Wildlife Action Plan for the Commonwealth of the Northern Mariana Islands 2015-2025

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EXECUTIVE SUMMARY

The lands of the Commonwealth of the Northern Mariana Islands (CNMI) support an incredible array of wildlife species that are found nowhere else in the world. Our waters contain some of the most pristine marine ecosystems in the United States. We truly live in a special place, with tremendous fish and wildlife resources that we want to conserve for this and future generations.

Conservation today is challenging, given the current and potential future impacts of invasive species, climate change, and other threats to our resources. Success will only happen with careful consideration of the values that we are trying to conserve, and a vision for what "success" means. This 2015 Wildlife Action Plan addresses the conservation values expressed by the people of the CNMI and gives a clear pathway to success.

Ten years have passed since we produced the Commonwealth's first Wildlife Action Plan (then called a "Comprehensive Wildlife Conservation Strategy"). The 2015 Wildlife Action Plan builds upon the foundation started in 2005. We reviewed the 2005 Plan and implementation outcomes at the beginning of our 2015 revision process to see what lessons we could learn.

First, while it is important to challenge ourselves, and have a grand vision for the future, we need to be realistic about what can be accomplished over the ten-year lifespan of a Wildlife Action Plan. We completed a small fraction of the actions laid out in the 2005 Plan, but not for lack of effort. We completed many actions with success, but the 2005 bar was set unrealistically high for a ten-year period. If we try to "save the world" in ten years, we aren't likely to be successful.

Second, without clear, specific objectives, prioritization among possible actions is not possible, and there is no way to measure success. While we took many actions to benefit Species of Greatest Conservation Need (SGCN) and their habitats since 2005, we cannot claim "success", because we did not explicitly set out objectives to meet. Our capacity is limited in terms of funding and local technical expertise. We need to allocate our limited resources to the highest priority actions, so in 2025 we will be able to claim success.

This 2015 Wildlife Action Plan improves upon our past work to better position us for success.

In Chapter 1, we describe some of the accomplishments from the 2005 Plan, the guiding principles for the 2015 Plan revision and update, and major changes from the 2005 Plan.

Chapter 2 provides an overview of our 14 islands. This chapter describes the geographic, political, and demographic context within which we conduct our conservation actions.

In Chapter 3, we describe the process and criteria used for selection of "Species of Greatest Conservation Need", and the list resulting from that process.

Chapters 4 and 5 describe the terrestrial and marine habitats, respectively, that are important to SGCN.

Chapter 6 summarizes the threats that are impacting, or are expected to impact SGCN within the next ten years.

Chapters 7 and 8 form the core of the 2015 Plan as they identify the specific objectives and actions that are planned over the next ten years. Chapter 7 summarizes ecosystem-based goals and strategies, i.e. those that will benefit most or all SGCN, and provides an introduction to the species-specific objectives and actions that are described in Chapter 8.

Chapter 8 contains a profile of each SGCN including:

- species-specific ten-year objectives for all SGCN and, for some, additional longer-term objectives
- federal and state Threatened and Endangered listing status, and International Union for the Conservation of Nature (IUCN) Red List status
- brief descriptions of distribution, abundance, and preferred habitat
- priority actions required to meet the ten-year objectives, and other possible supporting actions
- research and monitoring needs

The Wildlife Action Plan is not an agency document. Instead, it reflects broad input from people across our islands, as implementation of the Plan will require collaborative efforts to achieve success. Chapter 9 describes the process we used to gather input from the public, government agencies, and other stakeholders.

Chapter 10 lays out our vision for implementation over the next ten years.

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PREFACE

The CNMI Division of Fish and Wildlife (DFW) has received over $1,000,000 in funding over the last 10 years from the federal State and Tribal Wildlife Grants program (SWG) administered by the U.S. Fish and Wildlife Service (USFWS). SWG funding is valuable because it supports conservation efforts for species for which there is currently no other funding source available. This is important because it provides CNMI opportunity to institute conservation measures before native species are considered candidates for federal threatened and endangered species.

As a condition of receiving SWG funds, the U.S. Congress requires that all States commit to reviewing and, if necessary, revising their Wildlife Action Plan every 10 years. The last CNMI Wildlife Action Plan was completed in 2005. This document represents the revised and updated Wildlife Action Plan that is required for DFW to maintain eligibility for SWG funds.

Road Map to the Eight Required Elements

In addition, the U.S. Congress indicated that the USFWS should institute guidelines to maintain consistency across states. USFWS therefore stipulates eight required elements that must be included in the Wildlife Action Plan and process, and that each State provide a “road map” to describe where in the document these elements are addressed. The CNMI “road map” is provided here:

Element 1) the distribution and abundance of species of wildlife, including low and declining populations as each State fish and wildlife agency deemed appropriate, that are indicative of the diversity and health of wildlife of the State; (In subsequent discussions, these species were referred to as Species of Greatest Conservation Need or SGCN.)

Where addressed:

- Chapter 3, “Selection of Species of Greatest Conservation Need”, describes how SGCN were identified.
- Chapter 8, “Species of Greatest Conservation Need Profiles and Priorities”, contains information about the distribution and abundance of each SGCN

Element 2) the location and relative condition of key habitats and community types essential to the conservation of each State’s SGCN;

Where addressed:

- Chapter 2, “Our Islands”, provides a broad overview of location and major factors affecting relative condition of key habitats and community types (e.g. human population).
- Chapter 4, “Terrestrial Habitats of the CNMI”, describes more specifically the location and relative condition of key habitats and community types of terrestrial SGCN.

- Chapter 5, “Marine Habitats of the CNMI”, describes more specifically the location and relative condition of key habitats and community types of marine SGCN.
- “Preferred habitats” (i.e. key habitats and community types) for specific SGCN are described in the Chapter 8 Species Profiles.

Element 3) the problems which may adversely affect SGCN or their habitats, and priority research and surveys needed to identify factors which may assist in restoration and improved conservation of SGCN and their habitats;

Where addressed:

- Chapter 6, “Threats”, describes the problems faced by our SGCN and their habitats.
- Within Chapter 7, Section 7.3 describes broad research needs that address many or all SGCN.
- Species-specific research and survey needs are found within the Chapter 8 Species Profiles.

Element 4) the actions necessary to conserve SGCN and their habitats and establishes priorities for implementing such conservation actions;

Where addressed:

- Within Chapter 7, “From Goals to Actions”, Section 7.1 describes ecosystem-based actions, i.e. those actions that address ecosystem-wide issues, or the needs of many or all SGCN.
- Section 7.2 provides an introduction to species-specific actions, and provides a brief summary of species-specific “priority actions” by island.
- The Chapter 8 Species Profiles contain species-specific objectives and actions. Actions are prioritized by “priority actions” (i.e. the actions that must be implemented in order to meet the stated 10-year objectives) and “other actions” (i.e. those actions that provide additional or alternative benefits to SGCN that will be considered if priority actions cannot be implemented for whatever reason, or if a unique opportunity arises).

Element 5) the provisions for periodic monitoring of SGCN and their habitats, for monitoring the effectiveness of conservation actions, and for adapting conservation actions as appropriate to respond to new information or changing conditions;

Where addressed:

- Monitoring needs are described within the Chapter 8 Species Profiles.
- The overall monitoring approach is described in Chapter 10.

Element 6) each State's provisions to review its Strategy at intervals not to exceed ten years;

Where addressed:

- Chapter 10, "The Next Ten Years"

Element 7) each State's provisions for coordination during the development, implementation, review, and revision of its Strategy with Federal, State, and local agencies and Indian Tribes that manage significant areas of land or water within the State, or administer programs that significantly affect the conservation of species or their habitats;

Where addressed:

- Chapter 9, "Participation"
- Chapter 10, "The Next Ten Years"

Element 8) each State's provisions to provide the necessary public participation in the development, revision, and implementation of its Strategy.

Where addressed:

- Chapter 9, "Participation"
- Chapter 10, "The Next Ten Years"

ABBREVIATIONS

APASEEM	Asia-Pacific Academy of Science, Education, and Environmental Management
BECQ	CNMI Bureau of Environmental and Coastal Quality
Bioscore	Biological vulnerability to extinction score
BTS	Brown Tree Snake
CAP	Conservation Action Plan
CCAP	Coastal Change Analysis Program
CNMI	Commonwealth of the Northern Mariana Islands
COTS	Crown of thorns Seastar
CRED	Coral Reef Ecosystem Division
DFW	CNMI Division of Fish and Wildlife
DLNR	CNMI Department of Lands and Natural Resources
DoD	U.S. Department of Defense
DoN	U.S. Department of the Navy
ESA	Endangered Species Act
FDM	Farallon de Medinilla (Noos)
Ma	Million years ago
MARAMP	Mariana Archipelago Reef Assessment and Monitoring Program
MES	Micronesian Environmental Services
MINA	Micronesia Islands Nature Alliance
MLA	Military Lease Area
MMT	Marine Monitoring Team
MPA	Marine Protected Area
NCCOS	National Centers for Coastal Ocean Science
NOAA	National Oceanic and Atmospheric Administration
SGCN	Species of Greatest Conservation Need
TNC	The Nature Conservancy
TOAD	Towed optical assessment device
USFS	U.S. Forest Service
USFWS	U.S. Fish and Wildlife Service
WAP	Wildlife Action Plan
WPRFM	Western Pacific Regional Fishery Management
WWII	World War II

1 INTRODUCTION

The lands of the Commonwealth of the Northern Mariana Islands (CNMI) support an incredible array of wildlife species that are found nowhere else in the world. Our waters contain some of the most pristine marine ecosystems in the United States. We truly live in a special place, with tremendous fish and wildlife resources that we want to conserve for this and future generations.

Conservation today is challenging, given the current and potential future impacts of invasive species, climate change, and other threats to our resources. Success will only happen with careful consideration of the values that we are trying to conserve, and a vision for what “success” means. This 2015 Wildlife Action Plan addresses the conservation values expressed by the people of the CNMI and gives a clear pathway to success.

In 2005, we completed our first-ever Wildlife Action Plan (then called the Comprehensive Wildlife Conservation Strategy) which outlined conservation priorities for the Commonwealth of the Northern Mariana Islands (CNMI) for the ten-year period 2005-2015 (Berger et al. 2005). The year 2015 has now arrived, which provides motivation and urgency to evaluate our accomplishments, and to consider whether our priorities have changed, or need to be changed.

The Wildlife Action Plan belongs to CNMI residents across all islands and reflects broad community input. The CNMI Division of Fish and Wildlife is the “keeper” of the Plan, overseeing Plan development and implementation. Starting in 2014, DFW reviewed the 2005 Plan and proposed that revisions and an update were needed to keep the Plan relevant and effective in meeting our islands’ conservation needs over the next ten years.

1.1. GUIDING PRINCIPLES

The following interdependent guiding principles guided Plan development, and will provide guidance during implementation through the ten-year life of this Plan.

1. Maintain fish and wildlife populations in sufficient abundance and distribution to meet the needs and values of the people of the CNMI, over the next ten years and beyond.

Our Needs and Values:

- sustainable harvest of fish and game resources
- sustainable ecotourism and recreation opportunities for visitors and residents
- delisting of current federally Threatened and Endangered species and prevention of new listings
- conservation-smart development
- perpetuation of traditional cultural practices

- biodiversity conservation and prevention of extinctions, especially of our endemic species

  While not everyone shares all of these values, or may value them differently, we can agree that these are important to the people of the CNMI and will guide Plan implementation.

2. Protect and manage habitats to meet the needs of fish and wildlife populations.

All of our species depend on habitats to meet their needs for food, shelter, and breeding areas. We cannot meet our goals for fish and wildlife populations without providing habitat of sufficient quantity and quality.

3. Cultivate conservation commitment to ensure we have the necessary political, social, technical, and financial support to meet our population and habitat goals across all islands.

We need the support of political and community leaders, resource users, conservation agencies and organizations, and the general public to meet our population and habitat goals over the next ten years and beyond.

1.2. Progress Report, 2005-2015

The 2005 Plan listed over 30 actions needed to benefit priority species and their habitats (pages 178-225, Berger et al. 2005). Of 32 actions, seven were implemented, one is in progress, and two were partially completed. Twenty-two of the 32 actions were not completed. With over 2/3rds of the prescribed actions not initiated, let alone completed, clearly we need to examine the reasons why so we can improve implementation going forward.

Notable successes over the last ten years include actions to conserve wedge-tailed shearwater nesting habitat at Mañagaha. In 2014, 118 active nests successfully hatched 86 young, an all-time high since the shearwater program began just over ten years ago (DFW 2015). Brown tree snake interdiction efforts have been successful, as we still do not have an established brown tree snake population on any of our islands. Golden white-eyes, bridled white-eyes, rufous fantails, Mariana fruit doves, and Tinian monarchs have all been translocated to establish new populations in the northern islands, reducing the likelihood of extinction in the case of catastrophic events such as establishment of brown tree snake in the CNMI.

Notable disappointments from the last ten years include continued insufficient biosecurity measures that permitted the introduction and establishment of orange-cheeked waxbill, now ubiquitous on Saipan and Tinian, and continued arrivals and detections of other potentially invasive species (e.g. Varroa mite, rose-ringed parakeet). In addition, scarlet gourd continues to spread unchecked through our forests today. When an attempt to control scarlet gourd on

Saipan using biocontrol failed, no alternative actions were implemented to control or contain scarlet gourd on Saipan or any other island.

Unrealistic Goals

The priority actions described in a Wildlife Action Plan should be challenging yet achievable within a ten year period. Certain actions were not likely achievable regardless of the timeline (e.g. eradication of scarlet gourd on Saipan), but most were technically achievable. No single action was unrealistic, but with the benefit of hindsight, we see that implementation of all 32 actions described was too lofty a goal for a ten-year period, and consequently our implementation success rate was low.

Lack of Capacity

Shortly following the release of the 2005 Plan, the CNMI government experienced severe economic hardship which necessitated the implementation of a range of austerity measures, including a mandatory reduction in work hours and associated pay for all government employees (CNMI Public Law 15-24). Due to these austerity measures, the CNMI Division of Fish and Wildlife, along with many other CNMI government agencies, experienced a major loss of professional staff. Through most of the last ten years, DFW was understaffed. While the Wildlife Action Plan is designed to be a collaborative effort involving public and private partners, the CNMI Division of Fish and Wildlife plays a critical coordinating role. With the loss in staffing, DFW was challenged to maintain leadership and coordinate implementation of the Wildlife Action Plan. As new staff came aboard in DFW and other agencies, they were not adequately informed about the priorities described in the 2005 Plan. Consequently, implementation faltered.

1.3. Major Changes and Additions for the 2015 Wildlife Action Plan

Regardless, most of the goals from the 2005 Plan were sound and remain relevant today. The 2005 Plan provides a sound foundation to build on as we continue to improve upon our Plan in this and future iterations. We have made several major changes and additions for this 2015 Plan.

1.3.1. Objectives

The 2005 Plan outlined broad priorities and actions, but did not establish specific objectives associated with these priorities and actions. Specific, measurable objectives in the 2015 Plan will provide focus as we identify actions needed, and provide measures for success.

1.3.2 Climate Change

Climate change impacts to our wildlife, lands, and waters were not considered in the 2005 Plan. Given the range and magnitude of the impacts that climate change will bring in coming decades, we need to explicitly evaluate and articulate the expected impacts on populations and habitats.

1.3.3. Criteria for Selection of "Species of Greatest Conservation Need" (SGCN)

For 2015, we adopted a more formal, structured approach to evaluate candidates for SGCN using unbiased, objective criteria. In 2005, species were selected as SGCN primarily based on professional opinion of biologists, a method that has the potential to introduce bias to the process.

1.3.4. Marine Habitats

Terrestrial and marine species are both included as SGCN in the Wildlife Action Plan. In the 2005 Plan, a Plan chapter was devoted to describing important terrestrial habitats for SGCN. A similar parallel chapter describing important marine habitats was added to this 2015 Plan.

2 OUR ISLANDS

2.1 INTRODUCTION

The Mariana Archipelago is comprised of 15 islands and numerous offshore banks and reefs that span a distance of 890 km in the western North Pacific Ocean, from 14˚ to 20˚ N, along 145˚ E longitude (Figure 1).

The southernmost island, Guam, and its associated offshore banks and reefs are under the jurisdiction of the U.S. Territory of Guam. The remaining fourteen islands fall under the jurisdiction of the Commonwealth of the Northern Mariana Islands. The CNMI also has jurisdiction over offshore banks and reefs and most submerged lands extending to 3 geographical miles from coasts. These fourteen islands became the Commonwealth of the Northern Mariana Islands (CNMI) in 1976 through The Covenant to Establish a Commonwealth of the Northern Mariana Islands in Political Union with the United States of America (“the Covenant”). This Wildlife Action Plan pertains to the CNMI only, and not to Guam.

The islands of the Mariana Archipelago range in size from <1 km^2 (Noos/Farallon de Medinilla) to 544 km^2 (Guam). The largest island in the CNMI is Saipan, with a total land area of 119 km^2. In contrast, the land area for the ten islands north of Saipan combined (Noos to Uracas) is only about 160 km^2 (Table 1).

Table 1. Area, elevation, and population of CNMI islands. Source for area and elevation, Brainard et al. 2012, except Noos, Camp et al. 2015. Source for human population figures for Rota, Tinian, and Saipan U.S. Census Bureau; northern island populations are estimates.

Island	Land Area (km^2)	% of Total Area	Maximum Elevation (m)	2010 Population	% of Total Population
Rota	85.13	18.0	496	2,527	4.69
Aguiguan	7.01	1.5	57	Uninhabited	
Tinian	101.22	21.4	187	3,136	5.82
Saipan	118.98	25.2	474	48,220	89.46
Noos (FDM)	0.74	0.2	25	Uninhabited	
Anatahan	33.91	7.2	788	Uninhabited	
Sarigan	4.47	0.9	538	Uninhabited	
Guguan	4.24	0.9	287	Uninhabited	
Alamagan	12.96	2.7	744	<10	<.02
Pagan	47.75	10.1	570	<20	<.04
Agrigan	44.05	9.3	965	<10	<.02
Asuncion	7.86	1.7	857	Uninhabited	
Maug	2.14	0.5	227	Uninhabited	
Uracas	2.25	0.5	360	Uninhabited	
TOTAL	**472.71**			**~53,900**	

2.2 Geology

Geologically, the archipelago is the southern extension of the 2,800 km-long Izu-Bonin-Mariana arc system, which extends from near Tokyo, Japan, southward beyond the island of Guam. The islands represent the summits of volcanic mountains that emerged from the subsidence of the Pacific plate under the Philippine plate.

The Mariana Archipelago can be divided into two geologic groups: the older southern islands which were formed 15-30 million years ago (Ma), which include Guam, Rota, Aguiguan, Tinian, Saipan, and Noos (FDM), and the younger (0-5 Ma) northern islands, which include Anatahan, Sarigan, Guguan, Alamagan, Pagan, Agrigan, Asuncion, Maug, and Uracas (also called Farallon de Pajaros). The six southern islands are part of the frontal arc, or fore-arc, of the Mariana arc-trench system, and although they are volcanic in origin the islands have rifted eastward from the active arc system, and are mostly covered by uplifted, layered limestone surfaces. The northern nine islands remain as part of the active Mariana Arc. All of the northern islands, which span from Anatahan to Uracas, are stratovolcanoes comprised of hardened lava, tephra and volcanic ash, and are characterized by steeply sloping topography, both above and below the ocean's surface (Brainard et al. 2012). Periodic, explosive volcanic eruptions occur on the islands, with the most recent major eruptions occurring at Uracas in 1967, Pagan in 1981, and Anatahan in 2003 (Global Volcanism Program 2013).

The West Mariana Ridge, which is a remnant volcanic island arc, forms a series of seamounts approximately 145-170 km to the west of, and parallel to, the archipelago. Estimated to have formed between 17 and 8 Ma, the West Mariana Ridge is younger than the southern part of the Mariana Arc that rifted eastward, but older than the northern portion. Some of the seamounts found along the West Mariana Ridge rise to within 10 m of the ocean surface, and, owing to their remote location away from human stressors, high coral cover reef ecosystems can be found at those seamounts.

The Marianas Trench, a 2,550 km-long seafloor feature formed at the subduction zone of the Pacific and Philippine plates, runs ~130-210 km to the east of, and parallel to, the archipelago. The Marianas Trench hosts Challenger Deep, which at 10,994 m is the deepest known location in the world's oceans, located southwest of Guam.

2.3 Climate

The climate of the CNMI is hot and humid year-round, with a mean annual temperature of 28.3°C (83°F) and mean annual rainfall of 213 cm (84 in) (Figure 2) (Starmer et al. 2008). The wet season generally occurs between July and November, and a drier season between December and June (Corwin et al 1957). During the dry season, brisk east and northeast trade winds dominate the western Pacific Ocean (Eldredge 1983), while slower east and southeast trade winds occur during summer months. The islands of the CNMI lie within an El Niño Southern Oscillation (ENSO) core region in the western North Pacific, with drought-like conditions in years following El Niño events (Brainard et al. 2012). The probability of tropical cyclone formation increases during El Niño years, while mean sea level drops during El Niño years and rises above normal during La Niña periods (Brainard et al. 2012). The North Equatorial Current, which flows from east to west in the tropical Pacific Ocean, is the primary ocean current that influences the archipelago (Starmer et al. 2008).

The western North Pacific is the most active tropical cyclone basin in the world. Tropical storms frequently affect the CNMI, with an average of three tropical cyclones passing within 300 nm of Saipan each year since 1970 (Lander 2004). Category 3 and stronger typhoons can be quite destructive, affecting both terrestrial and marine habitats and species.

2.4 Population

The population of the CNMI from the 2010 Census was 53,883, a 22% decrease from the 2000 population of 69,221 (U.S. Census Bureau 2010) (Table 1). The vast majority, approximately 48,220, or 89% of the total population of the CNMI, reside on Saipan, while 3,136 (6%) reside on Tinian, and 2,527 (5%) on Rota. While small permanent and seasonal communities occur on some of the northern islands, volcanic activity has caused the evacuation of most residents. Currently, a few families intermittently reside on Pagan, Alamagan, and Agrigan. Resettlement remains a goal for some evacuated families and the Northern Islands' Mayor's Office.

2.5 Protected Lands and Waters

"Protected lands and waters" are those areas legally designated by the federal or CNMI government primarily for conservation of natural resources. Conservation Areas, Marine Protected Areas, and National Monuments are examples of protected lands or waters. Generally, protected lands and waters are secured from habitat conversion to development and have associated regulations regarding hunting, fishing, and other uses of the area. These regulations vary among protected areas, as each area has a distinct history and purpose for protection.

2.5.1 Marianas Trench Marine National Monument

In 2009, U.S. President George W. Bush established the Marianas Trench Marine National Monument, which covers approximately 246,608 square kilometers of waters and submerged lands in the Mariana Islands. The Monument is comprised of the Islands Unit, which includes the submerged lands and waters surrounding the three northernmost Mariana Islands (Uracas, Maug, and Asuncion); the Volcanic Unit, which includes the submerged lands within one nm of 21 designated volcanic sites; and the Trench Unit, which includes the submerged lands extending from the northern limit of the Exclusive Economic Zone of the United States in the CNMI to the southern limit of the Exclusive Economic Zone of the United States in the Territory of Guam; no waters are included in the Volcanic or Trench units. The Monument was placed within the National Wildlife Refuge System, with management falling under the jurisdiction of the U.S. Fish and Wildlife Service. The Secretary of Commerce, through the National Oceanic and Atmospheric Administration

(NOAA), has management responsibility for fishery activities within the waters of the Islands Unit. The CNMI government maintains jurisdiction of the area landward of mean low tide on Uracas, Maug, and Asuncion.

A management plan for the Monument is still in development. Upon agreement of the U.S. Department of Commerce (via NOAA), the Department of the Interior, and the Government of the CNMI to a coordinated management plan, the U.S. Department of Interior will convey to the Government of the CNMI title to the submerged lands around Uracas, Maug, and Asuncion.

2.5.2 CNMI Protected Lands and Waters

Many areas have been set aside for the conservation of terrestrial wildlife and marine species in the CNMI. These conservation areas have been established through various legal means: the CNMI Constitution, CNMI public laws and local laws, by agreement between government agencies, and by regulation. Conservation lands comprise 22% of Rota, 4% of Tinian, and 9% of Saipan (Figures 3, 4, 5). The entire islands of Guguan, Asuncion, Maug, and Uracas are constitutionally protected. The entire island of Sarigan is owned by the Department of Public Lands but regulated by the Division of Fish and Wildlife. CNMI conservation lands total 55.6 km^2, representing 12% of the total land area.

The CNMI government has designated protected waters around Rota, Saipan, and Tinian (Figures 3, 4, 5). While the total area is small relative to the vast protected waters of the Marianas Trench Marine National Monument, these areas provide critical protection to ensure sustainable use of highly visited areas and to provide protected source populations for species that can be harvested outside the protected waters.

3 Selection of Species of Greatest Conservation Need

"Species of Greatest Conservation Need" (SGCN) are those animal species or groups of particular importance to the people of the CNMI for biological, cultural, or economic reasons. We used separate processes to identify SGCN of biological or cultural/economic importance.

For clarity, the common and scientific species names mentioned in this chapter and throughout the document are cross-referenced in Appendix D.

3.1 Preliminary Criteria

All species first had to meet the following preliminary criteria before further consideration as "Species of Greatest Conservation Need":

- Animal species or groups only
  Mammals, birds, reptiles, fish, insects, crustaceans, corals, etc.; any species that is Kingdom Animalia
- Native species only
  Already occurred in the Marianas at the time of Chamorro arrival
- "Manageable" species only
  We can identify potential actions that could reasonably be expected to produce measurable population-level benefits for the species.
- Breeding species only
  Migratory birds and marine mammals are the primary groups that may spend only nonbreeding portions of their life cycle in the CNMI. We generally have little information about the status of nonbreeding birds or marine mammals here from which to base a decision. Regardless, the Marianas are not located along a major migratory flyway and therefore are not recognized as a globally important stopover or wintering destination for birds.

3.2 Biologically-important SGCN

Our overarching goal in the selection of biologically-important SGCN was to use the best available scientific information in a transparent, defensible, and objective process, in which all species were under equal consideration for selection. We used a two-step evaluation process to gather the information we needed to identify these SGCN. For each animal group, we identified the regional experts to share and review biological information. Regional experts are the biologists with the most direct experience working with these species in the CNMI. Experts were identified for the following groups: birds, terrestrial reptiles, tree snails, bats, coconut crab, terrestrial insects, sea turtles, marine mammals, and all other marine species (Appendix B). In consideration of conserving the unique genetic diversity of subpopulations across our islands, we conducted our evaluation at the subspecies level, if applicable, or for sea turtles, "distinct population segment" (Dutton et al 2014, Seminoff et al 2015).

We evaluated all native terrestrial vertebrates and all species that were identified as SGCN in the 2005 Plan (Berger et al. 2005). For invertebrates and marine species, there are thousands of species in the CNMI, and often little species information available, so logistically we were unable to individually evaluate all CNMI invertebrate and marine species. In addition to the 2005 SGCN, biological experts were asked to recommend other potential SGCN candidates for our evaluation and selection process. While the evaluation process is objective, the decisions made about which additional invertebrate or marine species to evaluate introduced some subjectivity to the process. By involving many experts in the process, we reduced the influence of bias in our decision.

Based on the recommendations of biological experts, we added to the evaluation process invertebrates that are listed under the Endangered Species Act, mangrove crab, ESA-listed and other corals, additional fish species, and an additional marine snail (branched murex).

Although the Mariana eight-spot butterfly (*Hypolimnas octocula mariannensis*) is described by USFWS as historically occurring on Saipan, we were unable to verify that this federally-endangered species ever occurred in the CNMI and therefore did not consider it a SGCN candidate.

3.2.1 Biological Vulnerability

We evaluated the biological vulnerability of all 2005 SGCN, all terrestrial vertebrates, and select invertebrates and marine species. Higher vulnerability means a species is less able to recover from catastrophic events and therefore has a higher probability of extirpation. We modified a method originally developed by the Florida Fish & Wildlife Commission (Millsap et al. 1990) to make it more relevant for island systems and for marine and invertebrate species. We considered other related vulnerability ranking systems, including the well-known International Union for the Conservation of Nature (IUCN) and NatureServe systems, but found other systems to be too unwieldy or inappropriate for our purposes.

Scoring was conducted to the subspecies level, and considered at the global level. Biological vulnerability scores, i.e. "bioscores" are therefore a measure of global extinction vulnerability.

We were mindful that some species that are rare in the Marianas are quite common elsewhere, and may better have their needs addressed elsewhere. Our ultimate concern is conservation in the Marianas, so our primary focus is our endemic species, which are not found anywhere else and therefore are completely our conservation responsibility. Our scoring system reflects this concern.

We scored at the finest taxonomic scale available, i.e. the subspecies level, because the Marianas host many endemic subspecies, including federally-listed subspecies (i.e. Mariana common moorhen, fanihi). If we had information that a species occurring in the Marianas constitutes a genetically-distinct breeding population (DPS), we scored based on the distinct population. The only species that fit this criteria was haggan (green sea turtle).

Bioscores for each species were based on 5 categories:

1) **Population size**
   Throughout the range of the taxon, the estimated number of adults, or the estimated number of colonies of sessile colonial animals.

2) **Population trend**
   Overall trend in number of individuals throughout taxon's range over the last 2 decades (or other appropriate time interval considering taxon's generation time).

   For most endemic birds, we have reasonably good information on island population trends for Saipan, Tinian, and Rota, but no method of producing a statistically-valid overall CNMI population trend. For these, if the population trend was documented declining on any of the three islands, the species was scored as having a known declining trend.

3) **Range size/Endemism**
   The number of islands with which the taxon is associated during the season when distribution is most restricted.

   In our small island system, we measure range in the number of islands that a species occupies, not in acres. Our islands are small enough that if a species occurs on an island, we can assume that its range includes the entire island, even if not all suitable habitats are occupied. For our purposes, we considered the Mariana Islands to consist of 15 islands, including Guam. The three Maug islets were treated as one island, Naftan Rock as part of Aguiguan, and Mañagaha Island as part of Saipan.

   The more islands that a species occupies, the less vulnerable it is to extinction, which is reflected in the scoring system. Species that occupy more than 15 islands received zero points under our system, a threshold which we purposefully chose to favor Mariana endemic species.

   We never had to question whether a landmass qualified as an island or not (e.g., is Australia an island?). Typically, if a species was associated with more than 15 islands, it was a wide-ranging, often circumtropical species that occupies dozens, if not hundreds, of islands.

4) Reproductive potential

Ability of the taxon to recover from serious declines in population size.

