the rapid response program is of great concern. As of 2015, only two USAF biosecurity team members (1 civilian / 1 contractor) possess the pre-requisite rapid response training for snake response. The USAF is committed to keeping these two individuals certified with refresher training and if funds are available, increasing the number of trained professionals with the certification as a responder. In 2016, the USAF 611th Natural Resource Project Manager will be attending the DoD Pesticide Applicators Course in order to become a DoD certified pesticide applicator, further increasing the capabilities of the biosecurity program and skill sets deployable during rapid response events.

8.0 BIOSECURITY LANGUAGE

The following language is used by the New Zealand Department of Conservation to define the different elements of biosecurity and applicable stages of a sound plan (Browne 2005).

1) Interception: occurs where a pest is detected in a secured area either on the mainland or island, e.g., quarantine store, wharf, helicopter pad, boat, aircraft, or on the island while unpacking, etc. *Implies: picked up outside a barrier.*

2) Incursion(s): occur where a pest is detected in the wild on an island or steppingstone island. *Implies: a breach; having got past a barrier.*

3) Establishment: implies that enough individuals have been detected that breeding is possible, or evidence of breeding or young is detected.

4) Spread: spread implies that the pest has already spread over the island at the time of detection.

5) Suspicion of invasion: Suspicion of invasion is used where the level of certainty for a possible pest sighting is from:

- a bird-wreck with possible bites or mauls on it having been recovered ;
- a bird-wreck which doesn't necessarily have any bites or mauls on it but from where a pest has been reported in the vicinity; or a second-hand report of a pest on the island.

6) Strait: body of water between islands or an island and the mainland.

7) Pest: An organism which is not wanted on the island or other biologically significant area. Includes both animals and plants.

8) Eradication: Completely remove all living examples of the pest from an island (or operational area).

9) Control: Reduce the numbers of a pest on an island (or within an operational area) to a level where their impact is minimised or mitigated, when measured against an indicator species.

10) Quarantine: Contain the target pest before it reaches the island (or other secure area).

11) Contingency Operation: Containing the target pest once it has arrived on the island (or secure area).

12) Biosecurity: Protecting an island (or secure area) from a target pest. (It encompasses both quarantine and contingency operations.)

13) Surveillance: Active searching for a target pest; it may not involve killing the pest.

14) Neophobia: Fear of new things; reference to rats, cats or other pests experiencing new baits, bait stations or traps within their territory.

9.0 WORKS CITED

Browne, B. and Raewyn Hutchings. 2005. Island Biosecurity Standard Operating Procedure. New Zealand Department of Conservation.

Department of Interior (DOI). 2015. Office of Insular Affairs: Wake Island. http://www.doi.gov/oia/islands/wakeatoll.cfm. Accessed 25 February 2015.

International Union for Conservation of Nature (IUCN). 2008. *Rattus tanezumi*. The IUCN Red List of Threatened Species. Version 2014.3.

International Maritime Organization (IMO). 2015. Biofouling. http://www.imo.org/ourwork/environment/biofouling/Pages/default.aspx. Accessed 25 February 2015.

Kenyon, Jean C., Victor Bonito, and Casey B. Wilkinson. 2013. Characterization of Coral Communities at Wake Atoll in the Remote Central Pacific Ocean. Atoll Research Bulletin No. 600. Smithsonian Institution, Washington, D.C.

National Invasive Species Council (NISC). 2008. 2008-2012 National Invasive Species Management Plan. http://www.invasivespeciesinfo.gov/council/actionc.shtml. Accessed 25 February 2015.

Ogden Environmental and Energy Services Co. Inc. May 2009. Biological Resources Report for Wake Atoll (Draft).

Pacific Rim Conservation (PRC). 2010. Wake Island Biological Monitoring: 23 October to 5 November 2010 Trip Report. Honolulu, Hawaii, USA.

Pacific Rim Conservation (PRC). 2011. Wake Island Biological Monitoring: Final Report March 2011. Honolulu, Hawaii, USA.

Pacific Islands Conservation Research Association (PICRA). 2008. Work plan, monitoring protocol, and sampling designs for seabird monitoring, shorebird monitoring, sea turtle monitoring, vegetation sampling, arthropod Sampling, and rodent population monitoring on Wake Island. PICRA, Newport, OR.

