Final

Joint Region Marianas Integrated Natural Resources Management Plan

June 2013

FINAL

INTEGRATED NATURAL RESOURCES MANAGEMENT PLAN

JOINT REGION MARIANAS

Prepared for

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INRMP CONCURRENCE PAGE

This Integrated Natural Resources Management Plan (INRMP) provides the updated plan for the management of natural resources at Joint Region Marianas (JRM), Naval Base Guam and Andersen Air Force Base. This INRMP has been prepared in accordance with regulations, standards, and procedures of the Department of Defense, the U.S. Navy, and the Sikes Act, as amended through 2012 (16 United States Code [U.S.C.] §670a) in cooperation with the U.S. Fish and Wildlife Service (USFWS); the National Marine Fisheries Service (NMFS); and state fish and wildlife agencies, represented by Guam Department of Agriculture, Division of Aquatic and Wildlife Resources (GDAWR) and the Commonwealth of the Northern Mariana Islands Department of Lands and Natural Resources (CNMI DLNR). This INRMP provides for management and stewardship of all natural resources present on the installation.

To the extent that resources permit, the USFWS, NMFS, GDAWR, CNMI-DLNR and JRM by signature of their agency representative, do hereby agree to enter into a cooperative program for the conservation, protection and management of fish and wildlife resources at JRM. The intention of this agreement is to develop functioning, sustainable ecological communities on JRM sites integrating the interests and mission of the agencies charged with conservation, protection, and management of natural heritage to the general public. This agreement may be modified and amended by a mutual agreement of the authorized representatives of the four agencies. The agreement will become effective upon the date subscribed by the last signatory and shall continue in full force for a period of 5 years, with coordination annually among party agencies. At the 5-year anniversary of the effective date of the INRMP, the party agencies shall perform a coordinated review to determine whether the INRMP requires significant revision, or minor updates. The 5-year review should be documented with a written concurrence of review for operation and effect. Thereafter, parties to this INRMP will coordinate annually, and, if the INRMP requires only minor updates, the INRMP shall remain in effect unless modified and amended by mutual agreement of the authorized representatives of the signatory agencies, or until terminated by written notice to the other parties, in whole or in part, by any of the parties signing this agreement.
By their signatures, or an enclosed letter of concurrence, all parties grant their concurrence and acceptance of this INRMP.

Approving Officials:

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National Oceanic and Atmospheric Administration National Marine Fisheries Service

Michael Tosatto Regional Administrator, Pacific Islands Regional Office National Oceanic and Atmospheric Administration National Marine Fisheries Service	**Date**

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Mrs. Mariquita F. Taitague Director Guam Department of Agriculture Division of Aquatic and Wildlife Resources	**Date**

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Concurring agency:

Commonwealth of the Northern Mariana Islands
Department of Lands and Natural Resources
Division of Fish & Wildlife

_____ _____

Mr. Arnold Palacios **Date**
Secretary
Commonwealth of the Northern Mariana Islands
Department of Lands and Natural Resources
Division of Fish & Wildlife

Executive Summary

The purpose of this Integrated Natural Resources Management Plan (INRMP) is to chart a course for natural resources management on Joint Region Marianas (JRM). JRM includes Navy holdings and former U.S. Air Force (USAF) holdings on Guam, and Navy-leased lands on Tinian and Farallon de Medinilla (FDM), which are part of JRM under Commander Navy Installations Command (CNIC). The USAF holdings on Andersen Air Force Base (AFB) were included under the Navy as a result of Base Realignment and Closure (BRAC). Management of natural resources is conducted by Naval Engineering Facilities Command Marianas (NAVFACMAR). The USAF continues to manage the mission-essential activities including managing flights and runways.

This INRMP was prepared in accordance with the Sikes Act as amended through 2012, Department of Defense (DOD) Instruction 4715.03 *Natural Resources Conservation Program*, Office of the Chief of Naval Operations Instruction (OPNAVINST) 5090.1C CH-1 *Environmental Readiness Program Manual*, and the most recent Department of the Navy (DoN), DOD, and INRMP guidance memoranda. The U.S. Fish and Wildlife Service (USFWS), National Oceanic and Atmospheric Administration (NOAA) National Marine Fisheries Service (NMFS), and the territorial fish and wildlife agencies, which for JRM is the Guam Department of Agriculture, Division of Aquatic and Wildlife Resources (GDAWR) on Guam, and the Commonwealth of the Northern Mariana Islands Department of Lands and Natural Resources (CNMI DLNR) for Tinian, and FDM, have reviewed and signed this INRMP, indicating their mutual agreement with the Regional Commander regarding natural resources management on the JRM sites.

This INRMP updates and combines the existing INRMPs for Naval Base Guam (NBG), Andersen AFB, and Tinian and FDM (USAF 2009, U.S. Navy 2009, and U.S. Navy 2010a), includes a discussion of the natural resources on the JRM sites, and reviews natural resources activities undertaken at JRM sites. This INRMP is organized according to the guidelines provided by the Office of the Under Secretary of Defense in August 2006 and NAVFACMAR, and strives to fully integrate and coordinate the natural resources program with other JRM plans and activities. This INRMP provides a description of JRM sites (e.g., location, history, and mission), information about the surrounding physical and biotic environment, and an assessment of the impacts on natural resources as a result of mission activities. Furthermore, the INRMP recommends various management practices, in compliance with Federal, territorial, commonwealth, and local standards, designed to conserve and rehabilitate natural resources on military installations. In addition to terrestrial resources, JRM managed submerged lands, which extend offshore 3 nautical miles from JRM holdings, are addressed in this INRMP.

It is the intent of this JRM INRMP to conserve and rehabilitate natural resources on military installations; to support sustainable multipurpose use the resources; and, subject to safety requirements and military security, allow public access to military installations to facilitate the use. It is also the intent of the JRM INRMP to preclude designation of critical habitat, when appropriate, by demonstrating special management of listed species. Special management or protection is a term that originates in the definition of occupied critical habitat in Section 3 of the Endangered Species Act (ESA). The ESA does not require additional special management/critical habitat designation if adequate management and protection is already in place. Adequate special management or protection is provided by a compliant INRMP that addresses the maintenance and improvement of the primary constituent elements important to the species and manages the long-term conservation of the species. Three criteria are used to determine if such special management and protection are provided: (1) there is a conservation benefit, (2) there are assurances that the management plans will be implemented, and (3) there are assurances that the conservation efforts will be effective. These three criteria will be met through the strategies presented in this INRMP; therefore, designation of critical habitat is neither necessary nor legally required (U.S. Navy 2006).

The National Defense Authorization Act for Fiscal Year 2004 (Public Law 108-136) amended the ESA (7 USC § 136, 16 USC § 1531 et seq.) to limit areas eligible for designation as critical habitat. Specifically, section 4(a)(3)(B)(i) of the ESA (16 USC 1533(a)(3)(B)(i)) now provides: "The Secretary shall not designate as critical habitat any lands or other geographical areas owned or controlled by the Department of Defense, or designated for its use, that are subject to an integrated natural resources management plan prepared under section 101 of the Sikes Act (16 USC 670a), if the Secretary determines in writing that such plan provides a benefit to the species for which critical habitat is proposed for designation." The benefits provided by this INRMP are addressed for each federally listed species in **Appendix F** (Benefits for Endangered Species). Federally listed species known to occur on JRM are listed in **Table ES-1**. For a complete list of Federal, GovGuam, and CNMI Listed Threatened and Endangered Species see **Table 4-4**.

USFWS is in the process of preparing proposed rules under the ESA to list and designate critical habitat for seven candidate species in the Mariana Archipelago. Several non-candidate Marianas species are also being considered for evaluation for inclusion in the proposed rules. Once the USFWS determines which species will be included in the proposed rules, JRM will develop a supplemental document for inclusion in the JRM INRMP for those species with the potential to be on Navy lands. The supplemental document will also include information on the known status of each species and will identify projects to be undertaken on JRM to manage the long-term conservation of the species.

This INRMP is a guide for the management and stewardship of all natural resources present on the JRM sites, while ensuring the successful accomplishment of the military mission. A multiple-use approach is used to allow for the presence of mission-oriented activities while efficiently managing the natural resources to conserve biodiversity and environmental quality. The INRMP presents practicable alternatives and recommendations for the management and stewardship of natural resources and the conservation and enhancement of existing ecosystems on the installation without any net loss in the capability of JRM to support its military mission. Consequently, in some cases, the implementation of certain recommendations might sacrifice the improvement of the installation's natural resources in deference to the safety and efficiency of the mission.

The intent of this INRMP is to take an ecosystem approach to managing the natural resources present on JRM. The interdisciplinary approach taken by this INRMP follows an ecosystem model, in which all appropriate components are integrated by their function. Ecosystem management is emphasized because it is recognized that the mission of the JRM is inextricably linked to local, regional, and global ecological integrity. Sustaining ecosystem integrity is also the best way to protect biodiversity, ensure sustainable use, and minimize the effort and cost of management. Native and natural communities, and the processes that sustain them, are essential to sustaining system function and resilience over a long-term.

The overall goal for the JRM INRMP is to provide for the restoration and enhancement of habitats for native species including listed species over a long-term in a manner that is consistent with the military mission.

Key components to meeting this goal include the development of long-term ecosystem-based management plans for the overlay lands of the Guam National Wildlife Refuge on NBG, Andersen AFB, and in JRM submerged lands in Sumay Cove and Apra Harbor that direct management of these areas over the next 30 to 50 years. These plans will direct management on JRM through the development of studies and projects that are based on, or have as primary components, goals and objectives that are consistent with the overriding goal for the restoration and enhancement of habitats for native species including listed species over a long-term. To ensure that JRM meets the overriding goal, coordination between JRM site land managers and resource agencies should also continue over a long-term.

Table ES-1. Federally Listed Species

Common Name (Chamorro Name)*	Scientific Name	Federal Status	GovGuam/ CNMI Status	Presence on JRM Lands
Mammals				
Sei whale	*Balaenoptera borealis*	E	-	Unknown
Blue whale	*Balaenoptera musculus*	E	-	Unknown
Fin whale	*Balaenoptera physalus*	E	-	Unknown
North Pacific right whale	*Eubalaena japonica*	E	-	Unknown
Humpback whale	*Megaptera novaeangliae*	E	-	Unknown
Sperm whale	*Physeter macrocephalus*	E		Unknown
Pacific sheath-tailed bat (finihi lihyang) [1]	*Emballonura semicaudata rotensis*	C	E	None
Mariana fruit bat (fanihi)	*Pteropus mariannus mariannus*	T	E	Guam, Tinian and FDM
Little Mariana fruit bat (fanihi) [1]	*Pteropus tokudae*	E	E	None
Birds				
Mariana swiftlet (Yayaguak)	*Aerodramus bartschi*	E	E	Guam and Tinian
Mariana crow (Åga) [1]	*Corvus kubaryi*	E	E	Guam
Mariana Common Moorhen (Pulattat)	*Gallinula chloropus guami*	E	E	Guam and Tinian
Guam rail (Ko'Ko') [2]	*Gallirallus owstonii*	E	E	None
Guam Micronesian kingfisher (Sihek) [2]	*Halcyon cinnamomina cinnamomina*	E	E	None
Micronesian megapode (Sasangat)	*Megapodius laperouse laperouse*	E	E	Tinian and FDM
Guam bridled white-eye (Nosa') [1]	*Zosterops conspicillatus conspicillatus*	E	E	None
Reptiles				
Loggerhead sea turtle	*Caretta caretta*	T	--	Unknown
Green sea turtle (Haggan)	*Chelonia mydas*	T	T	Guam, Tinian and FDM
Leatherback sea turtle	*Dermochelys coriacea*	E	E	Unknown
Hawksbill sea turtle (Haggan karai)	*Eretmochelys imbricata*	E	E	Guam, Tinian and FDM

Common Name (Chamorro Name)*	Scientific Name	Federal Status	GovGuam/ CNMI Status	Presence on JRM Lands
Invertebrates				
Mariana eight-spot (Ababang)	*Hypolimnas octocula marianensis*	C	--	Guam
Humped or Mariana tree snail (Akaleha')	*Partula gibba*	C	E/CNMI SC	Guam and Tinian
Guam tree snail (Akaleha')	*Partula radiolata*	C	E	Guam
Fragile tree snail (Akaleha')	*Samoana fragilis*	C	E	Guam
Mariana wandering butterfly (Ababang) [1]	*Vagrans egistina*	C	--	None
Vascular Plants				
Fire Tree (Hayun lågo)	*Serianthes nelsonii*	E	E	Guam

Sources: USFWS 2008, USEPA 2004, USGS 2008, and GDAWR 2006a
Note: *Chamorro Names from Government of Guam, Department of Agriculture Endangered Species Regulation No. 8 (2003)
Key:
E = Federal- GovGuam, or CNMI-listed as endangered
T = Federal- GovGuam, or CNMI-listed as threatened
C = Federal candidate for listing
SC = Species of Concern
[1] = extinct, delisted
[2] = Experimental population, or occurs in captivity

Throughout the development of this INRMP, management actions were identified in a number of natural resources subject areas. Some of these natural resources actions could have an adverse impact on the JRM mission or future planning operations. One of the purposes of this INRMP is to identify goals and objectives for the installation and to obtain workable and useful solutions. Actions involving natural resources constraints to planning and mission operations are discussed in detail in **Chapter 5** of this INRMP. Actions are grouped into management sections according to their relevance. **Appendix C** provides a list of projects to be implemented based on the actions discussed in **Chapter 5**. Individual management plans in Appendices provide detailed management goals and actions to be implemented.

This INRMP will serve as a planning tool for the installation, JRM, and CNIC. As opportunities become available to seek funding for environmental projects or as mitigation for future activities, this Plan will serve as a priority list to better enable the Natural Resources department to practice effective ecosystem management. This Plan is not meant as a definitive list of projects that will be automatically funded upon enactment. It provides guidance to the resource managers on strategies to employ for the next 10 to 20 years. The Navy will implement recommendations in the INRMP within the framework of regulatory compliance, national Navy mission obligations, anti-terrorism and force protection limitations, and funding constraints. Any requirement for the obligation of funds for projects in this INRMP shall be subject to the availability of funds appropriated by Congress, and none of the proposed projects shall be interpreted to require obligation or payment of funds in violation of any applicable Federal law, including the Anti-Deficiency Act, 31 United States Code (U.S.C.) § 341, et seq.

DOD and Navy guidance directs installations to coordinate their annual program evaluation with the appropriate field-level offices of the USFWS and the state (territorial and CNMI) fish and wildlife agency

(for JRM, GDAWR, and CNMI DLNR), as well as NMFS to enable partners to measure both the successes and issues resulting from INRMP implementation (U.S. Navy 2006). Results of the evaluation are used by natural resources managers to determine the effectiveness of the installation natural resources management program, to facilitate annual coordination with USFWS and the territorial and CNMI fish and wildlife agencies, and to provide data for the Navy portion of the DOD annual report to Congress (U.S. Navy 2006). An annual review was conducted in November 2012 with JRM, NBG, Andersen AFB, and all regulatory agencies.

Two meetings will be conducted annually by the Navy to coordinate with the USFWS, NOAA, DAWR, CNMI DLNR, and GNWR. One meeting will be conducted during October or November to review projects accomplishments during the previous fiscal year. The other meeting will be conducted in either April or May to develop and review future projects that will be proposed to CNIC for funding. The meetings will also be used to identify necessary modifications to the INRMP resulting from changes in mission, existing baseline natural resources conditions affecting natural resources management, or changes in the status of listed species that might affect management. Any modifications will be noted in the annual update and incorporated into the 5 year review for operation and effect. The INRMP implementation table **(Appendix C)**, annual project summaries **(Appendix D)**, and INRMP metrics **(Appendix E)** will be updated annually based on the outcomes of the two meetings described above.

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FINAL INTEGRATED NATURAL RESOURCES MANAGEMENT PLAN
JOINT REGION MARIANAS

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1 Overview

An Integrated Natural Resources Management Plan (INRMP) is a long-term planning document designed to guide the Regional Commander and specific Installation Commanding Officers and natural resources managers in the management of natural resources to support an installation's mission while protecting and enhancing installation resources for multiple use, sustainable yield, and biological integrity.

This INRMP complies with the Sikes Act Improvement Act Amendment of 1997 (SAIA) (16 United States Code [U.S.C.] 670a et seq.), which requires the preparation, implementation, and review for operation and effect of an INRMP for each military installation in the United States and its territories with significant natural resources. This plan is prepared in cooperation with the U.S. Fish and Wildlife Service (USFWS); the National Oceanic and Atmospheric Administration (NOAA), National Marine Fisheries Service (NMFS), also referred to as NOAA Fisheries; and the territorial and commonwealth fish and wildlife agencies, which for Guam is the Guam Department of Agriculture, Division of Aquatic and Wildlife Resources (GDAWR), and for Tinian and Farallon de Medinilla (FDM) is the Commonwealth of the Northern Mariana Islands Department of Lands and Natural Resources (CNMI DLNR).

This INRMP provides for the conservation and rehabilitation of natural resources and the sustainable multipurpose use of resources subject to safety requirements and military security. It provides for no net loss in the capability of installation lands to support the military mission and other activities as considered appropriate to the military. At the same time, this document provides for management of wildlife and land, wildlife habitat enhancement and modification, establishment of natural resources management objectives and timeframes, sustained use by the public of natural resources to the extent that such use is not inconsistent with other needs, public access where appropriate, and the enforcement of natural resource laws and regulations.

This INRMP is designed to support the military mission, manage natural resources, and ensure compliance with related environmental laws and regulations. The plan ensures the maintenance of quality training land, thereby supporting DOD in accomplishing its critical military mission.

For more detail on the purpose of the Joint Region Marianas (JRM) INRMP, management authorities, and legislative drivers for management, review **Sections 1.1** through **1.7**.

All figures in this INRMP were compiled by HDR, except if noted, using data believed to be accurate at the time of publication. However, a degree of error is inherent in all figures. The figures are distributed "AS-IS," without warranties of any kind, expressed, or implied, including, but not limited to, warranties of suitability to a particular purpose or use. No attempt has been made in either the design or production of the figures to define the limits or jurisdiction of any Federal, territorial, commonwealth, or local government. The figures are intended for use only at the published scale. Detailed on-the-ground surveys and historical analyses of sites might differ from the figures. The JRM natural resources manager should be contacted for the most current map information.

1.1 Purpose and Scope of Plan

The purpose of this INRMP is to chart a course for natural resources management of Navy and former U.S. Air Force (USAF) holdings on Guam, and Navy-leased lands on Tinian and FDM, that are part of JRM under Commander Navy Installations Command (CNIC). The USAF holdings on Andersen Air Force Base (AFB) were included under the Navy as a result of Base Realignment and Closure (BRAC). Management of natural resources is conducted by Naval Engineering Facilities Command Marianas (NAVFACMAR). The USAF continues to manage the mission-essential activities including managing flights and runways.

This INRMP is consistent with the Sikes Act, as amended through 2012; guidance and regulations provided in DOD Instruction 4715.03 (*Natural Resources Conservation Program*); Office of the Chief of Naval Operations Instruction (OPNAVINST) 5090.1C CH-1 (*Navy Environmental and Natural Resources Program Manual*); and the most recent Department of the Navy (DoN), DOD, and INRMP guidance memoranda. These guidance documents collectively require a plan and management approach that integrates mission support, ecosystem- or landscape-level management, and environmental compliance and stewardship.

This INRMP was developed based on a thorough review of the existing INRMPs for Naval Base Guam (NBG), Andersen AFB, and Tinian and FDM; review of new data pertaining to these sites; and detailed discussions with NAVFACMAR, JRM, and installation personnel, and various INRMP stakeholders. The plan strives to integrate INRMP activities with other installation plans and activities, and provides explicit goals and objectives to which natural resources strategies and projects will contribute. The projects and strategies contained in this plan include a combination of ongoing natural resources management activities from previous years and new projects and activities identified as priorities during the review process.

This INRMP updates and combines the existing INRMPs for NBG, Andersen AFB, and Tinian and FDM (USAF 2009, U.S. Navy 2009, and U.S. Navy 2010a); includes a discussion of the natural resources on the JRM sites; and reviews natural resources activities undertaken at JRM sites. This INRMP is organized according to the guidelines provided in August 2006 by the Office of the Under Secretary of Defense, and a crosswalk table between this INRMP and the 2006 guidelines is provided in **Appendix AA**.

The JRM INRMP addresses natural resources management on those lands and near-shore areas that are owned by the U.S. and administered by the Navy; used by the Navy via license, permit, or lease for which the Navy has been assigned management responsibility; or that are withdrawn from the public domain for use by the Navy for which the Navy has been assigned management responsibility. The scope of the INRMP does not include Navy properties on Guam that lack manageable natural resources, including urban properties and housing areas, or CNMI lands that are not leased by the Navy, such as Rota, Saipan, Pagan. The JRM lands and waters discussed in this INRMP are identified in **Table 1-1**.

This INRMP provides a description of JRM sites (e.g., location, history, and mission), information about the surrounding physical and biotic environment, and an assessment of the impacts on natural resources as a result of mission activities. Furthermore, the INRMP recommends various management practices, in compliance with Federal, territory, commonwealth, and local standards, designed to mitigate impacts of the mission on local ecosystems. In addition to terrestrial resources, JRM managed submerged lands, which extend offshore 3 nautical miles from JRM holdings, are addressed in this INRMP.

It is the intent of this JRM INRMP to preclude designation of critical habitat, when appropriate, by demonstrating special management of listed species. Special management or protection is a term that originates in the definition of occupied critical habitat in Section 3 of the Endangered Species Act (ESA). ESA does not require additional special management/critical habitat designation if adequate management and protection is already in place. Adequate special management or protection is provided by a compliant INRMP that addresses the maintenance and improvement of the primary constituent elements important to the species and manages the long-term conservation of the species. Three criteria are used to determine if such special management and protection are provided: (1) there is a conservation benefit, (2) there are assurances that the management plans will be implemented, and (3) there are assurances that the conservation efforts will be effective. These three criteria will be met through the projects and strategies presented in this INRMP; therefore, designation of critical habitat is neither necessary nor legally required (U.S. Navy 2006).

Table 1-1. Lands and Waters Managed under Joint Region Marianas

Facility Name	Previous Name	Terrestrial Acreage	Submerged Lands Acreage	Ecological Reserve Area Acreage	Overlay Refuge Acreage[3]
NBG Main Base[1]	Waterfront Annex	6,205	33,181	163[4]	1,061
Naval Munitions Site	Ordnance Annex	8,800	---	---	8,358
NBG Telecommunications Site (TS)[2]	Communications Annex Finegayan	3,000	19,550	252[4]	2,095
Naval Telecommunications Site Barrigada (Naval Computer and Telecommunications Station [NCTS] Barrigada)	Communications Annex Barrigada	1,800	---	---	---
Tinian		15,400	---	---	---
Farallon de Medinilla		182	---	---	---
Andersen AFB		16,021	26,529	---	10,300
Andersen AFB South	MARBO Annex	1,922	---	---	---
Barrigada Transmitter Site		432	---	---	---
Total Managed Acreage		**53,762**	**79,260**	**415**	**21,814**

Notes:
1. Orote Peninsula Ecological Reserve Area.
2. Haputo Ecological Resource Area.
3. Guam National Wildlife Refuge.
4. Terrestrial lands of ERAs are included in the Overlay Refuge; submerged lands of the ERAs are not included in the Overlay Refuge.

1.2 Goals and Objectives

According to the Sikes Act as amended through 2012, the vision of an INRMP is to ensure the sustainability of all ecosystems within the installation, and to ensure a no-net-loss of the capability of the installations to support the military mission (U.S. Navy 2006). To meet the intent of the Sikes Act, the DOD adopted an ecosystem management approach for their lands and waters that includes application of the principles of adaptive management and collaborating with parties both inside and outside the fence (DOD 2011). The DoN developed guidance for developing and implementing INRMPs at Navy installations in 1998, and revised the guidance in 2006 based on lessons learned from the first round of INRMPs developed by the Navy. The 2006 revisions included the following (U.S. Navy 2006):

1. Increasing the ties between natural resources management and military readiness
2. Establishing a consistent funding policy and project review process
3. Improving the efficiency of INRMP review and coordination
4. Increasing the effective implementation of INRMPs
5. Expanding opportunities for involvement with all INRMP stakeholders.

The 2006 guidance also stressed the need for clear INRMP goals and objectives to guide natural resources management on an installation while ensuring a no net loss to the mission. The guidance defines goals as

"broad guiding principles for the [installation natural resources] program" and objectives as "measurable targets for achieving the goals" (U.S. Navy 2006). In addition, the guidance states that the INRMP will provide parameters to determine "the effectiveness" of the natural resources program outlined in the INRMP through ensuring that the plan includes "quantifiable, scientifically valid parameters that will demonstrate achievement of objectives," or INRMP projects (U.S. Navy 2006).

The overall goal for the JRM INRMP is to provide for the restoration and enhancement of habitats for native species including listed species over a long-term in a manner that is consistent with the military mission.

Key components to meeting this goal include the development of long-term, ecosystem-based management plans for the overlay units on NBG, Andersen AFB, and in JRM submerged lands in Sumay Cove and Apra Harbor that direct management of these areas over the next 30 to 50 years. These plans will direct management on JRM through the development of studies and projects that are based on, or have as primary components, goals and objectives that are consistent with the overall goal for the restoration and enhancement of habitats for native species including listed species over a long-term.

To achieve this goal, resource-specific goals, objectives, and strategies have been developed to guide natural resources management on JRM sites. Each of the management strategies described in this INRMP should be monitored so that changes can be made as environmental conditions change. INRMP goals may be revised over time to reflect changing missions and environmental conditions. Any future changes in mission, training activity, or technology should be analyzed to assess their impacts on natural resources. As new installation plans and DoN guidance and regulations are developed, they will be integrated into this INRMP. The INRMP will be reviewed, assessed, and modified as needed annually, and updated every 5 years.

Throughout the development of this INRMP, management actions were identified in a number of natural resources subject areas. Some of these natural resources actions could have an adverse impact on the mission or future planning operations of JRM sites. One of the purposes of this INRMP is to identify goals and objectives for JRM and to obtain workable and useful solutions (strategies) for each action. The actions involving natural resources constraints to planning and mission operations are discussed in detail in **Chapter 5**. Natural resources actions are grouped into management sections according to their relevance. **Appendix C** provides a list of projects to be implemented based on the actions and strategies discussed in **Chapter 5**.

This INRMP will serve as a planning tool for CNIC, JRM, and the installation, and provides a priority list of strategies to enable the natural resources department to practice effective ecosystem management better. This Plan is not meant to provide a definitive list of projects that will be automatically funded upon enactment. It provides guidance to the resource managers on strategies to employ for the next 10 to 20 years. The Navy will implement recommendations in the INRMP within the framework of regulatory compliance, national Navy mission obligations, anti-terrorism and force protection limitations, and funding constraints. Funds necessary for projects in this INRMP are subject to availability through appropriation by Congress, and none of the proposed projects shall be interpreted to require obligation or payment of funds in violation of any applicable Federal law, including the Anti-Deficiency Act, 31 U.S.C. § 341, et seq.

1.3 Authority

This INRMP was developed consistent with guidance and regulations provided in the Sikes Act as amended through 2012, DOD Instruction 4715.03 - *Environmental Conservation Program* (DoN 2011), OPNAVINST 5090.1C CH-1 - *Environmental Readiness Program Manual* (DoN 2011), and associated

DoN and DOD INRMP guidance memoranda. These guidance documents collectively require a plan and management approach that integrates mission support, multipurpose use, ecosystem- or landscape-level management, and environmental compliance and stewardship. The Sikes Act is one of the primary drivers behind the JRM natural resources management program and INRMP. According to the Sikes Act, as amended through 2012, the purposes of a military conservation program are conservation and rehabilitation of natural resources, sustainable multipurpose use of those resources, and public access to military lands, subject to safety requirements and military security. Moreover, the conservation program must be consistent with the mission-essential use of the JRM and its lands and waters. The Sikes Act, as amended through 2012, requires the preparation and implementation of an INRMP to facilitate the conservation program. This INRMP has been prepared in cooperation with the USFWS, NMFS, and the territory and commonwealth fish and wildlife agencies, which for Guam is GDAWR, and for Tinian and FDM is CNMI DLNR. The resulting plan reflects the mutual agreement of all four parties concerning conservation, protection, and management of natural resources on the JRM sites.

The SAIA of 1997 states that "the Secretary of each military department shall prepare and implement an integrated natural resources management plan for each military installation in the U.S. under the jurisdiction of the Secretary, unless the Secretary determines that the absence of significant natural resources on a particular installation makes preparation of such a plan inappropriate." DOD Instruction 4715.03 prescribes procedures for integrated management of natural resources, including preparing an INRMP as required by the SAIA. DOD Instruction 4715.03 also states that "INRMPs shall be prepared, maintained, and implemented for all lands and waters under DOD control that have suitable habitat for conserving and managing natural resources." OPNAVINST 5090.1C CH-1 requires the preparation of INRMPs and prescribes Navy policies, procedures, and standards to "restore, improve, conserve, and properly use natural resources on Navy-administered lands."

The Deputy Under Secretary of Defense (Installations and Environment) (DUSD [I&E]) has developed several memos that include outlining *Implementation of the Sikes Act Improvement Act: Updated Guidance* (DUSD (I&E) 2002); memorandum providing policy on scope of INRMP review, public comment on INRMP review, and ESA consultation on INRMPs [DUSD (I&E) 2004]; memorandum providing policy on the applicability of the Sikes Act INRMP requirement for DOD lands leased to a non-DOD party [DUSD (I&E) 2005a]; and *Best Practices for Integrated Natural Resources Management (INRMP) Implementation* [DUSD (I&E) 2005b]. In addition, DOD developed a handbook to assist resource managers with developing and implementing INRMPs (*Conserving Biodiversity on Military Lands: A Guide for Natural Resources Managers*) (Benton et al. 2008). The DoN issued its implementing guidance on SAIA and INRMP requirements in OPNAVINST 5090.1C CH-1. The JRM INRMP is consistent with and was developed according to these guidance memoranda.

It is the policy of the Navy to act responsibly and in the public interest to restore, improve, preserve, and properly use natural resources. The Navy is charged with complying with Federal laws, regulations, and policies; and showing a conscientious and active concern for the inherent value of natural resources in all Navy plans, actions, and programs. The Navy environmental strategy is to protect the environment and conserve natural resources for present and future generations through compliance, conservation, pollution prevention, and stewardship. The Navy must ensure their operations comply with Federal, local, and host nation environmental requirements, which include endangered species and wetlands. Conservation is achieved through protecting and enhancing the life-sustaining quality of the land and waterways under Navy protection. The Navy manages, conserves, and rehabilitates the land and natural resources such as fish, wildlife, forests, and submerged lands. Additionally, the Navy strives to prevent or reduce pollution at its source through increased efficiency in the use of raw materials, energy, water, or other resources.

The Navy's Natural Resources Management Program follows policies established in DOD Instruction 4715.03, *Natural Resources Management Program*; OPNAVINST 5090.1C CH-1, *Environmental Readiness Program Manual*; and the NAVFAC *Real Estate Procedural Manual*, P-73, Volume II.

1.4 Stewardship and Compliance

The DoN has acknowledged and recognizes that simply complying with environmental regulations does not necessarily sustain the mission. The Navy Environmental Strategy, *Sustaining our Environment, Protecting our Freedom*, moves the Navy's environmental program beyond compliance to a long-range vision of sustainability that recognizes that environmental stewardship is part of the mission, not independent of the mission (U.S. Navy 2008). The strategy calls for all Navy personnel to "look ahead, think ahead, and plan ahead when it comes to the environment" (U.S. Navy 2008). JRM integrates environmental stewardship considerations into planning and analysis through personnel participation, and through the National Environmental Policy Act (NEPA) process.

INRMP implementation involves the anticipated execution of all "must fund" projects and activities (e.g., those projects and activities required to meet recurring natural resources conservation management requirements, or current natural resources compliance needs) in accordance with specific timeframes identified in the INRMP (DUSD [I&E] 2002). An INRMP is considered to be implemented by DOD if an installation does the following:

1. Actively requests, receives, and uses funds for "must fund" projects and activities
2. Ensures that sufficient numbers of professionally trained natural resources management personnel are available to perform the tasks required by the INRMP
3. Coordinates annually with all internal and external cooperating offices
4. Documents specific INRMP action accomplishments undertaken each year.

NEPA requires review of federally supported activities or actions to assess their potential impacts on the environment. The NEPA process is designed to identify potential environmental problems early in the planning process so the proponent of the action can resolve problems in the early stages of project development. OPNAVINST 5090.1C CH-1, Chapter 5, *Procedures for Implementing the National Environmental Policy Act*, sets forth policy, responsibilities, and procedures for integrating environmental considerations into Navy planning and decisionmaking.

An Environmental Assessment (EA) and Finding of No Significant Impact (FONSI) have been prepared to document implementation of the JRM INRMP (see **Appendix X**).

1.5 INRMP Review and Revision Process

The Sikes Act, as amended through 2012, requires INRMPs to be reviewed for operation and effect no less than once every 5 years. The JRM INRMP will be reviewed by the installation, the USFWS, NMFS, GDAWR, and CNMI DLNR. The DOD and DoN have provided specific guidance on the joint review and coordination process and timeframe (DUSD [I&E] 2002, DoN 2011). As part of the review, JRM will invite annual feedback from the USFWS, NMFS, GDAWR, and CNMI DLNR on the effectiveness of the INRMP and inform the agencies which INRMP projects and activities are required to meet current natural resources compliance needs. This information does not need to be included in the INRMP at the time of review, but may be provided after the installation reviews and validates the estimated costs of the requirements (DoN 2011). The annual review will be discussed with the agencies at the annual fall meeting and revisions will be finalized and published in December of each year.

JRM must complete an Annual Metrics Summary Report of the effectiveness of this INRMP. The Annual Natural Resources Conservation INRMP Metrics data call is to be completed via the Navy Conservation Website, hosted on the US Navy Environmental Portal, at https://eprportal.cnic.navy.mil/eprwebnet/logon.aspx

The Annual Metrics Summary Report should be completed in cooperation with the Installation's Sikes Act partners, including the U.S. Fish and Wildlife, state fish and wildlife agencies, and, when appropriate, NOAA Fisheries Service. Other participants can include internal Navy and external stakeholders.

The Annual Metrics Summary Report evaluates performance in the following areas:

- INRMP Implementation
- Listed Species and Critical Habitat
- Sikes Act Cooperation (Partnership Effectiveness)
- Recreational Use and Access
- Team Adequacy
- Natural Resources Management (Ecosystem Integrity)
- INRMP (Natural Resources Program) Support of the Installation mission

Annual review of the JRM INRMP will include revisions as appropriate.

If the 5-year INRMP review for operation and effect results in major revisions to the plan, JRM must solicit public review and comments (U.S. Navy 2006). The NEPA process may be used to meet public review requirements if the public is provided a meaningful opportunity to comment on the Draft Revised INRMP. Absent extraordinary circumstances, the public must be afforded a minimum of 30 days to review and comment on the revisions, either as part of the NEPA process or some other process. After soliciting public comments, JRM must afford the USFWS, NMFS, GDAWR, and CNMI DLNR the opportunity to review all public comments. If an existing INRMP requires only limited revisions that are not expected to result in significant environmental effects other than those anticipated for the existing INRMP, then neither NEPA analysis nor public review are necessary (U.S. Navy 2006).

According to recent Chief of Naval Operations (CNO) guidance, (U.S. Navy 2006), INRMPs must also be reviewed by installations at least once per year to verify the following:

- All “must fund” projects and activities have been budgeted for and implementation is on schedule
- All required trained natural resources positions are filled or are in the process of being filled
- Projects and activities for the upcoming year have been identified and included in the INRMP (an updated project list does not necessitate INRMP revision)
- All required coordination has occurred
- All significant changes to the installation’s mission requirements or its natural resources have been identified.

1.6 Responsible Parties for Natural Resources Management on Joint Region Marianas Lands

Successfully implementing an INRMP requires the support of natural resources personnel, other installation staff, command personnel, and installation tenants. The following section discusses the responsibilities for INRMP implementation within JRM.

As the lead service for natural resources management at JRM, responsibility for natural resources management falls to the Navy and is governed by OPNAVINST 5090.1C CH-1. The following sections describe command authority for natural resources management under OPNAVINST 5090.1C CH-1 (DoN 2011) and will be revised following the release of future versions of the OPNAVINST.

1.6.1 Commander, Navy Installations Command

Commander, Navy Installations Command

CNIC provides support for Navy-wide shore installation management. The role of CNIC in natural resources management is as follows (DoN 2011):

- Ensure all lands owned, leased, withdrawn, permitted, or otherwise under the control of Navy are evaluated for significant natural resources
- Ensure installations under their command develop, implement, review, and revise INRMPs as necessary
- Provide overall program management oversight for all natural resources program elements
- Program and budget resources to fund both routine and recurring costs to operate and maintain natural resources management planning and INRMP implementation
- Work with Naval Facilities Engineering Command field offices to develop and maintain liaisons with appropriate Federal, state, and local agencies and other organizations to facilitate implementation of INRMPs
- Implement Navy policy to ensure stewardship of Navy lands and resources and compliance with natural resources laws and regulations
- Implement policy for managing and conserving soil, water, forest, land, grounds, fish and wildlife, wetlands, floodplains, coral reefs, and natural areas.

1.6.2 Joint Region Marianas

Naval Facilities Engineering Command Marianas

NAVFACMAR provides oversight and support for the development, maintenance, and implementation of Navy Region Marianas installation INRMPs and the natural resources programs. In accordance with the Navy's Concept of Operations, NAVFACMAR integrates the planning, programming and execution of facilities engineering and environmental services to Supported Commands. The role of NAVFACMAR in natural resources management is as follows:

- Serve as the Navy's natural resources technical program manager
- Provide technical and contractual support to installation commanding officers for the preparation, development, and implementation of INRMPs and associated NEPA documents
- Facilitate and coordinate the issuance of INRMP-related NEPA documentation
- Evaluate and disseminate information concerning new technology, methods, policies, and procedures for use in the development and implementation of INRMPs
- Provide technical and administrative guidance for the development and execution of contracts and cooperative agreements to develop and implement INRMPs

- When requested by budget submitting offices (BSOs) and subordinate commands, coordinate natural resources management requirements with other Federal, state, territorial, or commonwealth agencies; or local professional authorities, including ESA Section 7 consultations
- Facilitate the acquisition of the INRMP "mutual agreement" between the Navy; USFWS; NOAA; and state, territory, or commonwealth fish and wildlife agencies
- Facilitate resolution of conflicts between the Navy; USFWS; NOAA; and state, territory, or commonwealth fish and wildlife agencies and other stakeholders, if necessary
- Provide technical oversight and resources for forest management and agricultural outlease projects
- Provide technical oversight and budget approval of installation fish and wildlife/hunting and fishing fee and permit projects
- Compile, track, and maintain Annual Natural Resources Conservation INRMP Metrics.

1.6.2.1 Naval Base Guam

Commanding Officer

The Commanding Officer (CO) has the ultimate responsibility for ensuring that NBG activities comply with applicable substantive and procedural Federal and local environmental laws and regulations, and is in charge of the overall management of the facilities and for successfully carrying out the mission. The CO's responsibilities include implementing and enforcing this INRMP and managing installation operations, including the facilities and security directorates, and contingency operations. The CO is responsible for ensuring that NBG has the funding, staff, and other resources necessary to manage the installation's natural resources effectively to fulfill the environmental stewardship component of the mission. The responsibilities of the CO regarding natural resources management on NBG are described in OPNAVINST 5090.1C CH-1.

1.6.2.2 Andersen Air Force Base

Installation Commander

The Installation Commander at Andersen AFB has the ultimate responsibility for ensuring that Andersen AFB activities comply with applicable substantive and procedural Federal and local environmental laws and regulations, and is in charge of the overall management of the facilities and for successfully carrying out the mission. Responsibilities include implementing and enforcing this INRMP and managing installation operations, including the facilities and security directorates, and contingency operations. The Installation Commander is also responsible for ensuring that Andersen AFB has the funding, staff, and other resources necessary to manage the installation's natural resources effectively and to fulfill the environmental stewardship component of the mission. The responsibilities of the Installation Commander regarding natural resources management on Andersen AFB are described in Air Force Instruction (AFI) 32-7064.

1.6.3 Signatory Agencies

1.6.3.1 U.S. Fish and Wildlife Service

The USFWS has the responsibility for the welfare and protection of endangered and threatened species, migratory birds, and certain anadromous fish occurring in the United States. The Division of Ecological Services staff provides technical assistance regarding invasive species threats and biosecurity issues as

they relate to threatened, endangered, and candidate species (Section 7 *consultation, listing, recovery, and habitat conservation planning*); Clean Water Act (CWA) permitting; NEPA analysis; and environmental contaminants. The Division of Law Enforcement enforces Federal and international laws and treaties that protect endangered and threatened species and migratory birds. The Federal Assistance Program and the Division of Fisheries and Habitat Conservation administers and provides Federal funds to state, territorial, and commonwealth agencies for the Sport Fish and Wildlife Restoration and Endangered Species Conservation programs. The Division of Fisheries and Federal Aid funds provided to the GDAWR benefit natural resources at JRM. The National Wildlife Refuge System provides for resource management, law enforcement, public use, and research in units of the Guam National Wildlife Refuge (GNWR).

The Navy and Air Force entered into a Cooperative Agreement with the USFWS in 1993 to designate portions of NBG Main Base, the Naval Munitions Site (NMS), and Andersen AFB as overlay refuge units of the GNWR. These lands are managed cooperatively by the USFWS and JRM natural resources personnel for protection of threatened and endangered species and other native flora and fauna, maintenance of native ecosystems, and the conservation of native biological diversity, consistent with the national defense mission of the Navy and Air Force (see Section 2.4 for additional discussion).

1.6.3.2 National Oceanic and Atmospheric Administration

NOAA is dedicated to protecting and preserving the nation's living marine resources through scientific research, fisheries management, enforcement, and habitat conservation (NOAA 2011a). NMFS, also referred to as NOAA Fisheries, is the lead Federal agency responsible for the stewardship of the nation's offshore living marine resources and their habitat. The mission of NMFS is to ensure healthy fisheries and habitat for the benefit of all Americans by managing, conserving, and protecting fish, whales, dolphins, sea turtles, and other living creatures in the ocean (NOAA 2011b). NMFS works within the Magnuson-Stevens Fishery Conservation and Management Act (MSFMCA), the Marine Mammal Protection Act of 1972 (MMPA), and the ESA to fulfill its mission of promoting healthy ecosystems.

The USFWS and NMFS share jurisdiction over sea turtles that are listed as endangered or threatened under the ESA of 1973, as amended. The USFWS has jurisdiction over sea turtles when they come ashore, while NMFS retains management control while sea turtles are in the ocean. In addition, both agencies enforce Federal laws concerning wildlife trade in endangered species. NMFS coordinates with other agencies and GDAWR in the review of projects that impact marine resources under Section 7 of the ESA. NMFS also maintains law enforcement personnel on Guam to enforce certain provisions of the MMPA, the ESA, and the MSFMCA.

1.6.3.3 Guam Department of Agriculture, Division of Aquatic and Wildlife Resources

GDAWR is the leading Government of Guam (GovGuam) agency responsible for fisheries, wildlife, and other natural resources management on Guam. GDAWR has an active natural resources management program that includes research on the natural history of endangered species; recovery of endangered species; captive breeding and release of the endangered Guam Micronesian kingfisher (*Todiramphus cinnamomina cinnamomina*), Mariana crow (*Corvus kubaryi*), and Guam rail (*Gallirallus owstoni*); monitoring of endangered species populations and trends; wetland studies and delineations; research into the control of the brown treesnake (*Boiga irregularis*); fisheries surveys and management; sea turtle monitoring; environmental education of the public; public hunting and game management;

control of invasive species; consultations for the protection of Threatened and Endangered Species and their Habitats under the ESA; and other programs. GovGuam administers several conservation areas, including Bolanos, Cotal, and Anao, and has concurrent jurisdiction over submerged lands around Guam in accordance with 48 U.S.C. § 1704. On May 16, 1997, Public Law (P.L.) 24-21 created five marine preserves on Guam and changed fishing regulations in these locations. One such preservation area is the Pati Point Preserve located on the eastern coastal boundary of Andersen AFB. Conservation Officers with GDAWR have jurisdiction on Federal lands for the enforcement of Guam wildlife laws. Guam Conservation Officers have also been deputized by the USFWS and are authorized to enforce Federal fish and wildlife laws. Through signing this INRMP, GDAWR is a party, with the USFWS, for the protection, development, and management of fish and wildlife resources on JRM sites in accordance with the Sikes Act, as amended through 2012. Funding for GDAWR is provided by the USFWS through the Fisheries and Federal Aid Program. GDAWR pursues local funding for their programs, public education, and brown treesnake research. Local funding is also available for GDAWR law enforcement agents and Conservation Officer programs.

1.6.3.4 Commonwealth of the Northern Mariana Islands Department of Lands and Natural Resources, Division of Fish and Wildlife

The CNMI DLNR, Division of Fish and Wildlife, was created in 1981 by the Fish, Game and Endangered Species Act, P.L. Number 2-51. The Division endeavors to conserve fish, game, and wildlife, and to protect endangered and threatened species. Through research, monitoring, regulation, enforcement, planning and management, the Division seeks to ensure the long-term survival and sustainability of the CNMI's natural resources for present and future generations.

The Division is directed by CNMI DLNR to provide and enforce regulations governing hunting, fishing, harvesting, and taking of species; and human behavior and activities in protected and conservation areas in the CNMI. The Division also reviews all development proposals submitted to the Coastal Resources Management Office (CRMO) and Division of Environmental Quality (DEQ) to ensure that negative impacts on endangered and threatened species are minimized, mitigated, or avoided.

1.7 Integration with Other Joint Region Marianas Site Plans and Programs

JRM could be affected both internally and externally by growth in the JRM region. Internal factors include meeting the needs of existing mission partners, anti-terrorism/force protection (ATFP) standards, and a potential increase in requests from Federal agencies for real property assets in terms of facilities and buildable land at JRM sites.

Outside factors expected to drive growth and development immediately adjacent to JRM include a reduction in available land in the region, a continuing increase in population growth, and development in the coming decades. Consequently, the impacts of planning and future development on Guam and JRM are inextricably linked.

The recognition of internal and external factors demands that natural resources management on JRM be integrated with other disciplines, programs, and planning beyond the scope of traditional fish and wildlife management on JRM sites. On a day-to-day basis, INRMP goals, objectives, strategies, and projects are integrated with other installation plans to sustain mission-oriented activities while managing the natural resources.

The following JRM site plans were reviewed to highlight key interrelationships, and recommendations contained within these plans were used in the development of this INRMP. Note that the INRMP is not intended to compile detailed information on each plan and its contents.

1.7.1 U.S. Navy

1. Record of Decision for the Guam and CNMI Military Relocation including Relocating Marines from Okinawa Transient Nuclear Aircraft Carrier Berth Air and Missile Defense Task Force: September 2010.
2. Orote Peninsula Ecological Reserve Area General Management Plan, Naval Base Guam: August 2010.
3. Interim Final Integrated Natural Resources Management Plan, Plan Years 2009–2014, Navy Base Guam: 2009.
4. Update of Integrated Natural Resources Management Plans for Navy Leased Lands on Tinian and Farallon de Medinilla, Plan Years 2010–2015: May 2010.
5. Guam Submerged Lands Management Plan. U.S. Navy Region Mariana: September 2007.
6. Management Plan for the Haputo Ecological Reserve Area: January 1986.
7. Haputo Ecological Reserve Area General Management Plan: 2010.
8. Biological Opinion for the Joint Guam Program Office Relocation of the U.S. Marine Corps from Okinawa to Guam and Associated Activities on Guam and Tinian: September 2010.
9. Joint Region Marianas Naval Base Guam Ungulate Management Plan: March 2013.

1.7.2 U.S. Air Force

1. Final Environmental Impact Statement for Establishment and Operation of an Intelligence, Surveillance, Reconnaissance, and Strike Capability: November 2006.
2. Biological Opinion on the Establishment and Operation of an Intelligence, Surveillance, Reconnaissance, and Strike Capability Project on Andersen AFB, Guam: October 2006.
3. Environmental Assessment Beddown of Training and Support Initiatives at Northwest Field Andersen AFB, Guam: May 2006.
4. Final Integrated Natural Resources Management Plan and Environmental Assessment for Andersen AFB, Guam: July 2009.
5. Final Mariana Fruit Bat (*Pteropus mariannus mariannus*) Management Plan for Andersen AFB, Guam: August 2008.
6. Green Sea Turtle (*Chelonia mydas*) Management Plan for Andersen AFB, Guam: May 2007.
7. Draft Adaptive Management Plan. Andersen AFB, Guam: February 2011.
8. Joint Region Marianas Andersen AFB Ungulate Management Plan: March 2013.
9. Request for Informal Section 7 Consultation for the Beddown of Training and Support Initiatives at the Northwest Field Project on Andersen Air Force Base, Guam: May 2006.

1.7.3 Guam Comprehensive Wildlife Conservation Strategy

In order to receive Federal funds through a State/Territorial Wildlife Grants Program, Congress charged each state and territory with developing a statewide or territorywide comprehensive wildlife conservation plan by October 1, 2005, through the Consolidated Appropriations Act of 2005 (P.L. 108-447). The State/Territorial Wildlife Grants Program provides Federal money to every state and territory for cost-effective conservation aimed at preventing wildlife from becoming endangered (P.L. 108-447).

Congress directed that the strategies developed in the comprehensive wildlife conservation plan identify and be focused on the species of greatest conservation need (SOGCN), while addressing the full array of wildlife and wildlife-related issues. The Guam Comprehensive Wildlife Conservation Strategy was completed in 2006 and goals and objectives for managing 65 species were identified within the plan (GDAWR 2006a). In addition, conservation actions that affect general groups of species were identified and included strategies such as the development of memoranda of understanding, rehabilitation of habitats, public education, and law enforcement (GDAWR 2006a).

The 2006 plan identifies conservation actions to be undertaken to restore and protect wildlife and their habitats on Guam. The conservation actions identified by the GDAWR in the plan were taken into consideration in the preparation of this INRMP.

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2 Location, Mission, and Land Use

2.1 Location

Guam, a U.S. Territory, is located in the western Pacific Ocean at 13º 30' north latitude and 145º east longitude and is situated approximately 3,700 miles (5,955 kilometers) west/southwest of Hawai'i and 1,560 miles (2,511 kilometers) southeast of Japan. Guam is the southernmost and largest island of the Mariana Islands archipelago (see **Figure 2-1a**). The island is approximately 30 miles (48 kilometers) long by 4 miles (6 kilometers) to 8 miles (13 kilometers) wide and has a total area of approximately 209 square miles (541 square kilometers). JRM sites are located throughout the island, and include both NBG and Andersen AFB sites (see **Figure 2-1b**) JRM submerged lands are shown in **Figure 4-3**.

Tinian is the fourth island, south to north, in the Marianas archipelago. It is located at approximately 15º north latitude and 145º 38' east longitude, and is about 5 miles (8 kilometers) south of Saipan. Tinian is roughly 12.4 miles (20 kilometers) long and 5 miles (8 kilometers) wide with a total land area of 39.3 square miles (101.8 square kilometers). See **Figure 2-2** for military use areas located on Tinian.

FDM is located at 16º 01' north latitude and 146º 04' east longitude. It is approximately 1.7 miles (2.8 kilometers) long and 0.3 miles (450 meters) wide and covers approximately 0.28 miles (0.74 kilometers). It is the northernmost island of the southern volcanic arc of the Mariana archipelago, which places it north of Saipan and south of Anatahan. FDM is an uninhabited island and is physically difficult to access except by helicopter.

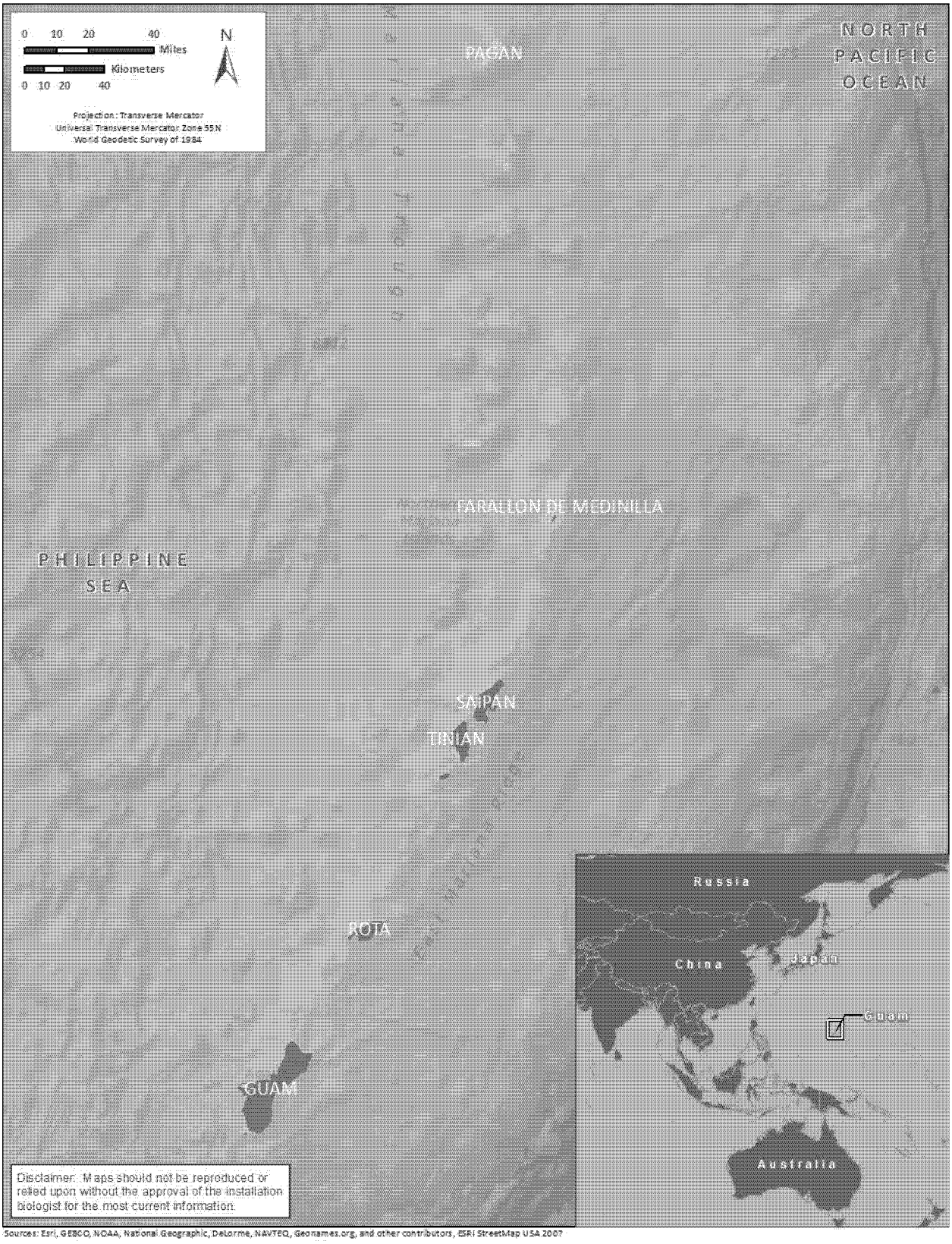
2.2 Abbreviated History of Guam, Tinian, and Farallon de Medinilla

Guam

The Portuguese navigator Ferdinand Magellan reached the Island of Guam in 1521. The island was claimed for Spain by General Miguel López de Legazpi in 1565. Spanish colonization commenced in 1668 with the arrival of Padre San Vitores, who established the first Catholic mission. The islands were then governed as part of the Spanish East Indies from the Philippines. Between 1668 and 1815, Guam was an important resting stop on the Spanish trade route between Mexico and the Philippines. Guam, along with the rest of the Mariana and Caroline islands, was treated by Spain as part of their colony in the Philippines. While Guam's Chamorro culture is unique, the cultures of both Guam and the Northern Mariana were heavily influenced by Spanish culture and traditions.

Apra Harbor and Orote Peninsula, circa 1945. Source: JRM NR Manager

The United States took control of the island in 1898 at the end of the Spanish-American War. Guam came to serve as a station for American ships traveling to and from the Philippines. During World War II, Guam was invaded by Japan on December 8, 1941. Guam's occupation by the Japanese lasted for approximately 31 months.



Sources: Esri, GEBCO, NOAA, National Geographic, DeLorme, NAVTEQ, Geonames.org, and other contributors, ESRI StreetMap USA 2007

Figure 2-1a. Location of Mariana Islands Archipelago

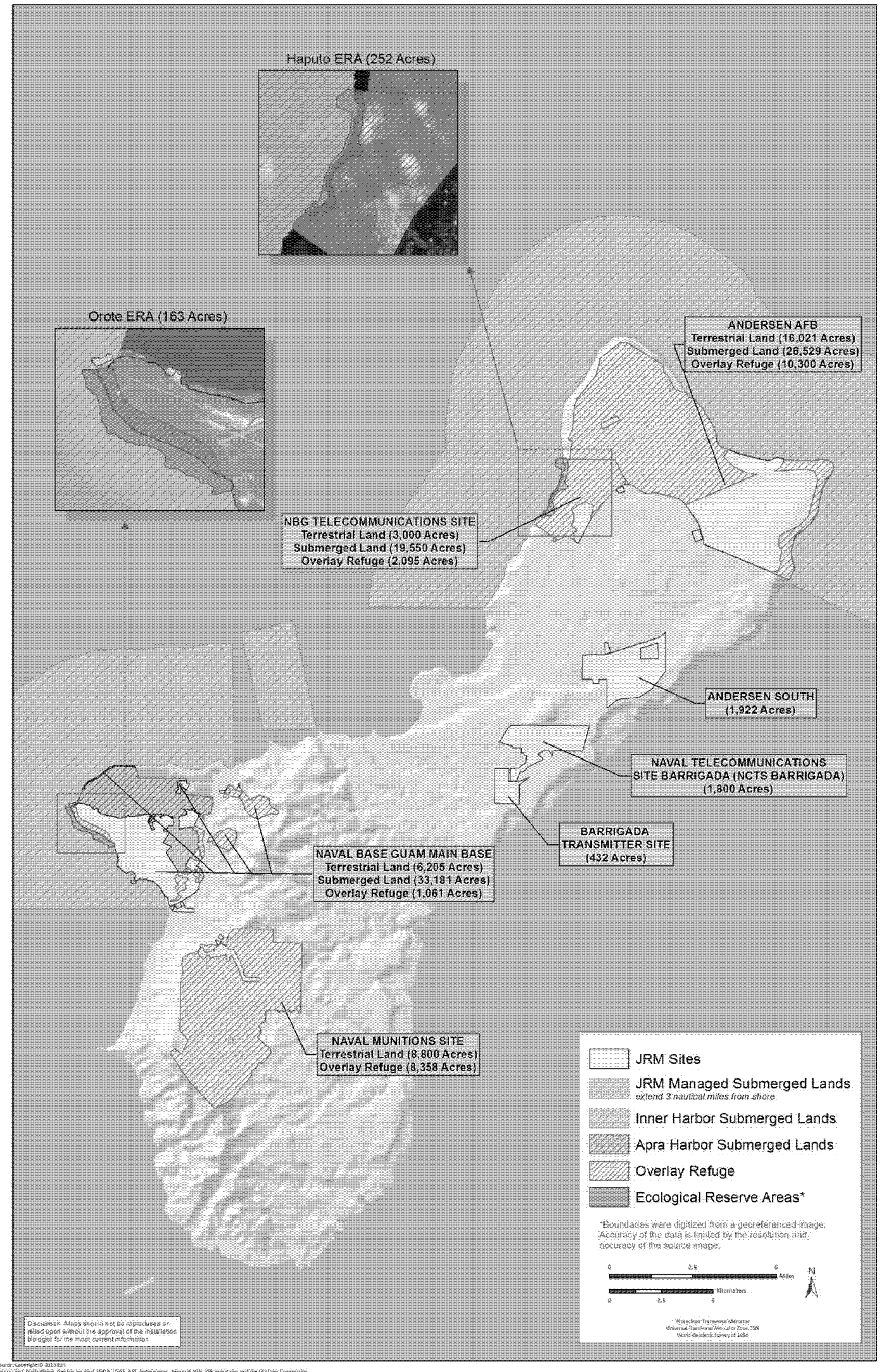


Figure 2-1b. Location of Joint Region Marianas Sites on Guam

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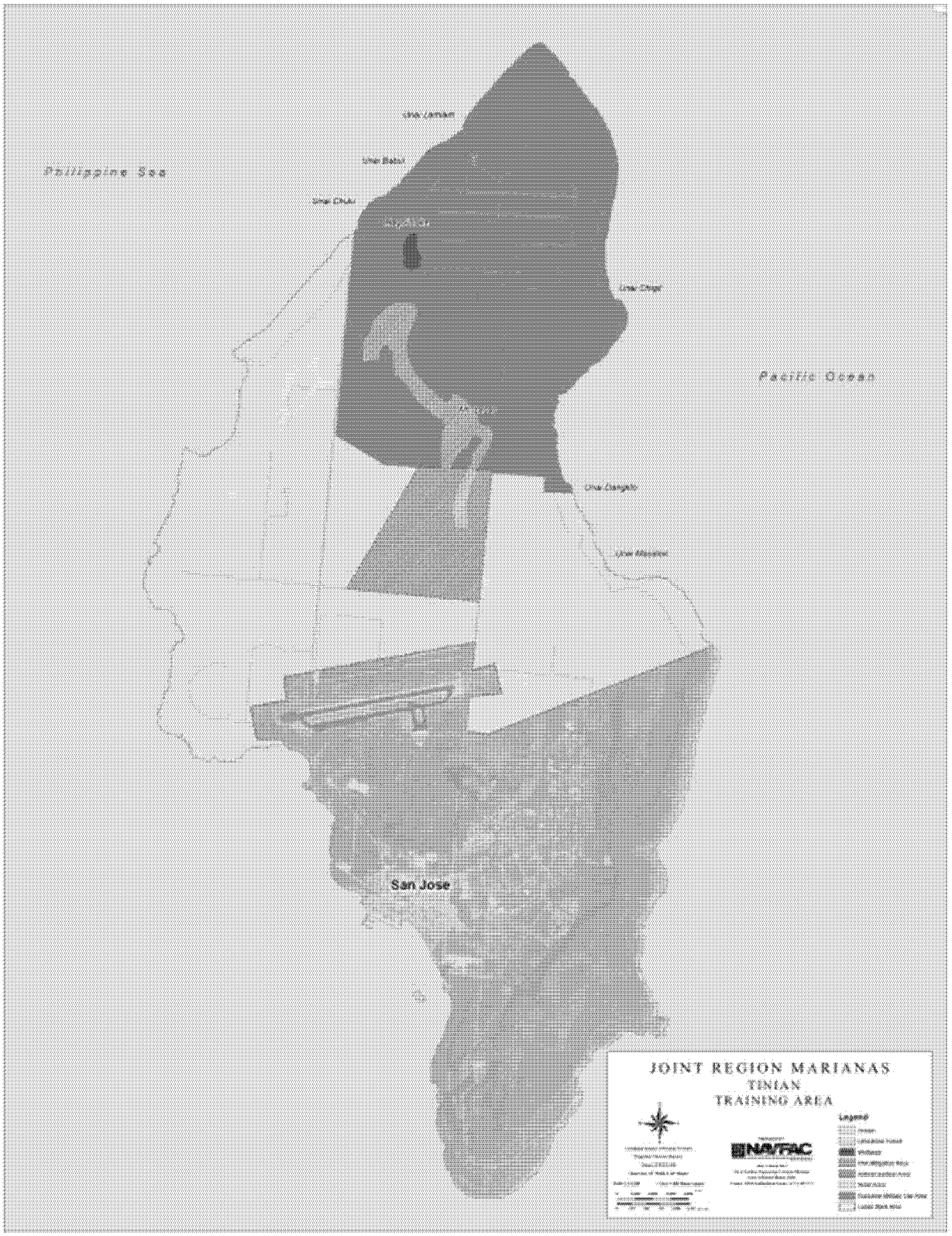


Figure 2-2. Location of Military Use Areas on Tinian

During this period, the indigenous people of Guam, the Chamorro, were subjected to forced labor, family separation, incarceration, execution, and concentration camps. Approximately 1,000 people died during the occupation. The United States initiated the Battle of Guam on July 21, 1944, to recapture the island from the Japanese. The United States also captured and occupied Saipan and Tinian in the Northern Mariana Islands. After the war, the Guam Organic Act of 1950 established Guam as an unincorporated, organized territory of the United States, which provided for the structure of the island's civilian government, and granted the people U.S. citizenship.

Andersen Air Force Base circa 1945. Source: JRM NR Manager

Tinian

At least three large village complexes historically existed on Tinian: Taga, Tachogna and Dångkolo, with smaller sites at Unai Chulu, Makpo, Unai Masalog, and Carolinas Ridge. First European contact occurred in 1521. The Spanish took formal possession of Tinian in 1565. At that time, the native population was estimated to be 7,000 people. In 1899, the Spanish lost control of their possessions in the Marianas to Germany. Tinian came under control of imperial Japan in 1914. Large-scale sugar production was established on 80 to 90 percent of the island's tillable soil, which resulted in the destruction of forests and archaeological sites. During this time, the island population was about 14,000.

In 1936, most of Tinian's Chamorro residents were relocated by the Japanese to Rota and Saipan. Subsequently, 1,200 Japanese convicts were brought to Tinian to build airfields and other military facilities. The invasion of Saipan and Tinian by American forces occurred in June and July 1944. Following the battle for Tinian, the U.S. military transformed the island into the largest B-29 base in the Pacific, and the largest operational base in the world. The existing North Field was expanded and West Field was developed to accommodate two 8,500-foot (2.6-kilometer) B-29 runways. Among the purposes of the Marianas operation was the provision of a base to initiate the B-29 bombings of Japanese home islands including the flights of the Enola Gay and Bock's Car, which dropped atomic bombs on Hiroshima and Nagasaki, respectively. The U.S. military population on Tinian grew to 250,000 and by the end of the war, 29,000 missions had been flown from the island.

FDM

An archaeological survey conducted on FDM concluded that it is unlikely that a permanent human population ever resided on the island due to the lack of water, its exposed environment, and difficult beach landing (Belt Collins 1997).

Germany purchased the Northern Marianas from Spain in 1898 and supplied licenses to private companies for the harvest of native birds (Spennemann 1999). FDM was leased by Germany in 1909 for the exploitation of birds after typhoons wrecked Alamagan, Pagan, and Anatahan. German control over the Northern Mariana Islands was lost in 1914 when they were annexed by Japan (Spennemann 1999). Japan retained possession of FDM until 1944 when United States defeated them during World War II.

2.3 Regional Land Use

Guam

Residents of Guam depend primarily on the U.S. military and tourism from Korea and Japan for their economy. Over the past 20 years, the tourism industry has grown rapidly, creating a construction boom for new hotels, golf courses, and other infrastructure. Nearly 1.2 million tourists visit Guam each year including about 962,000 from Japan and 114,000 from Korea. Most food and industrial goods are imported; however, some crops, primarily fruits and vegetables, are grown on the island. As tourism continues to grow, more and more land will be developed to support the industry. In addition, with the proposed military buildup on Guam, more development of military facilities and island infrastructure will be needed to support military and associated civilian personnel.

Tinian

Public land uses on Tinian include tourism, agriculture, commerce, recreation, and communication. The CRMO has designated areas of particular concern and is responsible for regulating the use of these areas. Land uses overlap to some extent, for example, civilian recreational use is permitted within the Military Lease Area (MLA).

FDM

The entire land mass of FDM and associated designated R-7201 restricted airspace is leased by NBG from the CNMI government (U.S. Navy 2009). The lease expires in 2075 (Smith and Marx 2009).

2.4 Guam National Wildlife Refuge

The Overlay Lands of the GNWR are Navy lands that are managed cooperatively with the USFWS.

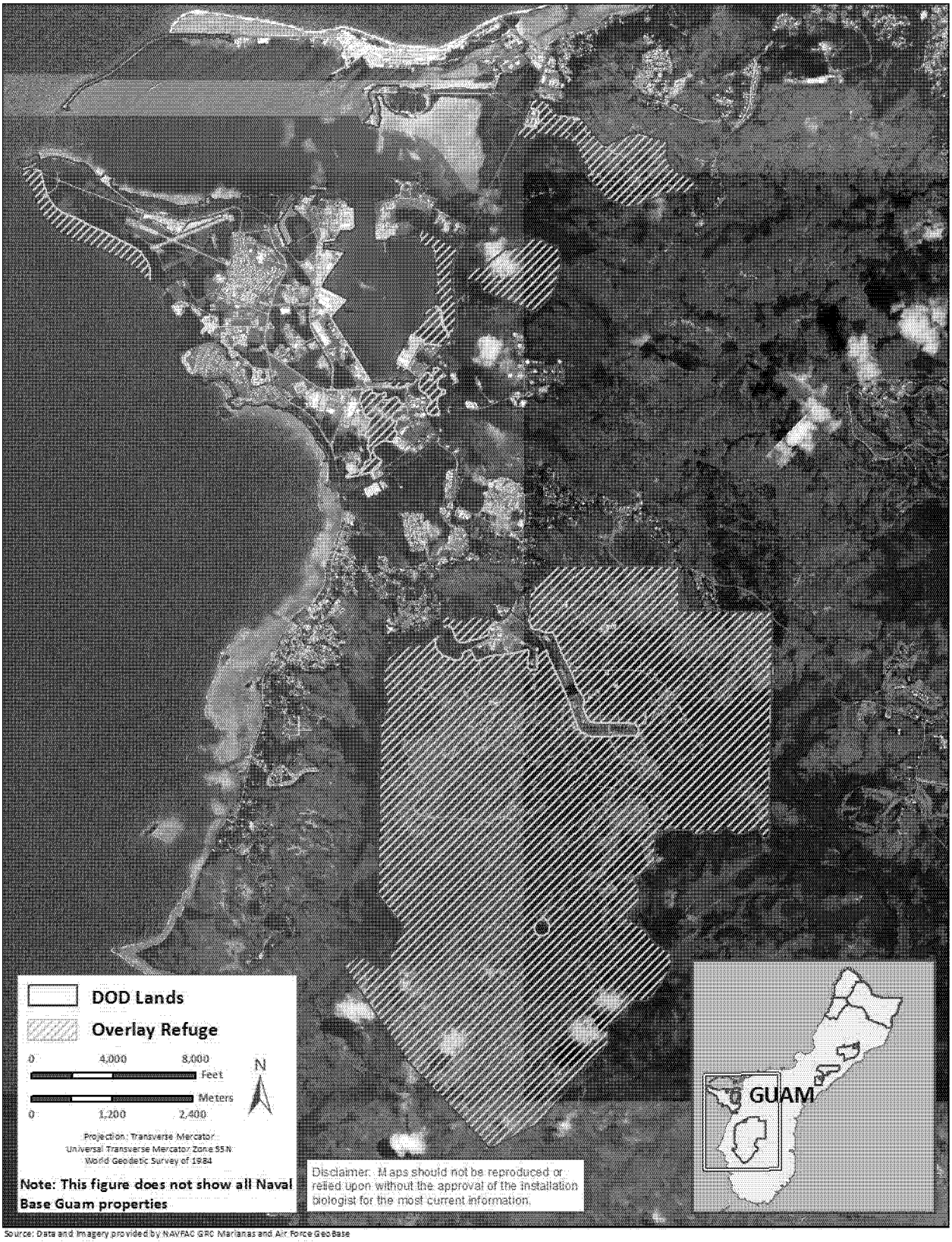
In 1991, the USFWS first issued a proposal for critical habitat for the Mariana fruit bat, Mariana crow, and Guam Micronesian kingfisher (USFWS 1991b). In 1993, the desire to create the GNWR was established by a Memorandum of Understanding (MOU) with the USFWS, Navy, Air Force, and GovGuam (GovGuam et al. 1993). Cooperative Agreements were signed in 1994 to establish the Overlay Refuge and define the management, administrative roles, and responsibilities (Air Force and USFWS 1994, Navy and USFWS 1994). The 1994 Cooperative Agreements provide a commitment by the Navy, Air Force, and USFWS for a coordinated program centered on the protection of threatened and endangered species and other native flora and fauna, maintenance of native ecosystems, and the conservation of native biological diversity in cooperation with DAWR, consistent with the national defense mission of the Navy and Air Force. The MOU and Cooperative Agreements are included in **Appendix I**.

Excess military land at Ritidian Point was then transferred to USFWS under the Federal excess property regulations for inclusion in the Guam NWR as the 376-acre (152-hectare) Ritidian Unit. Currently, the majority of the approximate 22,000-acre (8,900-hectare) GNWR is Overlay Refuge on lands administered by Andersen AFB and NBG.

Figure 2-3 shows the GNWR Overlay Refuge areas on NBG and NMS.

Figure 2-4 shows GNWR Overlay Refuge areas on NBG Telecommunications Site (TS).

Figure 2-5 shows GNWR Overlay Refuge areas on Andersen AFB.



Source: Data and Imagery provided by NAVFAC GRC Marianas and Air Force GeoBase

Figure 2-3. Guam National Wildlife Refuge Areas on Naval Base Guam Main Base and Naval Munitions Site

Source: Data and Imagery provided by NAVFAC GRC Marianas and Air Force GeoBase

Figure 2-4. Guam National Wildlife Refuge Areas on Naval Base Guam Telecommunications Site

Figure 2-5. Guam National Wildlife Refuge Areas on Andersen Air Force Base

2.5 Military Mission

The following sections describe the military missions of the NBG and Andersen AFB components of JRM. Biological Opinions, permits, leases and other MOUs or Agreements between JRM sites and other land managers are listed in **Table 2-1.** A 2006 agreement between the United States and Japan is currently in the process of shifting Marines of the U.S. Marine Corps' III Marine Expeditionary Force (III MEF) from installations in Japan to the Island of Guam, which will enhance the military mission of JRM (JGPO 2010).

2.5.1 Naval Base Guam

The mission of NBG is to support the U.S. Pacific Fleet and other forces operating from, serviced by, or supplied through Guam; to support the fighters based here or attached to tenant commands; and to support the families of sailors stationed in Guam. Both Tinian and FDM are used for training exercises that support the readiness of U.S. and allied troops.

2.5.2 Andersen Air Force Base

The mission of the 36th Wing (36 WG) is "to provide a U.S.-based lethal warfighting platform for the employment, deployment, reception, and throughput of air and space forces in the Asia-Pacific region." Guam serves as a stopping point for numerous aircraft en route to Japan, Korea, and other Asian locations. While Andersen AFB is a Navy installation, mission-support activities conducted at Andersen AFB are an Air Force mission function (e.g., runways), while installation-support activities are a JRM function.

2.6 Operations and Activities and Their Effects on the Natural Environment

JRM, which includes Navy and Air Force holdings on Guam, and U.S. Navy-leased lands on Tinian and FDM, is under CNIC. The following sections describe the operations and general associated environmental effects of NBG and Andersen AFB sites that now compose JRM.

The Navy supports numerous tenant commands and activities on four primary sites: NBG Main Base, NMS, NBG TC, and NCTS Barrigada (see **Figure 2-1b**). In total, Navy lands on Guam cover 19,805 acres (8,015 hectares). In addition, the Navy manages all submerged lands adjacent to its holdings from the shoreline out 3 nautical miles. Navy submerged lands total approximately 79,260 acres (32,075 hectares).

The Air Force supports two primary sites. The main installation of Andersen AFB is about 8 miles by 4 miles (13 by 6 kilometers) and covers 25 square miles (64 square kilometers), or about 16,021 acres (6,483 hectares), of a relatively flat, uplifted limestone plateau at the northern end of the island. Andersen AFB South (Andersen South), is approximately 1,922 acres (778 hectares), and is approximately 4 miles (6.4 kilometers) south of Andersen AFB (see **Figure 2-1b**).

Land and jurisdictional issues on Guam are complex. The key guidance documents are (1) P.L. 93-435(b)(ii) effective October 5, 1974, and (2) Presidential Proclamation 4347 effective February 1, 1975. The public law authorizes the Navy to retain title of submerged lands adjacent to property owned by the United States above the mean high tide. The Presidential Proclamation authorizes the Navy to retain title of submerged lands within Inner and Outer Apra Harbor and submerged lands adjacent to several other upland areas.

Table 2-1: Active Land Use and Natural Resource Agreements Regarding Joint Region Marianas Sites

JRM Site	Agreement	Date of Issue
Biological Opinions, Permits, and Correspondence with U.S. Fish and Wildlife Service and National Marine Fisheries Service		
Andersen AFB	• Biological Opinion for Northwest Field Beddown	2006
Andersen AFB	• Biological Opinion for Intelligence, Surveillance, Reconnaissance, and Strike Capability	2006
Andersen AFB	• Biological Opinion for Habitat Management Units Wells and Fence	2009
Tinian and FDM	• Biological Opinion for Mariana Islands Range Complex	2010
Andersen AFB	• Biological Opinion for Guam and Commonwealth of the Northern Mariana Islands Military Relocation	2010
Islands of Guam and Rota	• *Serianthes nelsonii* permit	2010
Joint Region Marianas	• Regional Strading Investigation Assistance Plan with NMFS	2013
Permits issued by U.S. Army Corps of Engineers		
Naval Base Guam Main Base	• Final Mitigation Plan for MILCON P-502 Kilo Wharf Extension Project	2008
Naval Base Guam Main Base	• MILCON P-502 Kilo Wharf Extension	2008
Memoranda of Understanding and Cooperative Agreements		
Naval Base Guam Main Base, Naval Munitions Site, Andersen AFB	• MOU among the Government of Guam and the U.S. Air Force and the U.S. Navy and the U.S. Fish and Wildlife Service for the Establishment and Management of the Guam National Wildlife Refuge	1993
Joint Region Marianas	• MOA between United States Navy, Supporting Component and United States Air Force and United States Marine Corps, Supported Component(s) for fully implementing Base Realignment and Closure (BRAC) 2005 Joint Base decisions	2009
Lease or Permit with State, City or Other Group		
Tinian, Northern Mariana Islands	• Technical Agreement Regarding Use of Land to be Leased by the United States in the Northern Mariana Islands	February 1975
Tinian and FDM	• Use by the United States of America of Farallon de Medinilla Island and a portion of Tinian Island Northern Mariana Islands	January 1978
Tinian	• Leaseback Agreement between the Commonwealth of the Northern Mariana Islands and the United States of America made pursuant to the covenant to establish the Commonwealth of the Northern Mariana Islands in political union with the United States of America	December 1988

JRM Site	Agreement	Date of Issue
Tinian	• Leaseback and Disposal Agreement between the Commonwealth of the Northern Mariana Islands and the United States of America made Pursuant to the Covenant to Establish a Commonwealth of the Northern Mariana Islands in Political Union with the United States of America	August 1994
Off-site	• Declaration of Deed Restriction for Cetti Bay Parcel No. 275	June 2008

2.6.1 Naval Base Guam Main Base

2.6.1.1 Operations

NBG Main Base is composed of several noncontiguous areas that were previously separate installations (see **Figure 2-6**). NBG Main Base, approximately 6,205 acres (2,511 hectares), consists of several sites including the Main Base (3,114 acres [1,260 hectares]), Tenjo and Sasa Fuel farms (651 acres [263 hectares]), Glass Breakwater (41 acres [17 hectares]), Polaris Point (254 acres [103 hectares]), and Drydock Island (48 acres [19 hectares]) (see **Table 1-1**).

JRM operations on NBG Main Base are very diverse and include several critical mission requirements. The primary function of NBG Main Base is to support fleet units and operational forces of the Fifth and Seventh Fleets. NBG Main Base operates the Kilo, Delta, and Echo wharfs on Dry Dock Island in Outer Apra Harbor. Several other wharfs within Inner Apra Harbor are also operated by NBG Main Base, including Alpha and Bravo on Polaris Point; and Lima, November, Oscar, Papa, Quebec, Romeo, Sierra, Tango, Uniform, Victor, and X-ray. Berthing of vessels requires adequate water depth (approximately 35 feet [11 meters]), Explosive Safety Quantity Distance (ESQD) arcs, and security around the vessels while in port. See **Figure 2-7** for ESQD arcs for NBG Main Base.

Shore-based support includes warehouses, power, water, sewage treatment, fuel transfer, and other facilities. NBG Main Base also supports military housing areas, recreational facilities, food services, Navy commissary, and Navy exchanges. Camp Covington is also located within NBG Main Base, and supports Naval Mobile Construction Battalions (SeaBees).

Training at NBG Main Base includes beach landing sites (amphibious assault vehicle [AAV], landing craft air cushion [LCAC], and landing craft utility [LCU] landing sites), riverine training, small unit maneuvers, rappelling, helicopter insertion and extractions, rapid runway repair, field exercises, small arms range, pistol range, stress course, sniper range, fire and maneuver range, and a skeet range. Training within Apra Harbor includes explosive ordnance disposal (EOD) deepwater mine countermeasures, helicopter paradrops, helicopter cast and recovery, drown-proofing, heliborne firebucket (offload), helicopter search and rescue, and combat swimmer.

2.6.1.2 Existing Conditions

Part of NBG Main Base is included within the GNWR Overlay Refuge (see **Figure 2-3**). Green and hawksbill (*Eretmochelys imbricate)* sea turtles are known to use the nearshore and Apra Harbor waters, and nest on the beaches within NBG Main Base. The Navy monitors for sea turtles on all beaches with known nesting activity and other beaches with suitable nesting habitat throughout the year. Nesting of hawksbill sea turtles was reported in 1995 on a small beach within the Sumay Cove; however, more recent nesting at this site has not been observed. In addition, turtle nests have been confirmed on Spanish

Source: Data and Imagery provided by NAVFAC GRC Marianas and Air Force GeoBase

Figure 2-6. Location of Naval Base Guam Main Base

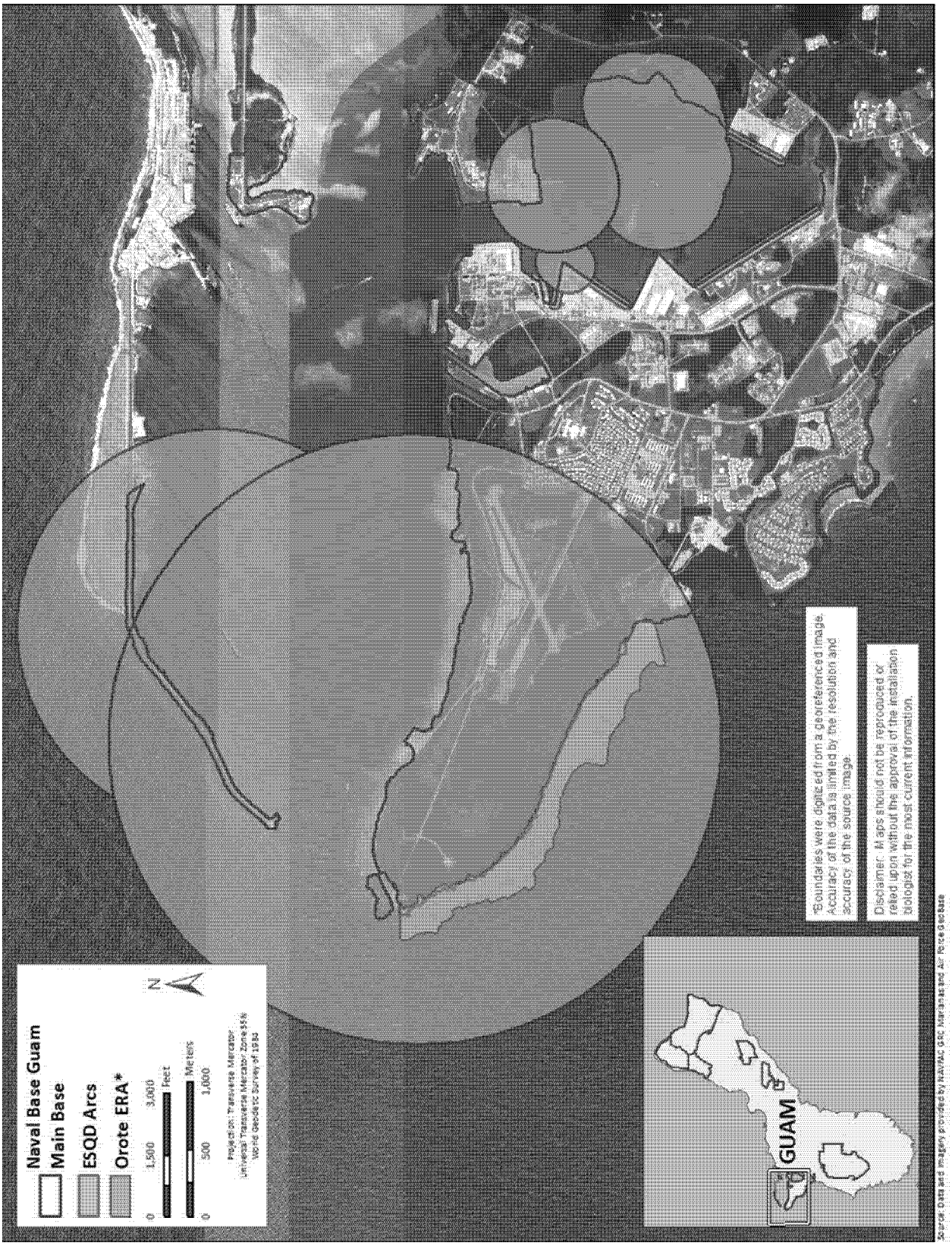


Figure 2-7. Explosive Safety Quantity Distance Arcs for NBG

Steps. The Mariana common moorhen (*Gallinula chloropus guami*) is known to occur within wetlands on NBG Main Base. The vegetation along the Orote cliff line retains functional components of native limestone forest, which is suitable habitat for avian species.

Offshore and harbor operations can affect the coral reef communities within the site. Coral reefs within Apra Harbor could be impacted by ship channel maintenance, ship movement, and water contamination or fluid spills. Under Executive Order (EO) 13089, dated June 11, 1998, actions that potentially affect coral reef ecosystems must be mitigated. The marine environment in the Orote Peninsula Ecological Reserve Area (OPERA) is currently on the U.S. Marine Managed Area Inventory and, similar to the Haputo Ecological Reserve Area (HERA) located at the NBG TS, may be designated a Marine Protected Area under EO 13158. Marine mammals could also be affected by training exercises offshore, and all species are protected under the MMPA.

As with the HERA, the Navy established the OPERA in 1984 as a mitigation measure for the construction of Kilo Wharf. The OPERA includes submerged lands from the shoreline to a depth of 120 feet (37 meters) offshore. The OPERA extends inland from the mean lower low water line to the upper edge of the cliff along the southwestern edge of Orote Peninsula. The terrestrial unit of this ecological reserve area (ERA) totals about 30 acres (12 hectares), and the submerged lands total about 133 acres (54 hectares). Potential impacts of military training in the OPERA were addressed in the Final Environmental Impact Statement Military Training in the Marianas Islands.

In addition, Guam is within the jurisdiction of the Western Pacific Regional Fishery Management Council (WPRFMC), which has designated the marine waters around Guam, including Navy submerged lands, as Essential Fish Habitat (EFH), and waters between 130 to 980 feet (40 and 280 meters) as bottom-fish Habitat of Particular Concern (HAPC) (Western Pacific Regional Fishery Management Council 1998).

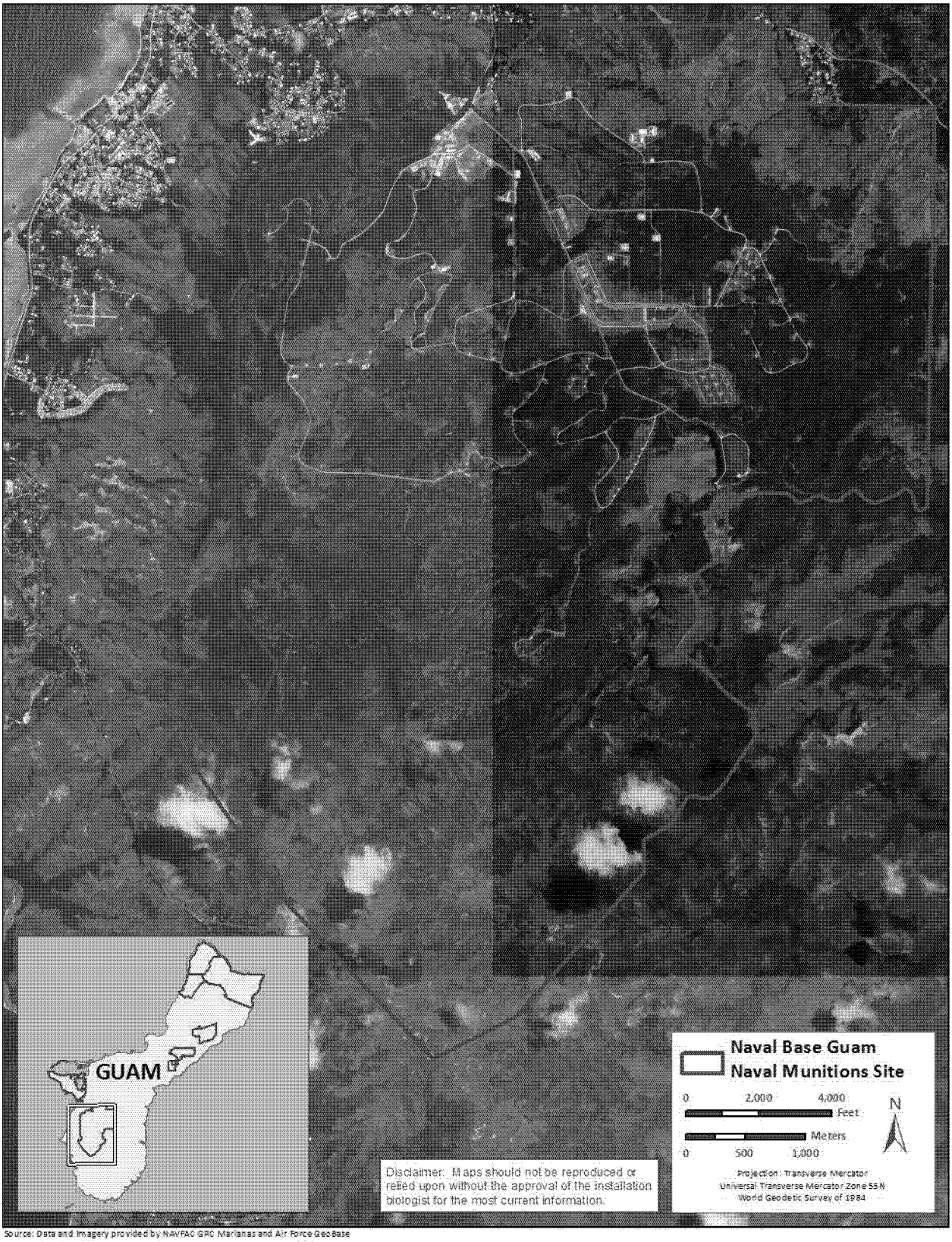
The shoreline and cliff lines along NBG Main Base, the wetlands, and the upland grass fields support a number of seabird and migratory shorebird species, which are protected under the Migratory Bird Treaty Act (MBTA). Certain activities, such as land clearing, can inadvertently impact these birds. There are several wetlands within NBG Main Base that are regulated by the U.S. Army Corps of Engineers (USACE). Wetlands in Guam are also protected under EO 78-21, EO 90-13, EO 99-09, *The Guam Water Pollution Control Act*, and Guam's *Wetland and Flood Hazard Area Regulations* (Title 13, Subchapter E. Section 12240-12246 and Subchapter D, Section 12230-12236, *Administrative Rules and Regulations*). Wetlands can be affected by operations on NBG Main Base due to construction or other activities that require filling, or from activities that cause erosion and sedimentation, which can degrade wetland quality.

Vegetated areas that have been disturbed by clearing, construction, and other activities are dominated by nonnative and invasive plant species, and include a number of invasive weeds.

2.6.2 Naval Munitions Site

2.6.2.1 Operations

The NMS is the largest JRM site on Guam and has the greatest area of terrestrial natural resources. The NMS is located on mountainous terrain in south-central Guam and consists of approximately 8,800 acres (3,561 hectares) (see **Table 1-1**). Approximately half of the NMS lies within the watershed of Fena Reservoir (see **Figure 2-8**).



Source: Data and Imagery provided by NAVFAC GRC Marianas and Air Force GeoBase

Figure 2-8. Location of the Naval Munitions Site

The NMS provides support through receiving, renovating, maintaining, storing, and issuing ammunition, explosives, and expendable ordnance materials to units of the Pacific Fleet operating in the Western Pacific. The site has the primary responsibility of providing ordnance support for the Seventh and Fifth Fleets and has been designated as the single transportation service for point-to-point ammunition hauling between military installations on Guam. Magazines at the NMS provide more than 250,000 square feet (23,226 square meters) of storage space for ordnance materials.

The extent of the ESQDs on the NMS limits development (see **Figure 2-9**). Approximately 70 percent of the NMS is retained as uninhabited and is used as an explosive safety zone. The facilities located within this zone include ordnance storage magazines, ordnance operating and support buildings, the Fena Reservoir Dam, and an extensive network of roads. The remaining land in this area is managed primarily for conservation and watershed.

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Fena Dam, built in 1951, impounds Fena Reservoir, the largest freshwater body of water on Guam, with a maximum storage capacity of about 7,500 acre-feet (925 hectare-meters). Fena Reservoir provides the majority of Navy's water. Surplus water is sold to GovGuam for distribution to residents in southern Guam. The Fena Water Treatment Plant is operated by NAVFACMAR.

Training within the NMS includes helicopter landings, field exercises, paradrops, small unit bivouac, land navigation, patrols, squad tactics, heliborne firebucket loading, tactical rescue of aircraft and personnel, escape and evasion, sniper range use, and small unit patrolling.

2.6.2.2 Existing Conditions

The majority of the NMS is included within the GNWR (see **Figure 2-3**). Three caves within the NMS contain the only nesting populations of Mariana swiftlets (*Aerodramus bartschi*) on Guam. The Mariana common moorhen is also known to inhabit the shoreline of Fena Reservoir and other wetlands on the NMS. Plant communities within the NMS retain functional components of native ravine and limestone forest, which are suitable habitats for the swiftlet and moorhen. The Mariana fruit bat has been sighted foraging in the NMS, and the USFWS recovery plan for the Mariana fruit bat identified the Fena watershed as the largest parcel of suitable habitat for the bat in southern Guam. Training exercises could affect these species if they take place within close proximity to nesting and foraging areas.

Migratory birds, which are protected under the MBTA, are frequently observed foraging and roosting on Fena Reservoir and along its shores and in upland habitats in the NMS. Operational activities around Fena Reservoir could result in further development and habitat loss which could affect these birds.

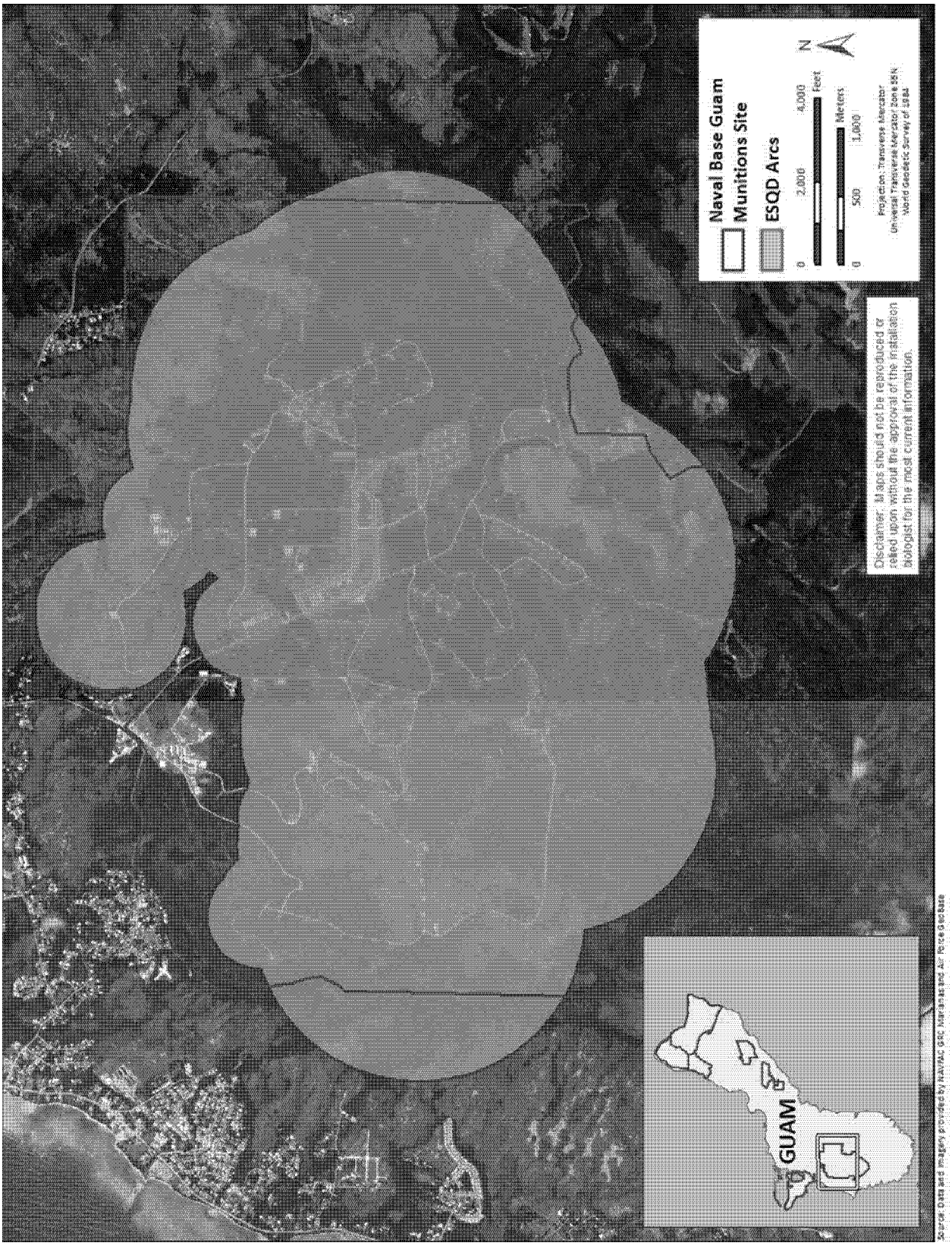


Figure 2-9. Explosive Safety Quantity Distance Arcs for Naval Munitions Site

Much of the NMS has been heavily disturbed and is dominated by nonnative, often invasive plant species. EO 13112 outlines the Federal government's responsibilities to prevent the introduction and provide for the control of invasive species. In addition to invasive vegetation, the NMS has a high population of invasive ungulates that impact vegetation communities, which, in turn, leads to habitat degradation, increased erosion, and reduced water quality.

2.6.3 Naval Base Guam Telecommunications Site

2.6.3.1 Operations

NBG TS is located on the northwestern side of Guam and totals 3,000 acres (1,214 hectares) (see **Figure 2-10** and **Table 1-1**). NBG TS operates communications systems including radio frequency (RF) systems and terrestrial-based fiber optic cables. This area is designated and maintained as an RF quiet zone for a minimum of a 1-mile (1.6 kilometer) radius. The South Finegayan housing area is in a separate parcel south of NBG TS. The Navy mission requirement for the family housing area is to provide a safe, secure environment for its residents.

The Navy also owns the submerged lands off of NBG TS out to a distance of 12 miles (19 kilometers) from the coast, but actively manages only up to 3 nautical miles (5.5 kilometers) seaward. The waters off of NBG TC are used for military training. Training at NBG TS includes training for Navy Special Warfare Units, Special Forces, and Marine Reconnaissance teams; use of existing trails for inland maneuvers and Military Operations in Urbanized Terrain (MOUT); and the use of small arms at the North Range.

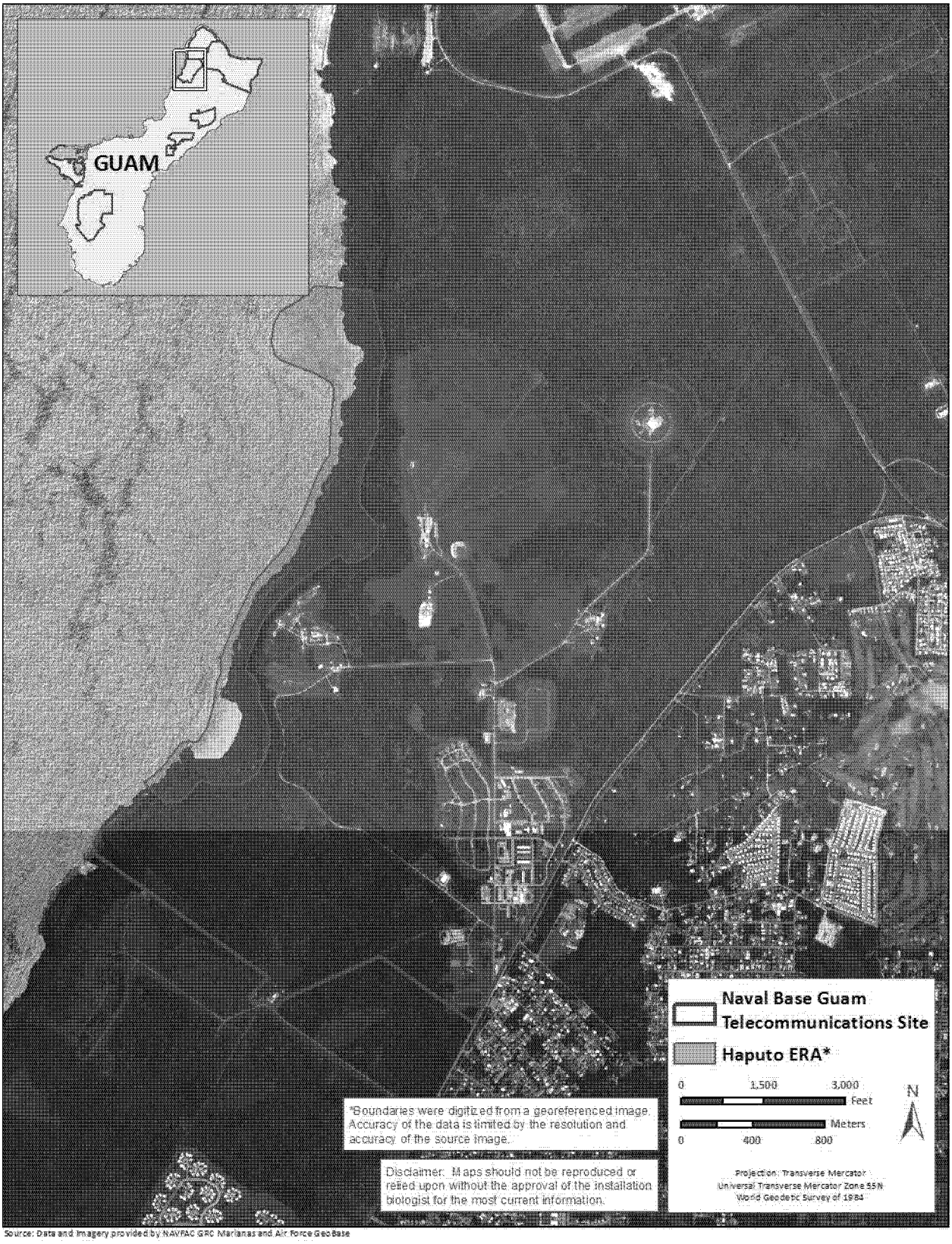
2.6.3.2 Existing Conditions

Land clearing and training exercises can affect endangered species that occur, or potentially occur, within the site by disturbing or removing habitat or food sources. Two endangered species and four candidate species have been documented within the site: the Mariana fruit bat and green sea turtle are threatened; and the Mariana eight-spot (*Hypolimnas octucual marianensis*), humped tree snail (*Partula gibba*), Guam tree snail (*Partula radiolata*), and fragile tree snail (*Samoana fragilis*) are candidate species. Haputo Beach supports nesting sea turtles and nesting activity has been observed.

Coastal training can affect coral reef communities. Under EO 13089, actions that potentially affect coral reef ecosystems must be mitigated. The marine environment in the HERA is currently on the U.S. Marine Managed Area Inventory. Marine mammals can be affected by training exercises offshore. All species are protected under the MMPA.

In 1984, the HERA was established as a mitigation measure for the construction of Kilo Wharf. The HERA includes submerged lands from the shoreline to the outer edge of the reef margin. Inland the HERA extends to the top of the limestone ridge along the full length of the coast. The terrestrial unit of this HERA totals about 180 acres (73 hectares), and the submerged lands total 72 acres (29 hectares). Potential impacts of military training in the HERA were addressed in the Final Environmental Impact Statement Military Training in the Marianas Islands.

The shoreline, cliff line, and upland habitats on NBG TS support a number of shorebird species, which are protected under the MBTA. Training activities on NBG TC can affect these birds. EO 13186, *Responsibilities of Federal Agencies to Protect Migratory Birds*, outlines Federal agencies' responsibilities to promote the conservation of migratory bird populations, and consultation with the USFWS if any planned action could harm migratory bird species listed in 50 Code of Federal Regulations (CFR) § 10.21.



Source: Data and Imagery provided by NAVFAC GRC Marianas and Air Force GeoBase

Figure 2-10. Location of Naval Base Guam Telecommunications Site

Receiving antennas and other communications equipment require open areas to prevent interference from surrounding trees or buildings. As a result, much of NBG TS has been cleared and is maintained as mowed grasslands. This has allowed for the establishment of nonnative vegetation primarily in the transition areas between the mowed grasslands and the forest areas. These species have also moved into the forest areas, especially along the roadsides where safety areas are maintained. This disturbance and increase in nonnative vegetation has contributed to a highly disturbed habitat and a severe decline in native forest species. These disturbed areas provide suitable habitat for invasive ungulate species.

2.6.4 Naval Telecommunications Site Barrigada

2.6.4.1 Operations

The NCTS Barrigada is located on the northeastern side of Guam (see **Figure 2-11**). The site is approximately 1,800 acres (728 hectares) (see **Table 1-1**) and supports a large antenna field developed around an active transmitter facility. The facility serves as the transmitting station for NBG TS. A 1-mile (1.6-kilometer) radius protection zone is designated around transmitting antennas to prevent electromagnetic radiation problems. Fifteen acres (6 hectares) are leased to the Guam Army National Guard for small-unit tactics and land navigation training. The Navy's Admiral Nimitz Golf Course is on the site and includes several small man-made ponds. The ponds on the golf course are ephemeral.

2.6.4.2 Existing Conditions

The open grasslands and constructed ponds on NCTS Barrigada are regularly used as resting and foraging areas for migrating birds, which are protected under the MBTA.

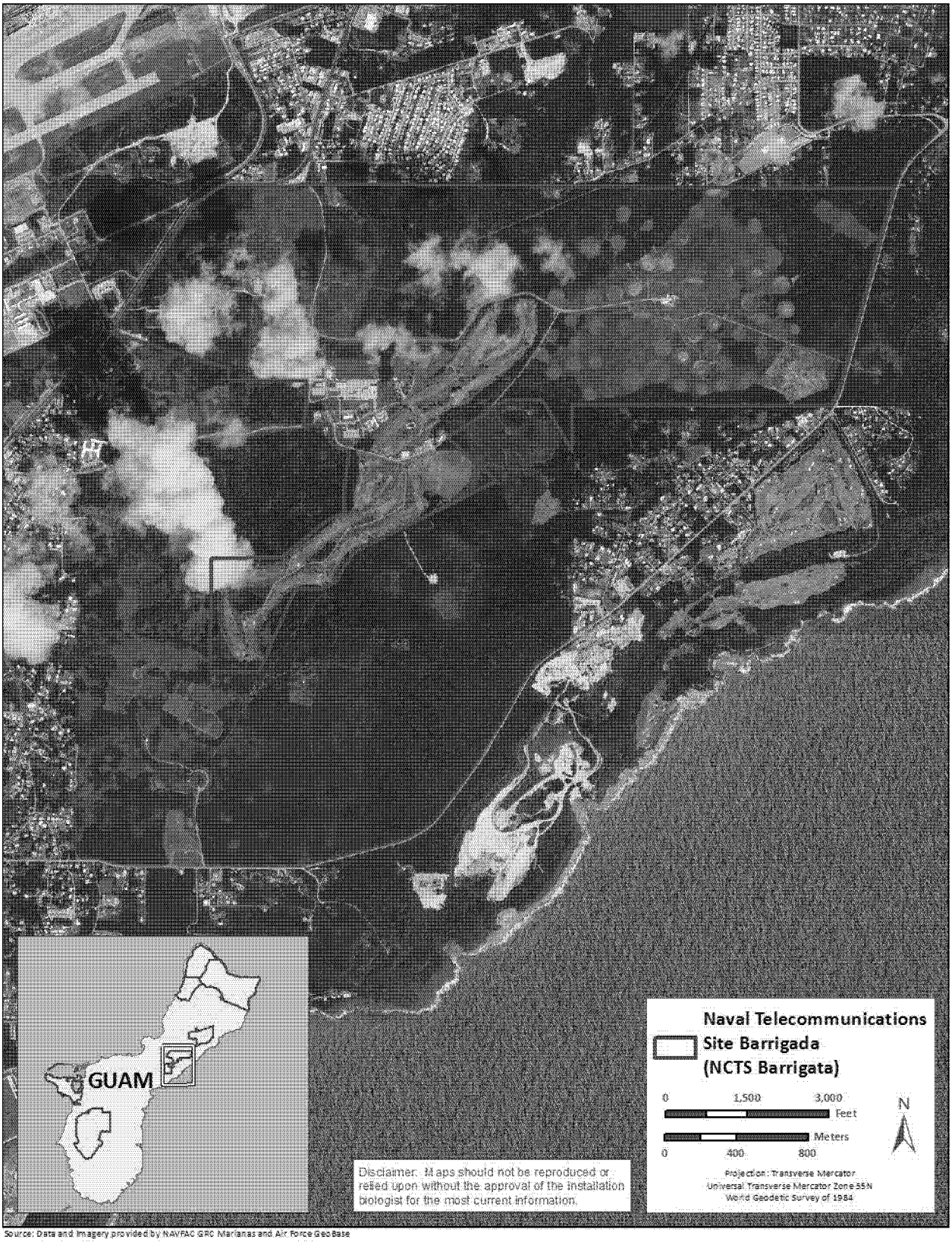
As with the NBG TS, the activities carried out at this site require large amounts of cleared, maintained land for operation. The disturbance of land has led to an increase of nonnative and invasive species. There is native understory, and canopy trees in forested areas on the site that could provide foraging habitat for the Mariana fruit bat.