Reproductive potential involves two components:

- The average number of offspring per adult female (or hermaphroditic adult) per year that survive to sexual maturity. If survivorship is unknown, then the average number of eggs/offspring produced per adult female per year.
- Minimum age at which females typically first reproduce

5) Specialization

Degree to which the taxon is dependent upon certain ecological or environmental requirements which may result in increased vulnerability of the taxon

Species are often subjectively classified as "specialists" or "generalists" in their ecological or environmental requirements. Generalists are species that can adapt to a wide variety of habitats and environmental conditions; specialists have specific requirements and are unable to adapt if requirements are not met. While this is a subjective simplification to describe species with complex life histories, it is widely used in the conservation and ecology fields. We applied it in our scoring system because, in general, highly specialized species are more vulnerable to extinction.

With the exception of the "Specialization" category, scores for each category were objective, as scores are based on documented information sources. "Specialization" required the experts to offer professional opinion on the degree of specialization of a species. While the specialization score is therefore subjective, we reduced the influence of bias by having multiple experts review the scores.

Bioscores could range from 0 to 60 points, with a higher score indicating higher vulnerability. Bioscores of all evaluated species are found in Appendix C.2.

3.2.2 Uncertainty in Biological Scoring

Overall, we had the most information available for the range size and population size categories, and the least information for reproductive potential. Level of uncertainty varied considerably among taxa, ranging from birds and bats, for which there is substantial information available collected by scientifically-valid, peer-reviewed methods, to marine invertebrates, for which there was almost no species-specific information available, except for the few that support commercial fisheries.

In cases where there was no species-specific information source available, we assigned scores based on information for closely related species if available, or by professional opinion. Because the scoring classes are quite broad (Appendix C.1), it was generally easy to select a score class, and we consider it unlikely that an assigned score, if incorrect, would be off by more than one score class. For example, although we rarely found species-specific information regarding the age at maturity for invertebrates, based on our general biological knowledge that invertebrates are typically short-lived, fast-reproducing species, we have little doubt that most achieve sexual maturity within 2 years, which is the youngest age at maturity score class.

If there was any question about which score class was appropriate, such as information indicating a value borderline between two score classes, we assigned scores conservatively, i.e. assigned the higher score indicating higher vulnerability.

For many wide-ranging species such as marine species and seabirds, we do not have good information for the global population trend. These generally were conservatively scored as "suspected declining", rather than "suspected stable or increasing", and so received more points.

For the population size, range size, and reproductive potential categories, to incorrectly assign a score class off by one class would have little impact on the overall score, usually two points. The population trend category, however, is more sensitive to error. In this case, if the trend is increasing but was classified as declining, or vice versa, there can be a significant difference in points awarded (up to 10). Similarly, while specialization scores are more subjective, the difference between specialization scoring classes is 5 points.

Any ranking process based on incomplete knowledge has inherent uncertainties, and we will never have complete knowledge. If we are transparent in our approach, i.e. acknowledge the uncertainties, they can be addressed. Information gaps can be filled.

It is therefore inevitable that the bioscores we arrived at for some species are lower than the "real" score, and others higher. We do not know today if these errors led to any species being wrongfully assigned or denied SGCN status because of it, but we can address known information gaps and update scores going forward. Because we took a conservative approach throughout the scoring process, it is likely that more species qualified, rather than were excluded, as SGCN according to our criteria.

Other systematic ranking projects similar to ours have created "uncertainty scores" to illustrate the degree of confidence in the information underlying biological scores (e.g. Wallace et al. 2011). We chose not to pursue this method because it was not likely to change any rankings or action recommendations. We are aware that for some species, our scores may have a high degree of uncertainty, i.e. marine invertebrates. In fact, the lack of information is a primary reason why these species were considered for SGCN status. When managers consider addressing the needs of a particular species, we expect that they will examine in detail the information associated with that species and achieve a comprehensive understanding of information needs far beyond what can be reflected in an "uncertainty score". Rather than developing an "uncertainty score", we provide all of the sources used from which these scores were derived (Appendix C.3.) so users of this Plan may independently assess uncertainty.

3.2.3 Threat Assessment

The same biological experts ranked or reviewed rankings of the threat status of the same set of species using a method originally developed by The Nature Conservancy (TNC 2007, TNC 2010). We used the simplified threat rating system in the TNC Conservation Action Planning (CAP) Workbook v6b.

For each species, the threats expected to cause a decline in that species in the CNMI over the next ten years (or three generations) were identified, and then the scope, severity, and irreversibility of each threat were ranked (Appendix C.1.). “Scope” refers to where or when that threat is occurring. “Severity” refers to the magnitude of the effects of the threat on the species. “Irreversibility” refers to how hard would it be to either stop the threat, or to mitigate the impacts of the threat through other actions. Of these, “scope” was typically objectively determined based on the location of the threat relative to the range of the species within the CNMI. Little information exists regarding the severity or irreversibility of threats, so these ranks are primarily assigned based on professional biological opinion. The involvement of multiple experts in the threat ranking and review process reduced the influence of individual biases in our results.

Each of these three variables was ranked as one of four classes, low, moderate, high, or very high. The total number of threats and the individual threat rankings are combined to generate an overall CNMI threat ranking for that species. Overall threat ranks could also be low, moderate, high, or very high, with a ranking of “very high” signifying a species experiencing many and severe threats. Overall threat ranks are found in Appendix C.

3.3 Economically or Culturally-important SGCN

Through formal and informal sharing with stakeholders and the public, we heard from people from all backgrounds in the CNMI regarding which species are important to them (described in Chapter 9). The species or groups frequently mentioned were fanihi, ayuyu, haggan, a variety of fish species, native birds, and medicinal plants. Many different fish species were mentioned in meetings and informal conversations, but the message was consistently that CNMI residents value all fish species that are harvested for commercial or personal consumption, and not one particular species. We call this group generically “food fish”.

Medicinal plants were not eligible for consideration as SGCN based on the criteria we applied, i.e. animals only. We recommend that in the next iteration of the Wildlife Action Plan, SGCN criteria are expanded to consider plant species.

3.4 Final SGCN Selection

Biologically-important SGCN were selected based on vulnerability and threat ranking criteria as follows:

- Any species with a bioscore of 18 or higher

- Any species with a threat ranking of “very high”
- Species with a bioscore of 13-17 and a threat ranking of “high”

Species or groups that were frequently mentioned in interactions with the public as important were added as SGCN, regardless of biological status. However, many of the species identified as economically and culturally important were also identified as biologically important (i.e. fanihi, ayuyu, and haggan).

Tables 2 and 3 summarize the 33 terrestrial and 27 marine species identified as SGCN.

Table 2. Terrestrial Species of Greatest Conservation Need, 2015. (ssp=subspecies)

Chamorro	Carolinian	English (with subspecies identifier if applicable)	Type	BioScore[1]	Threat Ranking[2]
Species identified for biological reasons[3]:					
Sasangat	Sasangal	Micronesian Megapode	Bird	27	H
Lifa'ru	Lifo'ro	Wedge-tailed Shearwater	Bird	18	M
Lu'ao (talisai)	Amwo	Masked Booby	Bird	18	M
Paya'ya	Asaf	Great Frigatebird	Bird	18	M
Pulattat	Gherel Bweel	Mariana Common Moorhen	Bird	36	H
Paluman kotbata	Apooka	White-throated Ground Dove	Bird	25	H
Paluman totut	Mwee'mwe	Mariana Fruit Dove	Bird	29	H
Chachaguak	Leghe'kiyank	Mariana Swiftlet	Bird	30	M
Sihek	Waaw	Mariana Kingfisher ssp. *albicilla*	Bird	23	H
Sihek	Waaw	Mariana Kingfisher ssp. *orii*	Bird	37	H
Sihek	Waaw	Mariana Kingfisher ssp. *owstoni*	Bird	19	M
Egigi	Tigh'par	Micronesian Honeyeater ssp. *saffordi*	Bird	27	H
Naabak	Leteghi par	Rufous Fantail ssp. *mariae*	Bird	25	H
Naabak	Leteghi par	Rufous Fantail ssp. *saipanensis*	Bird	27	VH
Chichurikan Tinian	Liteighi'par	Tinian Monarch	Bird	35	VH
Aga	Mwii'lup	Mariana Crow	Bird	46	VH
Ga'ga karisu	Litchoghoi bwel	Nightingale Reed-warbler	Bird	33	H
Nosa'/Chuchrika	Litchogh	Bridled White-eye	Bird	19	H
Nosa' Luta	Litchogh	Rota White-eye	Bird	31	H
Canario	Khanooriyo	Golden White-eye	Bird	31	H
Fanihin Liyang	Payesyes/Pai'Scheei	Pacific Sheath-tailed Bat	Mammal	40	L
Fanihi	Pai'Scheei	Mariana Fruit Bat	Mammal	34	H
Achi'ak		Littoral Skink	Reptile	17	H
Achi'ak		Mariana Skink	Reptile	25	H
Guali'ek	Galuuf	Micronesian Gecko	Reptile	13	VH
Ayuyu	Lyaf	Coconut Crab	Crustacean	17	H
Akmangao		Mangrove Crab	Crustacean	23	H
		Mariana Wandering Butterfly	Insect	50	M
		Rota Damselfly	Insect	46	L
Dengdeng		Humped Tree Snail	Snail	34	H
Dengdeng		Langford's Tree Snail	Snail	46	M
Dengdeng		Rota Unidentified Partulid Snail	Snail	44	M
Dengdeng		Fragile Tree Snail	Snail	40	H

Species identified for cultural or socioeconomic reasons[3]:					
Fanihi	Pai'Scheei	Mariana Fruit Bat	Mammal	N/A	N/A
Ayuyu	Lyaf	Coconut Crab	Crustacean	N/A	N/A

[1] BioScore can range from 0 to 60 with higher scores indicating greater vulnerability.

[2] VH=Very High, H=High, M=Medium, L=Low; “Very High” signifies a species experiencing many and/or severe threats.

[3] Many species have multiple values, i.e. biological, cultural, social, and/or economic. We identify here the value(s) for which this species was identified as SGCN. Many species have more values than what are listed here. Possible "biological reasons" are many, and does not necessarily mean that a species is in trouble.

Table 3. Marine Species of Greatest Conservation Need, 2015.

Chamorro	Carolinian	English	Type	Bioscore[1]	Threat Ranking[2]
Species identified for biological reasons[3]:					
Halu'u	Limwe	Grey Reef Shark	Shark	23	L
Tanguisson	Maam	Napoleon Wrasse	Fish	22	M
Laggua/Oscha	Igan-wosh	Steephead Parrotfish	Fish	18	M
Kabara		Seagrass Parrotfish	Fish	20	L
Toninos	Ghu	Spinner Dolphin	Mammal	18	L
Haggan karai	Wong maaw	Hawksbill Turtle	Reptile	38	L
Haggan	Wong mool	Green Sea Turtle	Reptile	46	M, H[4]
Laun	Larr	Collector Urchin	Urchin	13	VH
Mahonggang	Yuurr	Longlegged Spiny Lobster	Crustacean	18	VH
Mahonggang	Yuurr	Pronghorn Spiny Lobster	Crustacean	16	VH
Mahonggang	Yuurr	Painted Spiny Lobster	Crustacean	12	VH
Hima	Tto	Small Giant Clam	Clam	27	VH
Hima	Shafeshaf	Fluted Giant Clam	Clam	25	VH
Tapon/Amsun	Ai'mett/Ghatil	Pectinate Venus	Clam	15	H
Gamson	Ghuus	Day Octopus	Octopus	15	H
Do'gas prensa	Mwe'ell	Horned Helmet	Snail	23	H
Kulu	Sa'wi	Triton's Trumpet	Snail	18	H
Toro	Li'yang	Common Spider Conch	Snail	20	VH
Aliling pulan	Lifott maram	Silver-mouthed Turban	Snail	18	VH
Aliling pulan	Lifott maram	Tapestry Turban[5]	Snail	28	VH
Aliling pulan	Lifott maram	Rough Turban[5]	Snail	28	VH
Do'gas	Abwel	Branched Murex	Snail	16	VH
Kuraling	Yeal	*Acropora globiceps* Coral	Coral	23	VH
Kuraling	Yeal	*Acropora retusa* Coral	Coral	23	VH
Kuraling	Yeal	*Seriatopora aculeata* Coral	Coral	15	VH
Kuraling	Yeal	All Staghorn Corals[6]	Coral	23	VH

Species identified for cultural or socioeconomic reasons[3]:					
		"Food Fish"	Fish	N/A	N/A
Haggan	Wong mool	Green Sea Turtle	Reptile	N/A	N/A

[1] BioScore can range from 0 to 60 with higher scores indicating greater vulnerability.

[2] VH=Very High, H=High, M=Medium, L=Low; “Very High” signifies a species experiencing many and/or severe threats.

[3] Many species have multiple values, i.e. biological, cultural, social, and/or economic. We identify here the value(s) for which this species was identified as SGCN. Many species have more values than what are listed here. Possible "biological reasons" are many, and does not necessarily mean that a species is in trouble.

[4] Green Sea Turtle threats were separately assessed for terrestrial (nesting) and marine (foraging) threats. Terrestrial threat ranking is “High”, and the marine threat ranking is “Medium”.

[5] The Marianas host endemic, undescribed subspecies of Tapestry Turban (*Turbo petholatus* ssp. undescribed) and Rough Turban (*T. setosus* ssp. undescribed) (G. Paulay, unpublished data).

[6] “Staghorn corals” is a generic term for a group of corals, many of the genus *Acropora*, displaying an antler-like growth form and inhabiting nearshore shallow waters. Species in the CNMI include *Acropora aspera, A. austera*, *A. intermedia*, *A. muricata*, *A. pulchra*, and others.

4 TERRESTRIAL HABITATS OF THE CNMI

4.1 INTRODUCTION TO TERRESTRIAL HABITATS OF THE CNMI

The small islands of the CNMI are relatively simple geologically and topographically. The relatively simple terrain of our islands therefore supports a low diversity of terrestrial habitat types. However, as plants and animals arrived in the Marianas, they evolved in isolation, so that Marianas terrestrial habitats are occupied by many endemic plant and animal species (i.e. species that occur nowhere else in the world).

4.1.1 Forests

Forests are the most important terrestrial habitat for SGCN in the CNMI. While the larger southern islands support the most forest (~75% of the CNMI total), forests of the northern islands play a critical role in supporting redundant populations of SGCN and reduce the probability of extinction from natural disasters such as typhoons or volcanic activity, or in the event of introduction of brown tree snake in the southern islands (Table 4).

Table 4. Forest area by CNMI island. Calculated from NOAA Coastal Change Analysis Program data (NOAA 2009a-n).

Island	Hectares	Acres	% of CNMI Total
Rota	5,180.4	12,801.2	20.32
Aguiguan	404.6	999.8	1.59
Tinian	6,780.8	16,755.9	26.60
Saipan	7,265.9	17,954.9	28.50
Noos (FDM)	7.9	19.5	0.03
Anatahan	272.0	672.2	1.07
Sarigan	168.9	417.4	0.66
Guguan	170.3	420.7	0.67
Alamagan	484.7	1,197.6	1.90
Pagan	2,052.7	5,072.4	8.05
Agrigan	2,336.2	5,773.0	9.16
Asuncion	319.5	789.6	1.25
Maug	47.9	118.3	0.19
Uracas	0.0	0.0	0.00
TOTAL	**25,491.7**	**62,992.4**	100.00

4.1.1.1 Native forest

Native forest once covered most inland areas of the Marianas. Starting with Chamorro settlement ~4,000 years ago, agricultural development during the early 20th century German and Japanese administrations, and major impacts from WWII on Saipan and Tinian, widespread disturbance has resulted in loss and change in native forests of the southern islands. The label “native forest” cannot be equated with intact, undisturbed forest. Instead, this type refers to forest where higher numbers of native species are found.

On the southern islands, native forest grows on a limestone substrate and is therefore sometimes referred to as "limestone forest". Common tree species include kafu (*Pandanus tectorius*), paipai (*Guamia mariannae*), gulos (*Cynometra ramiflora*), nunu (*Ficus prolixa*), otot (*Discocalyx megacarpa*), agatelang (*Eugenia palumbis*), mapunyao (*Aglaia mariannensis*), pago (*Hibiscus tiliaceus*), trokon papaya (*Carica papaya*), nonak (*Hernandia sonora*), ahgao (*Premna obtusifolia*), aplokateng (*Psychotria mariana*), lagansát (*Barringtonia racemosa*), amahadyan (*Pipturus argenteus*), niyok *(Cocos nucifera*), joga (*Elaeocarpus joga*), ifit (*Intsia bijuga*), pahong (*Pandanus dubius*), panao (*Guettarda speciosa*), lemai (*Artocarpus altilis*), puteng (*Barringtonia asiatica*), fago (*Neisosperma oppositifolia*), chopak (*Mammea odorata*), lada (*Morinda citrifolia*), kahtat (*Dendrocnide latifolia*) and manga (*Mangifera indica*) (Donnegan et al. 2011). Native forest habitat is rare on Saipan and Tinian, but common on Rota (Figure 6).

In the northern islands, the soil substrate is volcanic. Native tree species that are important in the northern islands include mapunyao, kafu, talisai (*Terminalia catappa*), aguanai (*Trema orientalis*), lada, and gaogao (*Erythrina variegata* var. *orientalis*), among others (Fosberg et al. 1979; Ohba 1994; Vogt and Williams 2004; Pratt 2011).

Native forest is characterized by a closed canopy of broadleaf trees and dark, humid conditions at the forest floor (Figure 7). Trees may reach heights to 45 feet (14 meters), with some individual trees reaching 75 feet (23 meters) in height (Falanruw et al. 1989). Understory vegetation is dense and multilayered with ground herbs, shrubs, ferns, and small trees of varying heights. Epiphytic ferns and orchids are frequently found in canopy trees (Raulerson and Rinehart 1992; Vogt and Williams 2004).

4.1.1.2 Mixed forest

This forest habitat is a mixture of native and nonnative species representing forests recovering from disturbance, native forests invaded by nonnatives, and forests that are establishing in disturbed areas from a mix of seed sources (Figure 8).

Tree species composition in mixed forests varies considerably throughout the archipelago. Some native tree species favor these conditions such as langiti (*Ochrosia mariannensis*) and alum (*Melanolepis multiglandulosa*) (Vogt and Williams 2004). Other tree species found in mixed forest include nonnative species such as tangantangan (*Leucaena leucocephala*), kalaskas (*Albizia lebbeck*), trokon papaya, chotda (*Musa* spp.), *Spathodea campanulata*, sosugi formosa (*Acacia confusa*), niyok, colales (*Adenanthera pavonina*), kamachili (*Pithecellobium dulce*), and canafistula (*Cassia fistula*), and native species such as gagu (*Casuarina equisetifolia*), umumu (*Pisonia grandis*), mapunyao, kafu, paipai, pahong, gaogao, gulos, nunu, hodda (*Ficus tinctoria*), lada, pago, agatelang, ahgao, lala (*Pouteria obovata*), alum, sumac (*Aidia cochinchinensis*), fago, panao, ifit, and palma braba (*Heterospathe elata*).

Mixed forests commonly occur in areas that were formerly cleared for cultivated fields and coconut groves, World War II installations, and other developments (Engbring et al. 1986; Vogt and Williams 2004). The canopy is 2-20 meters in height with occasional canopy gaps and dense understory vegetation.

4.1.1.3 Tangantangan forest

Tangantangan (*Leucaena leucocephala*) is a tree species that was introduced in the Marianas in the early 1900s and became widespread following WWII. The islands of Saipan and Tinian are covered with vast monocultures of tangantangan (Figure 9); the islands of Rota and Aguiguan have a few isolated stands of this species (Vogt and Williams 2004).

These medium-sized trees may reach a height of 10 meters (33 feet) (Vogt and Williams 2004) with an open understory. Other tree species associated with this habitat include gulos, trokon papaya, arbol del fuego (*Delonix regia*), kalaskas, paipai, alum, aplokateng, ahgao, kamachili, ifit, chuti (*Cerbera dilatata*), and nunu (Donnegan et al 2011).

Some forest bird SGCN have adapted well to this introduced habitat type, notably the Nightingale reed-warbler on Saipan and the Tinian monarch on Tinian (Vogt and Williams 2004).

4.1.1.4 Agroforest

This habitat type occurs where people have planted tropical food trees (Figure 10). Common food trees include niyok, lemai, mangga, papaya, alageta (*Persea* spp.), kamachili, chotda, mansanita (*Muntingia calabura*), and trokon magsum (*Citrus* spp.). On the southern islands of Rota, Aguiguan and Tinian, agricultural forests are scattered in patches. On Saipan, agroforests are more extensive, and situated near urban centers (Engbring et al. 1986). Agroforests consisting mostly of niyok plantations are found on Anatahan, Sarigan, Alamagan, Pagan and Agrigan. Agroforests may be currently tended, or have been abandoned. Many forest bird SGCN can be found in agroforest, but typically at lower densities than in native forest.

4.1.2 Developed

Wherever trees, shrubs, and other vegetation are present in urban or residential areas of the southern islands, wildlife will occupy this habitat (Figure 11). Mariana kingfisher, Micronesian honeyeater, bridled white-eye, golden white-eye, rufous fantail, white-throated ground dove, and Tinian monarch can be found in developed habitat, although typically at lower densities than in native or mixed forest.

4.1.3 Grassland and Savanna

Grasslands are areas dominated by herbaceous vegetation; savannas are dominated by herbaceous vegetation but also have scattered trees and shrubs (Figure 12, Table 5). Grasslands and savannas occur on limestone soils, such as the Sabana of Rota and around Mt. Tapotchau on Saipan, and on volcanic soils, such as the slopes of Mt Pagan.

Native and non-native plant species commonly occurring in grasslands and savannas include masigsig (*Chromolaena odorata*), nette (*Miscanthus floridulus*), inifuk (*Chrysopogon aciculatus*), umok (*Digitaria* spp.), agsom (*Desmodium triflorum*), escobilla (*Sida acuta*) *Pennisetum* spp, *Gleichenia linearis*, *Nephrolepis* spp., *Blechnum orientale*, *Ipomoea* spp., *Spathoglottis* spp., *Mimosa invisa*, and *Panicum* spp. (Falanruw et al. 1989; Pratt 2011).

The distinction between savanna and grassland is not clearly defined, but this distinction is not important for the Mariana swiftlet, an endemic, endangered bird that forages in these habitats (Engbring et al. 1986; Vogt and Williams 2004).

Table 5. Area of grassland and savanna habitat by CNMI island. Calculated from NOAA Coastal Change Analysis Program data (NOAA 2009a-n).

Island	Hectares	Acres	% of CNMI Total
Rota	2,527.2	6,244.9	19.52
Aguiguan	261.1	645.3	2.02
Tinian	2,411.6	5,959.4	18.63
Saipan	1,669.6	4,125.8	12.90
FDM	48.1	118.9	0.37
Anatahan	1,308.5	3,233.3	10.11
Sarigan	150.8	372.6	1.16
Guguan	190.9	471.6	1.47
Alamagan	620.9	1,534.3	4.80
Pagan	1,311.0	3,239.5	10.13
Agrigan	1,935.3	4,782.2	14.95
Asuncion	343.7	849.3	2.66
Maug	113.2	279.7	0.87
Uracas	53.5	132.1	0.41
Grand Total	**12,945.3**	**31,989.1**	**100.00**

4.1.4 Wetlands

Wetlands are areas that are permanently or periodically immersed in water, vegetated with plants that are especially adapted for these conditions, and usually have unique soils. Wetland habitat includes lakes, ponds, estuaries, marshes, and swamps. Wetlands purify and recharge groundwater and provide important wildlife habitat. The SGCN Mariana common moorhen is completely dependent on wetland habitat, and wetlands are an important habitat for the SGCN nightingale reed-warbler.

In the CNMI, wetlands are extremely limited in extent, totaling 642 acres and occurring only on the largest islands, i.e. Saipan, Tinian, Rota, and Pagan (NOAA 2009a-n). The largest wetlands are Lake Susupe on Saipan and Lake Hagoi on Tinian (Figure 13).

Pagan is the only northern island with wetland habitat capable of supporting wildlife. Anatahan has a 61-hectare lake within the volcano caldera; we presume that the water is not potable and do not consider it manageable wildlife habitat at this time (Global Volcanism Program 2013).

Common native wetland plants include pago, karisu (*Phragmites karka*), *Acrostichum aureum*, *Fimbristylis* spp., and *Cyperus* spp. (Engbring et al. 1986, Zarones undated).

Man-made water features, including golf course ponds, are an important wetland habitat for moorhens (Figure 14). Many of the moorhens on Saipan and all of the moorhens on Rota are found in man-made wetlands. We do not know whether the productivity or survival of moorhens varies between natural and man-made wetlands.

4.1.5 Shorelines

4.1.5.1 Rocky shoreline

Among the types of rocky shorelines are sea cliffs, steep slopes, rocky headlands, low-lying raised limestone patches, bench platforms, and exposed beachrock. Sea cliffs and steep slopes are typically found along raised limestone terraces and rocky headlands where points of land project into the sea (Figure 15).

Cut bench platforms, which are common features along many rocky shorelines, are relatively narrow erosional platforms cut into limestone or volcanic rocks. The platforms are typically a few to 25 or more meters wide, and at an average elevation slightly higher than mean high tide. Platform elevations can vary, depending on the degree of wave exposure, with benches in high wave energy areas as much as 2 meters or more above mean tide level, and those in lower energy areas found within the intertidal zone to about 1.5 m above mean tide level. The interiors of wider platforms often contain a series of rimmed terrace pools, and the seaward margin of wider benches is usually raised. Narrower platforms are usually flat, or with minimal terrace pool development. Low-lying patches of raised, pitted, and pinnacled limestone can be found interspersed among beach deposits along portions of the leeward coasts of Saipan, Rota, and Tinian. These patches are likely the erosional seaward remnants of low limestone terraces (Eldredge and Randall 1980).

Beachrock, which is cemented sedimentary rock, typically slopes seaward at an angle of 5 to 10 degrees. Large boulders and blocks derived from slumping of the adjacent coastal area may also occur along the shoreline, most commonly along sea cliffs, steep slopes, and bench platforms.

The SGCN littoral skink (*Emoia atrocostata*), also called tide-pool skink, is a habitat specialist that only occupies rocky shorelines areas which are exposed to air but are regularly affected by wave splash. Many seabirds including the SGCN masked booby nest in cliffs associated with rocky shorelines.

4.1.5.2 Beach and Strand

Beaches are accumulations of unconsolidated deposits that occur along the shoreline. Beaches extend seaward to low tide level or to the edge of the inner reef flat or bench platform and landward to strand vegetation, the first major change in physiographic relief, or to the extent of their deposition, whichever occurs first (Eldredge and Randall 1980). Most beaches in the southern CNMI are composed of the whole (biogenic) and fragmented (bioclastic) skeletal remains of reef organisms, such as corals, calcareous red and green algae (especially *Halimeda* spp.), molluscs, echinoids, foraminiferans, and other organisms (Eldredge and Randall 1980). The porous limestone that predominates the exposed rocks of the southern islands results in high rates of percolation and low rates of surface water runoff, limiting the amount of land-based detrital material delivered to beaches. Exceptions can be found at a few locations along the east coasts of Saipan and Rota, where exposed volcanic rock and resulting surface water runoff occurs, allowing the accumulation of deposits resulting from the erosion of volcanic rocks. These beaches also contain some fraction of bioclastic materials, which are moved from adjacent subtidal areas shoreward by wave action (Eldredge and Randall 1980).

In the southern islands of the CNMI, beaches are most extensively developed along the shoreline of the barrier reef lagoon in Saipan. Beaches are also developed between rocky exposures along portions of the barrier reef lagoon shoreline in Tinian. The shoreline of the Tinian barrier reef lagoon have been substantially altered to accommodate docks and other harbor infrastructure. Beach development on exposed coasts around Saipan and Tinian is limited to areas where reef flat platforms or wide intertidal bench platforms border the shoreline (Figure 16) (Eldredge and Randall 1980). Beach development on Rota is limited to the western and southern coastlines, where reef flat platforms or wide intertidal benches occur. Small beach deposits can also be found where rivers reach the shore along the eastern coasts of Saipan and Rota (Eldredge and Randall 1980). The thickness of beach deposits in the southern islands of the CNMI is variable, ranging from a thin, patchy veneer of only a few centimeters to several meters or more; the thickest deposits are found along the shorelines of the barrier reef lagoons at Saipan and Tinian (Eldredge and Randall 1980). Even where beaches are well developed, remnant patches of raised, pitted, and pinnacled limestone are often found; at some locations these limestone patches form a narrow band seaward of beach deposits (Eldredge and Randall 1980).

Beaches are generally barren of vegetation, as few plants can grow in the loose, salty sand. However, some vines, such as alalak tasi (*Ipomoea pes-caprae)* and *Canavalia* spp. may creep seaward from the backshore strand habitat.

Strand is a narrow band of habitat comprised of salt-tolerant vegetation located immediately landward from the beach or rocky shoreline (Figure 17). Flora in this habitat are often succulent as an adaptation to the high salt levels and are light green-grey or covered with whitish hairs to provide protection from sunlight exposure (Mueller-Dombois and Fosberg 1998). The substrate supporting strand vegetation around high islands may be volcanic or coral sand beach, gravel beach, or volcanic or coral rocks/bluffs. The loose, shifting substrate of sand and gravel beaches, as well as the high salinity, high degree of sunlight exposure, and the drying effect of wind, present challenges that few plant species have overcome.

The creeping, mat-forming alalak tasi (*Ipomoea pes-caprae*) is perhaps the most commonly observed beach strand taxa found throughout the tropics. Alalak tasi is typically the species found closest to salt water, sometimes growing to the high-tide mark. More complex, diverse vegetation is usually found in the upper portion of the strand, and may include small trees and scrub vegetation, such as hunik (*Tournefortia argentea*), banalo (*Thespesia populnea*), and nanaso (*Scaevola taccada*); vines, such as alalak tasi, agasi (*Cassytha filiformis*), and *Vigna marina*, as well as various herbaceous vegetation and weeds (Falanruw et al. 1989).

Strand habitat is occupied by some forest bird SGCN (e.g. rufous fantail, Micronesian honeyeater), but is not a critical habitat for these species. Beaches are required for nesting haggan (*Chelonia mydas*) (Taborosi 2013). Sea turtles also occasionally nest in the strand, but the most important function of strand habitat is to provide a buffer for the turtle nesting beach from human disturbance (i.e. noise and artificial light). Beaches and adjacent strand must both be conserved to manage for nesting sea turtles.

4.1.5.3 Mangroves

Mangroves, or mangal, are a unique forested wetland type comprised of saline woodland or shrubland that occurs in depositional coastal environments with fine sediments, high organic content, and low wave exposure. The dominant feature of the mangrove habitat is the mangrove vegetation, including medium-sized trees and large shrubs that grow in saline coastal habitats in the tropics and sub-tropics. The salt-tolerant trees are also adapted to the anoxic conditions of coastal mud.