Pacific Islands Conservation Research Association (PICRA). 2009. Data Summary for 2009 biological monitoring on Wake Island. PICRA, South Beach, Oregon, USA.

Pacific Islands Conservation Research Association (PICRA). 2010. 2010 Data Summary and report: biological monitoring on Wake Island. PICRA, Columbia, Missouri, USA.

Rauzon, M.J., and J. Gilardi, 2007. Project Update: Natural Resource Assessment of Wake Island After Feral Cat Eradication and Super Typhoon Ioke. Marine Endeavors, 4701 Edgewood Ave. Oakland. CA.

Rauzon, M.J., D. Boyle, W.T. Everett, and J. Gilardi. 2008a. The status of the birds of Wake Atoll. Atoll Research Bulletin No. 561. Smithsonian Institution, Washington, D.C.

Rauzon, M.J., W.T. Everett, D. Boyle, L. Bell, and J. Gilardi. 2008b. Eradication of cat at Wake Atoll. Atoll Research Bulletin No. 560. Smithsonian Institution, Washington, D.C.

Russell, J.C., Towns, D.R., and M.N. Clout. 2008: Review of rat invasion biology: implications for island biosecurity. Science for Conservation 286. Department of Conservation, Wellington. 53 p.
United States Air Force (USAF). 2008. Environmental Assessment Addressing the Systematic Eradication of Rats From Wake Atoll, 15 AW Hickam AFB 2009.

United States Air Force (USAF). 2012. Integrated Natural Resources Management Plan for Wake Atoll. 15th Civil Engineering Squadron, Environmental Planning Element, 75 H Street, Hickam Air Force Base, Hawaii 96853-5233. September 2008.

United States Department of Agriculture, Animal and Plant Health Inspection Service (USDA-APHIS). 2015. Lacey Act. http://www.aphis.usda.gov/plant_health/lacey_act/. Last Update 12 February 2015. Accessed 25 February 2015.

United States Department of Agriculture, Forest Service (USDA-USFS). 2015. Early Detection and Rapid Response. http://www.fs.fed.us/invasivespecies/earlydetection.shtml. Last Modified 11 March 2014. Accessed 15 June 2015.

United States Department of Agriculture, Natural Resources Conservation Service (USDA-NRCS). 2015. Introduced, Invasive, and Noxious Plants. http://plants.usda.gov/java/noxious?rptType=State&statefips=15. Accessed 26 February 2015.

United States Department of the Navy (DoN). 2015. Regional Biosecurity Plan for Micronesia and Hawaii, Vol. 1. Eds. University of Guam and the Secretariat of the Pacific Community.

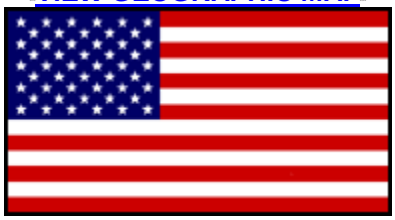
U.S. Fish and Wildlife Service (USFWS). 1999. Baseline Marine Biological Survey, Peacock Point Outfall and Other Point-Source Discharges, Wake Atoll, Pacific Ocean. Honolulu: U.S. Department of Interior Fish and Wildlife Service.

Zabin, Chela J., Aaron Hebshi, Blu Forman. 2009. Final Report: An investigation of the impacts of rats and rat eradication on intertidal benthic communities on Wake Island.

APPENDIX A

DEPARTMENT OF DEFENESE FOREIGN CLEARANCE GUIDE

VIEW GEOGRAPHIC MAP



WAKE ISLAND

Last Modified: 16-Mar-15

General Entry Requirements | Aircraft Entry Requirements | Personnel Entry Requirements for Official Travel | Personnel Entry Requirements for Leave Travel | Maritime Entry Requirements | Travel Information

---

SECTION I: GENERAL ENTRY REQUIREMENTS

A. IDENTIFICATION CREDENTIALS FOR OFFICIAL TRAVEL

1. Not applicable.
2. **Consult Section III, below, to ensure compliance with requirements for notification and Theater Clearance.**

B. IDENTIFICATION CREDENTIALS FOR LEAVE TRAVEL

1. Not applicable.
2. **Consult Section IV, below, to ensure compliance with any requirements for Country Clearance, Theater Clearance, and Special Area Clearance (if required).**

C. IMMUNIZATIONS AND OTHER MEDICAL REQUIREMENTS

1. For DoD immunization requirements and sources of additional information on immunization, see the Foreign Clearance Manual, C3.1.3 and C3.2.3.