2.6.5 Tinian

2.6.5.1 Operations

The Tinian MLA is approximately 15,347 contiguous acres (6,211 hectares) north of the Tinian International Airport (West Field) (see **Figure 2-3** and **Table 1-1**). The MLA is divided into the Exclusive Military Use Area (EMUA) and the Lease Back Area (LBA). The EMUA is approximately 7,577 acres (3,066 hectares) in the northern section of the MLA and the LBA includes approximately 7,770 acres (3,145 hectares) in the central section of the island.

The EMUA is the primary military training area on Tinian. The area is not secured from the public and day use access is not regulated, except when military exercises are in progress. Cattle ranching and resident human occupation is not permitted in the EMUA. Unai Chulu is the only beach that has been utilized for LCAC training. There are no live-fire ranges in the EMUA, with the exception of small arms fire into bullet traps associated with World War II structures located in North Field. Historic runways built in 1945 occupy much of North Field. This area is used for bivouac training, fixed-wing and helicopter activities, parachute drops, and helicopter training activities (JGPO 2010).



Source: Data and Imagery provided by NAVFAC GRC Marianas and Air Force GeoBase

Figure 2-11. Location of Naval Telecommunications Site Barrigada (NCTS Barrigada)

The LBA can be used for on-the-ground instruction associated with MOUT, bivouac, vehicle and land navigation, and other field activities. No live-fire ranges exist on the LBA however live and blank firing in an abandoned Japanese headquarters building associated with MOUT training occurs.

The Federal Aviation Administration (FAA) Mitigation Area was established within the LBA as a result of an agreement between the Commonwealth Ports Authority (CPA), FAA, U.S. Navy, and USFWS. It was designed to create an area of habitat protection as mitigation for past expansions of the Tinian Airport (West Field). The terms of the agreement allow the U.S. military to use the FAA Mitigation Area for low impact, nonhabitat destructive training (JGPO 2010).

2.6.5.2 Existing Conditions

DOD training is conducted in five general mission areas on Tinian: Air Warfare, Sea Warfare, Undersea Warfare, Land Warfare, and Amphibious Warfare. Training conducted in these mission areas occurs to ensure the readiness of the U.S. Navy, U.S. Marine Corps, and Air Force units; Guam Army National Guard (GUARNG), Guam Air National Guard (GUANG); Army Reserves Marianas (AR-Marianas); U.S. Coast Guard, and other commands based and deployed in the Western Pacific. Terrestrial training exercises can be categorized as one of six major training activities: Strike Warfare, Amphibious Warfare, Expeditionary Warfare, Special Warfare, Special Expeditionary Warfare, and Force Protection/Antiterrorism (U.S. Navy 2009). **Table 2-2** provides a list of the DOD training activities that might occur on Tinian and their locations.

Large-scale maneuvers occur periodically on Tinian. Operation Tandem Thrust, for example, tests U.S. Commander of the Pacific (USCOMPAC) joint capability and involves U.S. Navy, Marine, Army, and Air Force units. Joint Airborne/Air Transportability Training also occurs on Tinian. Strategic personnel airlift and drop/recovery using fixed-wing aircraft is the primary goal of the exercise. North Field is used for MC-130 shortened field training using C-130 aircraft with night vision equipment, close quarter battle, and rapid runway repair training. Amphibious assault training occurs at designated beach landing sites (Unai Babui, Unai Chulu, and Unai Dångkolo). Over-the-beach training is conducted at Unai Chulu beach and urban environment and in-extremis hostage rescue exercises are conducted in the Japanese World War II structures (Belt Collins 1998).

DOD services are permitted to use areas outside of the MLA, including Tinian Harbor, West Tinian Airport, and a staging area near San Jose for logistical support.

2.6.6 Farallon de Medinilla

2.6.6.1 Operations

The island is the Pacific Fleet's only U.S.-controlled range available for live-fire training. The island has been used as bombing range since 1971, both for live- and inert-fire bombing. It supports activities such as surface-to-ground and air-to-ground Gunner Exercise (GUNEX), Bombing Exercise (BOMBEX), Missile Exercise (MISSILEX), Fire Support, and Precision Weapons (U.S. Navy 2009). FDM can be divided into five zones, oriented north to south (see **Figure 2-12**):

- Zone 1 - no fire/no drop zone
- Zone 2 - impact area allowing inert ordnances only
- Zone 3 - impact area permitting live and inert ordnances
- Zone 4 - no fire/no drop zone
- Zone 5 - impact area allowing live and inert ordnances.

Table 2-2. Existing and Proposed Training Activities in the Exclusive Military Use Area and Lease Back Area of Tinian

Exercise		Location
Strike Warfare	Combat search and rescue (CSAR)	Tinian North Field
Amphibious Warfare	Amphibious Assault Marine Air Ground Task Force (MAGTF)	Tinian MLA (Unai Chulu, Dångkolo, and Babui; and Tinian Harbor; North Field)
	Amphibious Raid Special Purpose (MAGTF)	Tinian MLA (Unai Chulu, Dångkolo, and Babui; and Tinian Harbor; North Field)
Expeditionary Warfare	Military Operations in Theatre Training	Tinian
Special/Expeditionary Warfare	Land Demolitions (IED Discovery Disposal)	Tinian MLA
	Seize Airfield	Tinian North Field
	Airfield Expeditionary	Tinian North Airfield
	Intelligence, Surveillance, Reconnaissance (ISR)	Tinian
	Field Training Exercise (FTX)	Tinian North Field
	Non-Combatant Evacuation Operation (NEO)	Tinian MLA (Unai Chulu, Dångkolo, and Babui; and Tinian Harbor; North Field)
	Maneuver (Convoy; Land Navigation)	Tinian MLA
	Humanitarian Assistance/Disaster Relief Operation (HADR)	Tinian
Force Protection/Anti-Terrorism	Force Protection	Tinian North Field

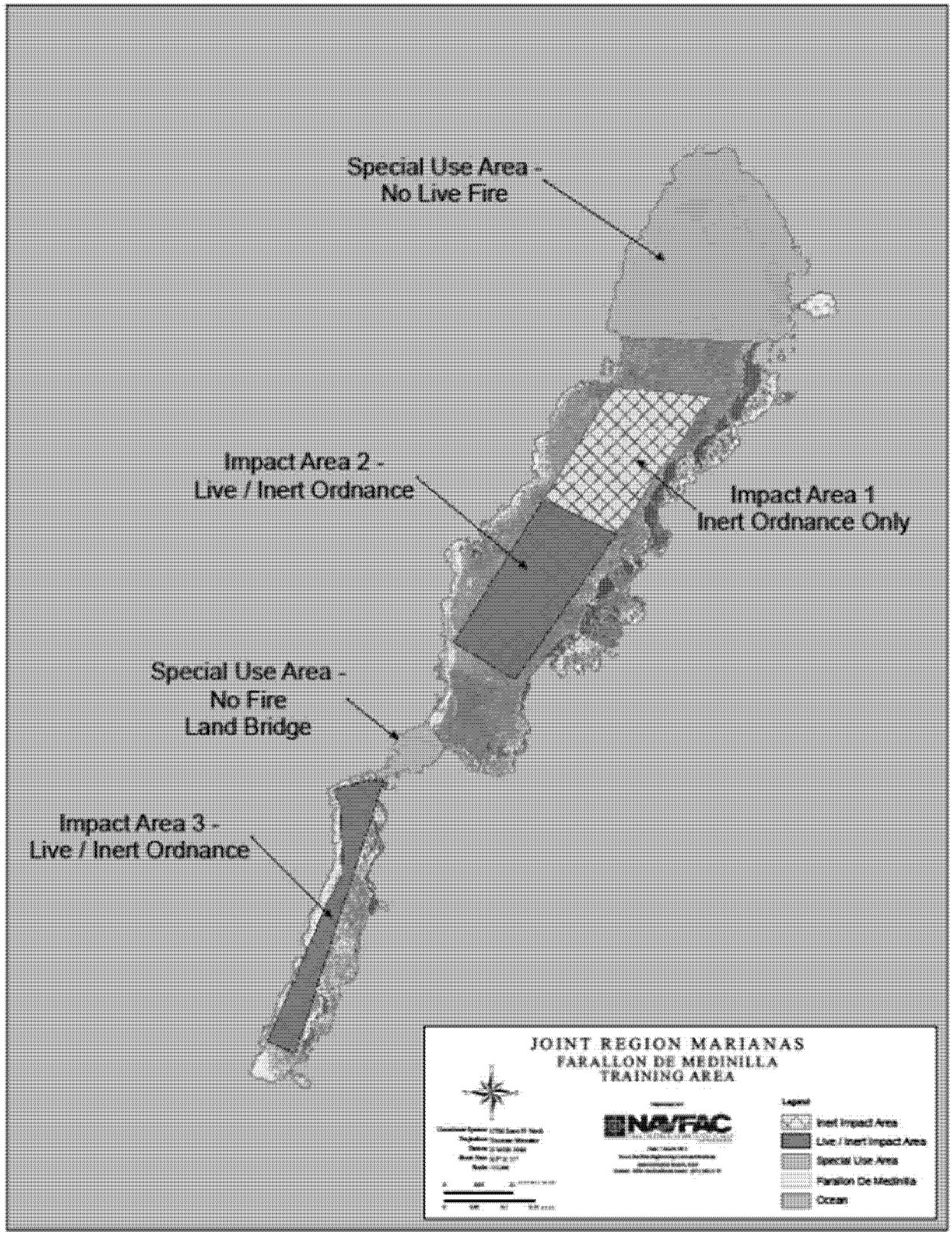


Figure 2-12. Military Training Areas on FDM

2.6.6.2 Existing Conditions

In March 2002, there was a ruling by the U.S. District Court of Appeals for the District of Columbia that stated military training exercises conducted by the U.S. Navy which resulted in the take of migratory birds was in violation of the MBTA. This ruling was the result of a private lawsuit brought about by the use of FDM as a live-fire range. As a result, U.S. Navy training exercises on FDM were temporarily halted.

The National Defense Authorization Act 2003 (NDAA) states under section 315, that the Secretary of the Interior will authorize as is permitted under section 704(a) of the MBTA the exemption of the armed forces from regulations regarding the incidental take of birds. While the MBTA permit regulations are not in effect for military training activities, the 2003 NDAA states that the DOD will give consideration to the protection of migratory birds while planning and executing military readiness activities; however, not at the cost of diminishing those activities. **Appendix W** contains additional informaiton on migratory bird management under MBTA.

2.6.7 Andersen Air Force Base

The DOD consults with the Secretary of the Interior to identify measures to:

- Minimize and mitigate, to the extent practicable, any adverse impacts of authorized military readiness activities on affected species of migratory birds
- Monitor the impacts of such military readiness activities on affected species of migratory birds.

The masked booby (*Sula dactylatra*), red-footed booby (*Sula sula*), and brown booby (*Sula leucogaster*) are nesting resident seabirds of FDM (Lusk et al. 2000, Wiles 2005, Vogt 2009b). These three species are protected under the MBTA. Migratory birds identified on FDM include the whimbrel (*Numenius phaeopus*), bristle-thighed curlew (*Numenius tahitiensis*), Pacific golden-plover (*Pluvialis fulva*), sooty tern (*Onychoprion fuscatus* [formerly *Sterna fuscata*]), cattle egret (*Bubulcus ibis*), wandering tattler (*Tringa incana*), and ruddy turnstone (*Arenaria interpres*) (Lusk et al. 2000).

2.6.7.1 Operations

Andersen AFB covers approximately 16,021 acres (6,483 hectares) (see **Table 1-1**). The main operations area of Andersen AFB is in the eastern third of the installation at approximately 500 feet (152 meters) above sea level. This area includes the main active airfield and an array of operations, maintenance, and community support facilities (see **Figures 2-13a** and **2-13b**). The central third of the installation is a Munitions Storage Area. The western third is Northwest Field, which was a World War II-era airfield used for fixed-wing aircraft. The area is used for helicopter training, various field exercises, and bivouacs.

Andersen AFB is vital to the security of the United States and its mission is expanding to support the new defense strategy specified in the 2001 Quadrennial Defense Review and the 2003 Defense Planning Guidance. This new defense strategy calls for the military to "deter forward" by stationing or deploying forces to five critical regions of the world: Europe, Middle East, Southwest Asia, Northeast Asia, and East Asian Littoral (e.g., region stretching from south of Japan through Australia and into the Bay of Bengal). Under this new defense strategy, Andersen AFB is proposed as a main operating base to conduct and support operations in the East Asian Littoral region due to its long runways, vast ramp space, and large fuel storage capacity. Andersen AFB would be used for potential strikes with bombers or fighters; for Command and Control; for Intelligence, Surveillance, and Reconnaissance; and for air refueling, airlift, and Search and Rescue.

Figure 2-13a. Location of Andersen AFB

Figure 2-13b. Location of Andersen AFB Operations

Major units of the 36 WG include the 36th Mission Support Group (36 MSG), the 36th Logistics Group (36 LG), 36th Medical Group (36 MDG), and the 36th Operation Support Squadron (36 OSS). The 36 MSG maintains an infrastructure of communications, engineering, information management, and security; and provides critical personnel support and morale, recreation, and services. The 36 LG provides superior transportation, aircraft maintenance/munitions, supply/fuel, contracting, and logistics planning.

2.6.7.2 Existing Conditions

Training and Support Operations

Northwest Field. Northwest Field is an unimproved expeditionary World War II-era airfield that is used for vertical and short field landings. Approximately 280 acres of land are cleared near the eastern end of both runways for parachute drop training. The south runway is used for training of short field and vertical lift aircraft and often supports various types of ground maneuver training. Helicopter units use other paved surfaces for Confined Area Landing, simulated amphibious ship helicopter deck landings, and insertions and extractions of small maneuver teams (U.S. Navy 2010b, PACAF 2006).

About 3,562 acres (1,442 hectares) in Northwest Field are the primary maneuver training areas available at Andersen AFB for field exercises and bivouacs. Routine training exercises include camp/tent setup, survival skills, land navigation, day/night tactical maneuvers and patrols, blank ammunition and pyrotechnics firing, treatment and evaluation of casualties, fire safety, weapons security training, perimeter defense/security, field equipment training, and chemical attack/response (U.S. Navy 2010b). The 36th Civil Engineering Squadron Environmental Flight (36 CES/CEV) routinely conducts a NEPA review for all training exercises conducted at Northwest Field.

Andersen Air Force Base Main Base. Andersen Main Base is dedicated to its primary airfield mission. Administered by 36 WG, the Main Base at Andersen AFB composes about 11,500 acres (4,654 hectares). The installation is used for aviation, small arms, and Air Force EOD training. As a working airfield, the installation has a full array of operations, maintenance, and community support facilities. 36 WG supports all U.S. military aircraft and personnel transiting the Mariana Islands Range Complex (MIRC). Facilities are available for cargo staging and inspection (U.S. Navy 2010b, PACAF 2006).

Tarague Basin Combat Arms and Training Maintenance (CATM) Range and EOD Pit. The CATM range, which is located east of Pati Point beach in the Tarague Basin, supports training with pistols, rifles, machine guns up to 7.62 millimeters (mm), and inert mortars up to 60 mm. Training is also conducted with the M203 40-mm grenade launcher using inert training projectiles only (U.S. Navy 2010b).

Land-based detonations at the Pati Point Explosive Ordnance Disposal Range, which is located separately from the CATM, were the subject of earlier consultations between Andersen AFB and USFWS which were concluded in August 2004 (U.S. Navy 2009, NMFS 2010a). The Pacific Islands Fish and Wildlife Office concluded that activities at the Pati Point Explosive Ordnance Disposal Range would not adversely affect ESA-listed species.

Explosive Ordnance Disposal Range. The EOD, Small Arms Firing Ranges, and associated Quantity Distance Safety Zones are located in fore strand and backstrand vegetation. The locations of the ESQD arcs on Andersen AFB are shown on **Figure 2-14**. EOD operations have been in existence since 1961 and are conducted in compliance with the U.S. Environmental Protection Agency (USEPA) and Guam Environmental Protection Agency (GEPA) laws. Increased security conditions afford the Mariana fruit bat and green sea turtle greater protection when they frequent this area of Tarague Basin. EOD and small

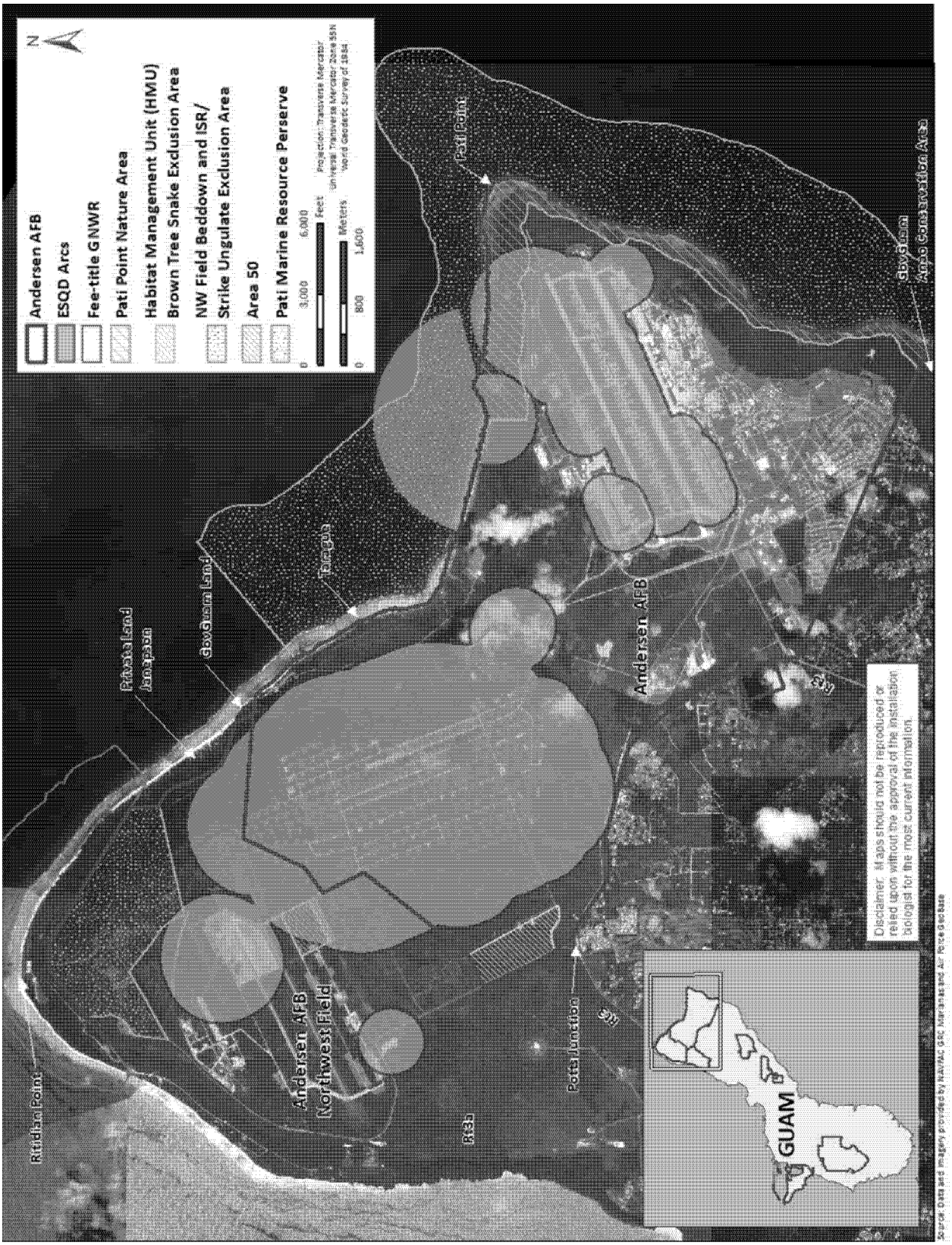


Figure 2-14. ESQD Arcs on Andersen AFB

arms firing operations impact only the immediate locations of detonation or firing. Explosions at the EOD pit and on the CATM range are on hardtop surfaces or within fire control pits and fires resulting from these explosions are negligible. Potential impacts on sea turtles in terrestrial habitats include noise from explosions; nest disturbance or destruction; beach erosion from the use of landing craft air cushions, landing craft utility, amphibious assault vehicles, combat rubber raiding craft, and rigid-hulled inflatable boats on nesting beaches; and nest disturbance or destruction and beach erosion from over the beach swimmer insertions, combat swimmer special training, diving, and ATFP (U.S. Navy 2010b, PACAF 2006).

The expansive safety distances (which include jungle/forest habitat and coastline) are off limits. In the event that an accident occurs, emergency response procedures would be enacted. Mariana fruit bats seek these lands as refuge from human disturbance found elsewhere, and also because these areas have high quality habitat for the species. Over the years, operations have been conducted in accordance with the USFWS and GDAWR. Operations will continue with the concurrence of the USFWS and GDAWR to ensure species protection. In the event that any associated operations or habitat conditions change, potential impacts will be coordinated with the USFWS and GDAWR.

There are approximately 10,300 acres included in the Overlay Refuge Unit at Andersen AFB (see **Figure 2-4**). The Overlay Refuge Unit provides for close coordination between JRM and the USFWS on Federal actions that might affect native, threatened, and endangered species and their habitats within the Overlay Refuge. The Refuge headquarters is located at Ritidian Point.

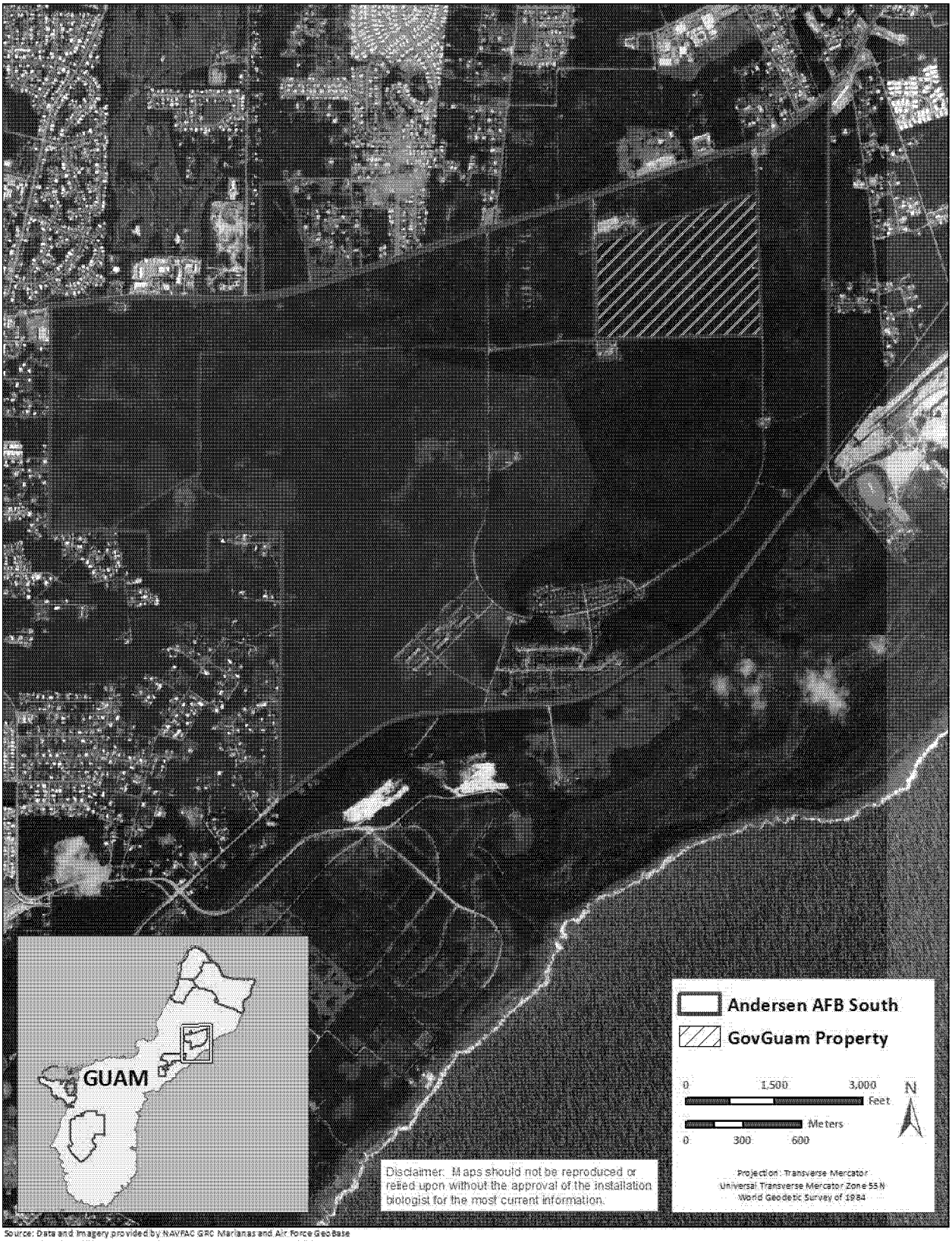
2.6.8 Andersen South

2.6.8.1 Operations

Andersen AFB South (Andersen South), is approximately 1,922 acres (778 hectares) (see **Table 1-1**), and is approximately 4 miles (6.4 kilometers) south of Andersen AFB (NAVFACPACIFIC 2010a). The property is located inland of the Pacific Ocean coast (see **Figure 2-15**) and west of Route 15. It is south of Route 1, except for a small parcel (approximately 29 acres [12 hectares]) that is the former site of the Yigo War Dog Cemetery. The dog remains have been relocated, but the area is still referred to as the Yigo War Dog Cemetery parcel. There is a water pump station on the site. Most of the site is vacant (i.e., no modern man-made structures) and naturally vegetated (Bureau of Statistics and Plans 2008).

Andersen South is an abandoned USAF housing area now used as a joint services ground-training site. The abandoned structures, which are situated adjacent to Route 15 along a relatively small portion on the southwest side of the site, are used for urban warfare training (JGPO 2010). The remainder of the Andersen South site is largely composed of an old road network and a few dispersed facilities that are surrounded by moderate-to-dense vegetation. Andersen South and the surrounding community of Yigo are situated on relatively flat topography and thus do not afford much in the way of views from adjacent roadways, which are blocked by the dense vegetation (JGPO 2010).

The Andersen South area consists of open fields, wooded areas, and vacant houses that have been used for humanitarian operations, staging, bivouac, equipment inspection, and small unit tactics. The most intensive use at Andersen South currently occurs during exercises involving up to three Marine Corps companies that use the Andersen South range for up to 3 weeks. The exercises currently occur twice a year. Blanks used in this training produce an estimated noise level of about 96 A-weighted decibels (dBA) at a distance of 500 feet (152 meters) and about 90 dBA at a distance of 1,000 feet (305 meters). These noise levels exceed compatible levels for residential use. There are no residences at Andersen South. The noise levels diminish with distance and do not encroach on the surrounding community.



Source: Data and Imagery provided by NAVFAC GRC Marianas and Air Force GeoBase

Figure 2-15. Location of Andersen South

MOUT training is conducted in abandoned housing areas. There are installation restoration (clean-up) sites and water production wells with wellhead clearance buffers in the area. Historically, the site was used for family housing and barracks, and includes a wastewater pump station, water booster pump station, water tanks, and electrical substation that are not currently being used (NAVFACPACIFIC 2010a).

2.6.8.2 Existing Conditions

Based on review of Volume 2, Chapter 8, *Land and Submerged Land Use* of the Final Environmental Impact Statement for the relocation of Marines from Okinawa, proposed uses of the Andersen South would not pose a significant environmental impact because the parcel is not located on the coast and only minor changes in land ownership are anticipated (NAVFACPACIFIC 2010a).

2.6.9 Barrigada Transmitter Site

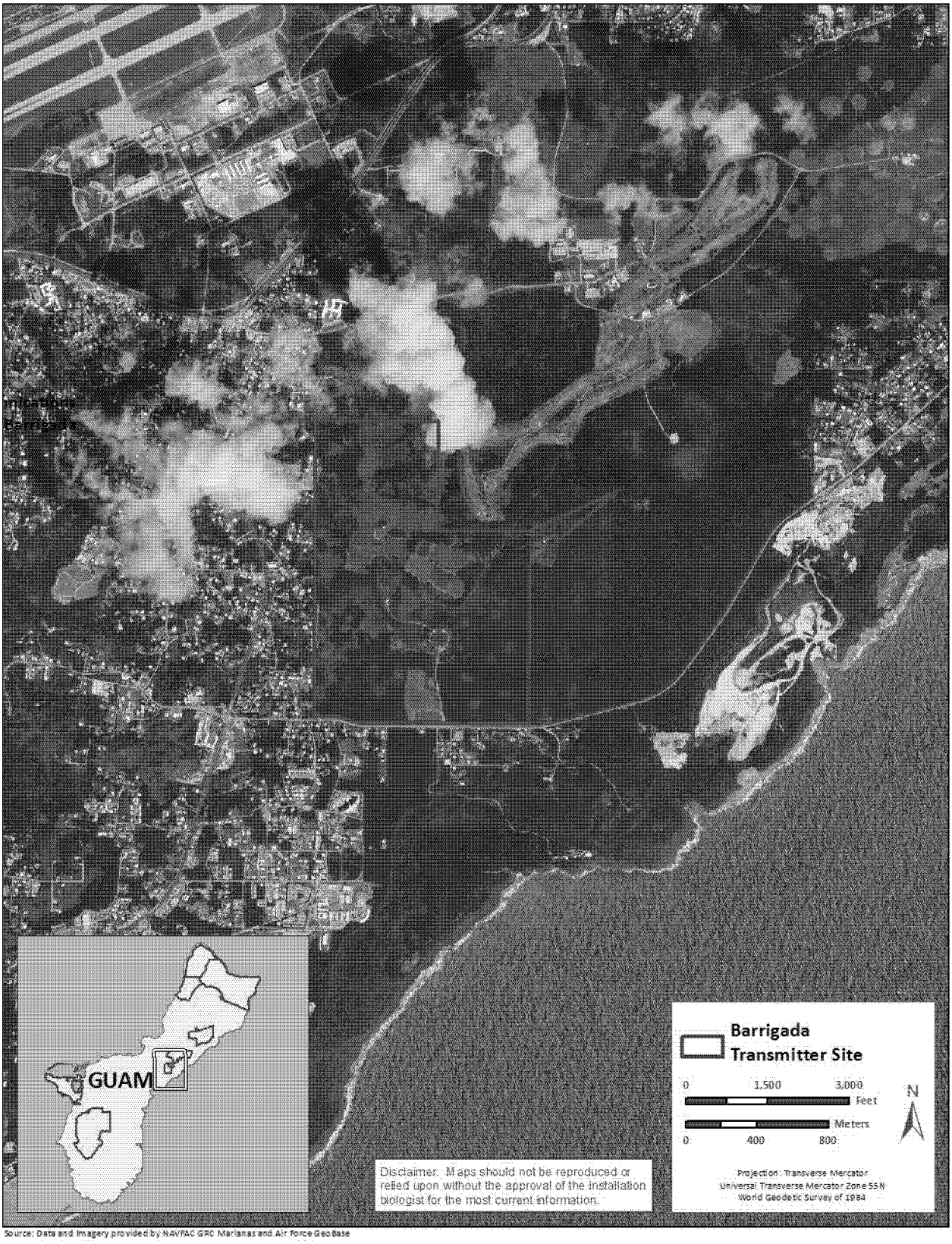
2.6.9.1 Operations

Barrigada Transmitter Site is approximately 432 acres (175 hectares) (see **Table 1-1**) and is located on the northeastern side of Guam. The site borders the southwest corner of NCTS Barrigada (see **Figure 2-16**). Barrigada Transmitter Site has a Next Generations Weather Radar antenna in the center of the parcel.

2.6.9.2 Existing Conditions

Much of Barrigada Transmitter Site is cleared and maintained land for operations. The disturbance of land has led to an increase of nonnative and invasive species. Vegetation communities on Barrigada Transmitter Site are characterized primarily by tangantangan (*Leucaena leucocephala*) forest and scrub. Shrub/grassland habitat occurs in the northeastern section of the site (JGPO 2010).

There are approximately 2.4 acres (1.0 hectares) of delineated wetlands on the Barrigada Transmitter Site (JGPO 2010). The open grasslands and wetlands within the Barrigada Transmitter Site likely provide resting and foraging areas for migrating bird species (JGPO 2010).



Source: Data and Imagery provided by NAVFAC GRC Marianas and Air Force GeoBase

Figure 2-16. Location of Barrigada Transmitter Site

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3 Environmental Management Strategy and Mission Sustainability

3.1 Natural Resources Management Strategy

Natural resources management conducted by the JRM sites on Guam strives to integrate biodiversity conservation and an ecosystem-based approach into an adaptive management framework compatible with the military mission. As a result, the natural resources program consists of multiple resource disciplines that are frequently interconnected and share similar objectives. Management projects and plans often consist of multiple program elements with several different resource experts collaborating together. This section describes the various natural resources Program Elements along with their primary goals and objectives.

The Navy is the lead service for natural resources management of DOD lands on Guam. As such, Navy policy on natural resources management, as summarized from OPNAVINST 5090.1C CH-1, is to manage natural resources to support and be consistent with the military mission, while protecting and enhancing those resources for multiple use, sustainable yield, and biological integrity. Land use practices and decisions must be based on scientifically sound conservation procedures and techniques, and use scientific methods and an ecosystem management approach.

Employing ecosystem management helps maintain and improve the sustainability and biological diversity of terrestrial and aquatic ecosystems while supporting sustainable economies, human use, and the environment required for realistic military training operations (DOD 2011).

The basic principles and guidelines of ecosystem management are as follows:

- Preserve the function and integrity of natural ecosystems
- Integrate human social and economic interests with environmental considerations
- Involve all interested parties (stakeholders) in identifying management goals
- Adapt to changing conditions and requirements.

Ecosystem function is a result of interactions of its various components: geologic and soil features, climatic elements, plants, animals, humans, and current and past disturbances (including past management practices). The function and integrity of an ecosystem are measured in terms of diversity, nutrient availability (productivity), and structural complexity. Assessing ecosystem health and sustainability requires objectively measuring a set of parameters that can be used to describe conditions. Adaptive management is an iterative cycle of planning, monitoring, evaluation, adjustment, and implementation that is best used to assess ecosystem function and the effectiveness of management practices.

3.2 Cooperative, Adaptive, and Ecosystem Management

The 1994 DOD policy memorandum *Implementation of Ecosystem Management in the DOD* was developed to ensure that resources on DOD installations were managed in a manner to conserve and protect biological diversity through adopting an ecosystem management approach to natural resources management (Benton et al. 2008). The policy states that "military installations will use ecosystem management to: (1) restore and maintain ecological associations that are of local and regional importance and compatible with existing geophysical components (e.g., soil, water); (2) restore and maintain biological diversity; (3) restore and maintain ecological processes, structures, and functions; (4) adapt to changing conditions, including changes resulting from a changing climate; (5) manage for viable populations, and (6) maintain ecologically appropriate perspectives of time and space" (Benton et al. 2008).

The DOD leadership further strengthened the need to manage resources using an ecosystem management approach in DOD Instruction 4715.03 (DOD 2011), that stressed the importance of recognizing the relationship between ecosystem management and biodiversity conservation (Benton et al. 2008). The instruction outlined five goals for installations to preserve and enhance biodiversity: "(1) maintain or restore remaining native ecosystem types across their natural range of variation; (2) maintain or reestablish viable populations of all native species in an installation's areas of natural habitat, when practical; (3) maintain evolutionary and ecological processes, such as disturbance regimes, hydrological processes, and nutrient cycles; (4) manage over sufficiently long time periods for changing system dynamics, including climate change; and (5) accommodate human use in those guidelines" (Benton et al. 2008).

With the passage of the SAIA in 1997, DOD ensured that all INRMPs were developed with an ecosystem management approach to overall natural resources management. One of the primary facets of ecosystem management is to maintain the ecological integrity of the area managed. Ecological integrity is defined as "the ability to support and maintain a balanced, integrated, adaptive community of organisms having a species composition, diversity, and functional organization comparable to that of natural habitat of the region" (Benton et al. 2008). The INRMP is developed to conserve and protect ecological integrity by promoting a proactive, as opposed to a reactive, strategy for managing resources. The Sikes Act, as amended through 2012, also requires that INRMPs are updated annually and reviewed for operation and effect every 5 years to ensure that these documents remain as living documents that can be revised based on changes to current conditions (including changes as a result of climate). The goals and objectives developed for this INRMP were developed using an ecosystem management approach that is flexible and takes into account ecosystem changes resulting from various factors including climate change.

The DoN has also developed the *Cooperative Strategy for 21st Century Sea Power* that addresses a need for adaptive management in the face of a changing climate (U.S. Navy, U.S. Marine Corps, and U.S. Coast Guard 2007). In addition, the 2008 DoN Environmental Strategy, *Sustaining our Environment, Protecting our Freedom* states the importance of all Naval bases to evaluate activities and ensure that best management practices (BMPs) have been put into place to reduce the overall environmental footprint of the Navy and enhance sustainability (U.S. Navy 2008). Finally, in May 2009, the DoN created a task force to explore and develop policies and strategies that address climate change. The Task Force Climate Change is made up of senior DoN staff and other stakeholders and findings will be based on many factors, including the most current scientific research.

Management Strategy

Communication of Ecosystem Management Philosophy to JRM Personnel

There is an ongoing need for coordination between JRM and other agencies, and between JRM and interested and affected public entities during plan development and implementation to manage the ecosystem effectively.

Objective: Develop the coordination necessary between JRM, other agencies, and public entities to ensure that an effective and viable ecosystem management approach is developed.

Strategies:

1. Complete this version of the INRMP with concurrence from USFWS, GDAWR, NMFS, CNMI-DFW, and GNWR and use it as a beginning point to develop an ecosystem management approach to natural resources management.
2. Develop a process and schedule for coordinating with agencies to allow for agency comment on all natural resources management plans.

3. Coordinate resources management efforts and projects with other agencies including coordinated monitoring programs and data sharing to take an islandwide (or ecosystem) approach toward conservation and resource management.

Ecosystem Management of JRM and Mission Requirements

Conceptually, ecosystem management is an appropriate strategy for managing installation natural resources, and can be used to develop a plan to guide natural resources management.

Objective: Develop an effective natural resources management approach that integrates all ecological components into a comprehensive management program.

Strategies:

1. Foster landscape-scale thinking among JRM staff and provide them with appropriate training if needed.
2. Enhance management through use of a geographic information system (GIS) to store, manage, analyze, interpret, and report data in a scientifically valid, efficient, and cost-effective manner. Develop new and enhance existing databases, and acquire applicable databases from outside sources for application in GIS.

3.3 Climate Change

The updated guidance for Navy INRMPs (OPNAVINST 5090.1C CH-1) added a requirement to address climate change in INRMPs (DoN 2011). It states that natural resources managers may use models to predict climate changes and evaluate needed research, data collection, and potential future management strategies as they make changes in ecosystem structure; however, due to their uncertainty, these models should be used to support and not guide environmental planning and natural resources management decisions.

Per OPNAVINST 5090.1C CH-1, INRMPs should address the following issues:

1. Include a more detailed discussion of the present climate including variability and periodic disturbances and how climate affects management and population dynamics.
2. Identify data and research needs.
3. Identify species and communities resilient/vulnerable to climate change impacts.
4. Ensure species/community conservation reflects climate change risks.
5. Identify restoration projects to provide habitat elements for specific species which might be altered by climate change.
6. Include BMPs related to climate change.
7. Establish need for electronic databases of demographic information from Navy gray literature.
8. Identify existing regional groups (e.g., species recovery teams) to establish partnerships for addressing climate change issues.
9. Identify and implement regional conservation designs that provide stepping stones for species to move (use existing programs such as borderlands and potentially new ones such as mitigation banking) to sites with suitable climates.

10. Provide for the management of threatened and endangered species such that changes in distribution and abundance on Navy installations can be understood in the context of climate change.

Issues

1. Scientific research indicates that climate change will have long-term, irreversible, adverse consequences on natural resources, including terrestrial and aquatic habitats.
2. Models are the only way to project future changes for JRM and the surrounding region, and to evaluate needed research, data collection, and potential management strategies. A range of scenarios is possible using accepted models, and local data sets need to be developed and integrated through collaboration and consensus.
3. Key questions for NEPA analysis include whether the proposed action is expected to cause climate change effects; whether the proposed action combined with other past, present, and reasonably foreseeable actions would cause such effects; and whether sufficient information is available to describe the nature and extent of the proposed action's effect. Developing mitigation for climate change should be included in NEPA analysis.

Management Strategy

Objective: Adapt and mitigate the adverse impacts of climate change through long-term planning and annual goal setting based on science-based scenarios, targets, collaborative planning, and adaptive management.

Strategies:

1. Identify data and research needs for ensuring an effective response to the impacts of climate change.
   a. Identify species and communities resilient/vulnerable to climate change impacts by conducting climate change vulnerability assessments.
   b. Improve the application of models through data collection and validation (as feasible and needed) and for using such science-based models in environmental and natural resources management planning.
   c. Improve the graphical depiction of the potential impacts of climate change on species ranges and population abundances in climate change vulnerability assessments.
2. Adapt and mitigate the adverse impacts of climate change, including stresses on infrastructure, aquatic vegetation, erosion, and shifts in distributions of terrestrial endemic species ranges and population abundances, and plant communities.
   a. Ensure that species/community conservation priorities and expenditures reflect climate change risks, such as those on the margins of their distribution patterns.
   b. Identify restoration projects to provide habitat elements for specific species, which could be altered by climate change.
   c. Provide for the management of threatened, endangered, and other special status species to avoid or minimize impacts from climate change.
   d. Monitor plant community composition and productivity for changes in status, or condition attributed to climate change and implement management strategies to address these concerns.

   e. Monitor intertidal and nearshore environments for changes in status, or condition attributed to climate change and implement management strategies to address these concerns.

3. Address the impact of human use of resources by emphasizing preventative technologies.
   a. Improve water conservation.
   b. Improve storm water management through use of low impact development (LID) technologies.
   c. Improve coordination between natural resources and development project proponents to ensure more energy-efficient design features.
4. Improve and strengthen coordination among JRM and non-JRM personnel with respect to climate change.
   a. Establish partnerships for collaboratively addressing climate change issues.
   b. Analyze project impacts and cumulative effects through NEPA in a consistent way.
   c. Incorporate climate change in Encroachment Action planning.
   d. Develop science-based agency coordination to protect, maintain, and restore at-risk habitats.
5. Ensure that JRM personnel have access to climate change education and outreach in order to help minimize effects of climate change through modification of individual behavior and lifestyle consumption patterns that contribute to climate change.

3.4 Mission Sustainability

Broadly speaking, sustainability takes a long-term view of natural resources stewardship, mission accomplishment, social responsibility, and economic prosperity into the future. For this INRMP, the topic of sustainability encompasses the following:

- Sustainability of the mission at JRM with respect to how natural resources support this mission
- Resource-specific BMPs, consistent with the installation-specific component plans
- Preparations for climate change and regional growth
- Resource use in the human environment
- Indicators that help monitor progress toward sustainability objectives.

OPNAVINST 5090.1C CH-1 requires installation managers to manage resources to support and be consistent with the military mission, while protecting and enhancing those resources for multiple uses, sustainable yield, and biological integrity (DoN 2011). The instruction further requires each command to establish procedures to keep Navy decisionmakers informed of the requirements, the current conditions of natural resources, and status of natural resources stewardship objectives contained within this INRMP (DoN 2011).

Specific objectives and strategies were developed to meet the goal of ensuring JRM sites can sustain the mission while protecting natural resources. In addition, a series of strategies for implementation are presented following the objective for each item. A summary of the management strategies and the estimated timeframe for completion is presented in **Appendix C.**

Some of the strategies described in this section will be accomplished through interactive partnerships with other Federal, territory, and local organizations. Natural resources staff at JRM sites will initiate partnerships based on the benefits to the regional ecosystem and the local environment.

3.4.1 Integrating Military Mission and Sustainable Land Use Decisions

The mission of JRM is to provide direct day-to-day operation of installation support functions and to ensure that the installation serves the fleet and tenant commands by providing the highest level of installation operating support and quality of life services for all operating forces and shore activities on JRM.

JRM does anticipate changes in land use and development based on the planned translocation of troops from Japan to Guam; however, JRM is well-positioned to implement and demonstrate environmentally sound land use planning and development through its land planning and NEPA processes, interdepartmental coordination, adherence to DoN guidance and regulations, and timely review and revision of installation site development plans. Development that does occur will be generic and flexible to preserve the natural environment of JRM. In addition, DoN policy requires that all military construction projects meet a silver rating under the U.S. Green Building Council Leadership in Energy and Environmental Design (LEED) 2.0 Green Building Rating System (U.S. Navy 2006).

Management Strategy

Objective: Sustain natural resources and the JRM mission by enabling innovation in planning, design, project management, and implementation for development projects affecting the built environment.

Strategies:

1. Ensure JRM leadership has visibility with respect to the total cost of mission sustainment, day-to-day operations, infrastructure and building development, and redevelopment. This should incorporate climate-change scenarios and the projected value of the loss of habitat associated with all actions. Natural resources asset evaluation is needed to implement business decisions that affect resource capability (e.g., value of permitted air emissions, water quality permits, water resources availability). This is completed by identifying those natural resources assets that sustain the mission, and assessing their condition, quality, capacity, and value.
2. Use a NEPA and site-approval process early in the project planning phase that includes water, air quality, engineering, and natural resources professionals.
    a. Improve the integration of JRM site natural resources professionals into sustainability planning through the NEPA and site-approval processes. Facilitate early and advance project review for storm water management, landscaping, shoreline, and in-water structures.
    b. Improve the integration of JRM site natural resources professionals into sustainability planning.
3. Apply sustainability principles to the management of habitats, species, and ecological functions on JRM by identifying resource-specific best practices similar to what has been done for energy and water in the human environment using LEED and LID approaches.
    a. Continue to comply with EO 13123 which tasks Federal agencies with defining principles for implementing sustainable development in construction. Promote sustainable land use through avoiding the use of undeveloped land, open space, water and soil conservation areas, existing natural ecosystems, endangered species habitats, and floodplains (NAVFACINST 11010.45).
    b. Implement LID practices for protecting water quality.
    c. Minimize effects on habitats, species, and ecological functions in land use planning, and construction projects to the fullest extent possible.

4. Use metrics (indicators) of sustainability that integrate environmental stewardship, mission accomplishment, social responsibility, and economic prosperity.
   a. Define and adopt standards, rating systems, and metrics.
   b. Collaborate with tenants to develop an integrated, measurable, installationwide sustainability effort.
   c. Incorporate metrics and standards of success meaningful to JRM.
5. Develop sustainability indicators and BMPs, to be incorporated into the JRM planning process. Monitor effectiveness of BMPs and revise as necessary.
6. Conduct training in sustainable design criteria in the Navy for engineers, construction and design specialists, water quality specialists, and biologists. This could be Web-based training.
7. Foster socially and environmentally responsible behavior through communication. Establish and promote submission for existing sustainability leadership awards for excellence in environmental, transportation, and energy management.

3.4.2 Natural Resources Military Mission Constraints

Proper management of natural resources on JRM sites, including maintaining or improving ecological conditions and capability of natural landscapes has numerous effects, including an increased ability to support military training and readiness; an improvement in the quality of life of military personnel and their families; a streamlining of the compliance process and a reduction in conflicts; and a reduction in littering, pollution, and poaching of wildlife and vegetation by limiting access (Keystone Center 1996).

Maintaining compliance with the numerous laws, policies, and regulations that provide protection of environmental elements and guidance for management of natural and cultural resources could affect the military mission. Some of these laws include the ESA, CWA, and the National Historic Preservation Act (NHPA). Effects include limitation of access to, or restriction of, certain activities in some areas. Natural resources management can temporarily preclude use of areas to prevent damage to soils and wildlife during periods required for vegetation recovery or during breeding seasons. Military training and nonmilitary use is prohibited in restricted areas to preclude damage to important cultural and natural resources. Without management of natural resources, military use could degrade the land and decrease the ability of the land to support the training mission of the installation.

Management Strategy

Objective: Achieve no net loss of military value by aligning current and future land and water use (location, extent, timing, and intensity) with environmental value protection into the future, while minimizing the cost of environmental conflict resolution and mitigation.

Strategies:

1. Maintain and enhance existing land uses to support the mission through coordination with all JRM Navy and Air Force stakeholders.
2. Locate new facilities within existing facility footprints or other previously disturbed areas to the extent practicable.
3. Conduct appropriate environmental surveys on any proposed new land use within an undeveloped area to identify sensitive natural and cultural resources, environmental resources, and installation restoration program (IRP) hazardous waste cleanups.

4. Ensure compliance with statutes and regulations to protect sensitive natural and cultural resources, to maintain environmental quality, and to exercise responsible stewardship of public lands.
5. Maintain and enhance coordination and cooperation with neighboring communities, agencies, and organizations to ensure compatibility of natural resources uses with the mission.
6. Provide reasonable accommodation of compatible nonmilitary land use to the extent practicable.
7. Maintain healthy and intact habitats using principles of ecosystem management and sustainability to balance short-term projects with long-term goals.
8. Address long-term threats to the stability of the natural environment including soil erosion, invasive exotic species, climate change, sea level rise, and habitat fragmentation.
9. Continue to use NEPA documentation, including cumulative effects analysis, to guide specific projects and document choices.
10. Track implementation of natural resources mitigation requirements from NEPA documents.
11. Ensure the CO and Wing Commander are prepared to answer, as part of the Annual Natural Resources Conservation INRMP Metrics data call, the following questions:
    a. Does the Natural Resources program effectively consider current mission requirements?
    b. What is the level of coordination between natural resources personnel and other installation departments and military staff?
    c. To what extent has the INRMP successfully supported other mission areas? (e.g. encroachment, BASH, range support, port operations, air operations, facilities management, etc.)
    d. To what extent has there been a net loss of training lands or mission-related operational/training activities?

3.5 Natural Resources Consultation Requirements

A number of Federal laws, including the ESA, MBTA, MSFMCA, and CWA, require consultation with a designated Federal regulatory agency such as USFWS, NMFS, or the USACE if a Federal action has the potential to impact a regulated resource adversely.

Endangered Species Act: Federal agencies are required by the ESA to manage federally listed threatened and endangered species and their habitat in a manner that promotes conservation of threatened and endangered species and is consistent with species recovery plans. Section 7 of the ESA requires all Federal agencies to enter into consultation with the USFWS or NMFS whenever proposed actions might affect listed threatened, endangered, and proposed species of plants and animals. At JRM sites, proposed projects, operations, or other actions are scrutinized for potential impacts on threatened and endangered species through a formal review process. Section 7 consultations will be initiated if warranted; otherwise, written documentation that there are no effects on threatened and endangered species will be generated by the natural resources manager and kept with the project files. The natural resources manager will use the installation's INRMP as a tool to identify at an early stage the potential impacts of planned Navy actions on endangered or threatened species and provide a basis for altering the action to prevent or minimize those impacts. Federally listed threatened and endangered species known to occur on Guam are listed in **Appendix H**.

DOD Policy on Endangered Species Act Consultation: INRMPs should incorporate, by reference, the results of an installation's previous species-by-species ESA consultations, including any reasonable and

prudent measures that might have been identified in an incidental take statement (U.S. Navy 2006). Neither a separate biological assessment nor a separate formal consultation should be necessary concerning most INRMPs or INRMP revisions. Nonetheless, because the INRMP might include management strategies or other actions designed to balance the potentially competing needs of multiple species, listed or not, it might be prudent to engage in informal consultation with USFWS during the INRMP revision process to confirm that these proposed actions will not affect listed species or designated critical habitat. If the INRMP does include management strategies or other actions that could affect listed species or designated critical habitat and these actions have not been the subject of previous consultations, then Section 7 consultation on these actions will be necessary before the actions may be implemented.

USFWS or NMFS (or both) could require changes or minimization measures that could result in delays and additional costs. Because of this, it is imperative that the installation initiate early preconsultation with USFWS and NMFS, and environmental/natural resources review of proposed actions in order to assess risks, develop alternatives, and correctly identify minimization measures both in terms of time and dollars. Additionally, the Secretary of the Navy released Policy Guidance for Endangered Species Actions in 2002 (SECNAV 2002) which directs installations to properly staff through their chain of command any ESA actions that have the potential to affect mission readiness.

Clean Water Act: Under Section 404 of the CWA, discharge of dredge and fill material into waters of the United States, including wetlands, is prohibited unless a permit is issued by the USACE. Military construction (MILCON) and other activities with the potential to disturb wetlands must be reviewed individually with respect to wetland impacts, and Federal permits sought as needed.

Migratory Bird Treaty Act: The MBTA prohibits the taking, killing, possession, transportation, and importation of migratory birds, their eggs, parts, and nests. An exemption to the MBTA that allows incidental take of migratory birds by DOD during military readiness activities was finalized in February 2007 (Federal Register [FR] Vol. 72, No. 39). As directed by Section 315 of the 2003 National Defense Authorization Act, this rule authorizes such take, with limitations, that result from military readiness activities. If DOD determines that a proposed or an ongoing military readiness activity might result in a significant adverse effect on a population of a migratory bird species, they must confer and cooperate with the USFWS to develop appropriate and reasonable conservation measures to minimize or mitigate identified significant adverse effects (see **Appendix W**).

Magnuson-Stevens Fishery Conservation and Management Act: The MSFCMA sets mandates for NMFS, regional fishery management councils, and Federal action agencies to identify and protect important marine and anadromous fish habitat. The councils, with assistance from NMFS, are required to delineate EFH in fishery management plans or fishery management plan amendments for all managed species. Authority to implement the MSFCMA is given to the Secretary of Commerce through the NMFS. The MSFCMA requires that the EFH be identified and described for each federally managed species,

The MSFCMA requires Federal agencies to consult with NMFS on activities that could adversely affect EFH or when NMFS independently learns of a Federal activity that could adversely affect EFH. The MSFCMA defines an adverse effect as "any impact which reduces quality and/or quantity of EFH [and] may include direct (e.g., contamination or physical disruption), indirect (e.g., loss of prey, reduction in species' fecundity), site-specific or habitat wide impacts, including individual, cumulative, or synergistic consequences of actions" (50 CFR 600.810). In 2011, the Navy released a policy on EFH assessments and consultations which supersedes 5090.1C; Chapter 24, Section 24-6(f) and clarifies the MSFCMA consultation requirements with NMFS (OPNAV N45 2011).

Marine Mammal Protection Act: All marine mammals are protected by the Marine Mammal Protection Act of 1972, as amended. The MMPA prohibits the take (hunting, killing, capture or harassment) of

marine mammals in U.S. waters and by U.S. citizens on the high seas, and the importation of marine mammals and marine mammal products. The USFWS is responsible for the following marine mammals: sea and marine otters, walrus, polar bear, three species of manatees, and dugong. The USFWS may authorize and permit take (with limitations and mitigation measures) of marine mammals under their purview. Those mammals that are truly marine inhabitants, cetaceans and pinnipeds, other than walrus, are the responsibility of NMFS.

3.6 NEPA Compliance

The Council on Environmental Quality (CEQ) defines an INRMP as a major Federal action requiring NEPA analysis. As a result, the Navy Office of General Counsel has determined that Sikes Act requirements for INRMP implementation necessitate the preparation of NEPA documentation prior to INRMP approval. It is expected that annual updates and revisions would be covered under the original NEPA documentation unless there has been a major change in installation mission or program scope.

An EA has been developed in association with this INRMP to comply with CEQ and NEPA. The EA evaluated the INRMP to ensure that there will be no negative environmental or social consequences for implementing the plan and its associated management projects. The full EA can be found in **Appendix X**.

3.7 Beneficial Partnerships and Collaborative Resource Planning

Collaborative partnerships are not only important for effective ecosystem-level management, but they also promote the sharing of personnel, data, and other resources among agencies/stakeholders, which can expedite project implementation and progress, and reduce overall costs for JRM.

JRM collaborates with USFWS, NMFS, the U.S. Geological Survey (USGS), U.S. Department of Agriculture (USDA), USACE, GDAWR, GEPA, Guam Department of Parks and Recreation (GDPR), CNMI DLNR, and the University of Guam (UOG) for management, conservation, and preservation of all natural resources on JRM lands. These relationships are critical for achieving the goals set forth in this INRMP, sharing resources and data, and developing ecosystem-level management practices that are not bound by political or property boundaries.

OPNAVINST 5090.1C CH-1 states that "the Sikes Act requires preparation of INRMPs in cooperation with the USFWS and the appropriate State Fish and Wildlife Agency. The Sikes Act, as amended through 2012, requires that the INRMPs reflect mutual agreement of the parties concerning the conservation, protection, and management of covered fish and wildlife resources. A memorandum of understanding (MOU) between installation, USFWS, and State may serve to address the responsibilities, expectations, and commitments of the various partners." This directive gives JRM the opportunity to use other resources for the development and implementation of the INRMP. An important resource or partner on Guam is GDAWR, which has the staff and expertise to assist JRM with implementing natural resources management projects. Currently, GDAWR only accesses Andersen AFB to assist Conservation Resources staff in collaborative management of the island's natural resources which occur on installation property. A memorandum of agreement (MOA) should be considered between JRM, USFWS, GNWR, and GDAWR to allow access to JRM lands and expand GDAWR's role in the overall management of resources where compatible and consistent with JRM security and mission requirements.

3.7.1 Other Department of Defense Organizations and Programs

3.7.1.1 Partners in Flight

It is DOD policy to promote and support the Partners in Flight (PIF) initiative that protects and conserves resident and migratory birds and their habitats. The DOD and its components support PIF by protecting vital habitat, enhancing biodiversity, and maintaining healthy and productive natural systems on their lands, consistent with military missions. PIF includes national working groups to deal with local and regional problems.

3.7.1.2 Department of Defense Legacy Resources Management Program

Congress instituted the DOD Legacy Resources Management Program in 1991 to promote stewardship of natural and cultural resources on DOD lands. The intent of the program is to fund natural and cultural resources management projects that would go unfunded through normal funding procedures. Legacy projects typically demonstrate innovative techniques for management, conservation, and preservation of natural and cultural resources. Legacy funds may be requested annually in accordance with instructions provided by the DUSD [I&E] and CNO.

3.7.1.3 U.S. Army Corps of Engineers

The USACE provides contract management, construction management, and technical support. DOD has the option to use USACE contracts as vehicles for natural resources management and to access USACE organizations, such as the U.S. Army Engineer Research and Development Center, for technical assistance and support for natural resources projects.

In addition, the USACE has regulatory authority over waters of the United States, which include activities within perennial and intermittent streams and wetlands. Section 404 of the CWA authorizes the Secretary of the Army, acting through the Chief of Engineers, to issue permits for the discharge of dredged or fill materials into the waters of the United States, including wetlands. Therefore, even an inadvertent encroachment into wetlands or other waters of the United States resulting in displacement or movement of soil or fill materials has the potential to be viewed as a violation of the CWA if an appropriate permit has not been issued by the USACE.

3.7.1.4 Armed Forces Pest Management Board

The Armed Forces Pest Management Board (AFPMB) recommends policy, provides guidance, and coordinates the exchange of information on all matters related to pest management throughout the DOD. The AFPMB's mission is to ensure that environmentally sound and effective programs are present to prevent pests and disease vectors from adversely affecting DOD operations. The AFPMB Natural Resources Committee provides guidance on integrating pest management and natural resources management programs including the following:

1. Addressing wildlife damage management and pest management requirements in aquatic, riparian, and wetland environments.
2. Identifying conflicts between threatened and endangered species and pest management actions.

3. Integrating pest management considerations with natural resources program responsibilities regarding vegetation management, forest insect and disease damage, and pest damage to ornamentals.
4. Coordinating approval and use of pesticides for vegetation management and other natural resources programs.
5. Initiating or reviewing research regarding natural resources pest management requirements/ considerations.

3.7.1.5 Partners in Amphibian and Reptile Conservation

Partners in Amphibian and Reptile Conservation (PARC) is an inclusive partnership dedicated to the conservation of the herpetofauna (i.e. reptiles and amphibians) and their habitats. Their mission is to conserve amphibians, reptiles and their habitats as integral parts of our ecosystem and culture through proactive and coordinated public/private partnerships. The DoD arm of PARC DoD has a primary responsibility to ensure that the DoD has the operational and logistical flexibility necessary for testing and training exercises. The PARC Web site can be viewed at: http://www.parcplace.org/

3.7.2 Other Federal Agencies and Programs

3.7.2.1 U.S. Environmental Protection Agency

The USEPA leads the nation's environmental science, research, education, and assessment efforts. Its activities include developing and enforcing environmental regulations; providing financial assistance to state and territory environmental programs, non-profits, and educational institutions; performing environmental research at laboratories nationwide; sponsoring voluntary partnerships and programs; and providing environmental education (USEPA 2011). The USEPA also provides guidance for managing wetlands and IRP sites.

3.7.2.2 Natural Resources Conservation Service

The Natural Resources Conservation Service (NRCS) has several natural resources conservation programs that could assist JRM in managing resources including conserving soils, improving water quality, increasing wildlife habitat, and reducing damage resulting from floods or other natural disasters (NRCS 2011).

3.7.2.3 U.S. Department of Agriculture – Wildlife Services

The mission of USDA-Wildlife Services (WS) is "to provide Federal leadership in managing problems caused by wildlife...[by] helping to solve problems that occur when human activity and wildlife are in conflict with one another" (USDA-WS 2011). The USDA-WS can be contracted by JRM to monitor nuisance wildlife, and provide nuisance and nonnative fauna control. USDA-WS is currently funded by JRM to conduct brown treesnake control and interdiction work on Andersen AFB and NBG.

3.7.2.4 U.S. Geological Survey

The USGS is a multidisciplinary organization that provides scientific information on biology, geography, geology, geospatial information, and water, to minimize damage from natural disasters; and manage the nation's water, biological, energy, and mineral resources. The USGS could assist JRM by helping design biological, water quality, and hydrologic surveys, and facilitating the integration of JRM data into national or regional databases. The USGS Brown Treesnake Project has been conducting research pertaining to brown treesnake population dynamics and life history on Andersen AFB for more than 10 years. In addition, the USGS has also researched and developed brown treesnake barrier technology that has been used on Andersen AFB.

3.7.2.5 U.S. Department of Agriculture Animal and Plant Health Inspection Service

The mission of the USDA Animal and Plant Health Inspection Service (APHIS) is to protect the health and value of agriculture and natural resources (APHIS 2011). APHIS is "a multi-faceted Agency with a broad mission area that includes protecting and promoting U.S. agricultural health, regulating genetically engineered organisms, administering the Animal Welfare Act and carrying out wildlife damage management activities. These efforts support the overall mission of USDA, which is to protect and promote food, agriculture, natural resources, and related issues" (APHIS 2011).

3.7.2.6 U.S. Coast Guard

The U.S. Coast Guard (USCG) patrols waters off of Guam and enforces Federal maritime laws and fishery laws of Guam.

3.7.3 Territory Agencies

3.7.3.1 Guam Bureau of Statistics and Plans

The Guam Bureau of Statistics and Plans serves as the territorial clearinghouse and is the lead agency for the Coastal Zone Management Program. The Bureau has a component of terrestrial lands (uplands) within its program to promote a watershed approach to maintaining healthy submerged lands.

3.7.3.2 Guam Environmental Protection Agency

The GEPA is an agency of the GovGuam established to protect human health and the environment by regulating industries and public utilities and enforcing the environmental laws of the territory. GEPA ensures that territorial environmental standards are met for IRP projects on JRM sites.

3.7.3.3 Guam Department of Parks and Recreation

The GDPR provides technical guidance on outdoor recreation programs at Andersen AFB under provisions of a Cooperative Agreement executed with the USAF. The State Historic Preservation Officer within the GDPR reviews all Federal actions that might affect listed or potential historic or archaeological sites for compliance with the NHPA on JRM sites.

3.7.3.4 Guam Department of Agriculture Division of Forestry and Soil Resources

The Guam Department of Agriculture Division of Forestry and Soil Resources mission is to conserve, protect, and enhance Guam's vegetative environment and sustain the natural resources which are

dependent on healthy forests. The department is responsible for protecting and restoring forest ecosystems on Guam.

3.7.3.5 Guam Department of Agriculture Division of Aquatic and Wildlife Resources

The Guam Department of Agriculture Division of Aquatic and Wildlife Resources is the equivalent of a State Fish and Game Agency. The mission of the Fisheries Section of the Division of Aquatic and Wildlife Resources is to restore, conserve, manage, and enhance the aquatic resources in and about Guam and to provide for the public use of and benefits from these resources. The mission of the Wildlife section is to manage Guam's wildlife resources for the benefit of present and future generations with the vision to recover endangered animal and plant species, manage sustainable populations of game species, and promote public awareness of natural resources.

3.7.4 University of Guam

The staff, faculty, and students of the UOG conduct research at JRM sites and are available for consultation on natural resources concerns including conducting wildlife and botanical studies and developing species monitoring plans. Some of the projects that UOG has conducted in conjunction with JRM staff include baseline surveys of the nearshore marine environment at the Andersen AFB Marine Resources Preserve, the *Serianthes nelsonii* Tree Recovery Project, field and nursery studies relating to native plant ecology and propagation, monitoring hydrology and soil erosion on NBG, marine monitoring at OPERA and HERA, surveys of endangered tree snails on JRM lands, and monitoring of the HERA.

3.7.5 Contractors

Contractors may be hired to perform specialized management projects or provide technical knowledge about natural resources management. Contractors must adhere to the requirements and management strategies detailed in the INRMP. Following are examples of contractor support for implementation of natural resources management goals:

- Endangered species surveys
- Invasive species surveys
- Soil surveys
- Wetland delineations.

3.7.6 Volunteers

OPNAVINST 5090.1C CH-1 states that commands shall interact with the surrounding community to develop positive and productive community involvement, participation, and educational opportunities; and use volunteers under the supervision of professionally trained natural resources personnel, when feasible. Through support from volunteers, JRM is able to educate the public on the natural resources programs conducted at JRM sites, demonstrate environmental stewardship of natural resources, and develop and maintain partnerships with the local community.

An example of volunteer work that supports JRM natural resources management includes activities conducted by Haggan Watch, which is an organization that collects data on Guam's sea turtles. Members of the organization walk along the coasts of Guam to record data on endangered and threatened species of sea turtles.

3.7.7 Nonprofit Organizations

3.7.7.1 The Nature Conservancy

The Nature Conservancy (TNC) and DOD signed a cooperative agreement in 1988. This agreement allows installation commanders to obtain technical assistance from TNC and to participate in programs and projects of mutual interest. It also permits TNC to study significant ecosystems under DOD's control. Natural resources staff at JRM sites can benefit from this agreement through use of TNC resources and staff to manage natural resources on the installation.

3.8 Public Access

Although provision of public access is addressed in the Sikes Act, as amended through 2012, security concerns in the aftermath of September 11, 2001, have greatly restricted public access on DOD facilities. However, the submerged lands near NBG Main Base (with minor exceptions in Apra Harbor) are accessible to the public.

3.9 Encroachment Partnering

Encroachment is defined in the OPNAVINST 11010.40 as "Any non-Navy or Navy action planned or executed in the vicinity of a naval activity or operational area which inhibits, curtails, or possesses the potential to impede the performance of the mission of the naval activity." OPNAVINST 11010.40 provides details for development of Encroachment Action Plans, which identify, quantify, and provide mitigation strategies for the potential encroachment threats to an installation. These plans delineate short-, mid-, and long-term strategies to address encroachment threats at an installation. Encroachment partnering with allowable entities will help accomplish DOD's goal of preservation and sustainment of conditions that are compatible with the mission and that achieve operational assurance.

3.10 Professional Education for Natural Resources Staff

Continuing education, training courses, and workshops allow managers to stay up to date with the latest research findings and application techniques. Membership in professional societies is encouraged, including The Wildlife Society, Society of Range Management, National Military Fish and Wildlife Association, Society for Ecological Restoration, and the Society for Conservation Biology. These societies produce some of the best scientific publications in natural resources. Meetings of these societies also provide excellent ways to communicate with fellow professionals, and to maintain professional standards.

Environmental personnel are encouraged to join professional societies and become active members. Personnel are sent to as many meetings as feasible to meet with other professionals to exchange ideas and attend technical meetings. Maintenance and enhancement of professional skills are emphasized.

At least one environmental staff person from JRM should, if funding allows, attend the following recommended annual workshops or professional conferences as funding permit (this is not an inclusive list and other relevant workshops or conferences may be attended):

- National Military Fish and Wildlife Association annual workshop;
- North American Natural Resources Conference;
- The Wildlife Society Conference (national, section, and chapter levels);

- International Erosion Control Association Conference and
- Environmental Systems Research Institute (ESRI) Users GIS Conference.

Other conferences/workshops will be evaluated for their usefulness. Decisions will be made based on the appropriateness to ongoing projects and funding availability. Training that is especially useful includes endangered species workshops, GIS basic and advanced training, watchable wildlife workshops, and wetlands training. It is especially useful to have as many people as possible attend NMFWA workshops, and efforts will be made to have more than minimal attendance at that meeting. Personnel will be trained in related environmental fields. NEPA training is required of all personnel who review or prepare NEPA documents.

4 Current Conditions

4.1 Guam

4.1.1 General Physical Environment

4.1.1.1 Climate

Guam is located in the low-latitudes zone (between 13° and 14° North) and has a maritime tropical climate with mean average temperatures of 81 degrees Fahrenheit (°F). Relative humidity during the day remains about 75 percent and typically increases at night. Daily temperatures do not vary much throughout the year, averaging 84 °F.

Seasonal variation in precipitation is strongly influenced by the position of the Inter-tropical Convergence Zone (ITCZ) and the subtropical high-pressure zones (Kellman and Tackaberry 1997). These zones shift latitudinally in a seasonal cycle resulting in two distinct climatic seasons. Monthly precipitation increases when the ITCZ shifts northward. Approximately 65 percent of the annual precipitation occurs July through October and precipitation declines significantly January through May when only 25 percent of the annual rainfall occurs. Mean annual rainfall varies considerably among years, although it typically averages 89 inches (226 centimeters [cm]) a year. Drought conditions can be experienced during periods of low precipitation. Rainfall can be intense during storms; the maximum 24-hour recorded rainfall was 27 inches (69 cm) in 1976. There is increasing evidence suggesting that rainfall variability throughout the Western Pacific is associated with the periodic oscillation in the atmosphere-ocean system known as the El Nino Southern Oscillations (ENSO) (Kellman and Tackaberry1997). During periods of ENSO, rainfall levels can decline significantly resulting in extended periods of drought.

Persistent easterly surface airflow dominates the circulation pattern of Guam's climate during the drier months. Trade winds are typically from the east at less than 10 miles per hour (mph) (16 kilometers per hour [km/h]), but are variable in late summer. Trade winds are disrupted when storms approach Guam. Based on data from the 60-year period of 1945 to 2004, an average of three tropical storms (40 to 75 mph winds [64 to 120 km/h]) or typhoons (greater than 75 mph [120 km/h]) pass within 180 nautical miles of Guam every year (NRLM 2007). Based on historical data, the probability of a tropical storm or typhoon passing within 180 miles (290 kilometers) of Guam is one every 7 years, although a higher frequency has been noted in recent years with storms recorded in 1990, 1991, 1992, 1997, 2002 (two storms), 2004, and 2007. Typhoon Pongsona passed within 19 nautical miles (35 kilometers) of Apra Harbor and Typhoon Kong-rey, the most recent storm, passed through the Mariana Islands on April 6, 2007.

4.1.1.2 Geology and Topography

Guam is the largest and the southernmost island in the Mariana Islands archipelago. The Mariana Islands are a volcanic island archipelago resulting from subduction of the Pacific tectonic plate beneath the Philippine plate at the Mariana trench, which runs south and east of Guam. The Island of Guam was formed by two separate emergent mountains that fused and formed one island. Southern Guam is made up of volcanic hills, which rise to a maximum height of 1,334 feet (407 meters) above sea level. Rivers cut through this terrain and create several high waterfalls. The central and northern sections of the island consist of a limestone plateau as high as 600 feet (183 meters) with steep cliffs dropping down to a narrow coastal shelf. The upper few hundred feet of the island are composed of basalt and andesite, tuff-derived sedimentary rock, and limestone (Tracey et al. 1964). The oldest exposed rocks on the island are from the Oligocene age (25–35 million years before present). See **Figures 4-1** and **4-2** for maps of the geology and topography of Guam, respectively.

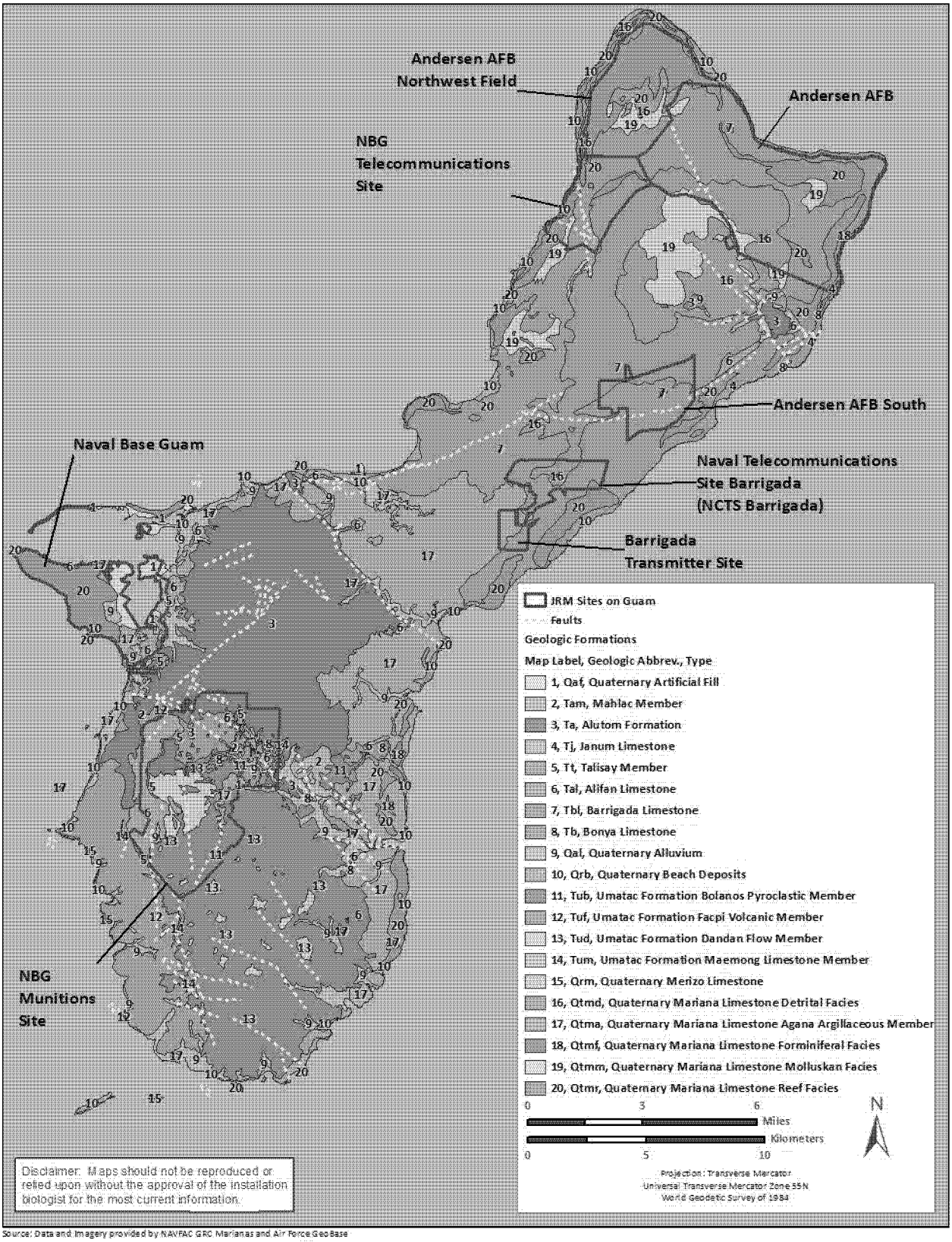
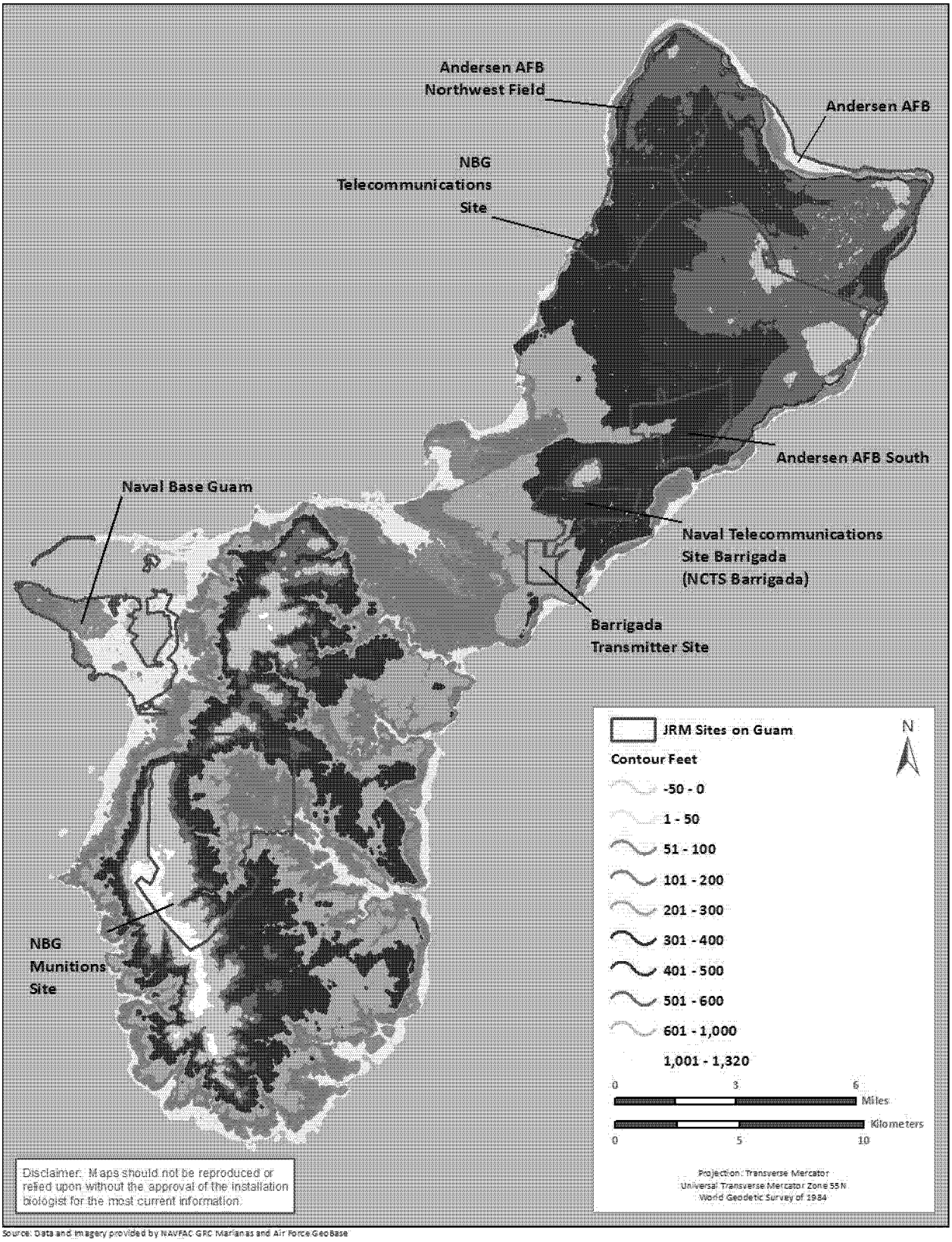


Figure 4-1. Geology of Guam



Source: Data and imagery provided by NAVFAC GRC Marianas and Air Force GeoBase

Figure 4-2. Topography of Guam

The island is separated into three main structural provinces: northern, central, and southern. The northern structural province is composed of the limestone plateau of northern Guam, the central structural province consists of the folded volcanic rocks of central Guam, and the southern province includes the east-dipping volcanic rock of southern Guam (Tracey et al. 1964). Most of the older northern half of the island is a relatively flat plateau overlain with the Mariana Limestone formation of the Quaternary Period (deposited less than 2 million years ago) that was formed from the growth of coral carbonate reefs. Smaller areas of the island are covered in older limestone of the Neogene Period (2 to 25 million years old). The island has experienced alternating emergence and submergence below sea level during the past 20 million years, allowing the limestone reef cap to develop into a thickness of up to 600 feet (183 meters) in some areas.

The southern half of the island is predominately volcanic in origin and is underlain by highly weathered basalt and tuff-derived sedimentary rocks. The island has two major fault zones, the Adelup and the Talofofo faults. The topography, surface drainage, distribution of bedrock and soils, groundwater storage and discharge, landslide potential, and coastal formation of the island is strongly affected by the numerous smaller faults, vertical joints, and local fractures associated with these fault zones.

4.1.1.3 Geologic Formations

Volcanic rock forms the foundation of the island and is exposed over about 35 percent of the island's surface, predominantly in southern Guam. Neogene limestone overlies the volcanic rock and is exposed over about 60 percent of the island, mainly in northern Guam. The high porosity of the limestone gives it high permeability, whereas the texture and poor sorting of the volcanic basement material usually gives it much lower permeability. All major limestone units have undergone pervasive meteoric diagenesis, thus most porosity and permeability is secondary. Faults transect the island throughout, complicating the structure and permeability of the rock units. Guam comprises seven major geologic units (Gingerich 2003), summarized as follows.

The **Facpi** and **Alutom Formations** contain the oldest exposed rocks, are of Eocene and Oligocene age, (34–56 and 25–35 million years before present, respectively), and underlie all other exposed rock units (Tracey et al. 1964, Reagan and Meijer 1984). These units crop out in the highlands from central to southern Guam and in the highest elevations of northern Guam. These exposures cover about 20 percent of the surface of the island. The maximum thickness of each unit is at least 1,000 feet (305 meters) (Reagan and Meijer 1984). The formations contain a series of pillow basalts and water-laid pyroclastic rocks of volcanic origin ranging from tuffaceous shale to coarse boulder conglomerate and breccia.

The **Umatac Formation** of the Oligocene to late Miocene age is separated from the underlying Alutom Formation by a structural unconformity (Tracey et al. 1964). The Umatac Formation crops out over about 15 percent of the land surface, principally in the south-central highlands and plateaus. The unit thickens to the south away from the Alutom Formation and is at least 1,050 feet (320 meters) thick along the southwest side of the island (Tracey et al. 1964). Here, the Umatac Formation is composed (from oldest to youngest) of about 250 feet (76 meters) of reef and fore reef limestone (Maemong Limestone Member), about 750 feet (229 meters) of tuff breccia and volcanic conglomerate (Bolanos Pyroclastic Member and Schroeder Flow Member), and about 50 feet (15 meters) of basalt flows (Dandan Flow Member) (Meijer et al. 1983, Reagan and Meijer 1984).

Three limestone units, which locally overlie the Alutom and Umatac Formations, are grouped together as **Older Limestone**. These three units, from Miocene to Pliocene age, are the Bonya Limestone, Alifan Limestone, and Janum Formation. These three units are facies with distinctions of limestone of the same age. Together, these units cover only about 5 percent of the island's surface and, individually, the units are each only about 70 to 200 feet (21 to 61 meters) thick.

The **Barrigada Limestone** of the late Miocene to Pliocene age covers about 9 percent of the island's surface, but forms the bulk of the aquifer underlying northern Guam. This formation consists of fine-grained, pure foraminiferal detrital limestone with a thickness of greater than 540 feet (165 meters) (Tracey et al. 1964). In places, the Barrigada Limestone grades upward and outward into the overlying Mariana Limestone.

The **Mariana Limestone** is of Pliocene to Pleistocene age and is the most extensive unit at the surface. The Mariana Limestone composes about 45 percent of the surface area, covering most of the northern half and parts of southeast Guam. The maximum thickness of the formation is at least 500 feet (152 meters) and can thin to zero inland. The Mariana Limestone is composed of reef and lagoonal limestone containing a wide range of lithologies (Tracey et al. 1964). The limestone is clay-rich near the older volcanic uplands.

Minor reef beach deposits, reef limestone, and alluvium are of Holocene age (11,770 years ago to the present). These deposits cover about 7 percent of the surface of Guam and can reach thicknesses of 200 feet (61 meters) at the mouths of some rivers. The beach deposits are composed of poorly consolidated sediments, mostly calcareous sand and gravel thrown onto beaches by waves; however, some deposits of volcanic sand can be found where streams drain volcanic uplands (Tracey et al. 1964). The Merizo Limestone is a reef limestone up to 12 feet (4 meters) thick. Deposits of alluvial clay fill stream valleys and cover the inner parts of coastal lowlands.

4.1.1.4 Seismology

Guam is located on the eastern edge of the Philippine Plate where it meets the western subduction boundary of the Pacific Plate (Karolle 1993). The Mariana Trench marks the boundary of the subduction zone. Movements of the lithospheric plates generate earthquakes of a sizeable magnitude. Between 1849 and 1911, four earthquakes with a magnitude of 7.0 or greater on the Richter scale occurred in the vicinity of Guam. The most recent large-magnitude earthquake was recorded on August 8, 1993, and measured 7.8 on the Richter scale (GHS 2008). Liquefaction and lateral spreading caused major damage to commercial and naval port facilities (GHS 2008). According to the Guam Hazard Mitigation Plan, the areas on Guam determined to be susceptible to a large tsunami include all landmasses below 16 feet (5 meters) in mean sea elevation, which incorporates 10 square miles (26 square kilometers), or 4.7 percent, of the island (GHS 2008).

4.1.1.5 Soils

The soils on Guam are in a pattern that is related to the geology, landforms, relief, climate, and natural vegetation of the island. The NRCS (formerly the Soil Conservation Service) published the Soil Survey of the Territory of Guam in 1988 (NRCS 1988). The Soil Survey grouped Guam soils into three broad classes: soils on bottomlands, soils on volcanic uplands, and soils on limestone uplands. Within these broad classes, the soils that occupied similar natural landscapes were defined as map units for broad interpretive purposes. Soils on bottomlands consist of a single map unit that occupies 4 percent of the island. Soils on volcanic uplands consist of two map units covering about 35 percent of the island and soils on limestone uplands consist of five map units covering 61 percent of the island (NRCS 1988).

4.1.1.6 Hydrology

The movement and storage of water on Guam is greatly influenced by the island's geology. Water is held in the soil pore space by cohesive attraction between water molecules and the mineral and organic components of the soil. The limestone geology of northern Guam is soluble and very porous. Dissolution of the limestone by percolating rainwater has resulted in complex underground drainage systems,

including caves and depressions. The large pore spaces and fractures in limestone rock result in water percolating rapidly downward through the soil profile; therefore, no surface water flow occurs and little water is stored in the upper soil profile. The limestone in northern Guam is underlain with impervious volcanic rock at varying depths. Where the underlain volcanic rock is situated below sea level, salt water permeates laterally through the porous limestone. The downward movement of water through the limestone continues until the water encounters an impervious mineral layer of volcanic rock or higher density salt water. If the downward percolating water encounters impervious mineral rock, parabasal water is stored in the porous limestone rock above the impervious rock (U.S. Navy 2009). The following description of Guam's hydrology (i.e., groundwater and surface water) has been adapted from Gingerich (2003), unless otherwise noted. Freshwater wetlands are discussed in this INRMP in **Section 4.2.1**, Terrestrial Ecosystems, and estuarine wetlands are discussed in **Section 4.2.3**, Estuarine Ecosystems.

Groundwater. The primary aquifer on Guam is the Northern Guam Lens Aquifer (NGLA) that extends from the northernmost tip of the island to where the southern highlands start north of Apra Harbor. The NGLA was designated as a sole-source aquifer in 1978 because it supplies drinking water to approximately 80 percent of the island's residents. The NGLA is composed of six distinct subbasins: the Agana, Mangilao, Andersen, Agafa-Gumas, Finegayan, and Yigo-Tumon. Water levels in the NGLA vary daily and seasonally in response to ocean tides, recharge rates, and groundwater withdrawal. Daily fluctuation of water levels driven by tidal changes are about 0.5 feet (0.2 meters) in wells near the coast, but these fluctuations decrease as distance from the coast increases and as the permeability of the aquifer material decreases. Well water levels in limestone formations can increase several feet in a matter of days when large storm events and associated runoff occur. Seasonal water level variations in the most permeable parts of the NGLA are less than 10 feet (3 meters). In the southern part of the NGLA, the seasonal water level variations can exceed 20 feet (6 meters) (JGPO 2010).

In northern Guam, water is obtained from wells that tap the upper part of a fresh groundwater lens in an aquifer composed mainly of limestone. Approximately 180 wells, nearly all in the north, withdraw about 35 million gallons per day (MGD) of water with chloride concentrations ranging from 6 to 585 milligrams per liter. In southern Guam, the main source of fresh water is from surface water, which runs off the weathered volcanic rocks that are exposed over much of the area. Approximately 10 MGD of fresh water are obtained from surface reservoirs.

Freshwater-lens System. On oceanic islands such as Guam, fresh water commonly forms a body of water called a freshwater lens that floats on salt water and is separated from the salt water by a transition zone of brackish water. The fresh water, brackish water, and salt water are all part of the freshwater-lens system. Salinity in a freshwater-lens system is gradational, from an upper freshwater core through the underlying transition zone to salt water.

Transition zone thickness depends on the extent of mixing between fresh water and salt water and is generally dozens of feet thick in northern Guam. Mixing in the transition zone results from tidal and pumping fluctuations superimposed on the gravity-driven flow of fresh water toward the shore. Under conditions of steady recharge and no pumping, the lens would ultimately have a fixed size. In reality, rainfall is episodic and seasonal, and lens volume fluctuates naturally with time. Groundwater discharges continuously throughout the year, but the lens shrinks during dry periods when recharge diminishes or ceases, and expands when recharge increases.

On Guam, freshwater-lens systems are found in limestone and volcanic rocks. The most important sources of groundwater are from the freshwater parts of these systems in the high-permeability limestone rocks of northern Guam. In the most permeable limestone, the water table is no more than a few feet above mean sea level (msl), and the slope of the water table is nearly flat. The freshwater lens in these rocks is relatively thin and is commonly referred to as basal water after similar occurrences in Hawai'i

(Meinzer 1930). Wells and springs in this part of the system generally have water level altitudes less than 8 feet (2 meters). In some areas, the freshwater lens is thick enough to extend into the low-permeability volcanic rocks underlying the limestone. The fresh water in the limestone is commonly referred to as parabasal water, where it is in contact with the underlying poorly permeable volcanic basement (Mink 1974). Ward et al. (1965) recognized that the low-permeability volcanic rocks must be saturated below the water table. Therefore, groundwater in the limestone and the underlying volcanic rocks is all part of a freshwater-lens system, but the depth of fresh water in the volcanics is unknown.

Freshwater-lens systems are recharged by direct infiltration of rainfall and by inflow from perched groundwater systems. Discharge from the freshwater-lens system in northern Guam is by diffuse seepage near the coast and to subaerial and submarine coastal springs. In southern Guam, much of the fresh groundwater discharges directly to stream valleys above sea level where the ground surface intersects the water table. In highly permeable rocks, freshwater flow is mainly horizontal and toward the coast, but in low-permeability rocks, vertical flow can be significant where there are substantial vertical head gradients.

Perched Groundwater Systems. Perched water is found in areas where low-permeability rocks impede the downward movement of groundwater sufficiently to allow a perched water body to develop within otherwise unsaturated rocks. Minor perched systems are found in some of the higher-altitude limestone overlying the volcanic rocks of southern Guam. The height of the water table above sea level and the extent of the perched system are respectively dependent on the altitude and areal extent of the low-permeability rocks and the rate and duration of recharge. Discharge from a perched system can be to springs, streams, downward to a lower water table, or to the atmosphere by evaporation.

Surface Water. Surface water resources consist of rivers, streams, lakes, reservoirs and ponds. Surface water is important for its contributions to the economic, ecological, recreational, and human health of a community or locale. Guam has 97 rivers and streams, ranging in length from 0.6 miles (1 kilometer) to more than 3 miles (5 kilometers). All of the rivers and streams are found in the central and southern half of the island. Northern Guam does not have perennial streams due to the karst geology of this area. Water in the area does not flow on the surface as a result of the high permeability of the limestone. Runoff quickly infiltrates the limestone resulting in recharge of the freshwater groundwater lens. There are no estuaries in the north due to the lack of perennial streams. In southern Guam, a mountain ridge runs along the western coast and creates small, steep drainage basins to the west. To the east, broader floodplains drain into longer, larger rivers. Forty-six of Guam's rivers and streams drain into the ocean, five drain into lakes, and the remainder feed into other rivers (JGPO 2010).

Southern Guam has many freshwater communities including water impoundments such as the Masso and Fena Reservoirs (U.S. Navy 2009). The 200 acre (81 hectare) Fena Reservoir is the largest freshwater body on Guam. Ponds created for agricultural purposes are also common.

Storm water is an important component of surface water systems because of its potential to introduce sediments and other contaminants that could degrade lakes, rivers, and streams. The volume and velocity of storm water flows can increase as a result of increases in impervious surfaces associated with buildings, roads, and parking lots. Storm water management systems are designed to control flow volume and velocity and to convey precipitation away from developed sites to appropriate receiving waters. Properly designed management systems can reduce runoff volume and velocity to pre-development conditions and reduce the transport of sediments and other contaminants that would otherwise flow directly into surface waters. Failure to properly manage increases in storm water runoff can result in downstream bank and channel scouring, water quality degradation and downstream flooding. Higher densities of development require greater degrees of storm water management because of the higher proportions of impervious surfaces.

4.1.1.7 Wildland Fire

Wildland fire has been a perennial problem and periodic threat on Guam. Fire history records available from 1979 to 2002 indicate that over this 23-year period more than 16,000 fires occurred (averaging more than 700 per year) that burned in excess of 100,000 acres (40,469 hectares) (about 4,500 acres [1,821 hectares] per year) on Guam. For the same period on NBG the number of fires was 477 (just over 21 per year) burning more than 9,800 acres (3,966 hectares) (about 427 acres [173 hectares] per year). **Table 4-1** provides the number of fires and acres burned on Guam and NBG during 1991–2002.

Table 4-1. Number of Fires and Acres Burned by Year for Guam and NBG, 1991 through 2002

Year	Acres JRM	No. Fires JRM	Acres Guam	No. Fires Guam
1991	67	11	1,541	475
1992	1,353	73	9,912	1,037
1993	82	23	3,256	1,138
1994	3	3	327	181
1995	1,801	22	5,628	598
1996	50	11	634	280
1997	174	17	972	524
1998	914	65	13,312	1,943
1999	41	15	625	527
2000	478	43	3,368	981
2001	56	39	1,178	1,245
2002	133	18	2,434	492
Total	**5,152**	**340**	**43,187**	**9,427**

Source: Wildland Fire Management Plan for Naval Base Guam, 2009

Records indicate that almost all wildland fires have occurred in the savanna grasslands on Guam. These areas are defined as grasslands with scattered or clumps of trees, such as pandanas (*Pandanus* spp.), tangantangan (*Leucaena leucocephala*), and ironwood (*Casuarina equisetifolia*) that cover extensive areas in southern Guam. The savanna communities, if left undisturbed, would gradually include an increasing number of woody trees and shrubs, and would convert into a ravine or limestone forest depending on the soil. Review of aerial photography taken over several decades indicates that, while the acreage of savanna grasslands has not appreciably increased, continued wildland fires have accelerated erosion which is degrading inherent site productivity, reducing the capacity of Fena Reservoir, and causing damage to coral reefs.

4.1.2 General Biotic Environment

4.1.2.1 Terrestrial Ecosystems

Flora

The floristic complexity of Guam's plant communities and the absence of distinct associations of species have led ecologists to emphasize the underlying soils and the relative degree of disturbance in classifying plant communities, rather than solely their floristic composition. Fosberg (1960) classified Guam's

principal vegetation types based primarily on general soils. Fosberg recognized that his grouping of the vegetation types did not result from any of the original plant communities because of the degree of modification by human activities. Stone (1970) adopted Fosberg's classification system and summarized the following nine vegetation types: (1) forest on elevated hard limestone, (2) ravine forest, (3) marshes, (4) swamps-mangroves, (5) strand vegetation, (6) savannas on volcanic soils, (7) argillaceous limestone vegetation, (8) coconut (Cocos nucifera) groves, and (9) weed communities.

These vegetation types can be grouped into the following five general plant communities: (1) limestone, (2) ravine, (3) wetland, (4) strand, and (5) savanna (U.S. Navy 2009). Mangrove swamps are more appropriately described in the estuarine environment. Argillaceous limestone vegetation is generally restricted to moist bottomlands and is floristically similar to the ravine communities. Coconut (known as niyok in Chamorro) groves are planted communities and are present in limestone, ravine, and strand communities. Weed communities are generally the result of recent disturbance (U.S. Navy 2009). The five general plant communities occurring on Guam are discussed in greater detail in the following paragraphs.

Limestone Communities. Limestone communities are situated on elevated limestone terraces, plateaus, and slopes. Limestone plant communities are diverse and highly variable, containing both native and nonnative woody plants, ferns, and herbaceous plants adapted to excessively drained, shallow limestone soils. In their least disturbed state, these plant communities have a stratified canopy consisting of scattered, large, emergent trees, such as breadfruit (*Artocarpus mariannensis*) (dukduk in Chamorro) and strangler fig (*Ficus prolixa*) (nunu in Chamorro), with a maximum height of 60 to 70 feet (18 to 21 meters). Other dominant species composing both the upper canopy and mid-canopy layers include *Aglaia mariannensis* (mapunao in Chamorro), *Ochrosia marianensis* (langiti in Chamorro), *Premna obtusifolia* (ahgao in Chamorro), *Elaeocarpus joga* (yoga in Chamorro), *Intsia bijuga* (ifil in Chamorro), *Pisonia grandis* (umumu in Chamorro), *Pandanus dubius*, and *Pandanus tectorius* (U.S. Navy 2009, NAVFACPACIFIC 2010b). Mid-canopy layers can be 30 to 45 feet (9 to 14 meters) in height. Smaller individuals of the above species and species such as *Guamia mariannae* (paipai in Chamorro), *Cycas micronesica* (fadang in Chamorro), and *Morinda citrifolia* (lada in Chamorro) are often present as an understory layer. The floristic composition of a limestone forest can be quite variable depending on location and the history of disturbance (U.S. Navy 2009).

Two subtypes of the limestone community type are recognized: disturbed limestone forest and halophytic-xerophytic scrub. Disturbed limestone plant communities are usually dominated by nonnative woody species of relatively short heights. The floristic composition represents subclimax seral stages following human-induced disturbances, such as land clearing. The canopy of disturbed limestone forest is fairly open, which allows abundant sunlight to reach the forest floor. The majority of the woody biomass in the disturbed areas is derived from nonnative species including tangantangan, *Triphasia trifolia* (lemon de china in Chamorro), and papaya (*Carica papaya*). Some areas of disturbed limestone forest are dominated by larger, nonnative trees such as African tulip (*Spathodea campanulata*) and vitex (*Vitex parviflora*). Scattered coconuts are common overstory components of disturbed limestone forests. Native species can be present in the understory, including *Pandanus* spp. *Scaevola sericea* (nanaso in Chamorro), *Guettarda speciosa* (panao in Chamorro), and *Ficus* sp. The open understory is occupied by various nonnative grasses, vines, and weeds. Chromolaena (*Chromolaena odorata*) (masiksik in Chamorro), a nonnative shrub, is common in recently disturbed areas (U.S. Navy 2009).

The halophytic-xerophytic scrub subtype of the limestone community is a unique plant community that exists on limestone terraces and cliff edges. The presence of drying winds, exposure to salt spray, and excessively drained limestone soils result in a microclimate that supports a stunted, wind-pruned plant community. The floristic diversity in these communities varies from low to high. Common species in halophytic-xerophytic scrub communities include *Pemphis acidula* (nigas in Chamorro), *S. sericea*,

G. speciosa, *Mammea odorata* (chopak in Chamorro), *Tournefortia argentea* (hunik in Chamorro), *Clerodendrum inerme*, *Pandanus* spp., sea hibiscus (*Hibiscus tiliaceous*) (pago in Chamorro), *Ochrosia mariannense* (langiti in Chamorro), *Ficus* sp., *Colubrina asiatica*, *Jasminum marianum*, and *Cynometra ramiflora* (gulos in Chamorro) (U.S. Navy 2009).

Ravine Communities. Fosberg (1960) classified the forest vegetation in valleys and ravines in southern Guam as ravine forests. Although the floristic composition of the ravine communities is similar to the limestone communities, these forests generally occur on volcanic soils or on argillaceous or clayey limestone soils, and are quite variable in floristic composition. Plant communities are often defined by the variability in soil moisture. Valley bottoms and ravines often have higher soil moisture than on the upper slopes. The canopies of ravine forest are structurally complex with multiple layers. Species present often include sea hibiscus, *Pandanus* spp., strangler fig, *Glochidion mariannensis*, *P. obtusifolia*, breadfruit, *Neisosperma oppositifolia* (fagot in Chamorro), *O. mariannensis*, and *Calophyllum inophyllum* (da'ok in Chamorro). Because of their proximity to freshwater streams in southern Guam, these plant communities contain many species of cultivated plants such as coconut, betelnut palm (*Areca catechu*), *Cananga odorata* (alangilang in Chamorro), and banana (*Musa* spp.). Epiphytes and common woody climbers (i.e., lianas) are also present (U.S. Navy 2009).

A disturbed ravine forest subtype is also recognized. Disturbed ravine plant communities are usually dominated by nonnative woody species with a more open canopy. The floristic composition represents subclimax seral stages following human-induced disturbances, such as agriculture. The majority of the woody biomass in the disturbed ravine forest is usually derived from nonnative species. *V. parviflora* and *C. odorata* are common components of disturbed ravine forests on Guam. The open understory is occupied by various nonnative grasses, vines, and weeds (U.S. Navy 2009).

Ravine forests and disturbed ravine forests are limited to the NBG Main Base and the NMS.

Wetland Communities. Wetlands are areas that are subject to permanent or periodic inundation by surface or groundwater with a frequency sufficient to support a prevalence of vegetative or aquatic life that requires saturated or seasonally saturated soil conditions for growth and reproduction. The surface or subsurface water must be sufficient for the establishment of hydrophytes or the development of hydric soils or substrates. Wetlands generally include swamps, marshes, bogs, and similar areas, such as sloughs, potholes, wet meadows, river overflows, mud flats, and natural ponds (U.S. Navy 2009). The northern limestone plateau of Guam is generally lacking in substantial wetlands (U.S. Navy 2009).

Fosberg (1960) described seven subtypes of the wetland plant communities based on their dominant floristic composition. Fosberg defined swamps as supporting plant communities with a predominance of woody species, and marshes as supporting herbaceous plant communities (Fosberg 1960). Marshes are generally situated in low places along the coast, along streams, in depressions and sinkholes with argillaceous limestones, or in poorly drained areas with volcanic soils. Marshes can be inundated with freshwater or brackish water if near the ocean. Swamps are generally situated along rivers, especially near the coast or along river valleys if inland, and are usually designated as ravine communities rather than as wetland communities (U.S. Navy 2009).

Natural freshwater marshes are also common on Guam. Most marshes on Guam are floristically simple with few dominant plant species. Phragmites (*Phragmites karka)*, a tall, reedy perennial grass, is the most common marsh species, often forming a dense monocultural plant community. *Scirpus littoralis*, a perennial sedge with rhizomes, is also found in dense pure stands along stream banks and in estuaries. Golden leather fern (*Acrostichum aureum*), a large fern, can dominate some marshes. Other floristic components of wetland plant communities on Guam can include *Cyperus* spp., *Paspalum vaginatum*, and *Brachiaria mutica* (U.S. Navy 2009).

Freshwater swamps on Guam are the largest category of wetland and can be found on the edges of marshes, along river courses, and in wet depressions in forests. The native sea hibiscus is usually the dominant species, although the largest tract of swamp forest on the island, the Talofofo River Valley to the east of the NMS, is dominated by *Barringtonia racemosa*. Other trees that might be present are screwpine (*Pandanus tectorius*) (kafu in Chamorro), cynometra (*C. ramiflora*), and the betelnut palm (GDAWR 2006a). Vegetation in man-made freshwater habitats is variable, but *P. karka* and sea hibiscus are usually present (GDAWR 2006a).

Strand Communities. Strand vegetation is adapted to excessively drained soils and salt spray from the adjacent coastal waters. Many of the beach areas on Guam are occasionally inundated with salt water during storms, which imposes a controlling influence on all biota. Strand communities vary floristically and in diversity. Some of the common overstory species found in strand plant communities include coconut, ironwood (gago in Chamorro), *Hernandia peltata* (nonag in Chamorro), and *C. inophyllum*. Where the overstory is lacking or the canopy is open shrub species often occur including *S. sericea, T. argentea*, and sea hibiscus. Vines, including *Ipomoea* spp. or *Vigna marina*, are often present. Grass species on these coastal strands can include bunchgrass (*Lepturus repens*) and *Paspalum distichum* (U.S. Navy 2009). Strand plant communities are limited to narrow strips in coastal areas within NBG Main Base, NBG TC, and Andersen AFB.

Savanna Communities. Savannas, which are defined as grasslands with scattered individual or clumps of trees, cover extensive areas in southern Guam. Savannas are predominately found on volcanic soils and are maintained by periodic burning initiated by humans (U.S. Navy 2009). If left undisturbed, the savanna communities would gradually include an increasing number of woody trees and shrubs, and would convert into a ravine or limestone forest depending on the soil type (U.S. Navy 2009). Fosberg (1960) recognized five savanna plant communities: (1) Miscanthus, (2) Dimeria, (3) erosion scar, (4) Phragmites, and (5) weed.

The ***Miscanthus* community** is dominated by the tall grass, Pacific Island silvergrass (*Miscanthus floridulus*), which can grow to heights of 10 to 15 feet (3 to 5 meters). In the absence of fire, scattered woody plants including Indian mulberry, *S. sericea*, and ironwood become established. Following burning, Pacific Island silvergrass sprouts vigorously from underground tissue. Pacific Island silvergrass is a bunch grass, leaving 30 to 40 percent of the ground surface as exposed mineral soil. Pacific Island silvergrass is suspected of producing and releasing a chemical that inhibits the germination and growth of competing plant species (i.e., allelopathy) (U.S. Navy 2009).

The ***Dimeria* community** is dominated by the shorter grass species, *Dimeria chloridiformis*, a soft, tufted grass that grows to heights of approximately 2 feet (0.5 meters) (Fosberg 1960). This community is usually more open and includes Pacific Island silvergrass and other species adapted to the low pH and high aluminum content of the highly weathered volcanic soils. Woody shrubs and trees are uncommon (U.S. Navy 2009).

The **erosion scar community** has sparse plant growth. These bare sites are the result of water and wind erosion in which all of the top soil has been eroded. The exposed subsoil usually has a very low pH, lacks organic matter and many essential plant nutrients. *Gleichenia linearis* is one of few plant species that can tolerate the low pH and lack of nutrients. Active erosion can prevent other plant species from becoming established in the erosion scar community (U.S. Navy 2009).

***Phragmites* communities** within savannas usually indicate the presence of higher soil moisture resulting from seeps. Phragmites can dominate these wetter sites excluding most other plant species (U.S. Navy 2009).

The weed community within savannas usually indicates recent disturbance and is dominated by nonnative pioneer plant species. Disturbance can be the result of fire, grazing, cultivation, or clearing. Some common species in the weed community include *Stachytarpheta jamaicensis*, *Elephantopus mollis*, *Hyptis* spp., *Mitracarpum hirtum*, and *Chrysopogon aciculatus*. Lantana (*Lantana camara*) and chromolaena are becoming more common in these weed communities (U.S. Navy 2009). See **Appendix H** for a full list of species presence and associations at JRM.

Fauna

Birds. Four endemic bird species from the Mariana Islands occur in small numbers on Guam. Three of these species are federally and Guam-listed as endangered and the fourth is Guam-listed as endangered. The Mariana common moorhen persists in low numbers throughout Guam and on JRM lands. The Mariana swiftlet was once common throughout the island but is now restricted to three caves on JRM lands in southern Guam. The Mariana crow, a bird relocated from Rota, has occurred in northern Guam on Andersen AFB in critically low numbers. However, the species is no longer present in the wild on Guam. The Micronesian starling (*Aplonis opaca guami*), listed as endangered by Guam but not by the Federal government, was nearly extirpated in the early 1990s; however, it currently appears to be making a modest recovery and occurs in small numbers on Andersen AFB, Cocos Island, parts of Hagatña, Apra Harbor, and some coastal areas in southern Guam (U.S. Navy 2009). A detailed treatment of these federally and Guam-listed birds can be found in **Section 4.1.2.6.**

Two other native terrestrial avian species are still found on JRM lands, neither of which is listed as threatened or endangered, but both are protected by the MBTA. These are the yellow bittern (*Ixobrychus sinensis*) and Pacific reef heron (*Egretta sacra*) (chuchuko' in Chamorro). The yellow bittern is the only native land bird that is still considered to be common on Guam (U.S. Navy 2009).

Common seabird species seen on Guam include the brown noddy (*Anous stolidus*) (fahang dankolo in Chamorro), white terns (*Gygis alba*) (chunge'in Chamorro), black noddy (*Anous minutus*) (fahang dikike' in Chamorro), and brown boobies (*Sula leucogaster*) (lu'ao in Chamorro). Brown noddies nest and roost on steep cliffs, rocky offshore islets and channel markers in Outer Apra Harbor. There has been a nesting colony of some 150 birds located just off the end of Orote Peninsula on NBG Main Base for many years and it is thought that this is the largest colony remaining on Guam. Additionally this species roosts on at least two small emergent rock islands off the north and south coast of Orote Peninsula. Brown boobies also nested on Orote Island previous to the construction of Kilo Wharf, but no longer nest on Guam. The coastal islets, reef flats, grassy fields, and other open areas on Guam provide seasonal foraging habitat to many migratory avian species. To date, more than 80 migrant and vagrant species have been recorded on Guam. Most common among the annual visitors to the island are the Pacific golden-plover (*Pluvialis fulva*), Mongolian plover (*Charadrius mongolus*), gray-tailed tattler (*Heteroscelus brevipes*), whimbrel (*Numenius phaeopus*), ruddy turnstone (*Arenaria interpres*), and cattle egret (*Bubulcus ibis*) (U.S. Navy 2009).

Several nonnative bird species are also present on Guam, which were either unintentionally introduced or intentionally introduced to provide hunting resources. Commonly observed introduced avian species include the island collared dove (*Streptopelia bitorquata*), Eurasian tree sparrow (*Passer montanus*), black francolin (*Francolinus francolinus*), and the black drongo (*Dicrurus macrocercus harterti*). In 1999, the GDAWR reported that the population of the island collared dove, which was introduced by the Spanish in 1771, was declining due to predation by the brown treesnake. GDAWR officially closed the dove hunting season in 1987 (U.S. Navy 2009). The island collared dove is present on all JRM lands on Guam (NAVFACPACIFIC 2010b). The Eurasian tree sparrow is commonly observed in small flocks, usually in close proximity to man-made structures. Black francolins were introduced to southern Guam as a game bird by the USFWS in 1961 and currently inhabit savanna plant communities, and strand

habitat on GNWR. The black drongo was introduced to the Marianas by the Japanese in the 1930s and is considered a nuisance species that can be hunted at any time of the year. The black drongo occurs mostly in developed areas (U.S. Navy 2009). See **Appendix H** for a full list of species presence and associations at JRM.