Mangroves contribute to maintaining coastal water quality by filtering nutrients, pollutants, and particulate matter from land-based sources, reducing the amount that reach seaward coral reef and seagrass habitats. The root system of mangroves also provide conditions for sediment deposition and the accretion of land, and protect shorelines and coastal infrastructure by absorbing wave energy generated by storms and tsunamis. Where they occur, mangroves are intricately linked to neighboring marine communities and contribute to sustaining populations of commercially and culturally important reef fisheries.

In the CNMI, mangroves are found only on Saipan, in scattered patches from American Memorial Park north to Tanapag (Figure 18). Common plants in the mangrove forest are mangle machu (*Bruguiera gymnorrhiza*), hufa (*Heritiera littoralis*), and lalamyok (*Xylocarpus moluccensis*) (Falanruw et al. 1989).

Mangroves are considered important nursery habitat for numerous marine fishes, including commercially valuable species, and invertebrates such as the SGCN mangrove crab (*Cardisoma carnifex*). The marine fishes and invertebrates utilize the habitat provided by the sub-tidal prop roots and pneumatophores of the mangrove trees. Various food fish species, such as rabbitfish (*Siganus* spp.), mullets (mugilid spp.), mojarras (*Mojarra* spp.), and juvenile jacks (*Caranx* spp.), barracudas (*Sphyraena* spp.), snappers (*Lutjanus* spp.), and napoleon wrasse (*Cheilinus undulatus*) can be found among the mangrove prop roots subtidally and at intertidal areas during periods of higher tide levels (Taborosi 2013).

4.1.6 Caves

The southern islands contain volcanic, non-carbonate rocks overlain by coral-algal limestone carbonate rocks (Stafford et al. 2004). Many caves and crevices within cliff faces have been created by chemical processes of erosion in the highly porous limestone surface. Caves are a unique landscape feature upon which the SGCN Mariana swiftlet and Pacific sheath-tailed bat are completely dependent for roosting and nesting habitat.

Caves used by swiftlets typically have high entrances (≥2 m), and have chambers with dark zones for nesting (USFWS 1992). They require crevices or pockets high on the walls or ceiling for securing nests (Cruz et al. 2008). Pacific sheath-tailed bats appear to prefer larger caves, and share caves with swiftlets (Wiles et al. 2011).

4.2 Terrestrial habitat composition of CNMI islands

Important wildlife habitats vary in plant species composition, extent, and condition. Habitat condition across the islands has been affected by man-induced changes and natural phenomena, as described below for each island.

4.2.1 Rota

Most of Rota was forested prior to the arrival of people over 4,000 years ago (Engbring et al. 1986). Land clearing began when the island was first colonized by Chamorros, but proceeded on a much larger scale during the Japanese administration (1914-1944) with sugar cane farming on flat lands and phosphate mining on the Sabana plateau (Amidon 2000). Although Rota was spared invasion during World War II, it was heavily bombed (Engbring et al. 1986). By the end of the war, approximately 25% of Rota was covered in well-developed forest divided into small parcels or located at the base of cliffs (Amidon 2000).

Falanruw et al. (1989) classified Rota's vegetation types based on 1976 aerial photography and found 62% in forest and 5% in agroforest for a total of 67% of Rota in forest habitat. In 2004, the U.S. Forest Service (Donnegan et al. 2011) also found 67% forest. While the two vegetation mapping efforts used different methods and classification systems, it appears that loss of forest habitat to development was balanced out by succession of savanna and other habitats to forest from 1976-2004. In 2014, the U.S. Forest Service completed data collection to repeat the 2004 forest inventory and analysis. When results from the 2014 forest inventory become available, we can assess more recent landscape changes.

Over half of Rota is native forest, a substantially higher proportion than any of the other southern islands. With over 4,500 hectares of native forest, Rota has by far the most native forest of any CNMI island (Figures 6, 19, and 20; Table 6).

Table 6. Composition of Rota terrestrial habitats, 2004 (Donnegan et al. 2011).

USFS Mapped Class	WAP Habitat Class	Hectares	Acres	% of Total Area
Agroforest	Agroforest	97.3	240.4	1.14
Agroforest -- Coconut	Agroforest	232.2	573.7	2.73
	Agroforest Total	**329.5**	**814.1**	**3.87**
Mixed Introduced Forest	Mixed Forest	741.6	1,832.6	8.72
Native Limestone Forest	Native Forest	4,428.6	10,943.0	52.08
Ravine Forest	Native Forest	82.7	204.3	0.97
	Native Forest Total	**4,511.3**	**11,147.3**	**53.05**
Leucaena leucocephala (Tangantangan)	Tangantangan	133.4	329.6	1.57
	All Forest Total	**5,715.8**	**14,123.6**	**67.22**
Barren/Sandy Beach/Bare Rocks	Bare Land	30.1	74.4	0.35
Urban Vegetation	Developed	308.0	761.1	3.62
Cropland	Other	142.7	352.5	1.68
Urban and Built-up	Other	254.6	629.1	2.99
	Other Total	**397.3**	**981.6**	**4.67**
Other Shrub and Grass	Grassland/Savanna	1,948.1	4,813.8	22.91
Strand	Strand	101.2	250.0	1.19
Water	Wetland	2.6	6.3	0.03
	Grand Total	**8,503.1**	**21,010.8**	**100.00**

The native forest on Rota consists of two types, divided by elevation. At low elevations, forests are drier because of low levels of rainfall during the dry season. At higher elevations, predominantly wet forests develop due to the persistent accumulation of clouds over the Sabana and higher levels of rainfall (Amidon 2000).

Engbring et al. (1986) found Rota's habitats to be in an altered condition as a result of its history of agricultural development. Native forest is restricted to the slopes leading up to the Sabana, areas too steep to be farmed. Areas of the eastern plateau and coastal shelves that were formerly farmed have regenerated with native species in a scrubby mixed forest. Where grazing by cattle or browsing by deer occurs, this mixed forest is open; otherwise the openings are heavily overgrown with grasses, vines and shrubs. The Sabana plateau is characterized by grasslands, native forest and mixed forest.

The majority of high elevation forests along the upper plateau of Rota have not been threatened by development or clearing because of their rugged topography. However, these high elevation areas have been exposed to the force of numerous typhoons. Rota experienced 4 supertyphoons between 1988 and 2004, in addition to many other typhoons and tropical storms in the last 25 years. Clearing of land on the Sabana has been limited, but may have contributed to damage to mature native forests on the Sabana by typhoons, because fragmentation of the forest increases the forest edge and exposes more of the forest to typhoon force winds. Large areas of mature native forest are being converted to *Pandanus tectorius* thickets as canopy trees are damaged and die off. We do not know if these *Pandanus* thickets are a successional stage and mature native forest will re-grow, or if factors such as browsing by deer (*Rusa marianna*) or typhoon frequency and intensity may be impacting natural regeneration of native forests in the Sabana.

4.2.2 Aguiguan

The island of Aguiguan essentially has three levels, two lower benches and a plateau, separated by limestone cliffs or steep slopes. The lowest bench is at 20-40 m elevation, the intermediate bench is at about 70-80 m elevation, and the plateau at about 150 m elevation (Rice 1991). Naftan Rock is a small islet 1 km off the southwest coast of Aguiguan.

When the island was inhabited during the Japanese administration (1914-1944), much of the plateau was converted to sugarcane fields. When these fields were abandoned after World War II, weeds invaded, primarily the non-native perennial *Chromolaena odorata* (Engbring et al. 1986). Many of these abandoned agricultural fields have since succeeded to monocultures of the invasive shrub *Lantana camara*, a species with few wildlife benefits and unpalatable to livestock.

Native forest is now limited to steep scarps and shelves rimming the high plateau. Common forest trees include gulos, paipai, and umumu. Puteng, figs (*Ficus* spp.), and breadfruit (*Artocarpus altilis*) also occur in some areas (Rice 1991).

Feral goats (*Capra hircus*) are abundant, lending Aguiguan its alternate name, “Goat Island”. At the time of a goat control effort in 1989-1990, the goat population was estimated at ~200 goats. No control efforts have occurred since, and hunting pressure is relatively light. We estimate that the population is now over 1,000 goats (Chynoweth et al. 2013; DFW, pers obs). The forest understory is extremely open as unrestricted goat browsing has consumed most understory vegetation.

The U.S. Fish and Wildlife Service produced a land cover of Aguiguan in 2008, primarily by groundtruthing a map digitized from 2001 imagery (USFWS 2009). Since the 1980’s, grasslands and savannas have succeeded to forest habitats (Table 7).

Table 7. Change in terrestrial habitat composition of Aguiguan, 1982-2008. Adapted from USFWS 2009.

Habitat Class	1982 (ha)	% of Total	2008 (ha)	% of Total	Change
Native Forest	281	47	340	49	+2%
Mixed Forest	21	4	95	14	+10%
Tangantangan	0	0	44	6	+6%
Grassland/Savanna	256	43	158	23	-20%
Strand	15	3	28	4	+1%
Bare Land	23	4	34	5	+1%
TOTAL	596	100	699	100	0%

4.2.3 Tinian

Like the other southern islands, Tinian has had a long history of disturbance and habitat conversion by human settlers. When the Chamorros arrived around 2,000 B.C., they brought agriculture to Tinian and likely converted substantial terrestrial habitats (Steadman 1999). The Spanish reached the Mariana Islands in 1521, colonizing the Marianas over the next few centuries. Although Tinian was probably uninhabited during the Spanish administration, they introduced wild cattle, pigs, and feral junglefowl that became abundant (Engbring et al. 1986). Between 1899 and 1914, Tinian was a German possession, resulting in a large increase in agriculture that included expanded crop production and large coconut plantations for oil (Spennemann 1999).

During the Japanese era, from 1914 to 1944, nearly the entire island of Tinian was deforested and replaced with sugar cane fields, except for the craggy, forested cliffs and ridges with shallow soils (Lusk et al. 2000b). During World War II, all vegetation on Tinian was virtually leveled, and only tiny pockets of native vegetation remained (Engbring et al. 1986). In addition, the Japanese established Tinian as a major military base that included four airfields (Rottman 2004).

The Americans captured Tinian from the Japanese in 1944 and converted the island into a major air base for the war on Japan. Two large airfields and associated structures were constructed on land used for sugarcane production, and the island housed up to 50,000 personnel, approximately five times the density under the Japanese administration (Bowers 2001).

In 1946, Tinian was largely abandoned by the military, and the first Chamorro families returned to the island from Saipan (Farrell 1992). The U.S. military continued administrative authority of the Mariana Islands until 1962, when the Islands reverted to civilian control. The Department of Defense (DoD) leased 6,211 ha in the northern two-thirds of Tinian (U.S. Navy 2013) (Figure 4). The U.S. military occasionally conducts low-impact military training on the Tinian lease land, and has recently proposed using the lease area for large-scale, high-level live-fire training (U.S. Navy 2015a). Portions of the northern half of the island are also used for public recreation, grazing, and agriculture. The airfields are now abandoned but sparsely vegetated with tangantangan (*Leucaena leucocephala*) (Figure 21) (Camp et al. 2012).

Recent landcover mapping for Tinian found a total of 68% of Tinian in forest habitats (Figure 22, Table 8)(USFWS 2009), an increase from 62% total forest as mapped by the U.S. Forest Service in 1982 (Engbring et al. 1986). Grassland and savanna habitats have apparently succeeded to mixed forest habitat. Over the same time period, developed area increased by about 10 times; most new developed habitat apparently was also converted from grassland/savanna.

Table 8. Change in Tinian terrestrial habitat composition, 1982 to 2008. Adapted from USFWS 2009.

Class	1982 (ha)	% of Total	2008 (ha)	% of Total	Change (%)
Native Forest	490	4.9	549	5.4	+0.6
Mixed Forest	1927	19.2	2916	28.8	+10.3
Tangantangan	3852	38.3	3417	33.8	-4.5
Agroforest	0	0.0	40	0.4	+0.4
Grassland/Savanna	3107	30.9	1950	19.3	-11.6
Cropland	190	1.9	134	1.3	-0.6
Strand	356	3.5	223	2.2	-4.5
Developed	78	0.8	776	7.7	+6.9
Wetland	26	0.15	26	0.3	+0.1
Bare Land	33	0.3	81	0.8	+0.5
TOTAL	10,048	100	10,113	100	0.0

Tangantangan forests dominate most of the level and moderately sloping areas in extensive, homogeneous stands which cover a great portion of the island of Tinian. Native forest is limited in extent to patches at cliff lines and escarpments around the Kastiyo, Piña and Carolinas plateaus on the southeast side of Tinian, and a narrow corridor on the escarpment that connects Mt. Lasso with Maga in the center part of the island.

Tinian's wetlands are formed by impermeable clay that impounds water. The largest is Lake Hagoi, 15.5 ha in area and situated in the northern part of the island within the Tinian Military Lease Area (MLA) (Figure 4). Water levels at Lake Hagoi drop during periods of drought, but this wetland has not been observed to be completely dry. Lake Hagoi is an important wetland for Mariana common moorhens. Other wetlands in Tinian are smaller and ephemeral, i.e. dry up between rainfall events; among these are Mahalang and Bateha complexes within the MLA. Makpo Swamp in the southern part of Tinian once had open water, but it became heavily overgrown by woody vegetation after municipal groundwater pumping altered water levels.

4.2.4 Saipan

The following brief history is taken from Engbring et al. (1986):
Similar to other Mariana Islands, Saipan was likely mostly forested prior to Chamorro arrival. Chamorros likely cleared land by cutting vegetation and using fire, probably converting large areas of forest to grasslands. A variety of plants and animals were introduced, including rats (*Rattus* spp.) and the red junglefowl (*Gallus gallus*). During the Spanish era (1521 to 1899), ungulates were introduced to Saipan, including goats, cattle, pigs and deer. These animals became feral and greatly modified the vegetation composition.

During the German administration (1899-1914), an active coconut planting program ensued. During the Japanese administration (1914-1944), sugar cane fields replaced much of Saipan's native forests, leaving forests only on rocky ridges and cliffs that were unsuited for sugar cane production. World War II brought tens of thousands of people to Saipan, and virtually all of the vegetation on the island of Saipan was leveled, leaving only tiny pockets of forest. After the war, fields on Saipan formerly cultivated by the Japanese were colonized by tangantangan.

Post-war development on Saipan has included rapid expansion of tourism (including golf courses); residential, commercial and industrial development along the western shore, and in Kagman; and agriculture in Kagman and on scattered private farms.

Falanruw et al. (1989) classified Saipan's vegetation types based on 1976 aerial photography. In 2004, the U.S. Forest Service conducted another vegetation mapping effort (Donnegan et al. 2011) (Table 9). The Falanruw and Donnegan vegetation mapping efforts used different vegetation classification systems, so direct comparisons of all habitat types is not possible, but clearly significant forest habitat was converted for development between 1976 and 2004. Falanruw et al. (1989) found 75% of Saipan in forest habitat, while ~30 years later Donnegan et al. (2011) found 64% forest. Developed areas (including "urban and built up and "urban vegetation") increased from 6% to 21% over the same time period.

In 2014, the U.S. Forest Service completed data collection to repeat the 2004 forest inventory and analysis. When results from the 2014 forest inventory become available, we can assess more recent landscape trends on Saipan.

Today, Saipan's native forest is limited to steep limestone escarpments. The most extensive and best developed native forest on Saipan is in the Marpi region (Figures 23, 24). Much of the island's native forests fall within the boundaries of established conservation areas, including the Saipan Upland Mitigation Bank, the Bird Island Wildlife Preserve, the Kagman Wildlife Conservation Area, and terrestrial portions of the Bird Island and Forbidden Island Sanctuaries (Figure 5). Mixed forests and tangantangan thickets are distributed throughout the island of Saipan.

Agroforests (notably coconut and betelnut plantations) are clustered around residential areas in Susupe and Garapan, and on agricultural homesteads scattered throughout the island. Grasslands and savannas cover much of the hillsides flanking Mt. Tapochao. Wetlands, including man-made wetlands, are located primarily on the southern part of Saipan and along the western coast, in flat areas. Lake Susupe is the largest wetland, with about 18 ha of open water surrounded by 518 ha of marsh vegetation. Lake Susupe along with numerous smaller wetlands provide important habitat for the Nightingale reed-warbler and the Mariana common moorhen. Saipan supports the only mangrove forest in the CNMI, as a narrow intermittent coastal strip from American Memorial Park in Garapan to Tanapag on the western side of the island.

Table 9. Composition of Saipan terrestrial habitats, 2004 (Donnegan et al. 2011).

USFS Mapped Class	Wildlife Action Plan Class	Hectares	Acres	% of Total Area
Agroforest	Agroforest	35.9	88.6	0.30
Agroforest -- Coconut	Agroforest	126.3	312.1	1.06
	Agroforest Total	**162.2**	**400.7**	**1.36**
Casuarina Thicket	Mixed Forest	30.7	75.9	0.26
Mixed Introduced Forest	Mixed Forest	5,180.5	12,800.8	43.51
	Mixed Forest Total	**5,211.2**	**12,876.8**	**43.77**
Native Limestone Forest	Native Forest	103.2	254.9	0.87
Leucaena leucocephala (Tangantangan)	Tangantangan	2,112.8	5,220.7	17.75
	All Forest Total	**7,589.4**	**18,753.1**	**63.74**
Barren/Sandy Beach/Bare Rocks	Bare Land/Beach	103.9	256.8	0.87
Urban Vegetation	Developed	1,515.5	3,744.7	12.73
Other Shrub and Grass	Grassland/Savanna	936.4	2,313.7	7.86
Savanna Complex	Grassland/Savanna	517.0	1,277.6	4.34
	Grassland/Savanna Total	1,453.4	3,591.3	12.21
Cropland	Other	94.6	233.7	0.79
Urban and Built-up	Other	1,016.2	2,511.0	8.53
	Other Total	1,110.8	2,744.6	9.33
Strand	Strand	83.0	205.1	0.70
Water	Wetland	38.9	96.2	0.33
Wetland	Wetland	11.6	28.7	0.10
	Wetland Total	50.6	125.0	0.42
	Grand Total	11,906.6	29,420.7	100.00

4.2.5 Noos (Farallon de Medinilla)

Noos is generally flat, but slopes gradually from east to west, with the highest point reaching 82 m. The southern third of the island is a narrow peninsula separated from the main body of the island by a partially collapsed isthmus. The entire island is surrounded by steep sea cliffs, particularly on the east side, which make access by boat exceptionally difficult. There are two small beaches, both of which are overwashed during periods of high tide (Lusk et al. 2000a).

Although Noos never likely supported a permanent human settlement, it does have a history of exploitation for human consumption. At the turn of the 20th century, exotic feathers for the European, American, and Australian hat industry were in high demand. Historical records show that between 1897 and 1915 more than 3.5 million seabirds were killed on islands in the central Pacific Ocean, including Noos and other islands in the Marianas. Noos was leased by Germany in 1909 for the exploitation of birds. By the end of the lease, which terminated in 1911, bird numbers were reduced to the point where further hunting became uneconomical (Spennemann 1999).

The U.S. military has used Noos as a bombing range since at least 1971, and in 1983 the agreement between the U.S. and CNMI Governments was formalized in a 50-year lease agreement. The U.S. Navy recently announced its intention to increase the current rate of bombing from 2,150 explosive bombs per year to over 6,000 bombs per year (U.S. Navy 2015b).

Few vegetation surveys have been conducted on Noos. The first published flora record by Fritz in 1902 described the island as a plateau covered by brush approximately 13 ft. (4.0 m) high; however, aerial photographs from 1944 show large canopy trees on Noos (U.S. Navy 2015b). Noos' vegetation appears to have undergone significant changes since the island was leased by the DoD and the subsequent bombardment for military training. The most intensive bombardment to date of Noos occurred during the Vietnam era, when as much as 22 tons of ordnance per month was dropped on the island (Lusk et al. 2000a). Based on early 20th century descriptions of Noos vegetation and aerial photographs of the island prior to military bombardment activities, island tree height and canopy cover have been greatly reduced (Lusk et al. 2000a; Mueller-Dombois and Fosberg 1998).

Currently, habitat condition at Noos cannot be studied on the ground due to the presence of unexploded ordnance and ongoing military bombing activities. Landcover data indicate that about 2/3rds of the island consists of grassland and savanna habitats (Table 10). A brief botanical survey of the northern portion of the island carried out in 1996 identified 43 plant species, 32 of which were native (Mueller-Dombois and Fosberg 1998). Micronesian megapode, a forest dwelling species, is known to breed on Noos. The cliffline ecosystem continues to provide important habitat for colonies of ground-nesting seabirds, including the Marianas' largest known nesting site for SGCN masked booby, and one of two known nesting colonies of SGCN great frigatebird in the Marianas (Lusk et al 2000a).

Table 10. Composition of Noos terrestrial habitats, 2004 (NOAA 2009f).

Class	Hectares	Acres	% of Total Area
Bare Land	16.63	41.09	22.9
Forest	7.88	19.46	10.8
Grassland	11.36	28.07	15.6
Savanna	36.78	90.88	50.6
TOTAL	72.64	179.50	100

4.2.6 Anatahan

Anatahan is a stratovolcano that contains the largest caldera in the Northern Mariana Islands. The caldera contains a large lake (61 ha). In May 2003, the volcano erupted for the first time in recorded history. Minor eruptions and low-level volcanic activity continued through the 2000's (Global Volcanism Program 2013).

Prior to the eruption, the island had a small number of human inhabitants, and extensive habitat degradation by feral goats and pigs (Cruz et al 2000a, Kessler 2011b). Pigs were already established on Anatahan during the late 1890s, and goats are thought to have been introduced in about 1960. An eradication campaign was underway around the time of the eruption, which removed nearly all of the island's vegetation and extirpated all land birds (Kessler 2011b).

In 2005, over half of the island was classified as bare land (Figure 25, Table 11) (NOAA 2009d). Vegetation is recovering (Figures 26, 27), but has not been recently quantified. Feral cats persist on the island. Feral pigs are considered eradicated as no evidence of live pigs was found during a 2013 island-wide search (DoN 2013).

Table 11. Composition of Anatahan terrestrial habitats, 2005 (NOAA 2009d).

Class	Hectares	Acres	% of Total Area
Bare Land	1730.1	4275.2	51.1
Forest	272.0	672.2	8.0
Grassland	784.6	1938.9	23.2
Savanna	523.8	1294.5	15.5
Wetland	61.1	150.9	1.8
Unclassified	17.0	41.9	0.5
Total	3388.6	8373.5	100.0

4.2.7 Sarigan

Sarigan consists of a central volcanic cone with steep eastern and southern slopes sparsely vegetated with grasses and ferns, and gentler western and northern slopes supporting native forest and coconut forest. The last eruption on the island probably occurred in the Holocene (Global Volcanism Program 2013). The coconuts were planted as part of copra (dried meat of the coconut used for coconut oil extraction and animal feed) production around 1900 which continued into the Japanese administration (1914-1944) (Russell 1998; Spennemann 1999). Currently the island is uninhabited. Feral pigs and goats were once found on the island but were removed in 1998 with subsequent tremendous positive responses of wildlife and vegetation (Kessler 2011b). Feral cats are still found on the island.

In 1999, Fancy et al. (1999) reported Sarigan as 133 ha agroforest (coconut) (82% of forest area), and 29 ha native forest (18% of forest area). In 2006, approximately 38% of Sarigan was generally classified as "forest" (Table 12) (NOAA 2009m).

Table 12. Composition of Sarigan terrestrial habitats, 2006 (NOAA 2009m).

Class	Hectares	Acres	% of Total Area
Bare Land	128.2	316.7	28.6
Forest	168.9	417.4	37.7
Grassland	73.5	181.5	16.4
Savanna	77.4	191.1	17.3
TOTAL	447.9	1,106.7	100.0

4.2.8 Guguan

Guguan is uninhabited and constitutionally designated as a wildlife sanctuary, managed by the CNMI Division of Fish and Wildlife. The island consists of two volcanoes, one older and one more recent. The only known historical eruption of the island occurred between 1882 and 1884 (Global Volcanism Program 2013). The rift valley between the two volcanoes is dominated by lava flows with sparse vegetation.

The newer volcano dominates the northern half of the island and has a maximum elevation of 248 m. In this portion of the island, the terrain is dominated by relatively recent volcanic activity, as evidenced by large cinder fields, cinder cones, and lava flows (Cruz et al. 2000b).

This area has apparently undergone many changes over the last 100+ years. Visitors in 1876 described a rift in the western rim of a high (2000 foot) caldera that was large enough for boats to enter a brackish water lagoon. In the early 1900's, visitors described craters on the western side that had partially slipped into the sea (Ludwig 1978). There are no lagoons or evidence of such craters currently. The large volcanic cone and surrounding cinder fields are in the process of being vegetated by grasses, vines and trees (Cruz et al. 2000b).

The older volcano makes up the southern half of the island and has a maximum elevation of 301 m. The southern portion of the island is bounded by high cliffs, and is heavily vegetated. The southern plateau is dominated by nette (*Miscanthus floridulus*). Native forest, composed of talisai, umumu, pago, and *Pandanus* spp., dominates the areas along the old crater wall and the ravines formed along the slopes of the old volcano (Amidon et al. 2010). The forests, which occupy 40% of the island, have among the highest frequency and density of native trees in the northern islands (Table 13) (Cruz et al. 2000b).

Table 13. Composition of Guguan terrestrial habitats, 2004 (NOAA 2009h).

Class	Hectares	Acres	% of Total Area
Bare Land	62.5	154.5	14.8
Forest	170.3	420.7	40.2
Grassland	104.7	258.6	24.7
Savanna	86.2	213.0	20.3
TOTAL	423.7	1046.9	100.0

4.2.9 Alamagan

Alamagan is composed of a single active volcanic cone with a maximum elevation of 744 m. The volcano has erupted at least twice in the last ~1,500 years (Global Volcanism Program 2013).

Copra production on Alamagan began around 1900 (Spennemann 1999) and occurred up to the 1970s (Russell 1998). Villages were once found on the southern and northern coasts. The island currently has only transient residents, but was regularly populated up until 2009 when residents were evacuated from the island after Supertyphoon Choi-Wan passed over the island. Terrestrial habitats are currently degraded by populations of feral goats, pigs, and cattle (*Bos taurus*), as well as feral cats (Amidon et al. 2010).

Alamagan's higher elevation areas are dominated by nette grassland and savanna. Coastal areas of the island are dominated by coconut forests. The island is approximately 37% forested (Table 14) with the majority consisting of coconut forest (Amidon et al. 2010). Native forests consisting of joga and pago are found in the ravines and at higher elevations on the island (Ohba 1994). The majority of the non-forested areas are dominated by nette (Ohba 1994).

Table 14. Composition of Alamagan terrestrial habitats, 2007 (NOAA 2009c).

Class	Hectares	Acres	% of Total Area
Bare Land	196.0	484.3	15.1
Forest	484.7	1,197.6	37.2
Grassland	335.9	830.0	25.8
Savanna	285.0	704.3	21.9
TOTAL	192.3	3,216.1	100.0

4.2.10 Pagan

The following description is largely taken from Pratt (2011):
Topographically, Pagan is composed of two active volcanoes (one in each of the northern and southern parts of the island) connected by a rocky isthmus.

The island was settled by 1,500 BC by Chamorros who practiced agriculture and cultivated plants (Bellwood 1989). It is likely that the original inhabitants altered the original vegetation, at least near the coast. During the Japanese administration (1914-1944), Japanese settlers had farms on the island, and many areas with suitable soils were intensively cultivated and delineated with windbreaks (Fosberg and Corwin 1958).

In 1981, Mt. Pagan, the volcano of the northern half of the island, experienced a major eruption and continues to produce intermittent lower level volcanic activity (Global Volcanism Program 2013). After the 1981 eruption, the human population was evacuated from the island, and subsequently inhabitation has consisted of transient residence by a few families. More recently, the U.S. military has proposed using of Pagan for high-impact live fire training (U.S. Navy 2015a).

The eruption eliminated much of the vegetation in the northern part of the island, and there was apparently little re-vegetation for almost two decades following the eruption, apart from an increase in ironwood (*Casuarina equisetifolia*) tree cover (Mueller-Dombois and Fosberg 1998). Feral goats (*Capra hircus*), pigs (*Sus scrofa*), and cattle (*Bos taurus*) are present on the island, and browsing damage has led to removal of natural vegetation, vegetation degradation, and loss of native species (Kessler 2011c; Mueller-Dombois and Fosberg 1998).

The circular caldera of Mt. Pagan encompasses most of the northern region of the island. Remnants of the old caldera wall are seen as prominent vegetated cliffs in the northern part of the island. Lava flows from the 1981 eruption cover the northern and southern slopes of Mt. Pagan, and much of the remaining northern section of the island is covered by historic and recent flows dated to a few hundred years. Thick ash and tephra deposits blanket most of the northern part of the island, particularly on the western and southern slopes (Trusdell et al. 2006). Only the far southern slope and patches of land on the northeastern side of the island predate the caldera (Fosberg and Corwin 1958), which formed about 1,000 years ago (Trusdell et al. 2006).

The isthmus connecting the two parts of the island and the southern tip of the island are old substrates predating the caldera, while the summit peaks and western slope of the southern part of the island are of more recent origin (Fosberg and Corwin 1958). Limestone is present only on the northern part of the island in the form of raised coastlines in the far north and south (Fosberg 1960).

A total of 215 vascular plant species are known from Pagan (Pratt 2011). Non-native plants make up a significant component of the flora of Pagan, with the number of non-native species increasing over the last 50 years (Pratt 2011). New non-native plant species recorded in 2010 included scarlet gourd (*Coccinia grandis*), which is a serious, rapidly growing pest. Because non-native plant introductions are occurring at a rapid pace and occur over large areas of the island, they are considered a substantial threat to ecosystem health on Pagan (Pratt 2011).

Surveys in 2000 and 2010 found the island’s forests and grasslands “severely overgrazed” due to the abundance of feral cattle, goats, and pigs that have done considerable damage to island vegetation. Overgrazing has resulted in large open areas susceptible to soil erosion. There is a significant lack of native ground cover, deterioration of the forest cover, and a distinct browse line within the vegetation communities where grazing by non-native ungulates (e.g., cattle, goats, pigs) is seen (Cruz et al. 2000c; Kessler 2011b). The southern region of the island is less affected by feral ungulates.

Although over 31% of Pagan is classified as native forest (Table 15), 75% of the native forest is comprised of ironwood (*Casuarina equisetifolia*) monoculture (Rogers 2010). Ironwood is a native early-successional tree species in the Marianas that colonized the airstrip and other portions of the northern part of Pagan following the 1981 eruption. These forest stands will eventually succeed to a more diverse native forest (Pratt 2011), however at present, we expect that they support lower diversity and abundance of SGCN than native forest with higher tree species diversity.

Table 15. Composition of Pagan terrestrial habitats, 2010 (Rogers 2010).