D. IMMIGRATION, CUSTOMS, OR QUARANTINE INSPECTIONS

1. Pets are not permitted on Wake Island.
2. A rodent eradication effort was conducted in May 2012 and a heightened level of biosecurity to inhibit rodent re-invasion has been implemented. As a result, all cargo entering Wake Island, regardless of origin, is subject to inspection by USAF-appointed inspector at point of departure and upon arrival. Direct inquires associated with invasive species and shipment requirements to the Wake Island Installation Commander via Base Operation at BaseOperations2@wakeisland.net.

E. UNIFORM REQUIREMENTS

1. Not applicable.

F. OTHER

1. None reported.

SECTION II: AIRCRAFT ENTRY REQUIREMENTS

A. CLEARANCE REQUIREMENTS

NOTE 1: Until further notice, USAF use of Wake Island is restricted to contingency operations, emergency diverts, and flights in direct support of activities on the island.

1. Blanket Clearances: None.
2. One-Time Clearances.
    a. Prior permission required (PPR). PPR request procedures and island limitations are published in DoD FLIP Area Planning (AP-3) Pacific-Australia, Antarctica (Oakland FIR-Wake Island).
    b. Wake Island is closed to non-US government aircraft.

B. LEAD-TIME AND VALIDITY

1. Lead-time: 14 days.
2. Clearance valid for: Unstated. For additional information, contact the USDAO.

C. CONTENT OF CLEARANCE REQUEST

1. Not required.

D. ROUTE, FLIGHT, AND OTHER OPERATIONAL INFORMATION

1. Wake Island is currently Day Visual Flight Rules (VFR) only (no lights) due to runway construction.

E. AIRPORTS

1. Enter and depart.

Wake Island/Wake Island Airfield (PWAK)

2. Additional airport information.
    a. Unit mission planners and/or aircrews should refer to the Defense Logistics Agency (DLA) Energy AIR Card System website (Agree with the "Usage Alert" statement by clicking "I agree"; then click on the "FBO Locator" menu on the upper right-hand side of the webpage) for available fuel contract merchants who accept the AIR Card for fuel and/or ground services. Every effort will be made to purchase fuel from the designated contract merchants. Any local merchant that accepts the AIR Card may be used for ground-handling services.
    b. Wake Island airfield is in very limited operations (VLO) status. POL servicing is available (JP-5 only) for emergency recoveries, island resupply flights, and contingency operations. No aircraft maintenance is available.
    c. The airfield on Wake Island operates Tuesday through Saturday 0730-1730 local time. Funding and approvals of other periods requires advance approval and issue of PPR.

SECTION III: PERSONNEL ENTRY REQUIREMENTS FOR OFFICIAL TRAVEL

NOTE 1: In September 2013, US Pacific Command issued the following liberty policy for Service members traveling on temporary duty orders and liberty in the US Pacific Command AOR outside of the United States and its territories. To ensure widest dissemination, travelers are required to acknowledge that they have read the policy when completing the TT/IATP entry.

NOTE 2: US Air Force (USAF) personnel, to include reserve and Air National Guard, must read and understand the additional Commander, PACAF (COMPACAF) requirements while on TDY and/or liberty (pass/leave) in the USPACOM area of responsibility.

A. CLEARANCE REQUIREMENTS

1. Notification of visit to Wake Island.

a. Because Wake Island is US territory, Country Clearance is not required. However, DoD and DoD-sponsored travelers must request entry authorization (EA).

(1) Submit all clearance requests (classified and unclassified) via the Aircraft and Personnel Automated Clearance System (APACS).

2. Theater Clearance.
   a. Theater Clearance is NOT required.
   b. TT/IATP is highly recommended so PACOM can provide traveler with emergency information (i.e., earthquake, tsunami, volcano, riot, political unrest, etc.).
   c. SERE 100 and ISOPREP are NOT required. However, to complete the TT/IATP, travelers will need to insert a valid date - Use 1 January of the current year.
3. Special Area Clearance.
   a. Special Area is not required.
4. Aircrew do not require Personnel Clearance. However, passengers must request Personnel Clearance.
5. The Personnel Clearance requirements in this section apply to official travel only. Refer to Section IV, below, for leave travel. Submit all clearance requests (classified and unclassified) via the Aircraft and Personnel Automated Clearance System (APACS). Note: To avoid delays and EXPEDITE APACS processing, complete Travel Tracker/Individual Anti-Terrorism Plan (TT/IATP) before submitting APACS and enter TT/IATP Entry # in the "Traveler" tab of the APACS request.