Mammals. Three species of bats, the Mariana fruit bat, the little Mariana fruit bat (*P. tokudae*), and the Pacific sheath-tailed bat (*Emballonura semicaudata rotensis*) were historically the only native mammals on Guam. The Pacific sheath-tailed bat has been extirpated from the island and the little Mariana fruit bat is thought to be extinct. The Mariana fruit bat is federally listed as threatened. See **Section 4.1.2.6** for additional information regarding threatened and endangered mammals on Guam.

Spanish introductions included Asiatic water buffalo (*Bubalus bubalis*) (carabao in Chamorro), Philippine deer (*Cervus mariannus*) (binådu in Chamorro), dogs (*Canis familiaris*), cats (*Felis catus*), feral pigs (*Sus scrofa*) (babuis in Chamorro), goats (*Capra hircus*), and cattle (*Bos taurus*). Four of these introduced species, the Asiatic water buffalo, Philippine deer, feral pigs, and the feral cat, are damaging natural resources on Guam (U.S. Navy 2009). Other introduced species include the Asian house shrew (*Suncus murinus*). house mouse, (*Mus musculus*), black rat (*Rattus rattus*), and Polynesian rat (*R. exulans*); other species such as domestic rabbits have not become naturalized. See **Appendix H** for a full list of species presence and associations at JRM.

Reptiles and Amphibians. Numerous native reptile species are still found in the wild on Guam (GDAWR 2006a). GovGuam lists eight species as endangered under its endangered species regulation. Native reptile species that are known to still exist on Guam include stump-toed (mutilating) gecko (*Gehyra mutilata*), blue-tailed skink (*Emoia caeruleocauda*), Slevin's skink (*Emoia slevini*) (Guali'ek halom tåno' in Chamorro), moth skink (*Lipinia noctua*) (Guali'ek halom tåno' in Chamorro), Pacific slender-toed gecko (*Nactus pelagicus*) (Guali'ek in Chamorro), mourning gecko (*Lepidodactylus lugubris*), oceanic gecko (*Gehyra oceanica*), Micronesian gecko (*Perochirus ateles*) (Guali'ek halom tano' in Chamorro), snake-eyed skink (*Cryptoblepharus poecilopleurus*) (Guali'ek halom tåno' in Chamorro), green sea turtle (*Chelonia mydas*) (Haggan in Chamorro), and hawksbill sea turtle (*Eretmochelys imbricata*) (Haggan karai in Chamorro). The monitor lizard (*Varanus indicus*), is common in some areas on Guam and has been recorded from archaeological deposits 1,500 years old. It is unknown whether the species was an early human introduction or if it dispersed naturally. The introduced Chinese softshell turtle (*Pelodiscus sinensis*) also occurs in Fena Reservoir.

Both green and hawksbill sea turtles occur in the two JRM estuaries of Sasa Bay and Inner Apra Harbor (U.S. Navy 2009). Threatened green sea turtles nest on beaches around Guam including beaches within the NBG and Andersen AFB. Most nesting by this species occurs on the southern end of Guam. Endangered hawksbill sea turtles have nested on beaches in northern and central Guam. Sumay Cove on NBG has supported hawksbill sea turtle nesting on the cobble and sand beach near the mangroves (U.S. Navy 2009). See **Section 4.1.2.6** for additional information regarding threatened and endangered reptiles on Guam. The leatherback sea turtle (*Dermochelys coriacea*) and loggerhead sea turtles (*Caretta caretta*) are also likely present in the waters around Guam, but their occurrence on Guam is unknown. These turtles have not been documented to nest on Guam.

There are no native amphibian species on Guam, however, several nonnative amphibians have been introduced, including the marine toad (*Chaunus marinus*), greenhouse frog (*Eleutherodactylus planirostris*), eastern dwarf tree frog (*Litoria fallax*), Guenther's Amoy frog (*Rana guntheri*), Hong Kong whipping frog (*Polypedates megacephalus*), Pacific chorus frog (*Pseudacris regilla*), slender-digit chorus frog (*Kaloula picta*), white-lipped tree frog (*Polypedates leucomystax),* grass frog (*Fejervarya cf. limnocharis*), crab-eating frog (*Fejervarya cancrivora*) and marbled pygmy frog (*Microhyla pluchra*) (Christy et al. 2007a). Incidental occurrences of the Malaysian narrowmouth toad (*Kaloula pulchra*) and

coqui (*Eleutherodactylus coqui*) have been recorded, but neither species has become established on Guam (Christy et al. 2007a).

The primary cause of the decline in native reptile populations on Guam is probably predation by introduced animals including the Asian house shrew, brown treesnakes, cats, and rats (*Rattus* ssp.). The population of blue-tailed skink has declined in response to predation or competition from the curious skink (*Carlia fusca*); however, it is relatively common in appropriate habitat. The stump-toed gecko has also declined, apparently in response to predation by introduced vertebrate predators including rats, cats, shrews, and the brown treesnake. The mourning gecko is relatively common (U.S. Navy 2009). See **Appendix H** for a full list of species presence and associations at JRM.

Invertebrates. Guam is home to dozens of endemic invertebrate species, many of which are rare or have extremely limited ranges. Endemic invertebrate species includes two ESA candidate butterfly species, the Mariana eight-spot butterfly or forest flicker, (*Hypolimnas octocula marianensis*) (Ababang in Chamorro), and the Mariana wandering, or rusty butterfly (*Vagrans egistina*) (Ababang in Chamorro). Three native tree snails (humped or Mariana tree snail [*Partula gibba*], fragile tree snail [*Samoana fragilis*], and Guam tree snail [*Partula radiolata*]) (all Akaleha' in Chamorro) are candidate species for listing under the ESA. Population declines of native tree snails are likely due to predation by introduced vertebrate predators including cats, Asian house shrew, rats, predatory carnivorous snails such as *Euglandia rosea*, overgrazing of vegetation by ungulates, and the introduced terrestrial flatworm *Platydemus manokwari* (U.S. Navy 2009). Additionally, Guam has a number of endemic invertebrate cave species that are likely extremely limited in their distribution. Among these are the Almagosa Cave amphipod (*Melita* sp.), at least three Almagosa isopods (*Isabelloscia* spp.), and the Guam karst katydid (*Salomona guamensis*).

The native mangrove crab (*Cardisoma carnifex*), land hermit crab (*Coenobita brevimanus*) and coconut crab (*Birgus latro*) (ayuyu in Chamorro) begin life in the sea. After a planktonic larval stage, small crabs emerge from the ocean to live on land. Mangrove crabs live in burrows among the roots of riverbank trees. Land hermit crabs rely on borrowed shells for protection throughout their lives, often using the shell of the African land snail (*Achatina fulica*). Coconut crabs are the largest terrestrial land arthropod on earth. They initially borrow shells, but then develop their own hard exoskeleton. Coconut crabs hide in holes during the day and, like the land hermit crab, forage at night. Land crabs are omnivorous and eat foods such as fruits, seeds, plants, rotting wood, dead insects, and carrion. Both species are found on JRM. Threats to these species include rats, feral pigs, dogs, monitor lizards, and humans (U.S. Navy 2009). See **Appendix H** for a full list of species presence and associations at JRM.

4.1.2.2 Freshwater Ecosystems

Freshwater communities include lentic (i.e., standing-water) habitats and lotic (i.e., running-water) habitats. Lentic habitats differ from wetlands in that the water depth is sufficient to preclude the establishment of terrestrial plant communities.

Southern Guam has many freshwater communities including numerous streams and water impoundments created by dams such as the Masso and Fena Reservoirs (U.S. Navy 2009). In contrast, the karstic characteristics of the limestone plateau in northern Guam results in rapid infiltration of water, and consequently only a few freshwater communities exist in the vicinity of Mount Santa Rosa (GDAWR 2006a). While freshwater ecosystems occupy a relatively small portion of Guam's land area, these ecosystems are important as sources of water and wildlife habitat, and are integral to the hydrological cycle. Surficial freshwater habitats on JRM are limited to NBG Main Base and the NMS (U.S. Navy 2009). The largest freshwater body on Guam is Fena Lake (200 acres [81 hectares]), which functions as an important reservoir for drinking water. Other sites are much smaller and tend to have deeper, more

open water than natural marshes. These include ponds dug for aquaculture purposes. A number of these sites are crucial to the preservation of the Mariana common moorhen and are very important to migratory species (GDAWR 2006a).

Flora

Guam has at least three species of native freshwater aquatic plants (see **Table 4-2**). Two of the three species have wide distributions. One pondweed species, *Potamogeton mariannensis*, might be endemic to Guam. *Potamogeton* spp. are flowering plants, and can produce both sexually and vegetatively. *Ceratopteris thalictroides* is a fern, and reproduces via airborne spores. While none of these plants are abundant, they all have a fairly wide distribution on Guam. *Potamogeton* spp. and *C. thalictroides* have relatively soft, submerged leaves, and are at risk from overfeeding by exotic snails and herbivorous fish (GDAWR 2006a). See **Appendix H** for a full list of species presence and associations at JRM.

Table 4-2. Native Freshwater Aquatic Plants of Guam

Family	Species	Habitat
Potamogetonaceae	*Potamogeton lucens*	Slow moving water, soft substrates
	Potamogeton mariannensis	Slow moving water, soft substrates
Parkeriaceae	*Ceratopteris thalictroides*	Sluggish water, mainly lakes and ponds

Source: GDAWR 2006a

Fauna

Birds. More than 100 species of birds have been documented on Guam including migrant, wetland, seabird, grassland, and forest birds (GDAWR 2006a). The Mariana common moorhen is the only native freshwater obligate bird species still found on Guam. Extirpation of the Mariana mallard (*Anas platyrhynchos oustaleti*), white-browed crake (*Porzana cinerea*), and nightingale reed-warbler (*Acrocephalus luscinia*) (ga'kaliso/ga'karriso in Chamorro) occurred between 1945 and 1970 (Ritter and Savidge 1999). The Mariana common moorhen was listed as endangered in 1984 due to loss of wetland habitat. In 2001, the moorhen population was estimated to be 287, with 154, 41, 2, and 90 adult moorhens on Saipan, Tinian, Rota, and Guam, respectively (Takano and Haig 2004). This suggested an overall increase in birds on Saipan and Tinian, and a possible decline in moorhen numbers on Guam (Takano and Haig 2004). See **Appendix H** for a full list of species presence and associations at JRM.

Fish. Guam's freshwater ecosystems have not been well studied. All of the indigenous fish found on Guam are diadromous, requiring access to both salt water and fresh water during their life cycles. Prominent among Guam stream fauna are numerous species of native gobies (family Gobiidae), all of which are amphidromous (i.e., migrates between fresh water and salt water, but not for breeding) (U.S. Navy 2009). See **Appendix H** for a full list of species presence and associations at JRM.

Macroinvertebrates. Aquatic macroinvertebrates are organisms that live in or on water for all or part of their life cycle, do not have a backbone, and are large enough to be seen without the aid of a microscope. Crustaceans, including Tahitian prawn (*Macrobrachium lar*) (uhang in Chamorro) and several species of mollusks (i.e., snails) are present in freshwater streams on Guam. Macroinvertebrates have not been extensively studied in freshwater streams on Navy lands (U.S. Navy 2009).

Guam has 17 species of native freshwater snails, belonging to two families (i.e., Nertidae and Thiaridae). The only freshwater invertebrates of concern on Guam are *Stenomelania plicaria*, a thiarid snail, and *Neritodryas subsulcata*, a nertid snail. *S. plicaria* has a limited distribution on Guam, being found in a

few rivers. *N. subsulcata* is very uncommon on Guam (GDAWR 2006a). Neritids have an amphidromous life history, similar to that of the fish. Eggs are deposited in fresh water, the young hatch, and are swept to the ocean. After a marine larval stage, they return to fresh water to mature. Thiarids are normally found on sand or other soft substrates, where they spend a good portion of the day buried. Thiarids live their entire life cycle in fresh water (GDAWR 2006a).

Guam has at least 12 species of freshwater crustaceans: 9 species of freshwater shrimp, and at least 3 species of freshwater crab. All of these crustacean species are apparently amphidromous, with a marine larval stage, and a freshwater adult stage (GDAWR 2006a). Two families of shrimp are represented on Guam, Atyidae and Palaemonidae. The genera *Atyoida* and *Atyopsis* of the Atyidae family are generally found in high-current, shallow waters; and species of the *Caradina* genus are generally found in slow-moving, deeper waters. *Halocaradina trigonopthalma* occurs only in caves and sinkholes along the east coast. Palaemonid shrimp are widespread on Guam in rivers, reservoirs, and caves. They are able to survive in intermittent pools in the headwaters of streams, and are frequently the only fauna of such habitats (GDAWR 2006a). The freshwater crabs of Guam are poorly known and form a rather inconspicuous part of the freshwater fauna. Three species are known to occur on Guam: *Ptychognathus* sp., *Sesarma* sp., and *Varuna* cf. *littorata* (GDAWR 2006a). See **Appendix H** for a full list of species presence and associations at JRM.

Reptiles and Amphibians. Three species of introduced freshwater turtles are believed to have breeding populations on Guam and include the soft-shell turtle (*Pelodiscus sinensis*), red-eared slider (*Trachemys scripta elegans*), and the common snapping turtle (*Chelydra serpentina*) (Leberer 2003). Soft-shelled turtles have been found in Fena reservoir. There is also potential for snapping turtles to occur in the reservoir. See **Appendix H** for a full list of species presence and associations at JRM.

4.1.2.3 Estuarine Ecosystems

Estuarine communities are transitional areas between terrestrial and marine communities. An estuary is a semi-enclosed coastal body of water that has a free connection with the open sea. Estuarine communities are strongly influenced by tidal action. Within estuaries, seawater mixes with fresh water from land drainage resulting in the dilution of sea water. On Guam, estuarine communities are present at the mouths of the larger rivers and the inner waters of Apra Harbor (U.S. Navy 2009).

Estuarine wetlands occur in areas of tidal intrusion or brackish water, and consist primarily of mangroves in the lower channels of rivers. These habitats are facilitated by a daily tidal variation of about 30 to 35 inches (75 to 90 cm). Although they only total about 6 acres (2 hectares), Guam's mangroves are the most extensive and diverse in the Mariana Islands (GDAWR 2006a). Nine of the island's 46 rivers that empty into the ocean have true estuarine zones. The lower channels of these rivers, which are typically only 16 to 66 feet (5 to 20 meters) wide and 3 to 13 feet (1 to 4 meters) deep, have elevated salinity levels that extend 0.3 to 1 mile (0.5 to 1.6 kilometers) upstream (GDAWR 2006a).

Flora

Estuarine environments are uniquely stressful for plants due to the waterlogged soils and the relatively high salt content of estuary waters. These physical stresses strongly influence the species composition in estuarine communities. Mangroves are the predominant woody trees that are adapted to tidal estuarine communities (U.S. Navy 2009). The largest concentrations of mangroves exist along the eastern shores of Apra Harbor, with smaller zones present in Merizo and Inarajan. Plant species include Asiatic mangrove (*Rhizophora mucronata*), Indo-West Pacific stilt mangrove (*R. apiculata*), large-leafed mangrove (*Bruguiera gymnorrhiza*), gray mangrove (*Avicennia marina*), teruntum merah (*Lumnitzera*

littorea), nipa palms (*Nypa fruticans*), Xylocarpus moluccensis, looking-glass-tree *(Heritiera littoralis*), sea hibiscus, and golden leather fern (*Acrostichum aureum*) (GDAWR 2006a).

Nipa palms are found on Guam only in the lower reaches of rivers that exhibit a true estuarine habitat. Nipa palms are found along only ten rivers on Guam. Due to overharvesting and habitat loss, the nipa palm has become uncommon, and is now a protected species in Guam. Estuarine marshes dominated by bulrushes (*Scirpus littoralis*) are also found at several locations in Apra Harbor (GDAWR 2006a). See **Appendix H** for a full list of species presence and associations at JRM.

Fauna

Birds. Two indigenous avian species, yellow bittern and Pacific reef heron, rely on food resources within estuarine ecosystems on Guam. Neither species is listed as threatened or endangered. Exposed tidal mudflats and estuarine banks provide seasonal foraging and loafing habitat to migratory and vagrant avian species. There is incidental use of resources within estuarine systems by the endangered Mariana common moorhen, usually during low tides on NBG. Most common among the annual visitors to the island that could use estuarine habitats include Pacific golden-plover, lesser sand (Mongolian) plover, whimbrel, ruddy turnstone, and cattle egret (U.S. Navy 2009). See **Appendix H** for a full list of species presence and associations at JRM.

Mammals. The majority of the introduced mammalian species currently established on Guam use resources within estuarine communities, especially during low tides. These include Philippine deer, dogs, cats, feral pigs, Asian house shrew, and four species of rats and mice (Norway rat [*Rattus norvegicus*], black rat [*R. rattus*], Pacific rat [*R. exulans*], and house mouse [*Mus musculus*]). All of these naturalized mammalian species are deleterious to the remaining native floral and faunal resources. Rats, shrews, cats, and dogs prey on birds, eggs, lizards, and insects. Additionally, rats and mice eat seeds, roots, and new growth of native plants adversely affecting regeneration of native plants (U.S. Navy 2009). See **Appendix H** for a full list of species presence and associations at JRM.

Fish. Estuarine ecosystems play an important part in the life cycles of Guam's indigenous freshwater fish, which are all diadromous, requiring access to both salt water and fresh water during their lives. Estuarine areas are the gateway to the open ocean and to the streams in which these fish spend most of their adult lives. Estuarine waters also provide seasonal foraging resources and sanctuary to many of the 900 or so species of saltwater fish found in Guam's near shore waters. Maintaining high-quality estuarine ecosystems is imperative for the sustainability of near-shore fish populations (U.S. Navy 2009). See **Appendix H** for a full list of species presence and associations at JRM.

Reptiles and Amphibians. Little work has been done to address the distribution and abundance of terrestrial reptiles within estuarine ecosystems on JRM lands on Guam. It is expected that several introduced and indigenous lizards currently found on Guam use resources within estuarine communities. Two species of marine turtles use resources within the near-shore, estuarine, and beach zones on Guam. Threatened green sea turtles forage in offshore waters and nest on beaches around Guam, including Navy installation beaches at NBG TS. Most nesting by this species occurs in northern Guam. Endangered hawksbill sea turtles have nested on beaches in northern and central Guam and forage in certain estuaries, such as Sasa Bay. Grimm and Farley (2008) report that hawksbills are frequently sighted in the nearshore waters surrounding Guam. However, they are less common than green sea turtles (NMFS and USFWS 2007). According to Wiles et al. (1995), hawksbills represent about 13 percent of turtles sighted around Guam. The Sumay Marina Cove located in NBG Main Base has supported endangered hawksbill sea turtle nesting attempts on the cobble and sand beach near the mangroves. Introduced established amphibians on Guam, including the marine toad and the eastern dwarf tree frog, use resources in the estuarine ecosystem (U.S. Navy 2009). Gunther's Amoy frog also uses estuarine habitats associated with

the San Luis Ponds on NBG Main Base. See **Appendix H** for a full list of species presence and associations at JRM.

Macroinvertebrates. The estuarine communities on Guam support a diverse assemblage of macroinvertebrates, including numerous species of crabs, mollusks, insects, and other arthropod species. None of the invertebrate species present are listed as either threatened or endangered by the USFWS. Estuarine areas are particularly important to both the native land hermit crabs and coconut crabs. Adult females return to the sea to lay eggs. After a planktonic larval stage, small crabs emerge from the ocean to live on land (U.S. Navy 2009). See **Appendix H** for a full list of species presence and associations at JRM.

4.1.2.4 Submerged Lands

JRM managed submerged lands are areas in coastal waters extending from the Guam coastline into the ocean 3 nautical miles, including the seabed below and the airspace above, and the interface between terrestrial and aquatic habitats, known as the intertidal zone. The shoreline of the intertidal zone of the Mariana Islands is very narrow because of the narrow tidal ranges. The approximate tidal range on Guam is 1.6 feet (0.48 meters) (NOAA 2006). The coastline consists of exposed rocky shores and an intertidal bench providing habitat for many intertidal invertebrate species including octopus, sea cucumbers, swimming crabs, slipper lobster (*Parribaccus antarcticus*), and spiny lobsters (*Panulirus* spp.) (JGPO 2010).

JRM manages 79,260 acres (32,075 hectares) of submerged lands (52,731 acres on Navy and 26,529 acres on Andersen AFB). Submerged lands are managed through the Guam Submerged Lands Management Plan (see **Appendix T**). The resources described in the following paragraphs are found in submerged lands around Guam, but vary slightly in prevalence based on the specific location.

Marine lands at Tinian and FDM are under the management of the CNMI government.

Fishery Resources and Essential Fish Habitat

The MSFCMA (16 U.S.C. 1801–1883) calls for direct actions to stop or reverse the continued loss of fish habitats. Toward this end, Congress mandated the identification of habitats essential to managed species and measures to conserve and enhance this habitat. Under the MSFCMA, Congress directs NMFS and the eight regional Fishery Management Councils (FMCs) (under the authority of the Secretary of Commerce) to describe and identify EFH in Fishery Management Plans (FMPs); minimize, to the extent practicable, the adverse effects of fishing on EFH; and identify other actions to encourage the conservation of EFH. EFH is defined as those waters and substrate necessary to fish for spawning, breeding, feeding, or growth to maturity.

The MSFCMA requires cooperation among NMFS, the FMCs; fishing participants; and Federal, territorial, and state agencies to protect, conserve, and enhance EFH. Section 305(b) of the MSFCMA mandates that Federal agencies must consult with the Secretary of Commerce on all proposed activities authorized, funded, or undertaken by the agency that might adversely affect EFH. NMFS recommends consolidated EFH consultations with interagency coordination procedures required by other statutes, such as NEPA or the ESA, to reduce duplication and improve efficiency (50 Code of Federal Regulations [CFR] 600.920[e][1]).

The Mariana Islands are within the jurisdiction of the WPRFMC, which has designated the marine waters around Guam, Tinian, and Pagan as EFH, and adopted a precautionary approach to EFH designation due to the lack of scientific data (JGPO 2010). The WPRFMC currently manages fisheries in the Western

Pacific under five FMPs: (1) coral reef ecosystems, (2) bottomfish and seamount groundfish, (3) crustaceans, (4) precious corals, and (5) pelagic species. Each of these FMPs identifies areas of EFH and HAPC for different life stages of species managed under the respective plan.

EFH habitats in Guam include the following:

- *Intertidal Zones.* This habitat includes a small margin of seabed existing between the highest and lowest extent of the tides extending around Guam.
- *Seagrass Beds.* Seagrass beds occur in patches within Outer and Inner Apra Harbor and other isolated areas around Guam (e.g., Agat Bay).
- *Macroalgae.* Macroalgae habitats occur within most areas around Guam.
- *Mangrove Forests/Wetlands.* These forests occur in the intertidal zone along the coast of Outer and Inner Apra Harbor.
- *Coral Reefs and Colonized Hardbottom.* Coral reefs are located on shoals (e.g., Big Blue Reef, Western Shoals, Middle Shoals, and Jade Shoals) and the coasts of Outer and Inner Apra Harbor.
- *Estuarine Water Column.* This habitat includes the open water areas within Sasa Bay and river mouth areas.
- *Marine Water Column.* Many managed species occur in this habitat and rely on this for development, dispersal, or feeding.
- *Unconsolidated Bottom.* This habitat includes benthic substrates along the coast or within Apra Harbor such as clay and silt, sand, gravel, rubble and boulders.

In addition, Habitat Areas of Particular Concern (HAPC) were designated. HAPCs are specific areas that are essential to the life cycle of species, including coral species. At least one or more of the following criteria established by NMFS must be met for HAPC designation: (1) the ecological function provided by the habitat is important, (2) the habitat is sensitive to human-induced environmental degradation, (3) development activities are, or would be, stressing the habitat type, or (4) the habitat type is rare. It is possible that an area can meet one HAPC criterion and not be designated an HAPC. The WPRFMC used a fifth criterion, not established by NMFS, in HAPC designation of areas that are already protected, such as wildlife refuges (WPRFMC 2005).

Flora

Tropical seagrass meadows typically occur in most shallow, sheltered, soft-bottomed marine coastlines and estuaries. Barrier reefs protect coastlines and the lagoon formed between the reef and the mainland is protected from waves, allowing mangrove and seagrass communities to develop. Tropical seagrasses are also important in their interactions with mangroves and coral reefs. Seagrasses trap sediment and slow water movement, causing suspended sediment to fall out. This trapping of sediment benefits coral by reducing sediment loads in the water. All of these systems exert a stabilizing effect on the environment, resulting in important physical and biological support for the other communities. Seagrasses are unique amongst flowering plants in that all but one genus can live entirely immersed in sea water (JGPO 2010).

There are three species of sea grass found on Guam; the dominant one is *Enhalus acaroids*. *Halophila minor* and *Haldule uninervis* are physically smaller and somewhat seasonal. Andersen AFB has a large bed of *H. minor* and *H. uninervis* off Tarague beach.

E. acoroides and H. uninervis were identified on NBG Main Base during surveys conducted at Dadi Beach (SWCA 2011). *E. acoroides* was located exclusively in the northern section of the field survey

area. Although primarily located to the south of *E. acoroides*, *H. uninervis* could also be found in small patches below the Japanese Fortifications near South Tipalao. The two species were somewhat disparate geographically, but isolated mixed patches occurred around the interface of these species, in the vicinity of Tipalao beach, and in a few isolated areas further south. The total area of seagrass coverage was estimated to be 4.6 acres (18,473 square meters), with 5.32 miles (8.6 km) of perimeter (SWCA 2011). See **Appendix H** for a full list of species presence and associations at JRM.

Fauna

Bottomfish. Seventeen species of bottomfish are managed by the WPRFMC through the *Bottomfish* and *Seamount Groundfish Fishery Management Plan* and subsequent amendments. In Guam, the Bottomfish Management Unit Species (BMUS) are divided into a shallow-water complex and a deepwater complex based on depth and species composition (DoN 2005).

Except for several of the major commercial species, very little is known about the life histories, habitat use patterns, food habits, or spawning behavior of most adult bottomfish and seamount groundfish species. Furthermore, very little is known about the distribution and habitat requirements of juvenile bottomfish.

Generally, the distribution of adult bottomfish in the Western Pacific Region is closely linked to suitable physical habitat. Adult bottomfish are usually found in habitats characterized by a hard substrate of high structural complexity. The total extent and geographic distribution of the preferred habitat of bottomfish is not well known. Bottomfish populations are not evenly distributed within their natural habitat; instead, they are found dispersed in a non-random, patchy fashion. Deepwater snappers tend to aggregate in association with prominent underwater features, such as headlands and promontories.

In the Northern Mariana Islands, the bottomfish fishery can be divided into two distinct fisheries: a shallow- and a deepwater bottomfish fishery, based on species and depth. The shallow-water (0 to 328 feet [0 to 100 meters]) bottomfish complex comprises groupers, snappers, and jacks in the genera *Lethrinus*, *Lutjanus*, *Epinephelus*, *Aprion*, *Caranx*, *Variola*, and *Cephalopholis*. The deepwater (328 to 1,300 feet [100 to 400 meters]) bottomfish complex comprises primarily snappers and groupers in the genera *Pristipomoides*, *Etelis*, *Aphareus*, *Epinephelus*, and *Cephalopholis*.

The eggs and larvae of all BMUS are pelagic, floating at the surface until hatching, and subject thereafter to advection by the prevailing ocean currents. There have been few taxonomic studies of these life stages of snappers (lutjanids) and groupers (epinepheline serranids). Presently, few larvae can be identified to species. As snapper and grouper larvae are rarely collected in plankton surveys, it is extremely difficult to study their distribution.

EFH for adult and juvenile bottomfish is the water column and all bottom habitat extending from the shoreline to a depth of 1,300 feet (400 meters [200 fathoms]) encompassing the steep drop-offs and high-relief habitats that are important for bottomfish. EFH for bottomfish eggs and larvae is the water column extending from the shoreline to the outer boundary of the Exclusive Economic Zone (EEZ) to a depth of 1,300 feet (400 meters). HAPC for bottomfish includes all slopes and escarpments between 131 and 919 feet (40 and 280 meters).

Pelagics. Thirty-three pelagic species are currently managed as Pelagic Management Unit Species (PMUS) by the WPRFMC through the Fishery Management Plan for Pelagic *Fisheries of the Western Pacific Region* and subsequent amendments. These are divided into the following species complex designations: marketable species, nonmarketable species, and sharks. The marketable species complex has been further divided into temperate and tropical assemblages. The temperate species complex includes those PMUS that are found in greater abundance outside tropical waters at higher latitudes

(e.g., broadbill swordfish [*Xiphias gladius*], bigeye tuna [*Thunnus obesus*], northern bluefin tuna [*T. thynnus*], and albacore tuna [*T. alalunga*]). Additionally, a squid PMUS consisting of three flying squid species was incorporated into the existing Pelagics FMP.

The pelagic management unit species are typically found in epipelagic to pelagic waters; however, shark species can be found in inshore benthic, neritic to epipelagic, and mesopelagic waters. Factors such as gradients in temperature, oxygen, or salinity can affect the suitability of a habitat for pelagic fishes. Skipjack tuna (*Katsuwonus pelamis*), yellowfin tuna (*T. albacares*), and Indo-Pacific blue marlin (*Makaira nigricans*) prefer warm surface layers, where the water is well-mixed and relatively uniform in temperature. Species such as albacore tuna, bigeye tuna, striped marlin, and broadbill swordfish, prefer cooler temperate waters associated with higher latitudes and greater depths. Certain species, such as broadbill swordfish and bigeye tuna, are known to aggregate near the surface at night. However, during the day broadbill swordfish can be found at depths of 2,625 feet (800 meters) and bigeye tuna around 902 to 1,804 feet (275 to 550 meters). Juvenile albacore tuna generally concentrate above 295 feet (90 meters) with adults found in deeper waters (295 to 902 feet [90 to 275 meters]) (DoN 2005).

Migration and life history patterns of most pelagic species in the Pacific Ocean are poorly understood. Additionally, very little is known about the distribution and habitat requirements of the juvenile lifestages of tuna and billfish prior to recruitment into fisheries. Seasonal movements of cooler-water tunas such as the northern bluefin and albacore are more predictable and better defined than billfish migrations. Tuna and related species tend to move toward the poles during the warmer months and return to the equator during cooler months. Most pelagic species make daily vertical migrations, inhabiting surface waters at night and deeper waters during the day. Spawning for pelagic species generally occurs in tropical waters but can include temperate waters during warmer months. Very little is known about the life history stages of species that are not targeted by fisheries in the Pacific such as gempylids, sharks, and pomfrets (DoN 2005).

Crustaceans. Crustaceans are currently managed by the WPRFMC and include spiny and slipper lobsters, Kona crabs (*Ranina ranina*), and deepwater shrimp. Four species are managed as the spiny and slipper lobster complex: spiny lobsters (*Panulirus penicillatus* and *Panulirus* spp.), ridgeback spiny lobster (*Scyllarides haani*), and Chinese slipper lobster *(Parribacus antarcticus*). The Kona crab is managed as a single species. Deepwater shrimp includes several species including, *Heterocarpus ensifer*, *H. laevigatus* and *H. longirostris*, *H. tricarinatus*, *H. gibbosus*, and *H. sibogae* (DoN 2005, WPRFMC 2009).

Spiny lobsters are found throughout the Indo-Pacific region. All spiny lobsters in the Western Pacific Region belong to the family Palinuridae. The slipper lobsters belong to the closely related family, Scyllaridae. There are 13 species of the genus *Panulirus* distributed in the tropical and subtropical Pacific between 35° N and 35° S. *P. penicillatus* is the most widely distributed, the other three species are absent from the waters of many island nations of the region. Spiny lobsters are typically found on rocky substrates in well-protected areas, in crevices, and under rocks. Unlike many other species of *Panulirus*, the juveniles and adults of *P. marginatus* are not found in separate habitats apart from one another. Juvenile *P. marginatus* recruit directly to adult habitat; they do not use a separate shallow-water nursery habitat apart from the adults as do many palinurid lobsters. Similarly, juvenile and adult *P. penicillatus* also share the same habitat. *P. marginatus* is found seaward of the reefs and within the lagoons and atolls of the islands. The reported depth distribution of *P. marginatus* is 9 to 656 feet (3 to 200 meters). While this species is found down to depths of 656 feet (200 meters), it usually inhabits shallower waters. *P. marginatus* is most abundant in waters of 295 feet (90 meters) or less. Large adult spiny lobsters are captured at depths as shallow as 9 feet (3 meters) (WPRFMC 2009).

In the southwestern Pacific, spiny lobsters are typically found in association with coral reefs. Coral reefs provide shelter and a diverse and abundant supply of food items. *P. penicillatus* inhabits the rocky shelters in the windward surf zones of oceanic reefs and moves on to the reef flat at night to forage (WPRFMC 2009).

Very little is known about the planktonic phase of the phyllosoma larvae of *P. marginatus*. Evidence (found in Hawai'i) suggests that fine-scale oceanographic features, such as eddies and currents, serve to retain phyllosoma larvae (WPRFMC 2009).

Non-Coralline Invertebrates. Sponge diversity is greatest, regardless of depth, on coral reefs, in caves, and vertical areas not colonized by hard corals. They are also abundant in seagrass beds, mangroves, and other environments, providing residence for a huge variety of animals, including crustaceans, annelids, and echinoderms.

4.1.2.5 Coral Reef Ecosystems

Guam is almost entirely surrounded by fringing reefs, is entirely surrounded by fore reefs, and has barrier reefs at Apra Harbor, Luminao Barrier Reef (at the western end of Guam), and Cocos Lagoon (southern end of Guam). The fringing reef is interrupted at several locations along the coastline by bays and channels (JGPO 2010). From Pagat Point south to Taguan Point coral reefs and colonized hard bottom (live coral) (10 to 50 percent) and coralline algae (10 to 50 percent) are present seaward of the exposed wave-cut platforms. Corals found above the 100-foot (30-meter) isobath in this area include encrusting or massive growth forms of corals and columnar, platy, and branching growth forms, which are conditioned to withstand heavy wave action and would recover if damaged (DoN 2005).

Definition of Coral and Coral Reef

Corals from one or more taxa are present from the North Pole to the South Pole and from the intertidal zone to the abyss. Corals addressed in this document are exclusively tropical species occurring (primarily) at depths of less than 325 feet (100 meters).

The Coral Reef Conservation Act of 2000 defines several related terms: coral, coral reef, and coral reef ecosystem as follows.

CORAL - The term "coral" means species of the phylum Cnidaria, including all species of the orders Antipatharia (black corals), Scleractinia (stony corals), Gorgonacea (horny corals), Stolonifera (organpipe corals and others), Alcyonacea (soft corals), and Coenothecalia (blue coral), of the class Anthozoa; and all species of the order Hydrocorallina (fire corals and hydrocorals) of the class Hydrozoa.

CORAL REEF - The term "coral reef" means any reefs or shoals composed primarily of corals.

CORAL REEF ECOSYSTEM - The term "coral reef ecosystem" means coral and other species of reef organisms (including reef plants) associated with coral reefs, and the nonliving environmental factors that directly affect coral reefs, that together function as an ecological unit in nature.

To clarify the definition of coral and coral reef further, the following definition is provided. It is not intended to alter the legal definition provided in the Act, but to facilitate taxonomic comparisons.

CORAL - The term "coral" means species of the phylum Cnidaria, including the following:

- Class Hydrozoa Order Milleporina (fire corals also known as Hydrocorallina)
- Class Hydrozoa Order Stylasterina (lace corals also known as Hydrocorallina)

- Class Anthozoa, Subclass Hexacorallia, Order Scleractinia (stony corals)
- Class Anthozoa, Subclass Ceriantipatharia, Order Antipatharia (black corals and wire corals)
- Class Anthozoa, Subclass Octocorallia, Order Alcyonacea (soft corals and Tubipora corals)
- Class Anthozoa, Subclass Octocorallia, Order Gorgonacea (horny corals/sea fans)
- Class Anthozoa, Subclass Octocorallia, Order Helioporacea (blue corals).

Distribution of Corals

All major coral taxa are present in Guam. There are approximately 5 species of the Order Milleporina (fire corals), 21 species of the Order Stylasterina (lace corals), 375 species of the Order Scleractinia (stony corals), 10 species of the Order Antipatharia (black corals and wire corals), 60 species of the Order Alcyonacea (soft corals and Tubipora corals), 20 species of the Order Gorgonacea (horny corals/sea fans), and 1 species of the Order Helioporacea (blue corals) (Paulay et al. 2001, Riegl et al. 2008). **Table H5-2** in **Appendix H** provides a list of coals that have been identified on JRM.

In addition to supporting a very diverse mix of corals, Guam also has five of the six the major reef types: fringing reefs, patch reefs, submerged reefs, offshore banks, and barrier reefs. Atolls are the only major reef type missing from Guam and the Mariana Islands.

Proposed Listing of Species of Coral

The Center for Biological Diversity (CBD) submitted a petition to add 82 species of coral to the Federal list of Threatened and Endangered Species and to designate Critical Habitat for those species. In response to the petition, NMFS reviewed the status of 82 "candidate species" of corals. In April 2012, NMFS completed a status review report and draft Management Report of the candidate species of corals. In November 2012, NMFS proposed to list 66 of those petitioned species of corals as threatened or endangered under the ESA.

In response to the Federal Register Status Review, the DoN prepared and distributed language that is intended to preclude critical habitat designation and is to be included in INRMPs of affected installations (NAVFAC ESC 2010). The JRM current conditions from the DoN required text are incorporated as follows, and additional background information is included in **Appendix S**.

U.S. Navy INRMPs and relevant literature were reviewed to identify which Navy installations and lease areas in the near-shore zone and within U.S. Territory have, or might have, one or more of the 66 coral species proposed for listing. Near-shore is defined as all submerged marine lands titled to the military and all other submerged lands that are adjacent to installations that extend from the mean high water level, offshore to the boundary of any security areas controlled by the Navy, including Andersen AFB.

Forty-four of the 66 species being evaluated by NOAA occur or potentially occur within Navy installations, training ranges, and Operating Areas (OPAREAs) in the United States or U.S. territories. Most of the stony coral species (84 percent) that are being petitioned are found within the Pacific Ocean region; seven of the petitioned species occur within the western Atlantic and Caribbean.

Per Secretary of the Navy policy (SECNAV 2002) the Navy shall participate in ESA listing decisions, critical habitat designation, and recovery planning for those actions that have the potential to affect mission readiness. Therefore, it is the goal of the Navy for INRMPs to fulfill the criteria to be considered for exemption for the designations of critical habitat. The ESA does not require additional special management/critical habitat designation if adequate management and protection is already in place. Adequate special management or protection is provided by a compliant INRMP and addresses physical or biological features that provide a conservation benefit for the species.

Table 4-3 lists all proposed species that may be present at NBG, Andersen AFB, and CNMI.

Land and Jurisdictional Issues

Land and jurisdictional issues are more complex on Guam than at any of the other locations being addressed by the DoN. The key guidance documents are (1) P.L. 93-435(b)(ii) effective October 5, 1974, and (2) Presidential Proclamation 4347 effective February 1, 1975. The public law authorizes the Navy to retain title of submerged lands adjacent to property owned by the United States above the mean high tide. The Presidential Proclamation authorizes the Navy to retain title of submerged lands within Inner and Outer Apra Harbor and submerged lands adjacent to several other upland areas. **Figure 4-3** shows the JRM Submerged Lands off Guam. Additional detail on submerged lands can be found in maps in **Appendix T**). It is important to note that the Commercial Port Authority's jurisdiction covers the commercial port portion of Apra Harbor and part of Sasa Bay. Also of significance is the fact that the JRM Managed Submerged Lands extend offshore for 3 geographical/statute miles.

Two ecological reserve areas (ERAs) are superimposed on top of the JRM Submerged Lands, the OPERA and the HERA (see **Figure 4-3** and maps in **Appendices P, Q, and T**). The HERA supports some of the healthiest and most complex coral reefs around Guam.

The WPRFMC has designated all the waters surrounding Guam as EFH from the shoreline to depths of 1,300 feet, for one or more of the managed species (Western Pacific Regional Fishery Management Council 1998). The Council has also designated HAPC for Coral Reef Ecosystem Management Unit Species at five locations in Guam: Jade Shoals, Ritidian Point, HERA, OPERA, and Cocos Lagoon. All of these HAPC sites are located on JRM Submerged Lands, except for Cocos Lagoon (see **Figure 4-3** and maps in **Appendices P, Q, and T**). It is noteworthy that Ritidian Point, the OPERA, and the HERA have dual designations as HAPCs and as ERAs.

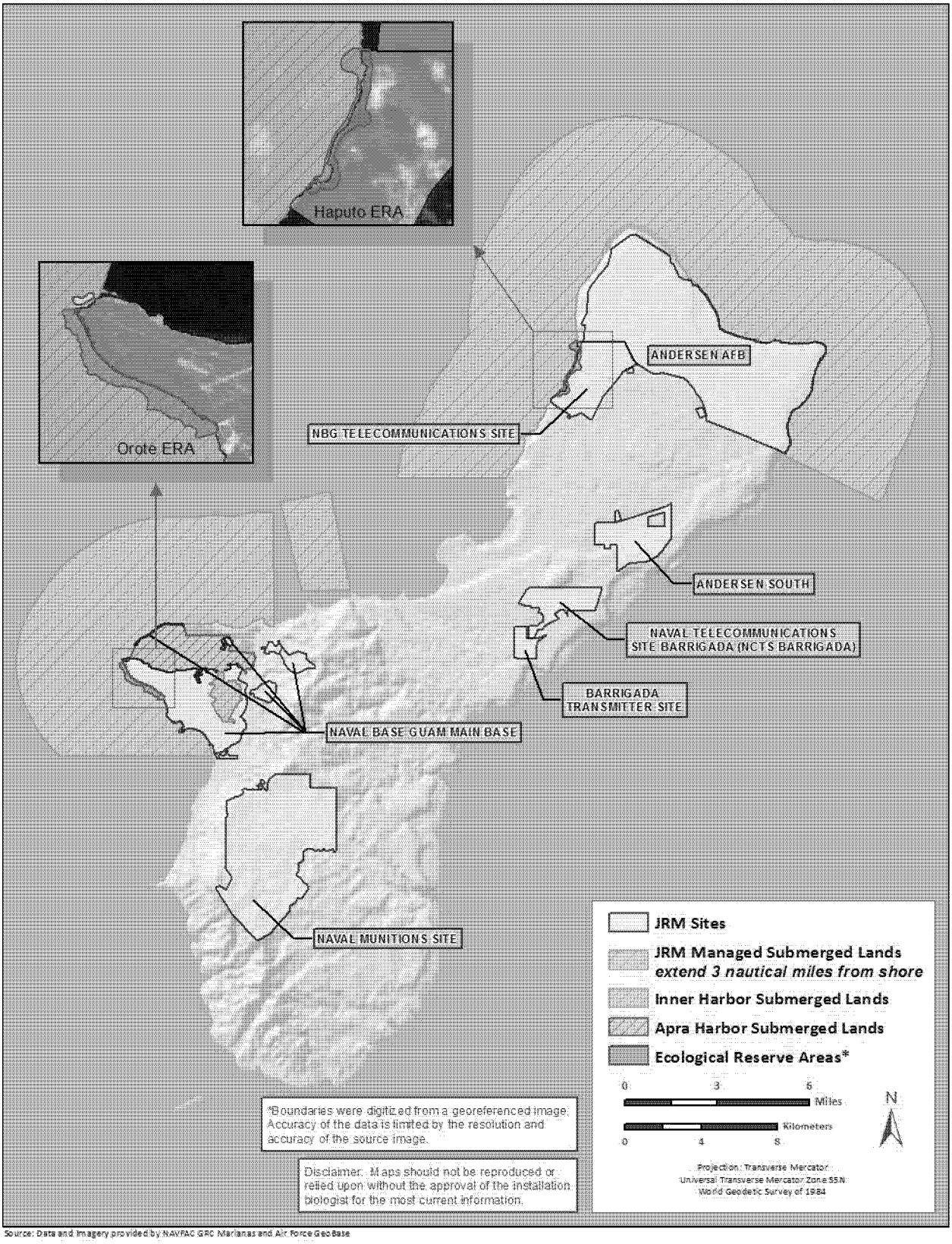
Key Factors Influencing Corals – Natural Stressors

The corals and reefs of the Mariana Archipelago have not sustained serious widespread impacts related to climate change or coral bleaching, which have impacted other Indo-Pacific reefs since 1998 (Burdick et al. 2008). Minor to moderate bleaching did occur in August and September 2007. This was a regional event that extended from southern Japan to the Republic of Palau (Smith and Marx 2006). If sea surface temperatures continue to rise, more serious bleaching events are likely to occur. The archipelago is located within one of the world's most active tropical storm/cyclone regions in the world (Smith and Marx 2006). For example, between 1945 and 1993, 84 tropical storms or typhoons passed through the Mariana Islands. The large waves produced by these storms have a tremendous impact on shaping and structuring the reefs in this region.

The Mariana Archipelago is also located within an extremely active seismic area and some of the islands are active volcanoes (e.g., Anatahan, which is only 60 miles from FDM). Between 1999 and 2008, the USGS recorded 232 earthquakes, some with magnitudes up to 5.7. Tsunamis are produced by fault movements caused by earthquakes and volcanic activity. The Mariana Islands have been impacted by both locally generated tsunamis and tsunamis originating from Indonesia, the Philippines, and Japan. Micro-tsunamis can be produced by surface wave or moment magnitudes (Mw) greater than 6.5 and a depth of 60 miles or less, or an event for which a Tsunami Information Bulletin, Expanding Regional Warning, Indian Ocean Bulletin, or Japan Meteorological Agency Tsunami Watch Information was issued (Smith and Marx 2006). These extreme natural events play a major role in shaping the distribution of coral and coral reefs within the Mariana Archipelago.

Table 4-3. Occurrence of Proposed Coral Species at Naval Base Guam, Andersen AFB, Farallon De Medinilla and Tinian Military Lease Areas

Coral Species	Proposed Status	Pacific
Acanthastrea brevis	Proposed Threatened	NBG and CNMI
Acanthastrea ishigakiensis	Proposed Threatened	NBG and CNMI
Acropora aculeus	Proposed Threatened	NBG, Andersen AFB, and CNMI
Acropora acuminata	Proposed Threatened	NBG, Andersen AFB, and CNMI
Acropora aspera	Proposed Threatened	NBG, Andersen AFB, and CNMI
Acropora palmerae	Proposed Threatened	NBG, Andersen AFB, and CNMI
Acropora striata	Proposed Threatened	NBG, Andersen AFB, and CNMI
Acropora vaughani	Proposed Threatened	NBG, Andersen AFB, and CNMI
Acropora verweyi	Proposed Threatened	NBG , Andersen AFB, and CNMI
Alveopora fenestrata	Proposed Threatened	NBG, Andersen AFB, and CNMI
Anacropora puertogalerae	Proposed Threatened	Naval Base Guam and CNMI
Anacropora spinosa	Proposed Endangered	Naval Base Guam and CNMI
Barabattoia laddi	Proposed Threatened	NBG, Andersen AFB, and CNMI
Euphyllia cristata	Proposed Threatened	NBG, Andersen AFB, and CNMI
Millepora foveolata	Proposed Endangered	NBG, Andersen AFB, and CNMI
Millepora tuberosa	Proposed Threatened	NBG, Andersen AFB, and CNMI
Montipora caliculata	Proposed Threatened	NBG, Andersen AFB, and CNMI
Montipora lobulata	Proposed Threatened	NBG, Andersen AFB, and CNMI
Pavona diffluens	Proposed Threatened	NBG, Andersen AFB, and CNMI
Pectinia alcicornis	Proposed Threatened	Naval Base Guam and CNMI
Pocillopora danae	Proposed Threatened	NBG, Andersen AFB, and CNMI
Pocillopora elegans	Proposed Endangered	NBG, Andersen AFB, and CNMI
Porites horizontalata	Proposed Threatened	NBG, Andersen AFB, and CNMI
Seriatopora aculeata	Proposed Threatened	NBG, Andersen AFB, and CNMI



Source: Data and Imagery provided by NAVFAC GRC Marianas and Air Force GeoBase

Figure 4-3. JRM Submerged Lands

The crown of thorns sea star (*Acanthaster planci*) is a coral-eating starfish found throughout the Indo-Pacific. Outbreaks of the crown of thorns sea star have occurred since at least 2004. Burdick et al. (2008) found that "the widespread, persistent nature of these outbreaks, as well as observations of high crown of thorns sea star predation mortality among less-preferred coral species, suggest that these outbreaks have had, and are continuing to have, a severe impact on many of Guam's reefs."

Key Factors Influencing Corals - Anthropogenic Stressors

The three most significant anthropogenic stressors in the archipelago are (1) sedimentation of the nearshore environment due to severe upland erosion, (2) coastal pollution from microbial organisms and hydrocarbons, and (3) overfishing. Within the archipelago, these stressors are the most severe on Guam. Virtually all of these anthropogenic stressors are a result of actions taken by local residents and not JRM personnel, employees, and are not a result of DOD wastewater treatment plant operations.

Public wastewater treatment systems are generally not adequate or not operating at optimal levels. GEPA recreational water quality monitoring, based upon *Enterococcus* bacteria levels, have shown that water quality has not improved since 2003 when 27 percent of all samples exceeded standards, and all were non-DOD wasterwater treatment plant discharges (Burdick et al. 2008). It should be noted, however, that there is debate on the appropriateness of using this bacteria as an indicator since it occurs naturally in tropical soils.

Local residents intentionally light upland fires to clear vegetation and to improve hunting. Between 1979 and 2006, there was an average of 700 intentionally set fires per year on Guam (Burdick et al. 2008). The result is that large areas on Guam are denuded or have lost their natural vegetation. This has greatly increased soil runoff into the nearshore environment.

Unsustainable fishing practices are commonly used (e.g., night spear fishing with scuba to capture parrotfishes, which sleep at night and become easy targets). Parrotfishes, a key species within Indo-Pacific coral reef ecosystems, were once very abundant in Guam; they are now severely depleted. The widespread use of monofilament gill nets has also had destructive results. Most of the Pacific islands have banned both of these fishing practices, but Guam has not.

A fourth stressor of significance in Guam is tourism, and associated water sport activities, which are very popular. Burdick et al. (2008) estimated that more than 300,000 dives per year are made in Guam. Tourist scuba divers and snorkelers impact corals and coral reefs by accidentally scraping and breaking coral. Dive boat anchors cause substantial long-term damage, even though some of the dive sites use permanent moorings. Jet skis and speedboats create noise and water pollution. Even the sunblock lotions used by tourists can adversely impact corals when very large numbers of people using sunblock swim near the reefs (NAVFAC ESC 2010).

Operational and Training Requirements

Assuming the standard JRM environmental protection protocols are followed, there are no routine operational and training requirements that are conducted in Guam that are likely to result in adverse impacts on corals or coral reefs. In fact, the reefs and associated organisms that are within JRM "off-limits zones," such as the Kilo ammunition wharf and the fuel pier, are superior to those in areas accessible to the general public. This superiority is based on the health of corals, diversity of corals, fish, and associated invertebrates, and the biomass of fishery target species such as top shells (*Trochus niloticus*), surgeonfishes (Acanthuridae), and snappers (Lutjanidae) (Smith 2004, 2006, 2007, Smith and Marx 2006).

Additional Practices which Benefit Corals and Associated Organisms

NBG has funded, and continues to fund, a wide range of studies to assess and monitor corals and coral reefs. These studies have been and are being performed by marine ecologists; personnel from the UOG; contractors; and personnel from the USFWS, NOAA, and GovGuam. The focus of these studies is how to avoid, to the maximum extent possible, any adverse impacts on corals, coral reefs, and associated organisms. In addition, NBG has funded afforestation programs to improve nearshore water quality.

4.1.2.6 Protected Species

Under the Federal ESA, an "endangered species" is defined as any species that is in danger of extinction throughout all or a significant portion of its range. A "threatened species" is defined as any species that is likely to become an endangered species within the foreseeable future throughout all or a significant portion of its range. The ESA of Guam (5 Guam Code Annotated 63208, P.L. 15-36) provides authorization to conserve and manage threatened and endangered species to achieve the purposes of the Federal ESA. It provides for the creation of a local endangered and threatened species list, and extends local protection to all federally listed species. Under the ESA of Guam, an "endangered species" is defined as any species which is in danger of extirpation on Guam and has been so designated by the Guam Department of Agriculture or that has been determined to be an endangered species pursuant to the Federal ESA. A "threatened species" is defined as any species of plant or wildlife which appears likely, within the foreseeable future, to become endangered and which has been so designated by the Guam Department of Agriculture or that has been determined to be a threatened species pursuant to the Federal ESA. Species listed as threatened or endangered by the Federal ESA or the Guam ESA and have the potential to occur on Guam are listed in **Table 4-4** and discussed in the following sections. Species listed as threatened or endangered by the Federal ESA, Guam ESA, or the CNMI Fish, Game and Endangered Species Act (CNMI P.L. 2-51), and have the potential to occur in the CNMI, are listed in **Table 4-4** and discussed in the following sections. Species with a former range that includes Guam and CNMI, and that are listed by the Guam ESA, or the CNMI Fish, Game and Endangered Species Act, but have no current potential to occur on Guam or CNMI are also listed in **Table 4-4,** but are not discussed further in this document. There are 19 federally threatened and endangered species on and around Guam, including 6 species of cetaceans, 2 terrestrial mammals, 6 birds, 4 sea turtles, and 1 plant. One mammal (the little Mariana fruit bat) and one bird (Guam bridled white-eye) are likely extinct; and two Guam endemic birds (Guam rail and Guam Micronesian kingfisher) survive only in zoos or in an experimental population outside its native range (Guam rail). The Guam ESA lists 37 species as endangered and one species as threatened.

The USFWS defines a candidate species as those plants and animals that have been studied and the Service has concluded that they should be proposed for addition to the Federal endangered and threatened species list. Species identified as candidates by the Federal ESA, Guam ESA, or the CNMI Fish, Game and Endangered Species Act, which have the potential to occur in the CNMI, are listed in **Table 4-4** and discussed in the following sections.

Table 4-4. Federal, GovGuam, and CNMI Listed Threatened and Endangered Species

Common Name (Chamorro Name)*	Scientific Name	Federal Status	GovGuam/ CNMI Status	Habitat	Presence on JRM Lands	Current Occurrence on Guam, Tinian and FDM
Mammals						
Sei whale	*Balaenoptera borealis*	E	-	Subtropical to subpolar waters on the continental shelf edge.	Unknown	Information Not Available
Blue whale	*Balaenoptera musculus*	E	-	Subtropical to subpolar waters.	Unknown	Information Not Available
Fin whale	*Balaenoptera physalus*	E	-	Deep offshore water in temperate to polar latitudes.	Unknown	Information Not Available
North Pacific right whale	*Eubalaena japonica*	E	-	Coastal to shelf waters in temperate to subpolar latitudes	Unknown	Information Not Available
Humpback whale	*Megaptera novaeangliae*	E	-	Feed in cold productive coastal waters, calve in warm water.	Unknown	Information Not Available
Sperm whale	*Physeter macrocephalus*	E		In waters > 1,968 feet (600 meters).	Unknown	Information Not Available
Pacific sheath-tailed bat (finihi lihyang)[a]	*Emballonura semicaudata rotensis*	C	E	Native limestone forest for foraging and caves for roosting.	None	Extirpated
Mariana fruit bat (fanihi)	*Pteropus mariannus mariannus*	T	E	Native limestone forest.	Guam, Tinian and FDM	Present
Little Mariana fruit bat (fanihi)[a]	*Pteropus tokudae*	E	E	Native limestone forest.	None	Presumed Extinct

Common Name (Chamorro Name)*	Scientific Name	Federal Status	GovGuam/ CNMI Status	Habitat	Presence on JRM Lands	Current Occurrence on Guam, Tinian and FDM
Birds						
Mariana swiftlet (Yayaguak)	*Aerodramus bartschi*	E	E	Mahlac Cave, Fachi Cave, and Maemong Cave.	Guam and Tinian	Present on Guam, Documented on Tinian
Micronesian starling (Såli)	*Aplonis opaca guami*	--	E	Native limestone forest.	Guam	Present
Mariana crow (Åga)	*Corvus kubaryi*	E	E	Native limestone forest.	Guam	Extirpated
White-throated ground-dove (Paluman apåka'/fache')	*Gallicolumba xanthonura*	--	E	Native limestone forest.	Guam	Occasional vagrants
Mariana Common Moorhen (Pulattat)	*Gallinula chloropus guami*	E	E	Fresh and brackish wetlands.	Guam and Tinian	Present
Guam rail (Ko'Ko')	*Gallirallus owstonii*	E	E	Edge and secondary growth.	None	Occurs only in captivity or experimental release population (Rota) and Cocos Island
Guam Micronesian kingfisher (Sihek)	*Halcyon cinnamomina cinnamomina*	E	E	Native limestone forest.	None	Occurs only in captivity
Micronesian megapode (Sasangat)	*Megapodius laperouse laperouse*	E	E	Native limestone forest.	Tinian and FDM	Present
Guam Broadbill (Chuguangguang)	*Myiagra freycineti*	--[a]	--	Formerly all habitats except southern savannas. Extinct.	None	Extinct
Micronesian Honeyeater (Egigi)	*Myzomela rubratra saffordi*	--	E	Beach strand, mangroves, upland forest, suburban, and disturbed areas.	None	Extirpated from Guam

Common Name (Chamorro Name)*	Scientific Name	Federal Status	GovGuam/ CNMI Status	Habitat	Presence on JRM Lands	Current Occurrence on Guam, Tinian and FDM
Birds (continued)						
Mariana fruit dove (Totot)	*Ptilinopus roseicapilla*	--	E	Native limestone forest.	None	Extirpated from Guam
Rufous fantail (Chichirika)	*Rhipidura rufifrons uraniae*	--	E	Native limestone forest.	None	Extirpated from Guam, Occurs on Tinian
Guam bridled white-eye (Nosa')	*Zosterops conspicillatus conspicillatus*	E	E	Native limestone forest.	None	Presumed Extinct
Reptiles						
Loggerhead sea turtle	*Caretta caretta*	T	--	Offshore waters.	Unknown	Unknown
Green sea turtle (Haggan)	*Chelonia mydas*	T	T	Offshore waters and nesting beaches.	Guam, Tinian and FDM	Present (nesting)
Snake-eyed skink (Guali'ek halom tåno')	*Cryptoblepharus poecilopleurus*	--	E	Coastal strand in rocky beach areas in loose sandy soils.	None	Unknown
Leatherback sea turtle	*Dermochelys coriacea*	E	E	Offshore waters and nesting beaches.	Unknown	Unknown
Tide-pool skink (Guali'ek kanton tåsi)	*Emoia atrocostata*	--	E	Intertidal zone in rock crevices, mangroves, and tree holes.	None	Present
Azure-tailed skink (Guali'ek halom tåno')	*Emoia cyanura*	--	E	Forest edge in loose ground cover.	None	Present
Slevin's skink (Guali'ek halom tåno')	*Emoia slevini*	--	E	Native limestone forest.	None	Unknown
Hawksbill sea turtle (Haggan karai)	*Eretmochelys imbricata*	E	E	Offshore waters and nesting beaches.	Guam, Tinian and FDM	Present (nesting)

Common Name (Chamorro Name)*	Scientific Name	Federal Status	GovGuam/ CNMI Status	Habitat	Presence on JRM Lands	Current Occurrence on Guam, Tinian and FDM
Reptiles (continued)						
Moth skink (Guali'ek halom tåno')	*Lipinia noctua*	--	E	Native limestone forest.	Guam	Present
Pacific slender-toed gecko (Guali'ek)	*Nactus pelagicus*	--	E	Native limestone forest.	Guam	Present
Micronesian gecko (Guali'ek halom tano')	*Perochirus ateles*	--	E	Native limestone forest.	None	Unknown
Invertebrates						
Mariana eight-spot (Ababang)	*Hypolimnas octocula marianensis*	C	--	Native limestone forest.	Guam	Present
Humped or Mariana tree snail (Akaleha')	*Partula gibba*	C	E/CNMI SC	Native limestone forest and ravine forest, only known populations occur in the HERA along the northwest coast and the GNWR.	Guam and Tinian	Present on Guam, Unknown on Tinian
Guam tree snail (Akaleha')	*Partula radiolata*	C	E	Native limestone and ravine forest, endemic to the Island of Guam.	Guam	Present
Mount Alifan tree snail (Akaleha')	*Partula salifana*	--	E	Native limestone forest near Mount Alifan. Endemic to the Island of Guam, presumed extinct.	None	Presumed Extinct
Fragile tree snail (Akaleha')	*Samoana fragilis*	C	E	Native limestone and ravine forest.	Guam	Present
Mariana wandering butterfly (Ababang)	*Vagrans egistina*	C	--	Native limestone forest.	None	Presumed Extirpated

Common Name (Chamorro Name)*	Scientific Name	Federal Status	GovGuam/ CNMI Status	Habitat	Presence on JRM Lands	Current Occurrence on Guam, Tinian and FDM
Vascular Plants						
Tree fern (Såtsa)	*Cyathea lunulata*	--	E	Native limestone forest.	Guam	Possible
No common name (Ufa-halomtåno')	*Heritiera longipetiolata*	--	E	Native limestone forest.	Guam	Present
Fire Tree (Hayun lågo)	*Serianthes nelsonii*	E	E	Native limestone forest.	Guam	Present

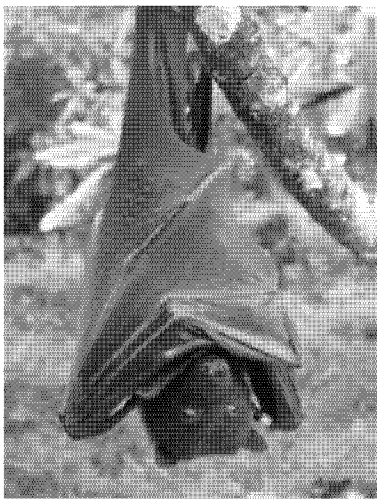
Sources: USFWS 2008, USEPA 2004, USGS 2008, and GDAWR 2006a
Note: *Chamorro Names from Government of Guam, Department of Agriculture Endangered Species Regulation No. 8 (2003)
Key:
E = Federal- or GovGuam-listed as endangered
T = Federal- or GovGuam-listed as threatened
C = Federal candidate for listing
SC = Species of Concern
[a] = extinct, delisted.

Fauna

Terrestrial Species

Mammals

Mariana fruit bat. The Mariana fruit bat, (fanihi in Chamorro) is a medium-sized bat measuring 7 to 10 inches (18 to 25 cm) from head to rump, with a wingspan of 34 to 42 inches (86 to 107 cm). The males are slightly larger than the females. The abdomen and wings are dark brown to black with individual gray hairs intermixed throughout the fur. The mantle and sides of the neck are bright gold on most animals, but in some individuals, this region can be pale gold or pale brown. The color of the head varies from brown to dark brown. The Mariana fruit bat forages and roosts in native limestone forest and occasionally in coconut groves and strand vegetation (Perez 1972, Wheeler 1979, USFWS 1990b). The bats roost in strangler fig, *M. odorata*, and *N. oppositifolia*, but have been known to roost in *Macaranga thompsonii* (pengua in Chamorro) and *G. speciosa* (Wiles 1987a). This species feeds on a variety of plant material but fruit makes up the majority of its diet (frugivorous) (Wiles 1987a, USFWS 1990b). Fruit bats are important components of tropical forest ecosystems because they disperse plant seeds as they consume fruit, contribute to forest regeneration following disturbance events, and sustain forest diversity (Shilton and Whittaker 2009, Whittaker and Jones 1994, Cox et al. 1992).



Mariana fruit bat
Source: A. Brooke

Historically, the Mariana fruit bat inhabited the native limestone forests throughout all the Mariana Islands except Uracas (Wiles 1989). No known historical records exist to document the status of the fruit bat throughout the Mariana Islands prior to the 20th century. However, research indicates that the Mariana fruit bat occasionally moves from one island to another in the Mariana archipelago (Perez 1972, Wiles 1987b, Wiles and Glass 1990). Genetic analysis of bats from Guam and the CNMI shows gene flow among islands within the Mariana archipelago (Brown et al. 2011).

On Guam, population estimates in 2006 indicated fewer than 100 individuals (Janeke 2006). The number of bats remaining on Andersen AFB is believed to be less than 25 individuals. Only 88 sightings of individual bats were recorded March–September 2012 during 82 surveys (SWCA 2012).

Three additional bats were sighted on NBG lands in 2008 during 90 hours of fruit bat surveys at 14 survey locations on or near NBG lands. It is likely that a small number of solitary-roosting fruit bats (> 10) also occur on NBG lands but were not observed. Solitary individuals can move to and from areas during the year. A survey of the Pati Point colony in 2010 resulted in a count of only 10 fruit bats and an estimate of fewer than 25 individuals islandwide (A. Brooke, Navy, personal communication). The majority of fruit bats remaining on Guam likely reside on Andersen AFB. Among all the islands of the CNMI, population estimates (2010) are variable but range from approximately 11 individuals on Maug to 1,017 individuals on Pagan with a total of 3,078 individuals (USGS 2010).

The Mariana fruit bat population has experienced a significant decline in the past century due to several factors. Fruit bats are an important cultural delicacy to the Chamorros' and were served at weddings, christenings, and holidays (Sheeline 1991). Guam's population of these bats was probably reduced greatly during the early 1900s when the expanding human population on Guam at that time probably fueled the demand for bats while an increased use of firearms might have made hunting more successful (Wiles 1987b, 1990). Territorial legislation that criminalized bat harvest in 1966, the designation of Pati

Point as a protected area by the USAF in 1973, and the listings as an endangered species by Guam in 1981 and the United States in 1984 have helped bats to survive on Guam, although the population was likely sustained by migration from Rota (Wiles and Glass 1990). Illegal hunting continues to be a serious threat to fruit bats in the Mariana Islands (Wiles et al. 1995, Esselstyn et al. 2006, and Wiles and Brooke 2009).

Other factors that have likely contributed to the decline of the Mariana fruit bat include predation, loss of habitat, and natural disturbances (Wiles 1987a, 1987b). Predation by brown treesnakes has very likely contributed to declining populations on Guam since the 1950s and prevented recovery despite legal protection (Wiles 1987a, Wiles et al. 1995). The colony of Mariana fruit bats at Pati Point was extremely sensitive to humans and was known to flush at the scent of people. The colony was habituated to the sound of aircraft and remained at the same location beneath the Andersen runways from 1984 to 2011. SWCA (2011) found aircraft departing from the north runway caused bats to flush more frequently than aircraft departing from the south runway. Clear-cutting of native forest for conversion to agriculture and construction of housing and other development in the central and northern parts of the island have removed potential roosting and foraging habitat. Destruction of habitat by feral ungulates is also considered a contributing factor (Wiles 1989). Lastly, the effects of natural disturbance events, like typhoons common in the Western Pacific Ocean, might be responsible for denuding bat roosting and foraging habitat (Wiles 1987b) and making them more vulnerable to poaching (Esselstyn et al. 2006).

The Guam population of the Mariana fruit bat was federally listed as endangered in 1984 (USFWS 1984). No Federal protection was afforded the species outside of Guam. In 2005, the USFWS published a final rule listing the Mariana fruit bat as a threatened species throughout the Mariana Islands. This change reflected the view that the fruit bats in the CNMI and Guam were a single population, and the threats to this species should be managed rangewide (USFWS 2005a). This view was further supported by genetic analysis that indicated that the Mariana fruit bats in the Mariana Islands were a single population (Brown et al. 2011). The Mariana fruit bat is listed as an endangered species by the Guam ESA.

Little Mariana fruit bat. The Little Mariana fruit bat, *Pteropus tokudae*, (fanihi in Chamorro) is much smaller than the Mariana fruit bat and has never been known to be common. The following description is from the original treatment by Tate (1934). The little Mariana fruit bat measures 5.5 to 6 inches (14 to 15 cm) head to rump, with a wingspan of 26 to 28 inches (65 to 71 cm). The belly and wings are dark brown with few gray hairs interspersed. The mantle is brown in color blending to russet on the sides, the top of the head is mottled brown and gray, a cinnamon buff neck, and the throat and chin are dark brown. The little Mariana fruit bat has always been considered rare; only three specimens have been collected (Tate 1934, Perez 1972). The last reported observation of a specimen was a female collected in 1968 (Perez 1972). Unlike the Mariana fruit bat that ranges throughout the Mariana Islands, the little Marina fruit bat has not been observed on other islands and is considered endemic to Guam. The same basic habitat and behavior is seen in this species as the Mariana fruit bat.

The little Mariana fruit bat was listed as endangered in August 1984 (USFWS 1984). Considering the species has not been observed since the 1968 record by Perez (a possible observation was made by Wheeler [1979]), the species is likely extinct. Designation of critical habitat for this species was considered twice by the USFWS, once in 1991 (USFWS 1991a) and once in October 2002 (USFWS 2002a), but it was found not to be prudent because the species is likely extinct. A recovery plan for the little Mariana fruit bat was published in 1990 (USFWS 1990b), however, because the species is likely extinct, no recovery objectives were established. The little Mariana fruit bat is listed as an endangered species by the Guam ESA.

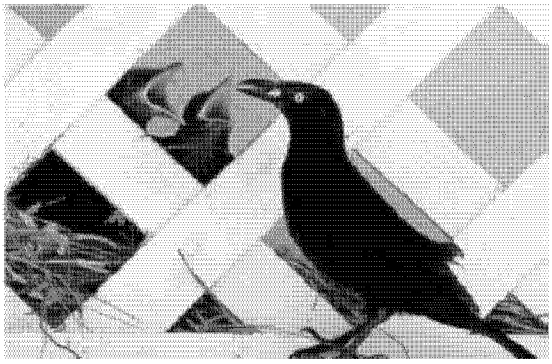
Birds

Mariana swiftlet. The Mariana swiftlet (Yayaguak in Chamorro) is a narrow-winged bird, dark gray above, and grayish brown on its underside. It is endemic to the Mariana Islands and known historically from Guam, Rota, Aguiguan, Tinian, and Saipan, but it is currently found only on Guam, Saipan, and Aguiguan. The Mariana swiftlet can be confused with the Asian barn swallow (*Hirundo rustica*), a vagrant species occasionally sighted on northern Guam. The Asian barn swallow is distinguished from the Mariana swiftlet by its pale underparts, the ability to perch, and a long forked tail. Swiftlets are known to forage over grassy areas and along cliff lines, feeding on insects caught in flight (USFWS 1991b), but studies conducted in 1996 indicate a preference for foraging in the Talofofo River Valley (Morton and Amidon 1996) which is composed of native forest, riparian forest, agricultural lands, and savanna. Foraging usually occurs in the early morning or early evening. They nest and roost colonially in caves, using moss and saliva to construct a nest on the cave wall. A single egg is laid between January and July. The Mariana swiftlet is an acrobatic flyer and uses a form of echolocation to navigate the dark interior of caves, though it is not as advanced as the echolocation of many bats. The reasons for the decline of the endangered Mariana swiftlet are not completely understood, but human disturbance of nesting and roosting caves and predation on swiftlets by brown treesnakes (Guam) have contributed to their current status.

Mariana swiftlet
Source: C. Kessler

The Mariana swiftlet was listed as endangered in August 1984 (USFWS 1984). A recovery plan for the species was published in 1991 (USFWS 1991b). Critical habitat has not been proposed, or designated for the species. The Mariana swiftlet is listed as an endangered species by the Guam ESA.

Micronesian starling. The Micronesian starling (Såli in Chamorro) is an endemic subspecies found in the southern Mariana Islands of Guam, Rota, Tinian, and Saipan (Baker 1951, Jenkins 1983). The Micronesian starling is a large starling with black plumage and a greenish-blue gloss. It has a heavy, slightly curved black bill, black feet, and yellow eyes (Jenkins 1983). It is considerably smaller than the Mariana crow and can be distinguished from the introduced black drongo by the latter's red irises and long forked tail. Micronesian starlings form small to moderate size flocks, but can also be found alone, or in pairs. The starlings use scrub, secondary growth, mixed woodland, and mature forest for habitat and feed primarily on the fruit and seeds of ripe papayas (Baker 1951, Jenkins 1983). They were often seen in urban areas but are generally more abundant in forested areas (Jenkins 1983). This species, unlike other starlings, is not an agricultural pest. Nesting has been observed from January through June. Starlings are cavity nesters and have been found nesting in the cavities of trees and rocky cliffs. Two green eggs spotted with drab rust- and purple-colored spots are laid per clutch (Baker 1951).



Micronesian starling
Source: M.P. Warner/DAWR

At one time, Micronesian starling were found throughout Guam but predation by the brown treesnake has restricted them primarily to Cocos Island, NBG Apra Harbor in buildings, Andersen AFB, parts of Hagatña and certain coastal areas in the south, and birds have been seen on the wing carrying nesting material in the vicinity of Sumay Marina. These birds are important because they help disperse seeds, which is vital for perpetuation of the native forests.

Populations of Micronesian starling on Guam have declined, but it is not a federally listed species and no recovery plan has been drafted. Due to the declining populations on Guam, GovGuam has listed the species as endangered.

Mariana crow. The Mariana crow (Åga in Chamorro) is a small black crow with a greenish-black sheen on the head and bluish-black sheen on the back, wings, and tail (Baker 1951). The crow, which is endemic to Guam and Rota, prefers native limestone forest for breeding and foraging, but it will forage in other habitats such as beach strand vegetation and coconut groves (Baker 1951, USFWS 2005b). This species is an omnivorous, opportunistic feeder that is known to feed on insects, lizards, bird eggs, hermit crabs, fruits, and seeds. On both Guam and Rota, Mariana crow nests have been found almost exclusively in the native tree species, such as *Elaeocarpus joga* and *Ficus prolixa*, which also serve as the primary sources for foraging. Nesting is reported to occur year-round on Rota with a peak between August and February, but typhoons have a significant effect on the breeding season (Morton et al. 1999). Nesting on Guam was generally recorded from October to mid-April (Morton 1996, USFWS 2005b).

Mariana crow
Source: M.P. Warner/DAWR

On Guam, Mariana crows have historically been found throughout forested areas and were considered common enough to be agricultural pests, even into the early 1960s (Seale 1901, Baker 1951). A USFWS survey in 1981, however, estimated only 357 crows, mostly in the northern limestone forest and mixed forest areas (USFWS 2010a). The last native Mariana crow on Guam likely disappeared between 2002 and 2003 (USFWS 2005b). In 2007, 10 crows translocated from nearby Rota or mainland zoos, remained on Guam, restricted in distribution to the northern cliff forests on Andersen AFB (USFWS 2010a). A survey conducted by SWCA from June 2007 until April 2008 indicated the Mariana crow population diminished from an estimated 10 individuals observed in 2006 to two males and one female. The female was sighted only once during the study (SWCA 2008). Surveys in 2010–2011 by SWCA found only a single male on Andersen AFB. The last remaining crow was most recently observed in July 2011 and heard in August 2011 (SWCA 2012). There have been no observations of the crow since then and it is believed to have died.

The Mariana crow is listed as endangered under the Federal ESA, and the ESA of Guam (USFWS 1984); critical habitat has been designated for this species (USFWS 2004a) at the GNWR. Forested habitats on JRM lands are important to the long-term conservation of the Mariana crow. In 2004, 10,838 acres (4,386 hectares) of Air Force lands, and 7,977 acres (3,228 hectares) of Navy lands were identified as essential to the recovery of the species, but were exempted from critical habitat designation under Section 4(a)(3) of the ESA, as amended by Section 318 of the fiscal year (FY) 2004 National Defense Authorization Act (P.L. No: 108–136) (USFWS 2004a). Predation by introduced brown treesnakes, rats, and monitor lizards; habitat loss and destruction, particularly of the native tree species *E. joga* and *F. prolixa*; and human persecution are responsible for the dramatic decline of the crows (USFWS 2005b).

White-throated ground-dove. The white-throated ground-dove (Paluman apåka' [male]/ Paluman fache' [female] in Chamorro) is roughly the size of a rock dove. Males and females are dimorphic in coloration as described by Baker (1951). The male forehead, face, chin, throat, and upper breast is white, washed with a pale buff, and sides of the head and nape are rusty- to pale-brown. The rest of the upper body is brown as are the underparts. Females are smaller, their head and neck are brown, and darker than the underparts with more rufus coloration. The underparts are more of a tawny cinnamon-brown. This species prefers the deep jungle and feeds on small seeds and berries found on the ground. Because of the difference in appearance between male and female ground doves, there are two Chamorro names for this species. The white-throated ground-dove has been recorded on every island in the Mariana from Guam to Asuncion; however, the population on Guam has been extirpated due to predation by the brown treesnake. A Ground-dove was heard on Andersen AFB by SWCA in 2011 surveys (SWCA 2012). Occasional individuals have been observed in recent years and are likely a result of immigration from neighboring Rota. The white-throated ground-dove is not a federally listed species, but it has been listed as endangered by the Guam ESA.

Mariana common moorhen. The Mariana Island subspecies of the common moorhen (Pulattat in Chamorro) resembles other moorhen subspecies found throughout the world. Moorhens in the Mariana Islands are found primarily in freshwater man-made and natural wetlands that are both seasonal and permanent. Occasionally, they are recorded in brackish water wetlands. Wetlands that support about equal amounts of emergent, submergent, or floating vegetation and open water are more suitable to moorhens for feeding and nesting than wetlands that are predominately open water, or that support mostly emergent wetland vegetation (Ritter and Savidge 1999). It should be noted, however, that the amount of emergent vegetation preferred by Mariana common moorhens depends on the size of the wetland, not just a preference for equal amounts of emergent vegetation and open water.

Mariana common moorhen
Source: S. Vogt

Islandwide surveys for the endangered moorhen were conducted on Guam and the CNMI from May through September 2001. Based on these counts, the total adult moorhen population was estimated to be 287, with 154, 41, 2, and 90 adult moorhens on Saipan, Tinian, Rota, and Guam, respectively. The results suggested an overall increase in birds on Saipan and Tinian, although moorhen numbers on Guam could be declining (Takano and Haig 2004). On Guam, this species occurs or potentially occurs at Fena Reservoir and other seasonal and perennial wetlands (Takano and Haig 2004).

The Mariana common moorhen was listed as endangered in 1984 (USFWS 1984); no critical habitat has been designated for this species. Declines in the moorhen population are attributable to invasive vegetation, introduced predators, and degradation of wetlands by feral ungulates and humans (USFWS 1991b). Recent changes to the nonnative and invasive aquatic vegetation at Fena Reservoir have caused a decrease in the number of moorhen at the reservoir (A. Brooke, Navy, personal communication).

Micronesian megapode. The Micronesian megapode was federally listed as endangered in 1970 (DOI 1970). Megapodes have been recorded on 11 of the CNMI islands (USFWS 2011) although large densities occur only on a few uninhabited northern islands. Megapodes were extirpated from Guam and Rota historically, and are believed extirpated from Anatahan by recent volcanic eruptions.

The megapode is a medium sized bird weighing up to 350 grams (12 ounces), with a dark brown/black body and a silver/grey head (Jones et al. 1995). The bird characteristically has large yellow feet that are

used, much like a chicken, to scratch in the soil and litter for invertebrate prey (Jones et al. 1995). Megapodes do not incubate eggs with body heat; instead, eggs are incubated by decompositional, geothermal, or solar heat (Jones et al. 1995). The eggs are buried in a substrate and incubation heat is generated by decomposing litter, volcanic vents, or solar heated soil (Jones et al. 1995).

Guam rail. The Guam rail (ko'ko'in Chamorro) is fast-running and flightless, and is characterized by a laterally compressed, elongated body, allowing it to escape into dense vegetative cover (Baker 1951, Jenkins 1979). This species was widely distributed across various habitats on Guam, including forest, savanna, scrub, secondary grassland, fern thickets, and agricultural areas (but not in freshwater wetland habitats). The Guam rail is an omnivorous feeder, consuming snails, slugs, insects, geckos, vegetable matter, seeds, and flowers from low grasses and shrubs, but it appears to prefer animal over vegetable food (Jenkins 1979).

Guam rail
Source: M.P. Warner/DAWR

Along with most other indigenous species, population levels began to decline in 1968, and a 1981 population count determined that approximately 2,000 rails remained on the island (Engbring and Ramsey 1984). By July 1985, only one rail could be located in the flightline area of Andersen AFB; by 1987, the species had been extirpated from the wild (USFWS 1990a). Captive breeding started in 1984. Since 1987, efforts have been underway to establish a self-sustaining, experimental population on the nearby brown treesnake-free Island of Rota. In 1999, birds bred there for the first time. Guam rails were experimentally released in 1998 and again in 2003 on Andersen AFB. This population of rails was preyed upon by feral cats, and the small size of the release area resulted in an approximately 80 percent mortality rate for the population. On November 16, 2010, 16 Guam rails were released on Cocos Island by GDAWR. Rats have been eradicated from the island, and there are no known cats or snakes on the island. In addition, the forest has been enhanced by removing invasive vines. These factors make successful establishment of a population of the birds on Cocos Island more viable.

The Guam rail was listed as endangered under the Federal ESA and the ESA of Guam in 1984 (USFWS 1984), but critical habitat has not be designated for this species. The experimental population of Guam rails on Rota is designated nonessential under the ESA.

Guam Micronesian kingfisher. The Guam Micronesian kingfisher (Sihek in Chamorro) is a medium-sized bird with short legs and a straight, heavy beak. Males and females are dimorphic. Males have a rusty-brown head, neck, upper back, and underparts. Females are similar to the males except their chin, throat, and upper breast are paler, and the rest of their underparts and underwing coverts are white. Both sexes have blue-green back feathers, lesser wing-coverts and tail, and a dark-colored orbital ring that encircles the head behind the eyes (Baker 1951). Kingfishers are noted for their raucous calls, used to defend their territories, which cover several acres. The Guam Micronesian kingfisher preys on insects and small vertebrates and builds nests in cavities of rotting mature trees, such as umumu (*Pisonia grandis*), breadfruit, and coconut.

Guam Micronesian kingfisher
Source: Philadelphia Zoo

The Guam Micronesian kingfisher is endemic to Guam and inhabited mature limestone forests, mixed woodlands, secondary growth stands, and scrub forests of the northern plateau (Jenkins 1983), coconut

forest, and riparian forest (USFWS 1990a). The population was estimated at 3,000 birds in a 1981 survey (Engbring and Ramsey 1984), but rapidly declined due to predation by the brown treesnake. By 1988, the Guam Micronesian kingfisher was extirpated and held in captivity (Wiles et al. 2003). As of 2008, 60 male, 36 female and 4 unsexed kingfishers were living in 17 captive propagation facilities on the mainland United States and Guam (USFWS 2008). The Guam Micronesian kingfisher was listed as an endangered species under the Federal ESA in 1984 (USFWS 1984) and is also listed as endangered under the ESA of Guam (Guam Public Law 15-36). Forested habitats on Andersen AFB are important to the long-term conservation of the Guam Micronesian kingfisher. In 2004, 10,838 acres (4,386 hectares) of Air Force lands, and 7,977 acres (3,228 hectares) of Navy lands were identified as important to recovery of the species, but were exempted from critical habitat designation under Section 4(a)(3) of the ESA, as amended by Section 318 of the FY 2004 National Defense Authorization Act (P.L. No: 108–136) (USFWS 2004a). However, critical habitat for the Guam Micronesian kingfisher is present on the GNWR.

Guam broadbill. This Guam broadbill (Chuguangguang in Chamorro) was a small flycatcher weighing approximately 0.4 ounces (12 grams) that was endemic to the Island of Guam. Although once widespread in all but grassland habitats, by 1983 the Guam broadbill was restricted to a small area on the north coast and was estimated at fewer than 100 individuals. The primary cause of the decline was predation by the brown treesnake. The last sighting of this species was in 1984. The Guam broadbill was federally listed as endangered in August 1984 (USFWS 1984), but was proposed for delisting in January 2002 due to extinction (USFWS 2002b). Designation of critical habitat for the species was proposed by the USFWS in 1991 (USFWS 1991a) and withdrawn in 1994 (USFWS 1994a). A recovery plan for the Guam broadbill was published in 1990 (USFWS 1990a); however, because the species is likely extinct, no recovery objectives were established other than to capture donor stock and establish a captive breeding population, if possible. The Guam broadbill was delisted on February 24, 2004, because all available information indicates that it is extinct (USFWS 2004a).

Guam bridled white-eye. The Guam subspecies of the bridled white-eye (Nosa'in Chamorro) was endemic to Guam and was one of two subspecies in the Mariana Islands. It weighed approximately 0.3 ounces (10 grams). The bridled white-eye was recorded historically in virtually all habitats at all elevations on Guam. By 1983, however, the population was restricted to northern Guam and was thought to have dropped below 50 individuals. The last family group was observed in 1982, and the last individual observed in 1983. The primary cause of the decline was predation by the brown treesnake.

The Guam subspecies of the bridled white-eye was listed as endangered in August 1984 (USFWS 1984), however, there is a likely possibility that this species is extinct (USFWS 2002a). Designation of critical habitat for this species was considered twice by the USFWS, once in 1991 (USFWS 1991a) and again in October 2002 (USFWS 2002a), but found not to be prudent because the Guam subspecies is likely to be extinct. A recovery plan for the species was published in 1990 (USFWS 1990a), however, because the subspecies is likely extinct, no recovery objectives were established other than to capture donor stock and establish a captive breeding population, if possible.

Reptiles

Snake-eyed skink. The snake-eyed skink (Guali'ek halom tåno' in Chamorro) is a slender tan to brown skink with a snout-to-vent length (SVL) of 1.75 inches (45 millimeters). It has a mottled pattern, sometimes appearing as spots or lines (Vogt and Williams 2004); sides are dark with light-colored flecks. It's known from most of the Mariana Islands, and is found mostly near the coast. It is found on the ground, in bushes, or in trees depending on location. The common name for the skink comes from the clear, immovable eyelids that make it snake-like in appearance. It prefers loose or sandy soil, so the eyes might be an adaptation to burrowing (Vogt and Williams 2004). Diet consists of small insects. The snake-eyed skink is not a federally listed species, but it is listed as endangered by the Guam ESA.

Tide-pool skink. The tidepool skink (Guali'ek kanton tåsi in Chamorro) is a larger skink with an SVL of 3.3 inches (85 millimeters) and a black-and-tan coloration in a mottled pattern. It is recorded from Guam, Aguiguan, Rota, Saipan, and Alamagan. On Guam, it is currently only known from Cocos Island off the southern coast where it is reported to be abundant, but it is seldom observed on the south side of the island (Vogt and Williams 2004). It can be found along coastal areas, climbing on rocks and strand vegetation. It will often jump into saltwater pools to escape predators. Diet likely consists of insects and small invertebrates. The tide-pool skink is not a federally listed species, but it is listed as an endangered species by the Guam ESA.

Azure-tailed skink. The azure-tailed skink (Guali'ek halom tåno' in Chamorro) is similar in appearance to the more common blue-tailed skink. This species is reported to be endemic to Guam, having been formerly reported from the Geus River watershed in southern Guam (GDAWR 2006a). Currently, this species is only found on Cocos Island, off the southern coast of Guam. The current status of the population is not known. The azure-tailed skink is not a federally listed species, but it is listed as an endangered species by the Guam ESA.

Slevin's skink. Slevin's skink (Guali'ek halom tåno' in Chamorro) is a large skink with a SVL of 3 inches (75 millimeters) and an olive- or brown-colored body with black flecks on the back. The belly is orange-tinted in larger specimens. It is a skink of the forest floor, and has been recorded on most of the Mariana Islands. Slevin's skink is the only reptile species endemic to the Mariana Islands. On Guam, this species was last recorded on Cocos Island, but has not been recorded there or elsewhere on Guam since the 1990s (Vogt and Williams 2004). Archaeological evidence suggests that this species was once one of the more common species in the Mariana Islands. It is speculated that the introductions of nonnative lizards and predators are the cause for this species' decline. The disappearance of Slevin's skink from Cocos Island roughly correlates with the arrival of the nonnative curious skink; however, there is no firm evidence to support that correlation (Vogt and Williams 2004). Slevin's skink is not a federally listed species, but it is listed as an endangered species by the Guam ESA.

Moth skink. The moth skink (Guali'ek halom tåno' in Chamorro) is a small brown to tan skink with a SVL of 2 inches (55 millimeters). There is a dark line with light colored flecks on either side of the body to the hind limbs. A yellow spot on the head continues down the back in the form of a light-colored strip ending at the base of the tail. Belly coloration is yellow to orange. This species is found across much of the western Pacific, but Guam is the only island this species has been recorded from in the Mariana Islands. It is found on the ground or low trees in native forest, often near *Pandanus* sp. It is the only lizard in the Mariana Islands to give birth to live young (Vogt and Williams 2004). Diet consists primarily of ants. The moth skink is not a federally listed species, but it is listed as an endangered species by the Guam ESA.

Pacific slender-toed gecko. The Pacific slender-toed gecko (Guali'ek in Chamorro) is a grayish-colored gecko with dark cross banding and a large head in relation to its body. It has straight toes that lack toe pads and has a series of bumps in lengthwise rows running down the back. It has an SVL of 2.75 inches (70 millimeters). It is nocturnal and terrestrial, preferring rocky areas, but will climb tree trunks (Vogt and Williams 2004). This species is entirely female, reproducing by parthenogenesis (essentially cloning itself). It is known to occur throughout the western Pacific, and in the Mariana Islands it has been recorded on Guam, Rota, Anatahan, Alamagan, and Sarigan. It is not a federally listed species, but it is listed as an endangered species by the Guam ESA.

Micronesian gecko. The Micronesian gecko (Guali'ek in Chamorro) is a large species with a SVL of 3.5 inches (90 millimeters). It has a greenish-mottled appearance. The tail is flattened laterally with small spines along the lateral edges. The fifth toe on each foot is reduced, giving the appearance of having four toes (Vogt and Williams 2004); this is a key identifying feature for this species. This species was one of the more common lizards in the Mariana Islands in prehistory; declines are thought to be a result of the introduction of competing species like the oceanic gecko, or predatory species like the brown treesnake. This species prefers native limestone forest, but has been documented around man-made structures. The diet is composed of insects. In the Mariana Islands, this species has been recorded from Guam, Rota, Tinian, and Saipan, but might occur on other northern islands in the archipelago. The Micronesian gecko is not a federally listed species, but it is listed as an endangered species by the Guam ESA.

Invertebrates

Insects

Mariana eight-spot butterfly. The Mariana eight-spot butterfly (Ababang in Chamorro) was first described as *Diadema octocula* by Butler in 1869 and subsequently renamed to the current nomenclature by Fruhstorfer in 1912 (Sweezy 1942). The parent species, *Hypolimnas octocula*, has been divided into eight subspecies occurring in the south and west Pacific Islands (Sampson 1986, Tennent 2006). The subspecies, *H. o. marianensis,* the Mariana eight-spot butterfly, is endemic to the Micronesian Islands of Guam and Saipan. Male butterflies are mostly black with a vertical orange stripe across both the fore- and hind-wing. The stripe on the hind-wing exhibits a series of black spots arranged vertically within the orange stripe. Females are overall more orange in color with the same basic pattern.

Habitat requirements for the Mariana eight-spot butterfly have not been described in detail. Schreiner and Nafus (1997) describe this species as inhabiting forest and forest clearings. Campora and Lee (2009) observed an adult butterfly in the upper sunlit canopy of limestone forest. Both host plant species, *Procris pedunculata* and *Elatostema calcareum,* are low-growing herbaceous plants found in limestone forest habitats.

Results of surveys conducted in 1996 found adult Mariana eight-spot butterflies at 3 of 12 survey locations on Guam: Orote Point, Tweeds Cave, and the lower Pagat area. Eggs, larvae, and pupae consistent with those of the Mariana eight-spot butterfly were observed on host plants at these and three additional locations, including Fadian Cove, Hila'an, and the Mangilao Golf Course. Eggs, larvae, and pupae of the Mariana eight-spot butterfly are difficult to differentiate from those of other *Hypolimnas* species on Guam; however, because other *Hypolimnas* on Guam are not host-specific to *P. pedunculata* and *E. calcareum*, life stages found on these host species are likely to be Mariana eight-spot butterfly (Campora and Lee 2009). Surveys conducted in 2009 identified at least one adult Mariana eight-spot butterfly along with eggs, larvae, and pupae in limestone forest along Route 15 in the Pagat area (Campora and Lee 2009). Additional surveys conducted on Andersen AFB in 2011 found 7 adult butterflies, 96 larvae, and 35 eggs within 73 host plant patches on the installation (HDR 2013).

The current population of the Mariana eight-spot butterfly is threatened by habitat alteration, predation, and parasitism. Host plant distribution on Guam has been significantly altered as a result of feral deer and pig browsing. Where feral ungulates are present, host plant populations are generally limited to limestone exposures out of reach of ungulate browsing, typically in "tower karst" areas near cliff edges (D. Janeke, personal observation). Ants were found to be major predators of the Mariana eight-spot butterfly and other *Hypolimnas* species on Guam (Schreiner and Nafus 1996), causing more than 90 percent mortality of Mariana eight-spot butterflies over the course of a one-year study. Native parasitoids have been observed parasitizing the eggs of the Mariana eight-spot butterfly (Schreiner and Nafus 1996) and introduced parasitoids have been found parasitizing related *Hypolimnas* species (Nafus 1992).

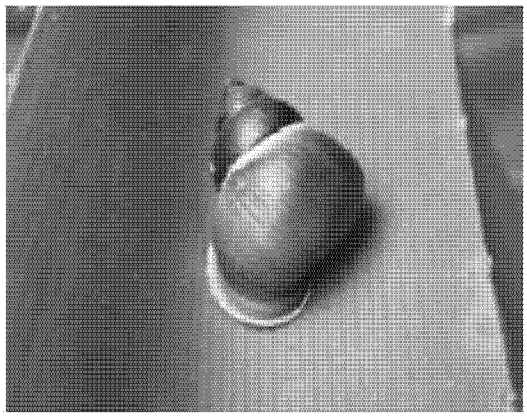
The current population of this species has not been established quantitatively (USFWS 2010b); however, the rarity of this species is alluded to by Schreiner and Nafus (1996) where they state that the maximum number of this butterfly observed in a single day was six. Schreiner and Nafus (1997) later refer to this species as "rare," and Sweezy (1942) was only able to collect a single specimen during his 1936 collection on Guam. The Mariana eight-spot butterfly was designated a candidate for listing as an endangered or threatened species with a priority number of three in 1997 (USFWS 1997). In 2009, the candidate listing status under the ESA for the Mariana eight-spot butterfly was reaffirmed (HDR 2013).

Mariana wandering butterfly. The Mariana wandering butterfly (Ababang in Chamorro) is endemic to the islands of Guam and Rota in the Mariana Archipelago. The overall color of this species is black with an irregular patch of orange color originating at the basal portion of the fore- and hind-wing, extending roughly halfway across the wing. There are no stripes or spots of note on the wings. Larvae of the Mariana wandering butterfly feed on the Mariana endemic shrub luluhut (*Maytenus thompsonii*) (Sweezy 1942).

The butterfly was last collected in Guam in the 1970s and last observed on Rota in 1995 (Schreiner and Nafus 1996) despite the widespread abundance of the host plant luluhut. The decline of the Mariana wandering butterfly populations is not well understood, but alien ants have been found to be major predators of both eggs and larvae of other butterfly species on Guam. In addition, butterfly parasites, some introduced intentionally, might have also contributed to the species' decline (USFWS 2010c). The Mariana wandering butterfly was designated a candidate for listing as an endangered or threatened species with a priority number of two (2) in 1997 (USFWS 1997). It is currently still a candidate for listing as an endangered or threatened species with a listing priority number of two (2) (USFWS 2010c).

Gastropods

Humped tree snail. The humped tree snail (Akaleha' in Chamorro) is so named for the last whorl of its shell which is somewhat enlarged into a hump. This snail has a conical-shaped shell with four to four and a half whorls, and is chestnut brown to whitish yellow or occasionally purple with a white or brown line along the suture between the shell whorls. According to Cowie (1992), the life span of a humped tree snail is about 5 years, with reproduction occurring after the first 12 months. Unlike many terrestrial snails that lay eggs, humped tree snails bear up to 18 live young a year. Adults are hermaphroditic. Crampton (1925) describes the habitat of humped tree snails in the Mariana Islands as having "sufficiently high and dense growth to provide shade, to conserve moisture and to effect the production of a rich humus." Humped tree snails are



Humped tree snail
Source: B. Smith

found in forests of low and high growth, but could be present in any vegetation type which provides the requisite environmental conditions (Crampton 1925). Within the forest structure, snails are typically found within 3 to 9 feet (1 to 3 meters) of the forest floor (Hopper and Smith 1992). They rest on the leaves and stems of bushes and trees during the day, coming out at night to feed on dead and decaying plant material.

The humped tree snail was originally known from nine of the Mariana Islands where it was widespread and abundant. Presently, it is thought to be extirpated from Tinian and Anatahan, the latter due to volcanic activity between 2003 and 2005 (USFWS 2010d). The total population in the Mariana Islands is estimated to number fewer than 2,600 snails (USFWS 2010d). Once the most numerous tree snail species on Guam, humped tree snails continue to decline, currently occurring only at the HERA on the northwestern coast of Guam.

The native snails of the Mariana Islands continue to decline and are threatened by deforestation, introduced predatory snails and flatworms, and alteration of the habitat by feral ungulates (Hopper and Smith 1992, Smith and Hopper 1994, Cowie 2000, Cowie and Cook 2001). The humped tree snail was designated a candidate to be listed as an endangered or threatened species in 1994 (USFWS 1994b) and is still a candidate for listing with a listing priority number of two (2).

Guam tree snail. The Guam tree snail (Akaleha'in Chamorro) has five whorls to its shell and is a pale straw yellow with darker axial rays and brown lines. The species is endemic to the Island of Guam where it was once the second most abundant tree snail species (Crampton 1925). Its biology is similar to that of the humped tree snail and once commonly co-occurred with the humped tree snail (Crampton 1925). Currently, there are 22 known populations of these snails remaining on Guam (USFWS 2010e).

Guam tree snail
Source: B. Smith

The native snails of the Mariana Islands continue to decline and are threatened by deforestation, introduced predatory snails and flatworms, and alteration of the habitat by feral ungulates (Hopper and Smith 1992, Smith and Hopper 1994, Cowie 2000, Cowie and Cook 2001). The Guam tree snail was designated a candidate to be listed as an endangered or threatened species in 1994 (USFWS 1994b) and is currently still a candidate for listing with a listing priority number of two (2).

Mount Alifan tree snail. The Alifan tree snail (Akaleha'in Chamorro) was first collected in 1920 and described by Crampton (1925). Subsequent surveys in the 1940s indicated that this species was endemic to the west-central highlands of Guam in the area of Mount Alifan. It had a thick, heavy shell, more like the Society Island partulid tree snails than the species known from Guam, with 5 to 5.25 whorls. It was chestnut brown in color, turning to purple with age. Surveys for partulid tree snails in 1989 failed to find any living Alifan tree snails in the west-central highlands or elsewhere and the authors considered the species to be extinct (Hopper and Smith 1992).

The native snails of the Mariana Islands continue to decline and are threatened by deforestation, introduced predatory snails and flatworms, and alteration of the habitat by feral ungulates (Hopper and Smith 1992, Smith and Hopper 1994, Cowie 2000, Cowie and Cook 2001). The Mount Alifan tree snail was designated a candidate to be listed as an endangered or threatened species in 1994 (USFWS 1994b)

and is currently still a candidate for listing with a listing priority number of two. There are no known sightings of the species since 1963 (USFWS 1994b).

Fragile tree snail. The fragile tree snail (Akaleha'in Chamorro) has a thin, semitransparent shell with four whorls. The background is buff-colored and tinted by narrow darker maculations and whitish banding derived from the internal organs of the animal that are visible through the shell. Biology of the fragile tree snail is similar to other partulid tree snails in the Mariana Islands except that sexual maturity is reached before maximum shell size and they have relatively large, tough calcareous-shelled eggs which are reabsorbed before giving birth to live young (Crampton 1925). This snail was originally known as a widespread but uncommon species, endemic to Guam and Rota. Only as single colony of fragile tree snails are known to exist on Guam at Pugua Point (Smith et al. 2008). The location of the original fragile tree snail colony observation on Rota has been converted to agricultural fields and no tree snail habitat remains. A new colony was located on Rota by Bauman (1996).

Fragile tree snail
Source: A. Gawel

The native snails of the Mariana Islands continue to decline and are threatened by deforestation, introduced predatory snails and flatworms, and alteration of the habitat by feral ungulates (Hopper and Smith 1992, Smith and Hopper 1994, Cowie 2000, Cowie and Cook 2001). The fragile tree snail was designated a candidate to be listed as an endangered or threatened species in 1994 (USFWS 1994b) and is currently still a candidate for listing with a listing priority number of two.

Marine Species

Marine Mammals

All marine mammals are protected under the MMPA as amended in 1994. In addition to the MMPA, the ESA provides protection to those marine mammals that have been federally listed as endangered or threatened. Federal agency actions that reasonably have the potential to "take" a marine mammal require permission from the appropriate regulatory agency. Take of marine mammals includes harassment. Two levels of harassment were defined in the 1994 amendments to the MMPA: Level A and Level B. *Harassment* is defined in the MMPA as any act of pursuit, torment, or annoyance that has the potential to injure marine mammal stock in the wild (Level A); or has the potential to disturb marine mammal stock in the wild by disrupting behavioral patterns, including migration, breathing, nursing, breeding, feeding, or sheltering (Level B).

Thirty-two marine mammal species have confirmed or possible occurrence in Guam and CNMI (DoN 2005, 2004, 2010), 23 of which are considered to have a regular occurrence in the area (regardless of their abundance); these are all cetaceans. The 23 marine mammal species include the ESA-listed blue whale (*Balaenoptera musculus*), fin whale (*B. physalus*), humpback whale (*Megaptera novaeangliae*), sei whale (*B. borealis*), and sperm whale (*Physeter macrocephalus*). The ESA-listed baleen whale species have a seasonal occurrence (mid-November thru mid-May) in the Mariana Archipelago, making migrations to feeding areas in higher latitudes (DoN 2005, DoN 2010). Since deep waters come close to shore around Guam and CNMI, it is possible that deepwater marine mammal species (those occurring along and seaward of the shelf break) would make their way into waters within a few kilometers of shore. For example, a group of sperm whales, including calves and a large male, was seen within 1.9 miles (3

kilometers) of Apra Harbor (DoN 2005, DoN 2010) and a large group of melon-headed whales (*Peponocephala electra*) were observed within Sasanhaya Bay (Rota) (DoN 2005, DoN 2010).

Bottlenose and spinner dolphins (*Tursiops truncatus* and *Stenella longirostris*, respectively) are the most likely marine mammal species to be encountered in the submerged lands offshore out to the 164 feet (50 meters) isobath (e.g., JGPO 2010).

The U.S. Navy prepared a comprehensive compilation of data and literature concerning the protected and managed marine resources for the Mariana Operating Area. The area assessed was south of Pagan and included the waters off of Guam, Tinian, and FDM. Prior to 2007, there was little information available on the abundance and density of marine mammals in the Mariana Islands (DoN 2005, 2004, 2010). The Mariana Islands Sea Turtle and Cetacean Survey (MISTCS) conducted from January through April 2007 in waters around Guam and the Northern Mariana Islands was the first systematic survey effort for marine mammals in this region (DoN 2004, 2010). The surveyed area included waters off Guam and Tinian; however, the northern boundary of the MISTCS survey area was south of Pagan (DoN 2004). Other recent data from this region include marine mammal monitoring efforts associated with Navy training exercises south of Saipan and east of Guam and Rota, and recent (2008) marine mammal sightings off Tinian reported by Minton et al. (2009). A large school of spinner dolphins was sighted in mid-July 2010 during a flyover of the eastern shore of Pagan.

Sei whale. Adult sei whales are up to 60 feet (18 meters) in length and are mostly dark gray in color with a lighter belly (Jefferson et al. 1993). There is a single prominent ridge on the rostrum and a slightly arched rostrum with a downturned tip (Jefferson et al. 1993). Sei whales are most often found in deep, oceanic waters of the cool temperate zone. They appear to prefer regions of steep bathymetric relief, such as the continental shelf break, canyons, or basins situated between banks and ledges (Kenney and Winn 1987, Schilling et al. 1992, Gregr and Trites 2001, Best and Lockyer 2002). Sei whales have a worldwide distribution, but are found primarily in cold temperate to subpolar latitudes, rather than in the tropics or near the poles (Horwood 1987). Sei whales are also known for occasional irruptive occurrences in areas followed by disappearances for sometimes decades (Horwood 1987, Schilling et al. 1992). Scientists estimate that the current worldwide population is about 80,000 individuals. After commercial whaling exhausted all known populations of this species, sei whales in the North Atlantic and North Pacific are considered to be relatively abundant by scientists, but the population in the Southern Ocean remains greatly depleted. During the 19th and 20th centuries, sei whales were targeted (along with blue and fin whales) and greatly depleted by commercial hunting and whaling, with an estimated 300,000 animals killed for their meat and oil. Other threats that affect sei whale populations are ship strikes and interactions with fishing gear, such as traps/pots. The sei whale was listed as an endangered species under Title 50 CFR, Part 17 Appendix A in 1970 (DOI 1970) and under the Federal ESA since its inception in 1973.

Marine mammal surveys were conducted in the waters off of Guam in the winter and spring of 2007, during which eight sei whales were observed (SRS-Parsons 2007).

Blue whale. Blue whales are the largest living animals. Adults in the northern hemisphere reach 75 to 92 feet (23 to 28 meters) in length (Jefferson et al. 1993). Blue whales inhabit both coastal and oceanic waters in temperate and tropical areas (Yochem and Leatherwood 1985). Feeding grounds have been identified in coastal upwelling zones off the coast of California (Croll et al. 1998, Fiedler et al. 1998, Burtenshaw et al. 2004), Baja California (Reilly and Thayer 1990), and off southern Australia (Gill 2002). Blue whales are distributed from the ice edges to the tropics in both hemispheres (Jefferson et al. 1993). Blue whales as a species are thought to summer in high latitudes and move into the subtropics and tropics during the winter (Yochem and Leatherwood 1985). Blue whales were significantly depleted by commercial whaling activities worldwide. In the Southern Hemisphere, preexploitation population

estimates range from 150,000 to 210,000 whales; recent abundance estimates range between 400 and 1,400 whales (NMFS 2008). The primary threats currently facing blue whales are vessel strikes and fisheries interactions. Additional threats that have not been documented but could affect these populations include natural mortality, anthropogenic noise, competition for prey resources, habitat degradation, and vessel disturbance. The blue whale was listed as an endangered species under Title 50 CFR, Part 17 Appendix A in 1970 (DOI 1970) and under the Federal ESA since its inception in 1973.

There is only one known occurrence of blue whale off the coast of Guam near Cocos, but this area is within the known distribution range with a higher probability of occurrence from November to May.

Fin whale. The fin whale is the second-largest whale species, with adults reaching 90 feet (27 meters) in length (Jefferson et al. 1993). Fin whales have a very sleek body, with a pale, V-shaped chevron on the back, just behind the head. The dorsal fin is prominent, but with a shallow leading edge and is set back two-thirds of the body length from the head (Jefferson et al. 1993). The fin whale is found in continental shelf and oceanic waters (Gregr and Trites 2001, Reeves et al. 2002). Globally, this species tends to be aggregated in locations where populations of prey are most plentiful, irrespective of water depth, though those locations can shift seasonally or annually (Payne et al. 1986, Kenney et al. 1997, Notarbartolo-di-Sciara et al. 2003). Fin whales are broadly distributed throughout the world's oceans, usually in temperate to polar latitudes, and less commonly in the tropics (Reeves et al. 2002). Fin whales are distributed across the North Pacific during the summer (May through October) from the southern Chukchi Sea (69° N) south to the Subarctic Boundary (approximately 42° N) and to 30° N in the California Current (Mizroch et al. 1999). During the winter (November through April), fin whales are sparsely distributed from 60° N, south to the northern edge of the tropics, near which it is assumed that mating and calving takes place (Mizroch et al. 1999). The population appears to be declining due to ship strikes, entanglements, and harvesting. The fin whale was listed as an endangered species under Title 50 CFR, Part 17 Appendix A in 1970 (DOI 1970) and under Federal ESA since its inception in 1973. A recovery plan for the fin whale was drafted in 2010 (NMFS 2010b). Critical habitat for the fin whale has not been designated.

There are no occurrence records for the fin whale in the Guam area, but Guam is within the known distribution range for this species.

North Pacific right whale. North Pacific right whales have a robust body shape with an overall body color of black, although many individuals also have irregular white patches on their undersides (Reeves and Kenney 2003). There is no dorsal fin on the broad back. The largest recorded North Pacific right whales are 60 feet (18.3 meters) for females and 54 feet (16.4 meters) for males (Omura et al. 1969). Feeding habitat for right whales is defined by the presence of sufficiently high densities of prey, especially calanoid copepods (Reeves and Kenney 2003). Right whales occur in subpolar to temperate waters. The North Pacific right whale is perhaps the world's most endangered large whale species (Perry et al. 1999, IWC 2001). The North Pacific right whale historically occurred across the Pacific Ocean north of 35° N, with concentrations in the Gulf of Alaska, eastern Aleutian Islands, south-central Bering Sea, Sea of Okhotsk, and the Sea of Japan (Omura et al. 1969, Scarff 1986, Clapham et al. 2004). There are no reliable estimates of current abundance or trends for right whales in the North Pacific. However, the preexploitation size of this stock exceeded 11,000 animals. In the North Pacific, ship strikes and entanglements can pose a threat to right whales. However, because of their rare occurrence and scattered distribution, it is impossible to assess the threat of ship strikes or entanglement to North Pacific right whales at this time. Thus, the estimated annual rate of human-caused mortality and serious injury appears minimal. The reasons for the apparent lack of recovery for right whales in this region are unknown. The right whale was listed as an endangered species under Title 50 CFR, Part 17 Appendix A in 1970 (DOI 1970) and under the Federal ESA since its inception in 1973. In 2008, NMFS separated northern right

whales into two endangered species; the North Pacific right whale and the North Atlantic right whale. A recovery plan is being developed for the North Pacific right whale, and critical habitat was designated for northern right whales in the Pacific in 2006 and redefined for North Pacific right whales in 2008.