Habitat Class	USFWS Mapped Class	Hectares	Acres	% of Total Area
Agroforest	Coconut	347	858	7.5
Mixed Forest	Mixed forest	161	398	3.5
Native Forest	Casuarina	1,092	2,698	23.5
Native Forest	Casuarina mixed	202	499	4.3
Native Forest	Native forest	169	418	3.6
	Native Forest Total	**1,463**	**3,615**	**31.4**
	All Forest Total	**1,971**	**4,871**	**42.3**
Bare Land	Bare Ground	379	937	8.2
Bare Land	Lava/Cinder	1,024	2,531	22.0
Bare Land	Sand	11	28	0.2
	Bare Land Total	**1,415**	**3,497**	**30.4**
Grassland	Grass	690	1,706	14.8
Savanna	Lava scrub	182	449	3.9
Savanna	Scrub	369	912	7.9
	Savanna Total	**551**	**1,362**	**11.8**
	Grassland and Savanna Total	**1,241**	**3,067**	**26.7**
Wetland	Lake	27	67	0.6
	Grand Total	**4,655**	**11,502**	

4.2.11 Agrigan

Agrigan's volcano, at 965 m, is the highest point in Micronesia. The only eruption known from the island occurred in 1917 (Global Volcanism Program 2013), though active steam vents are found throughout the island. A large crater dominates the center of the volcanic cone, with a continuous series of steep, narrow ridges and ravines on the slopes. This steep terrain separates populations of feral goats, pigs, and possibly cattle into different sectors, and limits the movement of the few people who live on Agrigan. Most of the ridge lines and upper slopes are covered with nette, which is thought to be maintained with regular burning by people on the island (Ludwig 1979, Ohba 1994). The coconut forests, which dominate the lower slopes of the island, were likely first established for copra production around 1900 (Spennemann 1999) and expanded during the Japanese Administration (1914-1944) and after WWII (Russell 1998). The U.S. military is reported to have broadcast tangantangan on Agrigan (Cruz et al. 2000h). Prior to the end of copra production on the island in the mid-1970s, a population of over 150 people was reported for the island (Ludwig 1979). Agrigan is now intermittently occupied by less than 10 inhabitants.

Over half of Agrigan is forest (Table 16). Compared to other northern islands, Agrigan is heavily vegetated, i.e. less than 3% is classified as bare land.

Table 16. Composition of Agrigan terrestrial habitats, 2001 (NOAA 2009a).

Class	Hectares	Acres	% of Total Area
Bare Land	121	299	2.8
Forest	2,336	5,773	53.2
Grassland	1,130	2,793	25.7
Savanna	805	1,990	18.3
TOTAL	4,393	10,854	100.0

4.2.12 Asuncion

The entire island of Asuncion is a constitutionally-designated wildlife sanctuary, managed by the CNMI Division of Fish and Wildlife. The island is essentially an active volcanic cone, with the last confirmed eruption in 1906 (Global Volcanism Program 2013).

Asuncion has only been sporadically inhabited since the arrival of the Spanish in the late 1600's. A coconut forest on the southern coast was likely planted as part of copra production in the 1890s (Spennemann 1999). Asuncion is currently uninhabited and no feral ungulates are recorded for the island.

The native tree species kafu and talisai are common in Asuncion forests (Ohba 1994). Falanruw (1989) mapped vegetation types using 1969 aerial photography, circumnavigations in 1972 and 1975, and an overflight of the island in 1975. She reported 12% in barren areas, 45% in sparse or low growth, and 43% in thickets, forests and coconuts. Based on 2004 landcover mapping, the island appears to have changed little in the last few decades (Table 17) (NOAA 2009e).

Table 17. Composition of Asuncion terrestrial habitats, 2004 (NOAA 2009e).

Class	Hectares	Acres	% of Total Area
Bare Land	123	305	15.7
Forest	320	790	40.6
Grassland	207	512	26.3
Savanna	137	337	17.4
TOTAL	787	1,944	100.0

4.2.13 Maug

The entire island of Maug is a constitutionally-designated wildlife sanctuary, managed by the CNMI Division of Fish and Wildlife. Maug is comprised of three islets which make up the wall of a sunken volcano. The volcano is not known to have erupted in the last 10,000 years (Global Volcanism Program 2013). The sides of the islets which face the crater of the sunken volcano are steep cliffs.

The island was briefly used for fish processing and as a weather station by the Japanese during their administration (1914-1944) (Russell 1998). Coconut forest and mixed *Pisonia grandis* and *Terminalia catappa* forest are found on the east and north islets, while the remainder is covered in grassland and savanna (Ohba 1994). Approximately 22% of the island is forested (Table 18), and there are no feral animals.

Table 18. Composition of Maug terrestrial habitats, 2003 (NOAA 2009i)

Class	Hectares	Acres	% of Total Area
Bare Land	52	129	24.4
Forest	48	118	22.5
Grassland	47	115	21.9
Savanna	66	164	31.2
TOTAL	213	448	100.0

4.2.14 Uracas

The entire island of Uracas is a constitutionally-designated wildlife sanctuary, managed by the CNMI Division of Fish and Wildlife. The island is comprised of a volcano cone. The volcano is the most active in the Mariana Islands, earning it the nickname “Lighthouse of the western Pacific”, but it has not erupted since 1967 (Global Volcanism Program 2013). The remote island is little visited, and has no history of inhabitation by humans or domestic animals.

Most (76%) of Uracas is unvegetated (Table 19). The majority of the vegetated areas are covered by *Fimbristylis cymosa*, a native sedge (Ohba 1994).

Table 19. Composition of Uracas terrestrial habitats, 2004 (NOAA 2009g).

Class	Hectares	Acres	% of Total Area
Bare Land	172.1	425.3	76.3
Grassland	46.0	113.8	20.4
Savanna	7.4	18.3	3.3
TOTAL	225.6	557.4	100.0

4.3 RELATIVE CONDITION OF CNMI TERRESTRIAL HABITATS

The composition and condition of terrestrial habitats varies considerably among the islands of the CNMI (Tables 4-19). On uninhabited islands without feral ungulates (Table 20), the condition of all terrestrial habitats is good to excellent (Sarigan, Guguan, Asuncion, Maug, and Uracas).

The 2003 volcanic eruption on Anatahan converted considerable native forest to bare ground, grassland, or other early-successional habitats, but ecological succession continues. The eruption presumably did not affect the quality of the terrestrial habitats, only the composition, but vegetation surveys have not been conducted on the ground since the eruption to verify the condition of terrestrial habitats. The eruption may have created conditions favorable to the spread of invasive plants.

Although Agrigan, Pagan, Alamagan, and Aguiguan are uninhabited or have very few residents, and so experience fewer human impacts, the terrestrial habitats of these islands are severely impacted by feral ungulates (cows, goats, and/or pigs). Feral ungulates have multiple negative impacts on terrestrial habitats including reducing forest understory through grazing and browsing, creating soil disturbance through hoof action or rooting that can increase the spread of invasive plants and erosion, inhibiting forest regeneration by repeated grazing and browsing of tree seedlings, and altering forest species composition through selective grazing and browsing of preferred food plants. While the impacts of feral ungulates are severe, the eradication of feral ungulates on Sarigan demonstrated that terrestrial habitats and associated SGCN can recover rapidly and dramatically following eradication (Kessler 2011b). Despite the negative impacts associated with feral ungulates, these islands continue to provide important habitats for many terrestrial SGCN.

Philippine deer (*Rusa marianna*) were introduced to Rota in around 1880 and Saipan in 1900 (Wiles et al. 1999). The negative impacts of deer herbivory on forest recruitment and composition are not as severe compared to Guam and other tropical islands (Gawel 2012), presumably because the populations receive more hunting pressure. While hunting pressure does limit deer populations on Saipan and Rota, localized effects of deer browsing can still be found.

The terrestrial habitats of Noos (FDM), which has experienced regular bombing during military training exercises going back decades, are assumed to be in poor condition but this assumption cannot be verified on the ground due to restricted public access.

While invasive species are impacting terrestrial habitats on all islands of the CNMI (i.e. rats and invasive plants), the inhabited islands of Saipan, Tinian, and Rota are the most affected by invasive species. In 2004, more than one third of all trees on Saipan, Tinian, and Rota were affected by vines, mostly invasive (Donnegan et al. 2011). Data from a repeated inventory in 2014 are not yet available, but we expect results to show that the proportion of trees affected by vines will be even greater. In addition, many invasive species occur on these islands that do not occur elsewhere in the CNMI, such as musk shrew (*Suncus murinus*) and curious skink (*Carlia ailanpalai*). Although not yet established on any CNMI island, the threat of introduction of brown tree snake on Saipan, Tinian, or Rota remains high, with the most recent capture of a live snake on Rota in September 2014.

In addition to greater invasive species impacts compared to other CNMI islands, Saipan, Tinian, and Rota also experience habitat conversion to development. Conversion of forest and other "natural" habitats to development continues on Saipan, and to a lesser degree on Tinian and Rota. Few terrestrial SGCN occupy developed habitat and typically at a lower density than in "natural" habitats. The direct effect of habitat loss is easily measured and results in significant losses to terrestrial SGCN populations. The indirect effects of fragmentation and degradation of remaining habitats are harder to measure and have not been quantified for any terrestrial habitat or SGCN in the CNMI.

Table 20. Presence across CNMI islands of select terrestrial invasive or feral animals of concern to native wildlife*. Y=known or presumed present, N=known or presumed absent; blank indicates status unknown. Numbers in parentheses indicate the source reference, listed below.

	Dog	Cat	Rat**	Cow	Goat	Pig	Deer *Rusa marianna*	*Euglandina* snail	*Platydemus* flatworm	Curious Skink *Carlia ailanpalai*	Oceanic Gecko *Gehyra oceanica*	Musk Shrew *Suncus murinus*
Rota	Y	Y (1)	Y (2)	N	N	Y (24)	Y (24)	N (3)	Y (3)	Y (4)	Y (5)	N (2)
Aguiguan	N (6)	N (6)	Y (6)	N	Y (7)	N	N	N (8)	Y (8)	Y (4)	Y (4)	N (4)
Tinian	Y	Y	Y (2)	N	N	N	N	N (8)	Y (8)	Y (4)	Y (4)	Y (2)
Saipan	Y	Y	Y (2)	N	N	N	Y	Y (9)	Y	Y (10)	Y (10)	Y (2)
FDM	N	N	Y	N	N	N	N					
Anatahan	N	Y (7)	Y (11)	N	N	N (12)	N			N (13)	Y (14)	N (13)
Sarigan	N	Y (7)	Y (11)	N	N	N	N	N (15)	N (15)	N (15)	Y (14)	N (15)
Guguan	N	N	Y (11)	N	N	N	N			N (16)	Y (17)	N
Alamagan	Y (7)	Y (11)	Y (11)	Y (11)	Y (11)	Y (11)	N			N (18)	Y (17)	N (18)
Pagan	Y (19)	Y (11)	Y (11)	Y (11)	Y (11)	Y (11)	N	N (20)		N (21)	Y (21)	N (21)
Agrigan	Y (11)	Y (11)	Y (11)		Y (11)	Y (11)	N	Y (9)		N (22)	Y (22)	N (22)
Asuncion	N	N	Y (11)	N	N	N	N			N (23)	Y (17)	N (23)
Maug	N	N	Y (11)	N	N	N	N					
Uracas	N	N	Y (11)	N	N	N	N					

*This is not a comprehensive list. Cuban slug, black drongo and other invasive animals are present and negatively impacting native wildlife.

**Different rat species occur on different islands, but all prey upon native birds and snails and impact forest regeneration.

Sources (see References section for full citations):

1, Zarones et al. 2015; 2, Wiewel et al. 2009; 3, Bauman 1996; 4, USFWS 2009; 5, Wiles et al. 1990; 6, Amidon et al. 2014; 7, Amidon et al. 2010; 8, Smith 2013; 9, Bauman and Kerr 2013; 10, Wiles and Guerrero 1996; 11, Kessler 2011a; 12, DoN 2013; 13, Cruz et al. 2000c; 14, Vogt et al. 2001; 15, Martin et al. 2008; 16, Cruz et al. 2000d; 17, Rodda et al. 1991; 18, Cruz et al. 2000b; 19, Kessler 2011b; 20, Hadfield 2010; 21, Reed et al. 2011; 22, Cruz et al. 2000a; 23, Williams et al. 2009; 24, Gawel 2012

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5 Marine Habitats of the CNMI

5.1 Introduction to Marine Habitats of the CNMI

The marine habitats presented below represent broad categories commonly used to describe coral-reef and marine ecosystems with relevance to human uses and needs. The amount of information presented for each major habitat type is proportional to the total area covered, as well as the biological diversity and social and cultural importance of the biological assemblages within.

5.1.1 Coral Reefs

Coral reefs are carbonate structures formed by the deposition of skeletal material produced by corals, coralline algae, and other calcium carbonate-secreting organisms. The mutually beneficial relationship between the coral host and single-celled algae that live within, called zooxanthellae, allow corals to harness sunlight through photosynthesis and grow extensively in nutrient-poor waters. Through time, this process allows for the formation of complex, sometimes immense reef structures, and facilitates globally significant amounts of carbon sequestration (Crossland et al. 1991). While corals can be found across the world's oceans and at depths of thousands of meters, the extensive development of structurally complex coral reefs requires nutrient-poor, warm (~23°C-29°C) water. As a result, coral reefs are generally restricted to shallow tropical and subtropical waters between 30°N and 30°S of the Equator. Coral reefs serve as the foundations of complex ecosystems that support an incredible diversity of organisms, with estimates ranging from ~600,000 to nine million coral reef-associated species worldwide (Reaka-Kudla 1997; Small et al. 1998; Bouchet 2006). Despite occupying less than one-tenth of one percent of the world's oceans (Spalding et al. 2001), coral reefs account for a quarter to a third of all marine species.

With their varying geological histories, the islands of the Mariana Archipelago, their associated banks and offshore reefs, and the distant banks and offshore reefs of the West Mariana Ridge represent a range of coral reef habitats (Brainard et al. 2012). Often coupled, geology and other aspects of the physical environment play a significant role in shaping each island's coral reef ecosystem (Brainard et al. 2012; Houk and Van Woesik 2010; Riegl and Dodge 2008). In the older southern islands, coral reef development during previous sea level stands resulted in the formation of carbonate terraces, which lie atop volcanic structures and, in some instances, have been uplifted and others downthrown (Brainard et al. 2012). The relatively flat, porous carbonate rock comprising the southern islands allows for little surface-water retention or runoff, leading to groundwater discharge as a major contributor of freshwater to nearshore marine ecosystems. Despite the volcanic nature of the active northern islands, freshwater discharge from the steep, sloping watersheds has both surface runoff and groundwater discharge components that influence reef growth, modern assemblages, and species diversity patterns (Houk and Starmer 2010).

According to estimates arrived at by the NOAA National Centers for Coastal Ocean Science (NOAA 2004), the total area of shallow coral reef habitat (all hard and softbottom habitat less than ~30 m water depth) around the islands of the CNMI is approximately 204 km^{2}. Of this total, approximately 151.5 km^2 is hardbottom habitat while an estimated 93.4 km^2 is comprised of soft bottom (e.g., unconsolidated sediments such as rubble, sand, silt, and mud) (Table 21). Previously, Hunter (1995) estimated the total area of coral reef hardbottom less than 100 m deep occurring within 3 nm of land forms in the CNMI at 45 km^2, with an estimated 534 km^2 occurring between 3 nm and 200 nm from land forms. The reef area offshore FDM was identified as the largest in the CNMI, at 311 km^2, or 58% of the total offshore reef area in the CNMI.

The CNMI archipelago also boasts relatively high coral reef species diversity, with a total of over 5,600 known reef-associated species (Paulay 2003a). More than 1000 species of reef-associated fish species, 280 species of hard coral (Randall 2003), 200 macroalgae species (Lobban and Tsuda 2003), 1,700 molluscs (Paulay 2003b; Smith 2003; Carlson and Hoff 2003; Ward 2003), 200 echinoderms (Paulay 2003c), and 800 crustaceans (Paulay et al. 2003) have been reported from the Mariana Islands. The actual number of reef-associated species that inhabit the archipelago's varied marine habitats is likely considerably higher than what is currently known. Even at currently reported numbers the coral reef ecosystems of the Mariana Archipelago are among the most biologically diverse of all U.S. States and Territories.

Table 21. Area (km^2) of coral reef and hardbottom, unconsolidated sediment, and total shallow (< 30 m depth) reef for the 14 islands of the CNMI, calculated using benthic habitat spatial data developed in 2005 by the NOAA Center for Coastal Monitoring and Assessment's Biogeography Team. The total shallow reef area (km^2) for the 14 islands and several offshore banks and reefs are provided in Brainard et al. 2012. The values from Brainard et al. (2012) were calculated from multibeam bathymetry data and are likely more accurate; however, the area of Coral Reef and Hardbottom and Unconsolidated Sediment were not provided.

Island/ Offshore reef	Coral reef and hardbottom	Unconsolidated sediment	Total shallow reef	Total Shallow Reef (Brainard et al. 2012)
Uracas	0.52	0	0.52	1.38
Asuncion	2.17	0.05	2.22	7.86
Maug	3.44	0.03	3.47	3.17
Agrigan	5.54	0.93	6.47	9.5
Pagan	11.23	0.88	12.11	16.29
Alamagan	2.92	0.47	3.39	4.28
Guguan	2.07	0	2.07	2.0
Sarigan	2.54	0.02	2.56	2.0
Anatahan	5.84	0.64	6.48	-
Noos (FDM)	4.66	1.36	6.02	-
Saipan	65.68	31.79	97.47	73.04
Tinian	20.76	5.45	26.21	16.2
Aguiguan	7.54	2.25	9.79	-
Rota	16.61	8.67	25.28	16.03
Supply Reef	-	-	-	0.1
Tatsumi Reef	-	-	-	2.26
Pathfinder Reef	-	-	-	0.85
Stingray Shoals	-	-	-	0.21
Arakane Reef	-	-	-	0.53

5.1.1.1 Reef types, zonation, and associated habitats

There are three principal types of coral reef formations: fringing, barrier, and atoll reefs. These reef types are consistent across oceanic islands, with younger fringing reefs developing around newly emergent land masses; barrier reefs forming after the land mass begins to subside and a lagoon develops between the reef and the land mass; and atoll reefs forming once land masses have subsided completely below sea level, leaving only a ring of shallow reef surrounding a lagoon (Figure 29). Fringing reefs are the most common reef type found in the Mariana Islands, found surrounding the entirety of most islands (Figure 30). Four barrier reef systems are found in the archipelago, with two occurring in the CNMI (Figure 31). Interestingly, CNMI barrier reef complexes, such as the Saipan Lagoon barrier reef, have had an atypical geological formation. Barrier reefs were created as a result of flooding of the Pleistocene shelf along the western coastline during sea level rise associated with the Holocene transgression (Cloud 1959). The barrier reef formed along the edge of the flooded Pleistocene shelf, and kept up with slow sea-level rise during the early Holocene. No atoll reef systems are present in the Mariana Islands. However, other reef types, including bank or platform reefs and flooded volcanic craters, are also considered here (Figure 32). Bank or platform reefs have no obvious connection to a coastline and do not possess the structure of barrier reef or atoll systems. Also sometimes referred to as shoals, these offshore reefs often grow on the surface of topographically raised areas of the seafloor or may have origins similar to barrier or atoll reef systems (Spalding et al. 2001). A flooded volcanic crater reef is partly or mostly surrounded by subaerial remnants of the volcanic land mass.

Each major reef type can be further divided into zones based upon unique natural environmental regimes. Abiotic factors of greatest significance to modern biological assemblages and reef development in the CNMI include the underlying geological structure, wave energy, freshwater input, temperature, salinity, and light availability. Abiotic environments can also be modified by human activities, such as nutrient and sediment input, and fishing for grazing herbivores and large, long-lived species that sequester carbon. Cumulatively, human stressors serve to enhance the growth and competitive dominance of algal substrates on reefs, and limit coral diversity, coral cover, and reef growth through time. Therefore, both natural and human-induced environmental regimes influence the composition and structure of biological assemblages in a given reef zone. While many coral reef organisms can be found in more than one reef zone across the stages in their life history, the relative abundances of dominant species are generally consistent within each zone. The reef zones for the Mariana Islands recognized in this document follow terminology used by Randall and Siegrist (1996) and Randall and Burdick (in prep). Common and notable reef organisms are presented for each zone. Particular focus is made on reef organisms that have been designated Species of Greatest Need (SGCN). The total shallow (< 30 m depth) reef area occupied by the primary reef zones, including reef flat platform, lagoon, and reef slope, is presented for each island in Table 22. Graphics illustrating the general reef zones of fringing reef and barrier reef systems are presented in Figures 33 and 34, respectively, while in situ images of examples of reef zones in the CNMI are presented in Figures 35-37.

Table 22. Area (km^2) of primary reef zones for shallow (< 30 m depth) coral reefs around the 14 islands of the CNMI, calculated using benthic habitat spatial data developed in 2005 by the NOAA Center for Coastal Monitoring and Assessment's Biogeography Team. The Reef Flat Platform zone includes the "shoreline intertidal", "reef flat", "back reef" and "reef margin" zones utilized for the NOAA Biogeography Team spatial data; the Lagoon zone includes the "Lagoon" and "Dredged" zones; and the Reef Slope zone incudes the "Forereef" and "Bank/Shelf" zones.

Island	Reef Flat Platform	Lagoon	Reef Slope
Uracas	0	0	0.52
Asuncion	0	0	2.07
Maug	0.01	0	3.46
Agrigan	0	0	6.47
Pagan	0	0	12.11
Alamagan	0.03	0	3.36
Guguan	0	0	2.07
Sarigan	0	0	2.56
Anatahan	0	0	6.53
Noos (FDM)	0	0	6.15
Saipan	7.94	25.08	65.62
Tinian	1.09	0.45	24.94
Aguigan	0.01	0	9.8
Rota	3.15	0	22.52

Coral-reef habitats represent the final level of detail, beyond major reef types and reef zones. Habitats refer to keystone species and/or physical features that influence the overall biological community at a specific locality. For instance, the primary defining feature of a given habitat may be a particular species (e.g., the seagrass *Enhalus acoroides*) or group of related species (e.g., staghorn *Acropora* corals). A defining physical structure, such as mudflat or coral-dominated hardbottom could also be used to distinguish a habitat. Dominant and notable habitat types and their associated biota are presented for each reef type/zone below. The total shallow (< 30 m depth) reef area occupied by the major benthic cover types, including coral, coralline algae, macroalgae, turf algae, seagrass and uncolonized, is presented for each island in Table 23. Note that these benthic cover types do not necessary represent distinct marine habitats, but are typically just a dominant biological component of a given habitat. In situ images of examples of marine habitats in the CNMI are provided in Figures 38-51.

Table 23. Area (km^2) of major benthic cover types for shallow (< 30 m depth) coral reef habitat around the 14 islands of the CNMI, calculated using benthic habitat spatial data developed in 2005 by the NOAA Center for Coastal Monitoring and Assessment's Biogeography Team.

Island	Coral	Coralline algae	Macroalgae	Turf algae	Seagrass	Uncolonized
Uracas	0.03	0	0	0.49	0	0
Asuncion	1.1	0.56	0	0.52	0	0.05
Maug	2.34	0.91	0.03	0.16	0	0.03
Agrigan	3.36	1.14	0.03	1.04	0	0.9
Pagan	7.64	2.56	0.1	0.93	0	0.88
Alamagan	2.08	0.68	0.03	0.13	0	0.47
Guguan	1.35	0.56	0.02	0.15	0	0
Sarigan	1.84	0.44	0.002	0.25	0	0.02
Anatahan	0.21	2.36	0.22	3.27	0	0.42
Noos (FDM)	4.36	0.02	0.64	0.27	0	0.71
Saipan	30.89	5.52	10.43	21.19	6.67	22.78
Tinian	9.42	7.47	2.02	1.85	0	5.46
Aguiguan	0.87	4.0	2.53	0.14	0	2.25
Rota	6.51	5.21	3.66	1.19	0	8.71

5.1.1.1.1 Fringing reefs

Generally, fringing reefs associated with oceanic islands are geologically young compared to barrier and atoll reef systems. Fringing reefs can occur as veneering reef communities, which exhibit no significant accretion of reef deposits; apron reefs, which exhibit accretions of reef material but which have not reached sea level equilibrium; and fringing reef platforms, where accretions of reef deposits have reached sea level equilibrium and have extended outward from shore as a shallow platform. Fringing reefs are the dominant reef type in the Mariana Islands, and range from volcanic boulders with incipient coral assemblages around much of the remote northern islands, to actively accreting reef platforms with well-developed reef flats at Obyan Beach and Bird Island, Saipan. Veneering and apron reef communities (i.e., limited modern coral growth) are the most common of the fringing reef types, while platform fringing reef systems (i.e., accreting reefs) are restricted to certain locations in the southern islands, and to very limited areas in the northern islands.

5.1.1.1.1.1 Veneering and apron fringing reef communities

The principal zones of veneering and apron fringing reef communities are similar, and can generally be divided into the upper, lower, and forereef slopes. The **upper slope** extends from the shoreline to "wave base" depth, which is typically between 4 to 8 meters, depending on the degree of exposure to the prevailing wind. The **lower slope** extends from the base of the upper reef slope to the depth at which light-dependent zooxanthellate corals give way to azooxanthellate corals; this transitional boundary is commonly referred to as the mesophotic zone. The **forereef slope** extends from the depths where light-dependent organisms are absent downward to the ocean floor. The marine biota associated with veneering and apron fringing reef systems is similar to that of the seaward reef slopes of platform fringing reef and barrier reef systems (see below). However, environmental regimes (i.e., high-wave energy, groundwater discharge, and/or steep bathymetry) are unfavorable for many species of framework building corals, thus modern reefs typically do not reach sea-level equilibrium and reef deposits from previous geological time periods persist in shallow waters (Houk and van Woesik 2010). In sum, coral growth and species richness on veneering and apron reefs is limited, and represents a subset of that found on more favorable platform fringing reef foundations.

5.1.1.1.1.2 Sea level platform fringing reefs

Sea level platform fringing reefs are fringing reef systems that have developed in conditions favorable to framework-building coral growth, and thus, have significant reef accretion. Coral communities on these reefs have reached sea level equilibrium, and have been growing seaward for thousands of years, often reaching several hundred meters from shore.

The **shoreline intertidal zone** of platform fringing reef systems occurs in the coastal area between mean low and mean high tides. Depending on the geology of a given area, the dominant substrate type of a shoreline intertidal zone may be comprised of unconsolidated sediment, such as sand, mud, or rubble; hardbottom, such as carbonate benches or volcanic rock; or a combination of both soft and hardbottom substrates. Depending on the width of the platform and the degree of exposure to wave energy, shoreline intertidal zones range from tumultuous areas of strong wave action to areas of relative calm waters. But even in calm, protected shoreline intertidal zones the regular tidal changes in sea surface height, which cause the intertidal zone to be completely or partially exposed subaerially at low tide and partially or completely submerged at high tide, make these zones a dynamic environment. Shoreline intertidal zones of fringing reef systems host marine species adapted to major changes in temperature, salinity, and dissolved oxygen and those able to tolerate subaerial exposure. These harsh environmental conditions limit the diversity of organisms that can inhabit the shoreline intertidal zone, but many of these organisms are found only in this zone. The biological assemblages found in shoreline intertidal areas can vary significantly in response to substrate type, degree of exposure to wave energy, freshwater input, and other environmental conditions. Examples of shoreline intertidal organisms commonly found in sandy intertidal habitats include ghost crabs, mysid shrimp, bivalves, gastropods, isopods, copepods, and polychaete worms. Biota associated with rocky intertidal zones include motile organisms, such as rock crabs (*Grapsus* spp.), gobies, blennies, and damselfishes, that can avoid harsh wave action and seek deeper tide pools, as well as less mobile or sessile organisms, such as chitons (e.g., *Acanthopleura gemmata*), barnacles (*Balanus* spp. and *Chthamalus* spp.), bivalves, neritid snails, limpets (*Patelloida* spp.), and algae that can tolerate emersion using an array of strategies to avoid desiccation. At higher tide levels, highly mobile organisms, especially fishes such as juvenile blacktip reef sharks (*Carcharhinus melanopterus*), trevally (carangid spp.), fringelip mullet (*Crenimugal crenilabis*), and mojarras (*Mojarra* spp.), enter the intertidal zone in search of prey or to avoid larger predators. Juvenile rabbitfishes (*Siganus spinus*), known locally as mañahak, also venture into the shoreline zone during seasonal runs, where fishers can catch them using throw nets. Corals are rarely found in the shoreline intertidal zone, but hardy species such as *Leptastrea purpurea*, *Pocillopora damicornis*, and *Porites* spp. can sometimes be found there, particularly in tide pools with at least a moderate degree of flushing. The mangrove crab (*Cardisoma carnifex*) is an SGCN found on mudflats associated with mangrove habitat in the shoreline intertidal zone.

The **reef flat platform** is a shallow platform extending seaward from the shoreline to the reef margin. The outer portion of the platform may be slightly elevated compared to the inner portion. The shallower outer platform, and occasionally the slightly deeper inner portion, may be exposed during low spring tides or may be only shallowly covered with water. A diversity of habitats and associated biota can be found on reef flat platforms depending upon the degree of wave exposure, flushing rates, the adjacent watershed size and geology, and the width between the shoreline and where the waves break. Examples of reef flat platform habitats include sandy bottoms, seagrass beds, algal pavement, rubble fields, and areas of scattered or dense coral growth. Each of these habitats support distinct assemblages adapted to environmental conditions specific to each micro-environment. Eldredge and Randall (1980) describe coral distribution on fringing reef platforms as absent to widely scattered on the inner third, scattered to locally abundant on the middle third, and most abundant on the outer third. A similar pattern is observed for coral diversity, with few (one to five) species on the inner platform and up to 20 or more at the outer seaward edge. Numerous coral species are commonly found on reef flat platform, including *Leptastrea purpurea*, *Porites* spp., *Pocillopora* spp., *Pavona* spp., *Acropora* spp., *Psammocora* spp., *Favia* spp., and *Favites abdita*. Within the CNMI, some species of staghorn *Acropora*, such as *A.* cf. *pulchra*, A. *muricata*, and A. *intermedia* can be found on reef flat platforms; these staghorn species can sometimes form extensive thickets and provide important habitat for various reef fishes and other organisms. Other sessile benthic organisms, such as soft corals (e.g., *Sinularia* spp., *Sarcophyton* spp., and *Lobophytum* spp.) and many species of sponges and algae can also be found on reef flat platforms. Reef flat platforms also host a wide variety of reef fishes, including parrotfishes (scarid spp., including the seagrass parrotfish, *Leptoscarus vaigiensis*, and juvenile and sub-adult green humphead parrotfish, *Bolbometopon muricatum*), emperors (*Lethrinus* spp.), rabbitfishes (*Siganus* spp.), goatfishes (mullid spp.), juvenile and subadult napoleon wrasses (*Cheilinus undulatas*), groupers (*serranid* spp.), needlefishes (belonid spp.), trevally (carangid spp.), surgeonfishes (acanthurid spp.), squirrelfishes (holocentrid spp.), triggerfishes (balistid spp.), damselfishes (pomacentrid spp.), butterflyfishes (chaetodontid spp.), and cardinalfishes (apogonid spp.). Numerous non-coral invertebrates, such as sea cucumbers (e.g., *Holothuria atra*, *H. leucospilota*, *Actinopgya mauritiana*, *Synapta maculata*), sea urchins (e.g., *Diadema savignyi*, and the collector urchin, *Tripneustes gratilla*), gastropod snails (e.g., the branched murex, *Chicoreus ramosus*), bivalves (e.g., giant clams, *Tridacna* spp., and the pectinate venus, *Gafrarium pectinatum*), the day octopus (*Octopus cyanea*), and crustaceans such as panulirid lobsters (*Panulirus* spp.) can also be found on reef flat platform.