B. LEAD-TIME

1. Not applicable.

C. CONTENT OF CLEARANCE REQUEST

1. Prepare and submit the clearance request automatically with APACS at https://apacs.dtic.mil or if classified, https://apacs.dtic.smil.mil.
2. Theater-specific information for inclusion in the “Theater Specific Information” field under “Country Information” on the “Itinerary” tab in APACS: None.
3. Country-specific information for inclusion in the “Country Specific Information” field under “Country Information” on the “Itinerary” tab in APACS: None.
4. If the Travel Clearance Request is classified, include paragraph markings and downgrade instructions to ensure timely processing. See the Foreign Clearance Manual, Figure C3.F1.
5. If personal information is required (e.g., Social Security number, birthplace), include the marking "Personal Data - Privacy Act of 1974."

SECTION IV: PERSONNEL ENTRY REQUIREMENTS FOR LEAVE TRAVEL

NOTE 1: In September 2013, US Pacific Command issued the following liberty policy for Service members traveling on temporary duty orders and liberty in the US Pacific Command AOR outside of the United States and its territories. To ensure widest dissemination, travelers are required to acknowledge that they have read the policy when completing the TT/IATP entry.

NOTE 2: US Air Force (USAF) personnel, to include reserve and Air National Guard, must read and understand the additional Commander, PACAF (COMPACAF) requirements while on TDY and/or liberty (pass/leave) in the USPACOM area of responsibility.

A. CLEARANCE REQUIREMENTS

1. Clearance not required.
2. Theater Clearance.
   a. Theater Clearance is NOT required.
   b. TT/IATP is highly recommended so PACOM can provide traveler with emergency information (i.e., earthquake, tsunami, volcano, riot, political unrest, etc.).

c. SERE 100 and ISOPREP are NOT required. However, to complete the TT/IATP, travelers will need to insert a valid date - Use 1 January of the current year.

3. See IDENTIFICATION CREDENTIALS FOR LEAVE TRAVEL requirements in Section I.B.
4. See IMMUNIZATIONS AND OTHER MEDICAL REQUIREMENTS in section I.C.
5. See IMMIGRATION, CUSTOMS, OR QUARANTINE INSPECTION in section I.D.
6. See OTHER general requirements in section I.F.

B. LEAD-TIME

1. Not applicable.

C. CONTENT OF CLEARANCE REQUEST

1. Not applicable.

SECTION V: MARITIME ENTRY REQUIREMENTS

A. CLEARANCE REQUIREMENTS

1. No information provided.

B. LEAD-TIME AND VALIDITY

1. No information provided.

C. ADDRESSES FOR CLEARANCE REQUESTS

1. No information provided.

Action:
Info:

D. CONTENT OF CLEARANCE REQUEST

1. No information provided.

E. NAVIGATION AND OTHER OPERATIONAL INFORMATION

1. No information provided.

F. OTHER

1. No information provided.

SECTION VI: TRAVEL INFORMATION

A. STATE DEPARTMENT TRAVEL ADVISORIES

1. Travel Warnings: None.
2. Travel Alerts: None.
3. The DoS Bureau of Consular Affairs posts Country Specific Information Sheets as well as Travel Warnings and Travel Alerts at http://travel.state.gov.

B. AMERICAN EMBASSY

1. Location:

a. Wake Island is an unincorporated US territory administered by the Department of the Air Force. Activities on Wake Island are conducted by a BOS Contractor.

2. Telecommunications Contact Information:

a. Phone:

(1) DSN 315-424-2000.

(2) COMM 808-424-2000.

3. Hours: The offices on Wake Island are staffed 24 hours a day.

4. Mailing Address: DET 1, 15AW/CC
APO AP 96518

5. Holidays: Wake Island observes all US holidays except Presidents' Day and Columbus Day. Wake Island also celebrates Wake Island Day (22 March) and the King of Thailand's birthday. In order to sync with US Holidays, all Friday holidays are celebrated on Saturday and all Monday Holidays are celebrated on Tuesday. Weekday holidays such as Thanksgiving are celebrated as they fall.