There are no confirmed records of the North Pacific right whale in the Micronesia region; however, Reeves et al. (1999) noted the remote possibility of encountering this species here. The highly endangered status of this species necessitates an extremely conservative determination of its occurrence in the Mariana area. There is a low or unknown occurrence of right whales from the coastline to seaward of Guam. Sightings have been made both in waters on and seaward of the shelf off the Hawaiian Islands (Herman et al. 1980, Rowntree et al. 1980, Salden and Mickelsen 1999); the predicted occurrence for the Mariana area reflects the possibility that right whales might be encountered close to shore and in much deeper waters. Right whales are not expected to make their way into lagoons or busy harbors such as Apra Harbor. Right whale occurrence patterns are assumed to be similar throughout the year.

Humpback whale. Humpback whales generally are found during the summer on high-latitude feeding grounds and during the winter in the tropics and subtropics around islands, over shallow banks, and along continental coasts, where calving occurs. There is a low occurrence of humpback whales near the coastlines (excluding harbors and lagoons) in the Mariana Islands. These occurrence patterns are applicable throughout the year, but they are not expected in the area from June through September. Humpback whales in other locales during the breeding season are typically found in insular shelf waters, but can also be found in deeper waters during the breeding season. Potential threats include ship strikes, entanglements, and other anthropogenic impacts. The humpback whale was listed as an endangered species under Title 50 CFR, Part 17 Appendix A in 1970 (DOI 1970) and under the Federal ESA since its inception in 1973. A recovery plan has been drafted for this species (NMFS 1991).

The winter range of the Western North Pacific stock of humpback whales extends, at least occasionally, into the Mariana region (Taitano 1991, Darling and Mori 1993).

Sperm whale. The sperm whale is the largest toothed whale species. Adult females can reach 40 feet (12 meters) in length, while adult males measure as much as 60 feet (18 meters) in length (Jefferson et al. 1993). Sperm whales show a strong preference for deep waters (Rice 1989), especially areas with high sea floor relief. Sperm whale distribution is associated with waters over the continental shelf edge, over the continental slope, and into deeper waters (Hain et al. 1985, Kenney and Winn 1987, Waring and Finn 1995, Gannier 2000, Gregr and Trites 2001, Waring et al. 2001). Sperm whales are found from tropical to polar waters in all oceans of the world between approximately 70° N and 70° S latitudes. During the past two centuries, commercial whalers took about 1,000,000 sperm whales. Despite this high level of "take," the sperm whale remains the most abundant of the large whale species. Currently, there is no good estimate for the total number of sperm whales worldwide. The best estimate, that there are between 200,000 and 1,500,000 sperm whales, is based on extrapolations from only a few areas that have useful estimates. The primary threats to sperm whales include predation by killer whales, whaling, shipping and fishing operations, and anthropogenic noise. The sperm whale was listed as an endangered species under Title 50 CFR, Part 17 Appendix A in 1970 (DOI 1970) and under the Federal ESA since its inception in 1973. A recovery plan has been drafted for this species (NMFS 2010c), and critical habitat has not been designated.

Whaling records demonstrate sightings year-round in the Mariana (Townsend 1935). In June 2001, a group of sperm whales that included a newborn calf was sighted off the west coast of Guam (Eldredge 2003). Sperm whale occurrence patterns are assumed to be similar throughout the year. During the 2007 marine mammal surveys off of Guam, 11 sperm whales were observed (SRS-Parsons 2007).

Sea Turtles

All sea turtle species are listed under the ESA. No critical habitat has been designated for any sea turtles on Guam. NMFS has jurisdiction over sea turtles while they are in the water and the USFWS has jurisdiction over sea turtles on land, including sea turtle eggs, nesting females, and hatchlings on the beach.

Only the threatened green sea turtle and endangered hawksbill sea turtle occur regularly in the nearshore marine region of the Mariana Islands (JGPO 2010). Leatherback sea turtles are infrequently sighted in waters off Guam. Sea turtles are expected to occur year-round in all waters off Guam and CNMI, with the highest concentrations of sea turtles occurring in waters less than 165 feet (50 meters) deep around Guam (DoN 2005).

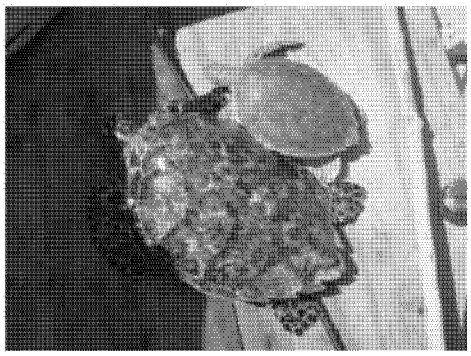
Estimates for sea turtles at Guam are generally lacking. GDAWR conducts aerial surveys that indicate the presence of a year-round population of green sea turtles in Guam's nearshore waters (DoN 2010, JGPO 2010). Aggregations of foraging and resting green turtles are often seen in close proximity to Guam's well-developed seagrass beds and reef flats, which are found in Cocos Lagoon, Apra Harbor, along Tarague Beach and Hilaan, in deeper waters south of Falcona Beach, and at several other locations throughout the island's shelf (DoN 2005). Hawksbill sea turtles have been observed via aerial surveys near river mouths and inside Apra Harbor (DoN 2005). These are areas where sponges, the preferred food of hawksbills, are common. Hawksbill sea turtles have been sighted in Sasa Bay inside Apra Harbor (DoN 2005, DoN 2010).

There is regular, low-density green turtle nesting on Guam (DoN 2005). Sporadic nesting by hawksbills is documented for this island (e.g., DoN 2005, JGPO 2010). Tarague, Falcona, Ritidian, Asiga, Urunao point, and the beaches along Cocos Island and Sella Bay are the most used nesting beaches on Guam (DoN 2005). GDAWR initiated a sea turtle program in 1999 to monitor nesting activity and collect population data (JGPO 2010). Currently, Haggan-watch, a community-based volunteer network administered by GDAWR, opportunistically documents nesting activity.

Loggerhead sea turtle. There are no sighting, stranding, or nesting records for loggerhead turtles around Guam. The nearest occurrences of this species are from the waters off Palau and the Philippines (Sagun et al. 2005). This species is more apt to be found in temperate waters of the North Pacific Ocean (i.e., north of 25° N) off of countries such as Japan, China, Taiwan, northwestern Mexico, and the southwestern United States including Hawai'i (Polovina et al. 2001, 2004), although Guam is identified as being within the species' overall range.

The westward flowing current of the North Pacific Subtropical Gyre system, which late juvenile stage loggerheads use when returning to the western Pacific, passes through the Marianas region (Pickard and Emery 1982, Polovina et al. 2000). As a result, the occurrence of the loggerhead turtle is low/unknown throughout the year in all oceanic waters off the coast of Guam. Since loggerhead occurrences in the waters off Guam would most likely involve transient individuals, occurrence is not expected.

Data are needed for an accurate determination on the trend of this species. The loggerhead turtle is currently listed as a threatened species by the Federal ESA. NMFS and USFWS are proposing to divide loggerhead turtles into nine distinct population segments with two segments to be listed as threatened and seven segments to be listed as endangered (NMFS and USFWS 2010). On September 22, 2011, NMFS and USFWS designated loggerhead turtles in the North Pacific Ocean as a distinct population segment (DPS), and listed that DPS as endangered (76 FR 58868).



Left: Young Hawksbill sea turtle
Right: Young Green sea turtle
Source: DAWR

Green sea turtle. Green turtles are by far the most abundant sea turtle found throughout the Mariana Archipelago. Aerial surveys conducted by GDAWR indicate the presence of a year-round resident population in Guam's near shore waters (NMFS and USFWS 1998a). From 1989 to 1991, green turtles accounted for at least 65.8 percent of all aerial survey sightings around the island (Davis undated). Aggregations of foraging and basking green turtles are often seen in close proximity to Guam's well-developed seagrass beds and reef flats (Davis undated, Wiles et al. 1995, DoN 2003, Abraham et al. 2004). Green turtle nesting on Guam is most prevalent at the northern and southern ends of the island. The population of green sea turtles appears to be stable but data are needed for an accurate determination. Threats to the green sea turtle on Guam include loss of nesting habitat, nest destruction by feral ungulates and dogs, artificial lighting in nesting areas, vehicle use on beaches, and exotic vegetation. The green sea turtle was listed as a threatened species in 1978 under the Federal ESA (NMFS and USFWS 1998a). A recovery plan has been drafted for the Pacific Ocean population (NMFS and USFWS 1998a) and critical habitat has been designated for the species in the Caribbean (NMFS 1998).

Leatherback sea turtle. The leatherback turtle is the least common (NMFS and USFWS 1998b). This species is occasionally encountered in the deep, pelagic waters of the Mariana archipelago, although only a few occurrence records exist (Eckert 1993, Wiles et al. 1995). In 1978, a 113-kilogram (249 pound) leatherback was rescued from waters southeast of Cocos Island, Guam (Eldredge 2003). Leatherbacks do not nest at any of the islands in Micronesia. As a result, leatherback turtles are not expected to occur in coastal (i.e., shelf) waters around any of the islands of the Mariana chain. In oceanic waters beyond the shelf break, leatherback occurrence is low/unknown due to a lack of survey effort in those waters, the weak association between leatherbacks and insular regions of the North Pacific Ocean, and the belief that any leatherbacks encountered in the area would be transient individuals (Eckert 1993, Kolinski 2001). Data are needed for an accurate determination on the trend of this species. The leatherback sea turtle is listed as an endangered species under the Federal ESA (NMFS and USFWS 1998b).

Hawksbill sea turtle. Although there are only a few recent hawksbill occurrence records for Guam (DoN 2005, Michael 2004), historical records indicate a likely presence of this species in the coastal waters surrounding all the islands of the southern Mariana arc (Wiles et al. 1989, 1990, 1995; Kolinski 2001, Gutierrez 2004). The most recent reports of hawksbill nests on Guam are from 2010 (4 nests) and 2009 (3 nests), data from 2011 and 2012 are still being reviewed (S. Wussting DAWR). As a result, hawksbill sea turtles are expected to occur in waters located inside the shelf break, including within Guam's Apra Harbor and Sasa Bay; however, since the species is highly endangered and does not occur in large numbers anywhere within the region, there are no areas of concentrated occurrence around Guam. Only one hawksbill was observed during a 3-month survey effort off the coast of Guam in 2007 (SRS-Parsons 2007). Grimm and Farley (2008) reported that hawksbills are frequently sighted in the nearshore waters surrounding Guam. However, they are less common than green sea turtles (NMFS and USFWS 2007). According to Wiles et al. (1995), as reported in the Navy Biological Assessment, hawksbills represent about 13 percent of turtles sighted around Guam. In deeper waters beyond the shelf break, the occurrence of the hawksbill sea turtle is low/unknown. In these waters, the preferred habitat of the hawksbill is scarce and survey effort is minimal. Around Guam, hawksbill sea turtles feed primarily on sponges and can be seen in coral reefs, harbors, and lagoons where sponges are abundant.

Data are needed for an accurate determination of hawksbill sea turtles. The hawksbill sea turtle is threatened by loss of nesting habitat, nest destruction by feral ungulates and dogs, artificial lighting in

nesting areas, vehicle use on beaches, and exotic vegetation. The hawksbill sea turtle is listed as an endangered species under the Federal ESA (NMFS and USFWS 1998c). A recovery plan for the U.S. Pacific populations of hawksbill sea turtles has been drafted (NMFS and USFWS 1998c) and critical habitat has been designated in the Caribbean (NMFS 1988).

Flora

***Cyathea lunulata* (no English common name).** *Cyathea lunulata* (known as Såtsa in Chamorro) is a tree fern native to Guam. It is not common and has become increasingly rare due to savanna fires that kill the ferns and destroy their habitat. They have also been collected for planting as landscaping plants (Raulerson and Reinhart 1992). Såtsa occurs on volcanic clay soils in southern Guam, typically near the edge of ravine forest and savanna habitats. Mature ferns grow to 16 feet (5 meters) tall with 6.5-foot- (2-meter-) long fronds. Såtsa is not federally endangered, but is listed as endangered by the Guam ESA.

Heritiera longipetiolata
Source: A. Brooke

***Heritiera longipetiolata* (no English common name).** *Heritiera longipetiolata* (ufa-halomtåno in Chamorro) is a buttressed tree growing to a height of 40 feet (12 meters). It grows from limestone, often in the rough limestone terrain of terrace cliffs. This species achieves its greatest height where it occurs in a sheltered location, but typically they are wind-stunted or broken by typhoons (Raulerson and Reinhart 1991). Ufa-halomtåno' is endemic to the Mariana Islands and is an important canopy tree in limestone forests. This species is not federally listed, but it is listed as endangered by the Guam ESA. Primary threats include deforestation and feral ungulate impacts on ufa-halomtåno' seeds and young trees.

Fire tree. The fire tree, or Serianthes, (Hayun lågo in Chamorro) is native to Guam and Rota and can reach 66 feet (20 meters) or more in height with a trunk diameter of nearly 6 feet (2 meters). Leaves are twice pinnate and superficially resemble tangantangan when young. Flowers have numerous prominent stamens, typical of the Mimosoideae subfamily. Fruits are pods, 3 to 5 inches (7 to 12 cm) long, brown in color with constrictions (Raulerson and Rinehart 1991). Type specimens collected in 1916 by Peter Nelson originated in Upe District and Abu. Both locations are now military installations, Andersen AFB and NBG, respectively. Only six adult trees have been recorded on Guam since the 1970s, located in the areas of Ritidian Point, Pati Point, and Tarzan River. At the time of listing as a federally endangered species there were at least two known mature (seed-bearing) trees on Guam in limestone forest at Andersen AFB. In 1992, super typhoon Omar killed one mature tree, but five wild seedlings were observed near the felled native adult tree (Wiles 1992). Protective fencing was erected around the seedlings in an effort to protect them from feral ungulates, but by 1994 only one seedling had survived (USFWS 1994c). In 2002, super typhoon Pongsona partially uprooted this young tree. This tree suffered regular heavy herbivory from butterfly larvae (an unidentified yellow butterfly with green larvae) but was still alive in 2006 (D. Janeke,

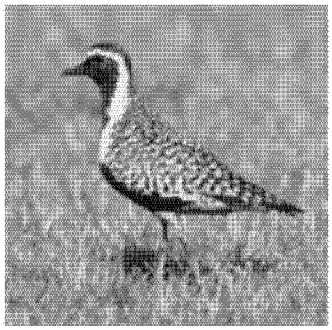
Serianthes nelsonii
Source: DAWR

personal observation). The tree has since died. The remaining original Serianthes is fenced and monitored. Seeds are collected by the Refuge staff and UOG who hold permits. In 1999, 20 fire tree seedlings from Rota were planted as a joint effort by USFWS, UOG, and Andersen AFB in limestone forest along a utility access road in Tarague Basin. Each seedling was protected from ungulate browsing with a wire enclosure. As of 2010, four of the original 20 seedlings were surviving, surrounded by a wire exclosure fence. GNWR collected and propagated Serianthes seeds from both Andersen AFB and Rota in 2008, 2009, and 2010. In 2010, 27 seedlings were outplanted on GNWR and 12 seedlings were outplanted in 2012. Of these, approximately 30 Serianthes outplanted saplings survive on GNWR.

Threats to the fire tree include typhoons, herbivory by feral ungulates, insect infestations, loss of genetic diversity, wildland fire, and damage from other wildlife such as strangler figs and birds or bats that might break branches or strip bark from the trees.

4.1.2.7 Other Species of Interest

Fauna



Pacific golden-plover
Source: DAWR

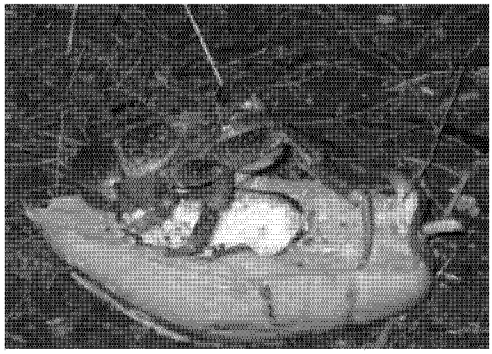
Pacific golden-plover. The Pacific golden-plover (dulili in Chamorro) is Guam's most common shorebird. Each year, this bird arrives by the hundreds from August to October to spend the winter on Guam and then migrates back to Alaska and Russia in April. These birds will eat marine invertebrates and terrestrial insects, and are often found on expansive grassy areas or on beaches throughout Guam. The Pacific golden-plover is the most abundant common shorebird in the Pacific (Engilis and Naughton 2004), and migratory bird surveys on JRM lands indicate that it is common on Guam (NAVFAC PAC 2010b). Populations of Pacific golden-plover appear to be stable.

Brown noody
Source: DAWR

Brown noddy. The brown noddy (fåhang in Chamorro) is a seabird. These birds nest primarily at Orote Point, on buoys in Apra Harbor, and small islets along Guam's southwest and northeast coasts. The birds build their nests of sticks on limestone rocks, cliff faces, and in trees. Since the introduction of the brown treesnake and various rat species, brown noddy populations and nesting have declined. Recent efforts to reduce invasive species on the Glass Breakwater within NBG have provided opportunity for natural resources managers to enhance the habitat for brown noddy. The combination of habitat enhancement and invasive species eradication in this area could lead to the reestablishment of other seabird colonies on Guam. Populations of brown noddy on Guam appear to be in decline. The brown treesnake is the primary threat to brown noddy.

Yellow bittern. The yellow bittern (kakkak in Chamorro) is the only native bird still commonly found on Guam. They are fairly common in Guam's southern savanna, northern forests, and even urban areas. They are excellent hunters and eat mostly geckos, snails, skinks, and insects. These birds serve an important function in controlling reptile and amphibian populations. Populations of yellow bittern on Guam appear to be stable. The brown treesnake has not impacted this species as much as others, but still poses a threat to its viability.

Coconut crab. The coconut crab (ayuyu in Chamorro) is the largest land-dwelling arthropod in the world, weighing up to 9 pounds (4 kilograms), measuring almost 16 inches (41 cm) in length, with a leg span of 3.3 feet (1 meter). Active mainly at night, they are solitary, living in burrows dug in sand, or in rock crevices near the coastline. Breeding occurs on land from May to September, and eggs are carried by females and released into the ocean in October and November during high tide. Their diet consists mainly of fruit, but they will also eat seeds, rotting wood, and carrion. The coconut crab is a regulated species; however, they are often illegally poached throughout Guam. Bait stations are set using coconuts to attract crabs. The current population of coconut crab on Guam is unknown. The primary threat to the coconut crab is overharvesting. Coconut crabs are regulated by GovGuam and harvesting is restricted. In addition to harvesting by humans, feral pigs have been documented to forage on coconut crabs.



Coconut crab
Source: P. Saverie

Humphead wrasse. The humphead wrasse (*Cheilinus undulates*) (tangison in Chamorro) is one of the largest coral reef fishes and occurs patchily throughout much of the Indo-Pacific region. Its late maturity, longevity, predictable spawning sites, sequential hermaphroditism (the fish is born as one sex and changes into the other sex later in its life) and natural rarity make it highly vulnerable to overexploitation. The species has been subjected to largely unmanaged fisheries that have resulted in consistent marked population declines in fished areas where the species is both protected and unprotected, and with localized extirpations at the edges of its range. The population is in decline due to intensive removal for the live reef food fish trade.

Bumphead parrotfish. Bumphead parrotfish (*Bolbometopon muricatum*) (atuhong in Chamorro) are the largest of all parrotfishes, growing to 4 feet (1.2 meters) in length and 100 pounds (45 kilograms) in weight. Adults are a dull green, with the front of the head pale yellowish to pink, while juveniles are greenish to brown with five vertical rows of small whitish spots (Randall 2005). The species has a very large range, but population sizes have been declining throughout due to overexploitation. The species has nearly disappeared from Guam's reefs. They are highly desired throughout their range and have declined from overharvesting in most places. Overfishing by net and spear is the primary threat to this species. Loss of habitat is also attributable to their decline.

Giant clam. Giant clams (*Tridacna* spp.) (hima in Chamorro) are culturally significant and are considered a prized delicacy. Guam is known to have had at least six kinds of giant clam: *Tridacna maxima*, *T. derasa*, *T. crocea*, *T. squamosa*, *T. gigas*, and *Hippopus hippopus*. The latter two species are believed to be extirpated on Guam, probably due to overharvesting. On Guam, giant clams can only be taken for consumption from April through July in designated areas, and commercial harvest is prohibited by law. Despite the demise of these species, harvesting still occurs. These clams are important for coral reef health because they help stabilize the substrate and improve water quality. A relocation program for giant clams was attempted in Apra Harbor; however, the clams were quickly taken by recreational divers. More data are needed; however, the population appears to be in decline. Human harvesting is the primary threat to this species.

Flora

***Tabernaemontana rotensis* (no common name).** *Tabernaemontana rotensis* is a small native tree to Guam and Rota that was proposed as federally listed endangered in June 2000 (USFWS 2000). In May 2004, based in part on a public comment by the USAF, the USFWS reexamined the basis of recognition

of *T. rotensis* as a distinct endemic species on Rota and Guam, and decided to not list this species as endangered (USFWS 2004b). The USFWS discovered that in an authoritative monographic work on the genus in the Old World, *T. rotensis* was submerged in an expansive interpretation of the widespread species *T. pandacaqui*, which was originally described from the Philippines, but that in Leeuwenberg's interpretation ranges from southern China to Australia and includes several dozen previously recognized species (Leeuwenberg 1991). Differences of this sort are not uncommon regarding species or groups of related species that have broad and discontinuous ranges. The USFWS reexamined the basis for recognition of *T. rotensis* as a distinct endemic species and now considers Leeuwenberg's treatment to be the most credible taxonomic interpretation of the native *Tabernaemontana* of Guam and Rota. Based on the current USFWS understanding of its taxonomy, it does not qualify for protection under the Federal ESA. If further information becomes available that supports recognition of an endemic taxon, the USFWS will reconsider the need to list (USFWS 2004b).

Tabernaemontana rotensis
Source: DAWR

Habitat for this species (or habitat necessary for the species survival) occurs in limestone forests on Guam and lowland dry forest on Rota. It grows to heights of 20 feet (6 meters) and is rather weak and spindly in appearance. A comprehensive survey of T. rotensis on Andersen AFB in 2006 indicated that 40 to 80 percent of the trees observed were in some stage of flowering throughout the year in the absence of typhoon disturbance (UOG 2007). An increase in flowering was noted in August and October.

A survey conducted by the UOG identified 21,669 *Tabernaemontana* individuals throughout Andersen AFB. These individuals occurred in an aggregated spatial distribution, revealing a clumped pattern within 265 specific sites. The average number of individuals at each site was approximately 80, with one site containing 850 individuals (UOG 2007).

The primary threat to this species on Guam is the lack of reproductive vigor and seed distribution due to a reduced number of individuals and reduced number of potential bird pollinators. Other key threats include competition with nonnative vines such as bitter melon (*Momordica charantia*), mile-a-minute (*Mikania micrantha*), and wild passionfruit (*Passiflora suberosa*); insect infestations; and browsing or trampling by feral ungulates.

Seeded Breadfruit. The seeded breadfruit (dukduk in Chamorro) is native to the Mariana Islands and Palau and is closely related to the seedless breadfruit (*A. altilis*). It is found in limestone and ravine forests from coastal to lower mountain slopes. The seeded breadfruit is distributed through its natural range primarily by fruit bats. The tree is single-trunked with a rounded, spreading evergreen canopy. The tree forms buttresses at its base. This species is an important canopy tree in limestone forests. Censuses conducted from 1989 to 1999 showed a dramatic decline of 65 percent in the population as a result of typhoon damage and a nearly complete lack of recruitment due to excessive seed predation and herbivory by feral deer and pigs (Wiles 2005).

Blue Marble Tree. The blue marble tree (*Elaeocarpus joga*) (known as joga in Chamorro) is a large tree up to 45 feet tall (14 meters) with distinctive horizontal and pagoda-like branching. It grows in limestone soils in open areas, or in forests and has a spherical bright blue fruit. This species is one of the dominant trees in the remaining limestone forest. The population appears to be stable or declining, but more information is needed to make an accurate assessment. Primary threats include deforestation, feral ungulates, and invasive species.

Cycad. Guam's native cycad, (*Cycas micronesica*) (fadang in Chamorro), was the most abundant tree in Guam's forest in 2002. Cycad aulcaspis scale arrived on Guam in late 2003 on ornamental plants and rapidly moved to plants in the native forest. By 2009 no seedlings or young cycad plants survived and 75 percent of mature trees had died. A bio-control beetle (*Rhyzobius lophanthae*) that preys on cycad scale (*Aulacaspis yasumatsui*) was introduced in 2005 and initially appeared to control the scale. However, the cycad blue butterfly (*Chilades pandava*) also arrived on Guam in 2005. The combined attack from cycad aulcaspis scale and cycad blue butterfly elicited such rapid plant mortality that the species went from being the most abundant to listed as endangered by GovGuam and the International Union for Conservation of Nature. Few seeds are now produced by the weakened plants, no new seedlings survive and the population is approaching extirpation. The scale and butterfly have spread throughout Guam's forest and to the islands of Rota and Palau.

Cycas micronesica
Source: A. Brooke

Screwpine. Screwpine (kafu in Chamorro) is native to Micronesia, and is found throughout the islands of the tropical Pacific to Hawaii. Trees grow to 25 feet (8 meters) tall and produce round, edible fruits, which are eaten and dispersed by fruit bats. This species has been used by native peoples for food, dental floss, flavoring for sweet dishes, medicine, thatch roofs, and clothing. In other regions, hermit crabs, scales, fungus, and loss of habitat all pose threats to kafu. More data are needed to assess the threats to this species on Guam.

4.1.2.8 Invasive Species

An invasive species is defined in EO 13112, *Invasive Species*, as a species that is nonnative (i.e., alien or exotic) to the ecosystem under consideration and whose introduction causes or is likely to cause economic or environmental harm or harm to human health. Invasive species can be plants, animals, or other organisms (e.g., microbes). Human actions are the primary means of invasive species introductions. Invasive species have had a catastrophic effect on the native flora and fauna of Guam. Attributes of island biota include small geographic ranges and population size, low reproductive rates, and lack of the ability to coevolve with invasive species and disturbed habitats. Islands typically have lower numbers of species than mainland areas, which results in fewer predators that would prey upon invasive species, and fewer species to compete with invasive species for resources; thereby, increasing the likelihood for establishment of invasive species on the island. As a result of evolving in isolation, island plants and animals have few defenses when exposed to introduced competitors and predators. These limitations on Guam have resulted in replacement of many island species by exotic and invasive species (Wiles et al. 2003).

Many of the native species on Guam are imperiled due to introduced predators, such as the brown treesnake, feral cats and dogs, and introduced ungulates such as the Philippine deer and feral pig. Other species such as the black drongo are competitors for nesting and foraging sites and also prey on other birds. Several species of rats, including the brown rat, black rat, and Polynesian rat, have colonized the island and also prey on the eggs and young of native species and destroy native flora (USAF 2009).

A biosecurity plan for Micronesia is being developed to address the risk pathways of invasive species and how to implement measures to combat their potential invasion. The Micronesia Biosecurity Plan is being developed in phases. Phase I is the risk analysis. Risk analyses were developed by the Smithsonian for marine resources, USDA APHIS for terrestrial resources and USGS for freshwater resources. The

University of Guam is working with local experts to develop a strategic implementation plan (Phase II). The draft Strategic Implementation Plan is to be submitted in January of 2014. The INRMP will be updated to reflect the elements of the MBP that are applicable to military operations.

Flora

Invasive plant species have impacted all terrestrial environments and have limited the ability of native plants to sustain significant populations. These species are generally very aggressive and can displace native vegetation for resources. Disturbances due to human activity, feral ungulates, or other causes create areas vulnerable to the establishment of invasives. Wildland fires are often intentionally set on Guam. Fires can erode forest edge and increase the spread of both native grasses (such as swordgrass) and non-native invasive species. Although many invasive plant species are present on Guam, a few species are of particular concern to JRM natural resources staff due to their abundance, aggressive growth, and invasion of native habitats. All of the species discussed in the following paragraphs are abundant on Guam and are threatening native species and habitats (U.S. Navy 2009).

Chromolaena. Chromolaena (*Chromolaena odorata*), also known as Siam weed, grows in dense stands, outcompeting native species. It also prevents the establishment of other species via allelopathy. Chromolaena is a skin irritant and an allergen. The establishment of this species can lead to uncontrollable brushfires (U.S. Navy 2009).

Indian snakeweed. Indian snakeweed (*Stachytarpeta indica*) grows aggressively in disturbed areas, such as along roadsides. It is also known to grow in rice fields and coconut plantations (U.S. Navy 2009).

Giant sensitive plant. Giant sensitive plant (*Mimosa diplotricha)* is more of a problem for cultivated areas and grasslands. It smothers other plants by growing over the top of them. Once established, giant sensitive plant can prevent animals from using the natural forage (U.S. Navy 2009).

Mile-a-minute vine. Mile-a-minute vine (*Mikania scandens*) grows at rates up to one inch (3 cm) per day. It overtakes other plant communities by smothering them and blocking out sunlight. It also releases chemicals to inhibit other plants growth (U.S. Navy 2009).

Chain-of-love vine. Chain-of-love vine (*Antigonon leptopus*) smothers other plant communities by blocking sunlight. It also produces large quantities of seeds, that are spread by water and animals that consume the fruits (U.S. Navy 2009).

Mission grass. Mission grass (*Pennisetum polystachion)* competes with native plant species, especially on open hillsides. Mission grass can act as a host for the maize streak virus. Well-established populations can serve as a fuel source for brushfires (U.S. Navy 2009).

Common bamboo. Common bamboo (*Bambusa vulgris*) grows in very dense clumps displacing native vegetation. It also spreads rapidly by its rhizomes (U.S. Navy 2009).

Burr marigold. Burr marigold (*Bidens alba*) is abundant in disturbed areas on Guam. It is extremely common in waste grounds and at the fringes of forest, at times forming dense thickets nearly 3 feet (1 meter) tall (Stone 1970).

Burr grass. Burr grass (*Cenchrus echinatus*) is common in disturbed sites, particularly near the ocean, on beaches, and on limestone soils. It colonizes bare or open ground, quickly filling gaps in cultivated fields, abandoned fields, pastures, field margins, along roadsides, in lawns, on dunes, along river sands, and in sandy soils along beaches. The plants can withstand repeated defoliation in lawns, in frequently harvested forage crops, or in pastures (Holm et al. 1977).

Seaside clerodendrum. Seaside clerodendrum (*Clerodendron inerme*) has aggressive growth characteristics, produces numerous seeds, and can naturalize in places where it is planted. It has the potential to form dense brambles smothering other plants. Invasion is most likely to occur in coastal sites, where it thrives (U.S. Navy 2009).

Phragmites. Phragmites (*Phragmites karka*) is a native, but invasive wetland reed that forms dense, monotypic stands (U.S. Navy 2009).

Tangantangan. The tangantangan (*Leucaena leucocephala*) tree grows in dense thickets, often so thick that it replaces naturally occurring ecosystems, leaving disturbed ground areas unusable and inaccessible. This species is wind-dispersed and spreads and establishes easily on disturbed soils such as road edges and clearings (U.S. Navy 2009).

African tulip tree. The African tulip tree (*Spathodea campanulata*) invades agricultural areas and natural ecosystems. This evergreen smothers other trees and crops, often becoming the dominant plant in the area. It rapidly spreads by sending up shoots from its roots and is considered one of the 100 most invasive plants worldwide (U.S. Navy 2009).

Vitex. Vitex (*Vitex parviflora*) is a Philippine species that was introduced to Guam prior to 1970 (Stone 1970) and has since become a common component of its forests (NAVFACPACIFIC 2010b). Vitex quickly establishes in disturbed areas displacing native vegetation. This tree produces numerous seeds which are spread by birds, Philippine deer, feral pigs, and other animals.

Vitex negundo var. *bicolor* also occurs on Guam, but it is believed to be a native species and is not invasive (Stone 1970).

Limeberry. Limeberry (*Triphasa trifolia*) is a common, naturalized shrub of limestone forests, often forming dense, spiny thickets of undergrowth. This species flowers on Guam and spreads by sprouting from roots (U.S. Navy 2009).

Bay rum. Bay rum (*Pimenta racemosa*) occurs in dry and moist forests, and in open areas.

Custard apple. Custard apple (*Annona reticulata*) forms dense, monotypic stands which displace native vegetation. It also is a prolific fruit bearer, accelerating seed dispersal (U.S. Navy 2009).

Hydrilla. *Hydrilla* sp. is a submerged aquatic plant that can grow to the surface and form dense mats. Hydrilla can grow in almost any freshwater environment, in water depths ranging from a few inches to more than 20 feet (6 meters). Hydrilla out competes native submerged plants by shading or crowding out these species. It can greatly slow water flow and interferes with boating and fishing. Dense hydrilla infestations can alter water chemistry and oxygen levels (Ramey 2001). Hydrilla occurs in freshwater bodies on Guam, including the Fena Reservoir and several streams (U.S. Navy 2009).

Fauna

Birds

Black drongo. The black drongo (*Dicrurus macrocercus*) was introduced to the Island of Rota to control agricultural insect pests and immigrated to the Guam where it has become a nuisance species (GDAWR 2005). It can be taken by any legal means during regulated times, in accordance with Guam law, year round. The black drongo occurs primarily in developed areas (U.S. Navy 2009).

Black francolin. The black francolin (*Francolinus francolinus*) was introduced to Guam from India in 1961. Francolins are a type of game bird, which means they are hunted for sport and food. The black francolin has done well on Guam. They are found throughout the southern and central portions of the island and parts of the north. They live in fields with tall grass and are most common in savanna and agricultural areas of southern Guam. They eat seeds and insects, including those that damage crops (GDAWR 2012).

Blue-breasted quail. Blue breasted quail (*Coturnix chinensis*) are now uncommon on Guam.

Eurasian tree-sparrow. The Eurasian tree-sparrow (*Passer montanus*) lives in highly disturbed, urban areas surrounded by automobiles, predatory domesticated animals, and fragmented habitat. Its numbers are relatively low due to predation by the brown treesnake (GDAWR 2005, USGS 2012).

Rock dove. Rock doves (*Columba livia*) were at one time abundant in urban and commercial areas; today they are considered uncommon on Guam (USGS 2012).

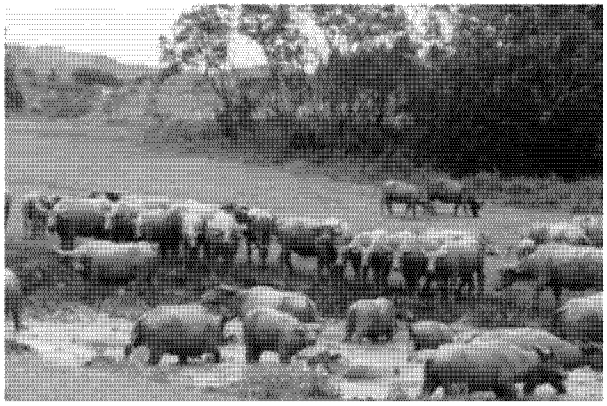
Island collard dove or Philipine turtle dove. The island collard dove (*Streptopelia bitorquata*) is a habitat generalist that has been found to suffer nest losses of 74–93 percent attributed to brown treesnakes. Its high reproductive output and ability to use a wide spectrum of nest sites and feeding ranges has allowed the island collard dove to persist on Guam. Poor nesting success demonstrated by studies done in 1984 and 1986, raise doubts as to this species' continued survival on Guam. Their numbers have declined 80–90 percent or more throughout Guam (GDAWR 2005, USGS 2012).

Feral chicken. The feral chicken (*Gallus gallus*) is commonly found on several Pacific islands. It is sometimes raised by residents as a fighting chicken, but its population has diminished on Guam due to predation by brown treesnakes.

Mammals

Feral ungulates are responsible for destroying wetland and forest vegetation and habitat, increasing erosion, and degrading water quality on Guam. Ungulate Management Plans have been developed for NBG and Andersen AFB, and are included in **Appendices L** and **M** of this INRMP. Feral ungulates occurring on Guam and other invasive mammal species are discussed in the following paragraphs.

Asiatic water buffalo. The Asiatic water buffalo (*Bubalus bubalis*) (carabao in Chamorro) was introduced to Guam in the 1600s for use as draft animals in agriculture. These are the largest mammals on Guam, weighing up to 1,500 pounds (388 kilograms). These ungulates feed on herbaceous vegetation primarily during the morning and evening hours. During the heat of the day, carabao rest in shade and create mud wallows in order to keep cool. Feral carabao can live up 25 years and the females can reproduce at 2 to 3 years of age. Females can breed year round. There are at least two feral herds of carabao, the largest on the NMS and another in the Bubulao watershed adjacent to the NMS (U.S. Navy 2009). Carabao also occur as individuals, or in small groups at several locations on Guam.



Asiatic water buffalo
Source: U.S. Navy

Philippine deer. Philippine deer (*Cervus marianna*) (binådu in Chamorro) were introduced to Guam in the late 1700s by the Spanish and a population of the deer is still present throughout most of the undeveloped lands on Guam. Philippine deer inhabit limestone, ravine, and savanna plant communities and graze on herbaceous vegetation and young shoots of woody plants. Females can breed as early as 6 months of age, and breed year-round, generally having one offspring at a time. Adult Philippine deer live for approximately 8 years (U.S. Navy 2009).

Philippine deer
Source: F. Dayton

Since the Philippine deer is a nonnative species with no natural predators, its numbers are high and it has become stable due to carrying capacity (U.S. Navy 2009). Philippine deer grazing on native tree seedlings adversely affect native tree regeneration. Grazing on the herbaceous understory plant species also exposes the soil to accelerated erosion (U.S. Navy 2009). Landscape level control of ungulates on Andersen AFB and NBG will begin in FY13. Public hunting is restricted to bow tackle and occurs only in limited areas of Andersen AFB.

Feral pig. Feral pigs (*Sus scrofa*) (babuis in Chamorro) inhabit similar habitat as Philippine deer (limestone, ravine, and savanna plant communities). Feral pigs average 86 pounds (39 kilograms) for males, and 67 pounds (30 kilograms) for females. Feral pigs are omnivorous, consuming a variety of food items including fruit, seeds, vegetation, young birds and eggs, reptiles and their eggs, and will scavenge other animal carcasses. The staple food of feral pigs on Guam is earthworms. Feral pigs forage for their food by digging up the soil (i.e., rooting). Similar to water buffalo, feral pigs create mud wallows to keep cool during the heat of the day. Females can breed as young as 6 months of age and have an average litter size of five (U.S. Navy 2009).

Feral pig
Source: DAWR

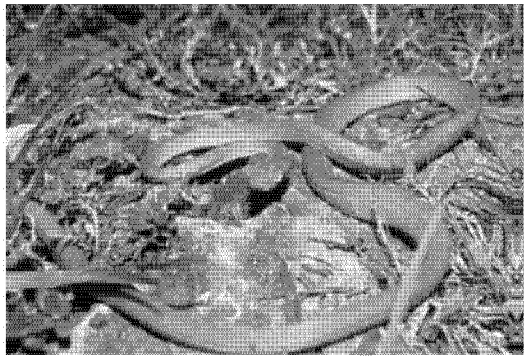
Feral pigs rooting for food decrease native tree regeneration. One feral pig can root up or till 270 square feet (25 square meters) of soil in one night (Conry 1988). This causes erosion, roots up native plants, and provides optimum conditions for invasion by alien plants. All ungulates increase the spread of exotic plants and edge effect. Ungulates facilitate the spread of invasive plants into the native forest interior by creating open trails (edges) and spreading seeds through their feces. Similar to water buffalo and Philippine deer, feral pigs have no natural predators. Landscape level control of ungulates on Andersen AFB and NBG will begin in FY13. Public hunting is restricted to bow tackle and occurs in limited areas of Andersen AFB.

Other species. Other established invasive mammals that potentially affect the natural resources on Guam include feral dogs, cats, Asian house shrew, and four species of rats and mice. All of these naturalized introduced mammal species currently found on Guam are deleterious to the remaining native fauna. Rats, shrews, cats, and dogs prey on birds, eggs, lizards, and insects (U.S. Navy 2009).

Reptiles and Amphibians

Several introduced reptiles are established on Guam, including the house gecko (*Hemidactylus frenatus*), curious skink, brahminy blind snake, and brown treesnake. Although all of these species are of concern, the brown treesnake is responsible for catastrophic changes to the Guam's ecosystem. The curious skink

is ubiquitous on Guam and inhabits disturbed sites such as suburban lawns and secondary forests. The introduced house gecko is the most common gecko observed on Guam (U.S. Navy 2009).



Brown treesnake
Source: DAWR

Brown treesnake. The brown treesnake (*Boiga irregularis*) is a nocturnal, arboreal snake that was accidentally introduced to Guam from the Admiralty Island group of northern Papua New Guinea following World War II (Rodda et al. 1992). Its native range includes northern Australia, eastern Indonesia, New Guinea, and the Solomon Islands. Brown treesnakes inhabit all habitats in Guam, including developed areas. The snake is a vertebrate generalist feeding on small prey items including mammals, birds and their eggs, reptiles (skinks and geckos) and their eggs, and amphibians (Savidge 1988, Christy et al 2007). Savidge et al. (2007) estimate sexual maturity for brown treesnakes to occur in their third or fourth year. Female brown treesnakes on Guam have been found to lay 2 to 9 eggs, and may have the potential to lay multiple clutches per year (Savidge et al. 2007). The mean total length of mature snakes on Guam ranges from 4.7 feet (1.4 meters) in females to 5.6 feet (1.7 meters) in males (Savidge et al. 2007), with the largest recorded female reaching 6.2 feet (1.9 meters) and male reaching 10.2 feet (3.1 meters) (Rodda and Savage 2007).

The lack of predators, competition and abundance of prey on Guam allowed the snake population to increase to very high densities which resulted in the devastation of Guam's native fauna (Rodda and Savage 2007). The brown treesnake is responsible for the extinction or extirpation of 13 of the 22 native breeding birds and 2 of 11 native lizards on Guam (Rodda et al. 1992, Rodda and Savidge 2007). The rapid nature of the decline of the birds was especially dramatic in the early to middle 1980s. Native fruit bats also have experienced similar declines. Although bird populations have dramatically declined, other food sources have become available for the brown treesnake, such as the recent introductions of several frog species that have established and developed breeding populations (Christy et al. 2007a). The brown treesnake is the single greatest factor preventing the recovery of terrestrial ecosystems in Guam (Colvin et al. 2005). Brown treesnakes are also a serious urban pest causing widespread power outages and concerns for human safety (Fritts et al. 1990, Fritts and Chiszar 1999, Fritts and McCoid 1999).

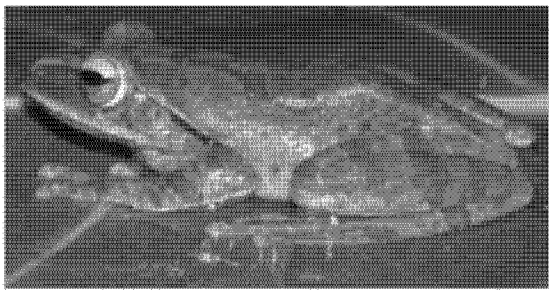
Since 2000, conservation efforts have been ongoing to control brown treesnakes around the Mariana swiftlet nesting and roosting caves in the NBG NMS. USDA-Wildlife Services (WS) has been funded to maintain snake traps around the three remaining swiftlet caves. In 2012, USDA-WS incorporated toxicant bait stations to the trapping perimeter to maximize snake control efforts. Studies are ongoing to determine the impacts of brown treesnakes on nesting and roosting swiftlets. A brown treesnake exclosure was constructed around the 135 acre (55 hectare) Habitat Management Unit (HMU) on Andersen AFB for the purpose of enhancing native habitat. The snake barrier is inspected and maintained on a weekly basis. A goal of the HMU will be the eventual removal of all brown treesnakes within the exclosure.

To prevent the spread of brown treesnakes to other Pacific islands including the CNMI and Hawaii, DOD funds USDA-WS to conduct brown treesnake control and interdiction efforts on NBG and Andersen AFB to prevent snakes from getting into the DOD transportation network. USDA-WS conducts brown treesnake trapping and spotlighting around all installation points of exit (piers/wharfs and flightlines) at NBG and Andersen AFB. USDA-WS has a goal of 100% inspection of all cargo and aircraft departing Guam for off-island destinations.

For all training events in the CNMI that originate from Guam, the DOD coordinates with regional stakeholders (USFWS, CNMI-DFW, USGS, USDA-WS) to determine the necessary level of brown treesnake control and interdiction needed for each training exercise. DOD develops brown treesnake control and interdiction plans for each training exercise that requires the movement of personnel and assets to the CNMI from Guam. Additional brown treesnake inspections and control measures are implemented in the CNMI when determined necessary by the stakeholders.

DOD facilitates land access for brown treesnake researchers on military installations on Guam, as well as funds research directed towards brown treesnake control and large scale suppression. Ongoing research by the USGS, Fort Collins Science Center, Invasive Species Science Branch and the USDA- National Wildlife Research Center (NWRC) includes development of snake control methods, establishment of snake-free areas, and study of basic snake ecology. In addition, several projects addressing control and suppression have either been initiated, or are planned for future implementation on DOD lands on Guam. Examples of these projects include targeted aerial application of acetaminophen, research on large-scale population suppression efforts, and development of non-prey bait for delivery of acetaminophen.

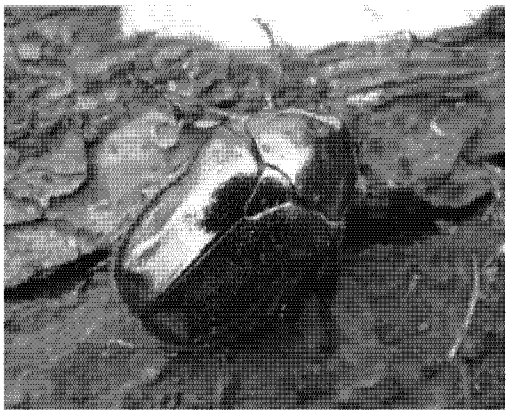
Frogs. Since 1937, 13 species of nonnative anurans have been recorded on Guam (Christy et al. 2007b). Eight of these species were recorded for the first time in Guam in the period from May 2003 to December 2005, all apparently the result of arrivals to the island since 2000 (Christy et al. 2007a). Three of the eight species (*Rana guentheri,* Hong Kong whipping frog, and greenhouse frog) had well-established breeding populations by 2005, and as many as six species are believed to currently have breeding populations (Christy et al. 2007b. A further three (*Fejervarya* cf. *limnocharis*, the crab-eating frog, and *Microhyla pulchra*) were recorded from a number of individuals, but it is not known whether these species have established breeding populations. Two species (*Kaloula pulchra* and coqui) appear to be incidental transportations to the island that have not established. In addition, a single specimen of *Pseudacris regilla* was recently discovered. The species had been transported to Guam on two previous occasions. Prior to 2003, five anuran species, all introductions, had been recorded on Guam. Three of these, *Polypedates leucomystax*, *Pseudacris regilla*, and *Kaloula picta*, were detected on Guam in incoming cargo and destroyed. Two species were established: marine toads were deliberately introduced and the eastern dwarf tree frog was probably an accidental introduction (U.S. Navy 2009).



Hong Kong whipping frog
Source: M.T. Christy

Invertebrates

Scarab beetles. Two species of scarab beetle, *Protaetia orientalis* and *P. pryeri*, were first noted on Guam in 1976 and 1990, respectively. Both scarab beetle species are present on JRM lands and continue to be a threat to native vegetation. These species can lead to reduced or dead leaves, decreased plant production or regeneration, disease, or death of plants. In addition, these insects are impacting species that are concurrently affected by habitat loss and reduced recruitment including the fadang, and Erythrina trees (U.S. Navy 2009). Adult *P. orientalis* are reported as serious pests of agriculture, being found in great abundance on coconut, betelnut, papaya, and mango blossoms and feeding upon tassles, silk, and occasionally kernels of corn



Protaetia pryeri
Source: DAWR

(Schreiner and Nafus 1986). More recently, this species has also become a threat to native plant species. Feeding by adult *P. orientalis* on flowering ifil trees, reduced the seed set of this important native forest tree on JRM lands on Guam by almost 98 percent in 2003 (U.S. Navy 2009).

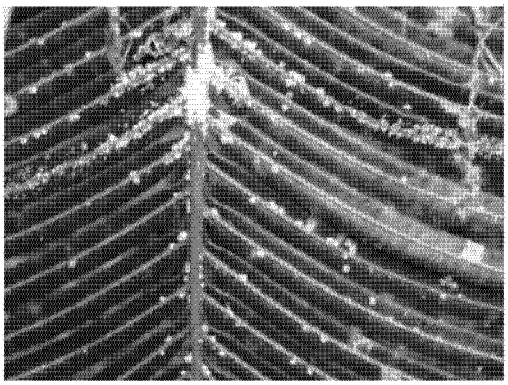
Coconut rhinoceros beetle. The coconut rhinoceros beetle (CRB) (*Oryctes rhinoceros*), an introduced, invasive species, was first detected on Guam in the Tumon Bay area on September 12, 2007 (Moore 2007). This large scarab beetle is a serious pest of palm trees, including coconut and betelnut, and also *Pandanus*. The beetle is also known to attack banana, taro, pineapple, and sugar cane. This species can lead to reduced or dead leaves, decreased plant production or regeneration, and disease or death of plants (U.S. Navy 2009). Adult coconut rhinoceros beetles damage palms by boring into the center of the crown, where they injure the young growing tissues and feed on the exuded sap. As they bore into the crown, they cut through developing leaves (Moore 2007). When the leaves grow out and unfold, the damage appears as V-shaped cuts in the fronds or holes through the midrib. Adult feeding damage to young palms is often lethal, either through direct injury to the growing tip, or from secondary infections of bacteria and fungi. Immature stages (eggs, grubs, and pupae) are found in dead coconuts and piles of rotting vegetation such as sawdust and leaf litter (Moore 2007).

An initial delimiting survey conducted by the Guam Department of Agriculture and the UOG indicated that as of October 2007, the CRB infestation was limited to Tumon Bay and Faifai Beach on Guam's northwest coast, an area encompassing approximately 1,000 acres (405 hectares) (Moore 2007). Following the survey, the Guam CRB Eradication project was launched. Two tactics were employed including mass trapping of adults using a commercially available pheromone, oryctalure (ethyl 4-methyloctanoate), and sanitation of breeding sites by removal and destruction of decaying vegetation, wherever grubs were found. Mass trapping has been ineffective, but there are currently about 700 traps across Guam used to monitor flight activity and geographical spread of the CRB population (Moore 2011). Sanitation has been successful in limiting population growth, slowing spread of the beetle, and reducing damage in the Tumon Bay hotel area. Detected breeding sites are removed and destroyed by physically removing decaying logs, stumps, and other dead vegetation. The material is transported outside of the infested area where it is either disposed of by burial or used in a composting operation (Moore 2011).

A quarantine regulation has been imposed by the Guam Department of Agriculture, which prohibits transport of green waste from within a prescribed quarantine zone without inspection or treatment. The area of the quarantine zone has been extended several times since the beginning of the CRB infestation. The extent of the quarantine area set on September 24, 2010, is 28,360 acres (11,477 hectares). Quarantine might have slowed down the initial spread of the CRB, but there are current CRB sites that are outside the quarantine area that extends north from the southern end of Tumon Bay and includes Andersen AFB, and Andersen South (Moore 2011).

As of 2011, the only conventional insecticides that have proven effective against CRB on Guam are the fumigants methyl bromide and phosphine. Biological controls have also been considered. An insect virus attacking CRB has been used successfully for suppressing CRB populations on other Pacific Islands, but several laboratory bioassays indicate that the Guam CRB are not susceptible to several strains of virus that have been tested (Moore 2011).

Cycad scale. The cycad scale (*Aulacaspis yasumatsui*) is native to Southeast Asia and is rapidly spreading worldwide. The scale has destroyed in excess of 70 percent of the endemic cycads on Guam. Initial damage appears as chlorotic spots. Scale populations quickly reach high densities causing necrosis of fronds and eventually plant death. Cycads in JRM are a very important component of the forest that is rapidly being lost.



Cycad scale
Source: A. Brooke

The UOG has conducted several studies to determine the impact of cycad scale to the endemic cycads on Guam. A few of these studies include research on the relationship between insects and reproduction in seed-bearing plants (including cycads); injecting chemicals directly into the cycad to control not only Asian cycad scale, but also the cycad blue butterfly; and studies into using a scale-eating ladybug beetle as a form of biocontrol.

The Navy also has a Cycad Collection located at the base of Mount Lasso on Tinian. In 2005, Navy Region Marianas contracted surveys and collected viable seed for propagation from habitats throughout Guam. More than 3,000 cycad seeds were collected, cleaned of scale insects, and the source of each seed documented by individual mother-tree habitat type. Seeds were then stored over a period of 12 months, and then transported to a nursery on Tinian until they reached maturity. In 2008, 1,000 of these seedlings were planted in a mapped experimental design on Tinian. The plants have been monitored monthly and encroaching vines and weed-like vegetation is removed. Young plants are monitored monthly for cycad scale and cycad blue butterfly larvae as well as other encroaching invasives.

Little Fire Ant. Little Fire Ant (*Wasmannia auropunctata*) was confirmed on Guam in November 2011, The first sighting was on Yigo, followed by subsequent discoveries in Dededo, Nimitz Hill, Piti, Santa Rita, Umatac, and Malesso. This species is highly destructive to the local ecology, is a generalist in its diet and life history, occurring in trees, on plants, in the grass or under leaf debris and stones. Occurring in the hundreds where found, it bites en masse if disturbed by an animal or human, causing a rash and severe itching. It is particularly problematic for children. Experts on ants in Australia, New Zealand, and the United States suggest that this ant has been on Guam for up to 10 years. Eradication measures include proper management of green waste, destruction of existing colonies, and reducing plant movement on Guam. No information on mode of entry and distribution of this species is available (RISC 2012, UFL 2012).

Manokwar flatworm. The manokwar flatworm (*Platydemus manokwari*) is a terrestrial flatworm that preys heavily on land snails, including the partulid snail (*Partula gibba*), a Federal candidate species.

4.2 Naval Base Guam Main Base

4.2.1 General Physical Environment

4.2.1.1 Climate

The climate at NBG Main Base is the same as the climate for Guam as a whole. See **Section 4.1.1.1** for a description of the climate on Guam.

4.2.1.2 Geology and Topography

Geologically, NBG Main Base is closer aligned with the northern structural province (see **Figure 4-1**). The underlying rocks are composed of coral limestone. Orote Peninsula is a raised limestone plateau reaching 190 feet (58 meters) in elevation above mean sea level (msl) (see **Figure 4-2**). The plateau slopes eastward to near sea level. Much of the land area has been substantially altered by shaping, dredging, and filling. The Dry Dock Island Peninsula, Polaris Point, and sections of the shoreline are the result of dredging and filling (U.S. Navy 2009).

4.2.1.3 Seismology

The lands surrounding Apra Harbor and the Inner Harbor on NBG are considered to be susceptible to inundation from a large tsunami (GHS 2008). Portions of the Main Base on NBG are susceptible to tsunami inundation from distances of 0.5 to more than 1 mile (2 kilometers) inland from the Inner Harbor (GHS 2008).

4.2.1.4 Soils

NBG Main Base is dominated by shallow, well-drained limestone soils; however, areas of soils formed on bottomlands and soils formed on volcanic plateaus are also present in specific areas. Large areas of the Orote Peninsula have highly disturbed soils classified as urban, and extensive areas along Apra Harbor consist of coastal fill and are covered by roads, buildings, and parking lots. Coastal and depressional areas often include poorly drained soils formed from a variety of sources (i.e., limestone, volcanic, and beach deposits). Upland soils are dominated by highly weathered shallow, well-drained volcanic soils (see **Figure 4-4**).

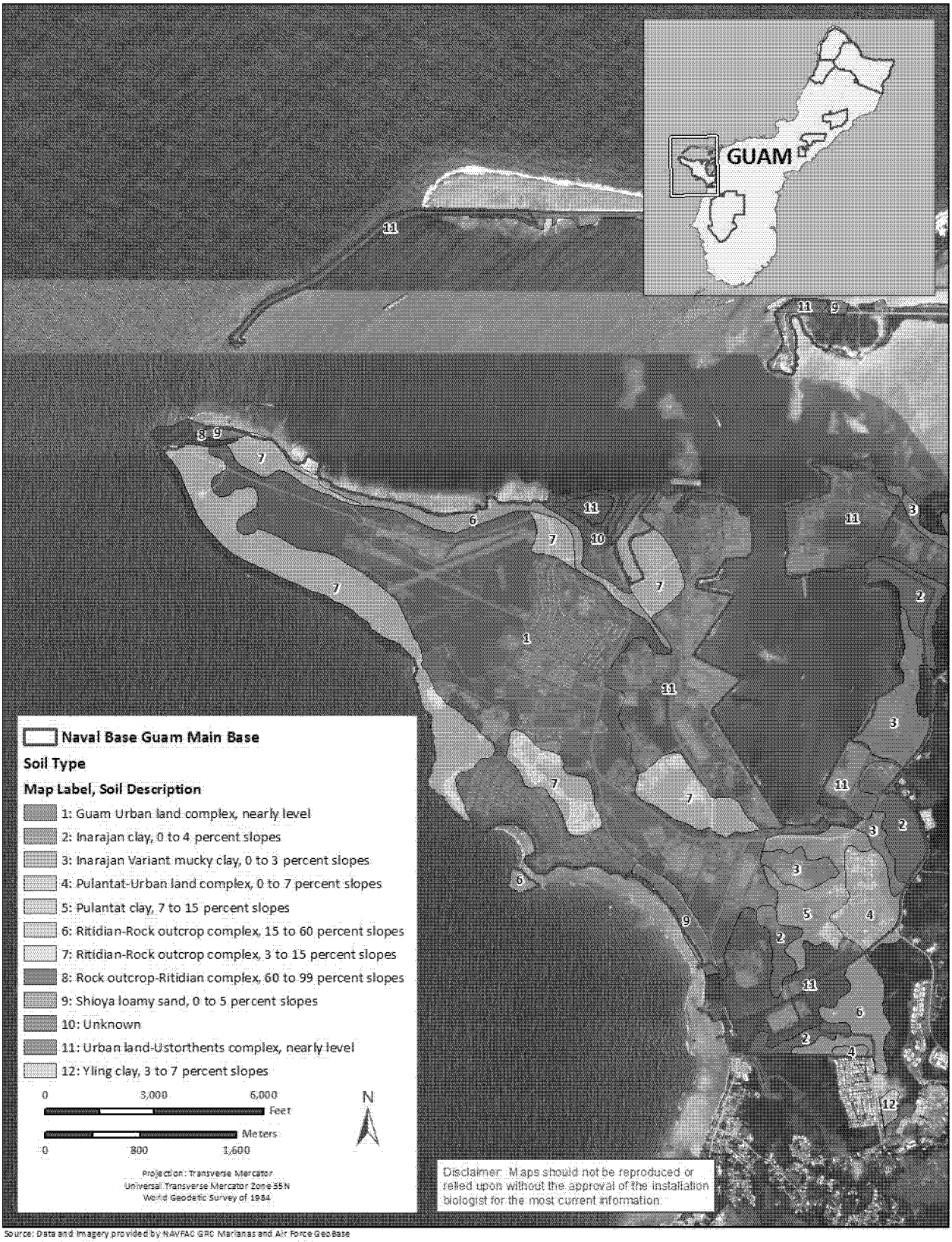
4.2.1.5 Hydrology

Groundwater. NBG Main Base is approximately 4 miles (6.4 kilometers) south of the southern extent of the NGLA. It is located primarily on porous coralline limestone and disturbed or created land. Infiltration in the coralline limestone is rapid and groundwater occurs at base level. There is no named aquifer system under NBG.

Surface Water. NBG Main Base is within the Apra Watershed. Several rivers flow in a general east-to-west direction across NBG (see **Figure 4-5**). The Masso River is adjacent to the northern boundary of NBG and is just north of the Apra Watershed boundary. The river flows into the Philippine Sea. The Sasa River flows from east to west in the northern section of NBG and discharges to Sasa Bay. The Aguada River is south of the Sasa River and also flows from east to west and discharges to Sasa Bay. The Atantano River is south of the Aguada River and flows from east to west into Inner Apra Harbor after being joined by the Tenjo River to the east of NBG. See **Section 4.2.2.2** for additional information regarding freshwater ecosystems on NBG.

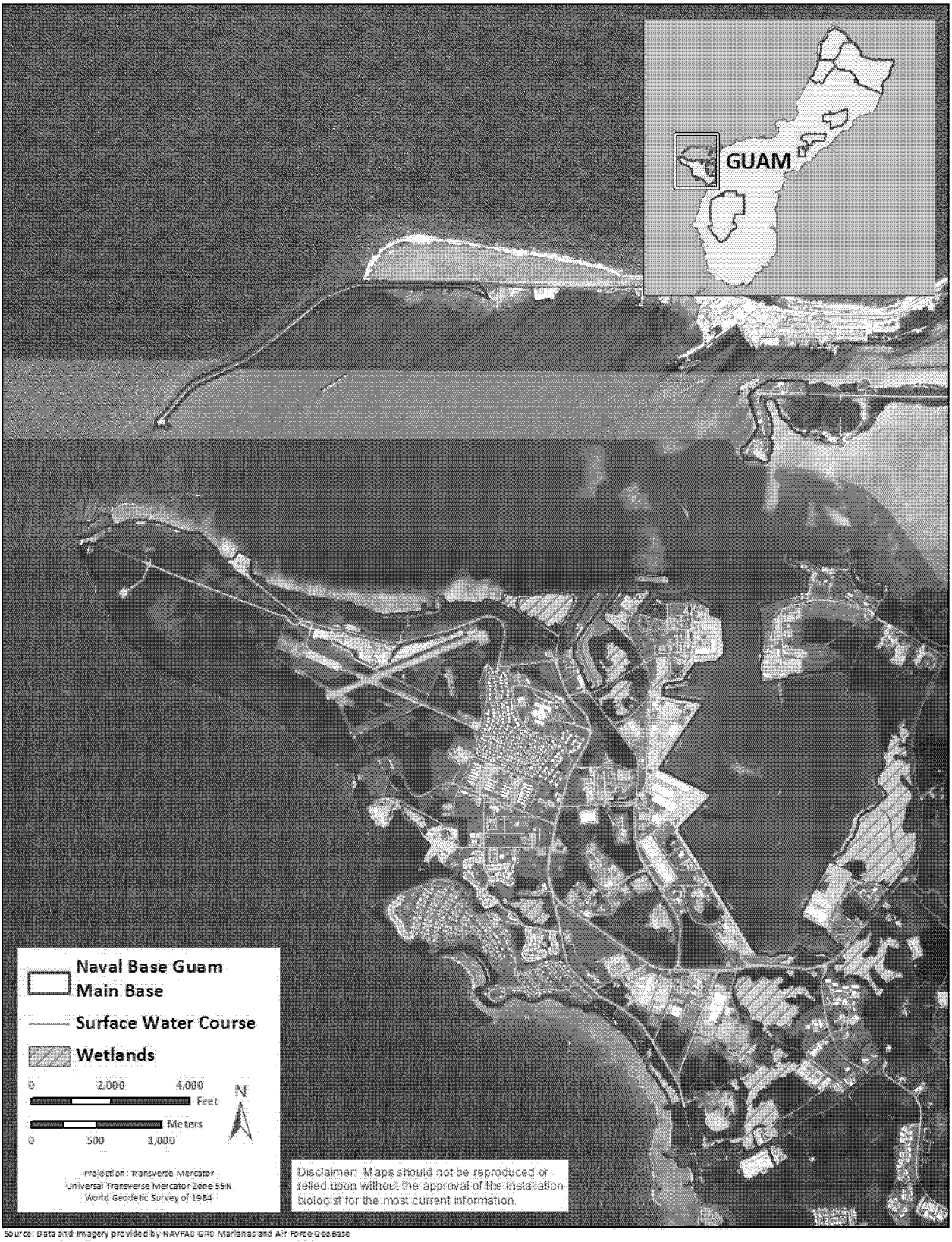
4.2.1.6 Wildland Fire

See discussion in **Section 4.1.1.7**.



Source: Data and Imagery provided by NAVFAC GRC Marianas and Air Force GeoBase

Figure 4-4. Soils on Naval Base Guam Main Base



Source: Data and Imagery provided by NAVFAC GRC Marianas and Air Force GeoBase

Figure 4-5. Surface Water and Wetlands on NBG Main Base

4.2.2 General Biotic Environment

4.2.2.1 Terrestrial Ecosystems

Flora

Vegetation communities on NBG Main Base include limestone, ravine, and wetland communities. See **Figure 4-6** for a map of the terrestrial vegetation communities occurring on NBG.

Limestone Communities. Limestone communities are situated on slopes found within NBG Main Base. Relatively large disturbed limestone communities are present on the lower slopes of Orote Peninsula and a narrow band of halophytic-xerophytic scrub communities exists on the cliff faces (U.S. Navy 2009).

Vegetation surveys were performed along a transect in the upper plateau to the west of the old runway in the southern sector of Orote in 2008. The area has rugged limestone karst topography. The limestone forest was characterized by native *Neisosperma oppositifolia* (fagot in Chamorro), which composed 28 percent of the relative density. Collectively, approximately one-third of the relative tree density within this transect were composed of introduced understory tree species (i.e., tangantangan, limeberry, and papaya). The remaining two-thirds of the relative density were composed of native species, including the Mariana Islands endemic species *Aglaia marianennsis* and *Tabernaemontana rotensis*. Absolute cover was highest for native upper canopy tree species including *Ficus prolixa*, *Pisonia grandis*, and *Tristiropsis acutangula* (NAVFACPACIFIC 2010b). Based on a 2008 vegetation survey on Polaris Point, tangantangan composed 88 percent of the tree layer within the transect (NAVFACPACIFIC 2010b).

Ravine Communities. Within NBG Main Base, ravine forests are restricted to narrow strips along the few freshwater drainages near the coast (U.S. Navy 2009).

Wetland Communities. The wetland areas of NBG Main Base were originally delineated and mapped in 1998 (Dueñas and Associates 1998). In March, May, and September 2007, biologists revisited the wetland areas delineated in 1998 and found that the 1998 boundaries had not changed in most locations (AECOS and Wil Chee 2009). In 2010, a wetland study was conducted in specific project areas to identify wetlands that could be affected by the proposed alternatives analyzed in the Guam and CNMI Military Relocation Environmental Impact Statement (EIS) (JGPO 2010).

Based on the original 1998 survey and the recent 2007 survey, there are approximately 343 acres (139 hectares) of wetlands in 48 separate wetlands within and adjacent to NBG Main Base. These wetlands range in size from 0.04 to 88.73 acres (0.02 to 35.90 hectares) and include freshwater and brackish water habitats. Estuarine wetlands (i.e., brackish water wetlands) on NBG are discussed in **Section 4.2.2.3**. In addition, there is a large 100-acre (40.5-hectare) wetland complex in Camp Covington. **Figure 4-5** presents wetland areas as delineated in 2007 (AECOS and Wil Chee 2009). Jurisdictional determinations were not obtained from the USACE for the wetlands that were delineated in 2007 (JGPO 2010).

Palustrine wetlands on NBG Main Base are the result of closed-basin features or lowlands isolated by fill as the military base developed (AECOS and Wil Chee 2009). Palustrine wetland communities are situated southeast of Sumay Cove, North Tipalao, and in Camp Covington (see **Figure 4-5**).

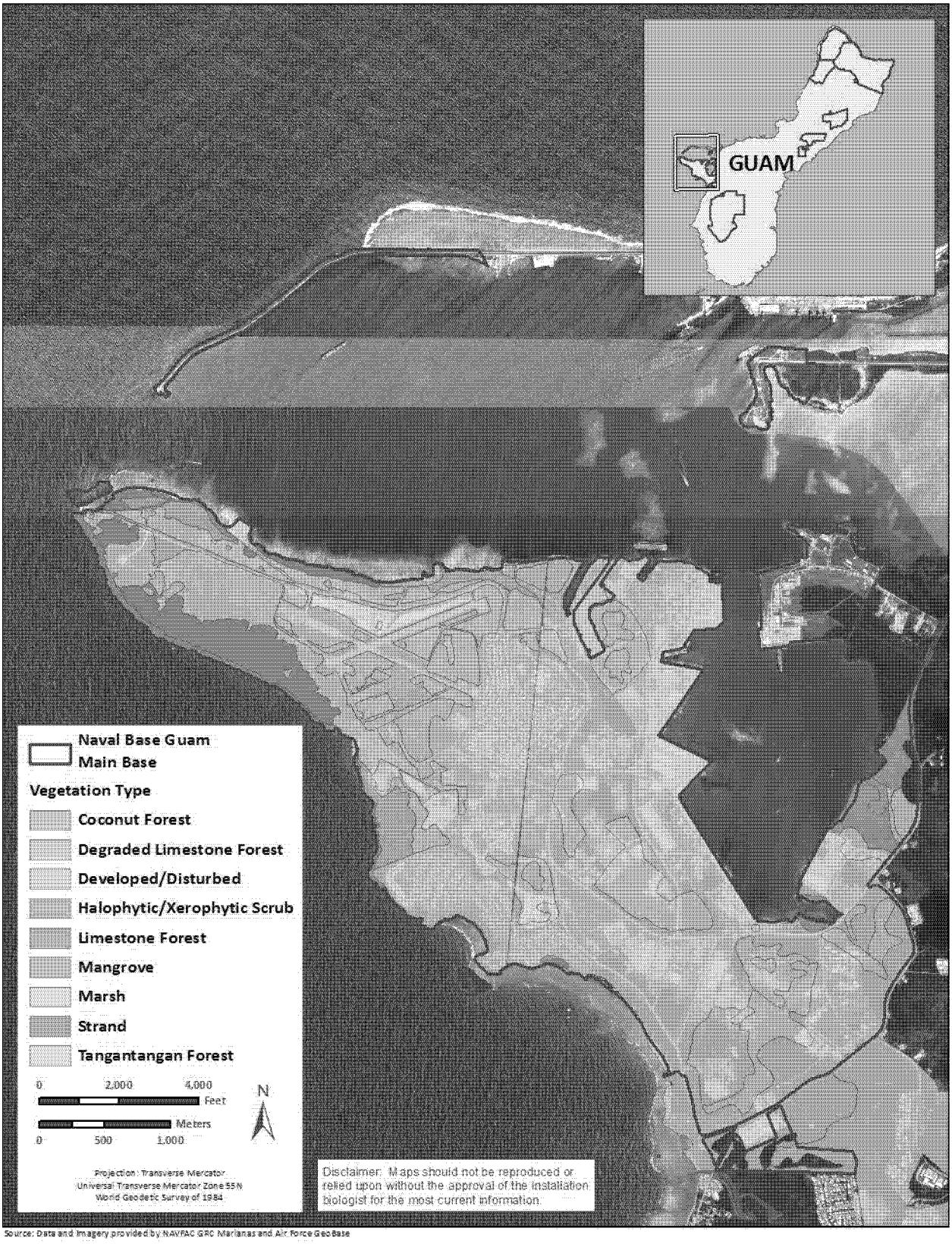


Figure 4-6. Vegetation Communities on NBG Main Base

The Sumay Cove wetland (Wetland C) is southeast of Sumay Cove and is separated from it by coral-gravel fill for a roadway. The wetland is primarily a marsh (i.e., herbaceous vegetation) with sea hibiscus swamp areas to the west and south (AECOS and Wil Chee 2009). The herbaceous vegetation includes *Urochloa mutica*, *Scirpus littoralis*, *Acrostichuim aureum*, *Saccharum spontaneum*, and *Thelypteris interupta* (Dueñas and Associates 1998).

The North Tipalao wetlands, on the western side of the installation, occur on a limestone plateau with typical karst topography consisting of shallow depressions of various sizes. Two palustrine wetlands, encompassing 10 acres (4 hectares) (Wetland G), and 0.3 acres (0.1 hectares) (Wetlands M), were delineated in this area. The larger wetland is surrounded by growth of pago and the fern association of golden leather fern and *Thelypteris interrupta* occupies most of the area (Dueñas and Associates 1998). In the smaller wetland, Dueñas and Associates (1998) found *Polygonum minus* fringing a shallow open water area, with typical weedy vegetation consisting of *Saccharum spontaneum*, *Urochloa muticum*, and *Cyperus ligularis* occurring around the perimeter.

The Camp Covington wetland is comprised of several palustrine habitats including Wetland L (33 acres [13 hectares]), N (4 acres [2 hectares]), J (37 acres [15 hectare]), K (1 acre [0.4 hectare]), and I (1 acre [0.4 hectare]). *Phragmites karka* is the dominant vegetation in most of these wetlands. Wetland K is characterized as a swamp with sea hibiscus, swamp fern, *Clerodendrum inerme* (known as lodugao in Chamorro), golden leather fern, *Rhizophora apiculata*, and duckweed (*Lemna* sp.) characterizing the vegetation in the habitat. The presence of *Rhizophora* is somewhat unusual as the wetland appears to be palustrine and unconnected to the harbor (AECOS and Wil Chee 2009, Dueñas and Associates 1998).

The wetland located east of Abo Cove (Wetland H), on the inland side of Marine Corps Drive is part of the larger 100-acre (40.5-hectare) open surface water and wetland complex located in Camp Covington. The wetland is approximately 24.7 acres (10 hectares) and contains both estuarine and palustrine systems. The estuarine portion is a conspicuous open mud flat surrounded by mangrove on the southeast side of Marine Corps Drive just inside the Main Gate. Since the site contains both estuarine and palustrine systems, it exhibits some of the more diverse wetland vegetation within JRM. The area fronting Marine Corps Drive is dominated by a mangrove swamp (*Rhizophora mucronata* and *Avicennia marina*) and reed marsh (*Scirpus littoralis*). The adjacent forest includes *Heritiera longipetiolata* and *Intsia bijuga*. Further inland, the palustrine vegetation encompasses *Phragmites karka* intermixed with wild cane (*Saccharum spontaneum*) and pago trees in tangled stands (Dueñas and Associates 1998).

There is a small, 0.10-acre (0.04-hectare) palustrine emergent, persistent, seasonal wetland (Wetland X) on the east side of Marine Corps Drive that extends parallel to the road along a Navy pipeline easement. Vegetation in the wetland is characterized by an elongated patch of *Phragmites karka* (Dueñas and Associates 1998).

There is a 2.02-acre (0.82-hectare) wetland (Wetland SVO) located at the southwestern corner of the Fleet and Industrial Supply Center (i.e., tank farm) perimeter fence line and Marine Corps Drive. The wetland is a palustrine emergent, seasonal habitat (Dueñas and Associates 1998, AECOS and Wil Chee 2009). The wetland is characterized by*Phragmites karka* bordered by a forest on the south and east (AECOS and Wil Chee 2009). The north boundary of the wetland might be fill-related to the early development of the tank farm (AECOS and Wil Chee 2009). The highway or west side of the wetland is also fill-related to the construction of the road, and this side of the wetland is dominated by para grass (*Urochloa mutica*), mile-a-minute vine, and ferns (AECOS and Wil Chee 2009).

Fauna

Birds. Avian surveys were conducted on the NBG Main Base on Orote Point and Polaris Point from 2008 to 2010. The following avian species were identified during the 2008–2010 roadside and forest bird surveys performed on Orote Point: Pacific golden-plover, black francolin, whimbrel, island collared dove, black drongo, and yellow bittern. The Pacific golden-plover, a common nonbreeding visitor to Guam, was the most common species observed on Orote Point (NAVFACPACIFIC 2010b). The black francolin, island collared dove, and black drongo are common, introduced, breeding residents on Guam (NAVFACPACIFIC 2010b). The whimbrel is a common nonbreeding visitor to Guam and the yellow bittern is a common, native, breeding resident on Guam (NAVFACPACIFIC 2010b). Avian species documented on Polaris Point during the 2008–2010 surveys included the yellow bittern, black drongo, island collared dove, and brown noddy. The brown noddy is an uncommon, native resident of Guam that nests on Cocos Island (NAVFACPACIFIC 2010b).

The Mariana common moorhen has been known to occur occasionally within the wetlands on NBG (U.S. Navy 2009). See **Section 4.2.2.5** for additional information on the common Mariana moorhen on NBG.

Mammals. Pigs have been found in increasing numbers on NBG Main Base, from the Camp Covington wetlands to Orote Peninsula. Trapping by Base Security removed 100 pigs in FY12. Deer and carabao have not been seen or detected on main base. In addition, surveys conducted in 2011 on Orote Peninsula did not detect any fruit bats. See **Section 4.1.2.1** for additional mammal species that are likely to occur on NBG Main Base. Specific species present on NBG Main Base will be included in the next update of this INRMP following completion of surveys prescribed by the Plan.

Reptiles and Amphibians. Herpetofauna surveys were conducted in 2008-2009 on NBG Main Base on Orote Point and Polaris Point. Nine herpetofauna species (five native and four introduced) were documented on NBG Main Base. Seven herpetofauna species were documented on Orote Point. Of these, four species are native: Pacific blue-tailed skink, mourning gecko, stump-toed gecko, and monitor lizard; and three species are introduced: curious skink, house gecko, and brown treesnake (NAVFACPACIFIC 2010b).

Eight herpetofauna species were documented on Polaris Point during the 2008–2009 herpetofauna surveys. Of these, four species are native: Pacific blue-tailed skink, moth skink (Guam listed as endangered), monitor lizard, and stump-toed gecko; and four species are introduced: curious skink, house gecko, brown treesnake, and marine toad (NAVFACPACIFIC 2010b). The continued widespread presence of the brown treesnake, the curious skink, and other introduced amphibian species is of concern because of each species' potential deleterious impacts on Guam's native fauna. Of particular concern is the potential for introduced species to serve as additional food sources for the brown treesnake (NAVFACPACIFIC 2010b).

The blue-tailed skink, curious skink, marine toad, Gunther's Amoy frog, and monitor lizard were also identified on NBG during site characterizations of the San Luis ponds conducted in October 2010 and February 2011. Monitor lizards, curious skinks, and Gunther's Amoy frogs were commonly observed or heard during the site characterizations.

Invertebrates. Invertebrate species on NBG Main Base are similar in composition to those occurring on nearby areas of Guam. Specific species present on NBG Main Base will be included in the next update of this INRMP following completion of surveys prescribed by the Plan.

4.2.2.2 Freshwater Ecosystems

Six freshwater rivers cross portions of NBG Main Base (i.e., Masso, Sasa, Laguas, Aguada, Gautau, and Atantano) (U.S. Navy 2009).

Flora

At the Route 1 (Marine Corps Drive) crossing, the Atantano River is approximately 43 feet wide and 6 feet deep (13 meters wide and 2 meters) at the downstream location on the NBG Main Base. Immediately downstream of Route 1, the river's banks consist of vertical sheet piling encrusted with marine life. Further downstream, woody vegetation is present to the edge of the bank. The benthic substrate consists of silty sand with some isolated rocks. No submerged aquatic vegetation was observed within the Atantano River during 2009–2010 natural resources surveys (NAVFACPACIFIC 2010b).

At the Route 1 crossing, the Aguada River is approximately 30 feet wide and 10 feet deep (9 meters wide and 3 meters deep) at the downstream location on NBG. Approximately 50 feet (15 meters) upstream of the bridge, the river narrows to less than 3 feet (1 meter) wide and less than 1 foot (0.3 meters) deep. At the time of natural resources surveys conducted in 2009–2010, the stream had an imperceptible flow and was choked with vegetation due to a downstream logjam that had backed up the flow. Downstream of the bridge, the river pools. The pool is approximately 30 feet (9 meters) wide and 50 feet (15 meters) long. The pool then empties into a swiftly flowing stream that is less than 3 feet (1 meter) wide. On the southern bank of the pool, a strip of hydrophytic vegetation is present. Downstream of the pool, the river is swift flowing and clear, with a rocky bottom. This portion of the river flows through a forested area dominated by palms and bamboo (NAVFACPACIFIC 2010b).

The Sasa River crosses the Sasa Valley Tank Farm and flows along the boundary of the Main Base before it empties into the Apra Harbor. Forested areas occur along the Sasa River upstream and downstream of the Route 1 crossing. Downstream of the bridge within NBG, the vegetation is low and dense. Upstream of the bridge, large bamboo stands line the riverbanks. No submerged aquatic vegetation was observed in the study area during the 2009–2010 natural resources surveys, although some filamentous green algae was observed on rocks immediately downstream of the bridge (NAVFACPACIFIC 2010b).

Fauna

Birds. Bird species observed during the 2009 natural resources survey on NBG Main Base that could use the freshwater habitats include the yellow bittern and Pacific golden-plover (NAVFACPACIFIC 2010b). Mariana common moorhens have also been observed in freshwater habitats on NBG Main Base.

Fish. Snorkel surveys were performed in the Atantano River in January 2010. The benthic substrate consists of silty sand with some isolated rocks. No submerged aquatic vegetation was observed within the study area. Marbled eel (*Anguilla marmorata*) and rock flagtail (*Kuhlia rupestris*) were the only fish observed within the river. Both species are native to Guam and use estuarine habitats at the mouth of the river and marine habitats (NAVFACPACIFIC 2010b).

Biological and habitat assessments were performed in 2008 by GDAWR on the Atantano, Aguada, and Sasa rivers on NBG Main Base. Species on NBG Main Base within these rivers generally use the freshwater and estuarine components of the river, and many spend a portion of their life cycle within the ocean. Native species observed within the Atantano River during the 2008 survey include common glass fish (*Ambassis buruensis*), dusky sleeper (*Eleotris fusca*), rock flagtail, silver moony (*Monodactylus argenteus*), bluespot mullet (*Moolgarda seheli*), bandfin mullet goby (*Mugilogobius cavifrons*), mudskipper (*Periophthalmus argentilineatus*), bigmouth goby (*Redigobius bikolanus*), gobies (*Stenogobius* spp.), and feathered river-garfish (*Zenarchopterus dispar*). Introduced species observed

within the Atantano River included the mosquitofish (*Gambusia affinis*) and guppy (*Poecilia reticulata*) (GDAWR 2008, NAVFACPACIFIC 2010b).

Native fish species observed within the Aguada River during the 2008 habitat assessment conducted by GDAWR included the marbled eel and goby. Native species observed within the Sasa River during the 2008 survey included Engel's mullet (*Moolgarda engeli*), bandfin mullet goby, mudskipper, and feathered river-garfish. Invasive species observed within the Sasa River included the Mozambique tilapia (*Oreochromis mossambicus*) (GDAWR 2008, NAVFACPACIFIC 2010b).

Macroinvertebrates. Similar to the fish species occurring within the portions of rivers crossing NBG Main Base, the macroinvertebrates within these waters use a combination of freshwater, estuarine, and marine environments. GDAWR identified macroinvertebrates occurring within the Atantano and Aguada rivers during 2008 biological and habitat assessments. Native macroinvertebrates within the Atantano River include ninja shrimp (*Caridina serratirostris*), shrimp (*Caridina* sp.), Tahitian prawn, the snail *Neritina squamipicta*, and *Thiara granifera*. Invasive macroinvertebrate species included leeches (Class Clitellata). Native macroinvertebrates observed within the Aguada River include green lace shrimp (*Atyoida pilipes*), shrimp (*Caridina* sp.), Malaysian trumpet snail (*Melanoides tuberculata*), the snail *Neritina pettiti*, mayfly larvae (order Ephemeroptera), dragonfly larvae (order Odonata), and pyralid caterpillars (family Pyralidae) (GDAWR 2008, NAVFACPACIFIC 2010b).

4.2.2.3 Estuarine Ecosystems

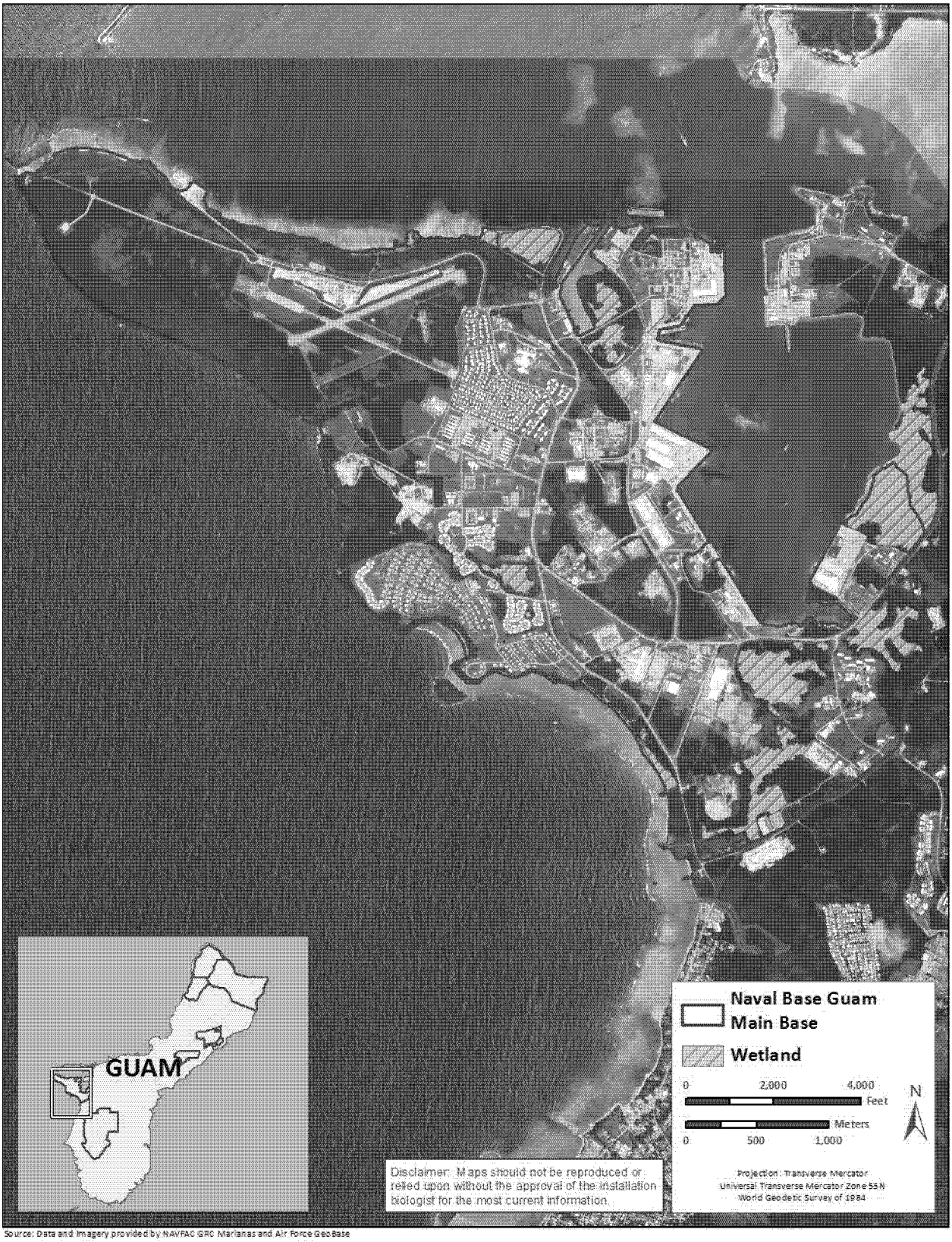
Estuarine communities are present on NBG Main Base at the mouths of the larger rivers and the inner waters of Apra Harbor (U.S. Navy 2009). Within Apra Harbor, marine investigations were conducted in 2009 along the wharves of Polaris Point, Oscar and Papa Wharves, Abo Cove, and Wharves S, T, U, V, and X (NAVFACPACIFIC 2010b).

Estuarine wetlands under JRM control at NBG Main Base occur scattered along the western shore of Inner Apra Harbor, at the mouth of the Atantano River, and along the shores and inland of Sasa Bay (see **Figure 4-7**). Most estuarine wetlands have a hydrological connection to the Harbor and are, thus, tide lands. However, the San Luis Ponds and the wetland behind Rizal Beach appear isolated from a surface water connection to the sea, but are influenced by a saline groundwater connection. These ponds are therefore brackish (estuarine) and show a much attenuated tidal response (AECOS and Wil Chee 2009). Naval Station Marsh occurs on NBG Main Base at the base of Orote Peninsula near the coast in Apra Harbor. This marsh is listed as a wetland of primary importance for Mariana common moorhens (USFWS 1992, UNEP-WCMC undated).

Flora

Much of Inner Apra Harbor supported mangrove communities prior to the dredging and filling of the Harbor in the 1940s. Remnant mangrove communities are still present along the shoreline of Inner Apra Harbor and extend inland along coastal streams that receive tidal waters (U.S. Navy 2009).

The mangrove forest present in Sasa Bay is the largest native mangrove community on U.S. land in the Pacific. Estuarine mangrove communities on NBG Main Base include the following plant species: Asiatic mangrove, large-leafed mangrove, *Avicennia* sp., *Xylocarpus moluccensis*, *Lumnitzera coccinea*, looking glass tree, sea hibiscus, and golden leather fern (U.S. Navy 2009). Estuarine marshes dominated by bulrushes are also found at several locations in Apra Harbor. The largest estuarine marsh area is the artificial San Luis Ponds. This habitat type is important for many species of migratory shorebirds, native aquatic and terrestrial invertebrates, and aquatic vertebrates (GDAWR 2006a).



Source: Data and Imagery provided by NAVFAC GRC Marianas and Air Force GeoBase

Figure 4-7. Wetlands on NBG Main Base

The San Luis Ponds are composed of two wetland areas (Wetland 1, is brackish to saline and 18.15 acres [7 hectares] and Wetland 2, is fresh to brackish water and 2.15 acres [0.871 hectares]) off San Luis Point (NAVFACPACIFIC 2010c). These wetlands are each characterized by a pond and marsh component and are influenced by saline groundwater and seepage through the limestone fill barrier that separates the ponds from the harbor (NAVFACPACIFIC 2010c, AECOS and Wil Chee 2009). Marsh vegetation in Wetland 1 is dominated by *Scirpus littoralis*, with golden leather fern, sea hibiscus, and *Pluchea indica* along the margins (see **Figure 4-8**). Marsh vegetation in Wetland 2 is also dominated by *S. littoralis*, with golden leather fern, *P. indica*, sea hibiscus, and *Phragmites karka* along the margins (AECOS and Wil Chee 2009). Mariana common moorhens were observed using the San Luis Ponds during the wetland delineation and site characterizations and surveys conducted in October 2010 and February 2011 by HDR. Yellow bittern were also observed to be common during the site characterizations.

Figure 4-8. Photograph of Marsh Vegetation in Wetland 1 of San Luis Ponds

Four wetlands delineated in 2007 (AECOS and Wil Chee 2009) are on the southern and eastern shores of Inner Apra Harbor (see **Figure 4-7**). These wetlands include:

- 1.65 acres (0.67 hectares) of estuarine, intertidal, scrub/shrub, broad leaved evergreen, regular tidal water regime wetland at the southernmost extent of Inner Apra Harbor (AECOS and Wil Chee 2009).
- 2 acres (0.81 hectares) of estuarine, intertidal, scrub/shrub, broad-leaved evergreen, regular tidal regime wetland stretched along the southern shore of Abo Cove (AECOS and Wil Chee 2009).
- 2.53 acres (1.02 hectares) of estuarine, intertidal, scrub/shrub, broad-leaved evergreen, regular tidal regime wetland located along the northern shore of Abo Cove (AECOS and Wil Chee 2009).
- 88.73 acres (35.90 hectares) of various wetland types, commonly known as the Atantano Wetlands, is along the eastern shore and inland of Inner Apra Harbor. A portion known as the

Atantano Wetland is 54.75 acres (22.15 hectares) and encompasses the mouth of the Atantano River, which drains the Guatali, Tenjo, and Alpacho rivers. The wetland has been cited as containing the best-developed and most mature mangrove swamp on Guam (JGPO 2010). The most dominant classification in the Atantano Wetlands is estuarine, intertidal, scrub/shrub, broad-leaved evergreen, regular tidal (AECOS and Wil Chee 2009).

Five wetlands are along the shores and inland of Sasa Bay (see **Figure 4-7**). These include:

- 1.09 acres (0.44 hectares) of estuarine, intertidal, scrub/shrub, broad-leaved evergreen, regular tidal wetland inside the southern shore of Sasa Bay.
- 1.45 acres (0.59 hectares) of estuarine, intertidal, scrub/shrub, broad-leaved evergreen, regular tidal wetland, also inside the southern shore of Sasa Bay (AECOS and Wil Chee 2009).
- 37.8 acres (15.3 hectares) of predominantly estuarine, intertidal, scrub/shrub, broad-leaved evergreen, regular tidal wetland in and adjacent to the eastern shoreline of Sasa Bay (AECOS and Wil Chee 2009).
- 0.24 acres (0.10 hectares) of estuarine, intertidal, scrub/shrub, broad-leaved evergreen, regular tidal wetland at the top of a small inlet in the north of Sasa Bay (AECOS and Wil Chee 2009).
- 3.23 acres (1.31 hectares) of predominantly estuarine, intertidal, scrub/shrub, broad-leaved evergreen, regular tidal wetland along and adjacent to the northern shore of Sasa Bay (AECOS and Wil Chee 2009).

Caulerpa verticillata is a green alga that copes well with increased levels of sedimentation and reduced salinities. Exceptionally large specimens of this alga were found in Abo Cove, probably a result of relatively low herbivore pressure. The distribution of the seagrass species *Halophila japonica* also seems to be restricted to Abo Cove in the inner harbor (NAVFACPACIFIC 2010b).

Fauna

Birds. Two indigenous avian species, the yellow bittern and Pacific reef heron, feed the in estuaries of NBG Main Base. Exposed tidal mudflats and estuarine banks provide seasonal foraging and loafing habitat to any number of migratory and extralimital avian species. To date, more than 80 migrant and vagrant species have been recorded from Guam, most of which are protected under the MBTA. Most common among the annual visitors to the island are Pacific golden-plover, intermediate egret (*Mesophoyx intermedia*), Mongolian plover, gray-tailed tattler, whimbrel, ruddy turnstone, and cattle egret (U.S. Navy 2009).

Mammals. Introduced mammalian species currently established on Guam, including Philippine deer, dogs, cats, feral pigs, Asian house shrew, rats, and mice, would be expected to use resources within estuarine communities on NBG Main Base, especially during low tides (U.S. Navy 2009).

Fish. In 2008, a Biological and Habitat Assessment of the Atantano River conducted by GDAWR indicated that the river has the largest and best developed mangrove swamp on Guam (GDAWR 2008, NAVFACPACIFIC 2010b). Species occurring within the rivers on NBG Main Base generally use the freshwater and estuarine components of the rivers, and many spend a portion of their life cycle within the ocean. Native species observed within the Atantano River during the 2008 survey include the following: common glass fish, dusky sleeper, rock flagtail, snappers, silver moony, bluespot mullet, bandfin mullet goby, mudskipper, bigmouth goby, gobies, and feathered river-garfish. Introduced species include mosquitofish and guppy.

Reptiles and Amphibians. The Sumay marina cove on NBG Main Base has supported endangered hawksbill sea turtle nesting attempts on the cobble and sand beach near the mangroves. Both of the introduced established amphibians on Guam, the marine toad and the eastern dwarf tree frog, use resources in estuarine ecosystems and likely occur on NBG Main Base (U.S. Navy 2009). Gunther's Amoy frog uses estuarine habitats associated with the San Luis Ponds on NBG Main Base.

Macroinvertebrates. Similar to the fish species occurring within the portions of rivers crossing NBG Main Base, the macroinvertebrates within these waters use a combination of freshwater, estuarine, and marine environments. GDAWR identified macroinvertebrates occurring within the Atantano and Aguada rivers during the 2008 Biological and Habitat Assessments. Native macroinvertebrates within the Atantano River include the following: ninja shrimp, shrimp, Tahitian prawn, snail, and *Thiara granifera*. Invasive macroinvertebrate species include leeches. Native macroinvertebrates observed within the Aguada River include the following: green lace shrimp, shrimp, Malaysian trumpet snail, snail, mayfly larvae, dragonfly larvae, and pyralid caterpillars (GDAWR 2008, NAVFACPACIFIC 2010b).

During the 2009 natural resources survey, 29 species of solitary macroinvertebrates were recorded within the Oscar and Papa wharves within the Inner Apra Harbor estuary and 30 species of solitary macroinvertebrates were recorded within the Abo Cove and Wharves S, T, U, V, and X (NAVFACPACIFIC 2010b). All macroinvertebrates encountered within the Inner Apra Harbor during this survey were suspension feeders (i.e., filter feeders). Bivalve mollusks (7 species) and solitary ascidians (8 species) dominated the macroinvertebrate fauna at the Oscar and Papa wharves, and mean densities were generally greater at Papa Wharf. Sponges were the predominant biotic cover organisms at Oscar Wharf. The bivalves *Malleus decurtatus* and *Spondylus squamosus* were remarkably more abundant at Papa Wharf, as was the ascidian *Rhopalaea circula*. Spondylid bivalves occurred at the greatest densities of all species at both sites.

Within the transects performed in Abo Cove and Wharves S, T, U, V, and X, the greatest diversity of species (16 species) was found on the vertical face at Wharf V. The lowest diversity of macroinvertebrates occurred within the coral reef at Abo Cove. Bivalve mollusks and ascidians dominated the macroinvertebrate fauna in terms of both diversity and density within Abo Cove and Wharves S, T, U, V, and X. All but 3 of the 30 species within this study site were suspension feeders; the others are detritus feeders. The predominance of suspension feeders in lagoonal environments, such as the inner harbor, could be a result of nutrient enrichment by terrestrial runoff and the extended residence time of waters in the lagoon (NAVFACPACIFIC 2010b).

Corals are the main constituents of the biotic assemblages at Abo Cove. Twenty-eight species of corals and related organisms, representing 11 families and 13 genera, were observed at the study site in Abo Cove in 2009. These included 26 species of scleractinian corals and 2 species of non-scleractinian anthozoans. Six coral species were documented in Oscar Wharf in 2009 and three species were documented in Papa Wharf. Species documented at both wharves include *Leptastrea purpurea*, *Pocillopora damicornis*, and *Porites lobata*. *Dendrophyllia* sp., and *Psammocora haimeana*; and *Porites rus* were documented only at Oscar Wharf (NAVFACPACIFIC 2010b).

4.2.2.4 Submerged Lands

JRM managed submerged lands which extend 3 miles from shore on NBG Main Base include portions of Agat Bay, Orote Point, Apra Harbor, and Piti Bay, as illustrated in **Figure 4-9**. Other designations for those JRM managed submerged lands, including ERAs, HAPCs, and Marine Preserves, are summarized in **Table 4-5**.

Table 4-5. JRM Managed Submerged Lands and Dual Designations

Installation	JRM Managed Submerged Land	Dual Designation (DOD)	Dual Designation (WP FMC)[1]	Dual Designation (GovGuam)	Dual Designation (USFWS)
Naval Base Guam Main Base	Apra Harbor				
	Inner Apra Harbor				
	Sasa Bay			Sasa Bay Marine Preserve	
	Eastern Apra Harbor				
	Commercial Port				
	Outer Apra Harbor		Jade Shoals HAPC		
	Agat Bay				
	Piti Bay			Piti Bomb Holes Marine Preserve	
	Orote Point	OPERA	OPERA HAPC		
NBG TS	Tanguisson Beach Park				
	Tanguisson Point to Urunao Point	HERA	HERA HAPC		
Andersen AFB	Ritidian Point		Ritidian Point HAPC		Ritidian Point NWR[2]
	Tarague Bay	Andersen AFB Marine Resources Preserve			
	Pati Point			Pati Point Marine Preserve	

Source: NAVFAC ESC 2010

Notes:

1. Guam is also surrounded by WPRFMC EFH, which is dually designated on all JRM managed submerged lands which extend 3 nautical miles seaward from the coastline.
2. Ritidian Point National Wildlife Refuge (NWR) is a 100-foot (30-meter) isobath that is not a JRM managed submerged land, but is surrounded by JRM managed submerged lands which extend three nautical miles seaward from the coastline.

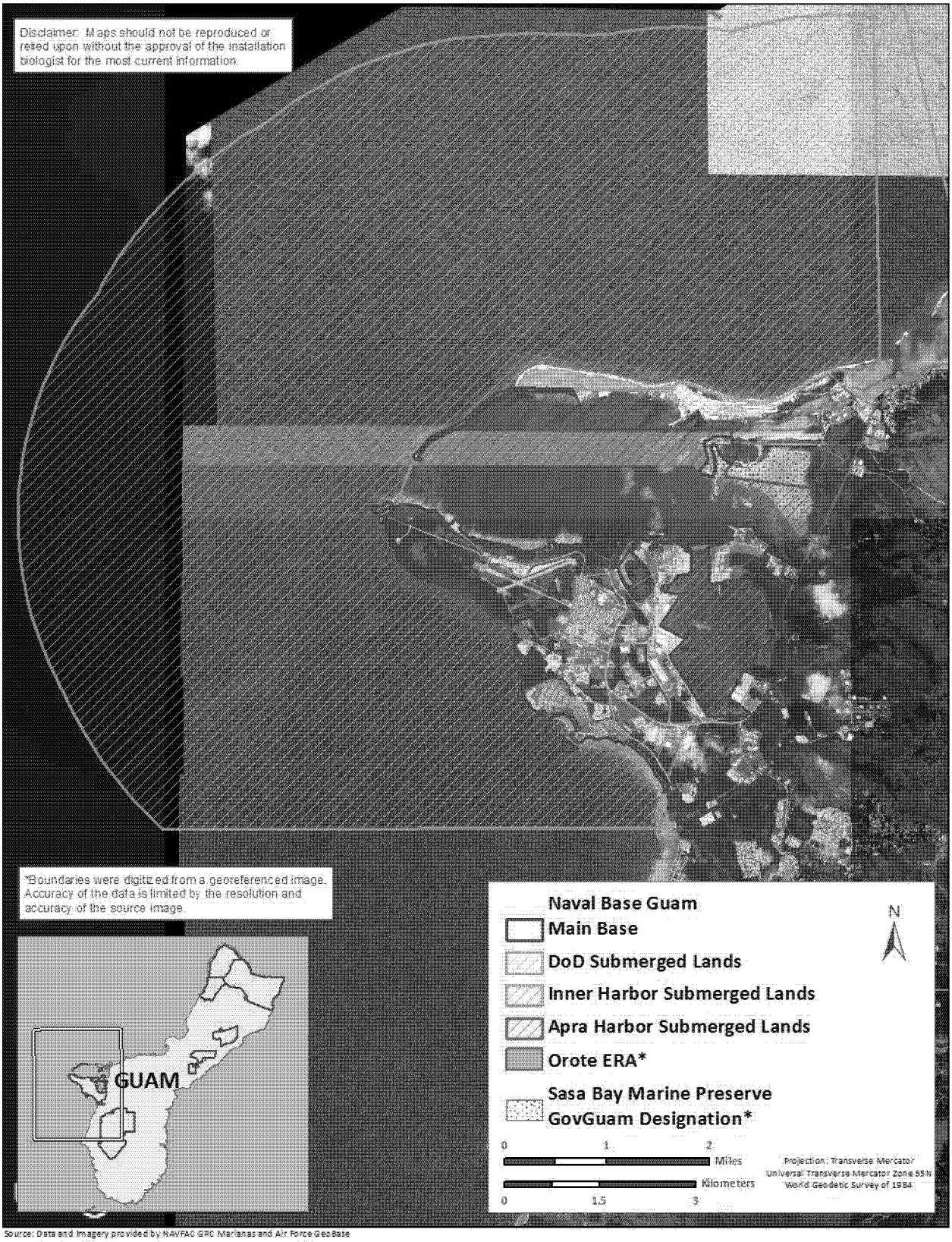


Figure 4-9. JRM Managed Submerged Lands at NBG Main Base

The majority of the Navy's activities with the potential to impact corals and coral reefs occur within Apra Harbor. Located midway along Guam's west coast, it is the archipelago's only deep lagoon with depths exceeding 150 feet. Apra Harbor was drastically altered during and after World War II. The harbor can be divided into five major components: Inner Apra Harbor, Sasa Bay, Eastern Apra Harbor, the Commercial Port, and Outer Apra Harbor (see **Figure 4-9**). Apra Harbor is the busiest commercial port in all of Micronesia; it also supports substantial recreational/tourist water sports activities and is the Apra Harbor Naval Complex. In spite of all this activity, Apra Harbor "…holds a vibrant and thriving marine community, including well developed reefs with some of the highest coral cover on Guam, and a diverse biota of algae, invertebrates, and fish. In this regard, the harbor is unlike most other major ports, which tend to become greatly degraded for marine life" (Paulay et al. 1997). Paulay's statements are still true; as of September 2010, there are still world-class reefs within Apra Harbor. This rating is based upon the percentage of sea floor covered by coral (more than 90 percent in many areas), the physical complexity and rugosity of the reefs, health of the coral, and diversity of corals and associated organisms (NAVFAC ESC 2010). In most of Apra Harbor, *Porites rus* is strongly dominant, based upon frequency of occurrence and percentage of total sea floor covered (Smith 2004, 2006, 2007; Smith and Marx 2006). This species is very tolerant to high levels of turbidity and is seldom, if ever, attacked by the crown of thorns sea star. *Porites rus* exhibits striking growth patterns of thin spires and wide plates, and stout knobs. The dominance of *Porites rus* is less pronounced on the deeper knolls in Outer Apra Harbor and near the mouth of the harbor (NAVFAC ESC 2010).

Most of the submerged knolls in the Outer Apra Harbor, the Western Shoals complex, Jade Shoals, and the western edge of Dry Dock Island all support well-developed complex reefs. It is essential to note that not all of Apra Harbor qualifies for such high ratings. Inner Apra Harbor was artificially created during and after World War II. Inner Apra Harbor and the Commercial Port do not support any coral reefs and nearly all the corals present are located on steel sheet piles or pilings. Sasa Bay, Polaris Bay, the Turning Basin, and the remaining portions of Eastern Apra Harbor contain corals and coral reefs; however, the reefs in these areas are inferior to those in the other portions of Apra Harbor based upon the percentage of sea floor covered by coral, the physical complexity and rugosity of the reefs, health of the corals, diversity of corals, and associated organisms (Smith 2007).

Additionally, a coral reef assessment for Guam was completed by the UOG Marine Laboratory in 2005, and included reefs on NBG in Apra Harbor, off Orote Point, and within the Haputo and Orote ERAs. Their findings show that the patch and fringing reefs in the southern portions of Apra Harbor are in good condition; however, those in the west and northwestern portions of the harbor have been impacted by sedimentation, recreational diving, and thermal discharges. The reefs within the Orote ERA were determined to be in fair condition (Porter et al. 2005). A General Management Plan for Orote Peninsula was prepared in 2010 (SWCA 2010a).

4.2.2.5 Protected Species

The federally endangered Mariana common moorhen and hawksbill sea turtle, the federally threatened green sea turtle, and the Guam endangered *Heritiera longipetiolata* have been documented on NBG Main Base. Potential habitat is present on NBG for six other federally endangered, threatened, or candidate species. Six federally listed cetaceans and one additional federally listed sea turtle have the potential to occur in the JRM managed submerged lands that extend 3 nautical miles seaward from the coastline off NBG.

Flora

There are several populations of *Heritiera longipetiolata*, a forest tree species Guam-listed as endangered by GovGuam, as well as *Cycas micronesica* within the OPERA (NAVFACPACIFIC 2010b). *H. longipetiolata* also occurs in the limestone forest adjacent to the San Luis Ponds.

Fauna

Terrestrial Species

Birds

Mariana common moorhen. Wetland habitats suitable for the Mariana common moorhen exist on NBG Main Base. Moorhens are known to occupy these wetlands at least during the wet season, and possibly also in the dry season, if open water habitat remains present. Two Mariana common moorhens were observed at the San Luis Ponds during a recent survey in 2010 and 2011. Moorhens are not known to nest at any of the wetlands on NGB. Wetlands I and J of the Camp Covington wetlands are designated as a Mariana common moorhen sanctuary (AECOS and Wil Chee 2009). The Camp Covington wetland on NBG was identified as a habitat requiring species-specific surveys to determine whether the Mariana common moorhen is present. Eleven listening survey stations were placed within the Camp Covington wetland during a 2009 endangered species survey. No Mariana common moorhens were detected during this survey (NAVFACPACIFIC 2010b). See **Section 4.1.2.6** for additional information on the Mariana common moorhen.

Mammals

Mariana fruit bat. Historic fruit bat colony roosts have been reported from forested cliffline habitat on NBG Main Base at Orote Point. Between January and April 1966, between 100 and 300 bats were observed at Orote Point, and by June of that year the total had increased to 600 (Wheeler 1979). In 1971, a colony of 150 fruit bats was observed at Orote Point (Wheeler 1979); this is the last record of a large fruit bat aggregation on NBG Main Base or anywhere in southern Guam. Incidental sightings of single fruit bats or pairs of bats have been made on NBG Main Base; but 4 days of fruit bat surveys conducted at the OPERA in 2008 did not detect any fruit bats (Brooke 2008). Limited forested cliffline habitat suitable for Mariana fruit bats exists on NBG Main Base in the Orote Point Area.

Invertebrates

Insects

Mariana eight-spot butterfly. Three adult Mariana eight-spot butterflies and four larvae were observed in the Spanish Steps area of Orote Point in 1995 (Schreiner and Nafus 1996). Larvae were observed on the host plant *Elatostema calcareum*. Surveys conducted by SWCA did not find any larvae in the HERA. The Mariana eight-spot butterfly has two host plants, *E. calcareum* and *Procris pedunculata*; both species are present on NBG in the OPREA. The current status of the Mariana eight-spot butterfly on NBG Main Base is not known.

Gastropods

Guam tree snail. Surveys conducted in 1920 by Crampton (1925) detected two species of partulid tree snail in the Orote Point area, the humped or Mariana tree snail and the Guam tree snail. The population was skewed heavily toward the Guam tree snail. In 1989, Hopper and Smith resurveyed Crampton's former Orote Point site and found only one species, the Guam tree snail (Hopper and Smith 1992). The current status of this population is not known. The humped tree snail was observed in strand vegetation at Gab Gab Beach during site characterizations conducted by HDR at the San Luis Ponds in 2011.

Marine Species

Marine Mammals

In 2007, SRS-Parsons et al. (2007) conducted a marine mammal and sea turtle survey covering 170,500 square nautical miles around Guam and the CNMI. The survey area was bounded by 10°–18° N Latitude and 142°–148° E longitude. Nine unique marine mammal species were identified, including the federally endangered sei, sperm, and humpback whales. Sperm whales were the most commonly observed whales during the study. Marine mammals have the potential to occur in JRM managed submerged lands that extend 3 nautical miles seaward from the coastline at NBG Main Base.

Sea Turtles

Green sea turtle. Green sea turtles are known to use the nearshore and Apra Harbor waters, and can nest on the beaches within NBG Main Base. A young green sea turtle was sighted during natural resources surveys in 2008 between Abo Cove and the south end of Victor Wharf (DoN 2010). Sea turtle nesting has been observed on the beaches of Andersen AFB, Cocos Island, and at the Spanish Steps on NBG Main Base. The Navy monitors for sea turtle nesting on selected beaches throughout the year.