The **reef margin** is the relatively narrow seaward edge of the reef flat platform zone where the waves break, straddling the reef flat and open ocean. The reef margin slopes gently seaward, and remains submerged for most of the time except during spring low tides. Surge channels are often cut into the reef margin, running perpendicular to the margin at more or less regular intervals. The narrow portion of the reef margin that receives the brunt of the wave action is dominated by coralline algae, including encrusting and sturdy branching species, which thrive in the high energy conditions. Tough brown algae species, such as *Sargassum* spp. and *Turbinaria* spp. are often found shoreward of the coralline algal ridge. Corals, such as some *Acropora* spp. (including *Acropora globiceps*) and *Pocillopora* spp., can be found across the reef margin, but are generally sparse along the algal ridge, increasing in abundance and diversity with increasing depth seaward. Numerous fish species, such as rabbitfishes (*Siganus* spp.), surgeonfishes (*Acanthurus* spp. and *Naso* spp.), rudderfishes (*Kyphosus* spp.), trevally (carangid spp.), and wrasses (labrid spp.), as well as specialized invertebrates, such as rock boring sea urchins (*Echinometra* spp.), the small giant clam (*Tridacna maxima*), and coral-dwelling crabs (*Trapezia* spp.) actively use this reef zone either intermittently or permanently.

The **reef front** extends from the reef margin downward to wave base depth. This reef zone typically experiences strong surging water movement. Buttress ridge and channel topography, also sometimes referred to as “spur and groove” formations, commonly develop in reef front zones that occur along windward exposed coasts. This kind of reef topography is caused by the formation of surge channels, which are cut at right angles to the reef margin and to prevailing wave action. The channels are lined with vertical to overhanging walls, and typically have flattened floors that extend downward to the wave-base depth. The floors of these channel, or ‘grooves’, remain mostly uncolonized, as the movement of coarse sand, rubble, and larger material prevent the establishment of coral, algae or other benthic organisms. In between the channels, or 'grooves', are lobate buttresses, or 'spurs', with a somewhat flattened surface and which slope downward in a seaward direction. This part of the reef front is generally considered to be the reef zone where modern reef assemblages grow most vigorously, as conditions appear to be optimum for the growth of often densely-packed coral colonies, coralline algae, and other reef building organisms. Beyond these major features, numerous microhabitats also exist within the reef front, such as the exposed upper surface of the buttresses, the steep and shaded channel walls, and various nooks and crannies. Corals, such as *Acropora* spp. (including *Acropora globiceps* and *A. retusa*), *Pocillopora* spp., *Porites* spp., as well as *Leptoria phrygia* and *Goniastrea retiformis*, tend to dominate the coral communities along the reef front. Macroalgae, such as *Valonia* spp., *Bryopsis* spp., *Chlorodesmis fastigiata*., and *Halymenia* spp., are conspicuous here, as are the sea cucumbers, *Actinopyga mauritiana* and *Stichopus chloronotus*, the sea urchin *Echinostrephus aciculatus*, giant clams (mainly *Tridacna maxima*), the day octopus (*Octopus cyanea*), panulirid lobsters (*Panulirus* spp.), many other crustaceans, as well as many other invertebrates. Reef fish species that can be observed in the reef front include parrotfishes (scarid spp., including the steephead parrotfish, *Chlorurus microrhinos*), surgeonfishes (acanthurid spp.), butterflyfishes (chaetodontid spp.), wrasses (labrid spp.), blacktip reef sharks (*Carcharhinus amblyrhynchus*), and various other fish species.

The **seaward reef slope**, also referred to as the forereef slope by some authors, extends downward from the reef front. The degree of steepness of the reef slope can vary considerably**,** and at many locations can be interrupted by flattened regions referred to as submarine terraces. The seaward reef slope extends to mesophotic depths, where light-dependent zooxanthellate corals give way to azooxanthellate corals, to the forereef and ultimately to the seafloor. A number of different habitats occur within the reef slope zone. The underlying structure of these habitats include a variety of hardbottom types, ranging from veneering communities, which are comprised of scattered corals on low relief pavement, to highly complex, coral-dominated aggregate reef structure. Various types of unconsolidated sediment habitats can also be found within the reef slope, including areas of turf or coralline algae-covered coral rubble, uncolonized sand, and rock/rubble with varying dominant cover types (e.g., turf algae, coralline algae, or coral). Owing to the varying hardbottom and softbottom structural types, the wide range of environmental conditions, and the comparative breadth of the reef slope, a high degree of biological diversity can be found in this important reef zone, including nearly all SGCN. Coral assemblages can vary significantly across gradients of exposure, depth, and other environmental factors, but within the CNMI the genera *Porites*, *Pocillopora*, *Montipora*, and *Acropora* typically dominate. While not commonly observed, the corals *Acropora globiceps*, *A. retusa*, and *Seriatopora aculeata* can also be found in the reef slope zone. Other coral genera, including *Favia*, *Goniopora*, *Astreopora*, *Lobophyllia*, and many others can also be found in the reef slope zone. The algae genera *Halimeda* spp., *Microdictyon* spp., *Caulerpa* spp., and *Liagora* spp., are frequently encountered, as are numerous species of soft corals, sponges, and other sessile organisms. Hundreds of species of reef fishes representing all major families and trophic groups are found in the reef slope zone, but parrotfishes (scarid spp., including the steephead parrotfish, *Chlorurus microrhinos*), surgeonfishes (acanthurid spp.), snappers (lutjanid spp.), emperors (lethrinid spp.), goatfishes (mullid spp.), rabbitfishes (siganid spp.), butterflyfishes (chaetodontid spp.), wrasses (labrid spp., including the napoleon wrasse, *Cheilinus undulatus*), damselfishes (pomacentrid spp.), and reef sharks (including the grey reef shark, *Carcharhinus amblyrhynchos*) are particularly common or notable reef fish taxa found in this zone. Notable non-coral invertebrates found in the reef slope zone include sea cucumbers (e.g., *Stichopus horrens*, *Thelenota ananas*, and *Holothuria whitmaei*), sea stars (e.g., *Acanthaster planci*, *Linckia guildingi*, and *Leiaster leachi*), sea urchins (e.g., *Echinothrix diadema* and *Echinometra* spp.), panulirid lobsters (*Panuliris* spp.) and other crustaceans (e.g., *Dardanus* spp. and *Zosimus aeneus*), giant clams (*Tridacna maxima* and *T. squamosa*), the day octopus (*Octopus cyanea*), and other molluscs, including the horned helmet (*Cassis cornuta*), the common spider conch (*Lambis lambis*), turban snails (*Turbo setosus*, *T. argyrostomus*, and *T. petholatus*), Triton's trumpet (*Charonia tritonis*), and the branched murex (*Chicoreus ramosus*). Spinner dolphins (*Stenella longirostris*) and hawksbill (*Eretmochelys imbricata*) and green (*Chelonia mydas*) sea turtles can also be observed in the reef slope zone.

5.1.1.1.2 Barrier reefs

A barrier reef system is comprised of a platform reef that is separated from land by a deeper lagoon. There are two general types of barrier reef systems, one comprised of a linear barrier reef and associated lagoon that does not encircle a land mass (e.g., those found at Saipan and Guam) and one comprised of a peripheral barrier reef and lagoon that encircles one or more lagoon islands (e.g., those found at Chuuk and Palau). Barrier reef systems can be divided into three distinct regions: the barrier reef platform, the lagoon that separates it from the landmass, and fringing reefs developed around lagoon island land masses. Each of these regions can be further divided into zones, each with distinct environmental attributes. The only barrier reef systems in the CNMI are found along portions of the western, or leeward, coasts of Saipan and Tinian. The barrier reef and its associated lagoon (called Saipan Lagoon) in Saipan occurs along most of the western coast, and contains a small islet, Mañagaha, that is a particularly important site for tourism. The barrier reef in Tinian is located off of Tinian Harbor, and is attached to the shore by a fringing reef.

As with platform fringing reef systems, the **shoreline intertidal zone** of barrier reef systems occurs in the coastal area between mean low and mean high tides and may be comprised by sand, mud, rubble, hardbottom, or a combination of these substrates. Depending on the width of the platform and the degree of exposure to wave energy, intertidal zones range from tumultuous areas affected by strong wave action to less dynamic, calmer environs. But even in calm intertidal zones protected against strong wave action, the regular changes in sea surface height cause the intertidal zone to be completely or partially exposed subaerially at low tide and partially or completely submerged at high tide. The biota of the shoreline intertidal zone of barrier reef systems is similar to that of fringing platform reef systems (see above).

The **lagoon** can be divided into floor, mound, pinnacle, and patch reef zones, although individual lagoon systems may not possess all of these zones. The lagoon floor, which is typically the most extensive region of a barrier reef system, generally deepens towards the center and often possesses scattered raised areas, including mounds, pinnacles, and patch reefs. Lagoon floors are typically comprised of sand, although areas of coral rubble and turf algae- and macroalgae-covered pavement with scattered coral may also occur. Mounds and pinnacles rise abruptly from the lagoon floor but do not reach the surface; mounds are those features with a width greater than their height, while pinnacles are higher than they are wide. Patch reefs rise from the lagoon floor and form a flattened platform that has reached sea level equilibrium. Mounds, pinnacles, and patch reefs can vary significantly in their size and shape and can be further subdivided in subzones that reflect the different biological assemblages that can occur in association with each of these features. For example, the upper surface of the patch reef flat platform, which may be exposed or have only a shallow covering of water during spring low tides, is suitable only for those organisms that can tolerate the temporary aerial exposure and rapid changes in temperature and salinity. The slopes of larger mounds, pinnacles, and patch reefs may be interrupted by submarine terrace subzones.

Coral assemblages associated with the lagoon can vary significantly across this zone, depending on the substrate, water depth, and other environmental factors. Sandy areas support little coral growth, although some staghorn *Acropora* corals and clusters of *Sinularia* soft corals may be present, while areas with hardbottom substrate, such as areas with pavement as well as mounds, pinnacles and patch reefs, can host a variety of corals, such as massive *Porites* spp., *Porites rus*, *Isopora palifera*, staghorn *Acropora* spp. and other *Acropora* spp., *Pocillopora* spp., and the reef-building octocoral, *Heliopora coerulea*. Similar to the varied lagoonal coral communities, fish and non-coral invertebrate assemblages can also vary significantly across lagoon habitats. Fish associated with sandy and rubble habitats include goatfishes (mullid spp.), mojarras (gerreid spp.), trevally (carangid spp.), rays (myliobatid spp.) and some wrasses (labrid spp.), while some common or notable non-coral invertebrates associated with sandy habitats include sea cucumbers (e.g., *Thelenota* spp., *Bohadschia* spp. and *Holothuria* spp.); urchins, such as the collector urchin (*Tripneustes gratilla*); and molluscs, including the pectinate venus (*Gafrarium pectinatum*), the branched murex (*Chicoreus ramosus*), and the horned helmet (*Cassis cornuta*). Hardbottom lagoonal habitats typically host a greater diversity of reef fish species, with different assemblages associated with each of the different hardbottom habitats. In general, some of the more common or notable reef fishes found in association with lagoon hardbottom habitats may include parrotfishes (scarid spp., including the seagrass parrotfish, *Leptoscarus vaigiensis*), surgeonfishes (acanthurid spp.), emperors (*Lethrinus* spp.), rabbitfishes (*Siganus* spp.), wrasses (labrid spp., including juvenile and subadult napoleon wrasse, *Cheilinus undulatus*), snappers (*Lutjanus* spp.), goatfishes (mullid spp.), groupers (*serranid* spp.), needlefishes (belonid spp.), trevally (carangid spp.), squirrelfishes (holocentrid spp.), damselfishes (pomacentrid spp.), butterflyfishes (chaetodontid spp.), and cardinalfishes (apogonid spp.). Numerous non-coral invertebrates, such as sea cucumbers (e.g., *Holothuria* spp., *Actinopyga* spp., *Synapta maculata*); sea urchins (e.g., *Echinothrix diadema*, *Diadema savignyi*, and *Tripneustes gratilla*); and molluscs, such as giant clams (*Tridacna* spp.), the day octopus (*Octopus* spp.), turban snails (*Turbo setosus*, *T. argyrostomus*, and *T. petholatus*), the Triton's trumpet (*Charonia tritonis*) and other gastropod snails, and panulirid lobsters (*Panuliris* spp.) and other crustaceans can also be found in association with lagoon hardbottom habitats. Green sea turtles (*Chelonia mydas*) may also be found in the lagoon reef zone.

Lagoonal islets may be present, and may range from very small, barely exposed rocks or aggregations of rubble, to substantial, vegetated land masses that can support human habitation. These islets and the land mass adjacent to the lagoon may possess veneering, apron, or platform fringing reefs, each with zonation patterns similar to those exposed directly to the ocean. The suffix "lagoon" can be added to these zones to differentiate them from their seaward analogues (e.g., "lagoon upper reef slope zone, lagoon lower reef slope zone, lagoon reef flat platform zone, lagoon reef margin zone, etc.). A lagoon channel zone, characterized by a relatively deep and narrow channel with steep to vertical walls, may be present where lagoon islands are closely associated. Strong bi-directional tidal currents occur in these channels, which are similar in morphology to channels through the barrier reef.

The **barrier reef flat platform** is a flattened region between the seaward reef margin and the lagoon that has reached sea level equilibrium. Similar to the fringing reef flat platform, the outer portion of the barrier reef flat platform may be slightly elevated compared to the inner portion, and the platform may be exposed during low spring tides or may be only shallowly covered with water. Where an islet (e.g., Mañagaha Island in Saipan Lagoon) is present on the reef flat platform, the ocean side can be referred to as the seaward islet reef flat platform and the lagoon side the lagoon islet reef flat platform. The seaward edge of the barrier reef flat platform can be divided into the same physiographic zones described for fringing platform reefs, but the prefix "seaward" can be added to differentiate them from similar zones on the lagoon side of the barrier reef flat platform (e. g. **seaward reef margin**, **seaward reef front**, and **seaward reef slope**). Where the barrier reef platform abruptly slopes into the lagoon the same zones discriminated on the seaward side can be found, and in order to discriminate from the seaward zones the prefix "lagoonward" can be added (e.g., **lagoonward reef margin**, **lagoonward reef front**, **lagoonward reef slope**). Most barrier reef-lagoon systems also possess channels that bisect the barrier reef platform and connect the lagoon waters with open ocean waters. The biota of the barrier reef platform, as well as the seaward reef margin, seaward reef front, and seaward reef slope zones, are similar to the biota described above for the analogous platform fringing reef zones. However, distinct assemblages may occur along deeper portions of the barrier reef platform. This is exemplified by the robust growth of *Isopora palifera* and massive *Porites* along the slightly deeper, lagoonward extent of the reef platform adjacent to the Saipan Lagoon. The biota of the lagoonward reef margin, lagoonward reef front, and lagoonward reef slope are also often distinct from their seaward analogues, particularly adjacent to deeper portions of the lagoon, owing to the low wave energy conditions typical of these areas. For example, the lagoonward reef margin along the lagoon waters near Mañagaha Island is typically inhabited by relatively large stands of *Isopora palifera* and massive *Porites* spp., with some corymbose *Acropora* and scattered *Pocillopora* spp.; in contrast, the seaward reef margin coral assemblages typically dominated by smaller *Acropora* spp. (and the occasional *Acropora globiceps* colony), *Pocillopora* spp., and smaller *Porites* colonies. Similarly, the low energy conditions of the lagoonward reef front and reef slope zones often support larger, more topographically complex, and more delicately-structured coral species not typically observed in their seaward analogues. The fish and non-coral invertebrate biota associated with the predominately hardbottom habits of the lagoonward reef margin, reef front, and reef slopes are similar to that described above for hardbottom lagoonal habitats.

5.1.1.1.3 Offshore banks and platforms

Offshore or open ocean banks are raised features of the seafloor topography or organic buildups that extend near the ocean surface, but which have not reached sea level equilibrium. Offshore or open ocean platform patch reefs are similar to banks, but they have reached sea level equilibrium. Offshore banks can be divided into submerged platform and slope zones. The submerged platforms generally have a somewhat truncated or undulating surface, and are surrounded by a slope that extends downward from the margin to mesophotic depths, the forereef, and ultimately to the seafloor. As with the seaward reef slopes of barrier reef and fringing reef systems, the slope of offshore banks may be interrupted by a flattened submarine terrace at various depths. The zonation of open ocean patch reefs is similar to that of open ocean banks, but the reef platform has developed upward to sea level equilibrium. The diversity of organisms represented on offshore banks and platforms is typically lower than that observed around islands, likely a result of lower habitat diversity, small size, and distance to sources of larvae. Still, numerous fish, coral, and non-coral invertebrate species can be found on offshore banks and platforms. A significant number of SGCN may be found on offshore banks and platforms, including spinner dolphins (*Stenella longirostris*), green (*Chelonia mydas*) and hawksbill (*Eretmochelys imbricata*) sea turtles, the grey reef shark (*Carcharhinus amblyrhynchos*), the napoleon wrasse (*Cheilinus undulatus*), steephead parrotfish (*Chlorurus microrhinos*), *Acropora globiceps*, *A. retusa*, *Seriatopora aculeata*, giant clams (*Tridacna maxima* and *T. squamosa*), the day octopus (*Octopus cyanea*), the horned helmet (*Cassis cornuta*), the common spider conch (*Lambis lambis*), turban snails (*Turbo setosus*, *T. argyrostomus*, and *T. petholatus*), Triton's trumpet (*Charonia tritonis*), the branched murex (*Chicoreus ramosus*), and panulirid lobsters (*Panulirus* spp.).

5.1.1.1.4 Flooded volcanic crater

A flooded volcanic crater, which is partly or mostly surrounded by subaerial remnants of the volcanic land mass, represents a unique reef type that cannot be strictly considered a fringing or barrier reef system, although it shares some characteristics with the latter. The subaerial remnants of the volcanic land mass form a partial or complete barrier that provides protection from wave action, producing relatively calm, lagoon-like conditions within the crater. No special terminology has been designated for this rare reef type, but these systems can be generally divided into an upper reef slope, which extends from the shoreline to wave base depth, and a lower reef slope, which extends from the base of the upper reef slope to the crater floor. Depending on the water depth within the crater, the lower reef slope may extend into the mesophotic zone, where it then transitions to the forereef slope until it reaches the sea floor. The seaward side of the crater typically hosts a veneering or apron fringing reef community, with zones as described above for these reef types. Maug hosts the only flooded volcanic crater in the Mariana Islands, and is one of the few flooded volcanic craters world-wide with conditions that allow for coral reef growth.

5.1.2 Seagrass beds

Seagrass beds are a distinct marine habitat typically found on fringing reef platforms and within barrier reef lagoons, but are addressed here separately due to their ecological, cultural, and economic importance. Seagrass beds in the CNMI are limited to the shallow reef flat and barrier reef lagoon areas along the west coast of Saipan, comprising approximately 6.7 km^2 (about 2.8%), of the island's shallow nearshore environment (Figure 38). Three seagrass species occur in the CNMI, including the largest species, *Enhalus acoroides*, which has thick blades that can grow up to 1.5 meters in height, and the more diminutive species, *Halodule uninervis and Halophila minor*, which grow up to 15 cm and 1.5 cm, respectively. Individual stands of *E. acoroides* are typically circular in shape, apparent when viewed from aerial photographs, and when clustered densely they form contiguous 'beds' or 'meadows'. *Halodule uninervis* and *Halophila minor* can be found in shallow sandy reef flats and deeper lagoon environments (Taborosi 2013). Seagrass communities are integrally linked to coral reef and mangrove ecosystems, serving as food for sea turtles, numerous fish species, sea urchins, and other marine invertebrates, and also providing shelter and substrata for a range of marine life, such as fishes, such as rabbitfishes (*Siganus* spp.), wrasses (labrid spp., including juvenile napoleon wrasse, *Cheilinus undulatus*), puffers (*Arothron* spp.), parrotfishes (scarid spp., including the seagrass parrotfish, *Leptoscarus vaigiensis*), and emperors (e.g., *Lethrinus harak*). Examples of invertebrates found in association with seagrasses include the collector sea urchin (*Tripneustes gratilla*) and sea cucumbers (e.g., synatpid spp. and *Holothuria* spp.). Seagrasses provide services for human populations by providing habitat for subsistence and commercial food fishes and invertebrates, stabilizing sand, trapping coastal sediments, filtering nutrients and contaminants, and protecting shorelines from erosion. Seagrass beds also serve as sources of biodiversity and sequester carbon from the ocean (Taborosi 2013).

5.1.3 Man-made submerged structures

Man-made submerged structures, such as wharfs, piers, breakwaters, pilings, sunken vessels, and other structures that occur in nearshore waters can support some organisms typically associated with coral reefs. In some instances, these structures can provide important habitat for SGCN and other ecologically and commercially important species, especially in areas with limited natural hardbottom habitat. However, it is generally held that man-made structures cannot replace or replicate the diversity and functions of natural coral reef ecosystems. The preponderance of available literature suggest that man-made structures may host a larger proportion of non-native species than their natural counterparts, owing to the unique substrate they provide or to use of some of these structures by ships, barges, and other vectors for these non-native species. For this reason, some man-made structures can be considered potentially facilitative of the spread of destructive invasive species to nearby natural habitats.

5.1.4 Open Water/Pelagic

Open water/pelagic habitat includes all waters that occur beyond coastal waters. For the purposes of this document, this habitat extends from coastal waters to the 200 nm limit of the U.S. Exclusive Economic Zone around the CNMI and from the sea surface to a depth of 1000 m. This depth limit represents the lower depth range of the grey reef shark (*Carcharhinus amblyrhynchos*), the deepest-occurring SGCN. The first 200 m of the open water/pelagic environment is referred to as the epipelagic zone, while the mesopelagic zone extends from a depth of 200 m to 1000 m. Each of these depth zones host different, but often overlapping and inter-dependent, assemblages, which are influenced by differences in light, pressure, temperature, nutrient availability, dissolved oxygen, and other physical and chemical conditions.

The abundance of light in the epipelagic, or photic, zone supports photosynthetic plankton, or phytoplankton, such as diatoms, dinoflagellates, and coccolithophores. Phytoplankton are responsible for all primary production in the open ocean environment and serve as the basis of the oceanic food web. Phytoplankton serve as prey for small heterotrophic organisms known as zooplankton, such as protozoa, copepods, euphasiid shrimp, jellyfish, siphonophores, as well as the fish and invertebrate larvae (Taborosi 2013). Free-swimming animals, known as nekton, feed on zooplankton and other nekton. Nekton in the open ocean waters around the Mariana Islands include the commercially important fish species mahi (*Coryphaena hippurus*), wahoo (*Acanthocybium solandri*), skipjack tuna (*Katsuwonus pelamis*), yellowfin tuna (*Thunnus albacares*), and Pacific blue marlin (*Makaira mazara*), as well as sharks, such as silky sharks (*Carcharinus falciformis*), Galapagos sharks (*C. galapagensis*), and tiger sharks (*Galeocerda cuvier*). While the grey reef shark (*Carcharinus amblyrhynchos*) is typically associated with coral reefs, they can also be found in the open water/pelagic environment, and have been recorded at depths up to 1000 m. Resident or migrating marine mammals, such as short-finned pilot whales (*Globicephala macrorhynchus*), sperm whales (*Physeter macrocephalus*), and dolphins, (*Stenella attenuata* and *S. longirostris*) and sea turtles, such as the leatherback sea turtle and the green (*Chelonia mydas*) and hawksbill (*Eretmochelys imbricata*) sea turtles (Taborosi 2013) can be found in the epipelagic zone.

Some light penetrates to the mesopelagic zone, also known as the twilight zone, but not enough to support photosynthetic activity. The epipelagic zone quickly becomes very dark, and bioluminescent organisms, such as ctenophores, siphonophores, lanternfishes (myctophid spp.), moonfish (*Lampris guttatus*), hatchetfishes (sternoptychid spp.), and deep sea anglerfish

(*Melanocetus johnsonii*), as well as the commercially targeted oilfish (*Ruvettus pretiosus*), snake mackerel (*Gempylus serpens*), and sickle pomfret (*Taratichthys steindachneri*) may be found in the mesopelagic zone (B. Tibbatts, personal communication). Some organisms, such as some sharks and marine mammals more commonly observed in the epipelagic zone descend into the mesopelagic to feed, while some mesopelagic organisms ascend to the nutrient-rich epipelagic zone to feed.

5.2 MARINE HABITAT COMPOSITION OF CNMI ISLANDS AND OFFSHORE REEF AREAS

This section includes summaries of the general composition of marine habitats of the islands and offshore reef areas in the CNMI. For each island or reef area, a brief description of its location, size, and general topography is provided, followed by a description of the overall submarine topography and the dominant and notable marine habitats around the island. The overall habitat complexity for each island/offshore reef area as estimated from NOAA MARAMP towed-diver surveys is presented in Figure 52.

Maps of the shallow (< 30 m) coral reefs of Rota, Tinian, and Saipan are presented in Figures 53-55. The extent and zonation of CNMI reefs are based upon spatial data developed by the NOAA Center for Coastal Monitoring and Assessment's Biogeography Team and presented in their 2005 *Atlas of the Shallow-Water Benthic Habitats of American Samoa, Guam, and the Commonwealth of the Northern Mariana Islands*. The NCCOS spatial data was modified to accommodate the small map scale used to depict benthic habitat data around entire islands. In particular, reef zones were combined into three primary reef zones, including the reef flat, lagoon, and reef slope. Beyond the depiction of reef zonation, areas of unconsolidated sediment are distinguished from the predominant coral reef and hardbottom structure. With the exceptions of seagrass beds in Saipan Lagoon, individual habitat types are not depicted in these maps, due primarily to the small map scale, which prevents the effective depiction of the large number of habitat types, most of which are small in spatial extent and embedded within a highly heterogeneous, complex mosaic of reef habitats.

5.2.1 Islands

5.2.1.1 Rota

Rota, the southernmost island of the CNMI, is located 76 km north of Guam and 117 km southwest of Saipan. Rota has a land area of 85.5 km^2 (Starmer 2005) and possesses approximately 25 km^2 of shallow (< 30 m) reef area. While the island is the fourth largest in the CNMI, the human population is small, accounting for only 1.5% of the total CNMI population. Rota’s coast is almost entirely composed of raised limestone, except for the Talakhaya area on the southern shoreline. This region hosts several intermittent streams, which deposit volcanic material originating from the island's interior. The eastern, high wave exposure shorelines are dominated by steep cliffs and slopes edged by a sea level bench; reef development is generally limited along these shorelines (Eldredge and Randall 1980; Eldredge 1983; Houk and van

Woesik 2010). Much of Rota's shoreline represents emergent Holocene reef due to geological uplifting and slight, eustatic sea level drop during the mid-Holocene (Kayanne et al. 1993). The vast expanses of emergent, fossilized reefs along most of Rota's shoreline are unique in the CNMI. However, the emergence of these reefs has prevented extensive biological production within reef flats and lagoons, as most of Rota's reef flats are completely exposed or isolated at lower tides. This has likely influenced the reef slope communities as well, as Holocene limestone is a porous rock that allows for rapid transport of groundwater to the nearshore assemblages, influencing modern coral growth on the reef slopes (Houk and van Woesik 2010). Although the raised, shallow reef platform surrounding Rota is mostly narrow, it reaches a width of 250 m along the leeward northwestern coastline (Eldredge and Randall 1980). Other areas of significant modern reef development include wave-sheltered portions of the northwest coast and west of Teteto Beach, Sasanhaya Bay, and a portion of the west coast (Starmer 2005). Likely due to Rota's unique geology, island-wide mean coral cover estimated from towed-diver surveys during the 2003-2007 NOAA Mariana Archipelago Reef Assessment and Monitoring Program (MARAMP) expeditions was low (4-9%) compared to other islands in the archipelago. In contrast to the low mean coral cover island-wide, towed-diver surveys along the eastern edge of Sasanhaya Bay indicated relatively high coral cover in the Coral Gardens marine protected area (Brainard et al. 2012).

5.2.1.2 Aguiguan

Aguiguan, also known as Goat Island, is a small (7.3 sq. km) island located approximately 9 km southwest of Tinian, to which it is connected by a submerged ridge at a depth of ~380 m. The island is comprised of a relatively flat, uplifted limestone plateau and is surrounded by steep cliffs. Aguiguan possesses approximately 9.8 km^2 of shallow (< 30 m) reef area. A narrow sea-level bench occurs along the eastern side, but no wide reef flats occur around the island (Eldredge and Randall 1980). A sloping bank surrounds the island, descending to approximately 400 m depth within about 2 km of the coast. Naftan Rock, a neighboring islet, was used as a bombing target prior to the U.S. Navy's use of FDM. Unexploded ordnance can be found in the waters surrounding this islet (Starmer 2005). Aguigan has been uninhabited since 1945, but is occasionally visited by hunters. Coral reef development is limited around Aguiguan, with the reefs off the northwest coast, which are situated on the most gently sloping seafloor, are the largest and most developed (Starmer 2005), The substrate is primarily hardbottom; a limited amount of unconsolidated sediment (primarily sand) is primarily found on the west side of the island, between Aguiguan and Naftan Rock. Island-wide mean coral cover estimated from towed-diver surveys was moderate (12-18%) compared to other islands in the CNMI (Brainard et al. 2012).