C. TIME CONVERSION

1. Local Standard Time is Z + 12.
2. Wake Island does not observe Daylight Savings Time.

D. CUSTOMS REGULATIONS

1. Not applicable.

E. HEALTH PRECAUTIONS

1. TRICARE eligible personnel (including eligible family members) requiring overseas emergency medical care, should contact the nearest TRICARE International SOS assistance center via the following website: http://www.tricare-overseas.com/ContactUs/default.htm . Select the applicable country from the drop-down menu for the International SOS assistance center name and 24-hour phone number.
2. Medical support on the island is severely limited. Emergent care and a limited pharmacy is available, but there is no flight surgeon, dental care, or pediatric healthcare.
3. Medical Travel Insurance: All personnel (other than uniform military and civilian expeditionary workforce members) deploying, assigned, attached, or TAD/TDY to Wake Island, to include contract personnel not specifically authorized DoD aeromedical evacuation through their contract, are highly encouraged to have either company provided or private medical travel insurance that specifically covers international healthcare and international medical evacuation services. Non-uniform personnel should complete DD Form 2569 and bring both this form and proof of insurance with them when traveling to Wake Island. DoDI 6025.23 and DoDI 4515.13R contain specific details regarding the limitations of aeromedical evacuation on non-DoD healthcare beneficiaries. Failure to obtain the appropriate insurance may result in the member being held financially liable for any DoD provided healthcare or aeromedical evacuation expenses.
4. While there are no mosquitoes found on Wake Island, precautions should still be taken to prevent insect bites. Wasps, centipedes, scorpions and rats should be avoided.

F. CURRENCY INFORMATION

1. The national currency is the United States Dollar (USD).

G. CLOTHING RECOMMENDATIONS

1. None reported.

H. TRANSIENT ACCOMMODATIONS

1. Billeting for RON personnel is available on a limited basis with prior coordination and approval from Site Manager, Wake Island. Billeting, food services, ground transport, and medical services are austere and severely limited. No off-base quarters are available. No common service support is available; all services are rendered on a cash and credit card (VISA) basis. Shortage of billets often requires doubling-up of RON personnel.

I. TRAVEL PRECAUTIONS AND INFORMATION

1. Force Protection Condition (FPCON) levels can be viewed via the SIPRNET Joint Risk Assessment Management Program (JRAMP) site via http://jramp.smil.mil.

TOP

APPENDIX B

US PACIFIC COMMAND DEFENSE TRANSPORTATION REGULATIONS_ PART V_ WAKE ISLAND

CHAPTER 511 UNITED STATES PACIFIC COMMAND (USPACOM)

USPACOM Defense Transportation Regulation

CC. WAKE ISLAND

1. Passengers. See the DOD Foreign Clearance Guide available at https://www.fcg.pentagon.mil/. From the left column select Pacific, South Asia, then Wake Island.

2. Cargo.

   a. All cargo entering Wake Island, regardless of origin, is subject to inspection by a US Air Force (USAF)-appointed inspector at point of departure as well as upon arrival. A rodent eradication was accomplished in May 2012 and a heightened level of bio-security to inhibit rodent reinvasion was implemented. The 611th Civil Engineer Squadron (CES) is the lead military POC for issues associated with invasive species and inspection issues. Inquiries associated with invasive species issues particular to Wake Island and shipment requirements to prevent transport of invasive species to the island will be directed towards the Wake Island installation CDR via Base Operations at BaseOperations2@wakeisland.net. All incoming cargo will meet the requirements of the United States Department of Agriculture, Natural Resources Conservation Service- Hawaii Invasive Species List. This list can be located at (http://plants.usda.gov/java/noxious?rptType=State&statefips=15).

   b. Military shippers will ensure that:

      (1) Cargo descriptions are complete and accurate.

      (2) Container packing lists will be in or attached to each container. The USAF requires a container packaging list for all containers. USAF inspectors may also conduct a physical inspection of the selected containers which are sealed with a Customs Seal and delivered to the consignee. These containers are not to be opened until they reach their final destination or unless a USAF inspector is present.

      (3) Advanced copies of the container packing list and the USAF Wake Island Vessel/Aircraft Rodent Pre-departure Inspection Forms are sent to the Wake Island Base Operations at BaseOperations2@wakeisland.net. A copy of the USAF Wake Island Vessel/Aircraft Rodent Pre-departure Inspection Form can be obtained from the Wake Base Operations, the 611th Natural Resources Program Manager, and/or the vessel government contracting officer.