Hawksbill sea turtle. Hawksbill sea turtles are known to use the nearshore and Apra Harbor waters, and can nest on the beaches within NBG Main Base. Nesting of hawksbill sea turtles has been recorded on a small beach within the Sumay inlet; however nesting has not been observed since 1995. The majority of sea turtle nesting on Guam occurs on the beaches of Andersen AFB to the north, or on Cocos Island to the south; however, the Navy monitors for sea turtle nesting on selected beaches throughout the year.

'Dark sky' appropriate lights have been installed at the Deployed Sailor Parking lot near the NBG Laundromat, the parking lot near BLD 2122A (across from Operations), and the parking lot in front of the Sumay Marina Clipper cove building. Wharf lighting is placed to minimize effects to sea turtles and other wildlife. As part of the Andersen AFB Tarague Beach electrical upgrade project Section 7 consultation (USFWS letter 2012-I-0007), turtle friendly lights are required and are being installed to illuminate the parking area and volleyball court. In other recreational areas in the Tarague Basin, outdoor recreation (FSS/MWR) has come up with some creative ways to reduce lighting impacts to nesting sea turtles, but has not directly installed turtle friendly specific lighting fixtures or bulbs.

4.2.2.6 Invasive Species

Flora

Vegetated areas that have been disturbed by clearing, construction, and other activities on NBG Main Base are dominated by nonnative and invasive plant species, and include a number of invasive weeds (U.S. Navy 2009). During the 2008 vegetation survey on Polaris Point, tangantangan composed 88 percent of the tree layer within the transect (NAVFACPACIFIC 2010b). Common introduced understory tree species documented on NBG Main Base include tangantangan, limeberry, and papaya. Other invasive fauna on NBG Main Base include house mice and rats, Asian house shrews, feral pigs, brahminy blind snakes, and manokwar flatworms. The Camp Covington Wetlands L, N, J, and I are dominated by the native invasive *Phragmites karka*. Large common bamboo stands occur along the banks of portions of the Aguada and Sasa rivers on NBG Main Base (NAVFACPACIFIC 2010b).

Fauna

The black francolin, island collared dove, black drongo and Eurasian tree sparrow occur on NBG Main Base (NAVFACPACIFIC 2010b). These species are common, introduced, breeding residents on Guam (NAVFACPACIFIC 2010b). Four exotic species were documented on Polaris Point at NBG Main Base

during the 2008–2009 herpetofauna surveys including curious skink, house gecko, brown treesnake, and marine toad (NAVFACPACIFIC 2010b). Gunther's Amoy frog was detected in the estuarine habitats associated with the San Luis Ponds on NBG Main Base during surveys conducted by HDR in November 2010 and February 2011. Other invasive fauna on NBG Main Base include house mice and rats, Asian house shrews, feral pigs, brahminy blind snakes, and manokwar flatworms.

4.3 Naval Munitions Site

4.3.1 General Physical Environment

4.3.1.1 Climate

The climate at the NMS is the same as the climate for Guam as a whole. See **Section 4.1.1.1** for a description of the climate on Guam.

4.3.1.2 Geology and Topography

The NMS is in the southern structural province of Guam (see **Figure 4-1**). The western boundary of this site coincides with a range of low mountains orientated on a north-to-south axis. This range includes Mount Alifan; Mount Almagosa; Mount Lamlam, which attains a height of 1,334 feet (407 meters) above msl; and Mount Humuyong (see **Figure 4-2**). This range lies on the Bolanos structural block, which consists of rock from the Miocene-aged Umatac Formation. The Umatac Formation is composed of east-dipping (5–10 degrees) volcanic rocks, including flow basalts (Dandan Member) and tuff breccia or tuff-derived conglomerate, sandstone, and shale (Bolanos Member). The tuff is consolidated volcanic ash that was marine-deposited and uplifted. Breccia refers to the angular fragments of the conglomerate. Portions of the range have alternated between periods of submergence and emergence as evidenced by the presence of the Alifan Limestone (U.S. Navy 2009).

4.3.1.3 Seismology

The Talofofo Fault Zone crosses the NMS in a northwest-southeast direction (GHS 2008). Several smaller faults cross the site in a north-south direction (GHS 2008). The NMS is not in an area vulnerable to liquefaction, nor is it in danger of tsunami inundation (GHS 2008).

4.3.1.4 Soils

The landscape of the NMS is more complex than the other JRM sites, and includes soils formed on bottomland, volcanic plateaus, and limestone plateaus. The soils found at the higher elevations along the mountain range from Mount Alifan to Mount Lamlam consist of shallow, well-drained limestone soils. Extensive areas of highly weathered volcanic soils are present in the central and southern portions of the NMS. Soils along the broad river bottoms tend to be poorly drained soils formed from sediment eroded from the upland limestone and volcanic soils (see **Figure 4-10**).

4.3.1.5 Hydrology

Groundwater. Groundwater on the NMS occurs in volcanic rocks and older limestone with low permeability. The water table occurs at elevated levels in places and discharges as springs where the groundwater intersects the ground surface.

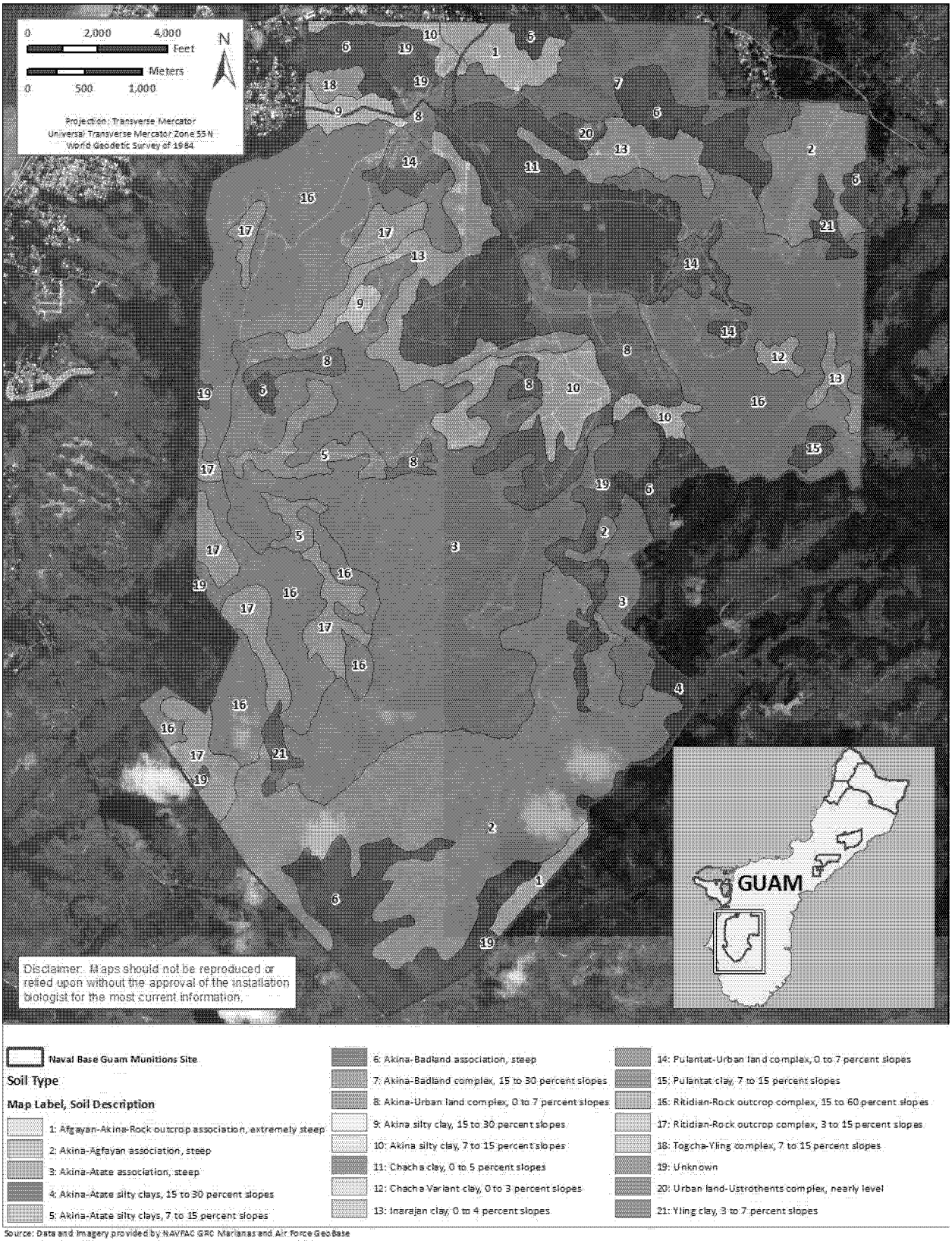


Figure 4-10. Soils on Naval Munitions Site

Surface Water. A total of nine major perennial stream courses exist within the NMS (see **Figure 4-11**). Four of the streams (Imong, Sadog Gago, Maulap, and Almagosa) have relatively steep gradients and flow into Fena Reservoir, which was formed from the construction of a dam. Three of the perennial streams (Bonya, Talisay, and Maemong) converge with the Maagas River before meeting the Talofofo River east of the NMS. The Maagas River is also known as the Lost River because it disappears underground and resurfaces again. The Mahlac River flows southeast out of the NMS eventually joining the Maagas River. The Mahlac, Bonya, Talisay, Maemong, and Maagas rivers have more gentle gradients than the streams flowing into Fena Reservoir, which results in broad river basins. See **Section 4.3.2.2** for additional information regarding freshwater ecosystems on the NMS.

4.3.2 General Biotic Environment

4.3.2.1 Terrestrial Ecosystems

Flora

Vegetation communities on the NMS include limestone, ravine, wetland, and savanna communities. See **Figure 4-12** for a map of the terrestrial vegetation communities occurring on the NMS.

Limestone Communities. Limestone communities are situated on elevated limestone terraces, plateaus, and slopes within the NMS. The NMS has the largest extent of interior limestone communities on JRM lands on Guam. These limestone communities persist on the ridge tops and upper slopes from Mount Lamlam northward to Mount Alifan. A narrow band of a halophytic-xerophytic scrub plant community occurs near Mount Almagosa on the NMS (U.S. Navy 2009).

Ravine Communities. Ravine forest plant communities are abundant in the NMS, occupying much of the south-central portion of the installation. Swamps, which are delineated as ravine communities, are often present on argillaceous limestone soils, bottomlands, and in depressional areas. Sea hibiscus and *Pandanus* spp. are the most common woody plants associated with these communities, often forming dense thickets. *Barringtonia racemosa*, a tall forest tree, dominates bottomland forest in areas along the Talofofo River. Extensive areas of disturbed ravine forest are also present in the NMS, especially in areas subject to low-intensity ground fires and past human disturbance. Several acres of coconut plantations still exist within the NMS (U.S. Navy 2009).

Twelve native species were documented along transects during the 2008 vegetation surveys within the ravine forests in the northern sector of the NMS: screwpine, sea hibiscus, *Calophyllum inophyllum*, *Glochidion marianum*, *Melastoma malabathricum*, *Cycas micronesica*, Indian mulberry, *Cynometra ramiflora*, *Cerbera dilatata*, *Pandanus dubius*, *Discocalyx megacarpum*, and *Eugenia reinwardtiana* (NAVFACPACIFIC 2010b). Native tree species dominated the relative density of trees in all transects performed in the northern sector. Screwpine and sea hibiscus were the most dominant native species in the northern sector (NAVFACPACIFIC 2010b). Common introduced tree and shrub species within the northern sector include the betelnut palm, vitex, the invasive bay rum tree (*Pimenta racemosa*), and limeberry (NAVFACPACIFIC 2010b).

The ravine forest in the valley slopes surrounding Mount Almagosa in the southern sector of the NMS is characterized by the dominant native *Merrilliodendron megacarpum* (known as faniok in Chamorro) that composed more than 63 percent of the relative density during the 2009 vegetation survey. The ravine forest along the Sadog Gagu River in the southern sector of the NMS is dominated by coconut and two introduced species, vitex and betelnut palm. The overall relative density of native species along the Sadog Gagu River was approximately 33 percent, which is lower than the densities observed in ravine forest transects in the northern sectors of the NMS. In the ravine forest in the southwestern sector of the installation, south and west of the explosive ordnance disposal range, the introduced species coconut and betelnut palms and native screwpine are dominant (NAVFACPACIFIC 2010b).

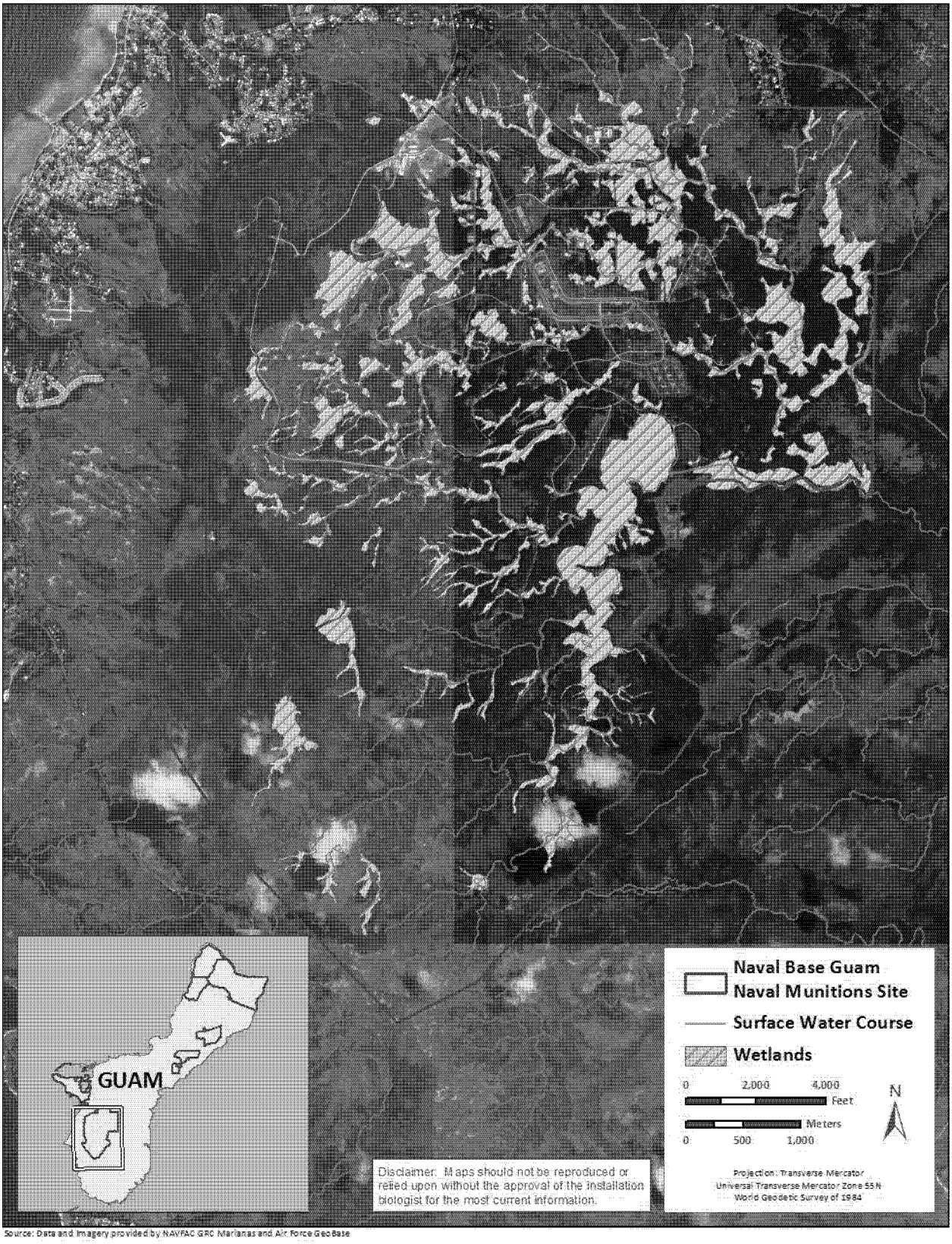
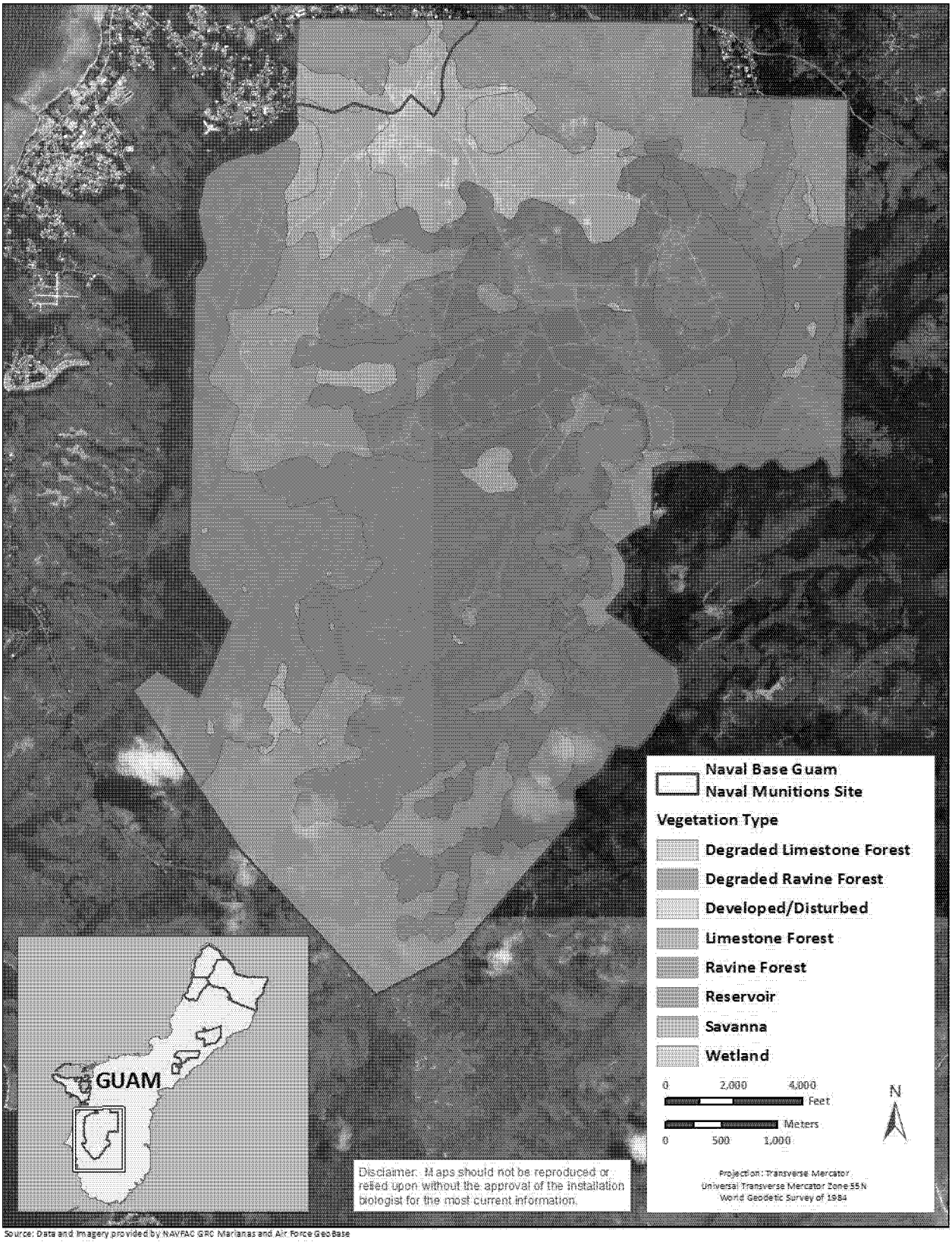


Figure 4-11. Surface Water and Wetlands on Naval Munitions Site



Source: Data and Imagery provided by NAVFAC GRC Marianas and Air Force GeoBase

Figure 4-12. Vegetation Communities on Naval Munitions Site

Wetland Communities. The NMS has the greatest delineated area of wetlands on JRM lands (U.S. Navy 2009). Based on the 2007 wetland survey and previous wetland delineations, the NMS has 1,149 acres (465 hectares) of wetlands, composing approximately 13 percent of the installation (see **Figure 4-11**) (AECOS and Wil Chee 2009). Most of these freshwater wetlands are adjacent to the rivers or their tributaries. Wetlands on the NMS occur in limestone forest, ravine forest, and savanna communities. Common forested wetland species include sea hibiscus, coconut, screwpine, and the betelnut palm (AECOS and Wil Chee 2009).

Savanna Communities. Erosion in savanna communities is particularly evident within the NMS. Large areas of bare ground are present primarily due to wildland fires and destruction of vegetation by feral ungulates. The Navy has been working to reestablish vegetation in these "badlands" with some success.

Fauna

Birds. The following avian species were identified during the 2008–2010 roadside and forest bird surveys performed on the NMS: island collared dove, black francolin, Pacific golden-plover, black drongo, white tern, yellow bittern, and gray-tailed tattler. The island collared dove and black francolin were the most commonly observed species on the NMS. In addition, even though the Mariana swiftlet was not observed during the 2008–2010 avian species roadside and forest bird surveys, the species is known to occur at the site. The island collared dove, black francolin, black drongo, and Eurasian tree sparrow are common, introduced, breeding residents in Guam (NAVFACPACIFIC 2010b). The white tern is an uncommon, native, breeding resident of Guam. The Pacific golden-plover and gray-tailed tattler are common, nonbreeding visitors to Guam (NAVFACPACIFIC 2010b).

Mammals. There are rare reports of Mariana fruit bats from southern Guam around the Fena Reservoir. Between 1985 and 1999, there were only 38 confirmed sightings of Mariana fruit bats in the upper Talofofo River watershed. Twenty-three of these occurred at or near Fena Reservoir. Other sightings of bats were fairly well-distributed across the NMS. No sightings were reported outside the NMS (Morton and Wiles 2002). Despite restricted public access to the NMS and the relative remoteness of this watershed, illegal entry by hunters might be frequent. Introduced Philippine deer and carabao are the main game hunted, but hunters presumably also take fruit bats when the opportunity arises (Morton and Wiles 2002). Other mammal species on the NMS include pigs, rats, feral dogs, and feral cats.

Reptiles and Amphibians. Twelve herpetofauna species were documented on the NMS during 2008–2009 herpetofauna surveys. Of these, five species are native to Guam: blue-tailed skink, moth skink, mourning gecko, stump-toed gecko, and Pacific slender-toed gecko; and seven species are introduced to Guam: curious skink, house gecko, brown treesnake, marine toad, eastern dwarf tree frog, crab-eating frog, and Gunther's Amoy frog (NAVFACPACIFIC 2010b). The capture of two Guam-listed endangered species (i.e., moth skink and Pacific slender-toed gecko) on the NMS is noteworthy. The distribution and abundance of the moth skink on Guam is unknown, due to the variability of information presented by authors. The Pacific slender-toed gecko is a rarely seen gecko (NAVFACPACIFIC 2010b). The continued widespread presence of the brown treesnake, the curious skink, and other introduced amphibian species is of concern because of each species' potential deleterious impacts on Guam's native fauna (NAVFACPACIFIC 2010b).

4.3.2.2 Freshwater Ecosystems

The NMS contains the greatest areas of freshwater habitats on JRM. There are nine rivers that cross portions of the NMS (i.e., Talisay, Maemong, Bonya, Mahlac, Maagas, Maulap, Almagosa, Sadog Gago, and Imong). Fena Reservoir is the largest freshwater body on Guam, spanning 200 acres (81 hectares) (U.S. Navy 2009). **Section 4.3.1.5** provides a description of rivers associated with the NMS.

Flora

During the 2009–2010 natural resources survey, some transects passed over streams and swampy ground where trees including coconut palm, pandanus, and sea hibiscus were dominant. One transect was dominated by Pacific Island silvergrass, a tall grass species that can grow to a height of 13 feet (4 meters) (NAVFACPACIFIC 2010b).

Much of the shoreline of Fena Reservoir supports wetland plant communities. As the water depth increases within the lake, the wetland communities are replaced with floating aquatic plants. Floating aquatic flora found in Fena Reservoir and some streams includes hydrilla (*Hydrilla verticillata*), curly pondweed (*Potamogeton crispus*), bladderwort (*Utricularia* sp.), and aquatic ferns (*Ceratopteris* sp.). Water current is a major limiting factor in the development of plant communities in lotic habitats. Water depth and current in streams varies with location and are strongly influenced by storm events (U.S. Navy 2009). Hydrilla has overwhelmed the Fena Reservoir and restricts sunlight to native plants (GDAWR 2006a). The native water fern, *Ceratopteris thalictroides*, is common in Fena Reservoir. This water fern might be an endemic species (GDAWR 2006a).

Fauna

Birds. Migratory birds, which are protected under the MBTA, are frequently observed foraging and resting on Fena Reservoir and along its shores. The largest population of the Mariana common moorhen, federally listed as endangered, is known to inhabit the shoreline of Fena Reservoir (U.S. Navy 2009).

Bird species observed during the 2009 natural resources survey on the NMS that could use the freshwater habitats on the installation include the yellow bittern and Pacific golden-plover (NAVFACPACIFIC 2010b).

Fish. In order to control the growth of pondweed and bladderwort in shallow waters of Fena Reservoir, two species of tilapia (the Mozambique tilapia and *Tilapia zillii*) were introduced into the reservoir in the 1950s. Mosquito fish and guppies were also introduced to the reservoir for the control of mosquitoes. During the 1960s, other species, including tucunare (*Cichla ocellaris*), small mouth bass (*Micropterus dolomieu*), largemouth bass (*Micropterus salmoides*), and channel catfish (*Ictalurus punctatus*) were introduced to control the stunting of the tilapia and to increase angling opportunities. Surveys to monitor the status of the introduced species ended in 1969, and, since that time, no stock assessments have been conducted in Fena Reservoir. Additionally, other species, such as unwanted aquarium pets, have been deposited in the lake over the years (GDAWR 2006b). These include peacock bass, tilapia, hydrilla, and soft-shell turtles. These introduced species pose a threat to the indigenous and endemic species within the reservoir and downstream waters (U.S. Navy 2009). Currently, there are no efforts being made to control established exotic fishes (GDAWR 2006a). Marbled eels have also been observed in Fena Reservoir (U.S. Navy 2009).

All of the indigenous fish occurring within the rivers on Guam are diadromous, requiring access to both salt water and fresh water during their life cycles. Although the streams have not been well-studied on the NMS, it is assumed that numerous species of native gobies (family Gobiidae), all of which are amphidromous, occur within the nine rivers that cross portions of the Annex (U.S. Navy 2009).

Reptiles and Amphibians. Four introduced amphibian species were observed on the NMS during the 2009 natural resources survey: marine toad, eastern dwarf tree frog, crab-eating frog, and Gunther's Amoy frog. The continued widespread presence of these introduced amphibians is of concern because of each species' potential deleterious impacts on Guam's native fauna (NAVFACPACIFIC 2010b).

Macroinvertebrates. Crustaceans, including Tahitian prawn, three species of native freshwater crabs (*Varunid* spp.), and several species of mollusks (snails) are present in freshwater streams on Guam. The native freshwater prawn, freshwater crabs, and nerite snails are especially common in the upper reaches of rivers on Guam, and likely occur within the nine rivers that cross the NMS (U.S. Navy 2009, GDAWR 2006a).

4.3.2.3 Estuarine Ecosystems

There are no estuarine ecosystems on the NMS.

4.3.2.4 Submerged Lands

No JRM managed submerged lands are associated with the NMS.

4.3.2.5 Protected Species

Fauna

Terrestrial Species

Birds

Mariana swiftlet. The Mariana swiftlet was once the most common bird on Guam (USFWS 1991b). It is currently known from only three caves, Mahlac, Maemong, and Fachi, all on the NMS. This is the only known roosting location for this species on Guam except for an unconfirmed report of a few birds in a cave near Janum Point in northern Guam (GDAWR 2006a). The Navy, USFWS, and GDAWR have been monitoring the population of swiftlets at these caves for 23 years. The Mariana swiftlet has maintained a small population of about 400 to 500 birds through the 1980s and 1990s. Although small fluctuations in the population have been documented during this period, there was no significant growth. Brown treesnake traps were initially deployed outside of Mahalac cave in 2000 and the population of swiftlets appears to be increasing (see **Figure 4-13).** The population of Mariana swiftlet in 2010 was estimated to be between 1,100 and 1,500 birds. Swiftlet populations on Saipan are also increasing and brown treesnakes are not believed to be present in those caves; therefore, recovery could be attributed to other things.

White-throated ground-dove. This species was extirpated from Guam along with several other forest bird species in the mid-1980s. In 2003, two male ground-doves were observed in the Tarague Basin area of Andersen AFB. These birds are assumed to be dispersing from neighboring Rota. Previously, the last white-throated ground-dove was sighted in northern Guam in 1987. The white-throated ground-dove has not been recently documented on the NMS, but suitable habitat for this species exists in the native forests surrounding Fena Reservoir and on the eastern slopes of the southern mountains from Mount Alifan to Mount Lamlam.

Mariana Common Moorhen. In 2001, Takano and Haig (2004) surveyed three wetlands on the NBG NMS including Fena Reservoir, Fena Dam spillway and the Naval Magazine Pond. Surveys were conducted during the dry season when moorhens were expected to be more concentrated on perennial wetlands and therefore easier to count. Of the 90 birds estimated to be on Guam during the survey, 38 were located on wetlands in the NMS. The majority of those birds, 33, were using the Fena Reservoir. Since 2001, eutrophication of Fena Reservoir following a typhoon resulted in the loss of *Hydrilla verticillata,* a water plant used by moorhens as a nesting substrate. The moorhen population at the reservoir declined following the loss of the plant (USFWS 2009b). A comprehensive survey of wetlands on Guam, Tinian, and Saipan is necessary to determine the redistribution and current population trend of the Mariana common moorhen following the partial abandonment of Fena Reservoir as a perennial wetland habitat.

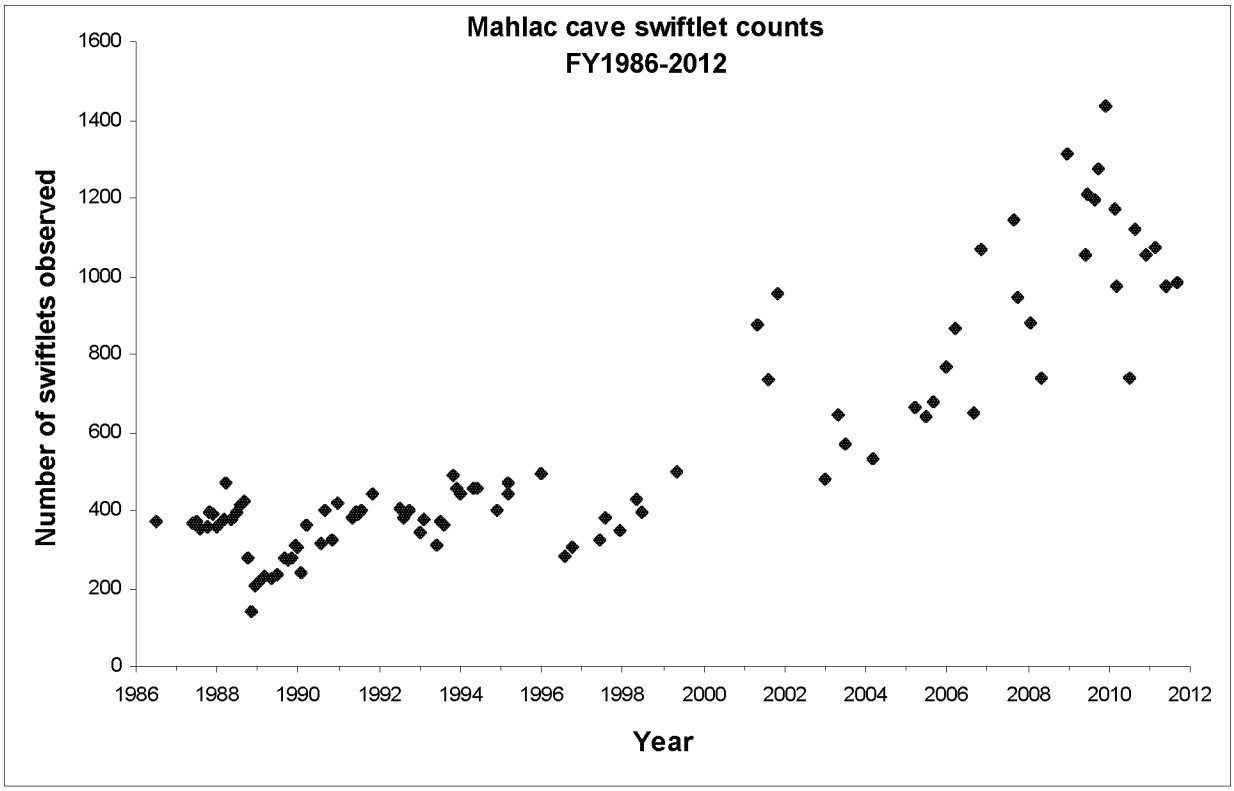


Figure 4-13. Mariana Swiftlet Population Data from Mahlac Cave within Naval Munitions Site from FY 1986–FY 2012. (Data provided by A. Brooke, NAVFACMAR)

Mammals

Mariana fruit bat. A monthly census of fruit bat numbers on Guam began in 1962. Since that time there have been no large fruit bat colonies recorded in the region of the NMS. Typically, solitary fruit bats, or small groups are observed flying, foraging, or roosting in the NMS. Between 1963 and 1968 the number of bat observations in the Fena Reservoir area of the NMS dropped from 53 bats per 100 acres to approximately five bats per 100 acres (Perez 1972). Wiles (1987b) estimated as many as 25 to 50 fruit bats occupied the interior forested region of the NMS and Talofofo. Fruit bat surveys conducted at nine stations on the NMS detected a single bat along Almagosa Road (Brooke 2008). Fruit bats have been observed by natural resources staff at Fena reservoir since 2008. In addition, a fruit bat was observed at Fire Break 3 road in 2010.

Reptiles

Moth skink. Moth skinks have an unknown distribution on Guam and are not frequently encountered. Five moth skinks were captured during herpetofauna surveys in the NMS in 2008 (DoN 2010). The moth skink is not a federally listed species, but GovGuam lists the species as endangered.

Pacific slender-toed gecko. Five Pacific slender-toed geckos were recorded during herpetofauna surveys on the NMS in 2008 (DoN 2010). Two individuals were captured using glue-boards, and three were observed during visual surveys. This species is rarely seen and has been listed as an endangered species by GovGuam. It is not a federally listed species.

Invertebrates

Gastropods

Humped tree snail. Early partulid tree snail surveys by Crampton (1925) and Hopper and Smith (1992) did not survey locations inside the NMS except for the Mount Alifan area. The Guam tree snail was detected in the west-central highlands near Mount Alifan along with two other species, the humped tree snail and the newly described Mount Alifan tree snail (*Partula salifana*). Extensive surveys by Hopper and Smith (1992) on 1989 failed to detect any living partulid tree snails at this location. Surveys conducted in 2009 in the NMS found dead, weathered shells of humped tree snails in the Alamogosa Springs area. No live humped tree snails were found.

Guam tree snail. Early partulid tree snail surveys by Crampton (1925) and Hopper and Smith (1992) did not survey locations inside the NMS except for the Mount Alifan area. The Guam tree snail was detected in the west-central highlands near Mount Alifan along with the humped tree snail and the Mount Alifan tree snail. Extensive surveys by Hopper and Smith (1992) in 1989 failed to detect any living partulid tree snails at this location. Surveys conducted in 2008 found two populations of Guam tree snails along Kitts Road on the NMS (Smith et al. 2008) (see **Figure 4-14**).

Mount Alifan tree snail. Early partulid tree snail surveys by Crampton (1925) and Hopper and Smith (1992) did not survey locations inside the NMS except for the Mount Alifan area. It was at the Mount Alifan site that Crampton described a new species of partulid tree snail, the Mount Alifan tree snail. This species was subsequently found and verified by Abbott in 1945 and by Langford in 1946 (Hopper and Smith 1992). The Mount Alifan tree snail was found to be restricted to the west-central highlands of Guam in the vicinity of Mount Alifan. Extensive surveys for the species by Hopper and Smith (1992) in 1989 failed to detect this species and it is assumed to be extinct.

Flora

Tree fern. The tree fern *Cyathea lunulata* was observed in the NMS during vegetation surveys conducted in 1989 (BioSystems Analysis, Inc. 1989). This tree fern is not a federally listed species, but GovGuam lists the species as endangered.

4.3.2.6 Invasive Species

Flora

Common invasive tree species within the ravine forests on the NMS include betelnut palm, vitex, bay rum tree, and limeberry (NAVFACPACIFIC 2010b). Coconut and betelnut palms are common in the forested wetlands on the NMS (NAVFACPACIFIC 2010b). Erosion in savanna communities is particularly evident within the NMS. Large areas of bare ground are present primarily due to wildland fires and destruction of vegetation by feral ungulates. The Navy has been working to reestablish vegetation in these areas with some success. Erosion within the savanna communities on the NMS creates areas vulnerable to the establishment of invasive plant species (U.S. Navy 2009).

Fauna

The Navy Munitions Site has a high population of invasive ungulates that impact vegetation communities, which in turn leads to habitat degradation, increased erosion, and reduced water quality (U.S. Navy 2009). Trend data compiled by the GDAWR indicate that the carabao population fluctuates; however, the trend from 1975 to 2000 suggested an increasing population on the NMS. Migration and immigration between the Navy Munitions Site herd and the Bubulao watershed herd is suspected. Immigration from recently

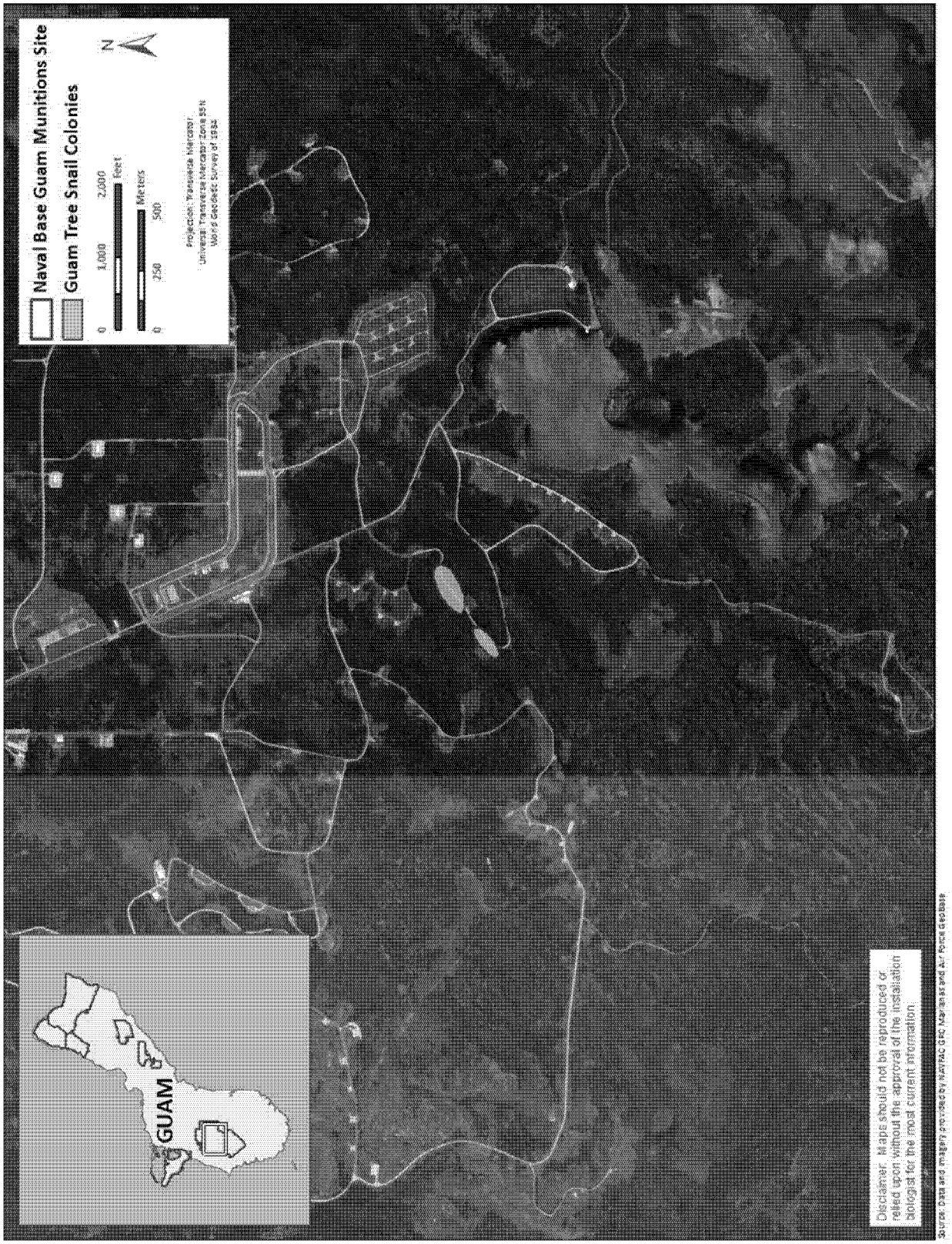


Figure 4-14. Guam tree snail populations observed during surveys conducted in 2009 in NMS (Smith et al. 2008)

escaped or released carabao from farms and villages also contributes to the herd size. Mortality in the carabao herds is low, although illegal poaching is common (U.S. Navy 2009). During the 2009 natural resources survey, ungulate activity on the NMS was evidenced by soil disturbance, such as rooting and browsing. Erosion, vegetation damage, and other disturbances from feral pigs, Philippine deer, and carabao are considered major problems at the NMS. The ungulate activity was especially conspicuous in the southern sector of the NMS, where active wallows, rooting, and live feral pigs were observed (NAVFACPACIFIC 2010b). An Ungulate Management Plan has been developed for NBG including the NMS, and is included in **Appendix M** of this INRMP. The Ungulate Management Plan provides implementation strategies for management and control of ungulates on NBG and the NMS.

The carabao, deer, and pig populations on the Navy Munitions Site are causing widespread damage to natural resources around the Fena watershed. Resource damage includes accelerated soil erosion, trampling of native vegetation, creation of mud wallows, and degradation of water quality due to sedimentation, and fecal material. Facilities within the Navy Munitions Site are also being damaged by these species, including destruction of chain-link fences, erosion of protective soil covering ordnance storage bunkers and around utility poles, and damage to vehicles by charging. Grazing also results in the deposit of large quantities of fecal material on roadways and parking areas (U.S. Navy 2009). Natural regulation or environmental resistance of populations is low. Other than poachers and feral dogs, there are no predators of these species on Guam. Mortality of these species is likely caused by accidents and infections such as tetanus.

The island collared dove, black francolin, black drongo, blue breasted quail, and Eurasian tree sparrow occur on the NMS. These species are common, introduced, breeding residents in Guam (NAVFACPACIFIC 2010b). During the 2008–2009 herpetofauna surveys performed on the NMS, seven introduced reptile and amphibian species were documented: curious skink, house gecko, brown treesnake, marine toad, eastern dwarf tree frog, crab-eating frog, and Gunther's Amoy frog (NAVFACPACIFIC 2010b). The continued widespread presence of the brown treesnake, curious skink, and other introduced amphibian species is of concern because of each species' potential deleterious impacts on Guam's native fauna (NAVFACPACIFIC 2010b).

4.4 Naval Base Guam Telecommunications Site

4.4.1 General Physical Environment

4.4.1.1 Climate

The climate at the NBG TS is the same as the climate for Guam as a whole. See **Section 4.1.1.1** for a description of the climate on Guam.

4.4.1.2 Geology and Topography

NBG TS lies in the northern limestone structural province (see **Figure 4-1**). Elevations at the top of the plateau range from 500 to 600 feet (152 to 183 meters) above msl. At the edge of the plateau to the north, west, and east, steep cliffs drop down to an intermittent narrow coastal lowland terrace. The coastal areas range from 200 to 900 feet (61 to 274 meters), stretching from the base of the cliffs to the shore (see **Figure 4-2**). The substrate composes a heterogeneous mixture of limestone subtypes ranging from highly friable to well-cemented, depending on the depositional source (COMNAV Mariana 2001).

The coastline in this area includes two small, localized, but important, reef flats: one off Haputo Beach and the second inshore of Double Reef (also known as Pugua Patch Reef). The Haputo area is established as the HERA. The HERA has a diverse assemblage of marine habitats, including Double Reef. Double

Reef is the most striking offshore feature along the entire northwest coast of Guam because it is the beginning of a young barrier reef that breaks the ocean surface (Paulay et al. 2002). It lies on a shallow shelf that extends considerably farther from the coast than adjacent areas. The area around Double Reef is topographically heterogeneous because of variation created by reef growth and the erosive action of the large quantities of freshwater discharge from the islands freshwater aquifer (Paulay et al. 2002).

The ground surface elevation of NBG TS generally grades downward from east-northeast to west-southwest. A north-south trending fault pattern might control formation of the karst topography. Both the southwest and southeast portions of NBG TS have evidence of sinkhole formation and clay filling of sinkhole depressions (GHS 2008). There is a small valley oriented perpendicular to the cliffline in the northwestern area that might be enhancing the erosion of the Mariana Limestone along the cliffline. This could affect surface drainage patterns in the area (GHS 2008). Numerous solution cavities and caves exist within the porous limestone bedrock. Collapses of these subterranean cavities often form sinkholes (COMNAV Mariana 2001).

4.4.1.3 Seismology

NBG TS overlies a minor fault line and is susceptible to earthquake events; however, the overall likelihood for the occurrence of landslides is generally low due to the lack of steep areas that contain soils vulnerable to slipping in seismic events. NBG TS has a low risk of liquefaction and tsunami inundation (JGPO 2010).

4.4.1.4 Soils

The majority of the soils in NBG TS are shallow, well-drained soils occurring on limestone plateaus. The cliffline areas are primarily rock outcrops with very shallow and well-drained coralline limestone soils (COMNAV Mariana 2001). Nearly all of the plateau area consists of Guam cobbly clay loams with 3–7 percent slopes (see **Figure 4-15**). Soils in the Guam-Urban Land complex and Guam-Yigo complex are also found at NBG TS.

4.4.1.5 Hydrology

Groundwater. NBG TS overlies the Finegayan Subbasin of the NGLA (see **Section 4.1.1.5**).

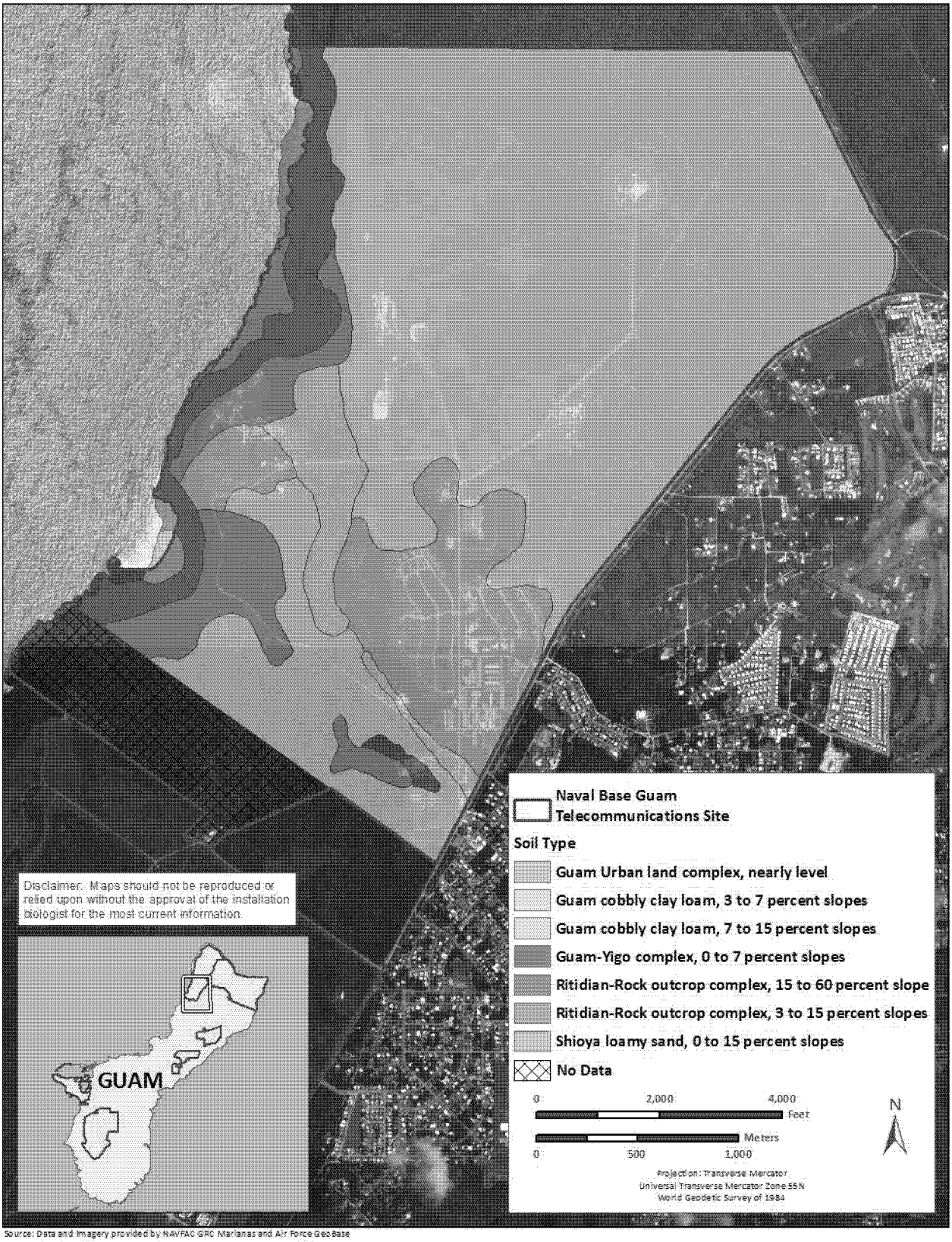
Surface Water. Because of the high permeability of the limestone substrate, no streams or other natural surface water drainage features occur on NBG TS.

4.4.2 General Biotic Environment

4.4.2.1 Terrestrial Ecosystems

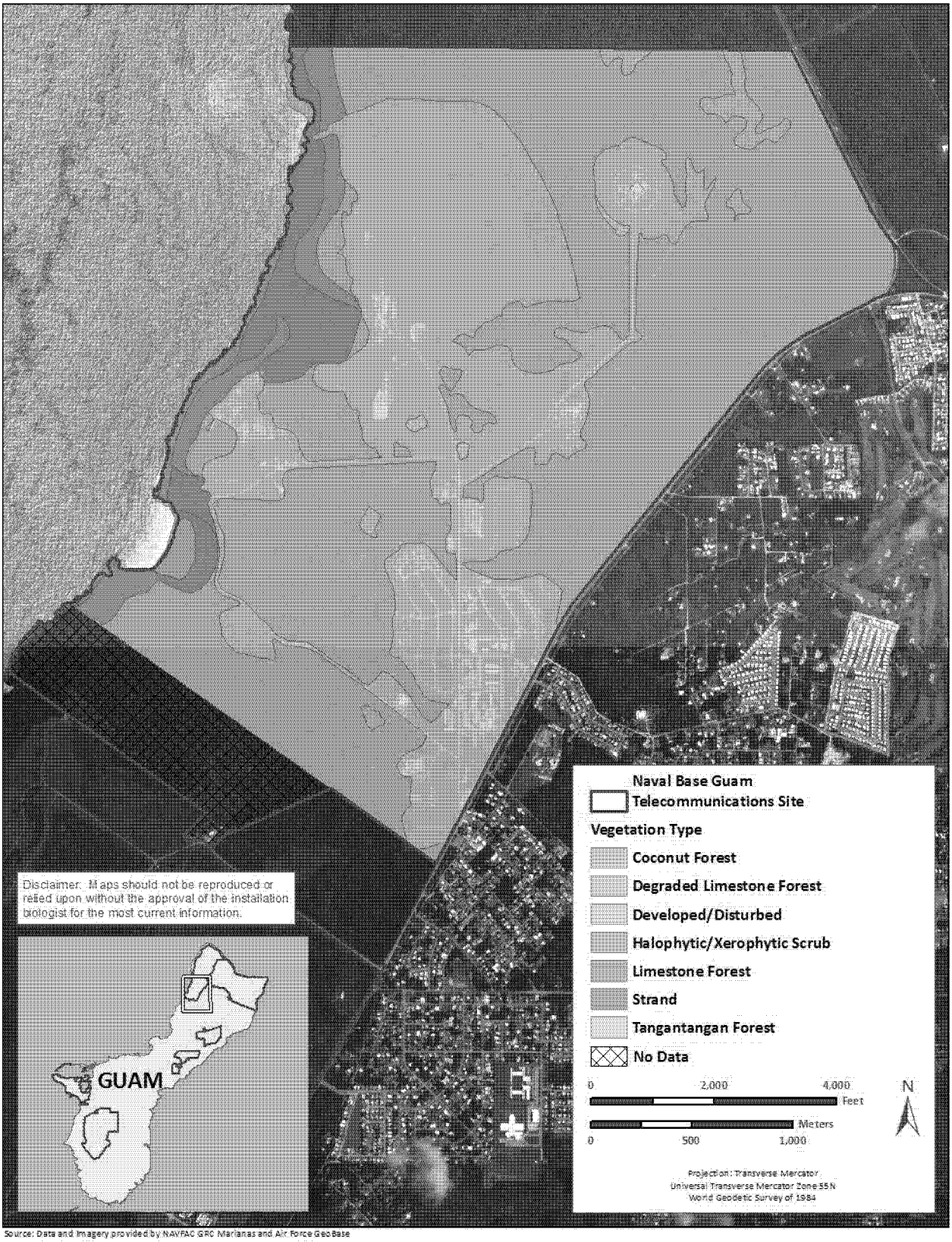
Flora

NBG TS is composed primarily of open areas (e.g., mowed grasslands) and secondary forest that is dominated by screwpine, *Guamia mariannae* (known as paipai in Chamorro), vitex, and sea hibiscus (NAVFACPACIFIC 2010b). See **Figure 4-16** for a map of the vegetation communities occurring on NBG TS. Receiving antennas and other communications equipment require open areas to prevent interference from surrounding trees or buildings. As a result, much of NBG TS has been cleared and is maintained as mowed grasslands. This has allowed for the establishment of nonnative vegetation,



Source: Data and Imagery provided by NAVFAC GRC Marianas and Air Force GeoBase

Figure 4-15. Soils on Naval Base Guam Telecommunications Site



Source: Data and Imagery provided by NAVFAC GRC Marianas and Air Force GeoBase

Figure 4-16. Vegetation Communities on Naval Base Guam Telecommunications Site

primarily in the transition areas between the mowed grasslands and the forest areas. These nonnative plant species have also moved into the forested areas, especially along the roadsides where safety areas are maintained.

This disturbance and increase in nonnative vegetation has contributed to a highly disturbed habitat and a severe decline in native forest species (U.S. Navy 2009).

Three vegetation types were described on NBG TS North (previously called Finegayan North) in 2008: limestone forest, coconut grove, and disturbed/weed community (see **Figure 4-16**) (NAVFACPACIFIC 2010b). The disturbed/weed plant community occurs at forest edges and in patches within the forest (NAVFACPACIFIC 2010b). The predominant vegetation community in NBG TS South is disturbed limestone forest (NAVFACPACIFIC 2010b). Limestone forest and the coconut grove are described in greater detail in the following paragraphs.

Limestone Communities. Limestone forests on NBG TS North occur on the upper plateau and below the cliffline (NAVFACPACIFIC 2010b). The largest area of halophytic-xerophytic scrub sub-type exists on the cliff of HERA. The majority of the plateau area supports disturbed limestone communities composed of nonnative species (U.S. Navy 2009).

During 2008 vegetation surveys performed on NBG TS North, 13 of the 19 tree species encountered on the transects in the limestone forests on the upper plateau of the annex were native trees. However, vitex, an introduced species, is a dominant component of these forests. Vitex had the highest relative density (about 22 percent), followed by native screwpine and endemic *Guamia mariannae* trees, with densities of about 17 percent each (NAVFACPACIFIC 2010b). The limestone forest below the cliffline on NBG TS North is a distinctive community comprising a stand of *Merrilliodendron megacarpum* trees that provide habitat for the Guam tree snail. The forest is situated close to sea level along the base of an escarpment and overlies karst limestone substrate. From north to south, the site transitions from faniok-dominated forest to a more mixed community (NAVFACPACIFIC 2010b).

In the forests of the southern section of NBG TS North, the three species with the highest relative densities were *G. mariannae*, screwpine, and *Neisosperma oppositifolia*, which are all native species and collectively accounted for 62 percent of the overall density. All native tree species within the southern section of NBG TS North had a combined density of 87 percent. Two native tree species, *G. mariannae* and *Aglaia mariannensis*, are endemic to the Mariana Islands and had a combined density of 27 percent (NAVFACPACIFIC 2010b).

The west-central sector of NBG TS North in the vicinity of Pugua Point contains limestone forest with a native species density of 66 percent (NAVFACPACIFIC 2010b). The limestone forest in lower NBG TS North is a distinctive community composed of a stand of *M. megacarpum* trees that provides habitat for the Guam tree snail (NAVFACPACIFIC 2010b). *Merrilliodendron megacarpum* is a native species found in only a few localities on Guam in limestone forests (GDAWR 2006a). The forest is situated close to sea level along the base of an escarpment and overlies karstic limestone substrate. From north to south, the site transitions from faniok-dominated forest to a more mixed community (NAVFACPACIFIC 2010b).

The limestone forested area on NBG TS South is dominated by nonnative vitex, tangantangan, and papaya, which compose 67 percent of the trees. The remaining 33 percent of tree cover was by five native species, none of which are endemic to Guam or the other Northern Mariana Islands. The low native tree component might be the result of past clearing activities at the annex (NAVFACPACIFIC 2010b).

Coconut Grove. A coconut grove that is a remnant from an abandoned copra plantation occurs along the coast of the HERA embayment. A disturbed/weed plant community occurs at the forest edges and in patches within the forest. This area is located close to sea level below the limestone plateau of the main annex. *Hernandia peltata*, an indigenous tree, has a relative density of about 22 percent and coconut palms composed the remainder of the trees (NAVFACPACIFIC 2010b).

Wetlands Communities. No wetlands occur on NBG TS (COMNAV Mariana 2001). Geologic conditions needed to support wetland areas (i.e., hydric soils) are not found in the highly permeable limestone plateau of northern Guam (NRCS 1988, Wiles and Ritter 1993, COMNAV Mariana 2001, NRCS 2010). Sites with the greatest likelihood to support wetlands (e.g., sinkholes or drainage swales) on NBG TS were evaluated by wetland scientists in May 2010, but no wetlands were found. These areas are mapped as wetlands by the USFWS National Wetlands Inventory (NWI) and were mapped as containing hydric soils by the NRCS (NRCS 2010). Site visits conducted in May 2010 on NBG TS document the absence of these NWI-mapped wetlands (USFWS 2009a) and NRCS-mapped hydric soils (NRCS 2010). The results of the site visit support the conclusion that no wetlands are known or expected to occur on NBG TS (NAVFACPACIFIC 2010a).

Fauna

The following avian species were identified during the 2008–2010 roadside and forest bird surveys performed on NBG TS South: Pacific golden-plover, island collared dove, black drongo, Eurasian tree sparrow, rock pigeon (*Columba livia*), and yellow bittern. The Pacific golden-plover, a nonbreeding visitor to Guam, was the most common species observed on NBG TS South (NAVFACPACIFIC 2010b). The yellow bittern is a common native resident on Guam. The island collared dove, black drongo, Eurasian tree sparrow, and rock pigeon are common, introduced, residents in Guam (NAVFACPACIFIC 2010b).

The shoreline and cliff line along NBG TS North support a number of shorebird species, which are protected under the MBTA (U.S. Navy 2009).

Mammals. The Mariana fruit bat has been documented on NBG TS North (U.S. Navy 2009). In 2008, two bats were observed during a fruit bat survey on NBG TS North, one below the cliff line of the HERA and the other crossing Route 3A (NAVFACPACIFIC 2010b).

Reptiles and Amphibians. Ten herpetofauna species were documented on NBG TS North during 2008–2009 herpetofauna surveys. Of these, six species are native to Guam: blue-tailed skink, moth skink, mourning gecko, stump-toed gecko, monitor lizard, and Pacific slender-toed gecko; four species are introduced to Guam: curious skink, house gecko, brown treesnake, and marine toad (NAVFACPACIFIC 2010b). The capture of two Guam-listed endangered species (i.e., moth skink and Pacific slender-toed gecko) on NBG TS North is noteworthy. The distribution and abundance of the moth skink on Guam is unknown, due to the variability of information presented by authors. The Pacific slender-toed gecko is a rarely seen gecko. Both species were captured in the northeastern forested portion of NBG TS North (NAVFACPACIFIC 2010b). The continued widespread presence of the brown treesnake, curious skink, and other introduced amphibian species is of concern because of each species' potential deleterious impacts on Guam's native fauna (NAVFACPACIFIC 2010b).

Green sea turtle nesting has been documented on the beaches at NBG TS North (U.S. Navy 2009). See **Section 4.1.3.2** for additional information on this species.

Five herpetofauna species were documented on NBG TS South during 2008–2009 herpetofauna surveys. Of these, two species are native to Guam: blue-tailed skink and stump-toed gecko; and three species are introduced: curious skink, house gecko, and marine toad. The continued widespread presence of the

curious skink and other introduced amphibian species is of concern because of each species' potential deleterious impacts on Guam's native fauna (NAVFACPACIFIC 2010b).

Invertebrates. A tree snail survey was performed in 2008 on NBG TS North centered on the southern area of the annex, Haputo Beach, and along the cliff line at Pugua Point in the central-western area of the annex. The only colonies found were at Haputo Beach and Pugua Point. At Pugua Point, the colony was made up of fragile tree snails and Guam tree snails. The colony at Haputo Beach consisted of humped tree snails and radiolate tree snails. Shells of the introduced giant African snail and both live individuals and shells of the introduced snail *Satsuma mercatoria* were observed within the northeastern limestone forests on NBG TS North (NAVFACPACIFIC 2010b).

A small patch of *Procris pedunculata*, the host plant for the Mariana eight-spot butterfly was observed scattered in one area of cockscomb limestone on NBG TS North (NAVFACPACIFIC 2010b). The Mariana eight-spot butterfly was not observed.

4.4.2.2 Freshwater Ecosystems

There are no freshwater ecosystems on NBG TS.

4.4.2.3 Estuarine Ecosystems

There are no estuarine ecosystems on NBG TS.

4.4.2.4 Submerged Lands

JRM managed submerged lands which extend 3 nautical miles seaward from the coastline at NBG TS include the entire area from Taguisson Point to Urunao Point, and a small section of submerged land extending out from Taguisson Beach Park (see **Figure 4-17**) (PCR Environmental 2007). NBG TS submerged lands include the HERA. The reefs within the HERA were considered to be in the best condition of those areas surveyed during the 2005 UOG laboratory assessment (Porter et al. 2005).

The coastline off of NBG TS includes two small reef flats and the Double Reef habitat. Double Reef is the most striking offshore feature along the entire northwest coast of Guam because it is the beginning of a young barrier reef that breaks the ocean surface (Paulay et al. 2001). It lies on a shallow shelf that extends considerably further from the coast than adjacent areas (PCR Environmental 2007). Other than Double Reef, the forereef areas of the northwest coasts of Guam show relatively little variation in macrohabitat, but do illustrate widespread, fine-scale variation in benthic communities (Paulay et al. 2001).

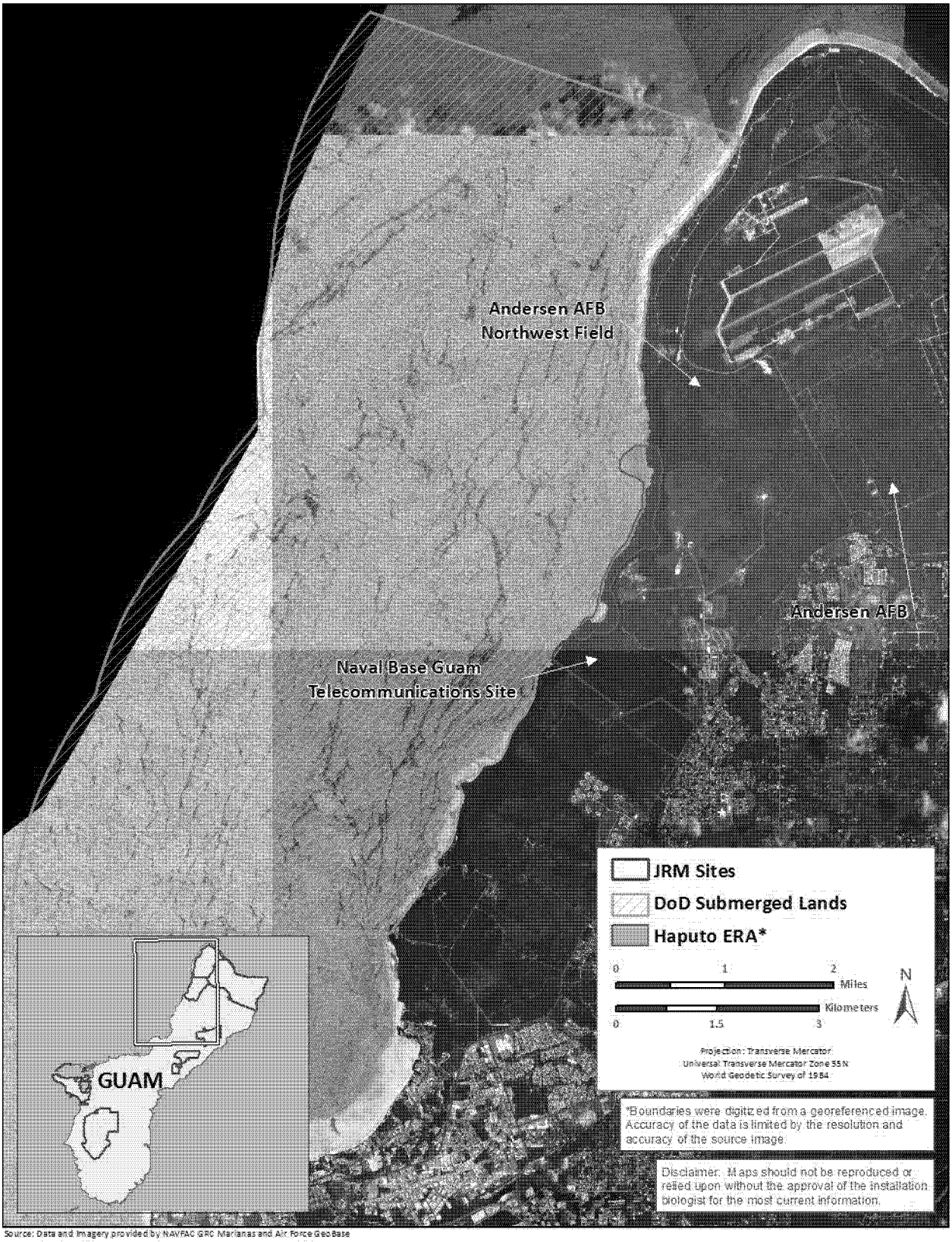
4.4.2.5 Protected Species

Fauna

Terrestrial Species

Birds

Micronesian starling. One of the few native bird species still surviving on Guam, it is known to occur in housing areas where brown treesnake populations might be reduced. An unknown number of Micronesian starlings occur near the entrance to NBG TS (e²M 2008).



Source: Data and Imagery provided by NAVFAC GRC Marianas and Air Force GeoBase

Figure 4-17. JRM Managed Submerged Lands at Naval Base Guam Telecommunications Site

Mammals

Mariana fruit bat. Fruit bat surveys were conducted in NBG TS between 1963 and 1968 as part of a regular effort by the GDAWR to monitor fruit bat populations (Perez 1972). Fruit bat densities in the area were found to have decreased from about 32 fruit bats per 100 acres to about 18 fruit bats per 100 acres over the survey period (Perez 1972). In the early 1980s, Wiles (1987b) estimated that approximately 50 to 100 fruit bats occupied the cliffline forest of northern Guam as solitary individuals or small groups, outside of the large colonies on Andersen AFB. However, fruit bat surveys in forested cliffline habitat between Amantes Point and Achae Point in 1984 did not detect any bats (Wiles 1987b). There are no historical records of large fruit bat colony roosts in the cliffline forest areas of NBG TS.

Fruit bat surveys conducted on NBG TS in 2008 recorded two Mariana fruit bats (Brooke 2008). Both bats were observed returning to their day-roost in the early morning. NBG TS and the HERA contain some of the best remaining fruit bat habitat on JRM managed lands. The native canopy and understory trees in the HERA have the potential to support foraging and roosting activities; however, there are no know roost sites present on the HERA (SWCA 2010b).

Reptiles

Moth skink. Moth skinks have an unknown distribution on Guam and are not frequently encountered. Eight moth skinks were recorded during herpetofauna surveys in the northern NBG TS in 2008 (DoN 2010). One individual was captured in a glue-board trap, and seven others were observed during visual surveys. The moth skink is not a federally listed species, but GovGuam lists the species as endangered.

Pacific slender-toed gecko. Two Pacific slender-toed geckos were recorded during herpetofauna surveys on NBG TS in 2008 (DoN 2010). This species is rarely seen and has been listed as an endangered species by GovGuam. It is not a federally listed species.

Invertebrates

Insects

Mariana eight-spot butterfly. The Mariana eight-spot butterfly was observed during surveys conducted in 2010 at the HERA. The butterfly was also observed outside of Navy lands at Hila'an Point, less than 2 miles (3.2 kilometers) south of the HERA (SWCA 2010b).

Gastropods

Humped tree snail. Humped tree snails were once the most common partulid tree snail on Guam and the most widely dispersed species in the Mariana Islands (Crampton 1925, Hopper and Smith 1992). The humped tree snail is now found at a single location on Guam at Haputo Beach on NBG TS (see **Figure 4-18**). The humped tree snail was first documented on NBG TS in 1989 by Hopper and Smith (1992). The location has been under frequent monitoring over the years and was resurveyed in 2008. While the population is still present, the density of snails is declining (Smith et al. 2008).

Guam tree snail. The Guam tree snail was first documented on NBG TS by Hopper and Smith (1992) in 1989. It was found to co-occur with a population of humped tree snails at Haputo Beach (see **Figure 4-18**). Surveys conducted in 2008 detected a second population of Guam tree snail co-occurring with a newly discovered population of fragile tree snails at Pugua Point, north of Haputo Beach on NBG TS.

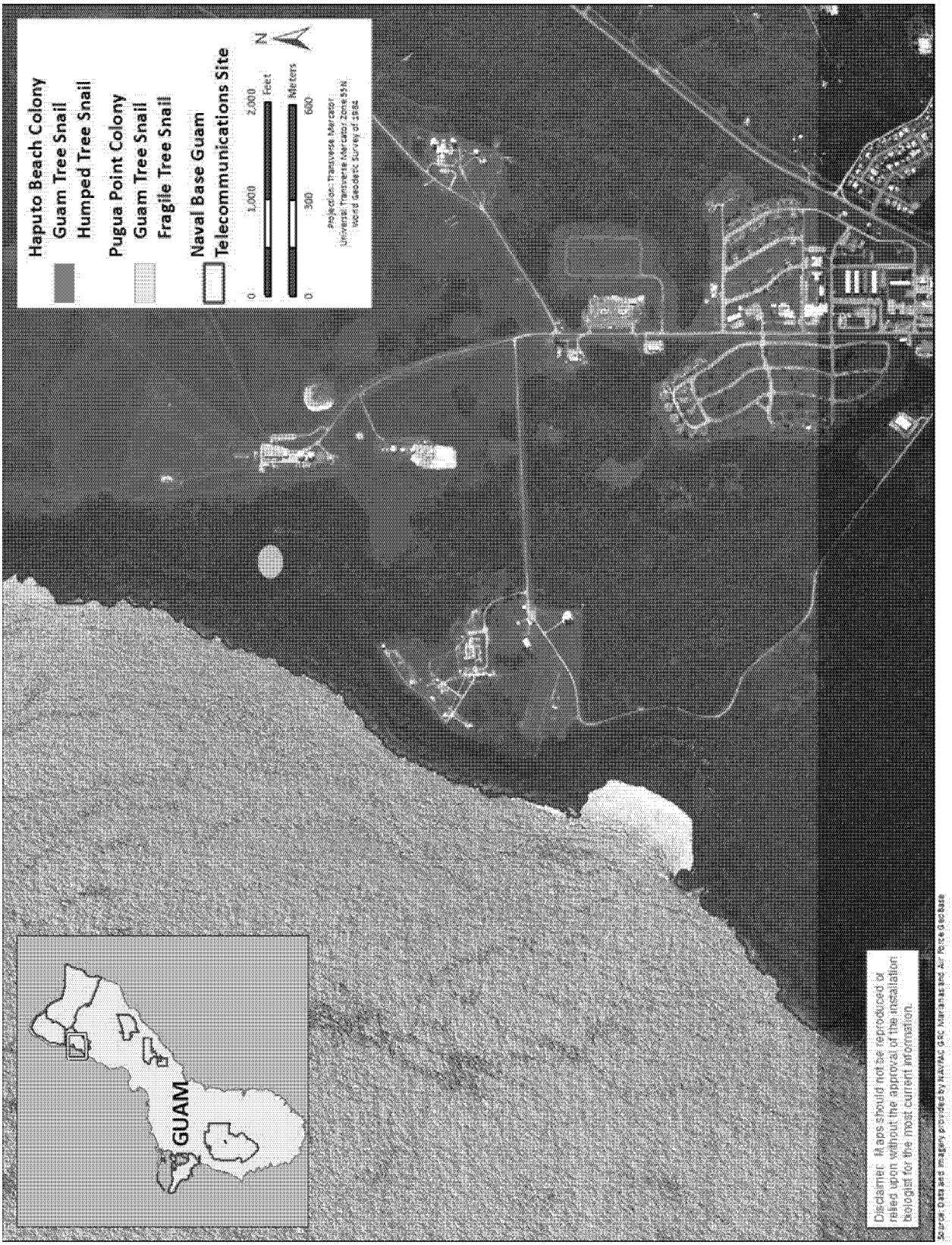


Figure 4-18. Partulid Tree Snail Populations on Naval Base Guam Telecommunications Site

Fragile tree snail. The fragile tree snail was never as abundant on Guam as the Guam tree snail and the humped tree snail, but it was more widespread than the Mount Alifan tree snail. Surveys by Crampton (1925) in 1920 found the fragile tree snail at 10 of 39 survey sites. A re-survey of Crampton's sites in 1989 by Hopper and Smith (1992) found fragile tree snails at 6 of the previously occupied survey sites. By 1994, fragile tree snails were present in only 3 sites on Guam and were considered the rarest of the three surviving partulid tree snail species on Guam (Smith and Hopper 1994). By 1996, the fragile tree snail had disappeared from their 3 remaining sites. A single population of fragile tree snails was discovered at Pugua Point on NBG TS in 2008 (Smith et al. 2008) (see **Figure 4-18**). This is the only population of fragile tree snails on Guam; one population might also remain on Rota (Smith et al 2008).

Marine Species

Marine Mammals

In 2007, SRS-Parsons et al. (2007) conducted a marine mammal and sea turtle survey covering 170,500 square nautical miles around Guam and the CNMI. The survey area was bounded by 10°–18° N Latitude and 142°–148° E longitude. Nine unique marine mammal species were identified, including the federally endangered sei, sperm, and humpback whales. Sperm whales were the most commonly observed whale during the study. Marine mammals have the potential to occur in JRM managed submerged lands that extend 3 nautical miles seaward from the coastline at NBG TS.

Spinner dolphins are often observed in the area surrounding Double Reef. In addition, spinner dolphins and bottlenose dolphins are frequently observed in the HERA (SWCA 2010b).

Sea Turtles

Green sea and hawksbill sea turtles are known to frequent the waters within the HERA (Helber, Hastert and Fee 2005).

Green sea turtle. Green sea turtles can occur in the JRM managed submerged lands and can nest on the beaches within NBG TS. The Navy monitors for sea turtle nesting on selected beaches throughout the year. Green sea turtles were observed in 2009 either underwater or on the surface at the HERA (SWCA 2010b). Regular monitoring for sea turtle nesting activity was initiated in 2007, and two suspected green sea turtle nest attempts and two false crawls were documented in 2008 (SWCA 2010b). Nesting habitat is present at Haputo Beach.

Hawksbill sea turtle. Hawksbill sea turtles also occur in the JRM managed submerged lands, and can nest on the beaches within NBG TS. The Navy monitors for sea turtle nesting on selected beaches throughout the year. Nesting habitat is present at Haputo Beach; however, it is unclear whether hawksbill sea turtles use the beaches of the HERA (SWCA 2010b).

Flora

Heritiera longipetiolata. This species has not been recorded from NBG TS at this time. However, *Heritiera longipetiolata* was recorded as a notable species in the area of Pugua Point during the 2011 surveys of the HERA and OPERA. *Heritiera longipetiolata* occurs in forested cliffline areas around Guam.

4.4.2.6 Invasive Species

Flora

Receiving antennas and other communications equipment require open areas to prevent interference from surrounding trees or buildings. As a result, much of Communications Annex NBG TS has been cleared

and is maintained as mowed grasslands. This has allowed for the establishment of nonnative vegetation, primarily in the transition areas between the mowed grasslands and the forest areas. These nonnative plant species have also moved into the forested areas, especially along the roadsides where safety areas are maintained. This disturbance and increase in nonnative vegetation has contributed to a highly disturbed habitat and a severe decline in native forest species (U.S. Navy 2009).

Vitex is a dominant component of the limestone forests occurring on NBG TS (NAVFACPACIFIC 2010b). The limestone forested area on NBG TS South is dominated by nonnative vitex, tangantangan, and papaya (NAVFACPACIFIC 2010b). The invasive chain of love vine, mile-a-minute vine, Siam weed, and Indian snakeweed also occur on NBG TS.

Fauna

In 2009, ungulate activity was observed most frequently in the form of rubbings on tree trunks and evidence of browsing on NBG TS North. A toppled fadang tree was observed, most likely caused by feral pigs to feed on the pith material in the trunk (NAVFACPACIFIC 2010b). Ungulate activity at NBG TS South was evidenced by rubbings and soil disturbance (NAVFACPACIFIC 2010b). Feral pig populations are also impacting the annex facilities by rooting up soil in the housing area (e.g., the children's playground) and around communication structures (U.S. Navy 2009). Ungulate Management Plans for NBG and Andersen AFB have been developed and are included in **Appendices L** and **M** of this INRMP.

The feral pig and Philippine deer are present in the HERA and have significantly affected natural ecosystem by causing soil erosion, stream and reef siltation, loss of native plant and animal species, vegetation damage, and degradation of native habitat (SWCA 2010b). Illegal hunting of ungulates has also occurred on the HERA. Other invasive fauna present on the HERA include rats, feral cats, Asian house shrews, house mice, and feral dogs (SWCA 2010b). Manokwar flatworms are also found in the HERA and other areas of the NBG TS.

The island collared dove, black drongo, Eurasian tree sparrow, and black francolin occur on NBG TS North (NAVFACPACIFIC 2010b). These species are common, introduced, breeding residents in Guam (NAVFACPACIFIC 2010b). On NBG TS South, invasive bird species include island collared dove, black drongo, Eurasian tree sparrow, and rock pigeon (NAVFACPACIFIC 2010b). The black drongo is very territorial and aggressive and has been known to displace smaller birds that might otherwise nest within their territory (Fritts and Rodda 1998).

Four introduced herpetofauna species were documented on NBG TS North during the 2008–2009 herpetofauna surveys: curious skink, house gecko, brown treesnake, and marine toad; and three introduced species were documented on NBG TS South: curious skink, house gecko, and marine toad (NAVFACPACIFIC 2010b). Other species documented in the HERA include eastern dwarf frogs, greenhouse frogs, crab-eating frogs, Hong Kong whipping frogs, and Gunther's Amoy frogs (Christy et al. 2007b). Brahminy blind snakes are also found on the site.

4.5 Naval Telecommunications Site Barrigada (NCTS Barrigada)

4.5.1 General Physical Environment

4.5.1.1 Climate

The climate at the NCTS Barrigada is the same as the climate for Guam as a whole. See **Section 4.1.1.1** for a description of the climate on Guam.

4.5.1.2 Geology and Topography

NCTS Barrigada is situated in the northern limestone structural province of Guam (see **Figure 4-1**). The substrate composes a heterogeneous mixture of limestone subtypes ranging from highly friable to well-cemented depending on the depositional source. Elevations at the site range from approximately 240 feet (73 meters) to 500 feet (152 meters) above msl (see **Figure 4-2**). The most prominent feature is Barrigada Hill, which rises in the north-central part of the area with a maximum height of roughly 600 feet (183 meters) just north of the site boundary.

The geology of NCTS Barrigada is characterized by a broad limestone reef plateau underlain by volcanic rocks. Most of the site consists of young limestone rock (Pliocene to Pleistocene, 1.5–5 million years old) but the central-northern portion of NCTS Barrigada is old limestone rock (Miocene to Pliocene, 5–25 million years old). Numerous cavities and caves exist within the porous limestone bedrock in the general area and collapses of these subterranean cavities form sinkholes (COMNAV Mariana 2001).

4.5.1.3 Seismology

While the NCTS Barrigada does not directly overlie any fault lines, the area is susceptible to earthquake events. The overall likelihood for landslides to occur at NCTS Barrigada is low due to the lack of steep areas that contain soil vulnerable to slipping in seismic events. NCTS Barrigada is not in an area vulnerable to liquefaction, nor is it in danger of tsunami inundation (JGPO 2010).

4.5.1.4 Soils

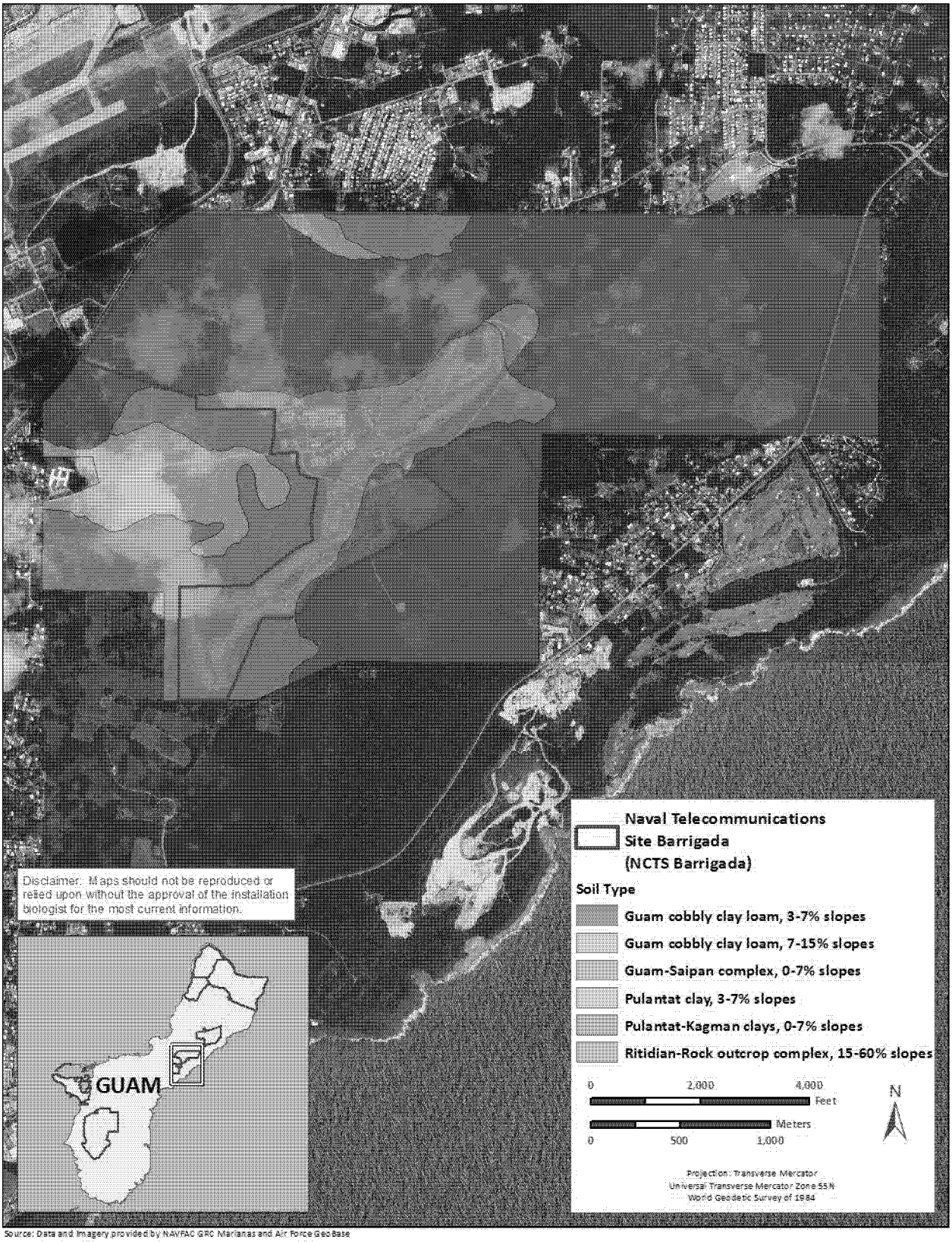
The soils at Communication Site Barrigada are similar to NBG TS, except for areas consisting of shallow, well-drained soils formed from argillaceous limestone, which contain clay soil particles (see **Figure 4-19**).

Soil formation on northern and most of central Guam is the result of intense weathering of the permeable limestone, which forms silica-poor soils rich in iron oxides and gibbsite clays (NRCS 1988). The following soil types occur on NCTS Barrigada: (1) Guam cobbly clay loam with 3 to 7 percent slopes, (2) Pulantat clay, (3) Pulantat-Chacha clay complex, (4) Chacha clay, and (5) Ritidian-Rock Outcrop complex (JGPO 2010). Guam cobbly clay loams are the dominant soil type on NCTS Barrigada. In general, erosion risks at NCTS Barrigada are slight to moderate, but do not present a major problem because the area is situated on a broad limestone reef plateau.

4.5.1.5 Hydrology

Surface Water. Because of the high permeability of the limestone substrate, no streams or other natural surface water drainage features occur on NCTS Barrigada.

Groundwater. NCTS Barrigada is underlain primarily by very permeable limestone in the Finegayan subbasin of the NGLA (see **Section 4.1.1.5**).



Source: Data and Imagery provided by NAVFAC GRC Marianas and Air Force GeoBase

Figure 4-19. Soils on Naval Telecommunications Site Barrigada (NCTS Barrigada)

4.5.2 General Biotic Environment

4.5.2.1 Terrestrial Ecosystems

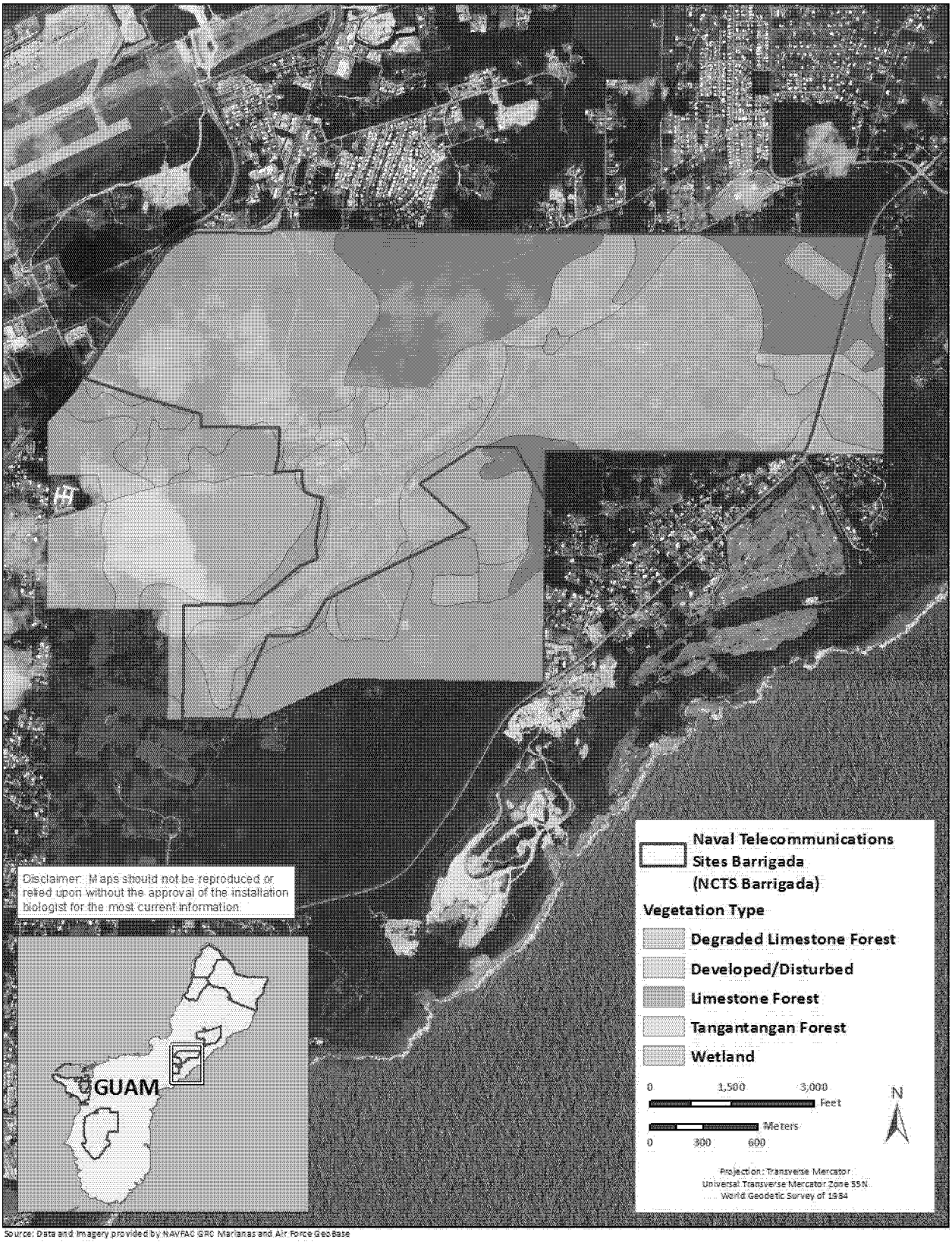
Flora

The activities carried out at NCTS Barrigada require large amounts of cleared, maintained land for operation. The disturbance of land has led to an increase of nonnative and invasive species. The degree of disturbance within the annex has resulted in portions of the remaining forested plant communities being highly modified and dominated by tangantangan and African tulip (U.S. Navy 2009). See **Figure 4-20** for a map of the vegetation communities occurring on NCTS Barrigada.

Twenty tree species were documented on transects conducted during the 2008 vegetation surveys performed on NCTS Barrigada (NAVFACPACIFIC 2010b). The highest dominance observed was for the strangler fig, an overstory species with numerous aerial roots that contribute to its large footprint. The species with the second- and third-highest dominances were sea hibiscus and *Neisosperma oppositifolia*, which typically occupy the overstory. All three species are native to Guam. *Guamia mariannae*, which is also native, is a dominant understory species within the forests on NCTS Barrigada. Common introduced species on NCTS Barrigada include custard apple, limeberry, and tangantangan. Native species had a combined relative density of approximately 77 percent, far exceeding the relative density of introduced species for the survey transects at NCTS Barrigada (NAVFACPACIFIC 2010b).

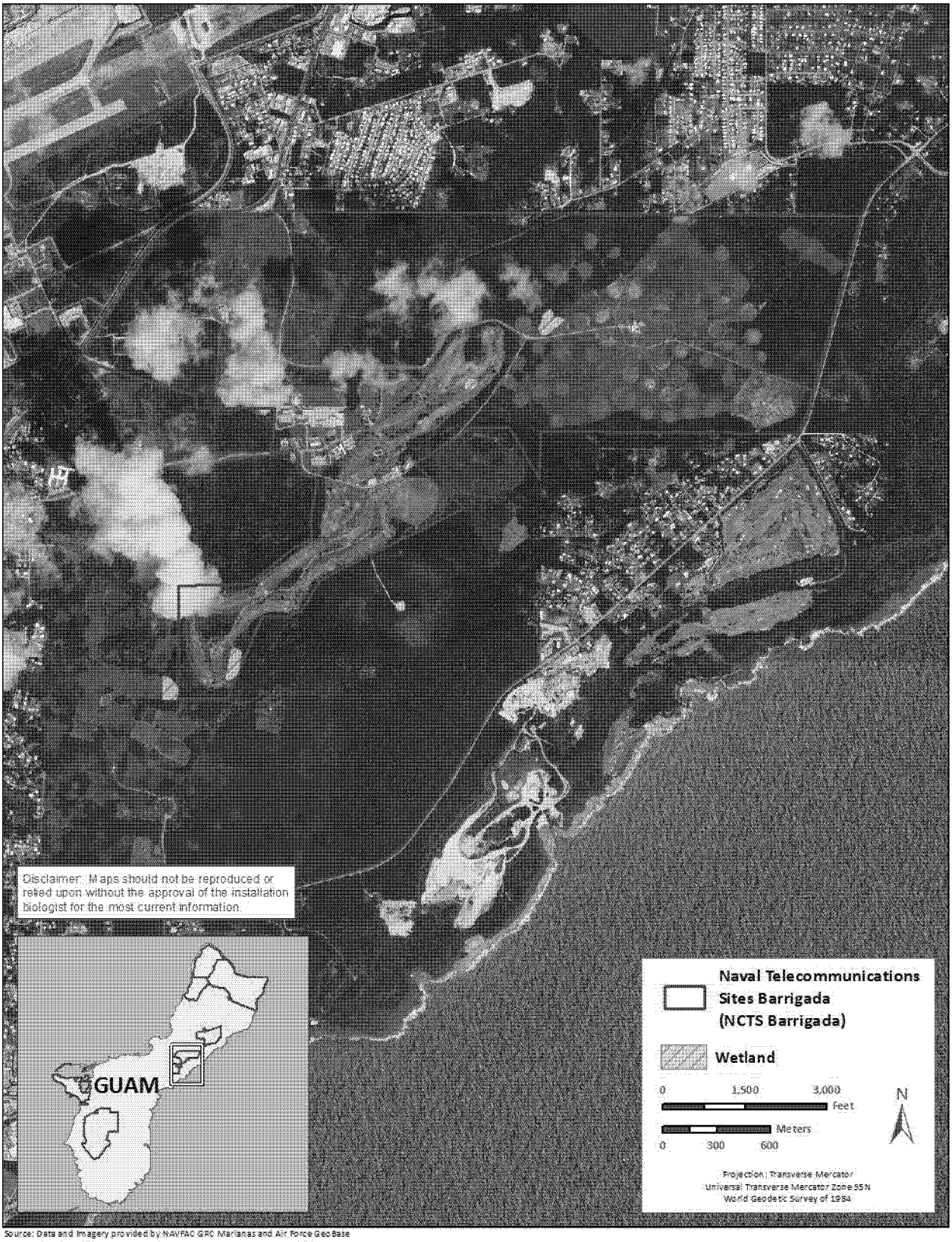
Wetlands Communities. The 2001 INRMP indicates the presence of several small man-made ponds in the vicinity of the Nimitz Golf Course (COMNAV Mariana 2001). These and other potential wetland areas were investigated in 2007 (AECOS and Wil Chee 2009) and some were found to lack wetland vegetation and hydrology. One wetland area, B-02, was identified in the southeast corner of Barrigada North, close to the southern end of the Nimitz Golf Course. The recent 2010 wetland study (NAVFACPACIFIC 2010a) confirmed the existence of this small palustrine emergent wetland of 1 acre (0.4 hectares).

Delineated and NWI-indicated wetland areas have been identified on Barrigada South (AECOS and Wil Chee 2009, USFWS 2009a). Two small sinkhole wetlands were delineated on Barrigada South in 2007: Wetland Areas Barr-03 and Barr-04 (AECOS and Wil Chee 2009). In 2007, these wetlands were described as not providing marginally useful habitat to waterbirds. These wetlands were observed to be overgrown with para grass and did not have any open water. The dense para grass within these wetlands suggests wet soil conditions rather than periodic flooding (AECOS and Wil Chee 2009). To evaluate wetlands further on Barrigada South, a wetland study was conducted in May 2010 (NAVFACPACIFIC 2010a, JGPO 2010). The recent study delineated Wetland Areas B-01, B-04, B-05, B-06, B-07, B-08, and B-09 on Barrigada South; Wetland Area B-03 is located just outside the boundary (see **Figure 4-21**). Wetland Areas B-01, B-03, B-05, B-06, B-07, B-08, and B-09 are NWI wetlands confirmed to meet USACE wetland criteria and NWI boundaries were adjusted during recent field studies (NAVFACPACIFIC 2010a). Wetland Area B-04 was previously delineated in 2007 (AECOS and Wil Chee 2009) and the boundaries were adjusted during recent field studies (NAVFACPACIFIC 2010a). The delineated wetland areas on Barrigada South total approximately 2.4 acres (1.0 hectares) and Wetland Area B-03, located adjacent to Barrigada South, is approximately 1.1 acres (0.4 hectares) (NAVFACPACIFIC 2010a, JGPO 2010).



Source: Data and Imagery provided by NAVFAC GRC Marianas and Air Force GeoBase

Figure 4-20. Vegetation Communities on Naval Telecommunications Site Barrigada



Source: Data and Imagery provided by NAVFAC GRC Marianas and Air Force GeoBase

Figure 4-21. Wetlands on Naval Telecommunications Site Barrigada

Fauna

Birds. The following avian species were identified during 2008–2010 roadside bird surveys performed on NCTS Barrigada: Pacific golden-plover, black drongo, cattle egret, island collared dove, Eurasian tree sparrow, black francolin, and yellow bittern (NAVFACPACIFIC 2010b). The Pacific golden-plover was the most commonly observed species during this survey. The yellow bittern is a common native breeding resident on Guam. The island collared dove, black drongo, Eurasian tree sparrow, and black francolin are common, introduced, breeding residents on Guam. The Pacific golden-plover and cattle egret are common nonbreeding visitors to the island (NAVFACPACIFIC 2010b).

The constructed wetlands within NCTS Barrigada are regularly used as resting and foraging areas for migrating birds, which are protected under the MBTA. Bird species observed during the 2009 natural resources survey on NCTS Barrigada that could use the freshwater wetlands include the yellow bittern, cattle egret, and Pacific golden-plover (NAVFACPACIFIC 2010b).

The open grasslands within NCTS Barrigada are also regularly used as resting and foraging areas for migrating birds.

Mammals. Potential habitat for the Mariana fruit bat occurs on NCTS Barrigada due to the native understory and canopy trees within the annex. No fruit bats were documented on NCTS Barrigada during a May 2008 fruit bat survey (NAVFACPACIFIC 2010b).

Reptiles and Amphibians. Seven herpetofauna species were documented on NCTS Barrigada during the 2008–2009 herpetofauna surveys. Of these, three species are native to Guam: blue-tailed skink, mourning gecko, and stump-toed gecko; and four species are introduced to Guam: curious skink, house gecko, greenhouse frog, and Hong Kong whipping frog (NAVFACPACIFIC 2010b). The continued widespread presence of curious skink and other introduced amphibian species is of concern because of each species' potential deleterious impacts on Guam's native fauna. Of particular concern is the ability of the introduced species to serve as additional food sources for the brown treesnake (NAVFACPACIFIC 2010b).

Invertebrates. Four butterfly species were identified during the 2009–2010 butterfly survey: blue-banded king crow (*Euploea eunice*), blue moon (*Hypolimnas bolina*), common Mormon (*Papilio polytes*), and common evening brown (*Melanitis leda*). The butterfly transect was within a forested area on NCTS Barrigada with several small clearings. None of the four species are considered endangered or threatened, and all are fairly well-distributed throughout Guam and the Northern Mariana Islands (NAVFACPACIFIC 2010b).

No living partulid tree snails or their shells were observed on NCTS Barrigada during the 2008–2010 tree snail surveys. Shells of the introduced giant African snail and both live individuals and shells of the introduced snail *Satsuma mercatoria* were seen on the transects. Additionally, live introduced Manokwar flatworms, which are predators of land snails, were observed on NCTS Barrigada (NAVFACPACIFIC 2010b).

4.5.2.2 Freshwater Ecosystems

There are no freshwater ecosystems on NCTS Barrigada. One decorative man-made pond with a fountain occurs on the Nimitz Golf Course; however, the value of freshwater habitat provided by this pond is assumed to be negligible. Several wetlands were delineated on NCTS Barrigada in 2007 and 2010 (AECOS and Wil Chee 2009, NAVFACPACIFIC 2010a).

4.5.2.3 Estuarine Ecosystems

There are no estuarine ecosystems on NCTS Barrigada.

4.5.2.4 Submerged Lands

No JRM managed submerged lands are associated with NCTS Barrigada.

4.5.2.5 Protected Species

Fauna

Terrestrial Species

Birds

There are no known Federal or Guam-listed birds at NCTS Barrigada.

Mammals

Mariana fruit bat. An islandwide survey for fruit bats was conducted in 1984 and included an observation station on Mount Barrigada near the NCTS Barrigada. No fruit bats were observed at this location despite potential fruit bat foraging habitat on the south side of Mount Barrigada within the installation boundaries (Wiles 1987b). No fruit bats were observed during surveys of NCTS Barrigada in 2008 (Brooke 2008). Limited Mariana fruit bat foraging habitat still exists within the installation boundary on the south side of Mount Barrigada.

Invertebrates

Gastropods

In 1920, Crampton (1925) surveyed a location in Barrigada and found three species of partulid tree snails including the humped tree snail, Guam tree snail, and the fragile tree snail. A re-survey of the Barrigada site by Hopper and Smith (1992) did not detect any living tree snails. Natural resources surveys conducted at NCTS Barrigada in 2009 detected Guam tree snails in forested habitats on the installation (DoN 2010).

Flora

There are no known Federal- or Guam-listed plants at NCTS Barrigada.

4.5.2.6 Invasive Species

Flora

Common introduced species in the forested areas on NCTS Barrigada include custard apple, limeberry, and tangantangan (NAVFACPACIFIC 2010b). The invasive chain of love vine, mile-a-minute vine, Siam weed and Indian snakeweed also occur on NBG TS.

Fauna

Introduced bird species occurring on NCTS Barrigada include the island collared dove, black drongo, Eurasian tree sparrow, and black francolin. These species are common, introduced, breeding residents on Guam (NAVFACPACIFIC 2010b). House mice and rats, Asian house shrews and feral pigs also occur on the site.

Four introduced herpetofauna species were documented on NCTS Barrigada during 2008–2009 herpetofauna surveys: curious skink, house gecko, greenhouse frog, and Hong Kong whipping frog (NAVFACPACIFIC 2010b). Other invasive herpetofauna on the site include the brown treesnake and brahminy blind snake. The continued widespread presence of curious skink and other introduced amphibian species is of concern because of each species' potential deleterious impacts on Guam's native fauna. Of particular concern is the ability of the introduced species to serve as additional food sources for the brown treesnake (NAVFACPACIFIC 2010b).

Shells of the introduced giant African snail and both live individuals and shells of the introduced snail *Satsuma mercatoria* were observed on NCTS Barrigada during the 2008–2010 tree snail surveys. Additionally, live introduced Manokwar flatworms, which are predators of land snails, were observed on the installation (NAVFACPACIFIC 2010b).

4.6 Tinian

4.6.1 General Physical Environment

4.6.1.1 Climate

The climate on Tinian is similar to the climate on Guam.

4.6.1.2 Geology and Topography

Tinian consists of a series of five elevated limestone plateaus at various elevations, separated by escarpments and steeply sloping areas. All four primary ecosystems (coastal waters, lowlands, wetlands, and cliff-line) occur within the EMUA.

Geologic Formations

There is no data on geologic formations for Tinian.

4.6.1.3 Seismology

There is no data on seismology for Tinian.

4.6.1.4 Soils

The USDA Natural Resources Conservation Service (NRCS) has identified ten General Soil Map Units on Tinian, including two lowland soil units, two upland soil units, and six limestone plateau soil map units (**Figure 4-22**). General Soil Map Units are a mapping convention used to represent a general population of soils on a landscape segment. There is considerable variation within the General Soil Map Units. The percent coverage for lowland, upland and limestone plateau soils is 3, 5, and 85 percent, respectively.

4.6.1.5 Hydrology

Tinian is composed of permeable limestone that overlays a relatively impermeable volcanic foundation. Surface runoff is practically non-existent due to rapid percolation through the soils. There are no springs or perennial streams. Most of Tinian's groundwater supply is located within the Takpochao Limestone and the Ghyben-Herzberg lens areas. The basal fresh water lens extends from 2 to 4 feet (0.6 to 1.2 meters) above msl to about 80 to 160 feet (24 to 49 meters) below sea level at its deepest point (NOAA et al. 1980).

Figure 4-22. Soils on Tinian

Existing resources may be capable of supplying up to 7 million gallons/day (gpd) (27 million liters/day [lpd]) of potable fresh water, which can support a population of 70,000 people at an average supply rate of 100 gpd/person (379 lpd/person). Recent assessments are more conservative and estimate 30,000 people can be supported by Tinian's water resources (Ramon Camacho 2010, NAVFACMAR, in litteris). In 1992, water usage was estimated at 650 gpd/person (2,460 lpd/person) compared to the U.S. average of 150 gpd/person (568 lpd/person). This difference in water consumption is attributed to leaking infrastructure and poor conservation practices on Tinian (USDA/SCS 1994). The majority of households utilize municipal water, although approximately 10 percent are totally dependent on rainwater catchment (USDA/SCS 1994).

Historically, groundwater resources supported over 150,000 military personnel during World War II. Peak usage during World War II is estimated at 2.3 million gpd (8.7 million lpd). To fulfill these water requirements, approximately 40 wells were drilled at an average depth of 300 feet (70 meters). Following the end of the war, most wells were abandoned (USDA/SCS 1994).

4.6.1.6 Wildland Fire

The EMUA is comprised of large areas of tangantangan, secondary forest, and open fields. Grass fires are common on Tinian and are more likely to occur during the dry season. Most fires are intentionally lit. Fires initiated in open fields have the potential to persist when forest habitat is reached, resulting in a direct threat to federally listed species (U.S. Navy 2009). Incidental sightings of intentionally set fires have been reported to be occurring in the EMUA. The purpose of these fires is unknown, though some speculate that the fires may be started by locals to facilitate collection of coconut crabs or scrap metal (Wenninger, 2010, NAVFACMAR, personal communication). There are no records of wildfires on Tinian resulting from U.S. military training activities (U.S. Navy 2009).

4.6.2 General Biotic Environment

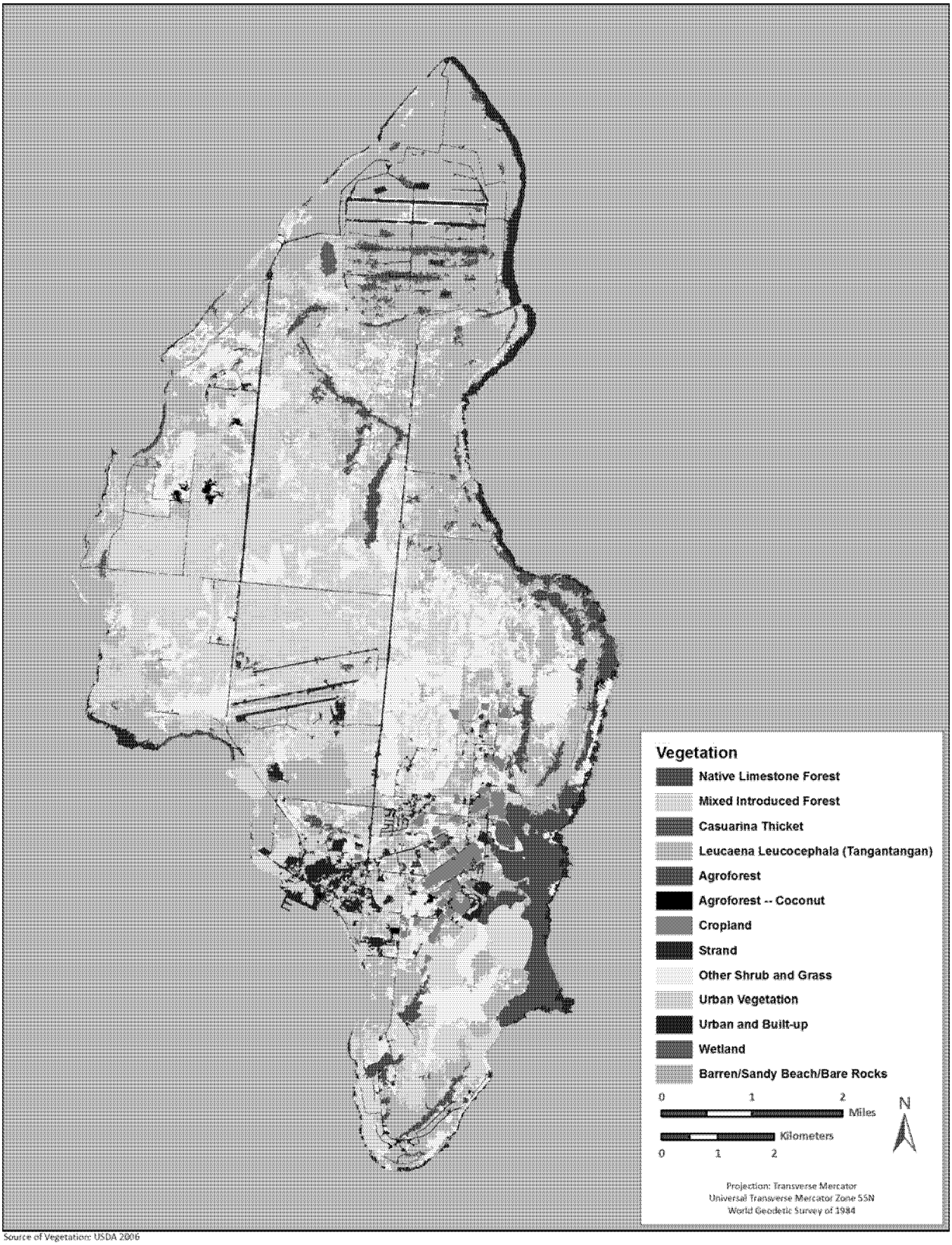
4.6.2.1 Terrestrial Ecosystems

Flora

Tinian consists of a series of five limestone plateaus at various elevations, separated by escarpments and steeply sloping areas. Terrestrial ecosystems can be generally divided into lowlands, limestone communities and wetlands. **Figure 4-23** provides a map of vegetation communities occurring on Tinian.