5.2.1.3 Tinian

Tinian is the second largest island in the CNMI, with a land area of 102 km^2 and approximately 26 km^2 of shallow reef area (including the adjacent Tatsumi Reef). Tinian hosts the second largest human population in the CNMI, at 3,136 (~5% of total population) in 2010. The island is relatively flat and is comprised of a series of uplifted carbonate platforms (Brainard et al. 2012). Although no permanent streams occur on Tinian, there are several small wetlands, with the most notable one adjacent to Unai Babui and Unai Chulu on the northwest coastline. In addition, freshwater runoff from unpaved roads enters nearshore waters and groundwater discharges through the porous karst aquifers at certain localities. As a result of unfavorable conditions promoting reef accretion through time, beaches are not well developed, with the exception of those at Tinian Harbor and at Unai Dankulu (Eldredge 1983). Most beaches are narrow and interrupted by raised limestone features (Eldredge 1983). The sand is primarily comprised of coral-algal-mollusk rubble (Eldredge 1983). A sea-level bench can be found at the base of low to high cliffs around much of the coast (Eldredge 1983). Tinian sits atop a steeply sloping bank primarily composed of carbonate terraces. The submarine bank forms ridges as it extends from various portions of the island. Most of the island is surrounded by raised reef platforms with limited reef flat and lagoon development, likely due to a combination of groundwater discharge, high wave exposure, and unfavorable geological foundations. Reef flats of relatively limited extent can be found at several locations around the island, and vary in width from less than 15 m to approximately 180 m at Tinian Harbor (Eldredge 1983). The reef flats are mostly shallow, with irregular surfaces and a grooved margin. A single small lagoon with patch reefs is located near Tinian Harbor, along the southwest shore. A barrier reef, attached to the shore by a fringing reef at Tinian Harbor, was altered to serve as a breakwater for the harbor. The lagoon, which was originally about 7 m deep was altered during the construction of docking facilities (Doan et al. 1960; Eldredge 1983). Similar to Rota, long-term monitoring sites examined by local monitoring teams highlight low coral cover associated with unfavorable geology, but also show one key region of high coral growth in Barcinas Bay associated with low wave exposure on the leeward side of the island. Island-wide mean coral cover estimated from NOAA MARAMP towed-diver surveys along the seaward reef slope was low (8-13%) compared to other islands in the CNMI (Brainard et al. 2012).

5.2.1.4 Saipan

Saipan, the largest island in the CNMI with a land area of 122 km^2, also possesses the largest reef area, with a total of 98 km^2 of reef (including the adjacent western banks). The island is comprised of a volcanic basement covered at most places by limestone (Cloud et al. 1956). Owing to its primarily limestone composition, surface water runoff is also limited on Saipan, with only a few intermittent streams; however, the amount of surface runoff is comparatively more than the other populated islands. Streams are found to the west of Okso' Talufo'fo and Okso' Achugao in the northeast of the island, as well as on the east-central coast adjacent to the island’s largest watersheds. Perhaps due to the comparatively favorable geological and environmental setting, approximately 90% of the total CNMI population resides on Saipan, with most development concentrated along the west (leeward) coast. Steep headlands and cliffs, often buttressed with blocks and boulders, line much of Saipan's coast, similar to other islands (Eldredge and Randall 1980; Eldredge 1983). However, larger watersheds provide for greater amounts of low lying coastal plains, and gentler nearshore bathymetry that facilitates reef growth. Extensive fine-sand beaches are found along the western shore within the barrier lagoon, while most other beaches are composed of sand and gravel (Eldredge 1983). While most of the shoreline is limestone, volcanic material is exposed at Maigo Fhang (Bird Island), Puntan Fununchuluyan, near Puntan Hagman, and north of Puntan I Naftan (Eldredge and Randall 1980; Eldredge 1983).

Saipan hosts the most diverse set of coral-reef habitats and reef-associated assemblages in the CNMI (Starmer 2005). The Saipan Lagoon, which occupies an area of approximately 30 km^2, is deeper in the central part due to dredging to provide access to shipping vessels. In the northern and southern parts, a shallow-water lagoon exists with more limited coral growth. Mañagaha Island, a small lagoonal islet, is an important cultural and tourist destination in the central portion of the lagoon. Seagrasses and sand habitats dominate the lagoon, with coral habitats, which host coral, algal, fish, and other species not found elsewhere in the CNMI, covering smaller areas. All three seagrasses known to occur in the CNMI, including *Enhalus acoroides*, *Halodule uninervis*, and *Halophila minor* are found there (Tsuda et al. 1977). Fringing reef flat platforms are more frequent around Saipan compared to all other CNMI islands, and vary in width from a few meters to nearly 200 m at Bird Island (Eldredge and Randall 1980). The reef flat platforms are covered by scattered boulders and exposed blocks, with coral growth most prevalent just behind the reef margin (Eldredge and Randall 1980). Corals are generally widely scattered on the shallow platforms, and are more abundant in deeper portions (Eldredge and Randall 1980). Limited reef development occurs on the windward eastern side of Saipan, likely due to exposure to high wind and wave energy (Houk and van Woesik, 2010), and broad shallow shelves like those found along the west coast are not as extensive. However, Bird Island and Lau Bay are two notable features with extensive reef flat platforms. Two large banks, including one that extends from approximately 10 km to the west of Saipan and another that extends from the harbor in the north to the southern end of the island, are used as anchorages for commercial and military vessels. Island-wide mean coral cover estimated from MARAMP towed-diver surveys was moderately high (21%) in 2003, but appears to have declined in 2005 and 2007 (10-11%). While island-wide coral cover in 2003 was higher compared to other southern islands with similar marine habitats, coral cover was also highly variable around Saipan. High coral cover was detected by NOAA MARAMP Towed Optical Assessment Device (TOAD) video surveys at depths between 61-70 m on the western banks (Brainard et al. 2012). Local monitoring efforts have also found Saipan to be the most favorable southern island for reef growth and modern assemblages given the geological setting (Houk and van Woesik 2010).

5.2.1.5 Noos (Farallon de Medinilla)

Noos is a raised limestone island located approximately 83 km northeast of Saipan. The island has a total land area of about 0.9 km^2 and 6 km^2 of shallow reef area. The coastline has been reported as having near-vertical cliffs with some slumping along the northeaster shore (Eldredge and Randall 1980). Eroded large blocks and boulders form small islets around the island. The U.S. Navy and Air Force have used Noos as a bombardment range since 1971 (Eldredge 1983). A fringing reef that surrounds the island has been reported to be comprised of pavement with scattered boulders, some spur and groove formations, and sandy flats (Starmer 2005). A shoal reaching a depth of about 35 m is found approximately 1.8 km to the north of the island. A comprehensive assessment of the marine habitats around Noos has yet to occur.

5.2.1.6 Anatahan

Anatahan is a small, active volcanic island located 120 km north of Saipan and 40 km south of Sarigan. The island is the southernmost island in the Northern Islands Municipality, with a land area of about 33 km^2 and 6.5 km^2 of shallow (< 30 m) reef area. The steeply, highly irregular sloping flanks that surround the compound caldera continue underwater (Brainard et al. 2012). Steep cliffs and headlands line most of the shore, and in more protected areas large blocks and boulders buttress the cliffs. The southwestern shoreline is comprised of truncated basaltic platforms. Only a few, small, widely scattered sand beaches occur around Anatahan (Eldredge 1983). Recent seismic and thermal activity of the Anatahan Volcano has prevented human habitation in recent decades. A major eruption in 2003 covered Anatahan village, as well as much of the island, in volcanic ash. The ash also impacted nearshore waters and in 2005 and 2007 NOAA CRED reported that the waters surrounding the island were a deep brown color as a result of the large amount of ash and volcanic input. Visibility was reported as < 0.6 m, which prevented surveys of any kind during the 2005 and 2007 MARAMP expeditions. It was also reported that the entire island was void of vegetation, and it was suspected that rainfall would easily wash ash and other material into nearshore waters (Brainard et al. 2012). Prior to the recent volcanic activity and associated destruction of most or all vegetation, the landscape of Anatahan had been significantly altered by pigs and goats, rapidly transitioning from high native forest cover as recent as 1994 to a primarily sword grass-dominated landscape in 2000 (Cruz et al. 2000a). Observations from NOAA MARAMP towed-diver surveys and TOAD video surveys suggest that the marine habitats of Anatahan are primarily comprised of sandy substrates supporting very low levels of live coral cover. Ash was observed covering benthic habitats in most of the towed-diver surveys. Habitat off the north and northeast coasts were of low to medium complexity, with high sand cover and relatively low coral cover. Sand flats with boulders, including a portion of the southeast coast with medium to medium-high complexity, were encountered in the south and southeast of Anatahan, while coral cover was variable. Sandy habitats, with scattered boulders and low coral cover, were reported from the west region, while in the northwestern point of the island relatively high coral cover was recorded. Island-wide mean coral cover estimated from towed-diver surveys was relatively low (8%).

5.2.1.7 Sarigan

Sarigan, which is centrally-located in the archipelago between Guguan to the north and Anatahan to the south, is, like most other islands in the CNMI, formed by the exposed summit of a mostly submarine volcano. With a land area of 4.9 km^2, the island is the fourth-smallest in the archipelago. A crater is located at the southern part of the island, and steep cliffs and irregular shorelines created by lava flows surround the island. Vegetation cover is relatively sparse, possibly indicating that the most recent eruption occurred sometime during the Holocene. It is generally held that Sarigan has been uninhabited since residents were removed after WWII, but 2010 legislation encouraging repatriation may lead to the re-population of the island in the future. Owing to its lack of inhabitants and isolation, there are believed to be minimal anthropogenic pressures on Sarigan's marine environment; however, multi-day fishing trips to Guguan and banks to the south may impact fish stocks around Sarigan. Feral animals had significantly impacted the landscape of Sarigan, but since the elimination of the animals between 1997 and 1998, vegetation has dramatically recovered and sedimentation of nearshore waters has likely decreased as a result (Starmer 2005).

In contrast to the steep submarine slopes that surround most of the northern islands, Sarigan is surrounded by a shallow shelf (30-150 m) that extends east for 2.7 km before it drops off steeply. The island possesses approximately 2.6 km^2 of shallow (< 30 m) reef area. Along the west side of the island, the edge of the shelf is intersected by channels and ridges. Habitat complexity in the east was reported by towed-diver observers as medium to medium-high, with a variety of habitats including boulders and pinnacles, rocky crags, and sand with boulder patch reefs. Habitat complexity in the northwest ranged from low to high, with patchy sand cover, boulders, steep walls, and continuous rocky reef. NOAA MARAMP TOAD video surveys at depths of 91-190 m found hard substrates with no living coral cover. Habitat in the southwest was comprised of boulders and continuous reef with sand patches, while the substrate in the southwest was described as mainly hard substrate, with limited sand cover, and no live coral cover. Island-wide mean coral cover estimated during NOAA MARAMP towed-diver surveys was moderate (13-18%) compared to other islands in the archipelago. High coral cover (> 50%) habitat was observed at localized areas along the southwest and eastern shores.

5.2.1.8 Guguan

Guguan, which is located in the middle of the archipelago, is formed by two volcanoes, including an older, eroded, vegetated volcano to the south, and a barren active volcano to the north. The island has a land area of 4.2 km^2, making it the third smallest island in the archipelago, and it possesses approximately 2.1 km^2 of shallow (< 30 m) reef area. Compared to neighboring islands of Alamagan and Sarigan, Guguan's elevation is relatively low and its slopes less steep. Guguan has not been inhabited and remains relatively undisturbed, supporting a diversity of terrestrial habitats and wildlife. Development on Guguan is banned by the CNMI Constitution and has been declared a wildlife conservation area (Starmer 2005). Guguan's coastline is mostly surrounded by steep cliffs and is highly irregular. Low, truncated basaltic platforms are found along the southwest shore, and a narrow, well-protected boulder and cobble shore occurs on the west coast. Vertical cliffs buttressed with blocks comprise the shore along the north and northwest of the island, and a small embayment surrounded by vertical cliffs occurs along the east coast (Eldredge 1983). The north of Guguan is surrounded by flanks with ridges in shallower (< 300 m) depths, but the slopes are relatively uniform and smooth below these depths. NOAA CRED towed-diver observers reported marine habitat of medium to high complexity, primarily spur and groove habitat, in the north. The substrate was reported as primarily hardbottom, with low sand cover. Irregular shelves extend off the south of Guguan, including a flat, shallow (25-50 m) shelf comprised of hard substrate and a deeper (80-130 m) shelf that is predominantly comprised of unconsolidated substrate. The steeply sloping flanks to the north and west and the extensive shelves in the south are highly similar to the general seascape of neighboring Sarigan. Island-wide mean coral cover estimated from NOAA MARAMP towed-diver surveys was moderate (23-27%) compared to other islands in the archipelago.

5.2.1.9 Alamagan

Alamagan is a steep-sloped active volcano in the middle of the archipelago with an area of 12.96 km^2 and approximately 3.4 km^2 of shallow (< 30 m) reef area. A deep crater sits atop Bandeera Peak, which is surrounded by steep slopes; flatter areas formed by lava flows extending to the north and south of the peak. Sea cliffs line most of the coastline; no small-grained beaches occur on the island. No recent volcanic activity has been reported for Alamagan, with the last known eruption occurring around AD 870. Small human populations have inhabited the island historically, and a small homestead site was observed on the northwestern side of the island in 2000. The island's human population is expected to increase in the future, as a result of legislation enacted in 2000 that encourages settlement of Alamagan. Extensive impacts to vegetation by feral pigs, goats, and cattle are likely resulting in increased sedimentation of nearshore marine habitats (Starmer et al. 2008). Moderately steep submarine flanks in the north and northeast are interrupted by steep, narrow ridges that are described by towed-diver survey observers as comprised of hard substrate of medium to high complexity. A small shelf with a complex substratum occurs in the southeast, while in the west a more extensive shelf is found at depths of 25-40 m. A second deep shelf occurs on the southwest of the island at depths of 80-120 m. Marine habitat in the south was described as having lower complexity, with high sand cover. Island-wide mean coral cover estimated from NOAA MARAMP towed-diver surveys was relatively high (17-22%) compared to other islands in the archipelago.

5.2.1.10 Pagan

Pagan is the fourth largest island in the CNMI, with a land area of 46 km^2 and 12.1 km^2 of shallow (< 30 m) reef area. The island was formed by two large volcanoes, the northern one active and the southern one dormant; the volcanoes are separated by a narrow isthmus. The steeply sloping flanks of Mount Pagan in the north descend to depths > 2000 m, while the slopes in the south extend to depths > 3000 m. Ridges and pinnacles can be found on the steep slopes. Pagan has been inhabited sporadically and mainly on a seasonal basis since the evacuation of residents after a major volcanic eruption of Mount Pagan occurred in 1981. The ashfall from the 1981 event was reported to have negatively impacted coral reef habitat around the island (Eldredge and Kropp 1985), and continued erosion of ash into nearshore waters and sedimentation resulting from damage to vegetation by feral pigs and cattle are potentially impacting reef habitat (Starmer et al. 2008). The depth of ash outfall on land from the 1981 eruption was correlated with compromised assemblages assessed in the mid-2000s (Houk and Starmer 2010), suggesting that coral recovery is impeded by naturally unfavorable environments or intermittent ash deposition into adjacent waters over the years. NOAA MARAMP towed-diver observers described shallow marine habitats in the north and east as moderately complex with hard substrate. TOAD video surveys conducted at depths of 50-100 m in the north and east suggests primarily hard substrates with patchy sand cover. Coral colonies were rarely observed at the TOAD survey depths, although it should be noted that these surveys covered only a small portion of the island. Shallow habitat in the northern parts of the south and west regions were of low complexity, dominated by soft-sediment habitats and possessing very little coral cover, while habitats were moderately complex on either side of the narrow isthmus connecting the north and south, and were primarily hardbottom with moderate coral cover. Sand and other low complexity habitat were dominant around South Point, more so than any other part of Pagan. TOAD video surveys conducted off the south coast at depths of 15-100 m suggest relatively low coral cover. Island wide mean coral cover estimated from towed-diver surveys was moderate-to-high (10-19%) compared to other islands in the CNMI.

5.2.1.11 Agrigan

Agrigan, the tallest island in the Mariana Archipelago, is located 65 km north of Pagan. Agrigan is also one of the largest northern islands, with a land area of 44 km^2, and possesses approximately 6.5 km^2 of shallow (< 30 m) reef area. The island, which reaches a summit of 965 m, is surrounding by steep slopes and sea cliffs. Agrigan has been inhabited sporadically over the last century, owing to volcanic activity, but one of the four original villages has been resettled and now has a small permanent population. As with many of the northern islands, the vegetation has been impacted by feral animals. The impact of feral animals on vegetation is particularly severe on the east side of the island, and coral reef habitats on that side of the island are believed to have been impacted by the resulting sedimentation of nearshore waters (Starmer 2005). The seascape of Agrigan is comprised of steeply sloped volcanic flanks cut by channels. A submarine ridge created by lava flow occurs off the northwestern coastline, and a shallow (30-40 m) shelf is found around much of the island. Towed-diver observers reported marine habitats of medium to high complexity in the northwest, dominated primarily by hardbottom and possessing little sand cover. Habitat in the northeast was more varied, ranging from medium-low to high complexity, and comprised of pavement, boulders on sand, and rocky ridges. Habitat in the southeast was of low complexity, and was characterized primarily by areas of high sand cover alternating with moderate-relief patch reefs and higher complexity spur-and-groove habitat. A large portion of the shallow southwest benthos was of low to medium-low complexity and was characterized by high sand cover and very low coral cover. Island-wide mean coral cover estimated from NOAA MARAMP towed-diver surveys was moderate (14-16%) compared to other islands in the CNMI.

5.2.1.12 Asuncion

Asuncion is the third most northerly island of the Mariana Archipelago, located approximately 100 km north of Agrigan. Asuncion has a land area of 7.76 km^2 and 2.2 km^2 of shallow (< 30 m) reef area. The active volcanic island is protected under the CNMI Constitution as an important habitat for birds, wildlife, and plants, and in 2009 the waters and submerged lands around Asuncion were designated part of the Islands Unit of the Marianas Trench Marine National Monument. Asuncion's slopes are the steepest among the northern volcanic islands. NOAA MARAMP towed-diver surveys reported marine habitat of medium to medium-high complexity, predominantly hardbottom supporting relatively low hard coral cover. The seafloor on the south of Asuncion is dominated by a large, flat shelf with several terraces. Island-wide mean coral cover estimated from NOAA MARAMP towed-diver surveys was moderate (10-18%) compared to other islands in the CNMI. Coral cover and colony density was highest on the west side of the island. Hard corals and sea pens (Order Pennatulacea) were observed between 70 and 600 m in TOAD survey video.

5.2.1.13 Maug

Maug is comprised of three separate islands (Higashi, Kita, and Nishi) formed by the rim of a submerged caldera. At a combined area of just over 2 km^2, these islands are the smallest in the CNMI. However, Maug possesses approximately 3.5 km^2 of shallow (< 30 m) reef area, second highest of the northern islands after Pagan. The islands each possess a narrow central ridge with steep slopes that terminate in sea cliffs along the coast. There have been no recent eruptions of the Maug volcano, but an active hydrothermal vent was observed during the 2003, 2005, and 2007 MARAMP cruises. Habitation or the building of permanent structures is prohibited on Maug under the CNMI Constitution, and in 2009 the islands, submerged lands, and waters of Maug were included in the Islands Unit of the Marianas Trench Marine National Monument. The steep outer slopes of the Maug volcano extend to a depth greater than 1500 m, while the submerged caldera reaches depths of between 200 and 240 m. A twin-peaked submarine dome rises to a depth of 20 m within the caldera. Towed divers reported habitat complexity as medium to high, with the benthos dominated by hardbottom and with low levels of sand cover compared to other areas in the archipelago. Island-wide mean coral was high 21-27% in the shallow waters surveyed during NOAA MARAMP towed diver surveys. Little coral cover was detected from TOAD video surveys in deeper waters, although some live coral was observed on the central dome at a depth of about 160 m.

5.2.1.14 Uracas

Uracas, also known as Farallon de Pajaros, is the northernmost island in the Mariana Archipelago, located 67 km northwest of Maug. It is the second-smallest island, with a land area of 2.2 km^2 and 0.5 km^2 of shallow (< 30 m) reef area. While the summit of this active volcano reaches an elevation of 360 m above sea level, the feature rises more than 2000 m from the seafloor and is between 15 and 20 km in diameter at its base. The aerially exposed summit is surrounding by steeply sloping sides covered with lava, cinders, and ash. The slopes extend downward to precipitous cliffs, which surround much of the coast. Uracas is one of the most volcanically active islands in the CNMI, with at least 15 known eruptions recorded since 1864 and the most recent in 1967. Volcanic activity and landslides are likely the most significant drivers of change in benthic habitat structure and community composition. Anthropogenic pressures are likely minimal, as CNMI-based fishing activity tends to be focused around the southern islands and multi-day fishing trips focused primarily on the islands and banks south of Guguan (Western Pacific Fishery Management Council, 2009). However, the level of fishing pressure from foreign vessels is unknown, and with limited reef area and limited reef fish biomass, reef fish stocks could likely be significantly affected by relatively little fishing pressure. Uracas, including the island and the surrounding waters and submerged lands, is also part of the Islands Unit of the Marianas Trench Marine National Monument. Multibeam acoustic bathymetry data collected during NOAA MARAMP expeditions revealed steeply sloping flanks surrounding Uracas, with ridges extending from < 30 m to 400-600 m. The data also indicate a narrow shelf between 10 and 40 m along the South and East sides of the island, and another larger shelf that extends from the northeastern point at depths between 150 and 250-300 m. Boulders were common along the slopes, indicating mass-wasting of surface material. Observations made during towed-diver surveys carried out during MARAMP expeditions indicate that the northeast and southeast regions, particularly on the shallow shelf extending from large embayments, possessed the lowest levels of habitat complexity and relatively high sand cover. In contrast, the west and south regions exhibited medium to medium-high habitat complexity, with patches of rocky reef and boulders on sand. Hard coral cover estimated from MARAMP towed-diver surveys was generally low (< 10%) in comparison to other islands in the archipelago. An exception was 30-40% coverage observed on the shallow shelf in the southeast region.

5.2.2 Offshore banks and shoals

5.2.2.1 Esmeralda Bank

Esmeralda Bank is a submerged stratovolcano located on the Mariana Arc, approximately 57 km southwest of Saipan and 37 km west of Tinian. The bank, which is one of 21 seamounts protected within the Volcanic Unit of the Marianas Trench Marine National Monument, is one of the southernmost active volcanoes in the Mariana Arc (Stern and Bibee 1984). Multibeam acoustic bathymetry data collected during NOAA Ocean Explorer expeditions indicated that the summit of Esmeralda Bank, which reaches a minimum depth of 43 m, is the rim of a crater approximately 300 m deep. No diver surveys have been carried out on Esmeralda Bank, but three TOAD surveys covering a distance of about 1 km at depths between 63 and >100 m were conducted during MARAMP 2003. Analysis of the TOAD surveys, all of which were located on the north crater rim, revealed both sandy seabeds and hard substrate. Live corals appeared quite rare, with only one of the 189 analyzed video frames revealing any coral colonies (Brainard et al. 2012).

5.2.2.2 Marpi Bank

Marpi Bank, which is located ~18 km north of Saipan, is a flat-topped structure that is likely comprised of uplifted limestone overlying a volcanic basement. The bank is part of the older Mariana frontal arc, formed between 15 and 20 million years ago. Multibeam bathymetry data collected by NOAA CRED indicate that the bank reaches a minimum depth of 53 m and that it has an elongated shape approximately 7 km long and 3 km wide. The bathymetry data suggests that the seafloor surrounding the bank is characterized by low slopes with ridges, fissures, and blocks of material likely derived from erosional processes. While observational data are not available to describe the habitat composition, mounds and channels on the top of the bank revealed by the NOAA CRED multibeam data may be indicative of coral habitat. Marpi Bank is reported to be a popular fishing location (Starmer 2005).

5.2.2.3 Zealandia Bank

Zealandia Bank is a submerged stratovolcano located on the active Mariana Arc, approximately 25 km northeast of Sarigan Island. The flat-topped bank, which is part of the Volcanic Unit of the Marianas Trench Marine National Monument, is elongated and formed by two volcanic pinnacles located approximately 1 km apart. One of the two pinnacles extends about 1 m above sea level during low tide (Siebert and Simkin, 2002) (NOAA CRED). Insufficient data exists to thoroughly describe the habitat of Zealandia Bank, but a single TOAD survey conducted during MARAMP 2003 at depths between 70 m and 120 m suggests that the substrate is variable, with about a third classified as hard substrate and the remainder as sand or mixed. No live hard corals were recorded during the survey.

5.2.2.4 Supply Reef

Supply Reef is a stratovolcano located on the active Mariana Arc, approximately 18.5 km northwest of Maug. Maug and Supply Reef form a twin volcanic massif, connected by a low saddle at a depth of about 1800 m (Siebert and Simkin 2002). Supply Reef was mapped using multibeam acoustic sonar during MARAMP 2007, adding to data collected by the NOAA Vents Program. The data indicated that Supply Reef reached a minimum depth of approximately 10 m, that the reef is conical with steep sides, and that the total area of shallow (< 30 m depth) reef was approximately 0.1 km^2. Observations made from a single towed-diver survey (4-25 m depth) during a 2003 NOAA MARAMP expedition suggest that the upper reaches of Supply Reef possessed habitat of medium-high to high complexity, with high live coral cover (30-50%) and low sand cover (<5%). The results of the two TOAD surveys indicate that reef habitat at mesophotic depths was similarly dominated by hard substrate, but live corals were rare (Brainard et al. 2012).

5.2.2.5 Arakane Reef

Arakane Reef is a small, shallow bank located approximately 110 km southwest of Tinian on the West Mariana Ridge. Multibeam bathymetry data collecting during a MARAMP expedition indicated that the total area of shallow (< 30 m depth) reef was about 0.5 km^2. Observations made during towed-diver surveys conducted during the 2003 and 2005 MARAMP expeditions suggested that the shallower depths of Arakane Reef were dominated by hard substrate with medium-low to medium complexity, but small, scattered sand patches were also present. Mean coral cover estimated from towed-diver surveys was 24% in 2003 and 12% in 2005, the lowest of the other surveyed reefs on the West Mariana Ridge. Towed-diver observers noted a high abundance of soft corals and fire corals. Analysis of TOAD survey video suggested a great degree of variability in coral cover (0-100%) at depths ranging from 20-280 m.

5.2.2.6 Pathfinder Reef

Pathfinder Reef is a remnant volcanic ridge located approximately 150 km west of Saipan, on the southern part of the West Mariana Ridge. Pathfinder Reef was surveyed in 2003 and 2005 as part of NOAA CRED's MARAMP. While no multibeam acoustic bathymetry data were collected at the site, single-depth soundings from 2003 indicated a minimum depth of 10 m and a total area of shallow (< 30 m depth) reef of about 0.9 km^2. Observations made during towed-diver surveys and the results of an analysis of TOAD video indicate that the seafloor at the summit of Pathfinder Reef is predominantly comprised of hard substrate, with medium-low to medium-high habitat complexity. The reef was described as “atypical spur and groove, with gently sloping mounds of coral interspersed with hard pavement channels.” Estimates of live coral cover from NOAA MARAMP towed-diver surveys ranged from 10-40%, with a mean of 24% in 2003 and 25% in 2005. Coral cover was highest (35%) along the interior, western edge, and northern border of the reef. Estimates of live coral cover from an analysis of TOAD video surveys, which cover more restricted portions of the seafloor compared to towed-diver surveys, were highly variable, ranging from 0-100%.

5.2.2.7 Stingray Shoals

Stingray Shoals is a remnant volcanic seamount located on the northern end of the West Mariana Ridge approximately 275 km west of Uracas. The steep-sided pinnacle, which reaches a minimum depth of 13 m, is part of the Volcanic Unit of the Marianas Trench Marine National Monument. Stingray Shoals was surveyed by NOAA CRED in 2003 during the first MARAMP research expedition. While the full suite of coral reef surveys were not carried out at the site, towed-diver surveys were conducted near the summit of the shoals and two TOAD surveys were conducted at depths of ~20-100 m. Multibeam acoustic bathymetry data were not collected during the 2003 MARAMP, but single-depth soundings collected across the shoals indicated that the seamount is an overall conical shape and has a total shallow (< 30 m depth) reef area of approximately 0.2 km^2. Observations made during the towed-diver surveys and the results of the analysis of TOAD video indicate that Stingray Shoal is predominantly covered by hard substrate. Towed-diver observers recorded habitat complexity ranging from medium-high to high, and noted high coral cover ranging from 40-100% (mean of 55%) that extended across a continuous, well-developed reef. The hard coral cover recorded at Stingray Shoal in 2003 was the highest recorded for any of the islands or banks in the Mariana archipelago surveyed between 2003 and 2007. The highest coral cover was observed in the north and west (75% and

76%, respectively). The analysis of TOAD video suggested that areas of high coral cover were more sporadic in the deeper waters of the northern and southern portions of the shoal.

5.3 Relative condition of CNMI marine habitats

Comparisons of the relative condition of marine habitats across the CNMI must take into account differences in the degree of coral reef development and community composition drive by natural variation in geomorphology and wave exposure, as well as by acute natural disturbances such as typhoons and volcanic activity. The northern islands are active or dormant stratovolcanoes that have formed along the tectonically active portion of the Mariana Arc, with many of the islands having erupted multiple times in recent centuries. The northern islands are all small, with land areas ranging from 2-34 km^2, with the exception of Pagan (46 km^2). These factors, accompanied by the strong influence of the northeast trade winds in the CNMI, together dictate that coral reefs in the northern islands are considerably less developed and host a lower number of species than those found in the older, larger, inactive southern islands. Despite less reef development and species richness, the marine communities are subjected to less human stress, notably fishing pressure and pollution. The southern islands and associated offshore banks lie atop much older, extinct volcanoes and are covered by carbonate formations. With the exception of the uninhabited island of Aguiguan, the southern islands are the largest in the CNMI, with land areas of 85-544 km^2. In addition, the seafloor around the southern islands is typically more gently sloping than the northern islands, and with step-like limestone topography. These conditions yield a larger range of habitat types and a greater diversity of marine species, but with greater exposure to human stressors.

Although the coverage of living coral is a somewhat limited measure of benthic habitat condition, some general statements could be made about relative benthic habitat condition of reef areas in the CNMI based on the amount of living coral observed across reef areas. However, without consideration of environmental and anthropogenic processes that influence benthic communities, and without information regarding changes in the amount of living coral and the composition of the benthic communities over time, such general statements should be considered tentative and subject to further inquiry. An examination of live coral cover values from 2003-2007 NOAA MARAMP towed-diver surveys suggest levels were highly variable across the CNMI, with no obvious north-south gradient or other archipelago-wide patterns (Figure 56). The highest levels of coral cover estimated from towed-diver surveys were reported from Maug and Guguan, both with 27% for at least one of the survey years. Among the volcanic islands, these two are associated with the longest timeframe since the last volcanic eruption. Saipan also had relatively high coral cover, with an overall mean of 21%, perhaps owing to the most favorable environmental regimes for modern reef growth. Relatively moderate coral cover was recorded at Aguiguan, Sarigan, Agrigan, and Asuncion, with means ranging from 12-18% across the three survey years; these are all small islands with stronger natural environmental limitations to coral growth. The lowest coral cover levels were reported from Rota (4-9%) and

Uracas (5-10%), where conditions selecting against coral growth were greatest, with groundwater contribution likely influencing reef development around Rota and volcanic activity with continuous ash resuspension affecting reef development at Uracas. Low coral cover was also recorded at Anatahan, with an overall mean of 8% from surveys conducted in 2003, shortly after the eruption. Coral cover estimates for the remote banks of the West Mariana Ridge were highest at Stingray Shoal in 2003 and Pathfinder Reef in 2005 (55% and 25%, respectively), although the lack of sampling stratification and high variance among coral cover values make it difficult to accurately assess coral cover at these locations. In addition, despite the high reported coral coverage, these reefs appeared to be dominated by only a few species (Brainard et al. 2012).