      (4) All vessels destined for Wake will have rat guards on board for immediate deployment upon docking at Wake.

   c. All cargo staging areas where equipment and supplies destined for Wake are held will show documented proof that the facilities have rodent control operations in place throughout the facility. Facilities will be maintained rodent free by continually deploying a network of the following tools: glue boards, snap traps, and anticoagulant baits in tamper proof stations (baits that fluoresce under UV light are recommended - see URL: http://www.belllabs.com/product_details/united-states-pest-control-contrac-with-lumitrack). The spacing of traps and stations will encompass the entire facility. These measures are required at each facility storing equipment that is destined for shipment to Wake Island. Facility pest management contracts will include a quarterly report that will be submitted to the 611th CES, Natural Resources Program Manager, in order to ensure the equipment and supplies came from a facility with an ongoing pest control operation. The reports from pest control contracts will display the type of rodent control in place, the frequency of baiting,

density of traps and trap results. The Wake Island CDR can prohibit the opening of containers or other cargo, if there is no documentation showing that the origin activity has an ongoing pest control program. Contact the 611th CES, Natural Resources Manager, for further information (907-552-0788) or Wake Island Base Operations (808-424-2222).

d. In the event that cargo destined for Wake is discovered to be contaminated with an invasive species (i.e., rodents, snakes, insects) after departure from point of origin, the pilot or captain will isolate the package or container, and refrain from offloading the item on Wake. The pilot or captain will immediately contact Wake Base Ops (DSN: 315-424-2222 or Commercial: 808-424-2222) and alert them to the presence of an invasive species on the vessel or aircraft. This notification will activate the Wake Island rodent rapid response team.

e. Vessel operators will ensure that during loading operation at the location of origin all mooring lines are protected with rat guards and baited snap traps are deployed at each line exit and tie off point. For areas of high activity, baited snap traps will be placed inside a protected station called a "bait station" to avoid accidental triggers.

f. All containers regardless of size will have one baited glue board and one baited snap trap inside of each container prior to sealing. Contract language will include this requirement. Contract language will also include the purchase of these detection devices and supplies (snap traps, glue boards, rat attractant, and/or bait).

g. Vessels or aircraft originating from Guam destined for Wake will display documented proof of equipment and vessel/aircraft inspection with USDA canine prior to unloading equipment on Wake Island. This inspection is required to ensure BTS are not contained within shipments, aircraft, or vessels. This USDA BTS inspection requires advanced coordination with the Guam USDA, Wildlife Services at 671 366 -3886 or 671 635-4400. The Guam USDA inspector will provide the vessel or aircraft operator with a letter of verification, this letter of verification is to be submitted to the Wake Island Base Operations at BaseOperations2@wakeisland.net prior to the vessel or aircraft arrival at Wake.

h. During loading operations at origin, any box, cargo, or container showing signs of infestation (feces, chew marks, urine scent, hair) will be pulled out of the shipment and placed in an isolated area and thoroughly inspected prior to being placed back in the shipment.

3. Personal Property. See the PPCIG at https://tops.ppcigweb.sddc.army.mil/ppcig/menu/home/warning.do. Select Query CG tab, select County Instructions tab, at the Country drop down box under Custom Selection, select Wake Island, submit. Click on the detail icon on the upper right hand side to review shipping requirements.

****Information depicted on <http://www.transcom.mil/dtr/part-v/dtr_part_v_511.pdf > accessed 16 June 2015****

APPENDIX C

US AIR FORCE WAKE ISLAND VESSEL AIRCRAFT RODENT PRE-DEPARTURE INSPECTION FORM

APPENDIX C

USAF Wake Island Vessel/Aircraft Rodent Pre-Departure Inspection Form

Inspectors Name/ Agency: _____

Email / Contact #: _____

Vessel/Aircraft: _____

Origin: _____

Estimated Date and Time of Arrival to Wake Island: _____

Date Cargo Inspection Occurred: _____

Date Vessel/Aircraft Inspection Occurred: _____

Pre-Departure Checklist (Yes/No/Not Applicable):

1) Visual inspection of all cargo for rodent sign____
(sign - feces, chew marks, holes in cardboard, food piles, strong urine scent)