Lowlands. Lowlands, the largest ecosystem on Tinian, comprise approximately half the total land area and extend between the coastal strand and the island's interior limestone cliffs. The lowlands have been heavily disturbed by historical land uses and violent typhoon weather systems that frequent the Marianas. Lowlands are characterized by secondary forests composed predominantly of tangantangan, with a mixture of non-native trees shrubs and dense herbaceous plants, thickets of ironwood (*Casurina equisetifolia*), and grazing lands.

Limestone communities. The cliff-line ecosystem consists of isolated areas of native limestone and mixed forest that follow ridgelines. Forested areas located at the top of Mt. Lasso and around the north escarpment of Maga contain native trees, such as *Pisonia grandis, Ficus* spp., *Cynometra ramiflora*, *Guamia mariannae*, *Pandanus tectorius*, *Cerbera dilatata*, and *Ochrosia mariannensis.* These species support Mariana fruit bats and Micronesian megapodes (*Megapodius laperouse laperouse*). Cliff-line habitat is also used by the Tinian monarch (*Monarcha takatsukasae*). Historically, some areas of cliff-line forest (e.g., Mt. Lasso and Maga) were used for cattle grazing; these areas are now dominated by *Cynometra ramiflora.*



Source of Vegetation: USDA 2006

Figure 4-23. Vegetation Communities on Tinian

Wetland communities. There are no delineated wetlands on Tinian; however, wetland/marsh ecosystems exist on Tinian. These wetland habitats are discrete areas of impermeable clay that impound rainwater.

The Hagoi wetland is considered jurisdictional and qualifies for official description to USACE standards (Wil Chee-Planning Inc. and AECOS Inc. 2008). Hagoi wetland is a fringing marsh with a total area of about 38.4 acres (15.5 hectares). Roughly 3.1 acres (1.25 hectares) are open water to a depth of 3 ft (1 m) (USFWS 1996). It is dependent entirely on precipitation and thus water levels fluctuate considerably (Vogt 2010, NAVFACPAC, in litteris). During the dry season, the water levels at established depth gauges are insufficient to measure and open water is reduced to small areas of ponding water (USFWS 1996). In the wet season however, open water can extend up to 0.5 mi (0.8 km) (Gingerich and Yeats 2000). Although farming adjacent to Hagoi has historically occurred, the interior has not been disturbed.

Other Tinian wetlands are ephemeral because they are rainfall dependent. Two are within the Military Lease area (MLA); Mahalang (size = 1.3 acres [0.5 hectares]) and Bateha (size = 1.5 acres [0.6 hectares]).

Mahalang is comprised of a cluster of 10 ephemeral ponds, with the two largest about 1.2 acres (0.5 hectares) (USFWS 1996). In 1994, all ponds were shallow, open water with some emergent vegetation. Six months after initial inspection, all but one area was dry (USFWS 1996). Inspection of the Mahalang area in 2007 yielded only a sink hole that could possibly represent some of the wetlands reported by USFWS (1996). The area was previously, but no longer, inhabited by cattle and located in a field of tall elephant grass (*Pennisetum purpureum*) (Wil Chee-Planning Inc. and AECOS Inc. 2008).

The Bateha wetland consists of ten ponds. Of these, only one was considered a wetland during the 1996 survey conducted by USFWS (Wil Chee-Planning Inc. and AECOS Inc. 2008). According to the USFWS (1996) survey, the open water area expanded after Typhoon Wilda in 1994, but shrank and disappeared by March 1995. A 2007 survey reported an area in the Bateha vicinity capable of accumulating water during the wet season.

Fauna

Birds. The Tinian monarch was listed as federally endangered in 1970 (DOI 1970), down listed to threatened in 1987 (USFWS 1987) and removed from the Federal List of Endangered and Threatened Wildlife and Plants in 2004 (USFWS 2004b). The CNMI government identifies the monarch as threatened and endangered and includes it on their local list (DLNR 2000).

Ten bird species that are commonly found in the native forest include: bridled white-eye (*Zosterops conspicillatus*), Tinian monarch, Mariana fruit dove (*Ptilinopus roseicapilla*), white-throated ground dove (*Gallicolumba xanthonura*), rufous fantail (*Rhipidura rufifrons saipanensis*), collared kingfisher (*Halcyon chloris*), Micronesian honeyeater (*Myzomela rubratra*), Micronesian starling (*Aplonis opaca*), and the island collared-dove. White terns are also seen in the native forest and yellow bitterns are present in open areas.

Non-native bird species include: island collared dove or Philippine turtle-dove, Eurasian tree sparrow, orange-cheeked waxbills (*Estrilda melpoda*) and feral chickens.

Migratory birds include the same species seen on Guam.

Mammals. The only native mammal is the Mariana fruit bat. It is an infrequent visitors to the MLA, likely originating from neighboring islands of Aguiguan or Saipan. Sheath-tailed bats are not present on Tinian but are resident on Aguiguan (Esselstyn et al. 2004).

Non-native rats, house mice, shrews, and feral cats are abundant in the MLA. Non-native Philippine deer and goats introduced by the Tinian Mayor are hunted by Tinian residents and are uncommon in the MLA. Domestic cattle are pastured in the Lease Back Area (LBA).

Reptiles and Amphibians. Nesting green sea turtles and nesting hawksbill sea turtles use beaches in the MLA. Lizard species are similar to those present on Guam: monitor lizard, Micronesian gecko, oceanic snake-eyed skink, littoral skink, Mariana skink, mutilating gecko, mourning gecko, blue-tailed skink, and Brahminy blind snake.

The marine toad is the only known introduced amphibian on Tinian and is believed to have been introduced in 1944 when approximately 4,000 individuals were observed in lily ponds and cisterns (Stohler and Cooling 1945 cited in Eldredge 1988). By 1974, the toad was common throughout the island (Owen 1974).

Invertebrates. The shells of candidate humped or Mariana tree snail are common on the ground in the native forest of limestone cliffs, but live snails have not been found. Candidate butterfly species including the Marianas rusty or wandering butterfly (*Vagrans egistina*) and the Mariana eight spot butterfly or forest flicker (*Hypolimnas octocula mariannensis*) (Family *Nymphalidae*) have not been found on Tinian although the host plants luluhut, *Procris pedunculata* and *Elatostema calcareum* are present (Hawley and Castro 2008). Coconut crab, mangrove crab, and land hermit crabs are also present (DLNR DFW 2005).

4.6.2.2 Freshwater Ecosystems

Vegetation present near open water at Hagoi is typically dominated by *Schoenoplectus litoralis* var. *capensis*, with patches of golden leather fern and *Paspalum orbiculare*. This band of mixed vegetation is surrounded by a band of *Phragmites karka*, an obligate wetland species (Wil Chee-Planning Inc. and AECOS Inc. 2008).

Phragmites karka surrounding Lake Hagoi is approximately 57 ac (23 ha) in area. The wetland submergent plant-like algae, *Chara* spp., is abundant in some of the open water areas within sedge vegetation. Green algae (Chlorophyta) are also present and increase during the dry season. During the dry season, >50 percent of the open water areas was found to be covered with algae (USFWS 1996).

4.6.2.3 Estuarine Ecosystems

There are no estuarine ecosystems on Tinian.

4.6.2.4 Submerged Lands

Marine lands at Tinian and FDM are under the management of the CNMI government.

4.6.2.5 Protected Species

Tinian has two federally endangered bird species including the Mariana common moorhen and Micronesian megapode. The Mariana swiftlet, also federally endangered, has been documented on Tinian, but has not been recorded since 1976 and is presumed extirpated from the island (Reichel and Glass 1991). Micronesia megapodes are uncommon transients. Mariana moorhens are present in the Hagoi wetland and the seasonal wetlands at Batehea and Mahalang.

Mammals

Mariana fruit bat. Fruit bats are uncommon on Tinian and no permanent colony is known. Sightings of two and as many as four fruit bats in the Kastiyu forest occurred in 1979 and 1983-1984, respectively (Wheeler 1980, Wiles et al. 1989). In 1994, a single bat was observed flying at the southern end of the island and in 1995 another fruit bat was noted near San Jose Village (Krueger and O'Daniel 1999). Fruit bats were not observed during surveys in 2000, 2001, and 2008 (Cruz et al. 2000b, Johnson 2001, Brooke 2008). The highest number of recent sightings from Tinian was in 2005 when approximately five individuals were detected in cliff-line forest in the Maga region (Brooke 2008). Aguiguan has a small colony of fruit bats, with an estimated 40 to 60 individuals in 2002 and 2008 respectively (Esselstyn et al. 2003, Brooke 2008). Sightings of fruit bats on Saipan are rare, but do occur (Johnson 2001).

Birds

Mariana swiftlet. Mariana swiftlet is presently found only on Saipan, Aguiguan, and Guam (Cruz et al. 2008). Despite more than 88 caves on Tinian, there are no records of swiftlets breeding (Reichel and Glass 1988). Prehistoric evidence of swiftlets was discovered at one rockshelter and one cave on the island in 1994 (Steadman 1999). Swiftlets are considered itinerant on Tinian, most likely moving from Saipan or Aguiguan (USFWS 1991a). Observations of swiftlets on Tinian were first reported in 1945 by Marshall (1949) and Gleize (1945). Swiftlets were noted in "fair numbers" on the island in 1976 (Pratt et al. 1979). These are believed to be the last swiftlet sightings on Tinian and they are considered extirpated from the island (Reichel and Glass 1991).

Micronesian starting. Micronesian Starlings are found throughout Tinian and are common in the native forest.

White-throated ground-dove. Ground-doves are regularly heard in the limestone forests on Tinian.

Mariana common moorhen. Moorhen are present throughout the year at the Hagoi wetland, and at the seasonal Bateha and Mahalang wetlands when water is present. Monthly counts of moorhen at the Hagoi wetland between 2002 and 2012 resulted in annual means of between 7 and 17 birds (Vogt 2009b). The low of 0 birds was recorded in May and June 2010 when Hagoi completely dried. The highest number of 29 birds was recorded in March 2012. Moorhen numbers are dependent on water being present. Takano and Haig (2004) cited habitat loss (vegetation encroachment), historical poaching, and predation by rats and monitor lizards as causative factors for decline in moorhen numbers.

Micronesian megapode. Megapodes on Tinian are not resident and are rarely detected. The birds are likely transient originating from Saipan or Aguiguan. Megapodes have been recorded in upland cliff-line forest in areas least disturbed by storms and anthropogenic forces. The species was first collected on Tinian in 1820 (Baker 1951). During World War II and throughout the 1970s and early 1980s, most ornithological surveys and inventories failed to locate megapodes on the island (Gleize 1945, Downs 1946, Marshall 1949, Pratt et al. 1979, Engbring et al. 1986).

Infrequent surveys on Tinian from 1970-2000 detected a total of seven Micronesian megapodes. The Maga region was a common area for megapode detections in 2001, 2004, and 2005 (Witteman 2001, Vogt 2008). The 2001 detections (n = 7) were believed to represent two individual birds (Witteman 2001). Megapodes were not detected during surveys on Tinian in 2006, 2007, and 2008 (Vogt 2008, Camp et al. 2012). However, one megapode was heard by an employee of Tinian's DLNR near the Seabees Monument in 2009 (Radley and CNMI-DFW 2010).

The Navy conducted monthly surveys for megapodes that began in 1999 and continued to 2012 when the frequency was changed to annual due to lack of sightings. Since 1999, 170 surveys have been completed.

No detections of megapodes have occurred during a point count sequence. However, during February 2004 one megapode was observed by a biologist while transiting between stations on the Magas transect. Again in June 2005, two megapodes were observed by a biologist while transiting between stations on the Magas transect. Critical habitat has not been designated for this species.

Reptiles

Micronesian gecko. The Micronesian gecko (Guali'ek in Chamorro) is a large species with a SVL of 3.5 inches (90 millimeters). This species was one of the more common lizards in the Mariana Islands in prehistory; declines are thought to be a result of the introduction of competing species like the oceanic gecko, or predatory species like the brown treesnake. In the Mariana Islands, this species has been recorded from Guam, Rota, Tinian, and Saipan, but might occur on other northern islands in the archipelago. The Micronesian gecko is not a federally listed species, but it is listed as an endangered species by the Guam ESA.

Green sea turtle. Green turtles are by far the most abundant sea turtle found throughout the Mariana Archipelago. The green sea turtle was listed as a threatened species in 1978 under the Federal ESA (NMFS and USFWS 1998a). A recovery plan has been drafted for the Pacific Ocean population (NMFS and USFWS 1998a) and critical habitat has been designated for the species in the Caribbean (NMFS 1998).

Hawksbill sea turtle. The hawksbill sea turtle is threatened by loss of nesting habitat, nest destruction by feral ungulates and dogs, artificial lighting in nesting areas, vehicle use on beaches, and exotic vegetation. The hawksbill sea turtle is listed as an endangered species under the Federal ESA (NMFS and USFWS 1998c). A recovery plan for the U.S. Pacific populations of hawksbill sea turtles has been drafted (NMFS and USFWS 1998c) and critical habitat has been designated in the Caribbean (NMFS 1998).

Other reptiles present on Tinian include the monitor lizard, snake-eyed skink (*Cryptoblepharus poecilopleurus*), tide pool shink (*Emoia atrocostata*), Slevin's skink (*Emoia slevini*), mutilating gecko, mourning gecko, blue-tailed skink, and Brahminy blind snake (*Ramphotyphlops braminus*).

Gastropods

Humped tree snail. The humped or Mariana tree snail is endemic to the Mariana Islands and is the most widely distributed tree snail in the archipelago. It is known from nine islands; Guam, Rota, Aguiguan, Tinian, Saipan, Anatahan, Sarigan, Alamagan, and Pagan (Kondo 1970, Smith et al. 2008). Abundance on the island is currently unknown. However, Mariana Islands tree snail shells were collected on the ground in 2008 along two permanent transects established for forest bird surveys located in the vicinity of the Mt. Lasso within the EMUA (Brooke 2010). Due to the abundance and presence of the predatory Manokwar flatworm, agricultural clearing by Japanese, and post World War II cattle pastures that included limestone forested cliff-line areas, there is concern regarding the partulid's ability to persist on Tinian (Smith 1995). The predatory flatworm, known to feed on juvenile partulid tree snails in the wild on Guam and Pacific tree snails in captivity, is believed to be the main threat to the continued existence of tree snails in the region (Hopper and Smith 1992). Hopper and Smith (1992) reported that on Guam where flatworm abundance was high, partulid tree snail populations were rapidly declining. Other potential predators of the Mariana Islands tree snail are the giant African snail and the wolf snail (*Euglandina rosea*). The giant African snail was recently observed around the Dynasty Hotel and wolf snail shells have been observed on Tinian (Brooke 2010).

4.6.2.6 Invasive Species

Flora

Invasive vegetation contributes habitat losses on Tinian and encroachment of vegetation is a major threat to moorhen habitat on the Hagoi wetland. Lantana, tangantangan and scarlet gourd (*Coccinia grandis*), chain of love vine, mile-a-minute vine, Siam weed, and Indian snakeweed are all invasive plants on Tinian that spread prolifically and are capable of out competing native plants. Scarlet gourd is particularity aggressive and is capable of altering landscape by growing over and entangling forest trees (IUCN/SSG 2005).

Fauna

Five introduced birds with potential to become invasive occur on Tinian including the orange-cheeked wax bills, rock pigeon, red junglefowl, Eurasian tree sparrow, and the island collared-dove. Orange-cheeked wax bills occur on Tinian where flocks of 30 or more birds are seen in grasslands and roadsides. Rock pigeons can be found in the LBA and appear to have taken on feral status (Wenninger 2010, NAVFACMAR, in litteris). Rock pigeons can also be found at the Dynasty Hotel where they are released in association with ceremonies for tourists (A. Brooke 2010, NAVFACMAR, personal communication). An estimated 120 red jungle fowl inhabited Tinian in 1982 (Engbring et al. 1986). These were believed to be associated with domestic flocks. Today red junglefowl are found throughout the island and are no longer exclusively associated with humans (Wenninger 2010, NAVFACMAR, in litteris). The Eurasian tree sparrow was first documented on Tinian in 1974, observed in San Jose village (Owen 1974). In 1982, Engbring et al. (1986) estimated about 276 sparrows on Tinian, most in the vicinity of San Jose village. The island collared-dove was introduced to the southern Mariana Islands by the Spanish from the Philippines in the 1700s (Baker 1951). Island collared-doves are considered common to abundant on Tinian since World War II. In 1982, 929 individuals were estimated on Tinian (Engbring et al. 1986). Surveys in 2008 indicated that the number was increasing, with an estimated 2,198 individuals on the island (Camp et al. 2012).

High densities of non-native Malayan house rats (*Rattus diardii*) are found in all habitats of the MLA and densities of the Asian house shrew (*Suncus murinus*) are high in native and tangantangan forest. House mice (*Mus musculus*) are also present on Tinian (Wiewel et al 2009). All three species are known to severely impact biodiversity of Pacific islands. Rodents and shrews are predators of native birds, lizards, insects and snails. Rat's omniverous diet also includes native plants, seeds and fruit. Changes in forest composition are associated with high rodent density. Feral pigs also occur on the island and feral cats are extremely common and have been observed hunting in native forest at night (Vogt 2008).

Introduced reptiles on the island include house gecko, curious skink and brahminy blind snake. The marine toad is the only known introduced amphibian on Tinian and is believed to have been introduced in 1944 when approximately 4,000 individuals were observed in lily ponds and cisterns. By 1974, the toad was common throughout the island (Owen 1974). In 2008, the marine toad was observed crossing roads throughout Tinian, and recorded in total removal plots located in mixed and limestone forest habitats (Rodda et al. 2008). The toad is a prolific breeder, laying up to 70,000 eggs per year. Marine toads have substantially impacted ecosystems via direct and indirect mechanisms (Crossland 2000) and are possibly a threat to the native herpetofauna on Tinian. This toad possesses large parotid glands that excrete poison and kill potential predators (Crossland 2000).

The manokwar flatworm also occurs on Tinian.

4.7 Farallon de Medinilla (FDM)

4.7.1 General Physical Environment

4.7.1.1 Climate

The climate on FDM is similar to the climate on Guam.

4.7.1.2 Geology and Topography

FDM consists of coastal near-shore areas, perimeter cliff-lines, and interior flat mesic areas. The northern two-thirds of the island are separated from the southern peninsula by a partially collapsed isthmus. The surface elevation of the plateau is relatively flat, and gradually slopes east to west. The highest elevation is 82 feet (25 meters).

Geologically, FDM is formed from uplifted lithified limestone substrata with steep vertical walls and numerous wave-cut caves, notches, and collapsed sinkholes. The perimeter is characterized by steep eroding sea cliffs to 82 feet (25 meters) from the surrounding ocean. There is substantial natural erosion resulting in many regions of mass wasting where large sections of deteriorated rock have slid into the ocean.

Geologic Formations

There is no data on geologic formations for FDM.

4.7.1.3 Seismology

There is no data on seismology for FDM.

4.7.1.4 Soils

There is no published information on the island's soil. The island's uplifted limestone geology is similar to Tinian and Rota and it is likely that similar soils have formed on FDM. Soils found on FDM are most likely shallow with frequent rock outcrops. Pockets of deeper soil may be present. The beaches are composed of very coarse carbonate sand and small rubble/cobble fragments.

4.7.1.5 Hydrology

No published data exists on the hydrology or aquifer presence on FDM.

4.7.1.6 Wildland Fire

FDM possess areas of grassland and forest that may support wildfires started by the detonation of explosive ordnance. Wildfires may alter plant species composition. Fire-related destruction within the plant community may impede successional growth and facilitate the establishment of fire tolerant species. Fire can also cause direct mortality to faunal species in addition to habitat loss.

4.7.2 General Biotic Environment

4.7.2.1 Terrestrial Ecosystems

Flora

Coastal. FDM has two small intertidal beaches, one on the northeast coast and the other on the west coast, north of the isthmus. These beaches are composed of coarse carbonate sand and small rubble fragments (TEC Inc. 2005). Both beaches are inundated during high tide. These beaches appear to be shrinking each year due to landslides (Smith and Marx 2009).

The topographic structure of the coastal submerged lands is generally homogeneous around the entire island with several exceptions. The submerged shoreline just below the water line consists of a nearly vertical wall, which is the extension of the emergent cliff area. The underwater cliff extends to a depth of approximately 20 to 30 feet (6 to 9 meters). Large submerged caves that reach into the base of the island are present in several areas. Submerged limestone boulders lie at the base of the submerged cliff face (Marine Research Consultants and Belt Collins 2000). A shallow, or shoal area composed of fossilized limestone extends seaward from the base of submerged shoreline cliffs at a depth of approximately 22 to 82 feet (10 to 25 meters) and a width of 98 to 164 feet (30 to 50 meters).

Limestone Cliff. The cliff-line ecosystem of FDM consists of vegetative communities on the steep sea cliffs. Migratory and resident seabirds use this habitat for nesting and resting. Substantial natural erosion has occurred in many of these communities in areas where large sections of deteriorated rock have fallen into the ocean. Sprawling woody shrubs that are adapted to shallow soils, low soil moisture, and salt spray dominate cliff-line ecosystems. Plant communities do not appear to exist on vertical cliff faces or where rocks are inundated by wave action.

Mesic terrace. The mesic terrace ecosystem consists of the interior portions of the island located on the high elevated flat plateau areas surrounded by cliff-line. This habitat includes grasslands and native forest areas used by migratory birds, Micronesian megapode, and Mariana fruit bat.

Fauna

Birds. FDM serves as an important stopover location for migratory bird species, including a number of shorebirds, waterbirds, and seabirds. These birds use FDM to carry out resting and foraging activities during their respective non-breeding seasons. Migratory birds identified on FDM include the whimbrel, bristle-thighed curlew (*Numenius tahitiensis*), Pacific golden-plover, sooty tern (*Onychoprion fuscatus*), cattle egret, wandering tattler, and ruddy turnstone.

At least six species of seabird are breeding residents on FDM including black noddy, brown noddy, masked booby (*Sula dactylatra*), red-footed booby (*Sula sula*), brown booby (*Sula leucogaster*), and white tern.

Monthly systematic surveys of the three booby species were carried out by U.S. Navy biologists between 1999 and 2009, and now quarterly surveys are conducted. Red-footed boobies, which roost and nest in trees, appear more common than masked and brown boobies, which roost and nest on the ground. Results from 40 surveys conducted between January 2005 and December 2007 showed an average of 511 red-footed boobies, 119 masked boobies, and 108 brown boobies were tallied each month (Vogt 2009b). However, individual numbers of all three booby species fluctuate seasonally (Wenninger 2010, NAVFACMAR, in litteris). FDM is especially important for the masked booby as it is the largest known nesting site for the species in the Mariana archipelago (Lusk et al. 2000).

Non-native bird species include island collared dove and Eurasian tree sparrow.

Mammals. A single Mariana fruit bat was sighted in 1996 and 2008 indicating that FDM is used by a small number o f bats, possibly as a stopover location. Invasive rats believed to be *Rattus exulans* are common.

Reptiles and amphibians. Green sea turtles have been observed in the waters surrounding FDM and hawksbill sea turtles are uncommonly sighted. Snake-eyed skink and blue-tailed skink have been reported on FDM (TEC Inc. 2005, Vogt et al. 2009c).

Invertebrates. Coconut crabs have been observed on FDM. No information is available on other invertebrates on FDM.

4.7.2.2 Freshwater Ecosystems

There are no freshwater ecosystems on FDM.

4.7.2.3 Estuarine Ecosystems

There are no estuarine ecosystems on FDM.

4.7.2.4 Submerged Lands

Marine lands at Tinian and FDM are under the management of the CNMI government.

4.7.2.5 Protected Species

On FDM there is one federally endangered bird species (Micronesian megapode), one federally threatened mammal (Mariana fruit bat), and two federally-listed reptiles (green sea turtle and hawksbill sea turtle).

Fauna

Terrestrial Species

Mammals

Mariana fruit bat. In 1971, fishermen reported modest numbers of fruit bats on the island prior to bombing (Wiles et al. 1989). Since then, observations of the Mariana fruit bat have occurred twice on FDM during ground surveys. A single fruit bat was observed by T. Sutterfield in the interior mesic terrace ecosystem during a 1996 U.S. Navy survey. During Micronesian megapode surveys in August 2008, one fruit bat was observed flying south in the northern region of the island, just north of the No Fire Line (Vogt 2010, NAVFACPAC, in litteris). These observations suggest that the island is utilized by a small number of bats, possibly as a stopover location. The limited availability of foraging and roosting habitat may restrict the number of fruit bats recorded on FDM to solely individuals moving between islands.

Birds

Micronesian starling. Starlings have been reported on FDM by DoN (1975). Pratt and Lemke (1984) tentatively identified two dark birds seen flying over the island as starlings. Reichel and Glass (1991) listed this species as a hypothetical resident although starlings were not observed in 1996 surveys by Lusk et al (2000).

White-throated ground-dove. Ground-doves have been observed on FDM (Lusk et al 2000).

Micronesian megapode. The Micronesian megapode is the only federally endangered species with a breeding population on FDM. In 1991, the megapode was listed as potentially inhabiting the island, based on a possible vocalization by H.D. Pratt and T.O. Lemke in 1984 (Reichel and Glass 1991). Four megapodes were observed by biologists in November 1996 and two were observed during a U.S. Navy site visit in December 1996 (Lusk et al. 2000). Sixteen megapode detections representing a minimum of 11 birds were recorded during a December 2007 survey (Vogt 2009a). In August 2008, 12 pairs and four individual birds were detected during surveys, resulting in a minimum estimate of 28 megapodes on FDM (Vogt 2009a).

Burrows similar in shape and size to ones used by megapodes for nesting in the Northern Mariana Islands were noted in 1996 (Lusk et al. 2000). Evidence of reproduction was documented in August 2008 when one juvenile and one chick were observed on the island (Vogt 2009a). Megapodes on FDM may serve as a critical genetic link for the rest of the population throughout the Mariana archipelago. The island is also believed to be a stopover location for dispersing megapodes from other islands (Lusk et al. 2000).

In December 2007 surveys recorded a total of 15 megapodes. In August, 2008, 12 pairs and 4 individual birds (28 total birds) were recorded. Of the individual birds one was a chick and one was a juvenile. The area occupied by the 10 pairs in the northern part of the island covers approximately 59 acres (24 hectares). This extrapolates to about 5 acres (2.4 hectares) per pair. Based on the August surveys there are a minimum of 28 megapodes (12 pairs and 4 individual birds) on FDM (Vogt 2009a).

Reptiles

Quarterly surveys of sea turtles are carried out from a helicopter at FDM by U.S. Navy biologists. Identifying turtles to species is not possible because of the altitude of the helicopter, but most turtles are believed to be green sea turtles (Vogt 2009b). The number of individuals recorded during each survey is usually low (1-3). However, 12 turtles were sighted in November 2007 (Vogt 2009b). Neither green sea nor hawksbill turtles are known to nest on FDM's beaches. The beaches on FDM are unsuitable for sea turtle nesting (TEC Inc. 2005, Smith and Marx 2009).

Green sea turtle. Green sea turtles have been observed in the waters surrounding FDM. During marine surveys conducted between 1999 and 2004, 25 green sea turtles were recorded in FDM's waters (TEC Inc. 2005). Twenty-two sightings of green sea turtles were documented during boat and underwater surveys in 2006 and 2007 (Smith and Marx 2009).

Hawksbill sea turtle. Although rarely sighted, hawksbill turtles have been detected in FDM's waters. During marine surveys in 2001 and 2004, two and one hawksbill turtles respectively, were observed at FDM (TEC Inc. 2005). Two hawksbills were sighted during surveys in 2006 (Smith and Marx 2009).

4.7.2.6 Invasive Species

Flora

Only two introduced plant species are common on FDM – spider lilies (family Amaryllidaceae) and *Operculina ventricosa*. These species, native to tropical America, possibly arrived via floatation of its seeds from other islands (Whistler 1996). Less common are *Blechum brownei*, *Amaranthus viridis*, tangantangan, *Physalis anguilata*, and *Stachytarpheta jamaicensis* (Whistler 1996).

Fauna

The current presence of invasive species on FDM is limited to a species of rat thought to be the Pacific rat (*Rattus exulans*), which is present in the interior mesic ecosystem. Rats are known to reduce forest regeneration.

4.8 Andersen Air Force Base

4.8.1 General Physical Environment

4.8.1.1 Climate

The climate at Andersen AFB is the same as the climate for Guam as a whole. See **Section 4.1.1.1** for a description of the climate on Guam.

4.8.1.2 Geology and Topography

Andersen AFB is situated on the northern plateau, which is underlain by massive limestone formations (see **Figure 4-1**). The limestone plateau's elevation ranges from 295 to 590 feet (90 to 180 meters) above msl. Steep cliffs surround the plateau on the north, east, and west with a narrow coastal lowland terrace at the bottom of the cliffs. This coastal terrace is 300 to 900 feet (90 to 270 meters) wide from the base of the cliff to the ocean (see **Figure 4-2**).

Andersen AFB overlies limestone, consisting primarily of younger age rocks (Pliocene to Pleistocene, 1.5–5 million years old). The upper few hundred feet of the plateau are composed of basalt and andesite, sedimentary rock, and limestone (U.S. Navy 2009). The area is karst and cavities and sinkholes occur in the porous limestone. A large sinkhole (IRP Site 66), approximately 700 feet by 900 feet (213 meters by 274 meters), is located on the northeastern portion of the installation, near the coastline. Rainwater easily percolates through the porous limestone (Gingerich 2003).

The coastline is composed of a relatively narrow margin of beach interspersed with basalt or limestone rock formations. Beach deposits consist of beach sand and gravel, beach rock in the intertidal zone, and patches of recently emerged detrital limestone (USGS 1992). A fringing reef extends around the coastline to approximately 200 feet (61 meters) offshore. The reef complex begins near shore as a relatively flat back-channel or moat (from 5 to 10 meters deep) that consists of large areas of flat, hard pavement with encrusting corals (Chirichetti et al. 1993). This deeper channel becomes shallower as it rises to the reef crest on the seaward side, which is formed by terraced algal pools. The reef complex is transected at various points by cracks or fissures (called "spur-and-groove" zones) that create shallow to slightly deeper pools in the back reef. These grooves run roughly parallel to the shoreline and can merge with the reef crest where they create deeper pools that are protected by the reef crest, but well-washed with waves. These are the areas of the highest coral diversity on the reef flat. Natural cuts on the reef (e.g., Tarague Cut) are dangerous areas where water constrained by the fringing reef is funneled back out to sea. The ocean bottom drops off abruptly just past the reef (USAF 2009).

4.8.1.3 Seismology

Tectonic uplift and sea level variations are apparent on Andersen AFB in the exposed limestone plateau and terraced escarpments (USAF 2009). The Mount Santa Rosa Fault Line is located just south of Andersen AFB and smaller fault lines are located throughout the installation. Andersen AFB is susceptible to earthquake events; however, the overall likelihood for the occurrence of landslides on northern Guam is generally low due to the lack of steep areas that contain soil vulnerable to slipping in

seismic events. The Guam Hazard Mitigation Plan reports that the northern portion of Andersen AFB has a high risk of liquefaction. The maximum reported tsunami wave height reached on Guam was approximately 12 feet (4 meters) in an 1849 tsunami event (GHS 2008). The Guam Hazard Mitigation Plan reports that areas most prone to large tsunamis are landmasses that are less than 16 feet (5 meters) above msl (GHS 2008). Because most of Andersen AFB is situated on a plateau with elevations ranging from 295 to 590 feet (90 to 180 meters) above msl, most of Andersen AFB would not be susceptible to tsunami inundation. Coastal areas of Andersen AFB below the cliff line could be susceptible to tsunami inundation.

4.8.1.4 Soils

The majority of Andersen AFB is within limestone uplands. A thin layer of soil (approximately 4 to 10 inches [10 to 25 cm]) covers the northern limestone. Eight soil map units are found on Andersen AFB: Guam cobbly clay loam (3 to 7 percent slopes), Guam cobbly clay loam (7 to 15 percent slopes), Guam-Urban Land complex, Guam-Yigo complex, Ritidian-Rock Outcrop complex (3 to 15 percent slopes), Ritidian-Rock Outcrop complex (15 to 60 percent slopes), Rock Outcrop-Ritidian complex, and Shioya loamy sand. There are four soil series composing the mapping units including the Guam, Yigo, Ritidian, and the Shioya series. The Guam series consists of well-drained, very shallow soils with moderately rapid permeability overlying limestone bedrock. They are on uplifted limestone plateaus and formed in sediments that overlie porous coralline limestone. The Yigo series consists of deep and very deep, well-drained soils that have moderate permeability. They are in depressions on limestone plateaus and formed in sediments overlying porous coralline limestone. The Ritidian series consists of very shallow, well-drained soils of moderately rapid permeability occurring on limestone plateaus and escarpments. They formed in slope alluvium, loess, and residuum from sediments overlying coralline limestone. The Shioya series consists of deep and very deep, rapidly permeable, excessively drained soils. They occur on coastal strands and formed in water-deposited coral sand (NRCS 1988). **Figure 4-24** shows the locations of soil map units occurring on Andersen AFB.

Soil formation on northern Guam is the result of intense weathering of the permeable limestone to form the silica-poor soils that are rich in iron oxides and gibbsite clays (NRCS 1988). Soils on Andersen AFB are classified as limestone upland. These soils exhibit moderately rapid permeability and low water capacity (NRCS 1988). A thin layer (from 4 to 10 inches [10 to 25 cm]) of Guam cobbly clay loam overlies the northern limestone substrate, contributing to a shallow vegetation root structure (PACAF 2006). Erosion does not present a significant problem on Andersen AFB because it is generally located on a broad limestone reef plateau underlain by volcanic rocks.

The South Ramp, North Ramp, and much of Northwest Field and the Munitions Storage Area (MSA) are in areas classified as Guam-Urban Land complex with 0–3 percent slopes. This soil complex is described by the NRCS (1988) as consisting of 55 percent Guam cobbly clay loam and 45 percent Urban Land. Urban land consists of land developed with roads, buildings, parking lots, and airstrips. A small part of the North Ramp and North Gate Access Road contain Guam cobbly clay loams with 3–7 percent slopes.

4.8.1.5 Hydrology

Groundwater. Groundwater under Andersen AFB is encountered at around sea level, which averages around 450 feet (137 meters) below the ground surface under the limestone plateau in the vicinity of the installation.

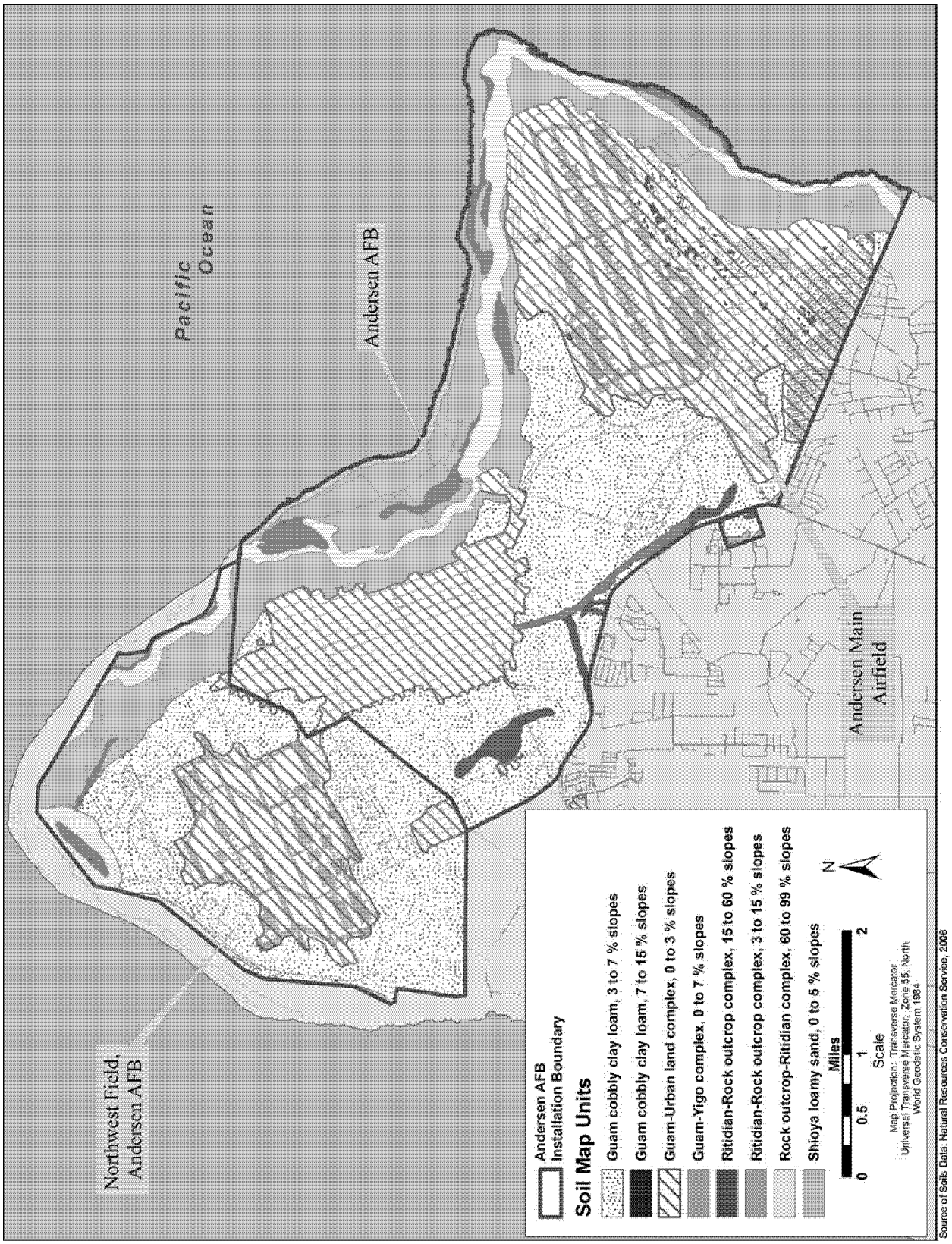


Figure 4-24. Soils on Andersen AFB

Andersen AFB overlies the northern portion of three groundwater subbasins: the Finegayan subbasin under the western third of the installation; the Agafa Gumas subbasin under the central portion of the installation, which includes Northwest Field; and the Andersen subbasin under the eastern portion of the installation. Approximately 100 dry wells have been drilled to facilitate the flow of storm water into the underlying basins. While this method of storm water management has the potential to cause groundwater contamination from storm water runoff, proper implementation of the Andersen AFB SWPPP has prevented extensive groundwater contamination (U.S. Navy 2010b). Andersen AFB's water supply comes from groundwater wells on Andersen South.

Surface Water. Because of the high permeability of the limestone substrate, no streams or other natural surface water drainage features occur on Andersen AFB. Rainfall percolates into limestone cavities or is channeled into underground injection control (UIC) wells throughout Andersen AFB. Storm water runoff from impervious surfaces is currently directed via concrete-lined culverts to UIC wells, which are permitted and regulated by GEPA (USAF 2009).

4.8.2 General Biotic Environment

4.8.2.1 Terrestrial Ecosystems

Flora

Basewide vegetation survey and mapping was conducted on Andersen AFB in 2007 and 2008. This survey included quantitative characterization of 3,211 randomly located plots on 15,371 acres (6,220 hectares) on Andersen AFB proper and the adjacent GNWR on Ritidian Point (e²M 2008). Twenty-two distinct communities (21 vegetative communities and disturbed land) were observed on Andersen AFB within the survey area (e²M 2008). Vegetation community types were named in accordance with the Fosberg (1960) classification, with secondary forest subdivisions based on descriptions of Donnegan et al. 2004. Community types were typically named by the dominant or keystone plant species therein. **Table 4-6** presents the community types identified in the installation wide survey and mapping along with the dominant vegetation species characterizing each community type. **Table 4-7** provides total acreage of each of the community types identified on Andersen AFB within the survey area at the time of the survey. **Figures H7-1a** through **H7-1l** on pages **H-23** through **H-46** in **Appendix H** provide the maps of vegetative communities occurring on Andersen AFB based on the installation wide vegetation survey and mapping. No wetlands have been identified on Andersen AFB (USAF 2009).

Given the change in plant species composition over the past 60 years, more vegetation communities exist and were observed during the installation wide vegetation survey effort, than were reported by Fosberg (1960). **Table 4-8** presents the correlation between the vegetation community categories used by Fosberg (1960) and the 2008 survey. **Table 4-9** presents the correlation between the vegetation community categories used by Donnegan et al. (2004) and the 2008 survey.

Because many of the vegetation communities are unique to their geographic location in the landscape of northern Guam, **Figure 4-25** presents the location of the vegetation communities observed by Fosberg (1960) and the 2008 survey (e²M 2008) relative to each other and their location in the landscape.

Table 4-6. Vegetation Community Types and Characteristic Species Found on Andersen Air Force Base

General Vegetation Type	Community Type	Characteristic Species
Mixed Limestone Forest	Mixed Limestone Forest-Plateau/Primary	*Ficus, Premna, Neisosperma*
	Mixed Limestone Forest-Plateau/Secondary	*Vitex, Ficus, Premna, Neisosperma, Guamia, Aglaia*
	Mixed Limestone Forest-Fore Slope	*Triphasia, Aglaia, Neisosperma, Guamia*
	Mixed Limestone Forest-Toe Slope/Primary	*Mammea, Aglaia, Cynometra, Hibiscus*
	Mixed Limestone Forest-Toe Slope	*Guamia, Neisosperma, Hibiscus*
Native Strand	Fore Strand/Sand	*Scaevola, Tournefortia, Sophora*
	Back Strand/Sand	*Hernandia, Casuarina, Cocos*
	Back Strand/Rock	*Callicarpa, Ochrosia*
	Strand/Rock	*Pemphis*
Native Scrub	Hibiscus-Ochrosia Scrub	*Hibiscus, Ochrosia, Cestrum, Neisosperma*
	Ochrosia Edge	*Ochrosia*
	Neisosperma Forest	*Neisosperma, Aglaia*
	Mixed Herbaceous Scrub	*Stachytarpheta*
	Hibiscus Scrub	*Hibiscus*
Native Shrub	Mixed Shrub	*Triphasia, Cestrum, Hibiscus, Morinda*
	Eugenia Forest	*Eugenia*
Invasive Plants	Coconut Plantation	*Cocos*
	Casuarina Forest	*Casuarina*
	Vitex-Closed Canopy	*Vitex*
	Vitex-Sparse Canopy	*Vitex, Guamia, Aglaia*
	Hibiscus-Leucaena	*Hibiscus, Leucaena*
Developed Land	Developed Land	pavement, structures, maintained lawn grasses

Source: e²M 2008

Table 4-7. Total Area for Each Vegetation Community Type on Andersen Air Force Base

Community Type	Total Area (acres)
Mixed Limestone Forest-Plateau/Primary	1,540.67
Mixed Limestone Forest-Plateau/Secondary	4,107.34
Mixed Limestone Forest-Fore Slope	833.88
Mixed Limestone Forest-Toe Slope/Primary	115.88
Mixed Limestone Forest-Toe Slope	26.69
Fore Strand/Sand	34.04
Back Strand/Sand	13.98
Back Strand/Rock	38.20
Strand/Rock	99.92
Hibiscus-Ochrosia Scrub	623.90
Ochrosia Edge	37.74
Neisosperma Forest	285.66
Mixed Herbaceous Scrub	731.81
Hibiscus Scrub	431.46
Mixed Shrub	32.26
Eugenia Forest	39.14
Coconut Plantation	486.96
Casuarina Forest	102.25
Vitex-Closed Canopy	850.77
Vitex-Sparse Canopy	807.01
Hibiscus-Leucaena	109.29
Developed Land	4,501.21

Source: e²M 2008

Table 4-8. Vegetation Community Correlation between Fosberg (1960) and the 2008 Survey on Andersen Air Force Base

Fosberg (1960)		2008 Survey
Significant Vegetation Type	**Variant**	**Vegetation Community**
Forests of Elevated Hard Limestone	Artocarpus Forest	*Vitex*-Closed Canopy
		Vitex-Sparse Canopy
		Mixed Limestone Forest-Plateau/Primary
		Mixed Limestone Forest-Plateau/Secondary
		Eugenia Forest
	Mixed Moist Forest	Hibiscus-Ochrosia Scrub
	Mammea Type	Mixed Limestone Forest-Toe Slope/Primary
		Mixed Limestone Forest-Toe Slope
		Neisosperma Forest
		Casuarina Forest
	Cordia Type	Ochrosia Edge
	Halophytic and Xerophytic Scrub	Strand/Rock
		Hibiscus Scrub
		Mixed Limestone Forest-Fore Slope
Strand Vegetation		Back Strand/Sand
		Fore Strand/Sand
		Back Strand/Rock
Coconut Groves and Plantations		Coconut Plantation
Weed Communities	Mixed Shrub Community	Mixed Shrub
	Leucaena leucocephala Thicket	Hibiscus-Leucaena
	Mixed Herb Type	Mixed Herbaceous Scrub

Table 4-9. Vegetation Community Correlation between Donnegan et al. (2004) and the 2008 Survey on Andersen Air Force Base

Donnegan et al. (2004)		2008 Survey
Significant Vegetation Type	**Variant**	**Vegetation Community**
Limestone Forest Types	Artocarpus Forest	*Vitex*-Closed Canopy
		Vitex-Sparse Canopy
		Mixed Limestone Forest-Plateau
		Eugenia Forest
	Mammea Type	Mixed Limestone Forest-Toe Slope
		Neisosperma Forest
		Casuarina Forest
	Cordia Type	Ochrosia Edge

Mixed Limestone Forest

The predominant vegetation type in undeveloped areas on Andersen AFB is mixed limestone forest (also called old growth limestone forest or "typhoon forest" due to the unique physiognomy of the forest trees caused by the high winds of typhoons). This vegetative community occurs along portions of the western boundary and the northern and eastern boundaries of the installation, atop the plateau, on the fore slope (cliff face), and at the toe of the cliff slope. Depending on the relative age of the vegetation within the community, mixed limestone forest can be further divided into primary and secondary forests, with primary forests being the historic limestone forest and the secondary being a successional form after primary forests have been impacted by catastrophic forces such as typhoons and intensive military actions (e.g., bombing).

Mixed Limestone Forest-Plateau/Primary, Mixed Limestone Forest-Fore Slope, Mixed Limestone Forest-Toe Slope/Primary. Vegetation in mixed limestone forest-plateau/primary, -fore slope, and -toe/slope/primary is very dense due to the relatively open canopy structure that allows light to penetrate to the understory and ground levels. Mature limestone forest is of moderate stature and is represented by a number of characteristic subtypes described in Fosberg (1960) and Stone (1970). Common limestone forest plants include breadfruit, strangler fig, *Pisonia grandis*, *Elaeocarpus joga*, *Neisosperma oppositifolia*, *Guamia mariannae*, *Aglaia mariannensis*, *Macaranga thompsonii* (pengua in Chamorro), *Premna obtusifolia*, *Tristiropsis acutangula*, ifil, *Eugenia thompsonii*, *Cycas micronesica* (fadang in Chamorro), *Pandanus tectorius* (kafo in Chamorro), *Ochrosia marianensis* (langiti in Chamorro), *Psychotria hombroniana*, *Psychotria mariana* (aplokating in Chamorro), *Jasminum marianum*, and *Morinda umbellata*. See **Figure 4-26** for photograph of a strangler fig, **Figure 4-27** for a photograph of *Neisosperma oppositifolia*, **Figure 4-28** for a photograph of *Macaranga thompsonii*, and **Figure 4-29** for a photograph of a *Cycas micronesica*.

Grasses, ferns, and orchids also occur in limestone forests. Limestone forest subtypes are distinguished on the basis of plant associations and are affected by aspect, substrate, and other factors. Rare plants found in the limestone forests on Andersen AFB include the last wild individuals of the federally endangered *Serianthes nelsonnii* tree on Guam, *Tabernaemontana rotensis,* and the rare *Heritiera longipetoliata* (listed as endangered by GovGuam endangered species list). Native limestone forest provides high-quality habitat for a number of endangered forest birds and fruit bats, and most of the installation's forested areas are included in the Overlay Refuge Unit. See **Figure 4-30** for a view of mixed limestone forest-toe slope/primary on Andersen AFB.

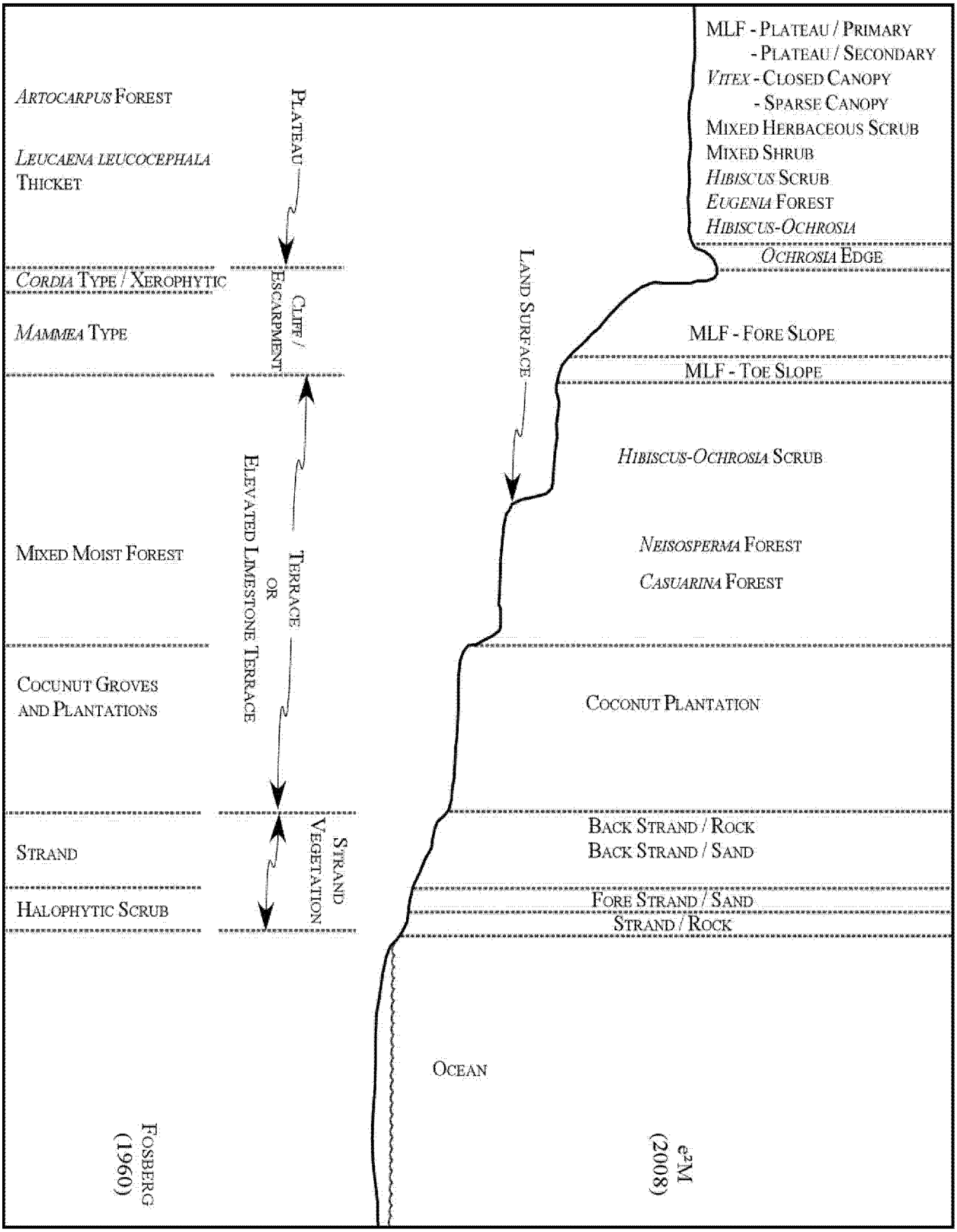


Figure 4-25. Correlation of Vegetation Community Locations Identified by Fosberg (1960) and the 2008 Survey

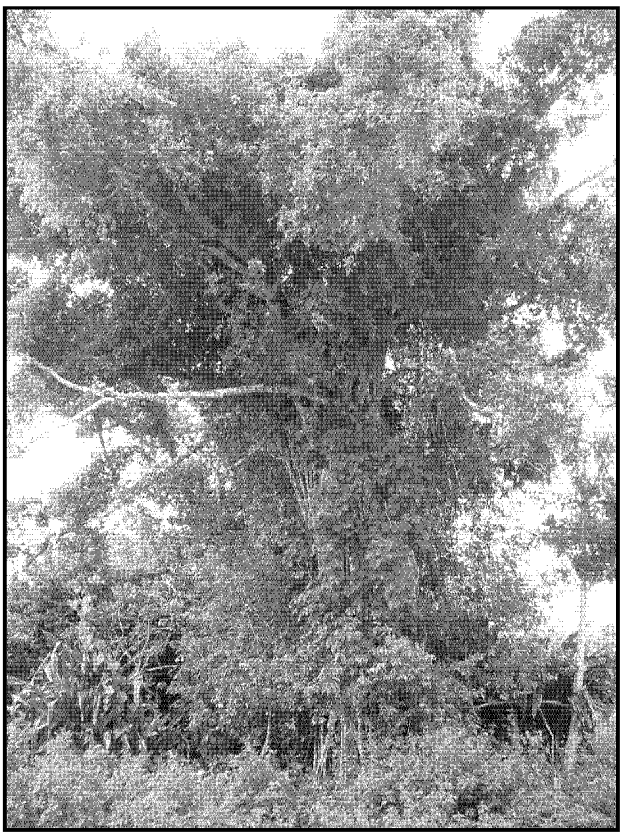


Figure 4-26. Strangler Fig on Andersen AFB

Figure 4-27. *Neisosperma oppositifolia* on Andersen AFB

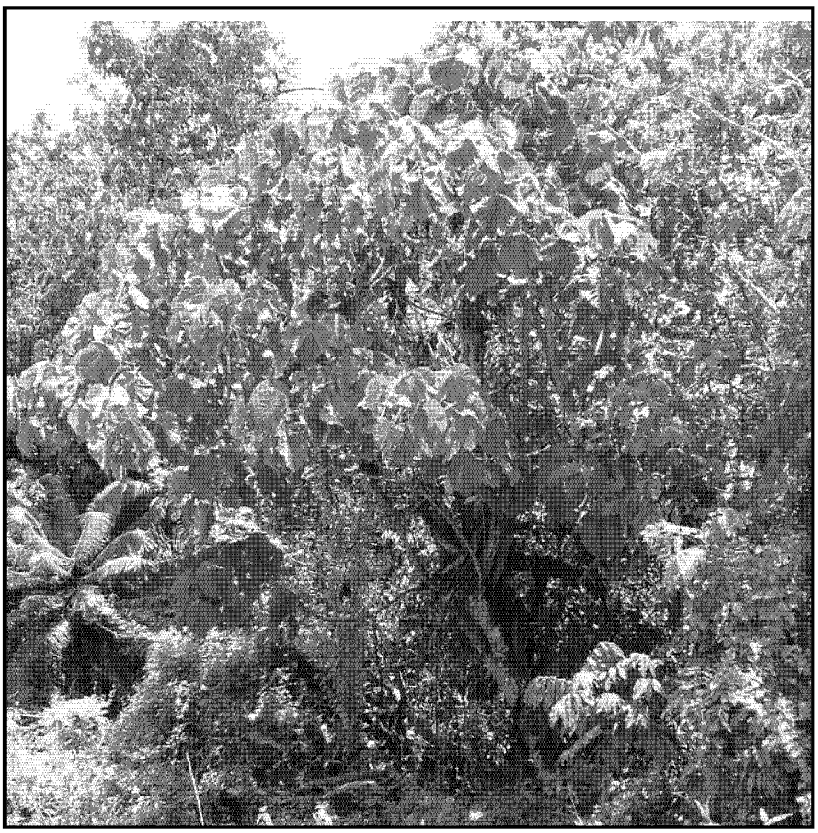


Figure 4-28. ***Macaranga thompsonii*** **on Andersen AFB**

Figure 4-29. ***Cycas micronesica*** **on Andersen AFB**

Figure 4-30. Mixed Limestone Forest-Toe Slope/Primary on Andersen AFB

It is important to note that the species composition of the mixed limestone forest-fore slope is similar to the other primary mixed limestone forests (-plateau/primary and -toe slope primary). However, due to the persistent winds buffeting the northern cliff face of Guam and paucity of soil, the plant community on the fore slope is far shorter in stature than those same species located on the plateau and the toe slope.

Mixed Limestone Forest-Plateau/Secondary, Mixed Limestone Forest-Toe Slope. Secondary growth mixed limestone forest (mixed limestone forest-plateau/secondary and -fore slope) occurs in areas that were once cleared of mature growth and are presumably returning to the climax successional stage. This forest type occurs in Northwest Field (far northwestern corner area of Andersen AFB) and in the MSA 1 (in the central area of Andersen AFB) and is typified by an open canopy of low to moderate stature. Small pockets of secondary growth limestone forest also occur just east of the military family housing area, near the Main Gate. Dominant flora include ironwood, screwpine, *Neisosperma oppositifolia*, Nanaso (*Scaevola sericea*), Indian mulberry, sea hibiscus, *Eleaocarpus joga*, *Cycas micronesica*, *Mammea odorata* (chopak in Chamorro), *Artocarpus altilis* (lemia in Chamorro), screwpine, and *Pandanus dubius* (Pahong in Chamorro) (36 CES/CEVN 2003). See **Figure 4-31** for a photograph of screwpine and **Figure 4-32** for a photograph of secondary growth limestone forest on Andersen AFB.

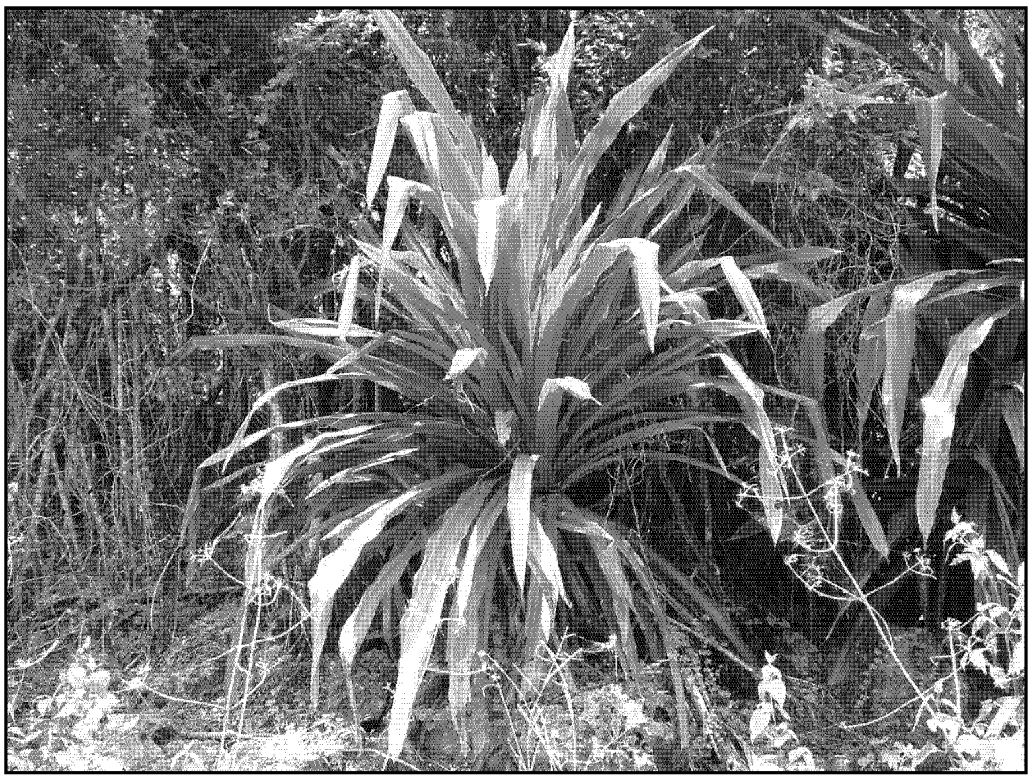


Figure 4-31. Screwpine (*Pandanus tectorius*) on Andersen AFB

Figure 4-32. Secondary Limestone Forest on Andersen AFB

Native Strand Vegetation

Fore Strand/Sand, Back Strand/Sand, Back Strand Rock, Strand Rock. Excellent examples of native strand vegetation are found on coastal areas of Andersen AFB. Strand plants are characteristically salt-tolerant, thrive in sandy soils or on rocky coasts, and tolerate direct sunlight and hot, dry conditions. Major components of the coastal strand flora include trees and shrubs such as nanso, tree heliotrope, *Triumfetta procumbens*, *Guettarda speciosa*, *Hernandia nymphaeifolia*, milo (*Thespesia populnea*), ironwood, *Barringtonia asiatica*, and coconut trees; grasses including bunchgrass, *Paspalum disthichum, Sporobolus virginicus*, and *Thuarea involuta*; and trailing vines including *Vigna marina*, beach morning glory (*Ipomoea pres-caprae* ssp. *brasiliensis*), and *Canavalia maritima*. Rocky coasts typically support stunted, wind-sheared shrubs such as *Hedyotis albido-punctata*, *Suriana maritima*, *Pemphis acidula*, and *Capparis cordifolia*. See **Figure 4-33** for a photograph of coastal strand vegetation on Andersen AFB.

Figure 4-33. Coastal Strand Vegetation on Andersen AFB

The fore strand/sand vegetation community is that area immediately landward of the beach face where the dominant substrate is sand. The back strand/sand vegetation community is immediately landward of the fore strand zone, and the dominant substrate is also sand. The back strand/rock vegetation community is in the same location as the back strand/sand community, but the dominant substrate is exposed limestone. The strand/rock vegetation community is immediately adjacent to the intertidal zone of the beach face, lies waterward of the fore strand zone, and the dominant substrate is exposed limestone.

Native Scrub

Hibiscus-Ochrosia Scrub, Ochrosia Edge, Neisosperma Forest, Mixed Herbaceous Scrub, Hibiscus Scrub. The native scrub community occurs in historically cleared areas on the plateau in the area of Northwest Field, along the top of the cliff edge, and along roadsides and previously disturbed areas on the northern limestone plateau and the terrace of Andersen AFB. The scrub community occurs in varying heights and densities that might be a response to extreme salt spray, to dryness resulting from excessive drainage, to excessive transpiration due to exposure to winds, or to any combination of these and other factors (Fosberg 1960). The native shrub community is generally of a lower stature than secondary growth mixed limestone forest. Native scrub can be subdivided into *Hibiscus-Ochrosia* scrub, *Ochrosia* edge, *Neisosperma* forest, mixed herbaceous scrub, or *Hibiscus* scrub depending on species characterizing the community. The *Hibiscus-Ochrosia* scrub is found below the toe of slope of the cliff on the terrace of Andersen AFB. Species characterizing the community include sea hibiscus, *Ochrosia marianensis*, china inkberry (*Cestrum diurnum*) (tintanchina in Chamorro), and *Neisosperma oppositifolia*. *Ochrosia* edge is only found along the top edge of the cliff on Andersen AFB and is characterized by *Ochrosia marianensis*. *Neisosperma* Forest occurs below the fore slope of the cliff on the terrace and is characterized by *Neisosperma oppositifolia*, and *Aglaia mariannensis*. Mixed herbaceous scrub occurs on the plateau and terrace in association with developed land and is typically characterized by a dominance of *Stachytarpheta jamaicensis*. The Hibiscus scrub community occurs on the plateau in the area of Northwest Field and is characterized by a dominance of sea hibiscus.

Mixed Shrub, Eugenia Forest. Excellent examples of native shrub vegetation are found in several small patches near the northern tip of the plateau and in association with mixed limestone forest primary on Andersen AFB. Mixed shrub habitat occurs in one area on the plateau just south of Ritidian Point. Vegetation occurring in the mixed shrub habitat is characterized by limeberry, china inkberry, sea hibiscus, and Indian mulberry. Eugenia forest occurs in several small patches within the mixed limestone forest primary near the edge of the plateau to the northeast of Northwest Field. Vegetation in the Eugenia forest is characterized by a dominance of *Eugenia reinwardtiana* (a'abang in Chamorro).

Developed Land

The main portion of Andersen AFB, including the runway and flightline, administrative areas, and community areas, is disturbed ground. The installation is landscaped according to the Andersen AFB *Architectural Compatibility and Base Design Standards* (Andersen AFB 2006), which promotes a tropical setting using native vegetation while minimizing maintenance costs, and to EO 13148, *Greening the Government Through Leadership in Environmental Management*. Palm trees (except coconut-bearing palms) are augmented by a variety of tropical trees, ornamental shrubs, and vines. Turf grasses used at Andersen AFB include low-maintenance varieties such as buffalo grass (*Stenotaphrum secundatum*), common Bermuda grass (*Cynodon dactylon*), centipede grass (*Eremochloa ophiuroides*), and pangola grass (*Digitaria decumbens*). Medium- and high-maintenance varieties of turf grass are also used as appropriate, and include Hilo grass (*Paspalum conjugatum*), kikuyu grass (*Pennisetum clandestinum*), mondo grass (*Ophiopogon japonicum*), and daylily (*Hemerocallis* spp.). Native ferns are also used as an attractive, low-growing, ground cover.

Fauna

Birds. Native terrestrial bird species on Guam are either endangered or extirpated in the wild due to predation by, or competition with introduced species. These bird species are discussed in **Section 4.8.2.5**. Some of the introduced bird species on Guam with potential to occur on Andersen AFB include black francolin, black drongo, Eurasian tree sparrow, and island collared dove. Regulated game species on Guam include black francolin and island collared dove. Introduced birds are a concern because of their

potential to displace, compete with, or transmit diseases to native birds. Black drongos are a conspicuous and aggressive avian species that can contribute to a decline in native bird species (USAF 2009).

Sea birds that have the potential to migrate through or reside at Andersen AFB include black noddy, brown noddy, brown booby, red-footed booby (lu'ao talisai in Chamorro), white tern, great frigatebird (*Fregata minor*) (ga'ga' manglo' in Chamorro), sooty tern (*Sterna fuscata*) (giree'girak in Chamorro), and the white-tailed tropicbird (*Phaethon lepturus*) (utag in Chamorro) (GDAWR 2005). Black noddies, brown noddies, white terns, and brown boobies are commonly observed at Andersen AFB (USAF 2009).

Shorebirds that have the potential to migrate through or reside in coastal areas of Andersen AFB include the whimbrel and sandpipers and plovers that share the collective Chamorro term "dulili," including the common sandpiper (*Actitus hypoleucus*), ruddy turnstone, Siberian tattler, wandering tattler (*Heteroseclus incanus*), Pacific piping plover, Pacific golden-plover, Mongolian plover, black-bellied plover (*Pluvialis squatarola*), the great sandplover (*Charadrius leschenaultii*), common ringed plover (*Charadrius hiaticula*), little ringed plover (*Charadrius dubius*), and snowy plover (*Charadrius alexandrinus*) (GDAWR 2005). Wintering shorebirds such as the Pacific golden-plover, Mongolian plover, wandering tattler, Siberian tattler, whimbrel, and ruddy turnstone are commonly observed on the beaches of Andersen AFB. GDAWR staff members have observed white tern, brown noddy, and Pacific golden-plover.

Wading birds that have the potential to migrate through, or reside at Andersen AFB include cattle egret, intermediate egret (*Egretta intermedia*), Pacific reef heron, and yellow bittern (GDAWR 2005). Pacific reef-herons have been observed at Andersen AFB foraging on the exposed reef.

The following avian species were identified during the 2008–2010 roadside and forest bird surveys performed by SWCA at the Northwest Field, North Ramp, and a Proposed Utility Corridor along Route 9 on Andersen AFB: black francolin, island collared dove, yellow bittern, black drongo, Eurasian tree sparrow, and Micronesian starling (NAVFAC Pacific 2010b). The black francolin was the most commonly observed species on this portion of Andersen AFB. The black francolin, island collared dove, black drongo, and Eurasian tree sparrow are common, introduced, breeding residents in Guam (NAVFACPACIFIC 2010b). The yellow bittern is a common, native, breeding resident of Guam. The Micronesian starling is a Guam-listed endangered species that is an uncommon, native, breeding resident of Guam (NAVFACPACIFIC 2010b).

The following avian species were identified during the 2008–2010 avian surveys performed on Andersen AFB Finegayan: black drongo, Eurasian tree sparrow, island collared dove, and feral chicken. The island collared dove and feral chicken are common, introduced, breeding residents in Guam (NAVFACPACIFIC 2010b).

Mammals. The only native terrestrial mammal species with the potential to occur on Andersen AFB is the Mariana fruit bat, which is federally listed as threatened and Guam-listed as endangered, and will be discussed further in the **Section 4.8.2.5**. Forested habitats on Andersen AFB are essential to the long-term conservation of the Mariana fruit bat. Specifically, 11,085 acres (4,486 hectares) of the installation were identified as important to the species in 2004, but were exempted from critical habitat designation under Section 4(a)(3) of the ESA, as amended by Section 318 of the fiscal year 2004 National Defense Authorization Act (P.L. No: 108–136) (69 FR 62944).

A number of species of whales and dolphins occur in the waters offshore of Andersen AFB. Marine mammals occurring in waters offshore of the installation are protected under the MMPA (USAF 2009).

Reptiles and Amphibians. Nine herpetofauna species were documented during the 2008–2009 herpetofauna surveys performed in the Northwest Field, North Ramp, and Proposed Utility Corridors on Andersen AFB (NAVFAC Pacific 2010b). Of these, three species are native: blue-tailed skink, moth skink (a Guam-listed endangered species), and stump-toed gecko; and six species are introduced: curious skink, house gecko, brown treesnake, brahminy blind snake, marine toad, and greenhouse frog (NAVFACPACIFIC 2010b). The continued widespread presence of the curious skink, the brown treesnake, and other introduced amphibian species is of concern because of each species' potentially deleterious impacts on Guam's native fauna (NAVFACPACIFIC 2010b).

The green sea turtle, federally listed as threatened, and the hawksbill sea turtle and leatherback sea turtle, both federally and GovGuam listed as endangered, can be found in the coastal waters off Andersen AFB. The green sea turtle is also documented to bask and nest on beaches on Andersen AFB (USAF 2009). Sea turtles are discussed further in **Section 4.8.2.5**.

Invertebrates. Endemic and indigenous tree and land snails, once abundant on the island, are in a state of serious decline and are disappearing from their former ranges. Causes of the decline include habitat loss to agriculture and development, pesticides, wildland fires, competition with introduced species, and predation by introduced predatory snails and the predatory Manokwar flatworm (USAF 2009). Shells of the introduced giant African snail and both live individuals and shells of the introduced snail *Satsuma mercatoria* were observed during 2009 tree snail surveys. Additionally, live introduced Manokwar flatworms were also observed (NAVFACPACIFIC 2010b). A total of 49 live tree snails, 20 Guam tree snails and 29 fragile tree snails were recorded during surveys conducted in 2011 (HDR 2013). Because of the possibility of impacting native tree and land snails, any projects including land clearing should be coordinated with natural resources personnel to ensure that native terrestrial snails are not impacted.

Five butterfly species were documented within forested areas on Andersen AFB during 2009–2010 butterfly surveys: lemon emigrant (*Catopsilia pomona*), monarch (*Danaus plexippus*), blue-banded king crow, blue moon, and common Mormon (NAVFACPACIFIC 2010b). These species are fairly well distributed throughout Guam and portions of the Mariana Islands. Additional butterfly species documented on Andersen AFB in previous surveys include Mariana wandering *(Vagrans egistina)*, cycad blue butterfly or plains cupid, three-spot grass yellow (*Eurema blanda*), and tiny grass blue (*Zizula hylax*) (Schreiner and Nafus 1997, USAF 2009).

The Mariana eight-spot butterfly and the Mariana wandering butterfly, which are both candidate species for listing by the USFWS under the ESA, were not observed on Andersen AFB during the 2009–2010 surveys. However, thirty-eight percent of host plant patches surveyed for the Mariana eight-spot butterfly during surveys conducted at Andersen AFB in 2011 were occupied by the butterfly (HDR 2013).

Other terrestrial invertebrates that occur at Andersen AFB include the native land hermit crab and the coconut crab, which both begin their life at sea. After a planktonic larvae stage, small crabs emerge from the ocean to a life on land. Land hermit crabs rely on borrowed shells throughout their lives, often using the shell of the giant African snail. Coconut crabs initially borrow shells, but then develop their own hard shell. Coconut crabs hide in burrows during the day and, like land hermit crabs, forage at night. Both species are omnivorous and feed on coconuts, fruits, plants, rotten wood, dead insects, and carrion. The coconut crab is large with a leg span up to 3 feet (1 meter). Threats to these species include introduced predators including rats, feral pigs, dogs, monitor lizards, and humans. Coconut crabs are a culturally important species and a local delicacy and, because of this, have been overharvested. They are considered a game species and are regulated by GovGuam.

4.8.2.2 Freshwater Ecosystems

There are no freshwater ecosystems on Andersen AFB.

4.8.2.3 Estuarine Ecosystems

There are no estuarine ecosystems on Andersen AFB.

4.8.2.4 Submerged Lands

JRM managed submerged lands that extend 3 nautical miles seaward from the coastline at Andersen AFB include the northern edge of Guam around Ritidian Point and extend eastward along the coastline to Pati Point, as shown in **Figure 4-34**.

In February 1993, the USAF established the Andersen AFB Marine Resources Preserve (MRP) to protect marine habitats and marine species, and to enhance Guam's marine resources. The seaward boundary of the Andersen AFB MRP extends to any distance where spear or net fishing is observed and the inland boundary extends landward 65 feet (20 meters) from the shoreline. The MRP supports a considerable variety of marine plants, fish, corals, and other invertebrates. The ocean currents in northern Guam carry fish, coral, and other invertebrate larvae to seed Guam's central and southern reefs. There is a permanent ban on any form of spearfishing, any form of fishing from land, taking of marine life (dead or alive) except for game fish trolling or spin casting from shore, and possessing spearfishing equipment within the area and adjacent beaches (Andersen AFB undated, Belt Collins Hawaii Ltd. 2002).

Two surveys were conducted on the reef flats and reef slopes within the boundaries of the MRP during the Baseline Survey of Marine Resources conducted in 1993 and 1994. Surveys were conducted for each of the major groups of marine organisms (i.e., marine plants, corals, macroinvertebrates, and fish). Sediment sampling was also performed (Andersen AFB 1995). In June 1999, a Legacy Program-funded marine resources survey, including an ocean current assessment, was contracted by the UOG Marine Laboratory to gather baseline data to support a marine resources management plan in the future at Andersen AFB.

The Pati Point Preserve was established on May 16, 1997, by Guam Public Law 24-21. The seaward boundary of the preserve extends to the 600-foot (182-meter) contour and the inland boundary of the preserve extends landward 32 feet (10 meters) from the mean high tide mark or to the nearest edge of a public right-of-way, whichever comes first. The Pati Point Preserve and the Andersen AFB MRP overlap in the nearshore area and approximately 32 feet (10 meters) along the onshore area.

At Ritidian Point, the JRM managed submerged lands do not include a designated 100-foot (30-meter) isobath that is part of the Ritidian Point NWR managed by the USFWS.

4.8.2.5 Protected Species

Three federally endangered species are currently known to occur on Andersen AFB, including the Mariana fruit bat, green sea turtle, and the fire tree. The Micronesian starling, and the *Heritiera longipetiolata* tree, Guam-listed endangered species, are also present. In 2003, two male white-throated ground-doves, a Guam-listed endangered species, were sighted on the installation. Potential habitat is present on the installation for nine other federally endangered, threatened, or candidate species, some of which might already be extinct. Six federally listed cetaceans and one additional federally listed sea turtle have the potential to occur in the JRM managed submerged lands off of Andersen AFB.

Figure 4-34. JRM Managed Submerged Lands at Andersen AFB

Fauna

Terrestrial Species

Birds

Micronesian starling. The Micronesian starling is found in the forests north of the flightline, east of the golf course, in the housing areas, and in an area to the south of Andersen AFB. The starling has adapted to nesting in the housing area as well as on buildings and other man-made structures. Starlings have persisted on Andersen where brown treesnake control has been ongoing for decades. See **Figure 4-35** for the range of the Micronesian starling on Andersen AFB and adjacent areas. The species is also still present on Cocos Island, parts of Hagåtña and the beach strand areas along the southeastern portion of Guam. In 1996, conservation staff at Andersen AFB initiated a volunteer program to protect nesting by Micronesian starling through the installation of nest boxes. By 2001, more than 80 nest boxes were in place.

Mariana crow. The last native Mariana crow on Guam likely disappeared between 2002 and 2003 (USFWS 2005b). GDAWR in cooperation with USFWS, CNMI DLNR, and Andersen AFB has released 31 Mariana crows on Guam since 1997 as part of the translocation and captive recovery and release program (USFWS 2010a). Translocated crows were released in an area of large scale brown treesnake control within the Andersen AFB Munitions Storage Area. In 2007, 10 crows, all of which were translocated from Rota, remained on Guam, restricted in distribution to the northern cliff forests on Andersen AFB (USFWS 2010a). A single banded Mariana crow was observed during the 2011 surveys. The crow was last seen in July 2011 and heard in August 2011 (SWCA 2012). There have been no observations of any crows since then and it is believed the last remaining bird has died.

White-throated ground-dove. This species was extirpated from Guam along with other forest bird species in the mid-1980s. However, one male white-throated ground-dove was heard, observed, and photographed on Andersen AFB during surveys conducted in June 2011 (SWCA 2012). During the survey, the ground-dove was initially observed 33 feet (10 meters) up in a *Ficus prolixa* tree, after which it flew and perched in vitex and sea hibiscus trees. The observed ground dove was most likely a recent arrival from Rota and not a bird that has persisted since extirpation. Predation by brown treesnakes was the main cause of their extirpation on Guam (GDAWR 2005).

Mammals

Mariana fruit bat. In 1972, 500 to 600 fruit bats on Andersen AFB made up the majority of the island population. The Pati Point area was declared a protected area in 1973. By 1978, the number of fruit bats on Guam had been reduced to 50 (Wheeler and Aguon 1978). Between 1980 and 1981 the fruit bat population grew to almost 1,000 bats, likely the result of immigration from Rota (Wiles 1987a, 1987b). The increased population was concentrated on Andersen AFB in one or two colonies at Pati Point. Between 1981 and 1987, fruit bats roosted in at least 19 locations along the northern coast of Guam, on Andersen AFB (see **Figure 4-36**) between Lafac Point and Ritidian Point (Wiles 1987c). The Mariana fruit bat colony on Andersen AFB has used the same roost location at Pati Point since 1994 (see **Figure 4-37**) (Wiles 1998). Except for the punctuated increase in the early 1980s, the overall population trend of this species has been declining (see **Figure 4-38**). In 2006, Janeke (2006) estimated fewer than 100 fruit bats at Pati Point. A survey conducted by SWCA on Andersen AFB from June 2007 until April 2008 indicated counts from 31 to 54 individuals with an average count of 40 bats (SWCA 2008). A recent count in May 2010 recorded only 10 bats at the Pati Point colony (Anne Brooke, U.S. Navy, personal communication). Surveys in 2011 by SWCA found 2 to 3 bats below Pati Point, but the colony is no longer present and surveys have not found that the colony has relocated (SWCA 2012). The surveys were conducted by SWCA at 111 stations throughout Andersen AFB (SWCA 2012). Sightings of fruit bats observed during surveys in 2012 by SWCA on Andersen AFB are illustrated in **Figure 4-39**.

Figure 4-35. Range of the Micronesian Starling on Andersen AFB and Adjacent Areas

Source: Data and Imagery provided by NAVFAC GRC Marianas and Air Force GeoBase

Figure 4-36. Historic Mariana Fruit Bat Roost Locations on Andersen AFB

Figure 4-37. Mariana Fruit Bat Colony at Pati Point.
Fruit Bats Pictured Roosting in *Mammea odorata* Trees

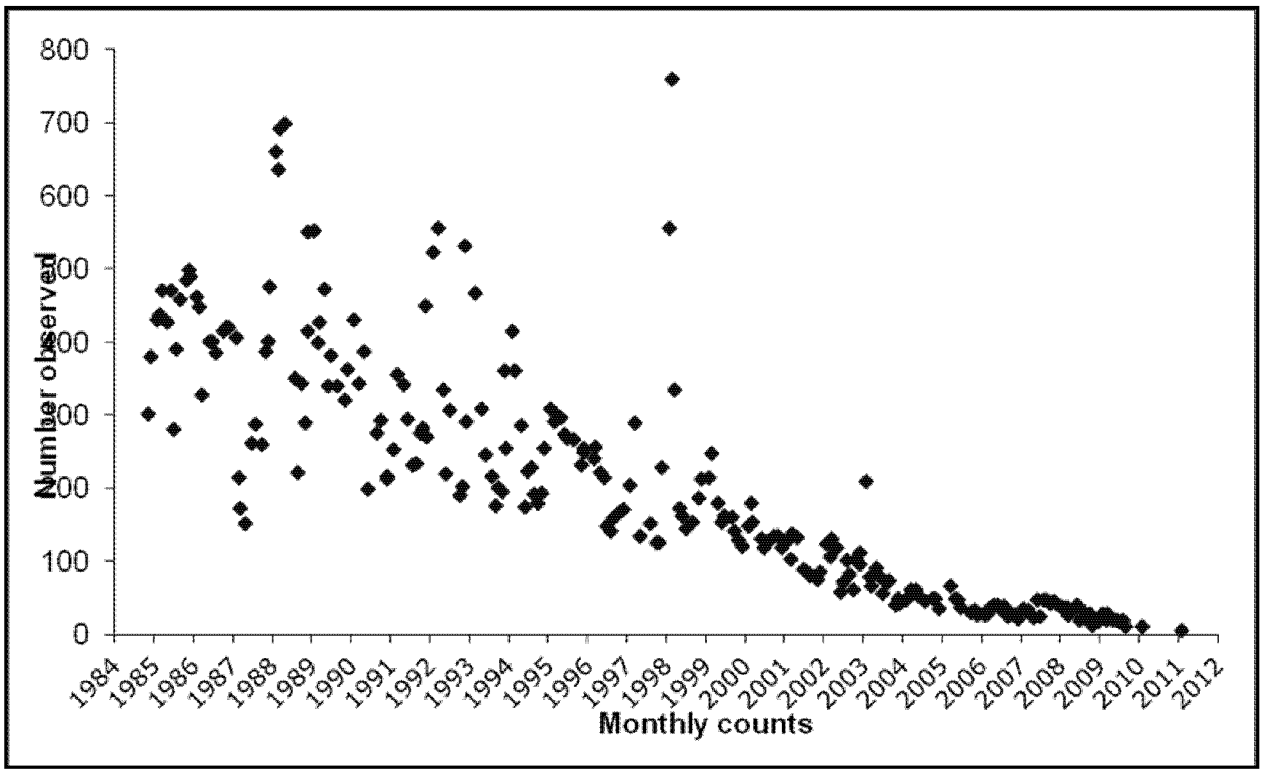


Figure 4-38. Mariana Fruit Bat Counts at the Pati Point Colony from FY 1984 to FY 2012

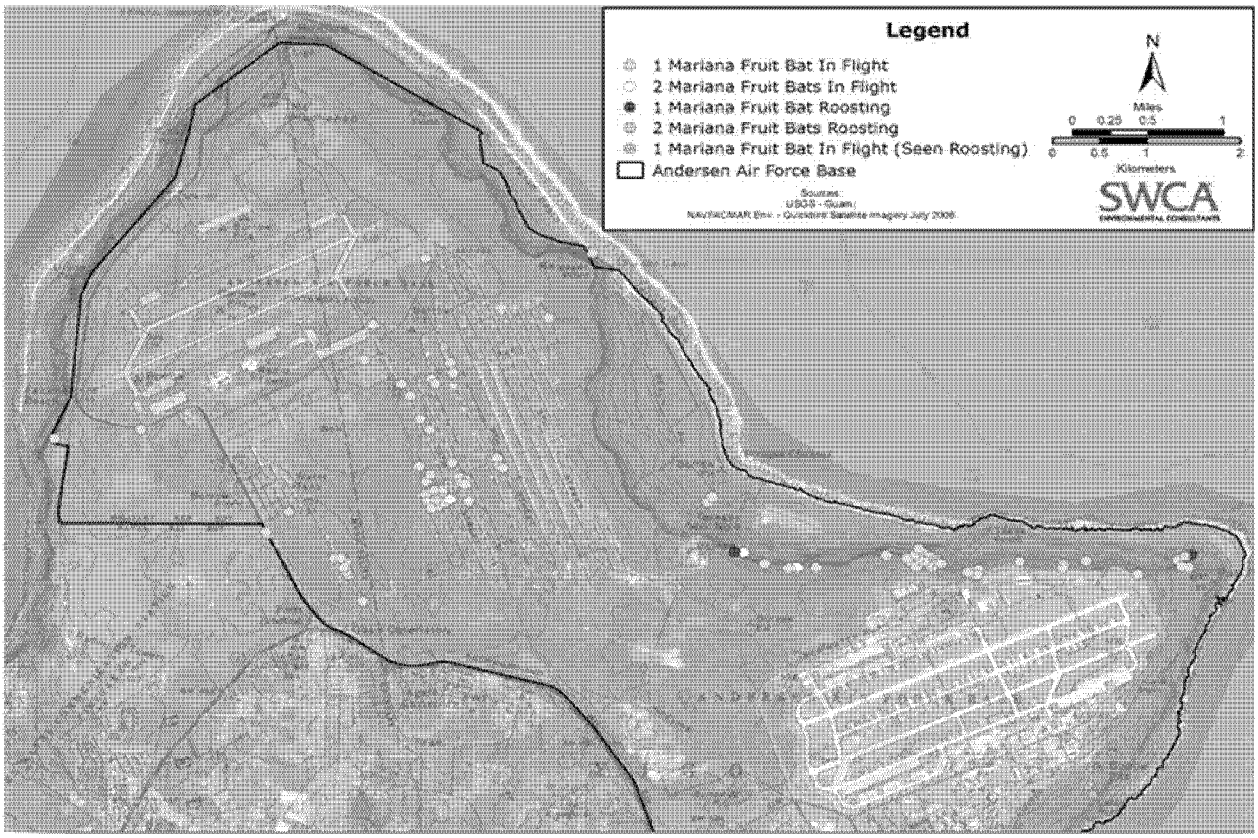


Figure 4-39. Observations of Mariana Fruit Bats on Andersen AFB (SWCA 2012)

Additional information on the Mariana fruit bat on Andersen AFB, including management recommendations, can be found in the Fanihi (*Pteropus mariannus marianmus*) Management Plan for Andersen Air Force Base, Guam, in **Appendix N**.

Reptiles

Moth skink. Moth skinks have an unknown distribution on Guam and are not frequently encountered. One moth skink was recorded during herpetofauna surveys on Andersen AFB in 2008 (DoN 2010). The moth skink was captured in a glue-board trap on a transect paralleling Route 9 near the solid waste landfill. The moth skink is not a federally listed species, but GovGuam lists the species as endangered.

Invertebrates

No federally threatened or endangered invertebrate species have been recorded at Andersen AFB. The federal candidate and Guam-listed endangered humped tree snail, Guam tree snail, fragile tree snail and the Mariana eight-spot butterfly have all been observed at the installation.

Insects

Mariana eight-spot butterfly. During surveys conducted in 2011 on Andersen AFB, 73 patches of host plants for the Mariana eight-spot butterfly were located and assessed between detailed and reconnaissance and meander searches. Thirty-eight percent of host plant patches were occupied by Mariana eight-spot butterflies. Seven adult butterflies, 96 larvae, and 35 eggs were observed during the surveys. Thirty of the 35 Mariana eight-spot eggs showed indications of parasitism (HDR 2013).

Marine Species

Marine Mammals

In 2007, SRS-Parsons et al. (2007) conducted a marine mammal and sea turtle survey covering 170,500 square nautical miles around Guam and the CNMI. The survey area was bounded by 10°–18° N Latitude and 142°–148° E longitude. Nine unique marine mammal species were identified, including the federally endangered sei, sperm, and humpback whales. Sperm whales were the most commonly observed whale during the study. Marine mammals have the potential to occur in JRM managed submerged lands which extend 3 nautical miles seaward from the coastline at Andersen AFB.

Sea Turtles

Historically, the EOD beach at Andersen AFB and Cocos Island have had the highest incidence of sea turtle nesting. The *Green Sea Turtle Management Plan* in **Appendix O** summarizes in detail nests recorded at Andersen AFB from June 1984 until June 2006. Data were not available from 1985 through 1990, 1992, 1994, and 2002 through 2004 (Andersen AFB 2008).

Considering the available data provided by GDAWR, nesting activity was only documented at the EOD beach from 1991 until 1997 and again in 1999, 2000, and 2005. The highest distribution of recorded sea turtle activity was in 1993 when 17 occurrences were observed at the EOD beach. Most of these, however, were recorded as false crawls. In 2000, 16 crawls were counted on Andersen AFB beaches. In FYs 2001 and 2002, funding was provided by Andersen AFB to GDAWR to track turtle activity on and near Andersen AFB. No turtle activity was reported on Andersen AFB beaches during 2001. Data were not available for turtle activity on nesting beaches at Andersen AFB in 2002, 2003, and 2004. In 2005, 11 occurrences of crawls, body pits, nesting, or hatchlings were documented at the EOD beach. The 2006 season recorded 5 occurrences of turtles at Tarague Beach (as of August 2006). No activity was recorded at the EOD beach during the 2006 nesting season. No turtle activity was documented on Andersen AFB during the 2007 nesting season. In 2011, 25 nests were observed on Andersen AFB, and 17 nests were observed in 2012 (see **Table 4-10**). See **Figure 4-40** for a map of green sea turtle nesting areas on northern Guam and Andersen AFB.

Table 4-10. Green Sea Turtle Nesting on Andersen AFB from 2005 to 2010 (Data provided by Shawn Wusstig, GDAWR)

Year	Total Nests	Month
2005	11	July –October
2006	5	February –June
2007	0	----
2008	6	July
2009	11	April–June
2010	16	January–(no end date provided)
2011	25	----
2012	17	----

In 2010 Turtle Friendly Lights were installed at the Tarague Parking Lot area, fluorescents at the Sirena pavilion were painted yellow to mask brightness.

Green sea turtle. During the nesting season, which is generally from April through August, female green sea turtles emerge from the sea to lay approximately 100 eggs in large sand-pit nests near vegetation above the high water line. After incubating for 50 to 60 days, 2-inch turtle hatchlings emerge from the nest and return to the ocean. An individual turtle can lay as many as 7 clutches of eggs in successive 14-day intervals over a several-month season (Davis 1991). However, green sea turtles will skip long periods of time between egg-laying seasons (estimated at 4 to 7 years). Green sea turtles will return to the same beach, if possible. A total of 49 green sea turtle nests have been recorded by GDWAR biologists on Andersen AFB beaches between 2005 and 2010 (see **Table 4-10**). Green sea turtles nesting areas on Andersen AFB are shown in **Figure 4-40**.

Hawksbill sea turtle. Hawksbill sea turtles have nested on beaches in northern and central Guam. The last sighting of a hawksbill sea turtle on the beach at Andersen AFB was a desiccated specimen found on the EOD beach in 1997. The cause of death was unknown. The last recorded nestings in the area were three unconfirmed sightings in 1984 between Urunao and Tarague (Green Sea Turtle Management Plan, **Appendix O**).

Flora

There are two Guam-listed endangered tree species (fire tree and Ula-halomatano') that occur on Andersen AFB, the fire tree is additionally federally listed as endangered.

Fire tree. As many as five fire trees currently survive on Andersen AFB, one mature seed-bearing adult and four saplings between 12 and 20 years old (see **Figure 4-41**). The adult tree is located in limestone forest in the Ritidian Point area and was evaluated on May 21, 2010. The ungulate exclusion fence established in 1996 to protect seedlings around the adult tree from ungulate damage was in terrible disrepair. There were several breaches in the fence and much of the fence was lacking sufficient support structures. The adult tree itself was in good condition, approximately 23 to 30 feet (7–9 meters) tall with a diameter of 20.9 inches (53 cm). Termite activity was noticed on the tree and has been present for many years. No obvious termite damage was observed. Two seedlings and one sapling were observed within the damaged exclosure, and the sapling had signs of ungulate browsing. The understory within the exclosure was clear, also indicating that ungulates were able to get inside the fence and browse on vegetation. The ungulate exclosure fence has been repaired since the 2010 observations.

In 1999, 20 fire trees seedlings from Rota were planted as a joint effort by USFWS, UOG, and Andersen AFB in limestone forest along a utility access road in Tarague Basin. Each seedling was protected from ungulate browsing with a wire enclosure. As of 2010, four of the original 20 seedlings were surviving, surrounded by a wire exclosure fence. The remaining fire trees from the Rota seedling stock in Tarague were visited on May 7, 2010. The exclosure fencing was in good condition, but with two possible breaches. Two trees were observed from outside the exclosure fencing and appeared to be in good health, but no attempt was made to enter and check the remaining two.

The third location in Area 53 was not visited and the status of that tree remains unknown. Two saplings were found under an adult fire tree at this location in 1991. The adult tree was killed in 1992 during Typhoon Omar. As of 1999, both saplings were still surviving, but by 2001, only a single sapling survived. In 2002, this sapling was partially uprooted by super typhoon Pongsona and it is regularly impacted by larval butterfly damage. The tree has since died.

Figure 4-40. Green Sea Turtle Nesting Areas on Andersen AFB

MAP REMOVED, AVAILABLE UPON REQUEST

Figure 4-41. Locations of Fire Trees on Andersen Air Force Base

A project was initiated in September 2012 to monitor and manage the sole surviving fire tree and its fenced exclosures at Ritidian Point, as well as the four saplings and their fenced exclosure in Tarague Basin. The project includes conducting monthly monitoring visits to the two sites; repairing and performing required maintenance of existing fence exclosures; vegetation clearing in the fenced exclosures; and pesticide application to promote the growth of fire tree seedlings and saplings. The objectives of the project are to increase the understanding of the ecology of fire tree plants and develop appropriate conservation measures for the species.

Ula-halomatano'. Ula-halomatano' (*Heritiera longipetiolata*) is an uncommon species in forested areas of Andersen AFB. No surveys have been conducted to document the distribution, numbers, or population trend of this Guam endangered species on the installation.

4.8.2.6 Invasive Species

Flora

Several large areas within the Tarague Basin between Mergagan Point and Tagua Point are locations of historic coconut plantations. These areas are now characterized by near pure stands of coconut palms in the overstory. In addition, numerous smaller areas dominated by coconut palms occur on flat ground across the plateau on Andersen AFB. Many of the coconut palm groves (former plantations) have thick undergrowths composed of various shrubs and young trees with an abundance of self-sown coconut palms (see **Figure 4-42**).

Near pure stands of ironwood forests occur on Andersen AFB on the terrace bordering the native strand community and within the strand, and in numerous smaller areas on the plateau. Ironwood is one of the most successful colonizers of denuded areas and will rapidly develop dense tall forests. *Vitex*-closed canopy and *Vitex*-sparse canopy occurs in large stands in the southwest section of MSA 1 and the area to the west of MSA 1, and in several smaller stands on the plateau. *Vitex*-closed canopy is characterized by a dense overstory of vitex. *Vitex*-sparse canopy typically occurs in association with the *Vitex*-closed canopy, but is more open and is characterized primarily by vitex, *Guamia mariannae*, and *Aglaia mariannensis*. *Hibiscus-Leucaena* occurs in several stands on the plateau primarily in the western section of the installation and in association with the clear zone at the western end of the airfield. Tangantangan, an introduced legume used for restoration after World War II, is one of the most common types of vegetation in recently cleared or disturbed areas on Guam and often forms dense pure stands. Tangantangan is one of the most conspicuous exotic invasive plants on Andersen AFB. This prolific tree forms extensive thickets in limestone soils that prevent recolonization by native species. For the most part, stands of tangantangan on the installation occur in association with sea hibiscus.

Chromolaena, or Siam weed, is a native to Central America and is a fast-growing, highly invasive shrub that is a prolific seed producer (**Figure 4-43**). The shrub occurs on Andersen AFB and is abundant in the Tarague Basin. Indian snakeweed, an erect exotic invasive herb, occurs in association with developed land on the installation and is prolific along many roadsides and the edges of clearings. Disturbed areas that are not landscaped on Andersen AFB are commonly colonized by exotic and invasive plant species, such as tangantangan, wild passion flower, and masiksik (36 CES/CEVN 2003). Other invasive plant species on Andersen AFB include chain of love vine and mile-a-minute vine.

Figure 4-42. Former Coconut Plantation on Andersen AFB

Figure 4-43. Chromolaena on Andersen AFB

Fauna

Introduced bird species occurring on Andersen AFB include the island collared dove, black drongo, Eurasian tree sparrow, and black francolin. These species are common, introduced, breeding residents in Guam (NAVFACPACIFIC 2010b). Introduced avian species occurring in the southwest section of Andersen AFB (Andersen AFB Finegayan) include black drongo, Eurasian tree sparrow, island collared dove, and feral chicken, all of which are common, introduced, breeding residents in Guam (NAVFACPACIFIC 2010b).

Several introduced mammalian species that threaten native flora and fauna occur on Andersen AFB, including feral cats, ungulates, and rats. Feral cats were primarily responsible for the eradication of a population of 16 captive-bred Guam rails released in an exclosure on Andersen AFB in 1999 (USAF 2009). A second release of 44 captive-bred rails occurred in the MSA 1 on Andersen AFB in 2003, with 21 of 26 transmittered rails succumbing to cat predation. All Guam rails from the 2003 release are presumed deceased (Paul Wenninger, unpublished report). Management efforts need to be focused on removing these nonnative predators.

Browsing and rooting by feral ungulates hastens the decline of native forests by directly killing native vegetation, preventing regeneration, spreading invasive alien plants, and altering soils. Other common introduced species on Andersen AFB include brown rat, black rat, Polynesian rat, and house mouse, which are collectively known as "cha'ka" in Chamorro (USAF 2009). In addition to preying on native birds and their eggs, rats eat rare plants and their roots. The Asian house shrew is another introduced mammalian species that might exist on Andersen AFB (USAF 2009).

Philippine deer populations on Guam are thought to be highest on Andersen AFB (Wiles et al. 1999). Surveys conducted in 2000–2001 estimated 468.5 deer per square mile (183 deer/square kilometer), or 920 deer in the 1.94-square-mile (5.03-square-kilometer) MSA 1 area, one of the highest deer densities in the world. The Pati and Tagua Point areas of Andersen AFB are thought to have the highest deer densities on Andersen AFB as they are regularly patrolled by Security Forces and not open to recreational hunting (Wiles et al. 1999). Recreational hunting in the MSA 1 area is limited to archery hunting by Munitions Squadron (MUNS) personnel only, limiting the number of population-control measures. Lower deer densities are expected in Northwest Field where regular recreational hunting activities are conducted; but a survey conducted in 2006 (Parsons 2006) indicated a density of 315.9 deer per square mile (122 deer/square kilometer). Hunting data indicate that deer populations are increasing in this area with the number of deer taken per year increasing while the effort per take has remained stable (JRM 2011).

Feral pig density in Northwest field was estimated at 55.4 pigs per square mile (21.4 pigs/square kilometer) in 2006 (Parsons 2006). At this density, the 4,400-acre (17.8-square kilometer) Northwest Field is estimated to hold approximately 381 feral pigs. The feral pig density in MSA 1 was determined to be 98 pigs per square mile (38 pigs/square kilometer) in 2000–2001 (Knutson and Vogt 2002 [unpublished report]) for a total of 186 pigs estimated in the 1.94-square-mile (5.03-square-kilometer) MSA 1. Feral pig density is highest in MSA 1 and thought to be lowest in the Pati Point area (Wiles et al. 1999). Results of a recent vegetation survey on Andersen AFB, indicated that 82 percent of 50 vegetation plots were found to have signs of ungulate presence (Philippine deer and feral pigs) (U.S. Navy 2009).

The only authorized means of take for any listed Guam game species on Andersen AFB is bow tackle. Use of shotguns is not permitted on the installation. Increased training in NW Field has restricted the areas for all hunting (**Appendix L**, Fig. 10). Currently, only Munitions Squadron personnel (MUNS) conduct depredation hunts on weekends and only in the MSA. The public is authorized to hunt on weekends with bow tackle on the southern side of Route 3A adjoining NBG TC. Volunteer Conservation

Officers may hunt in the C areas after regular working hours during the week, and in the A hunting areas after working hours and during the weekend (**Appendix L**, Fig. 10). The deer season on Guam starts on 1 October and ends 31 March of the following year. Hunters are limited to 3 deer for the season per GDAWR regulations. Pigs can be taken year round and there is no limit on the number of animals that a single hunter can take throughout the year.

With the loss of shotgun hunting in FY12, the number of recreational hunters on Andersen AFB declined sharply along with the number of deer and pigs removed. This is discussed in the FY12 Project summary for Andersen AFB (**Appendix D**).

All hunting effort, whether MUNS, VCOs, or public participants, is documented by the VCOs. Andersen AFB natural resources staff coordinate the number of personnel, times, and areas of hunting, and review recent sightings of Mariana fruit bats and Mariana crows to avoid impacts prior to authorizing hunts.

Six introduced herpetofauna species were documented on Andersen AFB during the 2008–2009 herpetofauna surveys: curious skink, house gecko, brown treesnake, brahminy blind snake, marine toad, and greenhouse frog (NAVFACPACIFIC 2010b). Four introduced herpetofauna species were documented on the southwest section of Andersen AFB (Andersen AFB Finegayan): curious skink, house gecko, brown treesnake, and marine toad (NAVFACPACIFIC 2010b). The continued widespread presence of the curious skink, brown treesnake, and other introduced amphibian species is of concern because of each species' potentially deleterious impacts on Guam's native fauna (NAVFACPACIFIC 2010b).

Cycad aulacaspis scale or Asian cycad scale has infested native and landscape cycads on Andersen AFB. The cycad is an important component of the native forest on Guam and is rapidly being lost. There has been 90 percent mortality of this species since 1994 as a result of cycad scale (USAF 2009). A predacious lady beetle, *Rhyzobius lophanthae* has been released on Andersen AFB in an effort to help control the scale. In addition to Cycad aulacaspis scale, the cycad blue butterfly larvae represent one of the greatest threats to Cycas species over a very wide range. The Cycas species like *C. micronesica* that evolved without any lepidoptera herbivory pressure are particularly susceptible to damage, possibly due to a lack of chemical defense. So when the cycad blue butterfly invades an insular population of any Cycas species, including *C. micronesica*, it represents an extreme threat to the cycad plants. The presence of ornamental plants throughout the urban landscape provides the butterfly with substrate for the larval stage that aids the butterfly population. This exaggerates the damage to native cycads in the forest.

Shells of the introduced giant African snail and both live individuals and shells of the introduced snail *Satsuma mercatoria* were observed on Andersen AFB during the 2009 tree snail surveys. Additionally, live introduced manokwar flatworms and the coconut rhinoceros beetle were also observed on Anderson AFB (NAVFACPACIFIC 2010b).

4.9 Andersen South

4.9.1 General Physical Environment

4.9.1.1 Climate

The climate at Andersen South is the same as the climate for Guam as a whole. See **Section 4.1.1.1** for a description of the climate on Guam.

4.9.1.2 Geology and Topography

The geology of Andersen South is characterized by a broad limestone reef plateau underlain by volcanic rocks (see **Figure 4-1**). The southern portion of the site consists of young limestone rock (Pliocene to Pleistocene, 1.5–5 million years old) and the northern portion is older limestone rock (Miocene to Pliocene, 5–25 million years old). Numerous caves are present on Andersen South.

The elevation of Andersen South gently rises from approximately 300 feet (91 meters) above msl in the northwestern portion to 500 feet (152 meters) above msl at the southeastern corner of the installation (see **Figure 4-2**).

4.9.1.3 Seismology

Andersen South overlies both a major and minor fault line and is susceptible to earthquake events. The overall likelihood for landslides to occur on northern Guam is generally low due to the lack of steep areas that contain soils vulnerable to slipping in seismic events. Andersen South is not an area of high risk for liquefaction or tsunami inundation (GHS 2008).

4.9.1.4 Soils

The following soil types occur on Andersen South: (1) Guam cobbly clay loam, covering the majority of the area, (2) Guam-Urban Land complex and Pulantat clay in the western portion of the installation, (3) Pulantat-Kagman clay in a small section in the center of the western border of the installation; and (4) Ritidian-Rock Outcrop complex in the southeastern corner of Andersen South. In general, erosion risks at Andersen South are slight to moderate, but do not present a major problem because the area is located on a broad limestone reef plateau.

4.9.1.5 Hydrology

Groundwater. Andersen South is underlain primarily by very permeable limestone of the Yigo Subbasin within the larger NGLA (see **Section 4.1.1.5**). Water levels in Andersen South wells indicate the presence of parabasal water at higher elevations than other areas of the NGLA due to the occurrence of a basement of less-permeable volcanic rock.

Andersen South has nine groundwater production wells that draw water from the Yigo Subbasin of the NGLA. Water is currently supplied to Andersen AFB from seven of the nine off-installation water production wells. Of the approximately 37 MGD (140 million liters per day [MLD]) of water withdrawn from the NGLA, 2.5 MGD (9.5 MLD) is pumped to Andersen AFB. Water is currently supplied from wells located in the MARBO Annex; stored, disinfected, and fluoridated; and then pumped to Andersen AFB. Two wells, Marbo Well No. 2 and Tumon Maui Well, are currently not operational due to the detection of volatile organic compounds (VOCs) in the groundwater at concentrations that exceed USEPA maximum contaminant levels (MCLs) for drinking water. Other active drinking water wells are either upgradient of, or a sufficient distance away from, contaminated areas and are not at risk of contamination. An analysis of chloride concentrations in Andersen AFB water supply wells at Andersen South indicates that chloride is increasing in approximately half of the wells and concentrations in several wells exceed the Secondary MCL (McDonald and Jenson 2003, NAVFACPACIFIC 2008).

The Agency for Toxic Substances and Disease Registry (ATSDR) evaluated past exposure to contaminants in the affected production wells and determined that drinking this water would not harm individuals or increase their likelihood of developing adverse health effects. ATSDR also concluded that it does not expect any public health effects, now or in the future, as a result of individuals drinking water

from the Andersen AFB water supply, or any other wells on Guam. Several reasons for this include (1) the military's remediation actions are further reducing contamination at the installation, (2) dispersion (i.e., natural mixing of contaminated with uncontaminated water dilutes chemical contaminants to concentrations well below levels of public health concern), and (3) the mixing of drinking water in the installation's distribution system further dilutes the levels of any contaminants in the water before the water reaches the taps. On the basis of its evaluation of available environmental information, ATSDR concluded that exposures to contaminants in groundwater, surface soil, and local plants and animals harvested for consumption are below levels that would cause adverse health effects. ATSDR has categorized the installation as "no apparent public health hazard" because of the education efforts, access restrictions, and monitoring programs at Andersen AFB (NAVFACPACIFIC 2008).

Surface Water. Because of the high permeability of the limestone substrate, no streams or other natural surface water drainage features occur on Andersen South.

4.9.2 General Biotic Environment

4.9.2.1 Terrestrial Ecosystems

Flora

Twenty-five tree species were identified on the transects quantified during 2008 vegetation surveys performed on Andersen South, and 17 are native to Guam (see **Table 4-11**) (NAVFACPACIFIC 2010b).

Table 4-11. Native Tree Species on Andersen South

Chamorro/ Common Name	Scientific Name
Mapunyao	*Aglaia mariannensis*
Sumak	*Aidia cochinchinensis*
Dugdug	*Artocarpus mariannensis*
Fadang	*Cycas micronesica*
A'abang	*Eugenia reinwardtiana*
Hodda	*Ficus tinctoria*
—	*Glochidion marianum*
Paipai	*Guamia mariannae*
Pago	*Hibiscus tiliaceus*
Ixora	*Ixora triantha*
Pengua	*Macaranga thompsonii*
Luluhut	*Maytenus thompsonii*
Ladda	*Morinda citrifolia*
Fagot	*Neisosperma oppositifolia*
Kafu (screwpine)	*Pandanus tectorius*
Ahgao	*Premna obtusifolia*
Nanaso	*Scaevola taccada*

Native Guam tree species had a higher collective relative density than introduced species on the Andersen South transects. The most common native tree species on Andersen South include the following: sea hibiscus, *Guamia mariannae*, Indian mulberry, *Neisosperma oppositifolia*, and *Premna obtusifolia*. The most common introduced tree species on Andersen South include the following: tangantangan and pickle tree (*Averrhoa bilimbi*). Aside from pickle tree, other nonnative species in the survey, such as papaya and custard apple, produce edible fruits that are likely dispersed by ungulate activity (NAVFACPACIFIC 2010b).

A vegetative survey was performed for the host plants (*Procris pedunculata* and *Elatostema calcareum*) for the Mariana eight-spot butterfly and the host plant (*Maytenus thompsonii*) for the Mariana Wandering Butterfly in 2009 (NAVFACPACIFIC 2010b). Only individuals of *Maytenus thompsonii* were observed on Andersen South (NAVFACPACIFIC 2010b).

Geologic conditions needed to support wetland areas (i.e., hydric soils) are not found on the highly permeable limestone plateau of northern and central Guam (NRCS 1988, Wiles and Ritter 1993). The absence of NWI-mapped wetlands (USFWS 2009a) and NRCS-mapped hydric soils (NRCS 2010) on Andersen South support the conclusion that no wetlands are expected to occur on this complex.

Fauna

Birds. The following avian species were identified during the 2008–2010 roadside and forest bird surveys performed on Andersen South: Eurasian tree sparrow, black francolin, Pacific golden-plover, island collared dove, and yellow bittern (NAVFACPACIFIC 2010b). The Eurasian tree sparrow and black francolin were the most commonly observed species on Andersen South. The Eurasian tree sparrow, black drongo, and island collared dove are common, introduced, breeding residents in Guam (NAVFACPACIFIC 2010b). The Pacific golden-plover is a common, nonbreeding visitor to Guam and the yellow bittern is a common, native, breeding resident of Guam (NAVFACPACIFIC 2010b).

Mammals. During the 2009 habitat quality survey at Andersen South, ungulate activity (feral pig and Philippine deer) on the installation was evidenced most commonly by rooting and rubbings (NAVFACPACIFIC 2010b).

Reptiles and Amphibians. Nine herpetofauna species were documented on Andersen South during the 2008–2009 herpetofauna surveys. Of these, three species are native to Guam: blue-tailed skink, stump-toed gecko, and monitor lizard; and seven species are introduced to Guam: curious skink, house gecko, brown treesnake, brahminy blind snake, marine toad, and greenhouse frog (NAVFACPACIFIC 2010b). The continued widespread presence of the brown treesnake, curious skink, and other introduced amphibian species is of concern because of each species' potential deleterious impacts on Guam's native fauna (NAVFACPACIFIC 2010b).