The relative amount of stressed coral cover, which includes corals that were bleached, pale, discolored, malformed, or exhibited tumors, can also provide an indication of the condition of the coral community and may indicate gradients of anthropogenic stressors that affect the overall benthic community condition and the condition of the ecosystem as a whole. Based on estimates recorded during NOAA MARAMP towed-diver surveys in 2005 and 2007, the highest island-wide mean stressed coral cover levels were recorded at Agrigan (5%) in 2005 and at Aguigan and Saipan (8% and 6%, respectively) in 2007. Stressed coral cover levels were lowest (< 1%) at Guguan and Sarigan for both years. Observations of relatively high crown of thorns seastar (COTS) densities at some locations likely contributed significantly to the high stressed coral cover levels at certain islands.

The *Archipelagic Benthic Condition Index* developed by NOAA CRED, while itself not a perfect measure, offers a more robust means of comparing relative benthic habitat condition by integrating various metrics of benthic habitat condition that were assessed during towed-diver surveys. The *Archipelagic Benthic Condition Index* includes rankings (high, medium, and low) for live coral cover, stressed coral cover, macroalgae cover, crustose coralline algae cover, and COTS density. A high overall *Archipelagic Benthic Condition Index* ranking, typically characterized by high cover of coral and crustose coralline algae, low macroalgae and stressed coral cover, and low COTS densities, indicates better condition relative to other reef areas in the CNMI. A low ranking, typically characterized by low coral and crustose coralline algae cover, high macroalgae and stressed coral cover, and high COTS densities, indicates poor habitat condition relative to other reef areas in the CNMI. In general, the condition of marine benthic habitats as measured using 2005 and 2007 *Archipelagic Benthic Condition Index* rankings decreased when moving from the northern to the southern islands, as expected, mirroring known human stressor gradients (Figure 57). The condition of benthic habitats along the reef slopes at Maug, Alamagan, Sarigan, and Guguan ranked the highest, with high or increasing coral cover and low stressed coral cover and COTS densities. The condition of benthic habitats around Asuncion and Uracas were also relatively high, but apparent decreases in coral cover and crustose coralline algae between 2005 and 2007 resulted in slightly lower rankings. Pagan and Agrigan had medium and medium-low benthic habitat condition rankings, respectively, with the lower rankings influenced by areas with high COTS densities. The benthic habitat condition of the southern islands of Saipan, Tinian, Aguigan and Rota were low to medium-low, with the exception of the southeast region of Saipan, northeast region of Tinian, and the west side of Rota, which had medium to high benthic habitat condition rankings. The generally lower rankings for the southern islands were attributed to relatively high stressed coral and macroalgal cover and low coral cover.

The extent and species present in seagrass beds within the Saipan Lagoon were related to watershed sizes in a 2008 study, while the 'health' within each seagrass habitat was better predicted by the amount of development and human population in the adjacent watersheds (Houk and van Woesik 2008). More recently, seagrass plots in the Garapan area that were followed for two years were found to have become overgrown by macroalgal stands, while similar stands in the north and south followed expected seasonal and weather-induced dynamics (Houk and Camacho 2010). These studies indicate that watershed pollution may be adversely impacting seagrass assemblages throughout the lagoon, but details surrounding the extent and timing are still being studied by local monitoring efforts.

A major qualification to the above discussion of the relative condition of marine habitats of the CNMI is that the primary data sources used for the archipelago-wide comparison are 8-12 years old. While NOAA MARAMP expeditions have occurred in 2009, 2011, and 2014, a comprehensive report summarizing the findings of these expeditions is not yet available. The condition of coral reef habitats across the CNMI may have changed significantly since 2007. Recent changes in the condition of reefs in the southern islands are well-documented by local monitoring efforts, while considerably less information is available for the northern islands.

More recently, an assessment of the resilience of reefs of the southern islands provides guidance for prioritizing sites for management (Maynard et al. 2015a, Maynard et al. 2015b). The ecological resilience assessment is used to assess spatial variation in resilience potential, and then target and tailor appropriate actions. The resilience of 78 reef sites on Rota, Tinian/Aguiguan, and Saipan were assessed by measuring indicators of resilience processes, combined with information on anthropogenic stress and larval connectivity. Saipan had more sites classified as high resilience, while Rota had more low resilience sites. Managers can use the results of the assessment to prioritize among sites to implement appropriate management such as conservation, reduction of land-based sources of pollution, and fishery management and enforcement.

Standardized, local monitoring efforts have been ongoing across the southern islands since 2000. Through these efforts a significant COTS disturbance period (late 2003 to early 2007) and subsequent recovery were well-documented. Because coral-reef disturbance and recovery rates are influenced by both natural environments and human stressors, their documentation offered insight into trends over the years. Recovery after COTS years was found to be lowest on Saipan and some Tinian reefs, while increasing for Aguigan and Rota (Houk et al. 2014). Rota reefs naturally differ from others in the southern islands, and so lower disturbance impacts and faster recovery may be due to the distinct species assemblages that exist there, or a combination of natural regimes and relatively low localized stressors. More notably, the gradient in recovery of both healthy substrates and coral species richness that existed on platform fringing reefs around Saipan and Tinian (i.e., 'spur-and-groove' reefs that represent the most optimal settings for reef growth in the CNMI) were significantly explained by a combination of compromised fish assemblages and watershed pollution proxies (Houk et al. 2014), with the former being most influential. The magnitude of impact from disturbances was simply predicted by the maximum density of COTS observed on the reefs.

The coral reefs of the CNMI have also been affected by significant thermal stress events in 2013 and 2014. The event in 2013 occurred between July and October, with offshore sea surface temperatures exceeding the maximum monthly mean by 0.5-1.6 °C. Significant coral bleaching as a result of the extended duration of elevated sea surface temperatures was documented across the southern islands of the CNMI, with approximately 85% of all coral taxa affected by the event (Figure 58) (Reynolds et al. 2014). Sea surface temperatures again exceeded the expected coral bleaching threshold in late spring/early summer 2014. While water temperatures did not reach the levels observed in 2013 and did not persist for more than a few weeks, significant mortality of certain coral taxa was observed. For example, approximately 85% of all staghorn *Acropora* corals monitored by the CNMI Marine Monitoring Team (MMT) within the Saipan Lagoon were lost, with a significant portion of the mortality likely a result of the 2014 event (L. Johnston, personal communication). Although it is less clear how the bleaching events affected the northern islands, observations made by the CNMI MMT while snorkeling during the first of two expeditions to the northern islands in the summer of 2014 indicate that a thermal stress event was underway inside the caldera at Maug and at Asuncion and Pagan, although few recently dead colonies were observed at these locations. The team also noted numerous dead acroporid and pocilloporid colonies in the shallow (2-6 m) waters around at Guguan, Sarigan, and Anatahan (Figure 59); it was suspected that a major 2013 bleaching event that had been well-documented in the southern islands had caused the mass mortality. During a second expedition that targeted Maug, surveys were carried out at depths of 7-9 m at two sites inside the caldera and one site outside. Data collected during these surveys indicated that a major bleaching event was underway, with 86-93% of all corals bleached across all three sites. The team reported that nearly all coral taxa were affected, and although the surveys were limited to the 7-9 m depth range, bleaching was observed to a depth of at least 20 m. Approximately 12% of coral cover at the site outside the caldera was recently dead (days to weeks). The limited quantitative data and the more extensive personal observations suggests that thermal stress events in 2013 and 2014 caused significant coral bleaching. Post-bleaching mortality was thought to be high based upon preliminary observations, but not confirmed in the northern CNMI.

In summary, based on an assessment of the available NOAA MARAMP survey results and other available literature, and in concordance with Starmer et al. (2008), the marine habitats of the CNMI exhibit a range of condition as a result of various environmental and anthropogenic factors. The reefs of the southern populated islands have clearly been impacted by anthropogenic stressors, such as runoff and fishing pressure, in compliment to crown-of-thorns starfish in the mid-2000s. In contrast, the northern islands appear to have mainly been impacted by natural environmental regimes, including volcanic activity, periodic ashfall from adjacent watersheds, and naturally slow recovery rates. Both the northern and southern islands appear to have been significantly impacted by the recent back-to-back coral bleaching events. Coral reef areas impacted by chronic anthropogenic stressors are less resilient to acute disturbances, such as cyclones, COTS outbreaks, and temperature stress events, and can be expected to deteriorate further, potentially shifting from coral-dominated to less productive and less diverse fleshy algae- and cyanobacteria-dominated systems. The predicted increase in the frequency and severity of thermal stress events in the coming decades and the looming threat of ocean acidification will likely challenge even the healthiest of reef systems, but those systems with suitable water quality and robust reef fish communities will have the best chance at adapting to rapidly changing environmental conditions and continuing to provide essential goods and services to human populations.

6 THREATS

We conducted a threat assessment for all terrestrial vertebrate species, all 2005 SGCN, and select marine and invertebrate species. The threat assessment was highly specific in that we examined the threats acting on a particular species (or subspecies) in the CNMI. There were many specific threats identified that are only acting on one SGCN. However, broad-scale themes emerged through this process. All of the species-specific threats identified (see Appendix C) fit under one of the following themes described below.

6.1 INVASIVE SPECIES

Invasive species are species that are not native to the CNMI (i.e. were not here when Chamorros first arrived), and whose introduction here does or is likely to cause environmental or economic harm or harm to human health. Due to their evolutionary history and high levels of endemism, animals of the Marianas are particularly susceptible to the threats posed by the introduction and spread of invasive species. Invasive species (sometimes called "non-native," "alien," or "exotic") may outcompete native species, or may directly harm native species through predation. Virtually no habitat important for SGCN is free from the threat of invasive species, and most habitats important for SGCN experience some negative effects related to invasive species which can result in habitat loss or degradation for our SGCN.

6.1.1 New arrivals and introductions

In addition to invasive species already established in the CNMI, numerous species are positioned to invade. While a potentially invasive species can be introduced through air or ship travel from anywhere, with the high frequency of travel between Guam and the CNMI, and the similarity of climate, we are particularly at risk to receive new invasive species introductions from Guam. Guam has several invasive species that have yet to invade the CNMI, but pose a serious threat to our native wildlife, ecosystem, economy, and public health. Measures have been established in the CNMI to prevent introduction of brown tree snake (*Boiga irregularis*), which has extirpated nearly all of Guam's native avifauna. However, Guam hosts other invasive species that could have devastating impacts if they became established in the CNMI, including the little fire ant (*Wasmannia auropunctata*) and coconut rhinoceros beetle (*Oryctes rhinoceros*).

Most invasive species introductions are accidental from species "hitchhiking" on a plane or boat. However, introductions can and have occurred intentionally. The CNMI has strict laws regarding importation of live organisms into the Commonwealth, but residents may be unaware of the laws, or disregard them. For example, apple snail (*Pomacea* spp.) appears to have been intentionally introduced on Saipan by individuals presumably trying to create a readily available "wild" food source, without knowledge of the devastating impact this species can have on natural communities. Apple snails can compete with native species for limited resources, consuming all types of aquatic plants, potentially altering the natural balance of a wetland system.

Other introductions have occurred from legally or illegally imported pets that then escaped or were released and formed wild populations. Orange-cheeked waxbills are now ubiquitous on Saipan for this reason. The Division of Fish and Wildlife has recently taken measures on Saipan to control an incipient population of rose-ringed parakeets (De La Torre 2015).

In addition to preventing new invasive species introductions to the CNMI, it is equally important to prevent the spread of invasive species among islands of the CNMI. Many of the invasive species that already occur in the CNMI may currently be restricted to just a few islands, often the southern inhabited islands (Table 20). Islands with few invasive species are refugia for many of our terrestrial SGCN.

6.1.2 Current Invaders

6.1.2.1 Habitat Modifiers

6.1.2.1.1 Invasive Vines and other Plants

One of the major threats to forest-dependent SGCN is the uncontrolled spread of many invasive plants. Because the seeds of many invasive plants persist for years, and many are bird-dispersed, eradication is exceedingly difficult after the plant is established.

Invasive vines including scarlet gourd (*Coccinia grandis*), chain-of-love (*Antigonon leptopus*), alalag/paper rose (*Operculina ventricosa*), bitter vine (*Mikania micranthra*), bitter gourd (*Momordica charantia*) and wood rose (*Merremia tuberosa*) are of particular concern as they are visibly rapidly spreading across many islands. Invasive vines can potentially smother and kill host trees, bringing down the canopy so that forest is converted to scrub-shrub or grassland habitat. They also reduce light availability under the canopy, impacting plant species composition and the rate of forest regeneration. The relative abundance of invasive vines likely also impacts the abundance, distribution, and reproductive success of forest-dependent SGCN, but we do not know species-specific responses, nor do we know which invasive plant species pose the greatest threat to SGCN.

In addition to forest habitat impacts, invasive plants that encroach on beaches can degrade nesting habitat for sea turtles. In wetlands, water hyacinth (*Eichhornia crassipes*), which is currently found in just a few wetlands on Saipan, could spread and invade wetland habitats occupied by Mariana common moorhen.

6.1.2.1.2 Introduced Ungulates

Introduced ungulates (hooved animals) in the CNMI include goats (*Capra hircus*), deer (*Rusa marianna*), pigs, and cattle (*Bos taurus*) (Table 20). Ungulates directly and indirectly affect ecosystems through damaging vegetation by grazing and browsing, trampling seedlings, spreading non-native plant seeds, disturbing soil, and increasing erosion. These activities can affect the amount of light and moisture levels within forests, as well as nutrient cycling, and result in modified or destroyed plant and animal communities, decreased water retention of soils, increased erosion, and decreased water quality.

Because our native plants only recently have been exposed to the effects of grazing, they lack common defenses such as thorns or toxins. Thus, grazing and browsing animals often prefer native plants over non-native plants. Grazing and browsing can result in the extirpation of native plant populations, but even low intensity browsing can affect the species composition of habitats.

Soil disturbance by rooting animals (i.e. pigs) favors the germination and establishment of alien plant species, many of which are adapted to such disturbances and may require disturbance to complete their life cycle. Conversely, native species are not adapted to such disturbances and tend to be negatively affected. This in turn affects the composition of plant communities, which indirectly affects the animals that depend on the community; effects on native invertebrates may be particularly acute.

We have conducted eradications of feral ungulates on two islands to date, Anatahan and Sarigan. There has been a tremendous positive response of wildlife and vegetation on Sarigan following the successful eradication (Kessler 2011b.) Feral ungulate control or eradication is more controversial on the islands where they remain (Aguiguan, Alamagan, Pagan, and Agrigan). Many CNMI residents value these populations as a food source, or simply enjoy hunting for recreation, so support for eradication or control may be weak or lacking.

6.1.2.2 Non-native Predators

Our terrestrial animals evolved in the absence of mammalian predators and are extremely vulnerable to predation by these invasive species, especially rats (*Rattus* spp.) and feral cats (*Felis catus*). These species prey on eggs, nestlings, and adult birds, limiting populations.

Rats are ubiquitous throughout our islands. Rats are commonly known to prey upon all of our bird species, even climbing into trees to prey upon canopy-nesting species. They are also known predators of our tree snails, and eat the seeds of a large number of native plant species, limiting their regeneration.

Feral cats are extremely skilled predators and have been responsible for the extinction of birds on other islands. In the CNMI, cats are widely distributed (Table 20). Presently, high densities of feral cats are partially blamed for the continuing decline of Mariana crow on Rota.

Other predators that pose ongoing threats to native bird species include feral and unleashed dogs (*Canis familiaris*). Fortunately, snakes have yet to become established in the CNMI. Given that the brown tree snake (*Boiga irregularis*) effectively caused the extinction of most of Guam's avifauna, it is expected that the successful establishment of predatory snakes in the CNMI would have equally devastating consequences.

Introductions of invertebrates, including ants, snails, and wasps, have been extensive throughout the CNMI. While we know much less about invasive invertebrates and how they affect our SGCN, we have examples that show that these can have devastating impacts on terrestrial invertebrate SGCN by preying on or parasitizing native invertebrates.

For example, the SGCN tree snail *Partula langfordi*, known only from the island of Aguiguan, survived many threats on that island going back hundreds of years, including the introduction of rats, introduction of goats, large-scale conversion of forest habitat to agriculture, and intentional introduction of a non-native carnivorous snail (*Gonaxis kibweziensis*). Despite all of these threats, the species persisted into the 1990s, at which point the invasive flatworm *Platydemus manokwari* was accidentally introduced with plant materials taken to the island. The species has not been seen since, and may well be extinct (Smith 2008).

6.1.3 Invasive and nuisance marine species

Non-native marine species have the potential to become invasive and cause significant impacts to marine habitats and species by out-competing and replacing native taxa and even altering the entire ecosystem. The introduction of non-native and potentially invasive coral reef species can be intentional, typically as a means to enhance fisheries, or accidental, primarily by transport on ship hulls and ballast water or by aquarists disposing of unwanted organisms. There are also concerns that red tilapia, *Oreochromis mossambica*, which was intentionally introduced in the 1950s, may enter the Saipan Lagoon from adjacent open-system pools (Starmer 2005).

Within the CNMI, non-native marine species that have been intentionally introduced include the topshell, *Tectus niloticus*, which was introduced by the Japanese in 1938. Topshell populations have been established in the CNMI and have become an important fishery requiring regulation, including a moratorium and the establishment of two no-take reserves. The effects of the introduced topshell on native taxa and coral reef ecosystems is unknown (Starmer 2005), but its abundance in unfished areas suggests that it may out-compete native topshell species and perhaps other organisms that share food sources and refugia. The potential for additional (and likely unplanned) introductions currently exist and will likely increase with an increase in ship activity directly or indirectly related to U.S. military activities in the CNMI and throughout the region. Unintentional introductions of non-native and potentially invasive marine species would mostly likely occur via transport on ship hulls or ballast water, although the risk associated with ballast water is at least somewhat mitigated by a prohibition on the discharge of ballast water in commercial port areas, and because vessels are more likely to take in rather than discharge ballast water in the CNMI (Starmer 2005).

A small number of coral reef species native to the CNMI, most notably the corallivorous crown of thorns seastar (*Acanthaster planci*), may be considered nuisance species in certain circumstances. Crown of thorns seastars can appear in great numbers, sometimes resulting in severe and potentially widespread coral mortality. The causes of periodic outbreaks are not well-understood, and while there may a natural component to their occurrence, it is possible that increased levels of nutrients and organic matter in nearshore waters, as well as fisheries-associated cascade effects, may influence the frequency and severity of the outbreaks.

6.2 DEVELOPMENT

Between the closure of the garment factory industry and the reduction in tourism with the global economic recession, we saw widespread abandonment of properties on Saipan, Tinian, and Rota over the last 10+ years, not development. The tourism market is beginning to rebound now, so we anticipate development to begin again, at least on Saipan, although at a modest pace (U.S. Census Bureau 2015). Large development projects (i.e. casino and resorts) are in the planning process for both Saipan and Tinian. Tinian development may hinge upon the outcome of the military's proposals there (see Military Expansion section). We are not aware of any major development projects planned for Rota, but certainly Rota residents would welcome economic investments.

"Development" encompasses the conversion of natural habitats for commercial, residential, or agricultural uses. Development impacts terrestrial SGCN through direct conversion from natural habitats. Developed areas typically support few terrestrial SGCN, and usually at reduced densities. Development can also result in fragmentation or degradation of adjacent natural habitats, further reducing terrestrial SGCN populations.

Commercial development is the development type considered the primary threat to terrestrial SGCN and their habitats, as it will likely result in conversion of the most habitat acres. It is also considered the primary type of development threatening marine SGCN, as commercial development encompasses resorts and other tourism infrastructure that are typically concentrated in coastal areas. Removal of natural vegetation nearer to the shoreline results in increased pollutant runoff, which impacts most of our marine SGCN (see Pollution section).

6.3 CLIMATE CHANGE

The concentration of carbon dioxide and other greenhouse gases have increased in the Earth's atmosphere primarily as a result of excessive anthropogenic greenhouse gas emissions since the advent of the industrial revolution in the late eighteenth century (IPCC 2014). These increased atmospheric greenhouse gas concentrations have, in turn, led to an unusually rapid increase in the average global temperature, a phenomenon known as global warming. While the average global temperature has increased, other effects on climate are more variable, and thus the phenomenon is also referred to as global climate change. The threats associated with excessive greenhouse gas emissions are wide ranging and potentially catastrophic, and, in addition to an increase in the average temperature of the Earth's atmosphere, also include an increase in ocean temperatures, a decrease in ocean pH, and a rise in sea levels.

Many impacts of global climate change are known or currently anticipated. Additional impacts that are not currently anticipated or understood may also occur. We refrained from identifying as threats those climate change effects that we are currently unable to predict, or for which we were unable to articulate the specific mechanism by which it would act on a SGCN.

For example, we anticipate that marine and terrestrial food webs will be altered in coming decades, and the threat of “altered prey or forage availability” will be an effect of climate change. However, the cascading effects through an ecosystem are very difficult to predict. Future changes are likely to benefit some species and harm others, but we do not know and cannot predict the outcome at this point, so we did not include this climate change effect as a threat for any SGCN. Similarly, we expect that climate change effects will ultimately result in changes in the structure and composition of our forests upon which many terrestrial SGCN depend, but at this time we cannot predict how the forest will change, and which SGCN may benefit or be harmed.

The effects listed below, therefore, are not a comprehensive list of all effects of climate change, or even all effects expected to impact our SGCN. Rather, these represent the most important climate change effects that will impact our SGCN that we can fairly reliably predict will occur or intensify in the coming decades (Leong et al. 2014) (Table 24). For each SGCN, we can articulate a reasonable mechanism of how a particular climate change effect would threaten that SGCN.

Generally, we find that our marine SGCN are at greater risk from the effects of climate change relative to terrestrial SGCN. Most of the effects of climate change on marine SGCN will be constant and inescapable (e.g. ocean acidification); climate change effects on terrestrial SGCN are more episodic (e.g. increased typhoon activity).

Table 24. Climate change projections for the CNMI. Adapted from Greene 2014.

Climate Change Variable	Projection
Air temperature	Steady increase, with seasonal extreme highs
Precipitation	Small increase in average rainfall. Increase in extreme rainfall events. Wet season gets wetter; dry season gets drier.
Sea level	Gradual increase, with interannual and decadal fluctuations.
Sea surface temperature	Steady increase, with interannual variations depending on El Nino-Southern Oscillation. Increase in degree heating weeks to induce coral bleaching on an annual basis before 2050.
Ocean acidity	Steady increase, with declining pH of up to 0.3 by the end of the century.
Storms	Intensification in extreme wave action, and potential increase in severity of typhoons.

6.3.1 Temperature rise

6.3.1.1 Air temperature

Air temperature rise due to climate change may be problematic for nesting sea turtles. The sex of sea turtles is determined in the egg by ambient temperature of the nest, with higher temperatures favoring development of females. Turtle biologists are concerned that air temperature rise in the future could result in only females and no males successfully hatching.

6.3.1.2 Sea temperature rise and coral bleaching

While shallow reef-building corals thrive in warm tropical waters, they live near the thermal threshold beyond which the association between the host coral animal and the symbiotic zooxanthellae begins to break down. The breakdown of this association results in the expulsion, absorption, or ingestion of the zooxanthellae, causing coral tissue to lose its color and appear “bleached.” If this condition persists beyond a few weeks the coral colony may experience partial or whole colony mortality. Coral bleaching and the resulting coral mortality can occur across large areas, from entire islands, to archipelagos, and even whole regions. With sea temperature rise, more frequent and severe coral bleaching events are expected.

Nowhere in the archipelago is immune to coral bleaching, as evidenced by observations of relatively high rates of bleaching at Uracas and Stingray Shoals in the remote northern end of the archipelago in 2003 (Starmer 2005). The potential for the mass mortality of corals across large spatial scales make sea temperature rise and associated coral bleaching a major threat to coral SGCN, with indirect cascading effects on reef-dependent SGCN.

6.3.2 Ocean acidification

A large proportion of the increasing amount of carbon dioxide in the atmospheric diffuses into the oceans, resulting in increased carbon dioxide concentrations in the ocean waters. It is estimated that the oceans have absorbed about half of the carbon dioxide released by human activities over the past 200 years (Feely et al. 2004; Sabine et al 2004). The increased carbon dioxide concentration causes the ocean to become more acidic, reducing the carbonate saturation state of oceanic surface waters. Average ocean pH has declined by 0.1 units, which is indicative of an increase in ocean acidity of approximately 30%. Ocean pH is expected to fall from the current pH of 8.2 to about 7.8 by 2100 (Orr et al. 2005).

Ocean acidification negatively affects survival, calcification, growth, and reproduction in many marine groups. Corals, molluscs and echinoderms appear particularly vulnerable to the effects of ocean acidification, as increased acidity makes it more difficult (i.e. energetically costly) to build skeletons and shells (Figure 60) (Kroeker et al 2013). The effects of ocean acidification on reef building corals could result in major alterations of entire reef ecosystems, including significant shifts in coral community structure or large-scale phase shifts from coral-dominated to algae-dominated systems (Orr et al. 2005). By the end of the 21st century, ocean acidification may become the single greatest threat to the viability of coral reef ecosystems worldwide.

Although we cannot predict the rate of species impacts, we expect ocean acidification to directly impact our coral, giant clam, and sea urchin SGCN in coming decades. Reductions in coral abundance may have cascading indirect effects, as many of our marine SGCN are reef-dependent.

6.3.3 Sea level rise

Sea levels may rise by several meters over the next century due partly to thermal expansion of warmer waters, but primarily due to land ice melt from polar regions (IPCC 2013).

While significant rapid sea level rise would clearly have devastating, costly effects on coastal human communities, the effect of sea level rise on coral reef ecosystems is not entirely understood. The increase in sea surface height may actually result in more habitable shallow substrate, expanding the area occupied by coral reefs including staghorn coral-dominated communities, or at least balancing the effect of a loss of available habitat due to reduced light at the deeper extent of reef growth. However, coral reefs adjacent to shorelines susceptible to erosion may be impacted by poor water quality associated with a relatively rapid rise in sea level. It is unlikely that sea level rise will outpace the growth of at least moderately-growing coral reefs, at least in the first half of the 21st century, but in areas where anthropogenic impacts have stymied reef building, sea level rise may outpace the ability of some reef systems to keep up, resulting in shifted reef community structures and potentially leaving coastal areas more vulnerable to storm surge and coastal erosion.

Sea level rise, possibly exacerbated by the inability of some coral reefs to maintain sea level equilibrium, could be expected to impact shorelines, causing erosion in some and accretion in others. Beaches, possibly including those in the CNMI that are particularly important to tourism and sea turtle nesting, could be significantly impacted. Mangroves, an extremely limited habitat in the CNMI found only on Saipan, may be eroded, inundated by seawater, and/or converted to other habitat types, threatening the persistence of the SGCN mangrove crab.

6.3.4 Increased severity of typhoons

The CNMI experienced fewer, but more severe, typhoons from 1990 to 2010 relative to the preceding 20 year period (NOAA 2013). Models suggest that this pattern will continue through coming decades (Keener et al 2012). Severe typhoons can have significant short- and long-term effects on terrestrial and marine SGCN populations (See Section 6.8 Natural Disasters).

Severe typhoons cause significant wind damage which puts the short-term survival of frugivorous SGCN such as fanihi at risk, as they may be unable to find fruits to eat immediately post-typhoon. Long-term persistence of forest-dependent SGCN is compromised, as it takes decades for trees to re-grow.

6.3.5 Altered precipitation patterns

The Marianas will experience altered precipitation patterns in the future. Overall, rainfall projections suggest that the wet season will get wetter, and the dry season drier. There may be an increase in mean annual precipitation overall, but a greater proportion of annual precipitation is expected to come in the form of extreme events (Green 2014). With an even drier dry season, we expect impacts to the endangered SGCN Mariana common moorhen. Wetland availability will be reduced because smaller ephemeral wetlands will dry up faster, and larger wetlands will hold less water.

With changes in precipitation patterns, we anticipate changes in terrestrial habitat composition and structure, and shifts in species abundance including invasive species. However, we cannot make specific predictions at this time about which SGCN might benefit or lose under future habitat conditions.

6.4 Military Expansion

The U.S. military has proposed to expand the scope of their training activities in the CNMI (U.S. Navy 2015a). While the ultimate outcome of their proposal is unknown at this time, for our purposes we took a conservative approach with our threat assessment and assumed the highest proposed impacts to SGCN and their habitats. We assumed that the military’s preferred alternative to install live-fire and bombing ranges on Pagan and Tinian would occur in the next ten years, and accordingly assessed the predicted impact on SGCN populations.

The military's preferred alternative would have devastating impacts on a variety of SGCN, both terrestrial and marine. For example, on land, the military proposes to eliminate nearly 10% of the habitat of the Tinian monarch, which occurs nowhere else in the world. In the water, the military proposes to eliminate 10 acres of coral reef at Unai Chulu on Tinian, which would severely impact the SGCN staghorn corals, the ESA-listed *Acropora globiceps*, and reef-dependent SGCN. DLNR-DFW produced written comments which describe in detail the anticipated impacts of the military's proposal on fish and wildlife populations (DLNR 2015).

6.5 POLLUTION

6.5.1 Land-based sources of pollution

Land-based sources of pollution, such as bacteria from human and animal waste, nutrients from agricultural land use, nutrients and chemicals from urban land use, and sediments from unpaved roads or improper land clearing are carried by rainfall into our waters, which can reduce survival and reproduction of marine SGCN, especially those nearer to shore and source points.

Land-based sources of pollution are among the primary causes of coral reef degradation around the world. A variety of pollutants, including sediment, organic matter, nutrients, sewage, herbicides, pesticides, petroleum products, and other substances detrimental to the health of marine organisms can enter coastal waters through riverine discharge, stormwater runoff, sewage outfalls, and submarine discharge of aquifer waters. The presence of these pollutants in nearshore waters is generally a result of coastal development, land clearing, burning, and other activities that alter the landscape, increasing the amount of runoff and introducing pollutants or elevating levels of substances (e.g., sediment) than may occur naturally at lower levels. The discharge of sediment at levels greater than the level to which coral reef communities in the receiving waters are adapted can result in mortality of corals and other benthic organisms through burial in extreme instances of sedimentation, but more often results in sublethal impacts that may eventually lead to whole colony mortality and to a shift in community structure and condition. Excess nutrients can fuel algal growth, allowing fleshy macrophytes and cyanobacteria to out-compete corals through direct interaction and by making substrate conditions unsuitable for the recruitment of many coral species. Pesticides, herbicides, petroleum products, and other chemicals can interfere with important physiological processes, such as reproduction and growth, of corals and other marine organisms. In addition to supplying an excess of nutrients and other chemicals to coastal waters, sewage discharge and runoff may also introduce pathogens that directly cause diseases of marine organisms.