2) Rodent Control Devices Deployed to cargo staging areas____
____Rodenticide Baited Stations within staging area
(Type of Chemical Compound & Commercial Name_____)
____Snap traps
____Glue Boards

3) Maps depicting the location of traps or control devices affixed to this form____

4) Functional Rat Guards aboard vessel and crew notified of immediate usage upon arrival to Wake____

5) Pre-departure crew notification of Wake Defense Transportation Regulation and steps to implement Rodent Rapid Response in the event of a rodent sighting____

6) Cargo identified as infested prior or during loading_____
Unique Identification of Cargo or Manifest # (ie. palletized, boxed, breakbulk)
_____
_____
_____

7) Was contaminated cargo loaded onto vessel/aircraft____

8) Has Wake Island Base Ops and 611 CES Environmental been contacted regarding potential infested cargo identified during loading____

Submit Pre Departure Checklist to Wake Island Base Ops and 611 CES Environmental for archival purposes
e-mail: BASEOPS@WAKEISLAND.NET; joel.helm.1@us.af.mil. *Rapid Response contact: 808-449-0574; 907-552-5230.*

The following recommendations are provided for updating the October 2012 Wake Island Biosecurity Management Plan:

- Update Appendix B with the 24 October 2013 Defense Transportation Regulation – Part IV – Department of Defense Customs and Border Clearance Policies and Procedures.

- Add the following note following the fifth bullet in Section 3.2 (Requirements of the 2009 Environmental Assessment for Addressing the Systematic Eradication of Non-Native Rodents from Wake Atoll):

  Note: The 2012 rat eradication was not successful. The Asian house rat was successfully eradicated, but the Polynesian house rat was not and their population has rebounded. Ongoing efforts to control the rat, including the use of bait stations, are being implemented. Efforts are being made to control the rat population in and around the commensal and marina areas; however these efforts have been very localized with the primary focus on biosecurity as well as health and safety. An approach for a follow-on eradication effort is being developed and evaluated for implementation.

- Throughout the document: Define acronyms when they are first used in the text.

- In Section 4.1 Air: Change the first sentence in the first paragraph to: Air transportation guidelines have been created to ensure that all pilots, loadmasters, and flights transiting through Wake are aware of the ongoing efforts to eradicate rats on the atoll.

- In Section 4.1 Air: In the second to last sentence of the first paragraph insert the following text: A stock of d-Phenothrin aerosol should be available in the Pest Management storage for aircraft disinfection if it is determined to be necessary, as required by the DTR and FCG.

- In section 4.2 in the second sentence of the first paragraph add: No Pest Strips.

- In Section 5.2 Prescreening: Add a bullet after bullet # 4 stating: All closed containers should include two No Pest Strips (20% dichlorvos).

- In Section 5.2 Prescreening: Add a bullet after bullet # 7 (7 after adding the bullet for No Pest Strips) stating:

DEPARTMENT OF THE AIR FORCE
PACIFIC AIR FORCE

JAN 17 2013

MEMORANDUM FOR RECORD

FROM: 611 ASG/CC

SUBJECT: 2012 Wake Island Biosecurity Management Plan

1. In accordance with Executive Order (EO) 13112, for the prevention and introduction of invasive species, the 611th Air Support Group is pleased to provide this Wake Island Biosecurity Management Plan.

2. The spread of invasive species is now recognized as one of the greatest threats to the ecological and the economic well-being of the planet according to the International Maritime Organization. An invasive species is defined by EO 13112 as a species whose introduction has caused or may cause harm to environmental or human health (National Invasive Species Council, 2008). This biosecurity plan has been created to help the Air Force carry out their responsibilities for the prevention, rapid response and control of non-native species on Wake Island. As global commerce, trade, and travel continue to exist and evolve, so will the need and policies of biosecurity management.

3. Please direct any questions regarding this subject matter to our Natural Resources Program Manager, Mr. Matthew T. Moran at (907) 552-0788 or matthew.moran.3@us.af.mil.

ROBYN M. BURK, Colonel, USAF
Commander

4 Attachments:
1. Wake Island Biosecurity Management Plan
2. Appendix A, DoD Foreign Clearance Guide
3. Appendix B, USPACOM Defense Transportation Regulation Part V Wake Island
4. Appendix C, USAF WI Vessel-Aircraft Rodent Pre-departure Inspection Form

THE END