Invertebrates. Three butterfly species were documented within forested areas on Andersen South during 2009–2010 butterfly surveys: lemon emigrant, blue-banded king crow, and common Mormon (NAVFACPACIFIC 2010b). All of these species are widely distributed in the Mariana Islands (NAVFACPACIFIC 2010b).

During the 2009 tree snail survey performed on Andersen South, no living partulid tree snails or their shells were observed on the transect performed. However, since there were several known host plant species present throughout the survey area, the possibility that tree snails, including candidate species such as humped, fragile, or Guam tree snails, are present on Andersen South cannot be dismissed. Shells of the introduced giant African snail and both live individuals and shells of the introduced snail *Satsuma mercatoria* were seen along the transect (NAVFACPACIFIC 2010b).

4.9.2.2 Freshwater Ecosystems

There are no freshwater ecosystems on Andersen South.

4.9.2.3 Estuarine Ecosystems

There are no estuarine ecosystems on the Andersen South.

4.9.2.4 Submerged Lands

No JRM managed submerged lands are associated with the Andersen South.

4.9.2.5 Protected Species

Fauna

Terrestrial Species

Birds

No Federal- or Guam-listed bird species have been recorded at Andersen South.

Mammals

No Federal- or Guam-listed mammals have been recorded at Andersen South. However, historical data might indicate the occurrence of the Mariana fruit bat on Andersen South. The vegetation study of the area provides evidence that the fruit bat used the site.

Invertebrates

No Federal- or Guam-listed invertebrate species have been recorded at Andersen South.

Flora

No Federal- or Guam-listed plant species have been recorded at Andersen South.

4.9.2.6 Invasive Species

Flora

The most common introduced tree species on Andersen South include tangantangan and pickle tree. Other nonnative species occur, such as papaya and custard apple, which produce edible fruits that are likely dispersed by ungulate activity (NAVFACPACIFIC 2010b). In addition, fruit bats and birds have also dispersed seeds from fruiting trees. Chain of love vine, mile-a-minute vine, Siam weed, and Indian snakeweed also occur on Andersen South.

Fauna

Introduced bird species occurring on Andersen South include the island collared dove, Eurasian tree sparrow, and black francolin. These species are common, introduced, breeding residents in Guam (NAVFACPACIFIC 2010b).

Introduced mammal species on Andersen South include feral pigs and cats, house mice and rats, and Asian house shrews. During the 2009 habitat quality survey at Andersen South, ungulate activity on the installation was evidenced most commonly by rooting and rubbings (NAVFACPACIFIC 2010b).

Six introduced herpetofauna species were documented on Andersen South during the 2008–2009 herpetofauna surveys: curious skink, house gecko, brown treesnake, Brahminy blind snake, marine toad, and greenhouse frog (NAVFACPACIFIC 2010b). The continued widespread presence of the brown treesnake, curious skink, and other introduced amphibian species is of concern because of each species' potential deleterious impacts on Guam's native fauna (NAVFACPACIFIC 2010b). One native herpetofauna species was documented during the surveys, the monitor lizard (NAVFACPACIFIC 2010b).

Shells of the introduced giant African snail and both live individuals and shells of the introduced snail *Satsuma mercatoria* were observed on Andersen South during the 2009 tree snail surveys (NAVFACPACIFIC 2010b). The coconut rhinoceros beetle was also observed on Andersen South during surveys conducted by UOG in 2010. The manokwar flatworm also occurs on Andersen South.

4.10 Barrigada Transmitter Site

4.10.1 General Physical Environment

4.10.1.1 Climate

The climate at Barrigada Transmitter Site is the same as the climate for Guam as a whole. See **Section 4.1.1.1** for a description of the climate on Guam.

4.10.1.2 Geology and Topography

Barrigada Transmitter Site is in the northern limestone structural province. The geology of the Barrigada Transmitter Site is characterized primarily by the Pliocene- and Miocene-aged Detrital facies of the Mariana limestone. The Detrital facies is characterized by friable to well-cemented, coarse to fine-grained generally porous and cavernous limestone, mostly of lagoonal origin. The topography of the Barrigada Transmitter Site is nearly flat with elevations ranging from approximately 280 to 290 feet (85 to 88 meters) above mean sea level.

4.10.1.3 Seismology

The Barrigada Transmitter Site does not directly overlie any fault lines, but it is susceptible to earthquake events. The overall likelihood for landslides to occur at Barrigada Transmitter Site is low due to the lack of steep areas with soils vulnerable to slipping in seismic events. The site is not in an area vulnerable to liquefaction or inundation from tsunamis (JGPO 2010).

4.10.1.4 Soils

The following soil types are mapped on Barrigada Transmitter Site: (1) Guam cobbly clay loam, in the southern section of the site; (2) Pulantat-Kagman clay, in the northern two-thirds of the site; and (3) Cha Cha clay loam in several small areas in the central section of the site (USDA 1988). In general, erosion risks at Barrigada Transmitter Site are slight to moderate, but do not present a major problem because the area is located on a broad flat lying limestone reef plateau (JGPO 2010).

4.10.1.5 Hydrology

Groundwater. The Barrigada Transmission Site is underlain primarily by very permeable limestone in the Finegayan sub basin of the NGLA (see **Section 4.1.1.5**).

Surface Water. Because of the high permeability of the limestone substrate, no streams or other natural surface water drainage features occur on the Barrigada Transmitter Site.

4.10.2 General Biotic Environment

4.10.2.1 Terrestrial Ecosystems

Flora

Vegetation communities on Barrigada Transmitter Site are characterized primarily by tangantangan forest and scrub. Shrub/grassland habitat occurs in the northeastern section of the site (JGPO 2010).

Wetland Communities. Delineated and NWI-mapped wetland areas have been identified on the Barrigada Transmitter Site (AECOS and Wil Chee 2009, USFWS 2009a). In May 2010 a wetland study was conducted to more accurately characterize the habitats on the site (NAVFACPACIFIC 2010a). The recent 2010 study delineated Wetland Areas B-01, B-04, B-05, B-06, B-07, B-08, and B-09 on Barrigada Transmitter Site. Wetland Area B-03 is located just outside the boundary of the site. Wetland Areas B-01, B-03, B-05, B-06, B-07, B-08, and B-09 are NWI wetlands that were confirmed to meet USACE wetland criteria and the NWI boundaries were adjusted as necessary during the 2010 studies. Wetland Area B-04 was previously delineated (AECOS and Wil Chee 2009) and the boundaries were adjusted during the 2010 field studies (NAVFACPACIFIC 2010a). The delineated wetland areas on Barrigada Transmitter Site total approximately 2.4 acres (1.0 hectares) and Wetland Area B-03, located adjacent to the site is approximately 1.1 acres (0.4 hectares) (JGPO 2010).

Fauna

Birds. The open grasslands and wetlands within the Barrigada Transmitter Site likely provide resting and foraging areas for migrating species. Recent bird surveys documented the Pacific golden plover and yellow bittern in the area (JGPO 2010).

Reptiles and Amphibians. Reptiles observed in the area of the Barrigada Transmitter Site include the blue-tailed skink and mourning gecko (JGPO 2010).

4.10.2.2 Freshwater Ecosystems

There are no freshwater ecosystems on the Barrigada Transmitter Site.

4.10.2.3 Estuarine Ecosystems

There are no estuarine ecosystems on the Barrigada Transmitter Site.

4.10.2.4 Submerged Lands

There are no submerged lands associated with the Barrigada Transmitter Site.

4.10.2.5 Protected Species

Fauna

Terrestrial Species

Birds

No Federal- or Guam-listed bird species have been recorded at the Barrigada Transmitter Site (JGPO 2010).

Mammals

No Federal- or Guam-listed mammals have been recorded at the Barrigada Transmitter Site (JGPO 2010).

Invertebrates

No Federal- or Guam-listed invertebrate species have been recorded at the Barrigada Transmitter Site (JGPO 2010).

Flora

No Federal- or Guam-listed plant species have been recorded at the Barrigada Transmitter Site (JGPO 2010).

4.10.2.6 Invasive Species

Flora

Forested and scrub habitats on the Barrigada Communications Site are characterized by the introduced invasive tangantangan. Other invasive plant species on the site include chain of love vine, mile-a-minute vine, Siam weed, and Indian snakeweed.

Fauna

Introduced bird species observed during surveys conducted for the JGPO EIS on the Barrigada Transmitter Site include the island collared dove, Eurasian tree sparrow, and black francolin (JGPO 2010). Curious skink and the house gecko were also observed in forested areas during surveys conducted for the JGPO EIS (NAVFACPACIFIC 2010b). Other introduced fauna expected to occur on the Barrigada Transmitter Site include house mice and rats, Asian house shrew, feral cat, brown treesnake, brahminy blind snake and manokwar flatworm.

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5 Management Goals, Objectives, and Strategies

JRM currently manages natural resources based on an ecosystem management approach through the implementation of several ongoing projects and management strategies. Examples of ongoing and past management strategies include soil and water conservation efforts to address erosion sites on the NMS; threatened and endangered species monitoring at NBG; endangered species mitigation on FDM, Anatahan, and Sarigan through the removal of feral goats and pigs; development of alternate survey protocols to more accurately survey Mariana swiftlets at the NMS; invasive species monitoring for the coconut rhinoceros beetle; and long-term vegetation surveys on NBG and Tinian leased lands. These projects, which are further described in the following sections, provide examples of JRM's current efforts to manage and enhance natural resources on their managed lands through an ecosystem approach in a manner consistent with implementation of the military mission. **Appendix C** provides the list of projects on NBG and Andersen AFB for FY 13 to FY18 and recurring future projects. Also included is a list of reports and documents generated in FY 12, and ongoing work anticipated in FY 13. **Appendix D** includes project reports from projects conducted in FY 12 and presented at the annual INRMP meeting of stakeholders. The following sections present management goals, objectives, and strategies to continue implementation of these projects along with additional current and new goals, objectives, and strategies for ongoing management of natural resources on JRM lands.

Projects on Tinian will be limited to existing conservation areas, at Hagoi and Mt. Lasso, until the Record of Decision for CNMI Joint Military Training EIS/OEIS (CJMT) specifies the areas that will be used to improve existing ranges and develop new live-fire military training areas.

Projects on FDM are limited to work that can be done from the air (surveys of booby and marine turtle species), or areas cleared of unexploded ordnance.

5.1 Purpose, Approach, and Rationale

Ecosystem management must be based on clearly stated objectives and strategies. The purpose of the INRMP is to identify goals and objectives and present the means to accomplish them. The Navy 2006 guidance defines goals as "broad guiding principles for the [installation natural resources] program" and objectives as "measurable targets for achieving the goals" (U.S. Navy 2006). In addition, the guidance states that the INRMP will provide parameters to determine "the effectiveness of the natural resources program outlined in the INRMP through ensuring that the plan includes quantifiable, scientifically valid parameters that will demonstrate achievement of objectives," or INRMP strategies and projects (U.S. Navy 2006). This INRMP is the mechanism to ensure that JRM facilities can successfully meet ecosystem and natural resources goals without compromising the mission.

Natural resources management at JRM strives to integrate biodiversity conservation and an ecosystem-based approach into an adaptive management framework compatible with the military mission. As a result, the natural resources program consists of multiple resource disciplines that are frequently interconnected and share similar objectives. Management projects and plans often consist of multiple program elements with several different resource experts collaborating together. This section describes the various natural resources program elements (i.e., Fish and Wildlife Resources Management) along with their primary goals and objectives. In addition, an Adaptive Management Team (AMT) consisting of representatives from JRM sites, USFWS Ecological Services, GNWR, and GDAWR was established in response to the Intelligence, Surveillance, Reconnaissance, and Strike Capability (ISR/Strike) BO requirements for management of natural resources at JRM (Andersen AFB). According to the Adaptive Management Plan, AMT members are to meet at least quarterly to discuss resources management issues, concerns, and successes at JRM sites.

5.2 Natural Resources Management Goals

The purpose of this section is to identify specific resource area goals, objectives, strategies, and projects for JRM and to obtain workable and useful solutions for natural resources management. In accordance with OPNAVINST 5090.1C CH-1 and the principles of adaptive ecosystem management, natural resources management goals, objectives, and strategies were developed for JRM by an interdisciplinary team of ecologists, biologists, geologists, planners, and environmental scientists (see **Section 7**). The natural resources management program at JRM encompasses various disciplines and activities, and a set of general goals for JRM has been identified to direct natural resources management activities (see **Table 5-1**).

Table 5-1. Summary of INRMP Goals

Long-term Ecosystem Management
• Manage all natural resources on JRM lands with a long-term goal of restoring and enhancing habitats for native species including listed species over the next 30 to 50 years.
Threatened and Endangered Species and Other Candidate, Locally Rare or GovGuam-Listed Species Management Goals
• Manage JRM on a regional ecosystem-based approach that manages sensitive species and their associated ecosystems while supporting the operational functionality of JRM site missions. Sensitive species include species that rely on specific habitat conditions that are limited in abundance, restricted in distribution or are particularly sensitive to changes in environmental conditions. • Ensure that JRM sites remain in compliance with ESA, conservation measures contained within biological opinions, Federal consistency determinations affecting listed species, and appropriate territorial regulations. • Provide a conservation benefit to threatened, endangered or candidate species. • Provide a conservation benefit to other locally rare and GovGuam listed species through ecosystem management and benefits seen from projects that support ESA listed species. • Provide assurances that management strategies will be implemented and effective. • Protect and enhance habitats for threatened, endangered, and species of concern on JRM. Species of concern include species that are declining or appear to be in need of concentrated conservation actions. • Implement programs and projects that will benefit the species in terms of population recovery towards the goal of delisting the species. • Develop outreach and education materials for distribution to appropriate JRM and military personnel, and the public. • Continue to support research conducted by GDAWR and UOG on all federally listed species on JRM lands, including research on identification of potential habitat for the species on Guam and JRM lands. • Encourage, support, and facilitate ecological research by Federal, Territorial and Universities on Guam's listed species, invasive species and habitats.

Wetlands and Floodplain Management Goals
• Remain in compliance with USACE and GovGuam wetlands regulations. • Minimize the operational impact of JRM missions on wetlands and coastal waters. • Maximize native floral and faunal diversity of wetland communities in the ecosystem. • Manage for no net loss of wetland functions and values. • Ensure that mapping of wetlands and other waters of the United States is conducted based on the 1987 USACE Wetlands Delineation Manual and the 2010 Draft Interim Regional Supplement to the USACE Wetland Delineation Manual: Hawaii and Pacific Islands Region, and is accurate and consistent across JRM sites.
Fish and Wildlife Resources Management Goals
• Manage based on an ecosystem management approach, rather than from a single-species paradigm. • Employ a systematic approach to managing fish and wildlife resources, using a process that includes inventory, monitoring, modeling, management, and assessment. • Minimize fish and wildlife-related health risks, safety risks, and environmental damage. • Restore and maintain a diversity of fish and wildlife in areas on JRM sites where there will be no conflict with the military mission. • Continue to remain in compliance with Federal, territorial, and local laws and regulations governing fish and wildlife. • Maintain and develop partnerships with agencies and groups involved in fish and wildlife management.
Vegetation and Habitat Management Goals
• Protect native habitat diversity. • Maximize use of regionally native plant species and avoid introduction of invasive, exotic species in revegetation activities. • Enhance habitat for native species by removing invasive vegetation and replacing with native vegetation. • Maintain and enhance vegetation community structure, functionality, and species diversity. • Lessen or avoid adverse effects from activities on the overall ecosystem and its sensitive resources.
Coastal, Marine, and Submerged Lands Management Goals
• Conserve and restore coastal, marine, and submerged lands that provide habitat for a variety of native marine plants and animals, especially coral reef systems. • Employ a systematic approach to managing coastal, marine, and submerged lands resources, using a process that includes inventory, monitoring, modeling, management, and assessment. • Complete an assessment and establish a monitoring program for coral reef health. • Develop best management practices for accommodating military training needs and recreation while conserving coral habitat. • Ensure JRM sites remain in compliance with MSFCMA and other appropriate Federal regulations.

Exotic and Invasive Species Management Goals
• Management and control of invasive species currently existing on JRM lands: control/eradication of deer, pigs and carabao; funding and support of brown treesnake research facilitating large-scale control efforts. • Employ a systematic approach for early detection and rapid response to control or remove invasive species that are having an adverse effect on native ecosystems. • Continually monitor and reduce the effects invasive species have upon the native ecosystems of Guam, such as habitat alteration, competition for resources, and predation. • Minimize invasive species-related health risks, safety risks, and environmental damage. • Continue to remain in compliance with Federal, territorial, and local laws and regulations governing invasive species, and implement measures from the Micronesia Biosecurity Plan once developed. • Maintain and involve partnerships with agencies and groups involved in invasive species control and removal. Develop Hazard Analysis and Critical Control Point (HACCP) or similar plans to ensure that invasive species from Guam are not spread to other locations on and off the Island of Guam. • Ensure JRM activities do not result in the introduction and spread of invasive species and to ensure that new invasive species are not introduced to Guam. • Participate/cooperate with local and other Federal agencies to support their invasive species management/control programs
Watershed Management Goals
• Develop an understanding of ecosystem dynamics within the watershed in an effort to prevent and respond to threats to its integrity. • Maintain healthy and stable soils; rehabilitate damaged areas to reduce soil and sediment inputs into the watershed that degrade water quality. • Minimize nonpoint source pollution of both surface and groundwater in the watershed through the implementation of BMPs. • Manage watersheds to maintain natural hydrology.
Developed Land Management Goals
• Minimize or avoid adverse effects from grounds maintenance activities on the overall ecosystem and its sensitive resources. • Make maximum use of regionally native plant species and avoid introduction of invasive, exotic species in revegetation activities. • Ensure compliance with Final Guam Landscaping Guidelines. • Reduce chemical usage, and maintenance inputs in terms of energy, water, manpower, equipment, and chemicals. • Ensure compliance with environmental legislation, regulations, and guidelines. • Control pest and invasive species. • Ensure the orderly and scientific management of the urban trees on JRM to the extent compatible and consistent with the mission.

Coastal Zone Management Goals
• Collaborate with Federal agencies, GovGuam, and local interests in preserving the marine environment through unifying policies, criteria, standards, methods, and processes for dealing with land and water use decisions of more than local significance. • Ensure that the future maintenance of JRM's coastal zone resources is performed in a manner that supports shoreline stabilization and the reduction of erosion and sedimentation into marine environments without compromising the military mission. • Ensure that future maintenance of JRM's coastal zone resources is performed in a manner that supports the diverse biological and hydrological functions unique and significant to coastal zones.
Wildland Fire Management Goals
• Support a Wildland Fire Management Program to protect high-value natural resources areas and operational facilities from catastrophic wildfire while conserving resources and military operational flexibility.
Urban Forestry Management Goals
• Ensure the orderly and scientific management of the urban trees on JRM sites to the extent compatible and consistent with the mission. • Promote use of native plants in landscaping where applicable. Replace any trees removed from landscaped areas with native trees.
Law Enforcement Goals
• Ensure compliance with Territory, CNMI, and Federal natural resources laws and regulations. • Provide training to personnel responsible for enforcement of applicable laws and regulations. • Secure and sustain dedicated conservation law enforcement personnel. • Ensure community is aware of Guam and Federal natural resources laws and regulations, and responsibility of law enforcement personnel. • Coordinate with USFWS law enforcement, and seek qualified trainers to help installation security to enforce all environmental regulations, not limited to those that protect threatened and endangered species.
Outdoor Recreation Management Goals
• Provide quality outdoor recreation experiences while sustaining ecosystem integrity. • Ensure that outdoor recreation activities are not in conflict with mission priorities or natural resources management objectives. • Ensure recreational activities comply with Federal and local laws and installation instructions, and provide recreation opportunities for disabled Americans and veterans were appropriate.
Educational Outreach
• Maintain an active Educational Outreach Program to inform JRM personnel and the public of ongoing and planned natural resources activities on JRM sites. • Work with partners to develop newspaper, radio, television public service messages and Web site and education materials for the public describing nonnative invasive species, their impacts on native species, and what can be done for their prevention and control. • Support opportunities to work collaboratively through a MOU or MOA with the local government and agencies, which will afford improved biosecurity for both DOD and the community as a whole.

Geographic Information Systems and Data Management Goals
• Collect, store, and maintain data about historical conditions, trends, and current status of natural resources. • Use GIS information as benchmarks for developing future natural resources management goals and objectives.

Management objectives and strategies were developed based on evaluation of the natural resources present on the JRM sites; discussions with natural resources personnel at JRM; and discussions with resource agencies, USFWS, CNMI DLNR, GDAWR, and GNWR. This section is divided into 18 subsections, 1 for each subject area. Each subject area has been abbreviated, as shown in **Table 5-2**. For example, the first management issue in **Section 5.3**, Long-Term Ecosystem-Management Goals, is identified as EM-1. In addition, a series of strategies for implementation are presented following goals and objectives for each item. These strategies are consecutively numbered for each resource, and strategies that were previously identified by BOs are identified. **Table 5-3** includes a list of conservation measures associated with BOs that are currently programmed, or in progress. BOs associated with conservation measures are also identified within the table. Projects, conservation measures, and maintenance work associated with a BO that have already been completed are not included in **Table 5-3**. Actions identified in **Table 5-3** are included as strategies in the appropriate subject area. Additional actions not identified in **Table 5-3** are also included as strategies in the appropriate subject area, and designated with the text [Requirement from BO] immediately following the strategy. Following the management strategies are the evaluation criteria, which are used to track the status of the resolution of the management issue. A summary of the management strategies and the estimated timeframe for completion is presented in the **INRMP Project Schedules and Implementation Table** included as **Appendix C.**

Table 5-2. INRMP Subject Area Abbreviations

Section	INRMP Subject Area	Abbreviation
5.3	Long-term Ecosystem Management	EM
5.4	Management of GNWR Overlay Lands	--
5.5	Threatened and Endangered Species, or Candidate Species, and Locally Rare, CNMI-Listed, and GovGuam-Listed Species Management (Protected Species)	PRO
5.6	Wetlands and Floodplain Management	WT
5.7	Fish and Wildlife Resources Management	FWM
5.8	Vegetation and Habitat Management	VHM
5.9	Coastal, Marine, and Submerged Lands Management	SLM
5.10	Exotic and Invasive Species Management	ISM
5.11	Watershed Management	WP
5.12	Developed Land Management	LM
5.13	Coastal Zone Management	CZM
5.14	Wildland Fire Management	WFM
5.15	Urban Forestry Management	FOR
5.16	Law Enforcement	LE
5.17	Outdoor Recreation Management	OR
5.18	Educational Outreach	EO
5.19	Geographic Information Systems and Data Management	DM

Table 5-3. Conservation Measures Associated with Biological Opinions that are Currently Programmed or in Progress

Biological Opinion / Consultation	Conservation Measure / Projects
MILCON P-502, Kilo Wharf Extension (ACOE 2008)	Expansion of the Orote Ecological Reserve by 112.6 acres: 80.6 acres of submerged lands from Orote Point to Adotgan Point, and 32 acres including the beaches, small islets in the cove between Orote Island and the main peninsula, and the limestone forest area inland of the Unit, including the 8.2-acre (3.3-hectare) Orote Island and the 24 acres (9.7 hectares) of cliffline at the north tip of Orote Peninsula. The management plan for the Orote ERA would be modified to restrict fishing and other types of consumptive activities that could adversely affect the EFH.
Mariana Islands Range Complex (DoN 2010)	Tinian: Development of a management plan specific to Hagoi and other wetlands within the Tinian MLA. The management plan will benefit the Mariana common moorhen and provide additional protection for these unique wetland areas.
	Tinian: Continued monitoring of Mariana moorhen at Hagoi to evaluate population trends and determine success of avoidance and minimization measures.
	Tinian: Continued monthly monitoring of all sandy areas within the MLA to note turtle activity, beach erosion, and compaction.
	Tinian: Continued surveys for Micronesian megapodes.
	FDM: Megapode surveys on FDM will be conducted only after removal of unexploded ordnance by EOD personnel during operational range clearance.
	FDM: Quarterly population monitoring of seabirds, turtles, and marine mammals conducted using aerial observations.
	Guam: Continued trapping of brown treesnakes in areas surrounding Mariana swiftlet caves to reduce or prevent brown treesnake predation on the swiftlets and continue monitoring swiftlet population trends on Guam to evaluate success of avoidance, minimization, and conservation measures.
	Guam: Maintain 328-foot (100-meter) no-training buffers around the known Mariana swiftlet nesting caves.
	Guam: Monitor Mariana fruit bats at the Pati Point colony and other locations above and below the cliffline to determine if the colony is shifting from its historical location. These data will be used to assess the current population size at the colony and determine if additional adaptive management actions are needed to minimize impacts associated with ISR/Strike and MIRC.
Northwest Field Beddown (2006)	Eradication of ungulates and feral cats in the Habitat Management Unit (HMU).
	Fenced ungulate exclosure of 113 acres (54 hectares) at Ritidian Point and eradication of ungulates within the exclosure.
	500-square-foot (50-square-meter) fenced plots within ungulate exclosure (double-fenced) for outplanting of native trees for forage used by fruit bats and crows.
Intelligence, Surveillance, Reconnaissance, and Strike Capability (2006)	Fenced ungulate exclosure of 494 acres (200 hectares) at Ritidian Point and eradication of ungulates within the exclosure.
	Development of a plan to reduce ungulate numbers in non-fenced areas. [Ungulate Management Plans for Andersen AFB]
	Basewide ungulate control to levels that allow for forest regeneration and self-sustaining populations of native animals. [Ungulate Management Plans for Andersen AFB]

Biological Opinion / Consultation	Conservation Measure / Projects
	500-square-foot (50-square-meter) fenced plots within ungulate exclosure (double-fenced) for outplanting of native trees for forage used by fruit bats and crows.
	Out plant trees used by fruit bats and crows within the exclosures.
	Telemetry studies of ungulate movements. [Ungulate Management Plans for Andersen AFB]
	Transplant *Tabernaemontana rotensis* saplings from areas that will be developed.
	Fund USDA research on brown treesnake control.
	All construction projects that could impact species, and for which a consultation was concluded, incorporate similar measures as those already outlined, minimizing and avoiding impacts through post-construction monitoring, flagging trees of value (if they can be retained), and restricting activities to daytime hours.
	Development and maintenance of the Adaptive Management Strategy and associated Team and the ongoing monitoring of Mariana fruit bats, both outlined in the BO.
Habitat Management Units Wells and Fence (USFWS 2009)	Eradication of ungulates, brown treesnakes, and other predators within the HMU.
Guam and Commonwealth of the Northern Mariana Islands Military Relocation (2010)	Ungulate control to levels that allow for forest regeneration and self-sustaining populations of native animals. [Ungulate Management Plans for NBG and Andersen AFB]
	Lighting will be designed to meet minimum safety, ATFP requirements.
	Ungulate Management Plans will be finalized by the DOD for DOD lands on Guam to include specific management and control of ungulates.
	DOD will develop a restoration plan for the Camp Covington wetlands in an effort to increase suitable habitat for the Mariana common moorhen.
	To address pathways and encourage a more holistic approach to managing invasive species the DoN has funded and is a participating agency in the development of the Micronesia Biosecurity Plan (Phase I). Individual activities for various species will continue, but the DoN and others agree it is more efficient to manage pathways and prescribe corrective measures for a suite of species which will be monitored at discrete control points through time. The Micronesia Biosecurity Plan is much greater and is applicable to all agencies in Micronesia and will provide a platform for coordination and integration of interagency invasive species management efforts such as control, interdiction, eradication, and research.
	Develop and implement a methodology (e.g., spreadsheet, database) for tracking project actions as described in the Project Description including the timing and implementation of the conservation measures and the Terms and Conditions. A mitigation tracking database has been developed in MS Excel.

Some of the projects described in this section will be accomplished through interactive partnerships with other Federal, territorial, CNMI, and local organizations. JRM natural resources management staff will initiate partnerships based on the benefits to the regional ecosystem and the local environment. Required projects, which are part of the continued management of JRM, will be internally funded through the JRM.

5.3 Long-term Ecosystem Management

The intent of this INRMP is to take an ecosystem approach to managing the natural resources present on JRM. The interdisciplinary approach taken by this INRMP follows an ecosystem model, in which all appropriate components are integrated by their function. Ecosystem management is emphasized because it is recognized that the mission of the JRM is inextricably linked to local, regional, and global ecological integrity. Sustaining ecosystem integrity is also the best way to protect biodiversity, ensure sustainable use, and minimize the effort and cost of management. Native and natural communities, and the processes that sustain them, are essential to sustaining system function and resilience over a long-term.

Native habitats occurring on JRM lands have been impacted by historical activities, introduction and spread of invasive and nonnative species, and the resulting loss of functions necessary to support healthy native habitats. The occurrence of healthy native habitats on JRM is necessary to support sustainability of native species including listed species on Guam and the CNMI. JRM recognizes that restoration and enhancement of native habitats on lands that they manage is an ongoing long-term process. JRM also recognizes that ongoing projects and management efforts need to be coordinated with future management efforts, and that they need to be directed towards a goal of restoring and enhancing habitats for native species including listed species over a long-term (30 to 50 years out).

JRM is currently implementing several projects and has projects planned with the goals of restoring and enhancing habitats for native species and maximizing availability of important habitat for listed species on terrestrial and submerged lands that they manage. Some of these projects include the following:

1. Conducting marine monitoring at the Pati Point Marine Preserve to determine the location and status of corals in the preserve, to assess the feasibility of monitoring within the preserve, and to establish permanent transects viable for continued monitoring.
2. Conducting surveys and studies on threatened and endangered species, populations, and their habitat to prevent further decline of listed species and to contribute to USFWS, GNWR, GDAWR, and CNMI DLNR goals to recover listed species.
3. Continuing to develop and implement projects to manage, control, and eradicate exotic and invasive species including ungulates, feral cats and dogs, coconut rhinoceros beetle, and the brown treesnake.
4. Ongoing management by JRM to stabilize and restore erosion scars caused by wildland fires and destruction of vegetation and disturbance of soil by ungulates in the savannah areas of the NMS and at other locations on JRM sites.

These example projects along with other ongoing and planned projects need to be linked to the long-term management goal. It is the intent of this INRMP to link ongoing projects and develop future projects from an ecosystem-based management approach that takes into consideration the overriding goal of enhancing habitats for native species including listed species over a long-term. It is understood that many projects and management actions are necessary to address needed management on a daily or short-term basis. It is also understood that many projects developed in this INRMP are necessary for ongoing management of natural resources. The daily and short-term management of resources is important towards reaching the long-term goals.

To ensure that JRM continues to meet the overriding goal of restoring and enhancing habitats for native species, including listed species, over the next 30 to 50 years, coordination between JRM site land managers, and resource agencies should continue. In addition, long-term, ecosystem-based management plans will be developed for JRM submerged lands in Apra Harbor, marine units of the OPERA and HERA, and the Overlay units on NBG and Andersen AFB. These plans will direct management on JRM through the development of studies and projects that are based on, or have as primary components, goals and objectives that are consistent and supplemental to long-term management goals developed in the Plans.

The goal for long-term ecosystem management for JRM is summarized in **Table 5-4**.

Table 5-4. Summary of Long-term Ecosystem Management Goals

Long-term Ecosystem Management
• Manage all natural resources on JRM lands with a long-term goal of restoring and enhancing habitats for native species including listed species over the next 30 to 50 years.

To meet the long-term ecosystem management goal identified in **Table 5-4**, the following management actions have been identified with the indicated objectives, strategies, and monitoring criteria to address them.

1. Vegetation mapping of invasive and native species
2. Delineating areas to be cleared of invasive vegetation and reforestation
3. Delineating areas of savanna grasslands for reforestation
4. Standard operating procedures or prescriptions for planting and maintaining native species
5. Removing invasive species and establishing native forest:
    a. determine species for reforestation
    b. delimit areas for reforestation
    c. long-term schedule invasive plant removal
    d. schedule for reforestation
    e. determine how invasives plant species will be removed

5.3.1 EM-1: Long-term Ecosystem Management on JRM

Issue: Natural resources management in the overlay units and submerged lands on JRM has a primary goal of maintaining the health of habitats associated with these areas and, where needed, working towards restoring and enhancing these habitats for native species, including listed species, in a manner consistent with the requirements of JRM's mission. Management of these areas is based on an ecosystem approach that considers the goals of management over a long-term. There currently are no management plans specific to the overlay units or JRM submerged lands that consider past, ongoing and future projects and their coordination towards the goal of management objectives for the long term (30 to 50 years). There is a need to develop long-term management plans that will combine and use the results and achievements of past management along with ongoing and future projects in the overlay units and in submerged lands on JRM. These long-term management plans will have the overriding goal of restoring and enhancing habitat for native species including listed species and their habitats over the next 30 to 50 years.

Objective: Develop two detailed watershed and forest management plans for the overlay units on NBG and Andersen AFB that use past and ongoing efforts and prescribe new and future specific actions and projects designed at achieving the long-term goals and precluding the need for designation of critical habitat. The management plans will develop a chronology of actions necessary to achieve the long-term goals (i.e., need to address ungulates first) and provide a conservation benefit to threatened and endangered species.

Revise and update the management plans for submerged lands in Apra Harbor, and marine units of the OPERA and HERA that evaluate current impacts on the submerged ecosystems, identifies sources of impacts, and recommends management directed at addressing impacts with the long-term goal of restoring and enhancing submerged ecosystems for native species and corals in these habitats over the next 30 to 50 years.

Strategies:

1. Develop a Long-Term Watershed and Forest Management Plan for terrestrial ecosystems on JRM lands for the overlay units on NBG, and a Long-Term Watershed and Forest Management Plan for terrestrial ecosystems on JRM lands for the overlay units on Andersen AFB. The detailed management plan for the overlay units will address past and ongoing efforts and prescribe new and future specific actions and projects that, in coordination with past and ongoing activities, are directed at achieving the long-term goal of restoring and enhancing habitats for native species including listed species over the next 30 to 50 years. The plan will be developed as a living document that can be updated over time to address changing management needs necessary to achieve the long-term goal
2. Develop a Long-Term Submerged Lands Management Plan for JRM submerged lands associated with Apra Harbor, and marine units of the OPERA and HERA. The plan will identify sources of impacts and recommend management directed at addressing impacts with the long-term goal of restoring and enhancing submerged ecosystems for native species and corals in these habitats over the next 30 to 50 years. The plan will be developed as a living document that can be updated over time to address changing management needs necessary to achieve long-term goals.

Monitoring Criteria: Development of three long-term management plans directed at management of natural resources in the overlay units and the submerged lands of Apra Harbor and marine units of the OPERA and HERA over a long-term. Development and implementation of all natural resources management projects and actions taking into consideration the overriding management goal of restoring and enhancing habitat for native species including listed species and their habitats over the next 30 to 50 years.

5.4 Management of GNWR Overlay Lands

The Overlay lands of the GNWR are Navy lands managed cooperatively with the USFWS GNWR.

Issue: Establishment of critical habitat by the USFWS on JRM sites could compromise the mission.

Objective: Manage Overlay Refuge lands according to the guidelines within this INRMP and the Cooperative Agreement.

Strategies: The 1994 Cooperative Agreements identified the following as goals for management of Overlay Refuge lands:

1. Protect and recover endangered, threatened, candidate, and proposed species and other native flora and fauna.
2. Complement ongoing efforts in natural resources management, protection, law enforcement and research.
3. Exchange technical information and expertise to implement conservation and environmental protection mandates.
4. Provide increased coordination on law enforcement issues.
5. Develop research and environmental education programs.
6. Ensure Federal actions and management plans comply with applicable Federal laws.
7. Provide coordination with GNWR Manager for actions that could impact habitat of threatened and endangered species even if those species are extirpated from the affected area, but not extinct.
8. Develop and implement an Overlay Refuge management plan and provide annual updates in coordination with the GNWR manager.
9. Consider wildlife and fisheries concerns in the development of other management plans such as law enforcement, prescribed burning, and public use.
10. Develop and implement an annual work plan and annual accountability report.

5.5 Threatened and Endangered Species, Candidate Species, Locally Rare, CNMI-Listed, and GovGuam-Listed Species Management

Management of threatened and endangered species at JRM includes implementing programs to protect species, and coordinating efforts with the appropriate agencies. Several of the endangered species listed in **Table 4-4** (e.g., little Mariana fruit bat, Guam broadbill) have already become extinct due to the key threats which still exist today. These key threats to threatened, endangered, or candidate species are as follows:

- Predation by brown treesnakes on native forest birds, lizards, and bats
- Overgrazing, rooting, and trampling of plants and wildlife habitat by feral ungulates
- Predation by feral cats, ungulates, and monitor lizards on birds, bats, and sea turtles and moorhen
- Human disturbance of threatened and endangered species and poaching of sea turtles and Mariana fruit bats
- Mortality or injury to native plants and wildlife due to natural stochastic events (e.g., typhoons)
- Low reproductive success due to small population numbers
- Habitat loss and fragmentation associated with military operations.

To address these key threats to listed species, efforts are underway to reduce brown treesnake numbers in the HMU, control brown treesnakes at swiftlet caves on JRM sites and to prevent their spread to other Pacific Islands by interdiction at ports. Captive breeding programs conducted by GDAWR and mainland zoological institutions are maintaining populations of Guam rail and Guam Micronesian kingfisher and are adding to the information needed for successful recovery of these species. Additional ecological research and monitoring is also being conducted by various agencies on Guam, including DOD, which will support research and management efforts for candidate snails on JRM sites.

In accordance with Section 7 of the ESA, a Federal agency shall consult with USFWS and/or NMFS to ensure that any action authorized, funded, or carried out by such agency is not likely to jeopardize the continued existence of any endangered species or threatened species. For Federal actions that might affect Guam-listed species, the GDAWR should be consulted. For actions that might affect listed species on Tinian and FDM, CNMI Division of Fish and Wildlife should be consulted. The Navy shall coordinate with the GNWR for any Federal action that is within the GNWR and is identified as providing habitat for threatened or endangered species. In addition, the Navy will, as the mission allows, avoid impacts on habitat suitable for threatened and endangered species, or candidate species, and locally rare, CNMI-listed, and GovGuam-listed species.

Species habitat on JRM sites is identified in published recovery plans for endangered native forest birds (USFWS 1990a, USFWS 1994a) and endangered fruit bats (USFWS 1990b). On JRM, areas with wildlife habitat are included in the OPERA, HERA, and the GNWR overlays. These habitats include primary and secondary native limestone forest, coastal strand and beaches, coastal plain communities, and submerged lands/coral reefs (for sea turtles). Habitat for endangered species also supports a diversity of other native plants and animal species. This INRMP qualifies as a "legally operative plan that provides adequate special management and addresses the maintenance and improvement of the primary constituent elements important to the species, and manages for the long-term conservation of the species" (67 FR 63738). An INRMP is considered acceptable in place of the designation of critical habitat if it meets the following criteria:

1. **The plan provides a benefit to the species.** Cumulative benefits of the management activities identified in a management plan, for the length of the plan, must maintain or provide for an increase in a species' population or the enhancement or restoration of its habitat within the area covered by the plan (e.g., those areas deemed essential to the protection of the species). A benefit could result from reducing fragmentation of habitat, maintaining or increasing populations, ensuring against catastrophic events, enhancing and restoring habitats, buffering protected areas, or testing and implementing new strategies.
2. **The plan provides certainty that the management plan will be implemented.** Persons charged with plan implementation are capable of accomplishing objectives of the management plan and there is adequate funding for the management plan. They have the authority to implement the plan and have obtained all necessary authorizations or approvals. An implementation schedule (including completion dates) for the management effort is provided in the plan.
3. **The plan provides certainty that the management effort will be effective.** The following criteria will be considered when determining the effectiveness of the management effort. The plan includes (1) biological goals (broad guiding principles for the program) and objectives (measurable targets for achieving the goals); (2) quantifiable, scientifically valid parameters that will demonstrate achievement of objectives and standards for these parameters by which progress will be measured are identified; (3) provisions for monitoring and, where appropriate, adaptive management; (4) provisions for reporting progress on implementation (based on compliance with the implementation schedule) and effectiveness (based on evaluation of quantifiable parameters) of the management effort are provided; and (5) a duration sufficient to implement the plan and achieve benefits of its goals and objectives.

In order to meet these criteria, the JRM INRMP specifies management strategies for the Mariana fruit bat, Mariana crow, Guam Micronesian kingfisher, Guam rail, Mariana swiftlet, Mariana common moorhen, Micronesian megapode, marine mammals, green and hawksbill turtles, and *Serianthes nelsonii* to reduce adverse impacts on the species. Habitat for threatened, endangered, and candidate species also supports a diversity of other native plant and animal species.

There is a timely schedule in the INRMP for implementation of the management strategies for these species. There is a high probability that the funding sources or other resource(s) necessary to implement the strategies will be available. JRM has the authority, legal requirement, and long-term commitment to implement the management strategies in the INRMP due to the Sikes Act, as amended through 2012, and other DOD and DoN policies and instructions.

The goals for this section are to manage JRM lands on a regional ecosystem-based approach that manages sensitive species and their associated ecosystems while protecting the operational functionality of the missions of the installation. Also, natural resources personnel from JRM sites will work to promote ecosystem-based management in the local region.

As a general guide, **Figure 5-1** presents a threatened and endangered species coordination decision chart that will be followed as part of the planning process for projects that could impact known or potential future populations of threatened or endangered species on the installation, or nearby critical habitat. The threatened and endangered species management goals are summarized in **Table 5-5**. Sensitive species at JRM will continue to be managed by implementing specific management strategies that enhance habitat for these species and by initiating specific strategies that address immediate needs of threatened and endangered, and other sensitive species on the installation. In addition, adherence to the goals set for threatened and endangered species management will ensure that the installation remains in compliance with ESA and applicable Territory and CNMI regulations.

Table 5-5. Summary of Threatened and Endangered Species Management Goals

Threatened and Endangered Species Management Goals
• Manage JRM on a regional ecosystem-based approach that manages threatened and endangered species and their associated ecosystems while supporting the operational functionality of JRM site missions. • Ensure that JRM sites remain in compliance with ESA, conservation measures contained within biological opinions, Federal consistency determinations affecting listed species, and appropriate territorial regulations. • Provide a conservation benefit to threatened, endangered or candidate species. • Provide a conservation benefit to other locally rare and GovGuam listed species through ecosystem management and benefits seen from projects that support ESA listed species. • Provide assurances that management strategies will be implemented and effective. • Protect and enhance habitats for threatened, endangered, and species of concern on JRM. • Implement programs and projects that will benefit the species in terms of population recovery towards the goal of delisting the species. • Develop outreach and education materials for distribution to appropriate JRM and military personnel, and the public. • Continue to support research conducted by GDAWR and UOG on the Mariana crow, including research on identification of potential habitat for the species on Guam and JRM lands. • Encourage, support and facilitate ecological research by Federal, Territorial, and Universities on Guam's listed species, invasive species, and habitats.

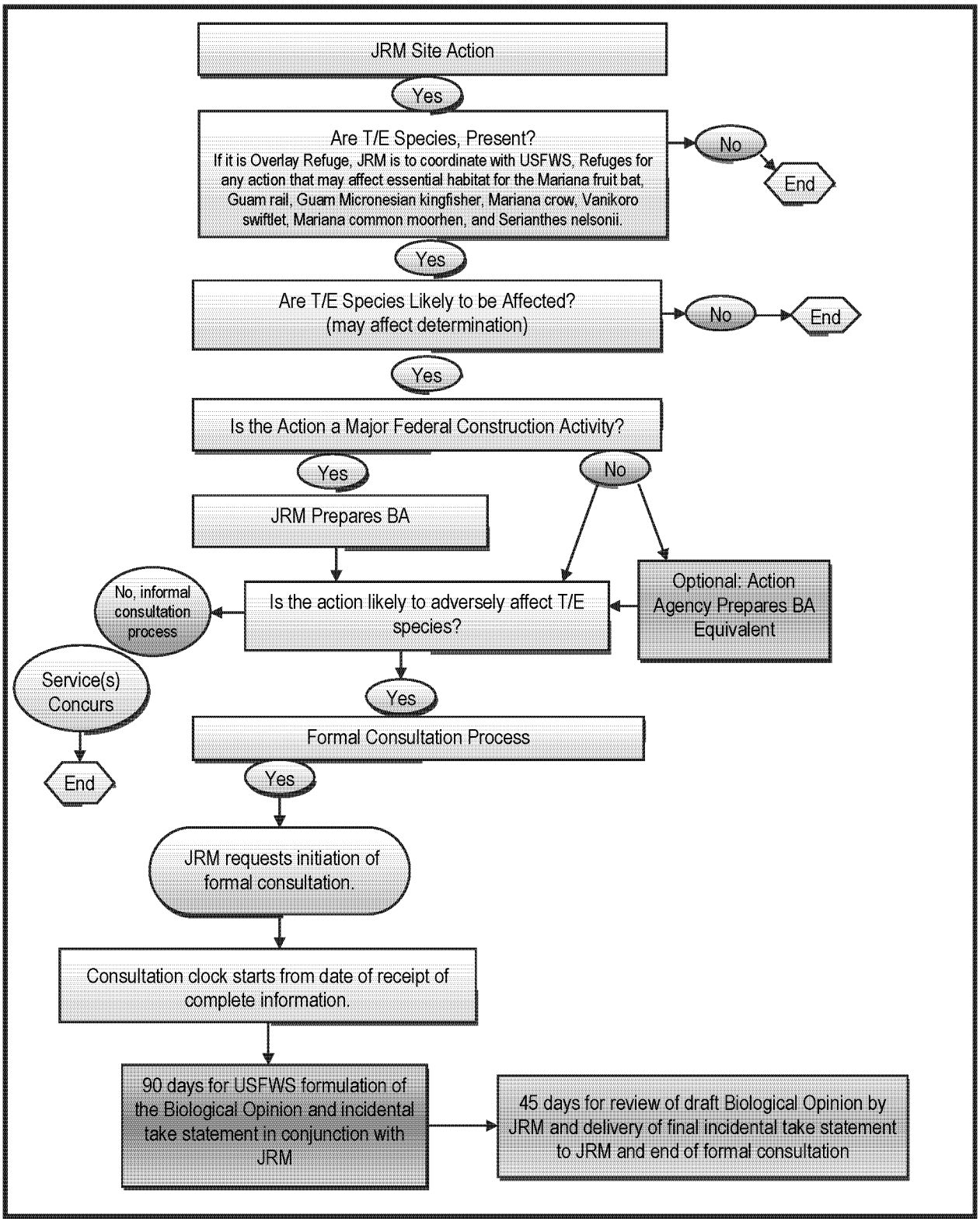

Figure 5-1. Threatened and Endangered Species Coordination Chart

To meet the threatened and endangered species management goals identified in **Table 5-5**, the following management actions have been identified with the indicated objectives, strategies, and monitoring criteria to address them.

5.5.1 PRO-1: Protection and Recovery of the Mariana Fruit Bat

Issue: The Mariana fruit bat or fanihi is federally threatened. A small number of Mariana fruit bats are currently resident on Guam; bats are rare visitors to Tinian and FDM.

Objective: With respect to mission requirements, continue to assist USFWS, GDAWR, and CNMI DLNR in achieving Mariana fruit bat recovery goals: (1) increasing fanihi subpopulations on three of the five southern islands (Saipan, Tinian, Aguiguan, Rota and Guam) as part of the overall species recovery, (2) recovering the species and delisting as soon as possible, and (3) sustaining recovery of the species in perpetuity.

The resident fruit bat colony was located in an off-limits area of Andersen AFB. Recent surveys of fruit bats at the colony site have shown that the site is no longer being used (SWCA 2011 and 2012). Surveys conducted throughout Andersen AFB in 2011–2012 have found very low numbers of bats and no colonial roosts. The number of bats remaining on Andersen AFB is believed to be less than 25 individuals. Only 88 sightings of individual bats were recorded March–September 2012 during 82 surveys (SWCA 2012).

With the continued decline of the Guam subpopulation, management on JRM lands will focus on restoration of fruit bat habitat including a goal of elimination of feral ungulates and vegetation restoration in areas where ungulates have been controlled or excluded. Elimination of feral ungulates and continued patrols of JRM lands will also help reduce illegal hunting.

Management will also focus on area-wide control methods for brown treesnakes, regular monitoring of fruit bat numbers and monitoring of habitats.

All strategies described as follows for Andersen AFB will be developed and implemented in coordination with the AMT.

Strategies:

1. Establish long-term survey stations and conduct monitoring surveys to obtain density estimates on Andersen AFB.
2. Implement the JRM Andersen AFB Ungulate Management Plan and the NBG Ungulate Management Plan to control and eliminate ungulates from the Overlay Refuge lands. [Requirement from BO]
3. Update and revise the 2008 Andersen AFB Mariana Fruit Bat Management Plan.
    a. Request funding to update the plan during FY 2013. Award contract in FY 2016.
    b. Incorporate November 1, 2012, USFWS comments on the August 2, 2012, JRM INRMP regarding the 2008 Mariana Fruit Bat Management Plan.
    c. Include management of possible additional bats arriving on Guam from Rota.
    d. Submit a draft of the updated plan for agency review in FY 2016.
    e. Once agency comments have been received and incorporated, finalize the plan.
4. Coordinate with CNMI DLNR and GDAWR on movement of bats from Rota.

5. Create ten 528-square-foot (50-square-meter) fenced vegetation plots within the Ritidian fenced ungulate exclosure and plant with native tree species utilized by foraging Mariana fruit bats and Mariana crows as required by the USFWS section 7 ESA Consultation for the Northwest Field Project and the ISR/Strike BO. Supplemental fencing within the ungulate exclosure will be provided around the vegetation plots. Additional actions within the vegetation plots include herbaceous plant management, fence line maintenance and quarterly monitoring of outplanting success. [Requirement from BO]
6. Restore fruit bat habitat by planting appropriate native forest species. [Requirement from BO]
7. Continue to manage existing Mariana fruit bat habitat in limestone, ravine, and coastal forest areas on JRM lands using strategies such as preventing forest clearing and preventing wildland fire. To avoid unnecessary clearing of forested areas on JRM lands, all proposed projects are coordinated with JRM natural resources personnel, USFWS, GNWR, and GDAWR to ensure that native species habitat is not adversely impacted. In addition, several vegetation plots have been established in limestone forested areas to encourage regeneration of forested areas. Prevention of wildland fire will be accomplished by using strategies identified in the Wildland Fire Management Plan for JRM, once it is developed.
8. Remove invasive plant species to aid in recovery of native forest.
9. Collaborate with USGS-FORT and USDA-NWRC to determine the most effective and least disruptive methods to control brown treesnakes, feral cats, and monitor lizards in Mariana fruit bat roosting and foraging habitat. Control methods should focus on area-wide suppression of fruit bat predators and the establishment of low-snake density areas with a minimum of disturbance. [Requirement from BO]
10. Continue to maintain a standardized, up-to-date inventory and GIS map of Mariana fruit bats including historic distribution, current distribution, location of sightings, and other status information useful for long-term management.
11. Within mission requirements, prevent unnecessary clearing of land in areas of colony roosting habitat.
12. Where possible, implement actions for Andersen AFB and DOD identified in the 2009 Draft Mariana Fruit Bat Recovery Plan.
13. Support research for ecosystem-wide control of brown treesnakes.
14. Review the status of actions prescribed under PRO-1 at the annual INRMP review meeting. Initiate actions based on the review to ensure that actions are, or will be, implemented as prescribed pending available funding.

Monitoring Criteria: Monitor to ensure that Mariana fruit bat habitat continues to be protected from illegal hunting and other non-permitted activities. Ensure that regular patrols by conservation officers are being conducted on JRM lands where fruit bats have been observed. Continue to regularly monitor all JRM lands for new Mariana fruit bat colonies, solitary individuals, and areas where suitable foraging habitat occurs. Monitor for the effectiveness of the control and removal of ungulates in the enhancement of Mariana fruit bat habitat.

5.5.2 PRO-2: Protection and Recovery of the Mariana Crow

Issue: The Mariana crow is federally endangered throughout its range in the Mariana Islands.

Objective: With respect to mission requirements, continue to assist the USFWS and GDAWR in achieving Mariana crow recovery goals. Recovery of Mariana crows includes 75 pairs in southern and 75 pairs in northern Guam.

There are no plans to translocate additional Mariana crows from Rota to Guam. The focus of Mariana crow management on JRM lands now centers on managing Mariana crow habitat and supporting Mariana crow conservation on Rota.

All strategies described as follows for Andersen AFB will be developed and implemented in coordination with the AMT, which includes USFWS Ecological Services, GNWR, and GDAWR.

Strategies:

1. Continue to manage existing Mariana crow habitat in limestone, ravine, and coastal forest areas on JRM lands using strategies such as preventing forest clearing and preventing wildland fire. To avoid unnecessary clearing of forested areas on JRM lands, all proposed projects are coordinated with JRM natural resources personnel, USFWS, GNWR, and GDAWR to ensure that native species habitat is not adversely impacted. In addition, several vegetation plots will be established in limestone forested areas to encourage regeneration of native forested habitats. Prevention of wildland fire will be accomplished by using strategies identified in the Wildland Fire Management Plan for JRM, once developed.
2. Continue to maintain a standardized, up-to-date inventory and GIS map of Mariana crow including historic distribution, current distribution, numbers of individuals; nesting sites or breeding locations; maps of important habitat; and other status information useful for long-term management.
3. Create ten 528-square-foot (50-square-meter) fenced vegetation plots within the Ritidian fenced ungulate exclosure and outplant with native tree species utilized by foraging Mariana fruit bats and Mariana crows as required by the USFWS section 7 ESA Consultation for the Northwest Field Project and ISR/Strike BO. Supplemental fencing within the ungulate exclosure will be provided around the vegetation plots. Additional actions within the vegetation plots include herbaceous plant management, fence line maintenance, and quarterly monitoring of outplanting success. [Requirement from BO]
4. Facilitate native forest revegetation by constructing three ungulate exclosures at Ritidian Point as per the Northwest Field Beddown consultation letter and the ISR/Strike BO. Ungulate exclosure areas should be developed following guidelines contained within the JRM Ungulate Management Plans. [Requirement from BO]
5. Implement the NBG and Andersen AFB Ungulate Management Plans to reduce and control ungulates on all JRM lands and to enhance Mariana crow habitat.
6. Plant native forest species used by Mariana crows in ungulate excluded areas. [Requirement from BO]
7. Where possible, implement actions identified for the Navy in the 2005 Draft Revised Recovery Plan for the Aga or Mariana Crow.
8. Review the status of actions prescribed under PRO-2 at the annual INRMP review meeting. Initiate actions based on the review to ensure that actions are, or will be, implemented as prescribed pending available funding.

Monitoring Criteria: Monitor for success of Ungulate Management Plan implementation and the control of ungulate populations in Mariana crow habitat. Evaluate success of prescribed strategies during the annual INRMP review.

5.5.3 PRO-3: Protection and Recovery of the Guam Micronesian Kingfisher

Issue: The Guam Micronesian kingfisher is presumed extirpated in the wild on Guam, but a captive population of approximately 100 birds exists in institutions on the mainland United States and Guam. Habitat for the Guam Micronesian kingfisher exists on JRM lands.

Objective: With respect to mission requirements, continue to assist the USFWS, GNWR, and GDAWR in achieving Guam Micronesian kingfisher recovery goals to downgrade the ESA listing status by (1) preventing extinction, (2) restoring a population of 500 individuals on northern Guam (including Andersen AFB) and 500 individuals in southern Guam (including NBG), and (3) achieving full recovery of the species in perpetuity. A species is delisted when it does not meet the definition of endangered or threatened because (1) it is extinct, (2) it has recovered, or (3) the data upon which the listing was originally based were in error. The Guam Micronesian kingfisher may be removed from the Federal list of endangered and threatened species when the following criteria are met: (1) Guam Micronesian kingfisher occur in 2 subpopulations (one in northern Guam and one in southern Guam) of at least 1,000 adults each; (2) both subpopulations are either stable or increasing; (3) sufficient Guam Micronesian kingfisher habitat is protected and managed; (4) brown treesnakes and other introduced predators are controlled over 10 consecutive years. See **Appendix Y9** for additional information on downgrading and delisting criteria.

All strategies described as follows for JRM will be developed and implemented in coordination with the AMT, which includes USFWS Ecological Services, GNWR, and GDAWR.

Strategies:

1. Continue to manage existing Guam Micronesian kingfisher habitat in limestone, ravine, and coastal forest areas on JRM lands using strategies such as preventing forest clearing and preventing wildland fire. To avoid unnecessary clearing of forested areas on JRM lands, all proposed projects are coordinated with JRM natural resources personnel, USFWS, GNWR, and GDAWR to ensure that native species habitat is not adversely impacted. In addition, several vegetation plots have been established in limestone forested areas to encourage regeneration of forested areas. Prevention of wildland fire will be accomplished by using strategies identified in the Wildland Fire Management Plan for JRM, once it is developed.
2. Facilitate native forest revegetation by constructing three ungulate exclosures at Ritidian Point as per the Northwest Field Beddown consultation letter and the ISR/Strike BO. Ungulate exclosure areas should be developed following guidelines contained within the JRM Ungulate Management Plans. [Requirement from BO]
3. Collaborate with USGS-FORT and USDA-NWRC to determine the most effective and least disruptive methods to control brown treesnakes, feral cats and monitor lizards in potential Guam Micronesian kingfisher habitat. Control methods should focus on area-wide suppression of predators and the establishment of low-snake-density areas following guidelines in the Brown Treesnake Control Plan developed by the signatories of the MOA on Brown Treesnake Control, which included DOD.
4. Continue to support control of nonnative competitors or predators, preventing the release of additional noxious exotic species, and the reduction of pesticide use where feasible.

5. Continue to support ungulate control through implementation of strategies in the JRM Ungulate Management Plans (**Appendices L** and **M**).
6. Where possible, implement actions identified for the Navy in the 2008 Revised Recovery Plan for the Sihek or Guam Micronesian Kingfisher (**Appendix Y9**).
7. Encourage, support and facilitate ecological research by Federal, Territory, and Universities on Micronesian kingfisher. Encourage, support, and facilitate ecological research by Federal, Territory, and Universities on methods to control and eradicate brown treesnakes including development of additional baits, methods of trapping, pheromones, reproductive control, movements, life history dynamics, and other management approaches.
8. Review the status of actions prescribed under PRO-3 at the annual INRMP review meeting. Initiate actions based on the review to ensure that actions are, or will be, implemented as prescribed pending available funding.

Monitoring Criteria: Continue to coordinate with the USFWS, GNWR, and GDAWR in meeting Guam Micronesian kingfisher recovery objectives without compromising the mission.

5.5.4 PRO-4: Protection and Recovery of the Guam Rail

Issue: The Guam rail is extirpated, but an experimental population was recently released on Cocos Island, and an experimental population has been released on Rota. GDAWR operates a rail breeding facility on Guam.

An HMU, fenced with a brown treesnake barrier, was constructed on Andersen AFB by GDAWR and USFWS. JRM is responsible to maintaining the snake barrier, and for eradicating brown treesnakes, ungulates, and predators from inside the area.

Objective: With respect to mission requirements, continue to assist the USFWS, GNWR, and GDAWR in achieving Guam rail recovery objectives by managing habitats on JRM lands to be favorable for the Guam rail.

All strategies described as follows for Andersen AFB will be developed and implemented in coordination with the AMT, which includes USFWS Ecological Services, GNWR, and GDAWR.

Strategies:

1. Continue to manage the primary threats to the species by supporting brown treesnake and predator control undertaken by other agencies. Collaborate with USGS-FORT and USDA-NWRC to determine the most effective and least disruptive methods to control brown treesnakes in potential Guam rail habitat. Control methods should focus on area-wide suppression of brown treesnakes and the establishment of low-snake-density areas following guidelines in the Brown Treesnake Control Plan developed by the signatories of the MOA on Brown Treesnake Control, which included DOD.
2. Implement the NBG and Andersen AFB Ungulate Management Plans to reduce and control ungulates on all JRM lands and to enhance Guam rail habitat.
3. Continue development of habitat restoration techniques and restore habitat for Guam rail on JRM lands.
4. Encourage, support and facilitate ecological research by Federal, Territory, and Universities on methods to control and eradicate brown treesnakes including development of additional baits,

methods of trapping, pheromones, reproductive control, movements, life history dynamics, and other management approaches.

5. Review the status of actions prescribed under PRO-4 at the annual INRMP review meeting. Initiate actions based on the review to ensure that actions are, or will be, implemented as prescribed pending available funding.

Monitoring Criteria: Continue to coordinate with the USFWS, GNWR, and GDAWR in meeting Guam rail recovery objectives and to ensure that recovery efforts are focused on the strategies listed for the protection and recovery of the species without compromising the mission.

5.5.5 PRO-5: Protection and Recovery of the Mariana Swiftlet

Issue: The Mariana swiftlet is federally endangered throughout its range in the Mariana Islands. JRM is currently developing alternate survey methods to estimate population size of endangered Mariana swiftlets (e.g., thermal imagery, infrared). Conventional methods to survey swiftlets on JRM lands are sensitive to observer bias and might be inaccurate at estimating population size.

The Navy has discussed swiftlet translocation to sites in northern Guam as a way to increase population numbers and move toward delisting with GDAWR, GNWR, USFWS, and USGS. Several locations in northern Guam have been identified as potential release sites however, the release of birds on Andersen AFB has mission-related and safety constraints. The greatest constraint for successful translocation is ecosystem-scale control of brown treesnakes. Success of translocation is dependent on the development of effective landscape control of brown treesnakes.

Objective: With respect to mission requirements, continue to assist the USFWS, GNWR, and GDAWR in achieving Mariana swiftlet recovery goals by managing habitats on JRM lands to be favorable for the Mariana swiftlet and controlling predation by brown treesnakes inside of swiftlet caves.

All strategies described as follows for Andersen AFB will be developed and implemented in coordination with the AMT.

Strategies:

1. Conduct quarterly surveys for Mariana swiftlet at JRM per guidelines contained within the JRM Mariana Swiftlet Monitoring Program Standard Operating Procedure.
2. Conduct a study to examine habitat use by Mariana swiftlets. Data will be collected to identify and examine forage habitat and prey base, nesting habitat, and roosting site selection of unpaired individuals of Mariana swiftlets.
3. Conduct specific studies on Mariana swiftlet life history, population biology, and suspected limiting factors.
4. Conduct banding and satellite telemetry studies to track movements of individual Mariana swiftlets and to track site fidelity and movements.
5. Continue to maintain a standardized, up-to-date inventory and GIS map of Mariana swiftlet including historic distribution, current distribution, numbers of individuals; nesting sites or breeding locations; maps of important habitat; and other status information useful for long-term management.

6. Conduct a study to support development of effective approaches for the management of habitat for Mariana swiftlets, including the control of predation by brown treesnakes, and to identify long-term management objectives for the bird.
7. Implement recommendations included in the JRM Wildland Fire Management Plan, once it is developed, to reduce potential for the occurrence of wildland fires in, or near, foraging or nesting habitats.
8. Continue to support surveys for securing and management of potentially suitable caves for the Mariana swiftlet and immediately surrounding buffer habitat on JRM lands by regulating human and ungulate entry into the caves, where practicable.
9. Encourage, support, and facilitate ecological research by Federal, Territory, and Universities on Mariana swiftlet.
10. Encourage, support, and facilitate ecological research by Federal, Territory, and Universities on methods to control and eradicate brown treesnakes including development of additional baits, methods of trapping, pheromones, reproductive control, movements, life history dynamics, and other management approaches.
11. Ensure that overflights follow guidelines within the JGPO BO and that all aviation training will be conducted so that flights will approach the southern portion of the NMS over the Talafofo River watershed and Fena Reservoir at heights of 1,000 feet (305 meters) or greater above ground level. Flights may go up the Ugum River at altitudes of 1,000 feet (305 meters) or greater above ground level until they reach 9,843 feet (3,000 meters) from the mouth of the river at Highway 4 and then flights may conduct low-level terrain flights. Low-level training flights should be restricted to the southernmost portion of the NMS to avoid adverse effects on Mariana swiftlets utilizing caves on the NMS. [Requirement from BO]
12. Consistent with the MIRC BO, the DOD will maintain 328-foot (100-meter) no-training buffers around the known Mariana swiftlet nesting caves (e.g., Mahlac Cave, Fachi Cave, Maemong Cave) on the NMS. [Requirement from BO]
13. Continue to trap brown treesnakes in areas around the three swiftlet caves to reduce or prevent brown treesnakes predation on swiftlets.
14. Continue to monitor Mariana swiftlets in occupied roosting and nesting habitat following guidelines in the Mariana Swiftlet Monitoring Program Standard Operating Procedure (SOP).
15. Conduct literature review and consult with USFWS, GNWR, and GDAWR to explore different methods for conducting monitoring of swiftlet populations on JRM sites. Investigate, develop and implement new field methods for counting swiftlets to obtain population estimates.
16. Review the status of actions prescribed under PRO-5 at the annual INRMP review meeting. Initiate actions based on the review to ensure that actions are, or will be, implemented as prescribed pending available funding.

Monitoring Criteria: Continue to coordinate with the USFWS, GNWR, and GDAWR in meeting Mariana swiftlet recovery objectives without compromising the mission. JRM should also conduct species population number trend analysis to monitor species recovery and stability, to determine if recovery efforts are effective and to identify any necessary changes in management.

5.5.6 PRO-6: Protection and Recovery of the Mariana Common Moorhen

Issue: The Mariana common moorhen is federally endangered throughout its range in the Mariana Islands.

Objective: With respect to mission requirements, continue to assist the USFWS, GNWR, and GDAWR in achieving Mariana common moorhen recovery goals by managing wetland habitats on JRM lands to be favorable for the Mariana common moorhen,

Strategies:

1. Conduct quarterly surveys for Mariana common moorhen on JRM sites per guidelines contained within the JRM species management SOP. Areas to be surveyed include wetlands, tributaries, reservoirs, and other suitable habitat for the Mariana common moorhen. Survey methodology will be coordinated with USFWS to ensure consistency with accepted protocols. [Requirement from BO]
2. Conduct a Mariana common moorhen habitat use study of JRM wetlands to include as many wetlands as possible. The study should include both wet and dry season observations.
3. Conduct a feasibility study for improvement of wetlands for Mariana common moorhen habitat. The study should include recommendations for predator control and habitat improvements. Implementation will be done as per study recommendations.
4. Continue to maintain a standardized, up-to-date inventory and GIS map of Mariana common moorhen including historic distribution, current distribution, numbers of individuals, nesting sites or breeding locations, maps of important habitat, and other status information useful for long-term management.
5. Develop a restoration plan for the Camp Covington wetlands (or alternatively identified wetlands) with the objective for increasing suitable habitat for the Mariana common moorhen. [Requirement from BO]
6. As per discussions with USFWS and COMPACFLT, moorhen monitoring will be conducted at the Hagoi wetland on Tinian. [Requirement from BO]
7. Develop a management plan for Hagoi and other wetlands within the MLA for the benefit of Mariana moorhen and to provide additional protection for the wetland areas. [Requirement from BO]
8. Continue to implement a Mariana common moorhen habitat monitoring program for Fena Reservoir and its tributaries. Note that Fena Reservoir is a man-made reservoir that supplies GovGuam and Navy with drinking water. Steep shorelines and banks limit moorhen habit to bays, particularly to areas where invasive *Hydrilla* collected. *Tilapia* was introduced by GDAWR to control *Hydrilla* in 1955. Loss of *Hydrilla* is believed to be the result of combination of a utrophication event from Typhoon Tingting and high numbers of *Tilapia* that have not allowed *Hydrilla* to re-establish. *Phragmites* is restricted to the dam area at Fena Reservoir.
9. Conduct a survey for the common snapping turtle in Fena Reservoir to determine if control or eradication is needed to protect bird habitat within the reservoir and its surrounding wetlands.
10. Enhance nesting habitat for nesting Mariana common moorhen by constructing and deploying floating nesting platforms to Fena Reservoir and other appropriate wetland areas. Consult with L. Takano (USFWS) on construction and placement of platforms at Fena, based on her previous study.
11. Implement strategies prescribed in the JRM Ungulate Management Plans (see **Appendices L** and **M)** to eradicate or reduce ungulate numbers to levels that will allow natural wetlands to function properly. This is necessary to maintain adequate foraging and nesting resources for the Mariana common moorhen.

12. Review the status of actions prescribed under PRO-6 at the annual JRM INRMP review meeting. Initiate actions based on the review to ensure that actions are, or will be, implemented as prescribed pending available funding.

Monitoring Criteria: Continue to coordinate with the USFWS, GNWR, GDAWR, and CNMI Division of Fish and Wildlife for meeting Mariana common moorhen recovery objectives without compromising the mission. JRM should also conduct species population number trend analysis to monitor species recovery and stability, to determine if recovery efforts are effective and to identify any necessary changes in management.

5.5.7 PRO-7: Protection and Recovery of the Micronesian Megapode

Issue: The Micronesian megapode is a federally endangered species that is resident on FDM and a rare visitor to Tinian leased lands.

Objective: With respect to mission requirements, continue to assist the USFWS in achieving Micronesian megapode recovery goals by (1) enhancing megapode habitat on Tinian, (2) preventing importation of brown treesnakes from Guam, and (3) controlling introduced predators.

Strategies:

1. Underplant nonnative *Leucaena leucocephala* (tangantangan) forests with native tree and shrub species to increase megapode habitat on Tinian leased lands.
2. Continue to implement brown treesnake interdiction measures on Guam. [Requirement from BO]
3. Investigate methods and implement control of introduced predators on Tinian leased lands.
4. Continue to monitor Micronesian megapodes on Tinian leased lands. Regular monitoring will help conservation managers detect if megapodes become resident on Tinian leased lands or remain uncommon visitors. Compile findings in an annual report. [Requirement from BO]
5. Continue to monitor on FDM every 5 years and increase survey area if possible to include enlarged unexploded ordnance (UXO) cleared areas. [Requirement from BO]
6. When UXO cleared areas on FDM are sufficiently large to capture megapodes, conduct banding and satellite telemetry studies to track movements of individual birds and to track site fidelity and inter-island movements.

Monitoring Criteria: Continue to coordinate with the USFWS and CNMI DLNR in meeting Micronesian megapode recovery objectives without compromising the mission.

5.5.8 PRO-8: Protection and Recovery of Marine Mammals

Issue: There are many threatened and endangered marine mammals in Guam, Tinian, and FDM waters.

Objective: With respect to mission requirements, continue to assist the NMFS in achieving marine mammal recovery goals by (1) determining the diversity and distribution of marine mammals in JRM submerged lands, and (2) assessing the potential for mission activities to affect marine mammal populations in JRM submerged lands.

Strategies:

1. Work closely with the NMFS Pacific Islands Regional Office, Marine Mammal Stranding Coordinator to implement the management strategy to respond to beached and stranded marine mammals at all JRM submerged land shorelines.
2. Educate personnel about the status of marine mammals and sea turtles in the Marianas, through in-shop briefs; required training for use of Morale, Welfare and Recreation (MWR) marine recreational facilities; and through signage at MWR beaches, marinas, and boat ramps.

Monitoring Criteria: Continue to coordinate with the NMFS, GDAWR, and CNMI DLNR for meeting marine mammal recovery objectives without compromising the mission.

5.5.9 PRO-9: Protection and Recovery of Sea Turtles

Issue: The green sea turtle is threatened and the hawksbill is endangered. Green sea turtles and hawksbill sea turtles have been known to nest on Andersen AFB and NBG including Tinian; both species also use marine habitats on Navy submerged lands around Guam, Tinian and FDM.

Objective: With respect to mission requirements, continue to assist the USFWS, NMFS, GNWR, GDAWR, and CNMI DLNR in achieving threatened and endangered sea turtle recovery goals.

Implement the *Sea Turtle Management Plan* recently developed for the coastal areas of the Tarague Basin on Andersen AFB (see **Appendix O**), and continue to implement the SOP developed by the Navy to monitor sea turtle activity on nesting habitat on JRM lands.

Coordinate with other agencies (e.g., NMFS and USFWS) to obtain permits for managing sea turtles.

All strategies described as follows for Andersen AFB will be developed and implemented in coordination with the AMT, which includes USFWS Ecological Services, GNWR, GDAWR, and CNMI DLNR.

Strategies:

1. Conduct studies including in-water surveys to determine sea turtle distribution and habitat use in the area including Apra Harbor, Sasa Bay, OPERA, HERA, Dadi Beach, and Tipalao Bay. Continue to support research on the ecology of green and hawksbill sea turtles and conduct studies to identify migration patterns and nesting trends of hawksbill and green sea turtles in the JRM area including Tinian. Continue studies of turtle grass beds at Dadi Beach.
2. Prevent or minimize, to the extent possible, potential lighting impacts on sea turtles at Tarague, Scout, Sirena, Sirena Beach, Spanish Steps, HERA, and Sumay Cove. To the maximum extent practical, hooded and night-adapted lights will be used where lights illuminate beaches, beach roads, and parking areas. [Requirement from BO]
3. Update the Green Sea Turtle Management Plan.
    a. Submit a request for funding to update the plan during FY 2013. Incorporate November 1, 2012, USFWS comments on the August 2, 2012, JRM INRMP regarding the 2008 Green Sea Turtle Management Plan.
    b. Initiate the development of the plan update in FY 2016.
    c. Submit a draft of the updated plan for agency review FY 2016.

   d. Once agency comments have been received and incorporated, finalize the plan (FY 2016).

4. Conduct a predator study to determine if sea turtle populations are impacted by activities of feral cats or dogs, brown treesnakes, feral pigs, rats, or monitor lizards on JRM sites. Based on study results, develop and implement a plan to reduce the impact of predation by these species on nesting beaches managed by JRM.
5. Continue to monitor for sea turtle nesting activity on JRM beaches following guidelines in the Sea Turtle Monitoring SOP.
6. Increase the monitoring program to nightly patrols during peak nesting seasons, or during expected hatchling emergence.
7. Provide annual training for patrolling security personnel, lifeguards at Tarague Beach, and others who could encounter sea turtles or their tracks.
8. Establish an annual meeting with USFWS, NMFS, GNWR, GDAWR, and CNMI DLNR to address turtle conservation.
9. Prevent vehicle usage on beaches.
10. Enhance turtle nesting habitat on JRM lands through removal of nonnative invasive plants, replacing nonnative species with native species, controlling predators, and conducting beach cleanup to remove plastic and wood debris.
11. Assess the condition of sea turtle habitat at the Pati Point Marine Preserve and the suitability of that habitat for nesting sea turtles.
12. Develop a public education and awareness program to educate installation personnel, dependents, and the public about natural and cultural resources on JRM sites. This program would provide detailed information about protected species, such as sea turtles and marine mammals, and sensitive habitats, such as coral reefs. This would include developing outreach material for JRM and public distribution concerning the importance of natural resources and include applicable Federal and local laws and regulations.
13. Conduct quarterly overflight turtle surveys in the nearshore waters around FDM. [Requirement from BO]
14. Conduct sea turtle surveys on Tinian beaches in coordination with USFWS and CNMI DLNR. [Requirement from BO]
15. Support the development of, and cooperation with, volunteer groups that are dedicated to habitat restoration (beach and stream cleanups and replacement of nonnative vegetation), data gathering for protected species, and other support of NAVFACMAR Environmental programs.
16. Review the status of actions prescribed under PRO-9 at the annual INRMP review meeting. Initiate actions based on the review to ensure that actions are, or will be, implemented as prescribed pending available funding.
17. Coordinate with Coast Guard by reporting oil spills and notify them of oil found on beaches.

Monitoring Criteria: Continue to monitor for sea turtles and their habitats on JRM. Continue to coordinate with the USFWS, NMFS, GNWR, GDAWR, and CNMI DLNR in meeting sea turtle recovery objectives without compromising the mission.

5.5.10 PRO-10: Protection and Recovery of *Serianthes nelsonii*

Issue: *Serianthes nelsonii* is federally endangered throughout its range in the Mariana Islands.

Objective: With respect to mission requirements, continue to assist the USFWS, GNWR, GDAWR, UOG, and the Guam Department of Agriculture Division of Forestry and Soil Resources in achieving *Serianthes nelsonii* recovery goals on Guam, including Andersen AFB and NBG to (1) downgrade the species to threatened status, and (2) achieve full recovery of the species in perpetuity.

Support goals to (1) establish at least three wild populations each consisting of 25 reproducing individuals, (2) protect habitat needed for reintroductions and expansion of these populations, and (3) partner with groups such as GNWR and the UOG Guam Plant Extinction Group for work on *Serianthes* to establish and manage outplantings.

All strategies described as follows for JRM will be developed and implemented in coordination with the AMT, which includes USFWS Ecological Services, GNWR, and GDAWR.

Strategies:

1. Define and develop strategies for management of *Serianthes nelsonii* considering long-term ecosystem management goals to enhance the restoration of native habitat over a long-term, and implement strategies once developed. Develop a timeframe to meet short-term and long-term management goals. Evaluate the effectiveness of the protection and recovery strategies for *Serianthes* on Guam.
2. Continue to manage existing limestone forest on JRM, including prevention of fires. Continue to control and remove invasive plants according to prescriptions identified in the long-term ecosystem management section.
3. Repair, maintain, and upgrade all ungulate exclosure fences around *Serianthes nelsonii* individuals. Develop and implement a monitoring protocol for maintaining ungulate exclosure fencing. Monitoring should occur at least two to three times per year. Regular checks of all known trees and exclosures should be made as soon as possible after typhoons.
4. Develop and implement a program to monitor individuals of *Serianthes nelsonii*. The program should include monitoring health of individual trees and addressing any damage.
5. Seeds should be collected at least on an annual basis and used for propagation or research.
6. Continue to manage additional key threats to the species by supporting the control of nonnative competitors or predators and preventing the release of additional noxious exotic species.
7. Encourage, support, and facilitate ecological research by Federal, Territory, and Universities for *Serianthes nelsonii* studies including pollination, seed dispersal, seed, leaf and flower predators, invasive insects, propagation methods, microclimate, soil and sunlight requirements, seed storage methods, and other life history and management approaches.
8. Implement long-term ecosystem management discussed in **Section 5.3**, which includes native habitat restoration over a long-term.
9. Consult with the Guam Department of Agriculture Division of Forestry and Soil Resources, Guam Plant Extinction Prevention Program, and GNWR on propagation techniques, nursery support, and outplanting. Develop an outplanting program for *Serianthes nelsonii* with appropriate monitoring and maintenance protocols. Coordinate with USFWS, Guam Plant Extinction Prevention Program, GNWR, GDAWR, and CNMI DLNR to determine appropriate

seed source, and where best to employ outplanting programs on JRM sites. Seed from the Guam tree is preferable, but seed from Rota sources may be used.

10. Review the status of actions prescribed under PRO-10 at the annual INRMP review meeting. Initiate actions based on the review to ensure that actions are, or will be, implemented as prescribed pending available funding.

Monitoring Criteria: Continue to observe the known tree for health and viability to ensure the effectiveness of replanting nursery cultivated individuals, and to ensure that recovery objectives are being met. Provide support for and partner with the Guam Plant Extinction Prevention Program to monitor wild and outplanted populations in managed wild sites. Continue to coordinate with the USFWS, GNWR, GDAWR, the Guam Department of Agriculture Division of Forestry and Soil Resources, and the CNMI Forestry Division in meeting *Serianthes nelsonii* recovery objectives without compromising the mission.

5.5.11 PRO-11: Protection of Candidate, Locally Rare, GovGuam and CNMI-Listed Species

Issue: A variety of locally rare, GovGuam or CNMI-listed plant and animal species occur or have the potential to occur on JRM lands, including Guam and CNMI listed species, and candidate species including Pacific sheath-tailed bat, Mariana eight-spot butterfly, Mariana wandering butterfly, Guam tree snail, humped tree snail, and fragile tree snail. Additional species will be considered for listing under the ESA, or their status will be revised (i.e., status changed from threatened to endangered, status downgraded from endangered to threatened, or species is delisted).

Objective: With respect to mission requirements, continue to assist USFWS, GDAWR, GNWR, and CNMI DLNR in the study and protection of other locally rare or listed plant and animal species. To enhance and manage habitats on JRM lands to be favorable for native species, implement the strategies in **Section 5.3.**

All strategies described for Andersen AFB will be developed and implemented in coordination with the AMT, which includes USFWS Ecological Services, GNWR, and GDAWR.

Strategies:

1. Continue to coordinate with USFWS, GDAWR, GNWR, and CNMI DLNR and other agencies studying the ecology of candidate species, locally rare or locally listed species. Support the development of new control methods against key threats especially the brown treesnake.
2. Design and conduct candidate snail surveys in the Tinian MLA.
3. Develop management plan for candidate land snails and butterfly species.
4. Continue to monitor known colonies of candidate snails.
5. Conduct surveys for the moth skink and Pacific slender-toed gecko on DOD lands. [Requirement from BO]
6. Design and conduct density surveys of the Tinian Monarch in the MLA.
7. Conduct a study to determine population size and locations of the Micronesian starling on JRM managed lands. Enhance nesting opportunities for the Micronesian starling by placing nest boxes on JRM managed lands. Begin pilot translocations of starlings from Andersen AFB to other suitable locations on Guam such as GNWR, NMS, and other locations on NBG.
8. Enforce NBG and Andersen AFB closure of coconut crab harvesting.

9. Propagate butterfly larvae and host plants for release and planting in the wild. Continue to monitor candidate butterfly species and develop management strategies based on monitoring.
10. Conduct studies that assess the impacts of parasitoids on the Mariana eight-spot butterfly. Based on study results, develop methods for control of parasitoids, and evaluate the effectiveness of these control measures. Coordinate with USFWS and UOG to include captive propagation of candidate butterflies to help supplement populations.
11. If species that were presumed to be extirpated are discovered, develop strategies to manage species and their habitat.
12. Continue to maintain a standardized, up-to-date inventory and GIS map of Federal, GovGuam, and CNMI DLNR listed species. Develop long-term forest management plans as described in **Section 5.3** and implement the plans in cooperation with the USFWS, GDAWR, GNWR, and CNMI DLNR.
13. Once the USFWS determines which species will be included in the proposed rules to list and designate critical habitat for seven candidate species in the Mariana Archipelago, JRM will develop a supplemental document for inclusion in the JRM INRMP for those species with the potential to be on Navy lands. The supplemental document will also include information on the known status of each species and will identify projects to be undertaken on JRM to manage the long-term conservation of the species.
14. Review the status of actions prescribed under PRO-12 at the annual INRMP review meeting. Initiate actions based on the review to ensure that actions are, or will be, implemented as prescribed, pending available funding.

Monitoring Criteria: Continue to monitor the wild populations for health and viability, to ensure the effectiveness of replanting nursery-cultivated or captive-bred individuals, and ensure that recovery objectives are being met.

5.5.12 PRO-12: Protection and Recovery of *Tabernaemontana rotensis*

Issue: *Tabernaemontana rotensis* is a locally rare species on Guam. The *2007 Survey of Tabernaemontana rotensis on Andersen AFB* conducted by the UOG suggests a widely distributed population of 21,669 individuals (UOG 2007). The population is healthy, reproductively viable, and resilient with a robust structure represented by mature, young reproductive, juvenile, and seedling recruits. At this time, the population structure is not a conservation concern. However, spatial distribution is a major concern since many individuals were found growing in close proximity on only 265 sites throughout the installation. The aggregated pattern increases the vulnerability of the population and is exacerbated by the fact that almost all of the *Tabernaemontana* trees on Andersen AFB are located on sites with less than 15 percent slope. This is terrain that is also suitable for human development (UOG 2007).

Objective: Continue to assist UOG, GDAWR, GNWR, the Guam Department of Agriculture Division of Forestry and Soil Resources, and the CNMI Forestry Division in the study and protection of the locally rare *Tabernaemontana rotensis*, and to protect its habitat.

All strategies described as follows for Andersen AFB will be developed and implemented in coordination with the AMT, which includes USFWS Ecological Services, GNWR, and GDAWR.

Strategies:

1. Continue to monitor health, reproduction, growth, recruitment of new plants, and maintain a database of existing plants.
2. Develop and implement a project to grow and outplant *T. rotensis* into fenced areas on Andersen AFB. Propagate, out-plant, and manage plantings for 2 years. [Requirement from BO]
3. Continue to support research on the ecology of the species, the impacts of key threats to the species, and the development of new control methods against key threats. Implement prescriptions identified in long-term ecosystem management section (**Section 5.3**).
4. Continue to manage existing limestone forests on JRM lands to benefit *T. rotensis*.
5. Continue to manage the primary key threats to the species by implementing long-term ecosystem management discussed in **Section 5.3**, which includes native habitat restoration over a long-term.
6. Review the status of actions prescribed under PRO-11 at the annual INRMP review meeting. Initiate actions based on the review to ensure that actions are, or will be, implemented as prescribed pending available funding.

Monitoring Criteria: Continue to observe *T. rotensis* plants for health and viability to ensure the effectiveness of replanting nursery cultivated individuals. Continue to coordinate with the USFWS, GNWR, GDAWR, the Guam Department of Agriculture Division of Forestry and Soil Resources, and the CNMI Forestry Division in meeting *T. rotensis* recovery objectives without compromising the mission.

5.5.13 PRO-13: Sensitive Species Habitat Protection

Issue: Sensitive species and their habitats might be significantly impacted as a result of JRM site activities (e.g., grounds maintenance activities or construction).

Objective: Protocols must be established and BMPs implemented to mitigate future potential impacts on sensitive species and their associated habitats. Minimize the potential for adverse effects on special status species and their associated ecosystems while protecting the operational functionality of the installation mission by using an ecosystem-based management approach. Note: Special status species include any species which is listed, or proposed for listing, as threatened or endangered by the USFWS or NMFS under the provisions of the ESA; any species designated by the USFWS as a candidate, sensitive or species of concern, and any species which is listed by a State or Territory in a category implying potential danger of extinction.

All strategies described as follows for Andersen AFB will be developed and implemented in coordination with the AMT, which includes USFWS Ecological Services, GNWR, and GDAWR.

Strategies:

1. Initiate habitat improvement projects to conserve biodiversity and protect plant and animal habitats, as funding is available and when such projects will not adversely affect the military mission (e.g., invasive species removal).
2. Develop and implement a program to remove or control nonnative invasive species and to reestablish native vegetation in habitats that are important to threatened and endangered species (e.g., habitats destroyed by ungulates at Tarague Basin and Pati Point). Ensure that all plants are inspected at the source to ensure pest-free status (e.g., little fire ants, weeds/seeds, vertebrates, arthropods, and diseases/pathogens). Treatments of plants containing or suspected of containing

pests will be conducted in accordance with current control technologies for the target pest. Develop and implement BMPs to prevent invasive species introductions as a result of planting native vegetation.

3. Implement erosion-control BMPs to ensure adverse environmental impacts on sensitive species habitat do not occur.
4. Minimize vegetation removal and preserve emerging trees (e.g., Yoga, Dukduk, or Faia), where possible, during construction.
5. Use native species for all revegetation projects on the GNWR Overlay lands.
6. A plan for native forest habitat restoration will be developed as part of the long-term ecosystem management plan and implemented for JRM managed lands on Guam in cooperation with the USFWS, GNWR, and GDAWR. This plan will benefit Mariana crow, Mariana fruit bat, Micronesian kingfisher, Guam rail, and *Serianthes nelsonii* habitat, as well as candidate, locally rare, GovGuam and CNMI-Listed species.
7. Develop a native forest habitat restoration plan for the Tinian Monarch mitigation area, in the Tinian MLA, in cooperation with the USFWS and CNMI DLNR
8. Annually review the natural resources management program to ensure that management actions do not adversely impact habitat for species of concern.
9. Maintain accurate, usable, and informative GIS data for use in management planning and documentation.

Monitoring Criteria: Continue monitoring species and their habitat as described in this INRMP and adapt monitoring and management actions as needed. Use monitoring information and other information to guide adaptive management. Continue to coordinate with the USFWS, NMFS, GNWR, CNMI DLNR, and GDAWR to protect sensitive species habitat without compromising the mission.

5.5.14 PRO-14: Current Training Activities Could Impact Sensitive Species

Issue: JRM activities could impact sensitive species including

1. Sensitive marine species as part of training and research, development, testing, and evaluation activities within the MIRC.
2. Federal- and Guam-listed species resulting from construction and operation activities associated with the relocation of U.S. Marine Corps from Okinawa, Japan, to Guam.

Objective: Host, tenant, and transient training requirements should be evaluated to assess their impacts on sensitive species and their habitats.

All strategies described as follows for Andersen AFB will be developed and implemented in coordination with the AMT, which includes USFWS Ecological Services, GNWR, and GDAWR.

Strategies:

1. Training strategies will be consistent with the MIRC and updates.
2. Personnel who participate in, or are responsible for, conducting planning and training activities, should receive a brief outlining natural resources concerns, and be provided with maps illustrating sensitive habitat areas. During the planning process, direction will be provided to restore damage to areas used for training or bivouacking (i.e., creation of ruts, removal of trees, damage to

grassland areas) especially if training occurs in a location that is, or was restored or enhanced by a JRM project.

3. Evaluate and make recommendations on rotating training areas to minimize the impacts on any one site.
4. Place vicinity markers (e.g., Siebert stakes) around threatened and endangered species habitat to delineate no entry (training) areas in sensitive habitats (e.g., near the Mariana swiftlet caves on the NMS).
5. Use GIS to maintain a standardized, up-to-date inventory of threatened and endangered species and their habitat, and facilitate coordination between JRM personnel and natural resources personnel for long-term management.
6. Develop marine benthic habitat maps for all DOD submerged lands and use these maps as guidance for managing DOD activities and for avoiding and minimizing impacts on sensitive marine habitats and resources.

Monitoring Criteria: Training activities should continue to be monitored for impacts on threatened and endangered species, sensitive species, and species habitat.

5.6 Wetlands and Waters of the United States Management

USACE defines wetlands as "those areas that are inundated or saturated with ground or surface water at a frequency and duration sufficient to support, and that under normal circumstances do support, a prevalence of vegetation typically adapted to life in saturated soil conditions. Wetlands generally include swamps, marshes, bogs, and similar areas" (33 CFR Part 328). Wetlands are an important natural system because of the diverse biological and hydrologic functions they perform. These functions can include water quality improvement, groundwater recharge, pollution treatment, nutrient cycling, provision of wildlife habitat and niches for unique flora and fauna, storm water storage, and erosion protection.

Wetlands are protected under EO 11990 - *Protection of Wetlands* (*43 Federal Register 6030),* the purpose of which is to reduce adverse impacts associated with the destruction or modification of wetlands. According to OPNAVINST 5090.1C CH-1, the Navy will comply with the national goal of no net loss of wetlands, and will avoid loss of size, function, and value of wetlands.

The following goals and those summarized in **Table 5-6** apply to coastal water resources and any nontidal wetlands that occur on, or might be identified on, JRM sites in the future. The major goal in wetland management is to minimize the impact that JRM missions have on wetlands and coastal waters. To minimize impacts on wetlands, JRM natural resources staff strive to maintain healthy, functional wetlands and coastal waters that can sustain minor operational influences outside direct infringement of the resources. To achieve these goals it is necessary to have an accurate and complete understanding of the extent of these habitats on the JRM sites. It is also the goal to maximize native floral diversity of wetland communities which, in turn, maximizes the faunal diversity of the ecosystem. Through achieving these goals, JRM can manage for no net loss of wetland acreage, functions, and values. The goals for wetland management are summarized in **Table 5-6**.

Table 5-6. Summary of Wetlands and Waters of the United States Management Goals

Wetlands and Waters of the United States Management Goals
• Remain in compliance with USACE and GovGuam wetlands regulations. • Minimize the operational impact of JRM missions on wetlands, floodplains and coastal waters. • Maximize native floral and faunal diversity of wetland and floodplain communities in the ecosystem. • Manage for no net loss of wetland functions and values. • Ensure that mapping of wetlands and other waters of the United States is conducted based on the 1987 USACE Wetlands Delineation Manual and the 2010 Draft Interim Regional Supplement to the USACE Wetland Delineation Manual: Hawaii and Pacific Islands Region, and is accurate and consistent across JRM sites.

The major goal in wetland and floodplain management is to minimize the impact that JRM has on wetlands and floodplains. When possible, it is the goal to enhance wetland functions to create wetlands that maximize the values that wetlands have within the ecosystem and to society (e.g., floodwater retention, water quality protection).

5.6.1 WT-1: Wetlands and Waters of the United States

Issue: Some surface waters and wetlands have the potential to be impacted due to a lack of a current understanding of the extent of these habitats on JRM sites. Some potential wetlands and other waters of the United States have not been evaluated and mapped and others that were previously mapped need to be reevaluated. A current understanding of the condition and extent of these habitats is necessary to develop management goals and strategies to protect, manage, and, where feasible, enhance these habitats.

Objective: Identify and characterize all wetlands within the boundaries of JRM lands according to National Wetlands Inventory standards. Consult with Region 1, USFWS, National Wetlands Inventory coordinator on status of mapping for the region and potential to update the inventory maps with basic functional assessments. Maintain healthy, functional wetlands that can sustain minor operational influences and minor, inadvertent encroachments, and manage to enhance their habitat functions where feasible.

Strategies:

1. Conduct characterization and assessments of the current conditions of wetlands and other waters on the JRM sites and evaluate potential for water quality and habitat enhancement.
2. Plan development and training activities to avoid wetland impacts to the maximum extent possible and mitigate unavoidable impacts on wetland functions.
3. Delineate wetlands as needed on JRM lands including the military leased area on Tinian, based on USACE standards.
4. Coordinate with appropriate agencies (e.g., USACE, GDAWR, and CNMI DLNR) as necessary.
5. Remain in compliance with the CWA, EO 11988 (floodplain protection), and EO 11990 (wetland protection). Implement procedures to manage for a no net loss of wetland and floodplain acreage, functions, and values.
6. Reduce habitat fragmentation and control the spread of invasive species per guidelines contained within the OPERA, HERA, and JRM.

7. Implement guidelines within the JRM NBG Ungulate Management Plan to control feral ungulate populations around wetlands and riparian areas.
8. Develop and implement a program to manage *Tilapia,* and other non-native species including soft shell turtles and snapping turtles, if determined to be present, in Fena Reservoir.
9. Periodically review the natural resources management program to ensure that management strategies do not adversely impact wetlands. Address impacts or degradation of wetlands habitats that result from management strategies or operations, and remediate, restore and enhance protection accordingly.
10. Develop and implement erosion-control BMPs for all operations and development activities as needed to prevent sedimentation and water quality degradation of any wetlands or waters.
11. Conduct a feasibility study for improvement of wetlands for Mariana common moorhen habitat. The study should include recommendations for predator control and habitat improvements for Mariana common moorhen.
12. Establish water-monitoring stations with devices to measure storm water runoff velocity and quantity, turbidity, and other parameters.
13. Update GIS to include an accurate and consistent layer of wetlands and other waters of the United States occurring on JRM lands.
14. Maintain accurate, usable, and informative GIS data for ease in management planning and documentation.

5.6.2 WT-2: Stream Stability

Issue: The streams on Guam are heavily impacted by ungulates, which have reduced overall habitat and stream quality. Military activities, such as construction, can also result in stream destabilization.

Objective: Identify and develop measures to reduce impacts on streams resulting from ungulates or military activities.

Strategies:

1. Conduct surveys of rivers and streams within the JRM sites to establish baseline data from which the impacts of ungulates and training could be established.
2. Develop actions specific to each unstable river or stream reach that can be undertaken to assist with stream recovery. Support stream stability by managing activities that affect riparian buffers and water entering streams.
3. Assess the status and condition of riparian ecosystems and adjacent local drainages within the Fena Watershed to determine small-scale and large-scale processes that influence the water shed integrity. Results from this assessment aligned with a baseline assessment (conducted in 2001) will provide a measure of cumulative impacts applicable for large-scale planning efforts (Special Area Management Plans) to compare various "project alternatives" through a simulation of the potential impacts. The assessment will also support development of a restoration plan for riparian ecosystems in the watershed designed to reduce maintenance and general operational costs for the Fena Water Treatment Plant. [Requirement from BO]
4. Maintain accurate, usable, and informative GIS data for ease in management planning and documentation.

5.7 Fish and Wildlife Resources Management

Management of fish and wildlife species on JRM is primarily accomplished by managing habitats, and monitoring species numbers. Projects to manage wildlife habitat include invasive plant control, protecting wetlands, and conducting species surveys.

Habitat loss has a direct correlation to a decline or loss of fish and wildlife. The JRM INRMP is meant to be used as a tool in operational, training, and construction planning endeavors to minimize or prevent loss of habitat. The following management criteria will ensure that JRM provides wise stewardship ethics in managing their fish and wildlife resources.

Program and Project Review. The JRM Conservation Program Manager, NAVFACMAR and installation natural resources specialists, and the Environmental Flight Chief are part of the team that reviews all proposed projects, operations, and training plans for possible impacts on habitat and fish and wildlife at respective JRM sites. If impacts on habitat or fish and wildlife are identified, recommendations are provided so that changes or mitigation can be considered early in the planning process.

Habitat Inspections. JRM site natural resources managers periodically inspect various habitats for unauthorized encroachment or impacts, and stay familiar with fish and wildlife use of these areas. These natural resources managers have the ability to elevate concerns about habitat impacts on JRM sites to their respective COs.

Habitat Management – Developed Areas. The following items will enhance wildlife habitat:

- *Use native vegetation for landscaping around buildings.* Native vegetation is well-suited to local conditions and will require less maintenance to keep healthy. Native vegetation provides better wildlife habitat than exotic, nonnative plants and trees.
- *Inspect plants* at source to ensure pest-free status or apply a pre-treatment pesticide before planting.
- *Reduce pesticide/herbicide/fertilizer use.* Reducing the use of chemicals will help protect surface and groundwater quality on JRM sites.

For the purposes of this INRMP, wildlife management is defined as manipulation of the environment and wildlife populations to produce desired objectives. The primary goal of wildlife management at JRM is to maintain populations at levels compatible with land use objectives while promoting the existence, importance, and benefits of nongame species.

The basis of managing a rich assemblage of nongame wildlife is to provide a mosaic of habitats that are structurally and biologically diverse. In managing for a diversity of habitats and diversity within those habitats, the potential exists for numerous species to be found. JRM should employ these basic techniques for managing wildlife.

Monitoring Wildlife. The information obtained through monitoring can be analyzed to detect any long-term changes in population size or structure. Creating, monitoring, and updating GIS data on wildlife species will allow JRM sites to store, retrieve, present, and analyze the data to make informed management decisions.

Protecting Sensitive Areas. JRM should maintain biological diversity by protecting, to the extent practical, sensitive areas that provide unique habitat niches including the OPERA, HERA, and the

GNWR. Protection measures might include restricting vehicle movement, and protecting habitats of exceptional biological value by establishing protective buffers and maintaining healthy and diverse ecosystems.

PCBs, dioxin, metals and pesticides continue to contaminate fish above human health action levels at the Orote Point ERA. The source is unknown but fractured limestone formations allow tidally influenced groundwater contamination. This contamination is monitored and addressed under the IRP program.

Opportunities for the management of fish and wildlife species on JRM sites are primarily accomplished by managing habitats and sensitive areas (e.g., OPERA, HERA and GNWR). JRM site natural resources personnel coordinate with USFWS, GNWR, GDAWR, and CNMI DLNR to identify, prioritize, and implement habitat enhancement projects targeted for particular species (e.g., Mariana fruit bat) or groups of species. Projects to manage wildlife habitat include invasive plant control, enhancing and protecting wetlands, and conducting surveys.

Table 5-7 presents a summary of the wildlife and fisheries management goals for JRM.

Table 5-7. Summary of Wildlife and Fisheries Management Goals

Wildlife and Fisheries Management Goals
• Manage based on an ecosystem management approach, rather than from a single-species paradigm. • Employ a systematic approach to managing fish and wildlife resources, using a process that includes inventory, monitoring, modeling, management, and assessment. • Minimize fish and wildlife-related health risks, safety risks, and environmental damage. • Restore and maintain a diversity of fish and wildlife in areas on JRM sites where there will be no conflict with the military mission. • Continue to remain in compliance with Federal, territorial, CNMI and local laws and regulations governing fish and wildlife. • Maintain and develop partnerships with agencies and groups involved in fish and wildlife management.

The recognition of these goals has led to the identification of a variety of management issues. A series of management objectives and specific management strategies and the appropriate monitoring criteria have also been developed that address management issues and their associated goals. The management issues and their related actions for adaptive fish and wildlife management are presented as follows.

5.7.1 FWM-1: Wildlife Management

Issue: Native marine and terrestrial ecosystems on Guam, Tinian, and FDM have been substantially impacted by introduced nonnative predators, human disturbance, and invasive plant species resulting in many of the native fauna and flora becoming endangered, threatened, and extirpated.

Objective: Employ a systematic approach to managing wildlife resources, using a process that includes inventory, monitoring, modeling, management, assessment, and evaluation.

All strategies described as follows for Andersen AFB will be developed and implemented in coordination with the AMT, which includes USFWS Ecological Services, GNWR, and GDAWR.

Strategies:

1. Survey Fena Reservoir and tributaries for long-term trend analysis of the lake ecosystem to facilitate management of water resources used for potable water and habitat which supports native species.
2. Ensure that natural resources staff responsible for wildlife management and conservation obtain annual focused training regarding management of these resources as related to conservation on a military installation.
3. Continue to determine occurrence, relative abundance, and distribution of native plants and animals including migratory birds, reptiles, land crabs, land and tree snails, rare plants, and marine species. Record species sightings and ensure data are entered into the GIS database.
4. Periodically review the monitoring program, discussed in Strategy 3, to ensure it still meets ecosystem management goals.
5. Conduct a study to determine if Mariana tree snail habitat is present on Tinian. Based on survey results, develop and implement BMPs for the snail.
6. Develop and implement a project to estimate the abundance and distribution of reptiles and amphibians on JRM sites. Several introduced species of reptiles and amphibians have become established on JRM. Through predation and competitive exclusion these invasive species have adversely impacted native reptiles, birds, and other species. Identifying the abundance and distribution of native and nonnative herpetofauna will provide information to direct management and conservation efforts on JRM. Survey for and monitor herpetofauna populations using guidelines recommended by Partners in Amphibian and Reptile Conservation (PARC).
7. Where possible, use native species for reforestation and to control the spread of invasive plant species.
8. Continue to control harvesting of native species through the vegetation-removal permit program, or other management efforts.
9. Evaluate predator control and develop methods to reduce habitat fragmentation and improve connectivity as part of long-term ecosystem management plans.
10. Manage the HMU at Andersen AFB as a cooperative interagency site for natural resources management. [Requirement from BO]
11. Maintain and promote partnerships with agencies and groups involved in wildlife management.

Monitoring Criteria: Populations of native fish and wildlife species will be evaluated in incremental biological surveys on JRM sites. Continue to coordinate with USFWS, GNWR, GDAWR, and CNMI DLNR to ensure the meeting of wildlife management goals without compromising the mission.

5.7.2 FWM-2: Migratory Bird Management

The MBTA (16 U.S.C. 703–712) protects all migratory birds and prohibits the taking of migratory birds, their young, nests, and eggs, except as permitted by the USFWS. The protection of migratory birds is also a requirement of the Sikes Act, as amended through 2012, for developing and implementing DOD INRMPs, and a requirement within DOD Instruction 4715.03 and OPNAVINST 5090.1C CH-1 for natural resources management. The USFWS recommends that JRM avoid impacting birds protected under the MBTA by conducting regular surveys for migratory birds on JRM sites.

The MBTA implements various treaties and conventions between the United States, Canada, Japan, Mexico, and the former Soviet Union for the protection of migratory birds. Under the Act, taking, killing, or possessing migratory birds is unlawful.

Prohibited Acts. Unless permitted by regulations, the Act provides that it is unlawful to pursue, hunt, take, capture, or kill; attempt to take, capture, or kill; possess, offer to or sell, barter, purchase, deliver, or cause to be shipped, exported, imported, transported, carried or receive any migratory bird, part, nest, egg or product, manufactured or not.

Managing for Migratory Birds. The MBTA provides for a year-round closed season for nongame birds and prohibits the taking of migratory birds, nests, and eggs, except as permitted by the USFWS. Impacts on birds protected under the MBTA will be avoided through surveying for nesting birds in areas proposed for disturbance and, if necessary, waiting until the nesting and fledging process is complete. Alternatively, the USFWS recommends that conducting activities outside of nesting areas or outside of the general migratory bird-nesting season can help avoid direct impacts; in the case of Guam outside of the breeding season, or when most migrants occur on the island.

On March 15, 2005, the USFWS published in the Federal Register (FR 70[49]: 12710–12716) a final list of the bird species to which the MBTA does not apply because they are not native to the United States, or its territories, and have been introduced by humans everywhere they occur in the nation. The list is required by the Migratory Bird Treaty Reform Act of 2004. The actual list of migratory birds protected by the MBTA is published in the CFR (Title 50, Part 10.13). When it became law in 2004, the Reform Act excluded any species from protection that is not specifically included on the Title 50, Part 10 list.

Section 315 of the National Defense Authorization Act for FY 2003 (P.L. 107-314) directed the Secretary of the Interior to develop regulations for issuing permits for the "incidental takings" of migratory birds during military training exercises, and provided an interim exemption from the MBTA while these regulations were drafted (CRS 2007). A U.S. district court had ruled that Federal agencies, including DOD, are required to obtain permits for incidental takings. DOD had argued that an exemption was needed to prevent the delay of training activities until takings permits could be issued. In February 2007, the USFWS finalized regulations for issuing incidental takings permits to DOD. The interim exemption expired on the effective date of these regulations, March 30, 2007. DOD is now required to obtain permits for activities that could result in incidental takings (CRS 2007).

In 2008, DOD approved a new "Coordinated Bird Monitoring (CBM) Plan" designed jointly by DOD and USGS biologists and managers during the previous 3 years. The CBM Plan outlines procedures for ensuring that bird monitoring and assessment address important issues for DOD; follow accepted procedures for design, data collection, and analysis; and that the data be preserved in long-term archives. This project includes maintaining the database and developing decision support tools of special importance to DOD. The Navy is also working closely with DOD to follow the guidelines in the DOD CBM Plan. Assistance includes (1) specifying what DOD issue(s) will be addressed using the survey data, (2) how to phrase the objectives in quantitative terms, (3) design of the sampling plan for selecting survey times and places, (4) choice of the field methods, (5) preparation of the field forms, (6) formatting the data for entry into the CBM database, and (7) preparation of the metadata. USGS personnel will also be available to help with analysis as needed. The Great Basin Bird Observatory, USACE, USGS, and the American Bird Conservancy, all of whom were involved in the year two project, will continue their collaboration to provide technical assistance to DOD installations throughout the United States.

JRM supports the conservation of migratory birds that occur on Guam including the federally endangered Mariana common moorhen, Mariana swiftlet, and other non-listed migratory birds that occasionally or regularly occur on JRM lands. Some examples of ways in which JRM supports conservation of migratory

birds are through habitat conservation, restoration and enhancement. Conserving biological diversity on JRM lands within the context of its mission is an important goal as conserving native species is a crucial element of maintaining biological diversity. In this context it is in JRM's best interest to manage migratory birds through such programs as Monitoring Avian Productivity and Survivorship (MAPS) and other habitat and species management programs such as Partners in Flight.

Objective: Maintain and enhance migratory bird populations and their habitats on JRM sites.

All strategies described as follows for Andersen AFB will be developed and implemented in coordination with the AMT, which includes USFWS Ecological Services, GNWR, and GDAWR.

Strategies:

1. Identify any actions that require an MBTA permit and, if necessary, obtain the appropriate permit for intentional take of migratory birds.
2. Develop effective management for minimizing the unintentional take of migratory birds.
3. Conduct regular surveys for migratory birds on JRM lands to examine distribution and abundance; data will be used to support management of migratory birds and their habitats.
4. Once finalized, implement monitoring protocols contained within the DOD Coordinated Bird Monitoring Plan. Contribute data to the Coordinated Bird Monitoring Database.
5. Develop migratory bird-specific BMPs and ensure these BMPs are included in project plans.
6. Develop and implement a project to examine the movement of migratory birds over and around the Island of Guam during spring and fall migration periods. Most migratory birds pass over Guam and do not use the island as a wintering site or stopover site; this factor, along with the presence of nocturnal movements of flocks, would require methods such as radar to estimate the number of birds and the route of migrants accurately over and around the island. Estimating the number of birds migrating over JRM sites and identifying migratory routes over Guam will provide information to assist in identification of turbine and other sites that have potential to impact migratory birds.
7. Develop and implement a strategy to identify habitat use by migratory birds on JRM. Identifying habitats that support migrants and the variables that contribute to habitat selection will provide data that can be used for land use planning purposes, such as identifying strategies for managing grass fields and other migratory bird habitats.
8. Develop and distribute outreach and education materials on migratory birds.
9. Participate in DOD Partners in Flight Initiative.
10. Ensure feral dog and cat colonies are eliminated from JRM sites per Secretary of the Navy Instruction (SECNAVINST) 6401.1A.

5.7.3 FWM-3: Conduct a Coconut Crab Study to Determine Sustainable Population Level

Issue: JRM follows GDAWR regulations for conservation and management of coconut crabs, but further study is needed to ensure sustainable yields. In addition, nonanthropogenic threats to coconut crab numbers on JRM sites need to be determined.

All strategies described as follows for Andersen AFB will be developed and implemented in coordination with the AMT, which includes USFWS Ecological Services, GNWR, and GDAWR.

Objective: Conduct a study of sustainable levels of coconut crabs by identifying areas of suitable habitat.

Strategies:

1. A survey should be conducted to determine the presence of coconut crabs and suitable habitat on JRM lands.
2. Conduct survey of coconut crabs at Tarague Basin. Prior to survey, conduct research on carrying capacity of habitat and replacement levels. Once the survey has been completed, ensure results of the survey are included in this INRMP.
3. Research should be conducted on the carrying capacity of suitable habitat.
4. Coordinate and share research with GDAWR, CNMI DLNR and GNWR staff.

Monitoring Criteria: Monitor the number of coconut crabs. Develop a management plan for the coconut crab and implement management strategies prescribed in the plan.

5.7.4 FWM-4: Management of BASH at Andersen AFB

Bird strikes to aircraft, or bird/wildlife aircraft strike hazard (BASH; referred to as bird/animal aircraft strike hazard by Navy), are a serious safety and economic problem in the United States, annually causing millions of dollars in damage to civilian and military aircraft and occasionally loss of human life. The USAF is responsible for implementing the BASH program at Andersen AFB. The USAF actively implements a BASH Reduction Plan, thereby reducing the potential for a bird strike to occur on the airfield. Birds can be encountered at altitudes of 30,000 feet (9,144 meters) and higher. However, most birds fly close to ground level, and more than 95 percent of all reported incidents in which an aircraft has struck a bird have been below 3,000 feet (914 meters) above ground level (AGL). Approximately half of these bird strikes occur in the airfield environment, and approximately one-quarter occur during low-altitude training. Strike rates rise significantly as altitude decreases, which is partly due to the greater number of low-altitude missions, but mostly because birds are commonly active close to the ground. Any gain in altitude represents a substantially reduced threat of a bird strike (USAF 1997).

More than one-half of all bird-aircraft strikes in the US occur at or below 600 feet (183 meters) AGL during low-level flights (AFSC 2011). In addition, the majority of the total costs associated with bird-aircraft strikes result from strikes in this region of airspace. Many low-level strikes occur on low-level routes associated with airdrops and bombing runs (USAF 1997). During these flights, aircrews are involved in specific duties that leave little time to monitor bird activity. Instead, flight crews use the Low-Level Bird Avoidance Model (BAM) to understand risks associated with each particular route. Should the BAM show an unacceptable level of risk, the operation time or route is adjusted to maximize safety. Refer to the Andersen AFB BASH Reduction Plan for data specific to Andersen AFB.

Several bird species that might be present and pose a hazard to military aircraft include Pacific golden-plovers, whimbrels, yellow bitterns, cattle egrets, black drongos, Micronesian starlings, Eurasian tree sparrows, and island collard doves. Abundance of birds on JRM lands peaks during the spring and fall migration periods; abundance remains relatively high throughout the nonbreeding season (September - May). Proximity of habitat commonly utilized by bird and other wildlife species to airfield, including Mariana fruit bats and Philippine deer should also be considered as a part of BASH management planning.

Issue: High BASH-threat species could be attracted as a result of sensitive species habitat modification and management activities. Therefore, a BASH strike threat exists at Andersen AFB.

Objective: The USAF and USDA-WS personnel will continue their extremely effective approach in identifying and reducing the BASH and wildlife strike threat on Andersen AFB. All habitat modification and management activities should be assessed for their potential to affect the safety of the flying mission prior to their incorporation into this INRMP.

All strategies described as follows for Andersen AFB will be developed and implemented in coordination with the AMT, which includes USFWS Ecological Services, GNWR, and GDAWR.

Strategies:

1. Continue implementation of the BASH program at Andersen AFB in accordance with U.S. Air Force Instruction (AFI) 91-202.
2. Continue USDA-WS studies to determine the resident populations and seasonal influxes of migratory species. As the species composition changes on Andersen AFB, management strategies will be modified on an as-needed basis.
3. Monitor sensitive species to assess potential threats to the safety of the flying mission.
4. Alter habitat enhancement activities when necessary to minimize BASH threat.
5. Continue to remove deer, feral pigs, feral dogs, and feral cats from the flightline area as needed and monitor for deer access to the flightline.
6. Continue to harass birds as necessary using a variety of techniques (e.g., pyrotechnics, model aircraft, propane cannons) to minimize wildlife-aircraft strikes. The use of a vehicle-mounted propane gun harassment device will be evaluated to reduce the habituation of BASH threat species to such devices.
7. Remove large debris piles in proximity to the airfield, as they serve as harborages for wildlife and can contribute to the increase of the BASH threat.
8. Obtain additional training (e.g., Annual Bird Strike Committee USA meetings) to ensure the use of the most current methods in wildlife damage prevention and control.

Monitoring Criteria: Continued evaluation of the BASH hazard at Andersen AFB will be used to assess the effectiveness of the BASH program. Management activities should be continually assessed during implementation, and should be modified as necessary if they result in the attraction of high BASH threat species.

5.8 Vegetation and Habitat Management

Vegetation and habitat management is a broad term that encompasses a wide range of issues affecting fish and wildlife; threatened and endangered species; and host, tenant, and transient training requirements. Habitat management could be required to decrease the abundance of certain wildlife species or to reduce animal damage or bird strike hazards. Habitat management on JRM will attempt to (1) protect and conserve threatened and endangered species through habitat conservation and enhancement at selected locations, (2) restore native forest ecosystems through revegetation using native plants, (3) deter animals from foraging or roosting in areas near or adjacent to areas of low-level flight activity, and (4) attract wildlife to areas away from the areas of low-level flight activity.

Guam presents a unique test of pollinator importance. The native bird and bat species that pollinate flowers, eat fruit, and disperse seeds are now missing from the ecosystem. By 1980, nine of the eleven native bird species had disappeared due to predation by brown treesnakes. The small and declining number of fruit bats still on Guam is expected to be lost in the near future (Wiles and Brooke 2009).

Forest plants continue to be pollinated by a variety of native and non-native insect species that include bees, flies, beetles, wasps, thrips, butterflies and moths (Brooke and Mortensen 2007). Lack of seed dispersers rather than pollinators is having a significant impact on forest regeneration because density-dependent mortality of seedlings that grow near the parent trees (Rogers 2011). High numbers of non-native ungulates add to lack of forest regeneration by trampling seedlings and browsing plants.

To restore Guam's ecosystem and return native birds entails landscape level control of brown treesnakes, deer and pigs. The HMU, protected by brown treesnake and ungulate-proof fencing, has been constructed as a first step in this process. On-going research into brown treesnake control and detection is being conducted by USDA-WS and USGS-FORT. Installation-wide control of deer and pigs is being started at AAFB and NBG.

The goals for habitat management are summarized in **Table 5-8**.

Table 5-8. Summary of Vegetation and Habitat Management Goals

Vegetation and Habitat Management Goals
• Protect native habitat diversity. • Maximize use of regionally native plant species and avoid introduction of invasive, exotic species in revegetation activities. • Enhance habitat for native species by removing invasive vegetation and replacing with native vegetation. • Maintain and enhance vegetation community structure, functionality, and species diversity. • Lessen or avoid adverse effects from activities on the overall ecosystem and its sensitive resources.

To meet the goals of habitat management, the following actions relative to achieving particular goals have been identified, and objectives and management strategies have been designed.

5.8.1 VHM-1: Habitat Protection, Restoration, and Rehabilitation

Objective: Develop and implement a program for natural land and habitat restoration and rehabilitation.

All strategies described as follows for Andersen AFB will be developed and implemented in coordination with the AMT, which includes USFWS Ecological Services, GNWR, and GDAWR.

Strategies:

1. Conduct long-term resource monitoring to detect changes caused by military activities. Continue to coordinate with operation and construction planners to ensure that military activities do not have short term adverse impacts to natural resource and that any unavoidable impacts are mitigated as appropriate.
2. Continue invasive and noxious weed identification and control as necessary.
3. Continue conducting surveys of vegetation plots on NBG and Tinian every 5 years to monitor ecosystem health, to determine species presence and develop long-term trend data on endangered species habitat. Data will be linked to GIS for mapping and analysis.
4. Update the OPERA and HERA management plans and implement measures to protect and enhance fish and wildlife resources. OPERA and HERA include terrestrial and marine

(submerged lands) components. Measures should ensure an ecosystem and watershed approach to protect native and migratory species that inhabit the terrestrial and marine environments through the following: controlling nonnative invasive plant and animal species, controlling overharvesting of fish and animal species, and incorporating a public education program on the purpose and function of the ERAs.

5. Timeline for update of the HERA Management Plan:
    a. Submit a request for funding to update the HERA during the last quarter of FY 2014. Incorporate November 1, 2012 USFWS comments on the August 2, 2012 JRM INRMP regarding the 2010 HERA Plan.
    b. Initiate development of the plan update in the spring of FY 2015.
    c. Submit a draft of the updated HERA for agency review in the last quarter of FY 2015.
    d. Once agency comments have been received and incorporated, finalize the HERA (target spring FY 2016).
6. Timeline for the update of the OPERA Management Plan:
    a. Submit a request for funding to update the OPERA during the last quarter of FY 2014. Incorporate November 1, 2012 USFWS comments on the August 2, 2012 JRM INRMP regarding the 2010 OPERA Plan.
    b. Initiate development of the plan update in the spring of FY 2015.
    c. Submit a draft of the updated OPERA for agency review in the last quarter of FY 2015.
    d. Once agency comments have been received and incorporated, finalize the OPERA (target spring FY 2016).
7. Develop specifications and standards for reseeding/revegetation of disturbed sites for use in contracts, maintenance, and other projects to ensure that invasive species are not inadvertently introduced as a result of reseeding/revegetation post construction. Use Hazard Analysis and Critical Control Point protocols or similar approaches to develop specifications and standards.
8. Develop and implement a revegetation plan with a long-term goal of restoring native forest for installation restoration program sites and sites where UXO have been removed. Use Hazard Analysis and Critical Control Point protocols or similar approaches to develop specifications and standards.
9. Develop a program to grow, plant, and monitor for 3 years, native forest species in areas where feral ungulate populations have been eradicated. The program would also include monitoring for nonnative vegetation, and removing nonnative vegetation when necessary within feral ungulate population eradication areas. The program would begin after ungulates have been removed from fenced areas. Growing, planting, and monitoring of native and nonnative vegetation would be conducted through an outside contract.
10. Monitor the effects of increasing rodent populations on forest regeneration and restoration efforts on Guam in areas where brown treesnake populations have been depressed through trapping and other control measures.
11. In the Tinian MLA, plant or underplant, and maintain up to 30 acres per year with native tree and understory species in 1) previously cleared pasture lands, 2) tangantangan forest or 3) native forest lacking biodiversity.
12. Periodically review management to ensure it still meets ecosystem management goals.

Monitoring Criteria: Continue to monitor habitats on JRM lands to protect and enhance floral and faunal resources on JRM managed lands. Continue to monitor for and removed invasive floral and faunal species from JRM lands.

5.8.2 VHM-2: Soil Resources

Issue: Soil erosion and compaction affects the productivity of some sites and threatens to expand these effects to unacceptable levels without protection and restoration.

Objective: Minimize soil compaction and restore erosion sites.

Strategies:

1. Complete an evaluation and prioritization of active erosion sites.
2. Tailor land uses to appropriate soil types.
3. Continue to implement plans for eroded site rehabilitation.
4. Identify additional sites for land rehabilitation planning.
5. Survey areas where soil erosion and compaction might occur to ensure that BMPs within the Erosion-Control Plan are implemented and are effective.
6. Continue to manage erosion on JRM sites, track successes, and progress and revise the INRMP as appropriate.

Monitoring Criteria: Continue to monitor for soil erosion and compaction on JRM lands, and implement BMPs within the Erosion-Control Plan.

5.8.3 VHM-3: Monitoring of Forest Regeneration in Ungulate Exclosures

Issue: The removal of ungulates is usually followed by the invasion of noxious plant species.

Objective: Monitoring of forest regeneration in any new exclosures and areas of wildlife habitat will be conducted after their installation. A baseline survey of vegetation will be completed prior to installation of the exclosures. The data from monitoring will be used to determine the effects of ungulate removal on the vegetation, the effectiveness of revegetation efforts, and to improve management strategies for native forest recovery.

All strategies described as follows for Andersen AFB will be developed and implemented in coordination with the AMT, which includes USFWS Ecological Services, GNWR, and GDAWR.

Strategies:

1. Assess vegetative changes in ungulate exclosures. If natural regeneration of these areas is not representative of species in the native limestone forest, adapt management strategies to assist towards revegetation of desirable native species.
2. Continue to identify and remove invasive plant species that out-compete the desirable native species.

Monitoring Criteria: Monitor exclosures and revegetate with native species as necessary, control and eradicate invasive species, and adapt management strategies to achieve recovery of the native limestone forest ecosystem in these areas.

5.8.4 VHM-4: Habitat Biodiversity Monitoring

Issue: Healthy native habitats are necessary for the maintenance and continuing evolution of biodiversity on Guam.

Objective: Habitat Biodiversity Monitoring will reevaluate established vegetation transects to measure changes in the condition of the resource. This information will be used to evaluate long-term trends in the condition of the resource and compare results with adjacent areas.

All strategies described as follows for Andersen AFB will be developed and implemented in coordination with the AMT, which includes USFWS Ecological Services, GNWR, and GDAWR.

Strategies:

1. Monitor plant diversity in the vegetation plots, record data observations, and compare to baseline survey data. Ensure that monitoring techniques encompass all species groups present or likely to be present in the vegetation plots.
2. Evaluate long-term trends in the condition of these resources. If these areas show severe degradation or simplification of the ecosystem that is not representative of native biodiversity, then adapt management strategies to assist towards the recovery of more representative native ecosystems (e.g., invasive species removal, revegetation with native species, creation of biological corridors).
3. Classify and delineate vegetation on JRM sites and identify the spatial distribution of target species (i.e., threatened and endangered species, and invasive species). Vegetation data will be used to identify and develop habitat maps for threatened and endangered species on JRM, where appropriate.
4. Conduct stream surveys above and below Fena Reservoir to determine presence/absence and relative abundance of native fish and invertebrate species. Conduct a feasibility study for fish access alternatives to upstream streams, such as fish ladders or sloughs. Conduct survey of non-native fish in Fena reservoir to determine whether the fish are predators on native fish and invertebrate species and to see whether control would even be necessary.

Monitoring Criteria: Continue to monitor plots, evaluate long-term trends, and adapt management strategies to maintain or achieve recovery of the native biodiversity in these areas.

5.8.5 VHM-5: Survey of Culturally Important Plants on Andersen AFB

Issue: There is a high demand for harvesting culturally important plants on Andersen AFB. The majority of the plant harvest occurs in the Tarague Basin, an easily accessed and popular location on Andersen AFB. Prior to 1995, there were no guidelines for the management of harvested plants such as breadfruit, coconuts, or moss. There is a need to address the management of these plants to prevent overharvesting and degradation of the native forests that support them.

Objective:

Collecting Plant Material for Cultural Purposes will only be permitted if it does not detract from the fulfillment of the Base Mission or the Base in providing for the conservation and management of fish and wildlife and their habitats, as well as historic and cultural resources.

Collection of plant materials including woody plant species, palm fronds, coconuts, moss, bread fruit, ferns, etc. from Andersen Air Force Base for personal use will be permitted with permission from the 36 Civil Engineer Squadron Environmental Flight Conservation Resources (36 CES/CEVN) Program staff. Allowing collection of plant materials for cultural purposes will contribute to the public's understanding and appreciation of natural and cultural resources.

Individuals requesting to collect plant material for cultural purposes will need to submit in writing their request for plant material collection. Collection of plant materials proposed for Federal or local listing is strictly prohibited and collection of plant material is intended for personal use only and not for resale. To ensure the protection of habitat for federally listed species, the final location site for plant material collection will be determined by the Natural Resources staff. GIS Location Points where the plant materials were collected and the time collection started and ended will be recorded.

All strategies described as follows for Andersen AFB will be developed and implemented in coordination with the AMT, which includes USFWS Ecological Services, GNWR, and GDAWR.

Strategies:

1. A survey should be conducted to determine the presence of culturally important plants in special access areas.
2. Research should be conducted on the population size, distribution, sustainable harvest methods, and sustainable yield of culturally important plants.
3. A management plan for the sustainable harvest of culturally important plants should be developed based on the research conducted. This plan will identify locations of populations suitable for sustainable harvest.

Monitoring Criteria: Continue to monitor the harvest of culturally important plants to ensure maintenance of sustainable population levels.

5.9 Coastal, Marine, and Submerged Lands Management

Coastal, marine, and submerged lands management applies to any installation habitat/property within the JRM that is partially or totally inundated by ocean waters. These areas include intertidal and estuarine areas and submerged lands, which are areas in coastal waters extending from the Guam coastline into the ocean 3 nautical miles (U.S. Navy 2010a). In addition to supporting a diverse aquatic ecosystem, these areas support a significant amount of current and proposed military training and recreational activities. Management of coastal, marine, and submerged lands in JRM will (1) protect and conserve threatened and endangered species through habitat conservation and enhancement, (2) ensure health and sustainability of coral reefs, and (3) provide continued access to training and recreational areas. The goals for coastal, marine, and submerged lands management are summarized in **Table 5-9**.

Table 5-9. Summary of Coastal, Marine, and Submerged Lands Management Goals

Coastal, Marine, and Submerged Lands Management Goals
• Conserve and restore coastal, marine, and submerged lands that provide habitat for a variety of native marine plants and animals, especially coral reef systems. • Employ a systematic approach to managing coastal, marine and submerged lands resources, using a process that includes inventory, monitoring, modeling, management, and assessment. • Complete an assessment and establish a monitoring program for coral reef health. • Develop best management practices for accommodating military training needs and recreation while conserving coral habitat. • Ensure JRM sites remain in compliance with Magnuson-Stevens Fishery Conservation and Management Act and other appropriate Federal regulations.

To meet the goals of coastal, marine and submerged lands management, the following actions relative to achieving particular goals have been identified, and objectives and management strategies have been designed.

5.9.1 SLM-1: Protection of Corals and Marine Ecosystems

Issue: On February 10, 2010, NMFS announced a 90-day finding on a petition to list 82 species of corals as threatened or endangered under the ESA (75 FR 6616 2010). NMFS solicited scientific and commercial information regarding these coral species including information pertaining to threats of ocean warming, ocean acidification, and other impacts that affect these species, stating that immediate action is needed to reduce greenhouse gas concentrations to levels that do not jeopardize these species. The petition also asserts that the species are being affected by dredging, coastal development, coastal point source pollution, agricultural and land use practices, disease, predation, reef fishing, aquarium trade, physical damage from boats and anchors, marine debris, and aquatic invasive species.

On December 7, 2012, NMFS announced completion of a comprehensive status review under the ESA of 82 reef-building coral species in response to a petition to list the species as either threatened or endangered (77 FR 236 2012). NMFS is proposing ESA listings for 66 coral species. Sixteen species (all Indo-Pacific) within the original petition were determined to not warrant listing as threatened or endangered under the ESA. Of the proposed 66 species, 12 species warrant listing as endangered (five Caribbean and seven Indo-Pacific), and 54 species warrant listing as threatened (two Caribbean and 52 Indo-Pacific), Forty-four of the species being evaluated by NMFS occur, or potentially occur within Navy installations, training ranges, and OPAREAs in the United States or U.S. territories. Most of the stony coral species (84 percent) that are being petitioned are found within the Pacific Ocean region (NAVFAC ESC SDS 2010).

JRM is faced with an unusual situation on Guam. Well-developed reefs are present within many of the nearshore portions of JRM submerged Lands, yet the Navy does not control the use of most of these areas nor can it control the anthropogenic factors, such as intentional burning, inadequate public wastewater systems/treatment, and tourist diving operations that have had and continue to have serious adverse impacts on marine natural resources. The following management strategies are proposed based on the constraints with which the Navy must deal and the physical and biological realities of Guam (NAVFAC ESC SDS 2010).

Objective: Per Secretary of the Navy policy (SECNAV 2002) the Navy shall participate in ESA listing decisions, critical habitat designation, and recovery planning for those actions that have the potential to affect mission readiness. Therefore, it is the goal of the Navy for INRMPs to fulfill the criteria to be considered for exemption for the designations of critical habitat. ESA does not require additional special management/critical habitat designation if adequate management and protection is already in place. Adequate special management or protection is provided by a compliant INRMP that addresses the maintenance and improvement of the primary constituent elements important to the species and manages the long-term conservation of the species. Three criteria are used to determine if such special management and protection are provided: (1) there is a conservation benefit, (2) there are assurances that the management plans will be implemented, and (3) there are assurances that the conservation efforts will be effective. These three criteria will be met through the strategies that follow, and therefore, designation of critical habitat is neither necessary nor legally required (NAVFAC ESC SDS 2010).

Strategies:

1. JRM will attempt to protect corals and coral reefs within JRM submerged lands, which extend from the intertidal zone to the 160-foot (48.7-meter) depth contour, which is the limit of the ecological reserve.
2. Update the Submerged Lands Management Plan to include all JRM managed lands on Guam. The timeline for the update of the Plan is:
    a. Submit a request for funding to update the plan during the last quarter of FY 2014.
    b. Initiate development of the plan update in the spring of FY 2015. Incorporate October 10, 2012 National Park Service's comments on the JRM INRMP regarding the 2007 Submerged Lands Management Plan.
    c. Submit a draft of the updated plan for agency review during last quarter of FY 2014.
    d. Once agency comments have been received and incorporated, finalize the plan (target spring 2015)
3. Conduct a feasibility study for placement of mooring buoys within Navy Submerged lands, and coordinate with GDAWR and other GovGuam agencies. Develop and implement buoy placement and maintenance protocols, and incorporate BMPs for boating into educational outreach materials.
4. Delineate benthic habitats and identify the spatial distribution of target species (i.e., threatened and endangered species, candidate species, and invasive species) on JRM submerged lands.
5. Annually review and revise, as needed, the Naval Base Guam Fishing Instruction and ERA management plans. Coordinate review with USFWS, GDAWR and NMFS to ensure goals and objectives of the fishing instructions and ecological reserve guidance are consistent with Federal and territorial objectives.
6. Ensure that the Base Fishing Instruction and ERA guidance, no-fishing, or collection of marine organisms policies are implemented.
7. Analyze the feasibility of using artificial reefs to encourage coral reef establishment. Coordinate with the USFWS, GDWAR, and NMFS to ensure goals and objectives of this proposal are consistent with Federal and territorial resource agency conservation goals and regulations.
8. Develop marine benthic habitat maps for DOD Submerged lands seaward to include Agat Bay, Orote Point, Apra Harbor, and Piti Bay. Benthic maps should describe the complex marine habitats and resources that exist in the DOD submerged lands within this management area. The marine benthic habitat maps should be used to support DOD management activities.

9. Continue to monitor sea grass beds at Dadi Beach, identify any adverse human impacts and develop plans to minimize/eliminate these impacts.

Monitoring Criteria: Implementation of these recommendations would greatly increase the effectiveness of the ERAs, and the HAPCs and create de facto preserves. These measures could enhance corals, coral reefs, fisheries, and all nearshore marine organisms for the entire island of Guam (NAVFAC ESC SDS 2010)

5.9.2 SLM-2: Monitoring of Coral Reefs

Issue: Long-term evaluation and monitoring of coral reefs in JRM submerged lands is required to provide comprehensive data on ecosystem health and sustainability and provide analysis of any potential military impacts. Submerged Lands Management Plans (SLMP) (**Appendix T**) were prepared in 2007 to supplement the Navy's INRMP (COMNAV Mariana 2001), and the OPERA General Management Plan (see **Appendix P**), and the HERA General Management Plan were prepared in 2010 (see **Appendix Q**) (SWCA 2010a and 2010b). Both plans provide management objectives that will assist in the evaluation of future military activities in JRM as they apply to submerged lands and especially to corals.

Objective: Implementation of the SLMP and establishing long-term coral reef monitoring will enhance protection and restoration of coral habitat and compound the benefit of the strategies described in **Section 5.7.1**.

Strategies:

1. Coral reef ecosystems should be monitored using permanent transects, and a GIS database of nearshore coral reef ecosystems should be created and should include seagrass habitats and areas suitable for other marine life. Coordinate with USFWS, NMFS, GNWR, GDAWR and CNMI DLNR where possible in the development of a long-term coral reef monitoring program.
2. Conduct preliminary surveys of corals within Pati Point Marine Preserve and establish permanent transects to monitor coral health. Coordinate surveys with the National Wildlife Refuge at Ritidian Point. Develop a written report on Pati Point Marine Preserve to incorporate into the SLMP.
3. Investigate and, if appropriate, deploy Autonomous Reef Monitoring Structures to monitor diversity of the coral reef ecosystem.
4. Conduct a long-term study to monitor water quality in Apra Harbor. Sampling should include: turbidity, contaminants, environmental parameters.
5. Assess public and recreational use of JRM submerged lands and educate users of ERAs and other JRM submerged lands on the importance of coral reef preservation.

Monitoring Criteria: A JRM Coral Reef Habitat Baseline Survey and long-term monitoring will provide additional information for coordination and response to future NMFS decisions related to listing and critical habitat designation. The survey and monitoring will be coordinated with the USFWS, NMFS, National Park Service, NOAA, and GNWR to ensure appropriate metrics are collected for the purposes of avoiding, minimizing and mitigating JRM operational impacts on marine fish and wildlife resources.

5.9.3 SLM-3: Conservation Measures from Biological Opinions

Issue: With the increasing military presence and reorganization of operations on Guam, consultation with USFWS and NMFS has resulted in BOs that specifically address coastal, marine and submerged lands associated with JRM managed lands.

Objective: Address recommended conservation measures, as related to coastal, marine, and submerged land habitat to the fullest extent possible for the following BOs:

1. NMFS BO on the U.S. Navy's Proposed Guam and Commonwealth of Northern Mariana Islands Military Relocation, dated August 25, 2010.
2. USFWS BO for the Joint Guam Program Office Relocation of the U.S. Marine Corps from Okinawa to Guam and Associated Activities on Guam and Tinian, dated September 8, 2010.
3. USFWS BO for the Mariana Islands Range Complex, Guam and the Commonwealth of the Northern Mariana Islands 2010-2015, dated February 22, 2010.

Strategies:

1. Ensure all construction and military operations incorporate prescribed BO conservation measures into planning, funding and execution. Coordinate with USFWS, GDAWR and the NMFS to identify the least environmentally damaging practicable alternative for construction projects and military operations, with an emphasis to avoid, minimize or mitigate for unavoidable impacts on fish and wildlife resources.
2. Map all nearshore marine resources on JRM submerged lands to provide comprehensive information when evaluating potential impacts on sensitive species and associated habitat. Coordinate marine benthic habitat mapping activities with the USFWS, GDAWR and the NMFS to ensure habitat classification consistency, appropriate mapping methodology is employed and mapping conservation objectives are shared among agencies.
3. Expand the OPERA based on the Mitigation Plan for MILCON P-502, Kilo Wharf Extension (see **Table 5-3**). [Requirement from BO]
4. Modify the OPERA to restrict fishing and other types of consumptive activities that could adversely affect the essential fish habitat within the OPERA. [Requirement from BO]

Monitoring Criteria: Required reporting to NMFS and USFWS for active BOs will demonstrate compliance with recommended conservation measures.

5.10 Exotic and Invasive Species Management

An invasive species is defined in EO 13112, *Invasive Species*, as a species that is nonnative (i.e., alien or exotic) to the ecosystem under consideration and whose introduction causes or is likely to cause economic or environmental harm, or harm to human health. Invasive species can be plants, animals, and other organisms (e.g., microbes). Human actions are the primary means of invasive species introductions. Invasive species have had a catastrophic effect on the native flora and fauna of Guam. Attributes of island biota include small geographic ranges and population size, low reproductive rates, and lack of the ability to coevolve with invasive species and disturbed habitats. Islands typically have lower numbers of species than mainland areas, which results in fewer predators and competitors that could prohibit the establishment of invasive species. These limitations have caused exotic and invasive species to replace native island species (Wiles et al. 2003). As a result of evolving in isolation, island plants and animals have few defenses when exposed to introduced competitors and predators. These limitations on Guam have caused exotic and invasive species to replace native island species (Wiles et al. 2003).

Many of the native species on Guam are threatened due to introduced predators, such as the brown treesnake, feral cats and dogs, and introduced ungulates such as the Philippine deer, feral pig and carabao that have altered native vegetation. Several species of rats, including the brown rat, black rat, and Polynesian rat, have colonized the island, prey on the eggs and young of native species and destroy native

flora. Examples of invasive species management approaches include the control of feral ungulates and removal of invasive plants to allow native species to flourish in degraded areas.

Invasive species control and removal efforts are mandated by Federal, DOD, and JRM regulations and MOA such as the following:

- *EO 11987, Exotic Organisms.* Agencies shall restrict the introduction of exotic species into the natural ecosystems on lands and waters which they administer.
- *EO 13112, Exotic and Invasive Species.* Directs Federal agencies whose actions might affect the status of invasive species, to the extent practicable 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.
- *Animal Damage Control Act (7 U.S.C. § 426–426b, 47 Stat. 1468).* Provides authority to the Secretary of Agriculture for investigation and control of mammalian predators, rodents, and birds. DOD installations can enter into cooperative agreements with USDA-WS to conduct animal control projects.
- *Federal Noxious Weed Act of 1974, 7 U.S.C. § 2801–2814.* The Act provides for the control and management of nonindigenous weeds that injure or have the potential to injure the interests of agriculture and commerce, wildlife resources, or the public health.
- *Non-Indigenous Aquatic Nuisance Prevention and Control Act of 1990 (104 Stat. 4761, 16 U.S.C. § 4701).* P.L. 101-646 establishes a broad Federal program to prevent the introduction of and control the spread of introduced aquatic nuisance species and the brown treesnake. The Act also established the Aquatic Nuisance Species Task Force which coordinates all government efforts relating to aquatic invasive species in the United States with those of the private sector and other North American interests via regional panels and issue-specific committees and work groups.
- *Brown Tree Snake Control and Eradication (7 U.S.C. 8501 et seq.).* The law provides for the control, interdiction, research, and eradication of the brown treesnake, including quarantine protocols to be undertaken to control the introduction and spread of the species.
- *MOA for Brown Treesnake Control. June 1, 2011.* Executed among the U.S. Department of Interior, DOD, USDA, U.S. Department of Transportation, National Invasive Species Council, GovGuam, the State of Hawaii, and CNMI. This agreement establishes a policy framework and working relationship to facilitate implementation of the Brown Treesnake Control Plan.
- *DOD Instruction 4150.07 DOD Pest Management Program. May 29, 2008.* Implements policy, assigns responsibilities, and prescribes procedures for the DOD Integrated Pest Management (IPM) Program.
- *U.S. Army Corps of Engineers Invasive Species Policy. June 2, 2009.* Establishes a consistent, nationwide policy that is applied to all Civil Works projects and programs. It complements the National Invasive Species Act. Measures to either prevent, or reduce establishment of invasive and non-native species will be a component of all USACE Operations and Maintenance (O&M) at project sites and a part of the implementation of Civil Works projects.

Table 5-10 presents a summary of the invasive species management goals for JRM. The primary goal of invasive species management in JRM is to control or remove invasive species that are having an adverse effect on native flora and fauna and create areas that are predator-free to assist in the recovery of a healthy native ecosystem that is compatible with the military missions.

Table 5-10. Summary of Exotic and Invasive Species Management Goals

Exotic and Invasive Species Management Goals
• Management and control of invasive species currently existing on JRM lands: control/eradication of deer, pigs and carabao; funding and support of brown treesnake research facilitating large scale control efforts. • Continually monitor and reduce the effects invasive species have upon the native ecosystems of Guam, such as habitat alteration, competition for resources, and predation. • Employ a systematic approach for early detection and rapid response to control or remove invasive species that are having an adverse effect on native ecosystems. • Minimize invasive species-related health risks, safety risks, and environmental damage. • Continue to remain in compliance with Federal, territorial, and local laws and regulations governing invasive species, and implement measures from the Micronesia Biosecurity Plan once developed. • Maintain and involve partnerships with agencies and groups involved in invasive species control and removal. • Develop HACCP or similar plans to ensure that invasive species from Guam are not spread to other locations on and off the Island of Guam and to ensure that new invasive species are not introduced to Guam. • Ensure JRM activities do not result in the introduction and/or spread of invasive species.

5.10.1 ISM-1: Conduct Exotic and Invasive Species Surveys

Issue: Invasive plant and animal species threaten the existence of native species, decrease habitat and lower habitat quality for native wildlife.

Objective: Develop methods to reduce new introductions of invasive plants and animal species using approaches that will cause the least disturbance. Develop and adopt proactive management measures to control the proliferation of invasive plants and animals.

All strategies described as follows for Andresen AFB will be developed and implemented in coordination with the AMT.

Strategies:

1. Conduct surveys to determine arrivals and establishment of new invasive plant species on JRM lands.
2. Conduct surveys to determine arrivals and establishment of new amphibians, reptiles, insects, and invertebrates on JRM lands.
3. Develop and implement measures to remove newly arrived species including chemical and mechanical. Coordinate with GDAWR, USFWS, UOG, USGS-BRD, USDA-WS and other agencies as applicable.
4. Perform surveys at annual intervals, or more frequently as necessary, to determine presence/absence of new invasive species.
5. Conduct surveys to determine current populations and abundances of non-native invasive plants.
6. Create GIS layers depicting high concentrations of invasive plant species on JRM sites.

7. Conduct an assessment to prioritize threats from existing non-native invasive species and develop and implement strategies to remove/control the species.
8. Evaluate impacts of non-native ants, flatworms, slugs and predatory snails. Develop and implement control strategies as a result of evaluations.
9. Assess invasive species and predators at the Hagoi wetland. If determined feasible, develop and implement a project to control predators at the Hagoi wetland.
10. Monitor for *Wasmannia* and coordinate with UOG entomologists for monitoring methods. If *Wasmannia* is detected on Navy lands, a management plan will be written and implemented to remove the species and continue periodic monitoring. Control of *Wasmannia* and fire ants, both chemical and non-chemical, are covered in the Pest Management Plan.
11. Assess rodent and shrew impacts to native vertebrate, invertebrate, and plant species in the Tinian MLA
12. Coordinate with the USFWS, GDAWR, USGS-BRD, USDA-PPQ, USDA-WS, USDA-NRCS, GDAWR, UOG and other stakeholders to assist in identifying any new invasive plant and animal species.

Monitoring Criteria: Continue to survey as needed for new invasive plant and animal species and implement a plan to control or eradicate these species. Update the plan as needed.

5.10.2 ISM-2: Assessment and Management of the Coconut Rhinoceros Beetle

Issue: Continued spread of CRB throughout Guam is the primary management concern. CRBs have been caught in traps NBG Main Base, north of NBG, and an infestation was identified on Andersen South.

Objective: Control of CRB on Guam is the overall management objective. CRB traps are monitored at both NBG and Andersen AFB and biologists record detections of the CRB in support of the Guam CRB Eradication Project. Coconut palm stands around various locations in JRM are monitored for signs of the occurrence of the CRB, including visual surveys for signs of the beetle's presence and continued monitoring of baited traps. When CRB is found, Guam Department of Agriculture is notified of the occurrence and management is coordinated. A management plan should be developed to address ongoing monitoring for CRB, coordination with Guam Department of Agriculture, and suppression and eradication of the beetle where it is detected.

All strategies described as follows for Andersen AFB will be developed and implemented in coordination with the AMT, which includes USFWS Ecological Services, GNWR, and GDAWR.

Strategies:

1. Continue to monitor traps, replace pheromone tablets as needed and look for indications of the occurrence of CRB on palms.
2. If beetles are found they are removed and destroyed as per USDA-APHIS and UOG recommendations.
3. Continue to coordinate with UOG, the Guam Invasive Species Council and USDA-APHIS for monitoring of CRB, coordination with Guam Department of Agriculture, and suppression and eradication of the beetle where it is detected.

4. Develop a management plan for ongoing monitoring, eradication of CRB infestations at breeding sites, removal and destruction of infected palms, and removal of potential breeding sites.

Monitoring Criteria: Palm stands will be monitored for signs of the presence of CRB. Coordinate with UOG and USDA-APHIS to determine appropriate course of action to manage CRB on JRM lands.

5.10.3 ISM-3: Assessment and Treatment of Cycad Scale and Cycad Blue Butterfly

Issue: The cycad scale has killed in excess of 70 percent of the endemic cycads on Guam. To support survival of the species, the Navy developed an experimental cycad collection located at Mount Lasso on Tinian. This cycad species was removed by the Japanese from Tinian prior to World War II. In 2005, Navy Region Marianas contracted surveys and collected viable seed for propagation from habitats throughout Guam. More than 3,000 cycad seeds were collected, cleaned of scale insects, and the source of each seed documented by individual mother-tree and habitat type. Seeds were then stored over a period of 12 months, and then transported to a nursery on Tinian until they reached maturity. In 2008, 1,000 of these seedlings were planted in a mapped experimental design on Tinian. The plants have been monitored monthly and encroaching vines and weed-like vegetation is removed. As a preventative measure, young plants are sprayed twice monthly to eliminate any infestations of cycad blue butterfly larvae.

Objective: An assessment of the current status of cycad scale damage on JRM sites should be conducted. Support UOG efforts in the research and control of cycad scale and other insects impacting cycads. Management and control of cycad scale and other insects should be considered on an ecosystem management scale. Continue to monitor and manage cycads introduced to Tinian from Guam.

All strategies described as follows for Andersen AFB will be developed and implemented in coordination with the AMT, which includes USFWS Ecological Services, GNWR, and GDAWR.

Strategies:

1. Monitor cycad collection on Tinian on a regular basis. Invasive insects, plants, and vines will be removed from the cycads as appropriate.
2. Develop and implement provisions to treat cycads to prevent the spread of contaminants to Tinian from Guam.
3. Monitor affects of low levels of sunlight on seedling growth. Remove invasive trees in experimental plot as necessary and adaptively manage for optimal sunlight.
4. Support UOG efforts on cycad research, control of cycad scale and other insects impacting cycads.
5. Evaluate biocontrol to determine the most effective method for controlling the insect.
6. Conduct long-term monitoring of changes in nitrogen fixation in the soil in experimental cycad plots and in comparative native forests lacking cycads.
7. Continue to monitor treated cycads on a regular basis and reapply the treatment if the scale insect, or cycad blue butterfly larvae reappears.
8. Develop strategies that include monitoring, detection, treatment, response and continued monitoring for absence or presence.

Monitoring Criteria: Cycads will be monitored for signs of the presence of the scale insect and cycad blue butterfly larvae, and treated as appropriate. Treated cycads will be monitored on a regular basis and reapplication of the treatment will occur if the scale insect reappears.

5.10.4 ISM-4: Control of Feral Ungulates

Past recreational hunting and depredation efforts have not resulted in adequate control of feral pigs, deer and carabao on DOD properties, as evidenced by continued habitat degradation through ungulate browsing and foraging activities. JRM has developed Ungulate Management Plans for NBG and Andersen AFB. These plans are included in **Appendices L** and **M**.

Issue: Control of feral ungulates on JRM lands is an important ongoing management issue because of the extensive damage caused by feral pigs, Philippine deer, and carabao to native ecosystems and threatened and endangered species habitat.

Objective: The goal is eradication within fenced areas and reduction in unfenced areas to near-zero numbers.

All strategies described as follows for Andersen AFB will be developed and implemented in coordination with the AMT, which includes USFWS Ecological Services, GNWR, and GDAWR.

Strategies:

1. Implement the JRM Ungulate Management Plans for NBG and Andersen AFB (see **Appendices L** and **M**). Develop a database to monitor ungulate control techniques and management. Review each management plan annually and update as necessary to ensure management prescriptions within the plan are current.
2. Remove feral ungulates from special ecological areas and endangered species' habitat on JRM. Coordinate with USFWS, GNWR, and GDAWR when appropriate.
3. Continue to remove deer and pigs from the flightline area on Andersen AFB as needed and monitor for deer access to the flightline.
4. Implement a study to examine home range and habitat use of ungulates on Andersen AFB.
5. Evaluate cost and feasibility of erecting and maintaining an ungulate-proof fence around limestone forests within the NMS.

Monitoring Criteria: Continually evaluate the presence of feral ungulates on JRM. Implement strategies within the JRM Ungulate Management Plans for NBG and Andersen AFB for removing feral ungulate species.

5.10.5 ISM-5: Construction of Ritidian Ungulate Exclosures and Ungulate Removal on Andersen AFB

Issue: Wildlife habitats on Andersen AFB are currently occupied by ungulates that are detrimental to habitat viability and survival of native species. As required by the Conservation Measures established in the Northwest Field Beddown Section 7 Letter and the ISR/Strike Capability BO, three units will be constructed at Ritidian Point enclosing approximately 628 acres (254 hectares) of Primary and Secondary limestone forest. These exclosures will be located near Ritidian Point.

Objective: To improve foraging and roosting habitat for native wildlife on Andersen AFB, the Ritidian Ungulate Exclosures will be constructed and ungulates will be eradicated within the fenced areas. Ungulate control will eliminate the key threat of habitat destruction from overgrazing, rooting, and trampling.

All strategies described as follows for JRM will be developed and implemented in coordination with the AMT, which includes USFWS Ecological Services, GNWR, and GDAWR.

Strategies:

1. Manage ungulates per guidelines contained within the NBG and Andersen AFB Ungulate Management Plans to eradicate all ungulates from within fenced areas, and to reduce and maintain numbers at near zero in unfenced areas. [Requirement from BO]
2. Conduct fence line reconnaissance and perform annual maintenance of exclosure areas. Reconnaissance of exclosure fence lines should be conducted on a routine basis and following typhoon events. [Requirement from BO]
3. Identify and prioritize areas in conjunction with the USFWS, GNWR, and GDAWR for the construction of exclosures.
4. Record information on ungulate kills. Measurements should be obtained from carcasses. The metrics should include sex, weight age determination, and fertility status. This information should be made available to research specialists.
5. Begin revegetation of the areas of wildlife habitat with important forest plants immediately following eradication of ungulates to ensure that noxious plant species do not reclaim these areas.
6. Continue to monitor the areas of wildlife habitat to ensure that noxious plants do not establish a foothold and exclosures are effectively controlling entry of ungulates.
7. Investigate the viability of using exclosure areas for outplanting of *Serianthes nelsonii* and *T. rotensis*.
8. Coordinate management activities with the appropriate cooperating resource agencies such as USFWS, GNWR, USDA, and GDAWR.

Monitoring Criteria: The exclosures will be continually monitored to determine if ungulates are entering, noxious plants are becoming established, and outplanting sites remain viable.

5.10.6 ISM-6: Assessment and Management of Feral Cat and Dog Populations

Management of feral animals is a component of pest management on JRM. Feral animals, especially feral cats and dogs, pose a potential threat to public health and safety. They also pose a threat to wildlife, especially federally listed species and migratory birds. Existing Navy policy included in SECNAVINST 6401.1A of 16 August 1994 regarding veterinary health services prohibits dogs, cats, and other privately owned or stray animals from running free on military installations. The CNO issued a policy letter on 10 January 2002 that clarifies the application of SECNAVINST 6401-1A. An objective of the existing policy is to control feral animals in a humane manner to prevent injury or disease to Navy personnel and eliminate adverse impacts on native wildlife. The instruction requires Navy commands to institute proactive pet management procedures to prevent establishment of free-roaming cat and dog populations.

Issue: Resident and transient feral cats and dogs pose a risk to native wildlife.

Objective: Conduct a baseline survey to determine the population of feral cats and dogs. Based on survey results, develop a management plan to control the population.

All strategies described as follows for Andersen AFB will be developed and implemented in coordination with the AMT, which includes USFWS Ecological Services, GNWR, and GDAWR.

Strategies:

1. Conduct a survey to assess the population of feral cats and dogs in JRM and identify areas of high density and potential resource impacts.
2. Develop and implement a Feral Cat and Dog Management Plan. Ensure that the plan identifies areas where control is needed and provide targets for control efforts in those areas. In addition, because feral cats are known to be important predators of Mariana crows and Guam rails, the plan should identify how implementation will benefit these species.
3. The use of feral cat exclosures should be examined to determine the best areas for their installation and the most effective technologies to be used.
4. Install/retrofit feral cat excluding devices to the HMU brown treesnake barrier at Andersen AFB. Cat exclosures should be tested and evaluated for wind-loading on the bulge barrier fence, effectiveness of excluding cats, and any impact on brown treesnake deterrence of the fence before being installed on the HMU. Purchase supplies and equipment necessary to implement cat control in the HMU. [Requirement from BO]
5. Coordinate installation of exclosures with the USFWS, GNWR, and GDAWR, and monitor exclosures to ensure their effectiveness.
6. Develop an outreach and education program to remind military personnel of the negative effects that releasing pets can have on the local wildlife.

Monitoring Criteria: Implement the Feral Cat Management Plan and continually evaluate the presence of feral cat populations to determine the effectiveness of control measures.

5.10.7 ISM-7: Area-wide Brown Treesnake Control

The National Defense Authorization Act of 2009 requires DOD to establish a comprehensive program to control, and to the extent practicable, eradicate brown treesnakes from military facilities on Guam and to ensure that military activities do not contribute to the spread of brown treesnake.

In June 2011, a MOA on brown treesnake control was signed by the U.S. Department of Interior, U.S. Department of Defense, U.S. Department of Agriculture, U.S. Department of Transportation, National Invasive Species Council, GovGuam, State of Hawaii, and the CNMI. This agreement facilitates the need for cooperative efforts to solve problems caused by the presence of brown treesnakes. The agreement also establishes a policy framework and working relationship to facilitate the implementation of the Brown Treesnake Control Plan.

In addition, several research projects addressing brown treesnake control and suppression have either been initiated, or are planned for future implementation on DOD lands on Guam. Brown treesnake research projects that have either been facilitated on DOD lands or funded by DOD include targeted aerial application of acetaminophen, research on large-scale population suppression efforts, investigating use of a protein substrate for brown treesnake attraction and as bait, and development of non-prey bait for delivery of acetaminophen.

Issue: Brown treesnakes continue to pose a threat to native fauna through predation. It is also a serious urban pest causing widespread power outages and concerns for human safety.

Objective: Control and reduce the brown treesnake population on JRM managed lands.

Strategies:

1. Continue brown treesnake control around Mariana swiftlet nesting and roosting caves on the NBG NMS.
2. Continue to maintain the HMU snake barrier on Andersen AFB to ensure barrier integrity in preventing snake ingress (barrier inspections, barrier maintenance, and vegetation maintenance). [Requirement from BO]
3. Develop and implement a strategy for the eradication of brown treesnakes from the HMU and develop a monitoring protocol to determine when eradication is complete. This plan should identify snake-control goals and identify areas where these efforts will occur.
4. Develop and implement a brown treesnake monitoring protocol within the HMU after snake eradication is complete to detect potential snake ingress.
5. Secure funding for applied research efforts by USDA-NWRC. The applied research efforts will focus on: 1) developing aerial broadcast techniques of toxicants; 2) development of artificial lures and attractants for brown treesnake toxicants; and 3) development of more cost-effective strategies to control or eliminate brown treesnakes in field situations. [Requirement from BO]
6. Continue to cooperate and coordinate with USFWS, GNWR, GDAWR, USGS-BRD, USDA-WS, and USDA-NWRC in brown treesnake control efforts. [Requirement from BO]

Monitoring Criteria: Continue to monitor the effectiveness of snake-control methods. Continue to inspect the HMU to reduce the risk of brown treesnake ingress or breaches. Implement brown treesnake monitoring protocol after eradication is complete.

5.11 Watershed Management

Watershed management directly affects both surface water and groundwater quality and is critical in maintaining freshwater aquatic habitats, marine resources and coral reefs. A summary of the watershed management goals is presented in **Table 5-11**.

Table 5-11. Summary of Watershed Management Goals

Watershed Management Goals
• Develop an understanding of ecosystem dynamics within the watershed in an effort to prevent and respond to threats to its integrity. • Maintain healthy and stable soils, rehabilitate damaged areas to reduce soil and sediment erosion inputs into the watershed that degrade water quality. • Minimize nonpoint source pollution of both surface and groundwater in the watershed through the implementation of BMPs. • Manage watersheds to maintain natural hydrology.

The following watershed objectives and strategies are designed to meet the watershed management goals of this INRMP.

5.11.1 WP-1: Erosion and Sedimentation

Healthy, stable soils are the foundation of a healthy ecosystem. As soils lose their structure and begin to erode, other systems also begin to fail. Vegetation and wildlife decline in numbers and diversity, and the quality of surface water declines as it becomes loaded with eroded sediments. Some soil types, such as those found on Guam, took centuries to develop and are not easily replaced or repaired if lost or damaged. The fragile nature of these soils makes the protection of soils vital for maintaining many of the systems that make up a healthy ecosystem.

OPNAVINST 5090.1C CH-1 requires that installation sources of dust, runoff, silt, and erosion debris be controlled to prevent damage to land, water resources, equipment, and facilities, including adjacent properties. An erosion-and-sediment-control plan must be implemented where appropriate. Maintenance of vegetative cover is consistent with ecosystem management goals expressed earlier. Other materials can be used including gravel, fabrics, riprap, and recycled concrete and pavement that are environmentally safe and compatible with the site. Where bare ground is necessary, other measures for dust, sedimentation, and erosion control should be implemented (e.g., check dams, wind breaks, diversions). To minimize land maintenance expenditures and help ensure environmental compliance, physically intensive activities should be located on those areas least susceptible to erosion. The erosion potential of a site and adjacent water resources need to be identified and analyzed in preparing development, training, and land use plans.

Issue: Disturbed soils on JRM sites lead to erosion and sedimentation. Control measures are needed to reduce adverse affects associated with erosion and sedimentation.

Objective: Maintain soil stability and stabilize soils in disturbed areas to reduce runoff, erosion, and gully formation.

Reduce erosion and sedimentation through the development and implementation of BMPs and management activities that reduce sediment inputs into the watershed.

All strategies described as follows for Andersen AFB will be developed and implemented in coordination with the AMT, which includes USFWS Ecological Services, GNWR, and GDAWR.

Strategies:

1. Develop and implement erosion-control BMPs to prevent and repair eroded areas on JRM sites (e.g., planting acacia and vetiver to control erosion in eroded areas). Periodically review erosion-control BMPs to ensure that they are still adequate to control erosion and sedimentation on JRM sites. Conduct surveys to determine whether activities on JRM sites are adversely impacting soil and water resources as a result of erosion and sedimentation.
2. Implement watershed and erosion control management plans developed for JRM. Annually review plans to ensure guidelines are still effective and revise plans as necessary.
3. Develop erosion and sedimentation BMPs, then disseminate informational materials and conduct a short seminar on the erosion-control BMPs and watershed-protection issues for personnel (e.g., contractors) who are likely to impact the watersheds.
4. Update and implement the 2009 Wildland Fire Management Plan for JRM.

5. Continue efforts to identify and protect all aquifer recharge zones on JRM.
6. Continue to plant trees and vetiver grass in eroded, or savanna habitat to reduce erosion and suppress fires.
7. Protect vegetation in primary aquifer recharge areas and revegetate exposed soils using suitable species.
8. Conduct water resources monitoring that assesses water quality at in-flow and out-flow points of rivers and streams on JRM sites.
9. Ensure that monitoring requirements, BMPs, and water quality parameter limits, as required by the NPDES storm water permits for JRM sites, are met.
10. Maintain accurate, usable, and informative GIS data for ease in management planning and documentation.
11. Continue to work with resource agencies and universities to evaluate and develop new erosion erosion control strategies.

Monitoring Criteria: Ensure that the BMPs are followed by inspecting construction sites and problematic areas periodically on JRM sites. Also, ensure that baseline water quality data collected as part of NPDES storm water monitoring show no net increase in nutrient and sediment loading in outfalls from JRM sites. Continue to coordinate with USDA-NRCS, GDAWR, GNWR, CNMI DLNR, and UOG to assist in the management of sedimentation and erosion issues on JRM without compromising the mission.

5.11.2 WP-2: Exposed Soils

JRM has been implementing studies and projects since the early 1990s to determine the best methods for restoring vegetation on eroded sites on JRM. Planning guidance to reduce soil erosion was developed by NRCS for the Pacific Basin Area in July 2004. In response, the Fena Ordnance Annex Conservation Plan was developed to provide guidance for reducing impacts on the Fena watershed resulting from DOD activities. Since then, 41 acres (16.6 hectares) of paspalum and vetiver grasses have been planted on the bare eroding sites on JRM, and 80 acres (32.4 hectares) of acacia tree seedlings have been planted in the savanna grasslands establishing shaded fuel breaks to stop the spread wildland fire. In addition, these plantings have reduced erosion and sedimentation entering the watershed and nearby coral reef ecosystems.

Issue: Areas on JRM might have exposed soils, which could impact onsite and offsite water quality.

Objective: Revegetate areas of exposed soil with suitable ground cover, native species when feasible, and suitable nonnative species like vetiver and acacia in a manner consistent with natural resources management guidelines included in this INRMP.

All strategies described as follows for JRM will be developed and implemented in coordination with the AMT, which includes USFWS Ecological Services, GNWR, and GDAWR.

Strategies:

1. Develop and implement the Long-Term Watershed and Forest Management Plans for NBG and Andersen AFB.
2. Prioritize areas of exposed soil for revegetation based on surveys.

3. Identify native flora to be used in revegetation efforts, planting prescriptions and monitoring techniques in SOPs developed in the Long-Term Watershed and Forest Management Plans for NBG and Andersen AFB.
4. Develop revegetation SOPs specific to IRP sites.

Monitoring Criteria: Periodically examine the revegetation sites in accordance with SOPs to determine if the restoration effort is producing the desired results.

5.12 Developed Land Management

Management of the entire installation needs to be conducted consistent with natural resources management prescribed in the INRMP. Environmentally and economically beneficial landscaping practices can reduce maintenance costs while also providing wildlife habitat. Planting windbreaks around buildings and parking areas, and reducing mowing are ways to spend dollars more wisely, educate the public about the benefits of reduced maintenance, and become better stewards of the environment. In managing natural resources, JRM site personnel acknowledge their responsibilities as listed in the White House Memorandum, *Environmentally and Economically Beneficial Practices on Federal Landscaped Grounds* (1994). The memorandum's requirements include the following:

1. Using regionally native plants for landscaping.
2. Using construction practices that minimize adverse effects on the natural habitat.
3. Reduce pollution by reducing the use of fertilizer and pesticides, using IPM, recycling green waste, and minimizing runoff.
4. Implementing water-efficient practices.
5. Creating demonstrations of these practices to promote their use elsewhere.

Contracted grounds maintenance personnel perform most grounds maintenance activities at JRM sites. Normal grounds maintenance operations are focused on lawn care, drainage ditch maintenance, road and runway maintenance, airfield management, landscaping maintenance, and pest management.

Grounds maintenance requires a variety of chemicals including pesticides, herbicides, fungicides, cleaning agents, oils, fuels, solvents, and paints. The use of chemicals for grounds maintenance should be optimized because of the need to protect wildlife species that occur on Guam. Guidance on the grounds maintenance program is contained in the JRM site IPMP, or site-specific Spill Prevention Control and Countermeasures (SPCC) plans.

An integrated grounds maintenance program requires periodic review and upgrading of maintenance practices. Maintenance practices that ensure plants are healthy will reduce the need for intensive chemical treatments. Current maintenance practices should be reviewed to ensure that fertilizer, watering, and pesticide application rates are optimal. Local specialists should be consulted when problems are encountered.

Native plants are best adapted for existing climatic and soil conditions and the use of potentially invasive plants should be avoided and eliminated. The list of approved plants in the Guam Landscaping Guide should be used to determine suitable plants to be included in JRM site plans (NAVFACPACIFIC 2011). This will reduce maintenance costs while enhancing the appearance of JRM sites.

Management Strategy

In the process of identifying grounds-maintenance strategies, a list of goals (see **Table 5-12**) was generated that was used to create ecologically sustainable management objectives.

Table 5-12. Summary of Developed Land Management Goals

Developed Land Management Goals
• Minimize or avoid adverse effects from grounds-maintenance activities to the overall ecosystem and its sensitive resources. • Make maximum use of regionally native plant species and avoid introduction of invasive, exotic species in revegetation activities. • Ensure compliance with Final Guam Landscaping Guidelines. • Reduce chemical usage, and maintenance inputs in terms of energy, water, manpower, equipment, and chemicals. • Ensure compliance with environmental legislation, regulations, and guidelines. • Control pests and invasive species. • Ensure the orderly and scientific management of the urban trees on JRM to the extent compatible and consistent with the mission.

Objectives, strategies, and monitoring criteria designed to address specific management issues on JRM sites are presented below.

5.12.1 LM-1: Implement Integrated Grounds Maintenance Consistent with the INRMP

Issue: Integrated grounds maintenance is important to minimize cost, protect the environment (particularly the sole-source aquifer and threatened and endangered species), and support the military mission.

Objective: Implement integrated grounds maintenance in a manner that minimizes cost, protects the environment (particularly the sole-source aquifer and threatened and endangered species), is consistent with the INRMP and is compatible with the military mission.

All strategies described as follows for Andersen AFB will be developed and implemented in coordination with the AMT, which includes USFWS Ecological Services, GNWR, and GDAWR.

Strategies:

1. Use and continue to update the Guam Landscaping Guide (NAVFACPACIFIC 2011).
2. Maintain or convert as much improved grounds to semi-improved acreage as possible by reviewing grounds maintenance areas, evaluating grounds maintenance requirements, and adjusting grounds maintenance maps as needed. Parcels should be chosen based on their current cover type, slope, and aspect to ensure that healthy grounds can subsist with minimal physical manipulation to the site. Converted improved grounds will be managed as semi-improved grounds.
3. Provide landscaping that is functional in nature, simple and informal in design, compatible with adjacent surroundings, and complementary to the overall tropical setting of JRM.

4. Protect native wildlife and their habitat as follows:
    a. Ensure grounds-maintenance and landscaping projects are coordinated with other natural resources programs including the protection of threatened and endangered species, the BASH program, IPM, and the Cultural Resources Management Program.
    b. Continue to coordinate with JRM site natural resources staff to reduce or avoid disturbing threatened and endangered species, or migratory birds during routine or special grounds maintenance projects by rescheduling or redirecting work to avoid excessive disturbance to species and by developing a sign program.
    c. Provide training to JRM site staff and contractors on the natural history and natural and cultural resources concerns at JRM sites, advising staff of responsibilities for wildlife protection, and assisting with the development of posters or brochures to aid in staff awareness of environmental concerns.
    d. Ensure the GIS database is current and includes grounds management units.

Monitoring Criteria: Periodically investigate areas converted to semi-improved acreage to assess the effects of the conversions on the military mission and the health and viability of the native vegetation. Evaluate the cost saving associated with conversions.

5.12.2 LM-2: Use of Native Species for Revegetation and Landscaping Activities

The Guam Landscaping Guide includes the following guidance for landscaping activities at JRM sites:

1. Ensure use of at least 50 percent native species for all landscaping projects.
2. Ensure at least 50 percent of the plants used are native species when existing landscape plants need to be replaced.
3. Implement a strategy of clumping several individual plants together whenever possible to increase potential for survival of plants during typhoons.
4. When possible, schedule planting to occur during the wet season between June and September to allow plants to become established before the dry season in January through May.

Issue: Nonnative and invasive species can be introduced to JRM sites during revegetation efforts and landscaping activities.

Objective: Maintain an aesthetically pleasing landscape on JRM sites that preserves natural ecosystem functions, conserves water in landscaped areas, and promotes pollinator species.

All strategies described as follows for Andersen AFB will be developed and implemented in coordination with the AMT, which includes USFWS Ecological Services, GNWR, and GDAWR.

Strategies:

1. Continue to revegetate exposed soils after ground-disturbing activities are conducted. In some situations, non-native species will have to be used to provide nutrients to the soil at some JRM sites (e.g., NMS) before native species are planted. Areas where non-native vegetation was used will be replaced in 5 to 10 years with native vegetation.
2. Implement recommendations within the Guam Landscaping Guidelines.

3. Ensure that regionally native species are selected for landscape plantings in accordance with EO 13148 and JRM site design standards.
4. Develop specifications and standards for reseeding/revegetation of disturbed sites for use in contracts, maintenance, and other projects to ensure that invasive species are not inadvertently introduced as a result of reseeding/revegetation post construction. Use Hazard Analysis and Critical Control Point, or similar protocols to develop specifications and standards.
5. Ensure that all plants are inspected at source to ensure pest-free status (e.g., little fire ants, weeds/seeds, vertebrates, arthropods, and diseases/pathogens). Treatments of plants containing or suspected of containing pests will be conducted in accordance with current control technologies for the target pest.
6. Provide professional advice to assist the grounds landscaping and maintenance program in the use of native species.
7. Ensure that plant material (including that which is contract grown and plant parts used for plant creation such as propagules) used for revegetation and landscaping activities come from local sources and is not introduced from other islands, or locations, to retain the genetic specificity of native species at a local level.

Monitoring Criteria: JRM site natural resources management staff will monitor the use and success of native species to rehabilitate exposed soils and the use of regionally native species for landscape plantings.

5.12.3 LM-3: Need for Control of Invasive Vegetation from Landscaping Activities

Objective: Develop and adopt proactive management measures to prevent the spread of invasive and nonnative vegetation from landscaping activities.

All strategies described as follows for JRM will be developed and implemented in coordination with the AMT, which includes USFWS Ecological Services, GNWR, and GDAWR.

Strategies:

1. Develop and implement BMPs to prevent the spread of invasive and nonnative species into other habitats adjacent to landscaped area. Where appropriate use Hazard Analysis and Critical Control Point, or similar protocols as a guide to developing specifications and standards.
2. For landscaping, use plants within the Guam Landscaping Guidelines.

Monitoring Criteria: Monitor landscaped areas where invasive plant species are known to occur and where management measures have been implemented. Survey landscaped areas for the emergence of invasive, exotic species and implement control measures as necessary.

5.12.4 LM-4: Implementation of the Pest Management Plan

Pest management objectives at JRM sites include the protection of real estate, control of potential disease vectors or animals of other medical importance, control of undesirable or nuisance plants and animals (including insects), and prevention of damage to natural resources. Two pest management plans have been developed for JRM sites, one for NBG that will be finalized as of 2013, and one for Andersen AFB that was completed in 2009. Authority for pest management activities on JRM is directed under the Federal Insecticide, Fungicide and Rodenticide Act as amended (7 U.S.C. 136r–1), DOD Instruction

4150.07, OPNAVINST 6250.4 series and OPNAVINST 5090.1C CH-1, Chapter 17, and AFI 32-1053, Pest Management Program.

Objective: Continue to implement the IPMP and ensure compliance with environmental legislation, regulations, and guidelines.

All strategies described as follows for Andersen AFB will be developed and implemented in coordination with the AMT, which includes USFWS Ecological Services, GNWR, and GDAWR.

Strategies:

1. IPM should use chemical, mechanical, physical, biological, and educational methods to maintain pests at populations low enough to prevent undesirable damage or annoyance.
2. Continue implementation of the IPMP at JRM sites.
3. Implement the IPMP and employ integrated pest management strategies that use methods of good management practices first and pesticide control measures last.
4. Methods that can be used to prevent the destruction of structures at JRM sites include the following:
    a. Prevent the entry of pests into buildings by closing holes, cracks, and crevices.
    b. Incorporate the latest barrier type technologies to minimize insect damage and chemical use.
    c. Use appropriate control methods to eliminate rodents that have established themselves in building interiors. The Integrated Pest Management Plan specifies the use of bait boxes and addresses the use of rodenticide as an option.
    d. Capture animals that pose a threat to building or infrastructure integrity for release or euthanasia. If released, these animals will be placed at a distance great enough from the improved areas of the site to prevent their reoccurrence.
5. Management measures to control pests posing a potential threat to human health include the following:
    a. Ensure proper sanitation and housekeeping to remove any food sources that might be attractive to interior pests (e.g., cockroaches, ants, flies).
    b. Remove the excrement of birds from underneath roosts on buildings and facilities to prevent the growth of harmful bacteria.
    c. Eliminate artificial breeding and larval habitat for flies and mosquitoes.
    d. Control mosquitoes, ants, termites, and other large insect infestations.
6. General management measures that should be used to control nuisance pests include the following:
    a. Capturing individual large animals for removal or euthanasia.
    b. Using snap traps and glue boards to trap rodents.
7. The IPMP should be reviewed and updated every 5 years to ensure that it reflects changes in pest populations and current management issues.

Monitoring Criteria: Monitor pest and invasive species populations. Track use of active ingredients and man-hours spent controlling pest and invasive species during implementation to ensure that the management strategies are sufficient.

5.13 Coastal Zone Management Act Compliance

The Coastal Zone Management Act (CZMA) (U.S.C. Title 16, Chapter 33) defines the coastal zone of a given area as "the coastal waters (including the lands therein and there under) and the adjacent shorelands (including the waters therein and there under) strongly influenced by each other and in proximity to the shorelines of the several coastal states and territories, and includes islands, traditional and intertidal areas, salt marshes, wetlands and beaches" (U.S.C. Title 16, Chap. 33). Coastal zones are important to natural functions because of the diversity of biological and hydrological interactions which occur in them. These include water and land forms interacting as integrated ecological units; and interactions between estuaries, brackish and saline water, shorelands, offshore islands, and freshwater wetlands within estuarine drainages. These interrelated features are crucial to coastal fish and wildlife and their habitats and to coastal waters in general.

The entire Island of Guam is designated as coastal zone. The CZMA was enacted to "preserve, protect and where possible, to restore or enhance, the resources of the Nation's coastal zone for this and succeeding generations" (U.S.C. Title 16, Chapter 33). One of the main provisions of the Act is to manage coastal development to minimize the loss of life and property caused by improper development in flood-prone, storm surge, geological hazard, and erosion-prone areas; in areas likely to be affected by or vulnerable to sea level rise, land subsidence, and saltwater intrusion; and by the destruction of natural protective features such as beaches, dunes, wetlands, and barrier islands (U.S.C. Title 16, Chapter 33). In doing so, the CZMA encourages the states and territories to exercise their full authority over the lands and waters in the coastal zone by assisting them in cooperation with Federal and local governments and other vitally affected interests, in developing land and water use programs for the coastal zone. These include unifying policies, criteria, standards, methods, and processes for dealing with land and water use decisions of more than local significance (U.S.C. Title 16, Chapter 33).

GovGuam implements the requirements of the CZMA through the *Organic Act of Guam of 1950, as amended, 64 Stat. 384* (48 U.S.C. § 1421, et seq.). This Act specifies that the Governor shall be responsible for executing the laws of Guam and applicable U.S. laws in Guam.

Coastal issues overlap with management issues and concerns for outdoor recreation and public access. Coastal areas at JRM support significant biological resources in a relatively undisturbed condition including native limestone cliffs and forests, native coastal plain forests, coastal strand vegetation, beaches, and the marine environment. The coastal areas provide habitat for the endangered Mariana fruit bat, nesting habitat for threatened and endangered sea turtles, and foraging areas for a variety of native shorebirds. Offshore, a rich and diverse marine ecosystem supports threatened and endangered sea turtles, marine mammals, and a variety of seabirds and shorebirds. Risk Assessment procedures ensure that coastal resources will be protected by ensuring consideration early in the planning stages, and through proper coordination with the appropriate agencies.

A summary of the CZMA compliance goals is presented in **Table 5-13**.

Table 5-13. Summary of Coastal Zone Management Act Compliance Goals

Coastal Zone Management Act Compliance Goals
• Collaborate with Federal agencies, GovGuam, and local interests in preserving the marine environment through unifying policies, criteria, standards, methods, and processes for dealing with land and water use decisions of more than local significance. • Ensure that the future maintenance of JRM's coastal zone resources is performed in a manner that supports shoreline stabilization and the reduction of erosion and sedimentation into marine environments without compromising the military mission. • Ensure that future maintenance of JRM's coastal zone resources is performed in a manner that supports the diverse biological and hydrological functions unique and significant to coastal zones.

5.13.1 CZ-1: Protection, Maintenance, and Enhancement of Natural Resources in Coastal Zones

Issue: Coastal areas of JRM are important to the health of the endangered Mariana fruit bat, nesting habitat for threatened and endangered sea turtles, and foraging areas for a variety of native shorebirds. Offshore, a rich and diverse marine ecosystem supports threatened and endangered sea turtles, marine mammals, and a variety of seabirds and shorebirds.

Objective: Continue to protect, maintain, and enhance natural resources in the coastal zone of JRM in a manner consistent with the CZMA.

All strategies described as follows for Andersen AFB will be developed and implemented in coordination with the AMT, which includes USFWS Ecological Services, GNWR, and GDAWR.

Strategies:

1. Ensure activities in the coastal zone have obtained Federal Consistency Review.
2. Ensure that human activities in the coastal zone do not affect coastal zone resources by:
    a. Minimizing future lighting in the beach areas and adjust existing lights to prevent disturbance to threatened and endangered nesting sea turtles.
    b. Limiting development in the shoreline areas to perpetuate their natural and scenic values.
    c. Continue to inform the public about the regulations regarding protection of coastal resources.
3. Review the status of actions prescribed under CZ-1 at the annual INRMP review meeting. Initiate actions based on the review to ensure that actions are, or will be, implemented as prescribed pending available funding.

Monitoring Criteria: Continue to ensure that proposed development activities have obtained Federal Consistency Review, human activities in the coastal zone are not adversely affecting the coastal and marine environment, and regulations are being enforced. Continue to inform, educate, and provide opportunities for the public with respect to the coastal zone.

5.14 Wildland Fire Management

Federal wildland fire policy requires that all Federal lands with burnable vegetation have a fire plan and resources to safely mitigate losses. This policy was adopted by the DOD Wildland Fire Policy Working Group in 1996. DOD fire policy was developed by DOD Instruction 6055.06 Fire and Emergency Services Program.

This is of particular concern because of the safety and mission-related consequences that could occur if wildland fires were to damage the Fuel Farm or ordnance-storage facilities. Although these dangers exist, wildland fire management has been limited to the construction and maintenance of fuel breaks, mowing and trimming grass, and the suppression of the smaller fires that are accessible to fire engines and larger fires encroaching into the wildland-urban interface. Helicopters have been used periodically, but infrequently, on problem fires. Recently the Navy identified the need for a more comprehensive wildland fire management program and is in the process of developing a Wildland Fire Management Plan for JRM.

Table 5-14 identifies the wildland fire goal for this INRMP.

Table 5-14. Summary of Wildland Fire Management Goals

Wildland Fire Management Goals
• Support a Wildland Fire Management Program to protect high-value natural resources areas and operational facilities from catastrophic wildfire while conserving resources and military operational flexibility.

5.14.1 WFM-1: Managing for Wildland Fire on JRM

Objective: Update and implement the Wildland Fire Management Program for NBG and ensure it is compliant with DOD Instruction 6055.06, meets the goals and objectives of this INRMP, and is compatible with the mission.

Strategies:

1. Continue revegetation of badlands within the NMS.
2. Update the Wildland Fire Management Plan.
    a. Request funding to update the plan during FY13. Award contract in FY16.
    b. Submit a draft of the updated plan for agency review FY16.
    c. Once agency comments have been received and incorporated, finalize the plan.
3. Develop and implement all goals and objectives within the Wildland Fire Management Plan. Review and update the Wildland Fire Management Plan according to DOD Instruction 6055.06.
4. Implement all erosion conservation strategies contained within JRM site conservation plans, and wildland fire management assessment for Fena Reservoir watershed, and the NMS. Implement recommendations identified in Wildland Fire Management Assessment and Fena Ordnance Site Conservation Plan, including critical area plantings of eroding sites, changing of forest fuel characteristics through establishing green forests for fuel breaks, and other soil and water conservation measures.

5. Determine areas on JRM sites that are susceptible to wildland fire, and continue to establish greenbelts to reduce spread of savanna grassland fires on JRM sites.

5.15 Urban Forestry Management

Andersen AFB has made a considerable investment in beautifying the installation by planting ornamental trees throughout improved areas, and by conservation planting in other areas. Andersen AFB possesses a significant urban forestry resource that must be managed properly. No commercial forestry resources are present on Andersen AFB. Native forest trees that were once considered important timber species do occur in limestone forests at Andersen AFB. However, these areas are currently managed as habitat for threatened and endangered species and to preserve native biodiversity.

Table 5-15 identifies the urban forestry goals for this INRMP.

Table 5-15. Summary of Urban and Commercial Forestry Management Goals

Urban and Commercial Forestry Management Goals
• Ensure the orderly and scientific management of the urban trees on JRM sites to the extent compatible and consistent with the mission. • Promote use of native plants in landscaping where applicable. Replace any trees removed from landscaped areas with native trees.

5.15.1 FOR-1: Management of Andersen AFB Urban Forest Resources

Urban areas on Andersen AFB and other JRM sites are managed primarily for aesthetics, recreation, and compatible wildlife preservation; and for visual and noise-buffering capacity. Urban forest management is accomplished largely by removal of trees that are dead, dying, diseased, or damaged; or that pose safety hazards, and by occasional brush removal. Trees used for urban planting should be native to the region and require minimal amounts of maintenance.

Issue: Andersen AFB and other JRM sites have urban forestry resources that require continuous management.

Objective: Ensure that management of urban trees on JRM sites is compatible with the goals and objectives within this INRMP.

All strategies described as follows for Andersen AFB will be developed and implemented in coordination with the AMT, which includes USFWS Ecological Services, GNWR, and GDAWR.

Strategies:

1. Continue to implement the integrated grounds maintenance program to minimize the amounts of chemicals and water needed to maintain grounds and landscaped areas in healthy and attractive conditions. Collaborate with technical specialists from local agencies to develop an Urban Forestry Plan for JRM that includes specifications for soil types, planting requirements, watering and fertilizer regimens, pest control, disease treatments, and other maintenance practices.

2. Develop and maintain an urban forestry database to catalogue existing trees and provide a schedule for their maintenance. Such a database will be useful in assessing the diversity of urban tree species and to gauge the selection of species for future plantings.
3. Continue to manage urban forest resources for disease, damage, and replacement.
4. Plant native trees along the cliff tops to provide native seed rain for passive native forest recovery.
5. Review the status of actions prescribed under FOR-1 at the annual INRMP review meeting. Initiate actions based on the review to ensure that actions are, or will be, implemented as prescribed pending available funding.

Monitoring Criteria: Ensure that urban forest resources are managed in accordance with the goals established in this section. Specific changes to management of urban tree species should be based on annual recommendations made by a consulting arborist/urban forester.

5.16 Law Enforcement

JRM has established the following objectives for enforcement: (1) enforce laws and regulations pertaining to the implementation of the natural resources program, (2) integrate natural resources enforcement into the overall natural resources program, and (3) use enforcement personnel to enhance the natural resources program at JRM.

A summary of the law enforcement goals is provided in **Table 5-16**.

Table 5-16. Summary of Natural Resources Law Enforcement Goals

Natural Resources Law Enforcement Goals
• Ensure compliance with Guam, CNMI and Federal natural resources laws and regulations. • Provide training to personnel responsible for enforcement of applicable laws and regulations. • Secure and sustain dedicated conservation law enforcement personnel. • Ensure the community is aware of Guam and Federal natural resources laws and regulations, and the responsibilities of law enforcement personnel. • Coordinate with USFWS law enforcement, and seek qualified trainers to help installation security to enforce all environmental regulations, not limited to those that protect threatened and endangered species.

Objective: Ensure compliance with Guam, Federal, and JRM natural resources laws and regulations.

Strategies:

1. Provide training to personnel responsible for enforcement of applicable laws and regulations.
2. Continue to protect rare, threatened, endangered, and species of concern and natural communities.
3. Cooperate with other agencies, particularly the USFWS, GNWR, CNMI DLNR and GDAWR, to ensure that natural resources laws are adequately enforced.
4. Establish and fill at least two conservation officer positions to patrol JRM sites (terrestrial and submerged lands) and enforce natural resources regulations (i.e., hunting, fishing).

5. Periodically review Federal and Guam laws and regulations to ensure natural resources laws and regulations are adequately enforced.

5.17 Outdoor Recreation Management

It is the policy of DOD to make lands accessible to the public for educational or recreational use of natural and cultural resources when such access is compatible with military mission activities; ecosystem sustainability; and other considerations such as security, safety, and fiscal soundness. Also, section 2904 of the 1997 SAIA states that each INRMP shall provide, to the extent appropriate, for the "sustainable use by the public of natural resources to the extent that the use is not inconsistent with the needs of fish and wildlife resources" and "subject to requirements necessary to ensure safety and military security."

Public access for recreational use of natural resources on JRM has varied over time and has included the following:

- Access to beaches and coastal areas for swimming, beachcombing, fishing, trapping, boating, bird watching, snorkeling, and SCUBA diving.
- Access to NMS, Fena Reservoir, HERA, OPERA, Tarague Basin, and Pati Point natural areas.
- Access to NBG TS and Andersen AFB for Philippine deer and feral pig hunting. There is no hunting on NBG, and AAFB has very limited hunting opportunities. NBG and AAFB also have a limited fishing.
- Access to undeveloped lands for nature hiking, gathering of medicinal plants, and subsistence collection of forest fruits and seeds.
- Access to inland waters and coastal areas for kayaking, sailing, and boating.

Outdoor recreation includes activities to maintain morale, and these activities are available to DOD personnel, civilians, and their guests. Outdoor recreation programs ensure that DOD personnel, civilians, and their guests are properly educated on the natural resources of Guam, the concerns and threats to those resources, and good stewardship practices to ensure that resources are maintained.

A summary of the goals used for managing outdoor recreation resources is provided in **Table 5-17**.

Table 5-17. Summary of Outdoor Recreation/Public Access Management Goals

Outdoor Recreation Management Goals
• Provide quality outdoor recreation experiences while sustaining ecosystem integrity. • Ensure that outdoor recreation activities are not in conflict with mission priorities or natural resources management objectives. • Ensure recreational activities comply with Federal and local laws and installation instructionsTable has been , and provide recreation opportunities for disabled Americans and veterans were appropriate.

The following are natural resources management issues that need to be addressed to maximize positive benefits of outdoor recreation programs and minimize potential adverse impacts on the environment.

5.17.1 OR-1: Coordination of Outdoor Recreation Programs at JRM

Issue: Outdoor recreation programs need to be coordinated with appropriate personnel to ensure that there will be no adverse impacts on wildlife, important wildlife habitat, or the mission.

Objective: Provide quality outdoor recreation experiences while sustaining ecosystem integrity and not conflicting with mission priorities.

All strategies described as follows for Andersen AFB will be developed and implemented in coordination with the AMT, which includes USFWS Ecological Services, GNWR, and GDAWR.

Strategies:

1. Continue to limit public access and outdoor recreation for reasons that include general security and liability issues, the presence of federally endangered and threatened species, and safety.
2. Remain in compliance with the requirements associated with the provisions of the American with Disabilities Act of 1990, as amended and the Disabled Sportsman Access Act, as amended.
3. Identify and evaluate suitable outdoor recreation opportunities for JRM personnel in undeveloped areas that do not contain or have the potential to impact sensitive species.
4. Develop outreach and education materials to inform recreational users about sensitive and protected marine resources. Distribute information in welcome aboard packages; through required training or certification programs (e.g., for MWR dive gear and boat rentals); and through signage at JRM recreational beaches, marinas, and boat ramps. [Requirement from BO]
5. Collaborate with local dive shops to educate dive operators on low-impact diving activities and implement "reef friendly" diving practices.
6. Collaborate with GDAWR to conduct Limit of Acceptable Change process for marine recreational activities.
7. Continue to ensure effective communication between the planners and recreational planners and users to protect natural resources through full consideration early in the planning process and through consultation to reduce or avoid adverse impacts on wildlife and their habitat in ERAs as follows:
    a. Coordinate new recreation programs and projects with the appropriate personnel (e.g., Environmental Flight at Andersen AFB, and NBG).
    b. Continue to evaluate the need for and environmental impact of proposed recreational activities and provide recommendations to minimize impacts on the coastal environment.

Monitoring Criteria: Continue coordination to protect habitat and the integrity of the coastal environment.

5.17.2 OR-2: Minimizing Human Disturbance to Threatened and Endangered Species and Protection of Coastal Habitat

Proposed recreational development projects should be coordinated with USFWS, GNWR, CNMI DLNR and GDAWR when these projects are in close proximity to habitats of threatened and endangered species.

Issue: Coastal areas at JRM sites provide habitat for many species. Noise from recreational boats, bands or other loud music, and the human disturbance inherent in large crowds could have an adverse impact on

wildlife at the HERA, OPERA, Spanish Steps, Gab Gab Beach, San Luis Beach, Dadi Beach, Tarague Basin, and other JRM sites. Public use of coastal areas increases the amount of solid waste that is introduced into the environment, the risk of the spread of noxious plants, and the risk of development that compromises the integrity of these areas.

Objective: Prevent human disturbance of threatened and endangered species. Preserve and protect high-quality habitat and coastal areas.

All strategies described as follows for Andersen AFB will be developed and implemented in coordination with the AMT, which includes USFWS Ecological Services, GNWR, and GDAWR.

Strategies:

1. Coordinate with appropriate JRM site personnel to protect all beaches with turtle nesting activity.
2. Establish a policy to ban driving on beaches, through placing barriers on beaches to prevent vehicular access for vehicles other than emergency responders. Develop signs that provide emergency phone numbers and place near barriers.
3. Beach lighting should be minimized to protect essential nesting areas at the Tarague Basin Area. Replace any lights at the public areas of Tarague and other active nesting sites that are adjacent to turtle nesting sites or beaches. All new facilities should be constructed in such a way that lighting impacts on sea turtle nesting beaches are reduced or avoided.
4. Develop and distribute educational outreach materials including signage and pamphlets, to discourage human disturbance to listed species.
5. Develop BMPs to prevent debris resulting from either recreational or construction activities from polluting the environment.
6. Enforce off-limit areas using trained military law enforcement staff.
7. Increase monitoring and enforcement in fruit bat roosting areas.
8. Enforce marine preserve rules, regulations, and laws.
9. Develop information signs concerning wildlife protection.
10. Coordinate with the USFWS to monitor the outdoor recreation program demands and resources and enforce use limits, if deemed necessary.

Monitoring Criteria: Ensure that coordination and enforcement continues to protect threatened and endangered species.

5.17.3 OR-3: Expansion of Interpretive Programs to Educate Installation Personnel and the Public about Natural Resources on JRM Sites

Recreational facilities with specific natural resources management strategies on NBG and Andersen AFB include the following (U.S. Navy 2010b):

Orote Point. The 1-mile (2-kilometer) hike begins near the end of Orote Peninsula. The trail leads through a forested area and through cave bases and terminates at a coral pebble beach. Hikers may swim and snorkel at the beach. The trail passes within the explosive arc for Kilo Warf, so access is limited.

Old Fuel Piers. North of the Old Fuel Piers are the remains of two Japanese seaplanes. Visitors may scuba dive or snorkel.

Shark Pit. This dive spot marks the site where, after World War II, AMTRACS, mess hall trays, old china, food, and garbage were dumped and ultimately attracted sharks. Sharks could be present, and tuna, jacks, butterfly fish, and parrotfish are abundant. Water depths range from 1 to more than 130 feet (40 meters).

Blue Hole and Crevice. This crevice is a deep canyon with a large boulder at the mouth off Orote Peninsula. There are sea fans, whips, fish, moray eels, shells, and corals in 60 to more than 130 feet (18 to 40 meters) of water.

Sponge Reef. This 300-foot (91-meter) reef is relatively flat where numerous corals, anemones, and fish are present at depths ranging from 40 to 100 feet (12 to 30 meters).

Finger Reef. The water depth at this reef reaches 100 feet (30 meters) in depth.

San Luis Beach and Fort San Luis. This beach offers picnic facilities and a swimming area.

Gab Gab Beach. This beach is noted for snorkeling and plenty of fish in waters reaching 100 feet (30 meters) in depth. There are picnic tables and shelters on site.

Dadi Beach. Dadi Beach is a kayak starting point to Turtle Rock, North Tipalao Cave, and Agat Marina.

Polaris Point Beach. A small beach located at Polaris Point. There is a small MWR club there with cabanas, canoes, and fishing boats to rent.

Guided interpretive outings at the Tarague Basin Nature Trail are provided on a time-allowed basis. These programs could be expanded to a regularly scheduled quarterly event if staffing permits. If staffing is a limited factor in presenting interpretive programs, JRM should consider using docents or volunteer work programs such as the Student Conservation Association (SCA) program. The SCA program allows volunteers with an interest in working in natural resources management-related fields to gain experience in interpretation and resource management.

Protection of historic and cultural resources, and development of interpretive programs that integrate cultural values, are important management concerns for outdoor recreation programs. Trails should be located to ensure protection of resources, but also to allow study and observation of these sites. Coordination of outdoor programs with the Guam Historic Preservation Officer and the Cultural Resources Planner will ensure that the public enjoyment of cultural resources is conducted in a manner that is culturally sensitive and meets mission requirements.

Educational and interpretive programs and materials (such as signs, brochures, lectures, and guided walks) foster an increased understanding of and appreciation for the unique natural heritage of recreational areas, encourage a conservation ethic, promote public safety, and inform the public of wildlife laws and USAF regulations. The development, installation, and maintenance of interpretive signs and kiosks simultaneously benefit both Natural Resources and Outdoor Recreation programs.

A Legacy Program project was completed in 2000 that established an interpretive trail and public program in the Tarague Basin. The project integrated the natural and cultural resources of the area into an interpretive trail. An interpretive brochure *Journey into Tarague's Past* was created and is available at information kiosks at the start of the Tarague Basin Interpretive Trail.

Adequate funding and staffing of outdoor recreation programs is essential to provide a safe, enjoyable, and quality outdoor recreation experience. Camping programs generate income, while intensive beach recreation areas tend to consume funds because of costs associated with lifeguard salaries, facility

maintenance costs, and operations expenses. Other programs, such as hiking programs, do not generate income, but also do not require extensive cash outlays.

Issue: There is a high demand for access to outdoor areas at JRM sites.

Objective: Continue to provide opportunities for public access and enjoyment of natural resources by implementing new interpretive programs that balance mission requirements for outdoor recreation with the need to protect and recover threatened and endangered species, and conserve other elements of natural biodiversity.

All strategies described as follows for Andersen AFB will be developed and implemented in coordination with the AMT, which includes USFWS Ecological Services, GNWR, and GDAWR.

Strategies:

1. Develop and conduct natural resources education classes for all new JRM personnel and local dive shops. [Requirement from BO]
2. Develop and implement a plan for recreational activities occurring within submerged lands. Plan development will include conducting user surveys and developing strategies to minimize impacts on coral reefs and other marine resources.
3. Continue to develop and distribute information about the natural resources at JRM sites. [Requirement from BO]
4. Continue to provide information about natural resources and outdoor recreation activities and services at JRM sites to JRM personnel and the public through the installation newspapers, "Commander's Channel," signs, flyers, briefings, and pamphlets.
5. Continue to seek out new funding sources for interpretive programs.
6. Coordinate with resource agencies to develop signage to inform visitors and recreational users about the protected resources present at particular sites, including restrictions against interactions with those resources.

Monitoring Criteria: Maintain programs and associated materials to improve JRM personnel and the public's knowledge of natural and cultural resources on JRM sites. Inform JRM personnel about the interpretive areas and their availability for outdoor recreation.

5.18 Educational Outreach

Conservation awareness is instrumental in creating conditions needed to manage natural resources. The JRM approach to awareness stresses education. It provides military personnel and the public with insights into installation natural environments and conservation challenges. The more that people know about the unique and valuable natural resources on JRM, the more responsibly they will act toward using them.

Education also promotes awareness of critical environmental projects and the rationale behind them. Activities such as habitat management, wildlife management, and land rehabilitation can be accomplished with little conservation awareness effort since installation personnel, recreationists, and the general public support these easily understood efforts. However, issues such as protection of sensitive areas for plant and wildlife species, invasive species management (ungulate management), wildfire suppression and restrictions on some recreational activities in JRM managed lands require effective conservation

communication to get positive support and, perhaps more importantly, to avoid adverse reactions from various users. A conservation awareness program must be directed to both installation and external interests if it is to be effective.

The goals for educational outreach are summarized in **Table 5-18**.

Table 5-18. Summary of Educational Outreach Management Goals

Educational Outreach Management Goals
• Maintain an active Educational Outreach Program to inform JRM personnel and the public of ongoing and planned natural resources activities on JRM sites. • Work with partners to develop newspaper, radio, television public service messages and website and education materials for the public describing non-native invasive species, their impacts to native species, and what can be done for their prevention and control. • Support opportunities to work collaboratively through a MOU or MOA with the local government and agencies, which will afford improved biosecurity for both DOD and the community as a whole.

5.18.1 EO-1: Develop and Implement an Educational Outreach Program for JRM

Natural resources personnel will work with local agencies and volunteers, whenever feasible, to use their skills and build their interest in the installation natural resources program.

Issue: Public outreach and education are instrumental in promoting awareness of critical environmental programs, issues and projects, and the rationale behind them. Public awareness helps to create support for natural resources management actions conducted by JRM.

Objective: Provide personnel on JRM lands and people in the surrounding community with an understanding of the JRM natural resources program.

Strategies:

1. Develop outreach and education materials to inform JRM personnel and the public of natural resources programs and activities on JRM sites.
2. Periodically review existing outreach and education materials to ensure that each is still current and meeting goals of the outreach and education program.
3. When possible, reach out to local community groups for volunteers.
4. Establish a watchable wildlife program.
5. Educate the local community, as well as JRM personnel and tenants about the installation natural resources program.
6. Develop outreach and education materials for the public describing non-native invasive species, their impacts to native species, and what can be done for their prevention and control.
7. Support opportunities to work collaboratively through a MOU or MOA with local government and agencies, to help improved biosecurity for both DOD and the community as a whole.

Monitoring Criteria: Maintain outreach and educational materials to improve JRM personnel and the public's knowledge of natural resources programs on JRM sites. Actively inform JRM personnel and the public about natural resources programs and activities being conducted on JRM sites.

5.19 Geographic Information Systems and Data Management, Integration, Access, and Reporting

Natural resources data will be stored and maintained within the GIS database. The GIS database will also provide support for the entire environmental program and the training community. JRM will use GIS for complex analyses such as project siting, data interpolations, and risk assessments.

GIS software enables installation staff to capture, store, update, manipulate, analyze, and display all forms of geographically referenced data and tabular information about the JRM sites The training of JRM staff and the allocation of their time to data entry, mapmaking, analysis of data, and interpretation of the results will determine the success of the installation GIS.

Once fully developed, the installation GIS databases can be used for projects such as the following:

- Providing maps.
- Selecting suitable areas for construction activities.
- Planning land rehabilitation projects.
- Providing special maps for Environmental Awareness materials.
- Ensuring avoidance of rare species habitats and other areas of special concern during construction projects.
- Identifying site options for use during NEPA evaluation of alternative sites.
- Calculating drainages and water flows.
- Determining wildlife habitat preferences.

The goals for establishing GIS management issues and strategies are summarized in **Table 5-19**.

Table 5-19. Summary of GIS and Data Management Goals

GIS and Data Management Goals
• Collect, store, and maintain data about historical conditions, trends, and current status of natural resources. • Use GIS information as benchmarks for developing future natural resources management goals and objectives.

5.19.1 DM-1: Continued Use, Development, and Maintenance of GeoBase for Natural Resources Management

Issue: A current and functional GIS database is required to effectively manage the natural resources on JRM lands and meet natural resources goals and objectives.

Objective: Collect, store, develop, and maintain data about historical conditions, trends, and current status for critical indicators of ecological integrity and sustainability.

Strategies:

1. Use GIS information as benchmarks for developing future natural resources management goals and objectives.
2. Use GIS to develop natural resources constraints maps for use in JRM management and planning decisions.
3. Ensure that GIS information is available to biologists, planners, contractors, and others in a quick and timely manner.
4. Annually review GIS data to advise resource managers of needs to update data sets during budget planning and programming.
5. Develop specific language that will be included in all contracts to ensure all spatial data produced are fully compatible with the installation GIS database.
6. Develop a standardized system for recording and mapping significant resource observations (e.g., plants, wildlife, erosion, damage) when incidentally encountered.
7. Provide annual funding for one person to be responsible for updating and maintaining the GIS database. This should include the necessary hardware, software, and training for the use of GIS.

Monitoring Criteria: Progress will be measured by the effectiveness and accuracy of the GeoBase Natural Resources theme in natural resources planning. All data will be collected in accordance with DOD and Navy standards.

6 Implementation

The U.S. Navy and JRM intend to implement this INRMP within the framework of regulatory compliance, national U.S. Navy mission obligations, ATFP limitations, and funding constraints. Any obligation of funds for INRMP actions shall be subject to the availability of funds appropriated by Congress, and none of the proposed INRMP actions shall be interpreted to require obligation or payment of funds in violation of any applicable Federal law, including the Anti-Deficiency Act, 31 U.S.C. § 1341, et seq.

There are many strategies and recommendations of this INRMP that will not require specific funding, but that constitute the management direction adopted by the Commanding Officer for NBG, and the General for Andersen AFB and are expected to be implemented by existing resources and staff. **Appendix C** summarizes INRMP actions that will require a request of funds. Separate tables for NBG and Andersen are provided to facilitate planning, funding, and implementation.

6.1 Project Prescription Development

The most recent policy on INRMP implementation is contained in DOD Memorandum *Implementation of the Sikes Act Improvement Act: Updated Guidance* (DUSD [I&E] 2002). According to the memorandum, an INRMP is considered implemented if an installation does the following:

- Actively requests, receives, and uses funds for "must fund" actions and activities.
- Ensures that sufficient numbers of professionally trained natural resources management personnel are available to perform the tasks required by the INRMP.
- Coordinates annually with all cooperating offices.
- Documents specific INRMP action accomplishments undertaken each year.
- Key elements of INRMP implementation (e.g., actions) are addressed in **Appendix C**.

Project priority within this INRMP is determined by funding classification, as defined in DOD Instruction 4715.03, *Environmental Conservation Program* (DOD 2011). The revised 4715.03 discusses recurring and non-recurring conservation management requirements. **Table 6-1** compares funding classes for recurring and non-recurring conservation requirements in DOD Instruction 4715.03, with the Environmental Readiness Levels (ERLs) used by the Navy (DoN 2007).

6.2 Project Development and Tracking

INRMP actions are tracked and allocated funding via the Navy Environmental Program Requirements Web (EPRWeb) (U.S. Navy 2006). The EPRWeb is used by the Navy to determine programming and budgeting requirements for INRMP actions under the Planning, Programming, Budget, and Execution System (PPBES) process (DoN 2007). Metrics support the "Department of Defense FY 2012 Defense Environmental Programs Annual Report to Congress (DEP ARC) and FY 2012 Environmental Management Review (EMR)." Each year, DOD submits a Congressional report in fulfillment of its reporting requirements to Congress. They FY 2012 Congressional report will discuss how the DOD's environmental programs used Congressional funding last fiscal year and will detail accomplishments and outline future plans for fulfilling commitments to protect human health and the environment. An FY 2012 DOD EMR is scheduled for February 2013 to ensure DOD is on track to meet its environmental management goals.

Table 6-1. Funding Classes for Recurring and Non-Recurring Conservation Requirements and Navy Environmental Readiness Levels

Recurring and Non-Recurring Conservation Requirements (DODI 4715.03)	Environmental Readiness Levels (DoN 2007)
Recurring Natural Resources Conservation Management Requirements: a. Administrative, personnel, and other costs associated with managing the DOD Natural Resources Conservation Program that are necessary to meet applicable compliance requirements in Federal, state, territorial and CNMI laws; regulations; EOs; and DOD policies, or in direct support of the military mission. b. DOD components shall give priority to recurring natural resources conservation management requirements associated with the operation of facilities, installations, and deployed weapons systems. These activities include day-to-day costs of sustaining an effective natural resources management program, and annual requirements, including manpower, training, supplies, permits, fees, testing and monitoring, sampling and analysis, reporting and recordkeeping, maintenance of natural resources conservation equipment, and compliance self-assessments.	**Environmental Readiness Level 4:** Legal requirements derived from existing laws and Executive Orders (E.O.) and Final Governing Standards or Overseas Environmental Baseline Guidance Document (OEBGD), as applicable, which apply to Navy activities, platforms and operations. These OMB/EPR Class 0, 1 and 2 EPRs/ongoing efforts include responding to applicable Federal, state and local requirements (e.g., ESA; MMPA; RCRA; CWE; CAA; SDWA; NEPA; TSCA; OPA, APS and Executive orders such as 12088 (Federal Agency Compliance), 12843 (ODS Conversion/ replacement), and 13423 (PW, Recycling, ODS, Energy Conservation). a.
Non-Recurring Natural Resources Management Requirements. **Current Compliance.** Includes installation projects and activities to support: a. Installations currently out of compliance (e.g., received an enforcement action from an authorized Federal, state, territorial, or CNMI agency or local authority). b. Signed compliance agreement or consent order. c. Meeting requirements with applicable Federal, state, territorial, or CNMI laws, regulations, standards, EOs, or DOD policies. d. Immediate and essential maintenance of operational integrity or military mission sustainment. e. Projects or activities that will be out of compliance if not implemented in the current program year including the following: i. Environmental analyses for natural resources conservation projects, and monitoring and studies required to assess and mitigate potential impacts of the military mission on conservation resources. ii. Planning documentation, master plans, compatible development planning, and INRMPs. iii. Natural resources planning-level surveys. iv. Reasonable and prudent measures included in incidental take statements of BOs; biological assessments; surveys; monitoring; reporting of assessment results; or habitat protection for listed, at-risk, and candidate species so that proposed or continuing actions can be modified in consultation with the USFWS or NMFS. v. Mitigation to meet existing regulatory permit conditions or written agreements. vi. Nonpoint source pollution or watershed management studies or actions needed to meet compliance dates cited in approved state or territorial coastal nonpoint source pollution control plans, as required to meet consistency determinations consistent with Coastal Zone Management. vii. Wetlands delineations critical for the prevention of adverse impacts on wetlands, so that continuing actions can be modified to ensure mission continuity. viii. Compliance with missed deadlines established in DOD-executed agreements.	**Environmental Readiness Level 3:** Requirements derived from DOD policy, Navy Policy, or proactive initiatives that could result in obvious returns on investments and support critical readiness activities by decreasing encumbrances of statutory compliance (e.g. PCB elimination, regional environmental coordination, candidate conservation agreements, etc). These project/proposed efforts are not mandated by law or other Federal, state, or local regulations/orders but would minimize current or future impacts (including costs) to the Navy mission.

Recurring and Non-Recurring Conservation Requirements (DODI 4715.03)	Environmental Readiness Levels (DoN 2007)
Non-Recurring Natural Resources Management Requirements. Maintenance Requirements. Includes those projects and activities needed to meet an established deadline beyond the current program year and maintain compliance. Examples include the following: a. Compliance with future deadlines. b. Conservation, GIS mapping, and data management to comply with Federal, state, territorial, CNMI, and local regulations; EOs; and DOD policy. c. Efforts undertaken in accordance with non-deadline specific compliance requirements of leadership initiatives. d. Wetlands enhancement to minimize wetlands loss and enhance existing degraded wetlands. e. Conservation recommendations in biological opinions issued pursuant to the ESA.	**Environmental Readiness Level 2:** a. Requirements derived from DoD policy, Navy policy, or proactive initiatives that result in speculative returns on investments and uncertain benefits to the Navy mission. These projects/proposed efforts are not mandated by law or other Federal, state, or local regulations/orders and should be based on best available scientific or commercial data; or pending Federal, state, or local regulations under development (where publication is scheduled) using, if available, model state regulations or permit standards.
Non-Recurring Natural Resources Management Requirements. Enhancement Actions Beyond Compliance. Includes those projects and activities that enhance conservation resources or the integrity of the installation mission, or are needed to address overall environmental goals and objectives, but are not specifically required by law, regulation, or EO, and are not of an immediate nature. Examples include: a. Community outreach activities, such as International Migratory Bird Day, Earth Day, National Public Lands Day, Pollinator Week, and Arbor Day activities. b. Educational and public awareness projects, such as interpretive displays, oral histories, Watchable Wildlife areas, nature trails, wildlife checklists, and conservation teaching materials. c. Restoration or enhancement of natural resources when no specific compliance requirement dictates a course, or timing of action. d. Management and execution of volunteer and partnership programs.	**Environmental Readiness Level 1:** Investments in environmental leadership and general proactive environmental stewardship, and provides manpower and recurring cost to support these functions. **Environmental Readiness Level 0:** a. Functions as a blank or null option. Some guidebooks have their default ERL level set to 0. This is to ensure that users intentionally pick an ERL and not use the default.

Projects identified in **Appendix C** will need to be entered into the EPRWeb to ensure that natural resources management prescriptions identified in this INRMP are reviewed by the chain-of-command, and are documented for inclusion in the annual DEP ARC report to Congress (U.S. Navy 2006). Once funding is allocated, natural resources personnel at JRM are responsible for ensuring that the EPRWeb is updated with the date funding was received, and progress made towards completion (U.S. Navy 2006).

The Navy Natural Resource Metrics were developed to assist installations in evaluating INRMP implementation. Annually, each installation receives a report card informing them on where they stand regarding INRMP implementation. The program also requires each installation to address specific questions related to implementation to ensure that the implemented INRMP meets all regulatory requirements. Navy guidance suggests that project progress be updated at least twice per year in EPRWeb, and the information used to answer questions in the Annual Metrics Summary Report, which will be used to evaluate INRMP implementation (U.S. Navy 2006).

6.3 Funding Sources and Mechanisms

The PPBES budget process employed by the DOD is an ongoing, continuously reviewed process that can be summarized as follows (DOD 2005):

- The PPBES process consists of long-range planning to anticipate and secure requirements to meet security threats and accomplish program goals.

- Resources to meet these requirements are estimated and programmed by program managers in the Future Year Defense Plan (FYDP). The FYDP is a list of resource requirements for the next 6 years. Specifically, the FYDP composes the subsequent fiscal year budget and funding requirements projected out 5 years.
- The FYDP resources are then analyzed via the Programming Process. In the Programming Process, program managers reassess their requirements, reprioritize planned activity, reevaluate existing funding guidance, and estimate their funding needs for the next budget year, plus the subsequent 5 fiscal years (referred to as Program Objectives Memoranda (POMs) 1–5).
- The POM process takes place within Defense Components beginning in the fall of each year. Then each DOD component submits the POM in the spring to the OSD. The OSD reviews the budget submissions and develops the President's budget that will be submitted to Congress. At the installation level, data submissions to support this are made to the Major Commands twice annually, in fall and spring.
- Based on POM decisions of each component, budget controls are issued to the field commands for budget preparation.

The time scale of an INRMP fits well into the DOD PPBES forecasting process. One full cycle of the DOD budget process includes the next budgeted fiscal year and projections for the following 5 fiscal years. One full cycle of the INRMP, with upper command reapproval, covers a 5-year period. This means that by relying on an INRMP that is updated regularly, natural resources managers should be able to project relatively accurate funding requirements for 5-year periods, at a minimum (DOD 2005).

The Regional Commander or CO of NBG and the Wing Commander of Andersen AFB are responsible for ensuring that JRM has sufficient staff to implement the INRMP. Each JRM facility environmental office is responsible for annual coordination with USFWS, GDAWR and CNMI DLNR, requesting funds for INRMP implementation, and documenting implementation actions. Consequently, the projects and schedules proposed in this INRMP are targets to facilitate natural resources program planning. When requested funds are not received, natural resources management prescriptions and the programming schedule may be reexamined. In addition, plans may be adapted to account for the revised project schedule and the proposed budget may be adjusted to account for available funding.

6.3.1 Funding Sources

Once a project has been placed into the EPRWeb a funding source needs to be determined. In general, ERL Level 3 and 4 projects will receive funding, but it is up to natural resources managers to find funds for ERL Level 1 and 2 projects (U.S. Navy 2006). The following are the primary funding sources for Navy natural resources programs (U.S. Navy 2006):

1. **Operation and Maintenance, Navy (O&MN) Environmental Funds.** The majority of natural resources projects are funded with O&MN environmental funds. These appropriated funds are the primary source of resources to support must-fund, just-in-time environmental compliance (i.e., Navy ERL Level 4 projects). O&MN funds are generally not available for Navy Environmental Readiness Levels 3–1 projects. In addition to the restriction to Environmental Readiness Level 4 requirements, there are other limitations placed on the use of O&MN funds:
    a. Only the initial procurement, construction, and modification of a facility or project are considered valid environmental funding requirements. The subsequent operation, modification due to mission requirements, maintenance, repair, and eventual replacement is considered a Real Property Maintenance (RPM) funding requirement. For example,

the cost of initially installing a BMP can be funded through O&MN, but future maintenance or repair of that BMP must be paid by RPM funds.

b. When natural resources requirements are tied to a specific construction project or other action, funds for the natural resources requirements should be included in the overall project costs. For example, if a permit for filling wetlands is required as part of a MILCON project, the costs of obtaining the permit and implementing required mitigation should be paid by MILCON funds as part of the overall construction project costs.

2. **Legacy Funds.** The Legacy Resource Management Program is a special Congressionally mandated initiative to fund military conservation projects. The Legacy Program can provide funding for a variety of conservation projects, such as regional ecosystem management initiatives, habitat preservation efforts, archaeological investigations, invasive species control, monitoring and predicting migratory patterns of birds and animals, and national partnerships and initiatives, such as National Public Lands Day. If the installation plans to request Legacy Program funds, it should be aware of the following:

   a. The availability of Legacy funds is generally uncertain early in the year.

   b. Pre-proposals for Legacy projects are due in March and submitted using the Legacy Tracker Web site: http://www.dodlegacy.org/.

   c. Project proposals are reviewed by the Navy chain-of-command before being submitted to the DOD Legacy Resources Management Office for final project selection.

   d. The Legacy Web site provides further guidance on the proposal process and types of projects requested.

3. **Fish and Wildlife Fees.** User fees collected for the privilege of hunting, fishing, or trapping will be collected, deposited, and used in accordance with the Military Construction Authorization Act—Military Reservation and Facilities-Hunting, Fishing and Trapping (10 U.S.C. 2671) and the DOD financial management regulations. This specifies that user fees collected for hunting, fishing, or trapping shall be used only on the installation where collected. Further, collections will be used exclusively for fish and wildlife conservation and management on the installation where collected.

   a. The same fee schedule will be used for all participants with the exception of senior citizens, children, and the handicapped. Membership in an installation conservation organization will not give members priority in participating in hunting, fishing, and trapping programs. Efforts should be made to use the services of the installation's MWR function to collect and administer these funds locally in accordance with SAIA authorization.

4. **Recycling Funds.** An installation with a Qualified Recycling Program (QRP) may use proceeds for some types of natural resources projects. Proceeds must first be used to cover QRP costs. Up to 50 percent of net proceeds may then be used for pollution abatement, pollution prevention, composting, alternative fueled vehicle infrastructure support, vehicle conversion, energy conversion, or occupational safety and health projects, with first consideration given to projects included in the installation's pollution-prevention plans. Remaining funds may be transferred to the non-appropriated MWR account for approved programs, or retained to cover anticipated future program costs. Natural resources projects can be funded as pollution prevention/abatement (e.g., wetlands or riparian forest restoration) or MWR projects (e.g., trail construction and maintenance).

5. **Strategic Environmental Research and Development Program (SERDP) Funds.** SERDP is DOD's corporate environmental research and development program, planned and executing in

full partnership with the Department of Energy and USEPA, with participation by numerous other Federal and non-Federal organizations. SERDP funds for environmental and conservation are allocated through a competitive process. Within its broad areas of interest the SERDP focuses on cleanup, compliance, conservation, and pollution prevention technologies. The purpose of the conservation technology program is to use research and development to provide improved inventory and monitoring capabilities, develop more effective impact and risk-assessment techniques, and provide improved mitigation and rehabilitation capabilities. Recently, the program solicited Statements of Need for conservation technology proposals to research indicators of stress on threatened and endangered species and to develop techniques to inventory and monitor threatened and endangered species in accessible areas.

6. **Non-DOD Funds.** Many grant programs are available for natural resources management projects, such as watershed management and restoration, habitat restoration, and wetland and riparian area restoration. When federally funded, these programs typically require non-Federal matching funds. However, installations may partner with other groups to propose eligible projects.

    a. The Five-Star Restoration Challenge Grants Program is sponsored by the National Association of Counties; National Association of Service and Conservation Corps; National Fish and Wildlife Foundation; and Wildlife Habitat Council in cooperation with USEPA, NMFS, and other sponsors. This program provides modest financial assistance ($5,000 to $20,000) on a competitive basis to support community-based wetland and riparian restoration projects that build diverse partnerships and foster local natural resources stewardship. Installations would need to partner with other groups to be eligible for this type of program. Applications are due in March. Information is available online at http://www.epa.gov/owow/wetlands/restore/5star/. INRMPs should include valid Class 2 and 3 projects and actions that would enhance an installation's natural resources.

    b. National Public Lands Day Grants. Installations are eligible to receive DOD Legacy funds in support of National Public Lands Day. Projects eligible for funds include habitat restoration, wetland restoration, and stream cleanup.

Nontraditional sources of funding for natural resources programs include nonappropriated reimbursable funds (i.e., agricultural or grazing outleasing, forestry, hunting and fishing fees), and appropriated reimbursable funds (e.g., DOD Legacy Program, USDA Pest Management Program). These accounts are sources of funds for Class 3 projects. Installations, however, should not depend on these programs to fully fund their natural resources management programs.

6.4 Effectiveness of INRMP Providing No-Net-Loss to Military Mission

Implementation of this INRMP by JRM will ensure that the natural resources on JRM will continue to support the JRM mission. This INRMP strives to integrate natural resources management with other installation plans and activities. It also establishes goals that represent a long-term vision for the health and quality of JRM's natural resources. The INRMP goals may be revised over time to reflect changing missions and environmental conditions. Any future changes in mission, training activity, or technology should be analyzed to assess their impact on natural resources. As new plans and DoN guidance and regulations are developed, they will be integrated with the goals and management strategies of this INRMP. The INRMP will be reviewed, assessed, and modified as needed on a regular basis to ensure continued integration with other management plans or changes in military mission.

6.5 Formal Adoption of INRMP by JRM Commanding Officers

By signing this INRMP, the Installation Commanding Officer for NBG, and the General for Andersen AFB are committing to "seek funding and execute, subject to the availability of funding, all ERL Level 4 projects and activities in accordance with specific timeframes identified in the INRMP" (U.S. Navy 2006).

6.6 Federal Anti-Deficiency Act

"All actions contemplated in this INRMP are subject to the availability of funds properly authorized and appropriated under federal law. Nothing in this INRMP is intended to be, nor must be construed to be a violation of the Anti-Deficiency Act (31 U.S.C. 1341 et seq.)" (U.S. Navy 2006).

6.7 Annual Natural Resources Conservation INRMP Metrics

JRM installation personnel will annually conduct an internal natural resources self-assessment to ensure that strategies and actions contained within the JRM INRMP are still effective to natural resources management need on JRM installation. These reviews will be based on the conservation metrics described in DOD Instruction 4715.03.

In addition, DOD and Navy guidance directs installations to coordinate their annual Metrics Summary Report with the appropriate field-level offices of the USFWS and the state (territorial and CNMI) fish and wildlife agency (for JRM, GDAWR and CNMI DLNR), as well as NOAA/NMFS to enable partners to measure both the successes and issues resulting from INRMP implementation (DOD 2011, U.S. Navy 2006). Results of the evaluation are used by natural resources managers to determine the effectiveness of the installation natural resources management program, to facilitate annual coordination with USFWS and the territorial and CNMI fish and wildlife agencies, and to provide data for the Navy portion of the DOD annual report to Congress (U.S. Navy 2006). An annual review was conducted in November 2012 with JRM, NBG, Andersen AFB and all regulatory agencies.

Two meetings will be conducted annually by Navy to coordinate with USFWS, NOAA, DAWR, CNMI DLNR, and GNWR. One meeting will be conducted during October or November to review projects accomplishments the previous fiscal year. The other meeting will be conducted in either April or May to develop and review future projects that will be proposed to CNIC for funding. The meetings will also be used to identify necessary modifications to the INRMP resulting from changes in mission, existing baseline natural resources conditions effecting natural resources management, or changes in the status of listed species that might effect management. Any modifications will be noted in the annual review and incorporated into the 5 year update. The INRMP implementation table (**Appendix C**), annual project summaries (**Appendix D**), and INRMP metrics (**Appendix E**) will be updated annually based on the outcomes of the two meetings described above.

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