6.5.1.1 Coastal development and associated runoff

Overall, the marine impacts of coastal development and associated runoff are relatively low across the CNMI, and limited primarily to nearshore areas adjacent to high density development and agricultural activities in Saipan, and to a lesser extent on Tinian and Rota. Most of the marine waters of the CNMI meet the high water quality standards designated by the CNMI Bureau of Environmental and Coastal Quality (BECQ), but where high density development does occur, impacts to nearshore water quality and marine ecosystems can be pronounced.

According to Starmer et al. (2008), impaired coastal waters in the southern islands are primarily a result of failing sewer collection systems, urban runoff, discharge from reverse osmosis water purification systems (addressed in more detail below), sedimentation from unpaved roads and improperly managed construction activities. In contrast to the populated southern islands, the very sparsely populated northern islands are largely removed from these development issues.

Of the 83 locations monitored for water quality by BECQ, a high number of microbiological violations occur in the highly developed Garapan district adjacent to the Saipan Lagoon, as well as at sites near Saipan's marinas and boat docks (Starmer 2005). Waters impaired by excessive nutrient or bacteria levels can be found across the southern islands, with 42%, 28% and 9% of the beach shorelines in Saipan, Tinian, and Rota, respectively, classified as impaired (Starmer et al. 2008). Data collected by the CNMI Marine Monitoring Team (MMT) suggests a continued decline in reef condition at sites with impaired water quality, indicated by decreased coral species richness and recruit abundance (Starmer et al. 2008).

6.5.1.2 Wastewater discharge

As with other kinds of pollutants, wastewater can enter coastal waters at discrete locations, such as sewage outfalls (i.e., point source pollution), or diffusely across a relatively large area (i.e., non-point source pollution). Two sewage outfalls exist in the CNMI, including one at Agingan Point and one at Sadog Tasi, Saipan. The Agingan Point outfall currently discharges treated effluent at the surf line into Class A receiving waters of the Tinian Channel, while the Sadog Tasi outfall discharges treated effluent approximately 365 m offshore into the Class A receiving waters in Tanapag Harbor, Saipan Lagoon, at a depth of 15 m. Both outfalls are in violation of local water quality standards, and although the U.S. Environmental Protection Agency has been working with the Commonwealth Utilities Commission (CUC) to bring the outfalls into compliance, it is not clear when this will happen. The relocation of the Agingan Point outfall to discharge approximately 244 m from shore at a depth of 30 m is planned (Starmer et al. 2008). While the Agingan Sewage Treatment Plant will not be upgraded from secondary to tertiary treatment, the discharge of effluent into offshore ocean currents may assist in diffusing the effluent and moving it away from shore (Starmer et al. 2008). In 2006, the CUC replaced a sewer line that had been chronically overflowing into the lagoon at San Antonio, Saipan (Starmer et al. 2008).

The discharge of hypersaline, nitrate- and phosphate-rich waters from reverse osmosis water purification systems also has the potential to impact nearshore marine habitats. Starmer et al. (2008) reported that in 2005 all major hotels were illegally releasing wastewater from reverse osmosis systems. After action by the U.S. Environmental Protection Agency, the majority of these systems now discharge into deep injection wells. This mitigation action appears to have resulted in a short-term improvement in nearshore water quality, but it is still not known how the injection wells may impact water quality (Starmer et al. 2008).

6.5.2 Marine debris

Marine debris, including derelict fishing nets, fishing line, plastics, glass, metal, rubber and other types of discarded or abandoned human-made objects, can enter the marine environment directly from ships or indirectly when washed or blown from land or waterways into nearshore marine waters. Marine debris arriving to the shorelines of the CNMI from offshore can be found along the beaches in the southern islands, but the predominately rocky, sea cliff-dominated shorelines and limited reef development on the windward exposures results in limited accumulation of marine debris in coral reef habitats. Debris generated by local, land-based activities are of greater concern (Starmer et al. 2008). This debris can impact marine habitats and species including sea turtle and seabird SGCN through breakage, entanglement, abrasion, and ingestion. Still, regular clean ups and outreach campaigns have limited the accumulation of these debris in shoreline and marine habitats and thus is considered only a minor concern in the CNMI.

6.5.3 Artificial light

Light pollution, i.e. artificial lighting, can impact use and habitat quality of beaches for sea turtle nesting.

The presence of lights on or adjacent to nesting beaches alters the behavior of nesting adults (Witherington 1992) and is often fatal to emerging hatchlings as they are attracted to light sources and drawn away from the water (Witherington and Bjorndal, 1991; Nelson Sella et al. 2006).

Sea turtle nesting in the CNMI is already restricted to a handful of beaches and associated strand that are currently little-influenced by artificial lighting. Additional coastal development could result in increased artificial lighting and therefore degradation of these areas for sea turtle nesting, in addition to other development impacts.

6.6 Harvest

The people of the CNMI are entitled to legally harvest and enjoy their fish and game resources. We have regulations in place for some species to ensure that these resources will be sustainable, so our children and grandchildren can continue to enjoy these resources. Most harvest is legal, welcome, and not problematic, but there are a few cases where harvest can negatively impact fish and game SGCN.

6.6.1 Poaching/Human Persecution

Illegal fishing and hunting are on-going threats to SGCN. Illegal fishing and hunting can involve poaching from a no-take area such as a Marine Protected Area, or taking fish, lobster, or ayuyu smaller than the legal size limit. Out-of-season poaching of ayuyu is anecdotally reported as common. Poaching of haggan and fanihi continues to hinder recovery of these two federally threatened species which cannot be legally harvested.

Illegal hunting generally targets game for consumption, but the Mariana crow is a unique case. In the past Mariana crows were reportedly shot by Rota residents disgruntled with their status as federally endangered species or concerned that crows on their private property might affect their property rights, but this threat appears to have declined. Although this type of targeted persecution has not been reported for nightingale reed-warbler on Saipan, it is possible that this could become a threat over the next ten years as wildlife-development conflicts may escalate.

6.6.2 Potentially unsustainable harvest

Some invertebrate SGCN, including mangrove crab and day octopus, are legally harvested, but with no catch limits or reporting requirements. We are lacking basic biological information on many of these consumed invertebrates, i.e. we know little of their life history, abundance, distribution, habitat requirements, movements or behavior. We know that CNMI residents are securing permits for harvest, but we do not know the extent of legal harvest. Given these unknowns, harvest could potentially be occurring at an unsustainable level. In this case, the "threat" is a lack of information; we do not know if harvest represents a "real" threat. Invertebrate SGCN groups for which this threat applies include mangrove crabs, octopus, and clams.

6.6.3 Trophic effects of fishing

Fishing is a vitally important commercial, recreational, cultural and subsistence activity across our islands. We have tremendous fisheries resources, but uneven harvest pressure. Overall, reef fisheries in the CNMI are generally considered to be in good condition, but local depletion of targeted species has occurred in the southern populated islands, particularly along the west coast of Saipan (Amesbury et al 1979; Cuetos-Bueno and Houk 2015; Duenas and Associates, Inc. 1997; Graham 1994; Houk et al. 2012; Starmer 2005; Trianni 1998b).

Humans become competitors of large piscivores like the SGCN grey reef shark, which will find less prey available in areas frequently fished by humans. Commercial harvesting of reef fish has been implicated as contributing to coral reef declines elsewhere as some fish targeted for market also serve important roles in reef ecology, but local experts disagree if this is a problem in the CNMI.

6.7 TOURISM & RECREATION

Tourism is the backbone of the CNMI economy. Most visitors to the CNMI come from Korea, China, and Japan, typically from large urban centers where they may have less opportunity to interact with nature and wildlife at home. Indeed, this is a primary reason why they visit our islands, to enjoy the natural beauty and wildlife, on land and in the water. However, they are often unaware of the impacts of their activities, in particular in the marine environment. CNMI residents participate in many of the same activities that foreign tourists do, but typically have a higher degree of awareness of how their actions can impact resources, at least in the marine environment.

6.7.1 Potential marine impacts

Reef sites visited on a regular basis by tourists and other recreational users may be impacted as a result of intentional and accidental physical contact with corals and other benthic organisms, which may result in breakage, tissue damage, and potentially secondary infection of those organisms directly impacted. Over time, these impacts may lead to coral mortality and may reduce the structural complexity and diversity of habitat available for reef fishes and other reef-dependent species. Physical contact with corals and other organisms can occur by individuals engaged in wading, swimming, snorkeling, scuba diving, kayaking, paddle boarding, and other recreational activities, or by anchors or vessels used in recreational activities. Physical impacts may result in long-term changes to the benthic community structure and composition, and ultimately to changes in reef fish communities and other reef-dependent species.

In some locations recreational overuse, which can occur even with informed and conscientious users, can be exacerbated by poor reef etiquette. The most severe instances of recreational overuse and misuse are usually restricted to high-traffic reef sites that are generally somewhat limited in size, although even areas that receive less traffic may still be impacted. While recreational impacts are generally limited in scale when compared to the total reef area of the CNMI, they also are often focused on more accessible, high value areas such as Mañagaha Island, and thus jeopardize the long-term viability of reef-centered tourism, and may also affect fishing and other uses of the area.

The problem can be partially addressed through better education of visitors. Most tourists are accompanied by tour guides, who are at the front lines of mitigating the recreation impacts on our resources. However, we also regularly see occurrences of tour guides misusing the resources, i.e. by feeding reef fish to bring them closer for tourists to view. The use of certain foods, such as those high in animal fats, may be directly harmful to fishes by negatively altering their diet. Fish feeding also appears to alter the behavior of fish species, causing some species to become more aggressive, even biting recreational users at sites where fish feeding is commonly practiced.

Another potential concern is the request by hotel operators to remove seagrass beds from designated swim zones (Starmer 2005). Although no action has been taken by the operators to obtain the proper permissions to remove the seagrass or move the swim zones, the requests indicate a need to educate the public about the importance of seagrass beds.

6.7.2 Potential terrestrial impacts

6.7.2.1 Cave disturbance

Although unquantified, we expect that cave visitation poses the most potential problem on Saipan, with the highest human population and one of only two CNMI islands that hosts the cave-nesting SGCN Mariana swiftlet, a federal and local endangered species. Human disturbance caused by entering swiftlet caves can alter the behavior of nesting swiftlets, and can even result in nest abandonment.

6.7.2.2 Driving on beaches

Vehicle driving on beaches is restricted and relatively uncommon now, but still occasionally occurs, potentially causing compaction of sand and other sediments, direct injury or mortality of wildlife, and reduction in habitat quality. This is of particular concern for those beaches utilized by sea turtles for nesting. Vehicle use in beach strand habitat may result in further habitat degradation by damaging strand vegetation, resulting in increased erosion.

6.8 Natural Disaster

6.8.1 Typhoons

The CNMI lies within a region of high typhoon activity, with an average of three typhoons passing within 300 nm of Saipan annually since 1970 (Lander 2004).

Strong typhoons that down many mature trees have short- and long-term impacts on SGCN. SGCN dependent on forest for food and shelter may find short-term survival challenging. For example, fruit-eating SGCN such as fanihi and totot can starve as most fruits are stripped from trees. Over the long-term, forest habitat can take years to re-grow, which has long-term population level impacts on forest SGCN.

In addition, typhoons create widespread disturbance across forests, which frequently benefits invaders. Following Typhoon Soudelor on Saipan in August 2015, invasive vines grew and spread rapidly. We do not yet know if Saipan's forests have been permanently altered, or whether trees will recover quickly enough to compete with the rapidly growing vines.

Severe typhoons are also accompanied by wave action that causes physical damage to coral SGCN, which can take years to be replaced and will have cascading, indirect effects on reef-dependent SGCN. Storm wind-driven waves can cause significant physical damage to shallow coral reef areas, and storm surge and setup can cause coastal erosion and associated reductions in nearshore water quality. The impacts of storm surge on nearshore habitats may be exacerbated where artificial shoreline structures, such as wharves, groins, and jetties occur; these structures reflect rather than attenuate wave energy, resulting in additional movement of sediments. Storm surge can also move loose objects, such as corals, sunken vessels, and other debris, causing additional physical damage to nearby marine habitats (Starmer 2005). Heavy rainfall and runoff associated with storms can result in large influxes of freshwater into the nearshore marine environment. The freshwater runoff can significantly alter the salinity and temperature of nearshore receiving waters, and can contain sediments, nutrients, and other pollutants that with prolonged exposure can stress or even cause mortality in corals and other marine organisms (Jokiel et al. 1993). Heavy rainfall can also cause upland erosion, adding to the load of sediments and organic matter in runoff. Heavy winds and rain can also deposit trash and debris into nearshore waters. The impacts of storm-associated runoff on nearshore marine habitats can be exacerbated by coastal development, poor land use practices, and inadequate stormwater drainage infrastructure. Large volumes of stormwater runoff may also overwhelm wastewater treatment facilities, resulting in the release of untreated or under-treated sewage into nearshore waters. In addition, coral reef ecosystems chronically affected by degraded water quality and with reduced herbivorous fish populations may not be able to recover from storm-associated damage, potentially shifting from a coral-dominated to algae-dominated state.

Although typhoons can be destructive to terrestrial and marine habitats, they are a natural occurrence in the CNMI, and SGCN and their habitats typically recover readily from temporary post-typhoon declines. Based on the historical frequency and severity of typhoons, we only consider typhoons a potential threat to very small SGCN populations, where any disaster could tip the scales toward extirpation. For example, the Pacific sheath-tailed bat lives only on Aguiguan, with fewer than 500 individuals in a single population. The effects of a severe typhoon hitting Aguiguan could be disastrous for a population in an already precarious position such as this.

However, we cannot assume that the frequency and severity of typhoons will continue according to the historical pattern, so the potential threat of typhoons may change. This was discussed previously in Section 6.3.4.

6.8.2 Volcanic activity

While all of the Mariana Islands are volcanic in origin, the northern islands are geologically younger and experience more volcanic activity. Volcanoes on Anatahan, Pagan, and Sarigan are particularly active and could experience an unpredictable eruption at any time. A devastating eruption could extirpate most terrestrial wildlife and vegetation on an island, and ash runoff can have nearly as devastating an effect on nearshore marine habitats, as happened on Anatahan in 2003. The 2003 eruption of Anatahan is believed to have resulted in the extirpation of all landbirds on the island. The coral reefs around Anatahan have not yet recovered.

Again, extirpations from volcanic eruptions are a natural, unavoidable process. On long timescales, these islands would recover and eventually be re-populated, at least by mobile species such as birds. However, many of our endemic SGCN have been greatly reduced from their historical abundance or distribution due to other human-related causes. Potential source populations for re-population are smaller and fewer, so the process will take much longer, and greatly increases the risk of extinction of narrow-range endemic SGCN. Mariana skink, for example, formerly occurred across the southern islands, but is now known to occur on only 5 northern islands, including Pagan and Sarigan. The loss of any of its island populations would significantly increase the overall risk of extinction.

6.9 Wildfire

Wildfire is very rarely a natural occurrence in the CNMI, but rather is typically human-caused, both intentionally and unintentionally. Some hunters on Saipan and Rota intentionally start fires in grassland areas to attract deer. Wildfires prevent these areas from succeeding to forest. Grassland does not prevent runoff as well as forest, so heavy rainfall results in increased erosion, with sediments carried into the marine environment and degrading habitats for marine SGCN. Wildfires can convert our forests, which are not fire-adapted, into grassland, or even to bare land with repeated fires. While wildfires are not necessarily common or widespread, they do affect a wide range of terrestrial and marine SGCN.

6.10 Sea Transportation

Various aspects of sea transport have the potential to negatively impact marine SGCN and their habitats. Commercial shipping activities, due to the larger size of the ships, have greater potential for negative impacts in the form of groundings. For example, the 2014 grounding of the *M/V Paul Russ* near the channel leading into the Port of Saipan impacted more than 3100m^2 of benthic habitat, including an estimated loss of more than 16,000 coral colonies, as well as a significant reduction in reef complexity at the impact site (Johnston et al., in prep). In some instances, in addition to the physical damage to reef habitat and species, vessel grounding can also result in the release of fuel, oil, and other chemicals that may impact marine habitats, including far from the grounding site.

Although very infrequent, dredging is required to maintain commercial shipping lanes. Dredging raises sediment that can smother and kill nearby corals and other organisms. When the Saipan shipping channel was last dredged in the mid-1990’s, spinner dolphins became stranded in the Saipan Lagoon, presumably after becoming disoriented by the dredging activities (Trianni and Kessler 2002).

Not restricted to commercial ships, boats of any size can strike and potentially kill or injure large marine animals. Little information is available on vessel strikes in the CNMI, but SGCN spinner dolphin and grey reef shark are seen with what appear to be scars or injuries from strikes (Trianni and Kessler 2002).

7 From Goals to Actions

Goals describe broad primary outcomes or desired conditions, i.e. what condition do we want for the species or island? Clearly articulated goals provide the necessary framework for decisionmaking when conservation resources are limited.

Strategies are the general approach taken to achieve a goal.

Objectives translate goals and strategies into measurable components.

Actions are the specific tool or method that we use to achieve the objective.

This CNMI Wildlife Action Plan addresses conservation issues that range from broad or ecosystem-scale, to highly specific or localized, which presented difficulties during development of goals and objectives. In general, the goal-setting process was simpler when addressing the most specific issues, i.e. addressing the needs of a particular SGCN. At a species-specific scale, there were typically fewer stakeholders with an interest, and fewer partners needed for future implementation. At the species-scale, we were able to develop ten-year objectives and associated actions using the SMART approach, i.e. **S**pecific, **M**easurable, **A**chievable, **R**elevant, and **T**imebound objectives.

For broad, ecosystem-scale issues, we developed goals and strategies, but the complexity of these issues hindered our ability to translate these into specific objectives and actions. These broad-scale issues necessitate involvement by many stakeholders and partners, and often warrant an in-depth issue-specific planning effort to achieve concensus on specific objectives and actions. We present the broad-scale or "ecosystem-based" goals and strategies here, and will develop specific management objectives and actions to address these issues prior to implementation.

7.1 Ecosystem-based Goals and Strategies

We refer to the overarching challenges and opportunities that affect most or all SGCN as "ecosystem-based". These may be biological in nature, i.e. directly impacting ecosystems, but can also be regulatory, administrative, social/cultural, organizational, etc. The goals and strategies will benefit entire ecosystems or suites of SGCN.

Invasive Species Prevention

Goals: Prevent introduction of new invasive species to the CNMI, including but not limited to brown tree snake; prevent the spread of invasive species among CNMI islands; manage invasive species as needed to protect key areas for SGCN

Strategies:

- Continue and improve upon existing brown tree snake prevention efforts
- Develop and implement a comprehensive biosecurity program that includes but goes beyond brown tree snake interdiction, focusing on other invasive species present on Guam but not yet in the CNMI, such as little fire ant and coconut rhinoceros beetle
- Develop new regulations and enforce biosecurity measures for all expeditions to the northern islands
- Educate boat owners about specific invasive species that could be spread among islands, and measures to take to prevent spread
- Establish an invasive vine management program on Saipan to conserve ecological structure and function of important forest areas for SGCN
- Develop protocols and capacity for early detection/rapid response to new invasive species arrivals

Compliance with Conservation Regulations

Goals: Increase resources for enforcement on all islands; increase public awareness of conservation regulations

Strategies:

- Install and maintain signage at all Conservation Areas and MPAs describing allowable uses
- Complete demarcation of all Conservation Area and MPA boundaries
- Continue and improve the delivery of information about conservation regulations through the DFW, BECQ, and other websites, and through social media networks
- Maintain existing funding for conservation enforcement, and seek new sources of funding

Public Engagement in Conservation

Goal: Increase public support for conservation of SGCN and habitats

Strategies:

- Continue and expand on environmental education and outreach efforts
- Create a community-based fish and wildlife advisory board, in particular to address issues related to harvested species
- Increase public support for conservation by providing trails, signage, and restoration demonstrations

Marine Protected Area Management

Goal: Increase the effectiveness of existing Marine Protected Areas

Strategies:

- Develop and maintain a long-term sustainable funding stream to support MPA management, conservation, and enforcement
- Demarcate all MPA boundaries with in-water buoys (where feasible) or land markers
- Develop and implement management plans for all seven MPAs, i.e. gather public and local resource management agency input, update, and implement three existing MPA management plans, and develop new plans for the remaining 4 MPAs
- Develop regulations to further MPA objectives, as outlined in Public Laws and CNMI Administrative Code
- Increase resources for enforcement of existing MPA regulations
- Conduct a comprehensive assessment of biological data collected in MPAs since inception; use the assessment results to refine the monitoring program and establish overall measures of effectiveness
- Institute a tour guide certification program for companies operating within MPA boundaries
- Install and maintain signage at all MPAs communicating responsible and allowable uses
- Maintain a current list of all fish, invertebrate, and coral species present in each MPA; develop a data management system to track annual presence/absence information and streamline updates to the checklist

Educated, Experienced Workforce in Conservation Agencies
Goals: Increase the educational level of professional and administrative staff working in conservation agencies; reduce turnover of professional staff

Strategies:
- Introduce financial incentives such as tuition reimbursement for existing employees to pursue degrees or certifications related to their position
- Develop an apprenticeship or other program for conservation agencies to hire and train recent college graduates with ties to the Mariana Islands
- Continue to provide opportunities for local high school and college students to intern with conservation agencies
- Ensure that salaries for conservation agency positions remain competitive compared to other U.S. states and territories

Coral Reef Restoration and Management
Goal: Build capacity to restore and enhance coral reefs, especially in response to bleaching events

Strategy:
- Establish a coral nursery with the infrastructure and staffing expertise needed for propagation and seeding of corals, including ESA-listed corals
- Prioritize reefs for management, and implement appropriate actions to reduce the

impacts of bleaching events

Marine Pollution Reduction
Goal: Reduce runoff from land-based sources of pollution

Strategies:

- Continue implementation of watershed plans such as the Garapan Conservation Action Plan (CAP), LauLau Bay CAP, and Talakhaya CAP
- Map the sources and distribution of pollutants in Saipan Lagoon in relation to pollution-sensitive marine SGCN; target actions in locations that can most benefit SGCN

Strategic Use of Resources
Goal: Enhance the capability of CNMI conservation agencies and organizations to coordinate on proactive conservation efforts

Strategies:

- Improve communication and cooperation among state and local agencies and organizations to avoid redundant efforts and to partner when interests are shared
- Develop island-wide conservation and management plans for all 14 islands in a process that includes stakeholder involvement; include an evaluation of restoration and reintroduction opportunities
- Conduct bioinventories to gather basic information about the abundance, distribution, and habitats of both rare and common native species on all islands; develop a data management system to track information as part of a proactive approach to avoid the need for ESA listings

7.2 SGCN Objectives and Actions

7.2.1 Species Objectives

For each SGCN, we identified one or more clear objectives that, when met, will contribute to our overall goal of species and habitat conservation for the benefit of the people of the CNMI.

Our objectives are measurable, achievable, and relevant. Wherever possible, objectives are quantitative. For some SGCN, especially marine and invertebrate species, we did not have the biological information we needed to establish a quantitative objective. For these, our objective is qualitative, typically expressed as an objective to maintain or improve existing condition while we collect the information we need that will permit us to later develop more refined, quantitative objectives.

For all species, we developed 10-year objectives. For some species, especially ESA-listed species, we developed 10-year or interim objectives, and also developed “long-term” objectives.

Species objectives are found in the SGCN profiles in Chapter 8.

Some closely-related SGCN were consolidated to develop suite-level objectives and actions, as they are more effectively managed as a suite rather than with separate, redundant species-specific objectives and actions. These included native giant clams (*Tridacna maxima and T. squamosa*), turban snails (*T. petholatus*, *T. setosus*, and *T. argyrostomus*), and spiny lobsters (*Panulirus penicillatus*, *P. longipes*, *P. versicolor*).

7.2.2 Species-specific Actions

For each SGCN objective, we identified the direct action or steps required to meet the objective. We identified “priority actions” for each SGCN. “Priority actions” are defined as those actions that must be implemented within the next ten years in order to meet the objective. We sometimes identified supplemental or “other” actions, which are additional actions that by themselves will not achieve our objectives, but will provide benefits to the SGCN and will be considered if, for whatever reason, priority actions cannot be implemented. Species-specific priority and other actions are listed in the individual SGCN profiles in Chapter 8.

7.2.3 Summary of SGCN-Specific Actions by Island

The following summarizes by island the priority actions identified for SGCN in Chapter 8. “Other” actions are not included here, but only in the individual SGCN profiles in Chapter 8.

7.2.3.1 All Islands

- Prevent brown tree snake introduction
- Determine the status of SGCN seabird nesting colonies
- Determine the presence, abundance, and distribution of SGCN terrestrial reptiles and ESA-listed coral SGCN.
- Reduce poaching of coconut crab through outreach, education, and enforcement
- Prioritize staghorn coral sites and implement appropriate management

7.2.3.2 Rota

- Continue existing education, monitoring, and enforcement efforts for fanihi conservation
- Control feral cats near crow nesting areas
- Augment wild crow population with captive bred birds
- Conduct outreach and education to build public support or tolerance for crow recovery efforts, and to reduce poaching of fanihi and other SGCN
- Educate community leaders and landowners about private property rights and ESA-listed species

- Reintroduce Mariana swiftlet (moving birds from Saipan population)
- Protect and enhance habitat at key tree snail colonies (i.e. ungulate/predator exclosures, rat trapping, and/or vegetation management)
- Address rat and drongo threats to Rota white-eye; petition to de-list Rota white-eye
- Determine presence, distribution, and abundance of SGCN corals, tree snails, and insects
- Map and quantify the extent of sea turtle foraging habitat

7.2.3.3 Aguiguan

- Control feral goats and *Lantana* shrubs
- Plant native trees
- If feasible, establish a sheath-tailed bat captive breeding program started from the Aguiguan population

7.2.3.4 Tinian

- Prioritize areas and implement habitat conservation and management for Mariana common moorhen and Tinian monarch
- Map and quantify the extent of sea turtle foraging habitat
- Prevent extirpation of humped tree snail colonies using predator/ungulate exclosures, rat trapping, and/or vegetation management
- Coordinate with the U.S. Navy on management of tree snail colonies and moorhen wetlands within the Military Lease Area
- Determine distribution and abundance of grey reef shark and SGCN corals

7.2.3.5 Saipan

- Conduct outreach, education, and enforcement to reduce poaching of haggan, fanihi, and other SGCN
- Establish a coral nursery for a propagation and seeding program
- Prioritize areas and implement habitat conservation and management for Micronesian megapode, golden white-eye, Mariana common moorhen, and nightingale reed-warbler
- Prevent extirpation of humped tree snail colonies using predator/ungulate exclosures, rat trapping, and/or vegetation management
- Coordinate with the National Park Service on management of the American Memorial Park tree snail colony
- Reduce disturbance at key swiftlet caves using signage and/or gates
- Develop a Saipan Habitat Conservation Plan
- Determine presence, distribution, and abundance of SGCN grey reef shark, napoleon wrasse, steephead parrotfish, corals, spiny lobsters, marine snails, collector urchin, day octopus, mangrove crab, pectinate venus, and Rota damselfly

- Map, quantify the extent, and maintain seagrass habitats and sea turtle foraging habitats

7.2.3.6 Noos (FDM)

- Coordinate with the U.S. Navy to manage masked booby and other seabird nesting colonies
- Induce the U.S. Navy to honor its conservation commitments from the Mariana Islands Range Complex Record of Decision, including rat eradication on Noos

7.2.3.7 Northern Islands

- Guguan: Complete the bridled white-eye and Tinian monarch introductions begun in 2015
- Alamagan: Control feral ungulates
- Agrigan: Introduce Mariana fruit dove, Nightingale reed-warbler, Rota white-eye, and Tinian monarch

7.3 Monitoring Strategy

7.3.1 Status Monitoring

"Status monitoring" is analogous to a doctor measuring a patient's pulse. We measure the status of SGCN populations, habitats, and threats in an ongoing evaluation of status relative to SGCN population and habitat objectives. Status monitoring is also a critical component of adaptive management, as it may lead to changes in prioritization, if, for example, we detect an unexpected SGCN population decline, or an increased threat.

In the CNMI, we do not have access to large-scale regional or continental monitoring programs such as the North American Breeding Bird Survey to support our monitoring strategy and adaptive management. We also do not have sufficient human population to draw from to develop large citizen science monitoring efforts. We therefore are dependent on conservation partners to develop and implement monitoring programs.

We have many long-term, ongoing monitoring programs active in the CNMI. Some began years before the CNMI first developed a Wildlife Action Plan in 2005. The purpose of these monitoring programs is rarely directly tied to the Action Plan, but rather was initiated and continues in response to a specific conservation need. The programs described below were designed for different purposes and may track different attributes of species, habitats, or threats, depending on the level and kinds of data needed by wildlife managers. All provide information that can be used for adaptively managing SGCN and their habitats. Many provide specific population or habitat information that we will use to directly measure our progress toward meeting the objectives described in this Plan.

Ongoing monitoring programs are summarized below. The lead or coordinating agency of a monitoring program is indicated in parentheses, but many monitoring programs involve important agency partnerships in implementation.

Fish

- *Shore-based Creel Program* (DFW): Captures information on nearshore landings for ongoing monitoring of the capacity of the reef fishery to meet subsistence and commercial demand
- *Boat-based Creel Program* (DFW): Captures information on vessel landings for ongoing monitoring of the capacity of the reef, pelagic, and bottom fisheries to meet subsistence and commercial demand
- *Commercial Purchase Data program* (DFW/WPRFM Council/MES): Captures commercial landing data for all fish species landed on the island of Saipan to inform management decisions
- *Exemption Surveys* (DFW): Captures information on net exemption landings for ongoing monitoring of potential impacts on the reef fishery
- *Life History Program* (DFW/NOAA): Captures biological information (e.g., reproductive cycle, age at length, age at maturity) on important commercial reef fish species (landed on Saipan) to inform management decisions
- *Marine Protected Area Surveys* (DFW): Monitors diversity and abundance of species within MPA's
- *Lagoon Surveys* (DFW): Monitors diversity and abundance of species within the Saipan Lagoon
- *Bio-Sampling Program* (NOAA): Captures catch and effort information on commercial reef fish and bottomfish catches landed on Saipan to inform management decisions

Birds

- *Breeding Bird Survey* (DFW): Quarterly bird surveys on Saipan, less frequently Rota and Tinian, which monitor long-term trends of island bird populations, especially forest birds.
- *Tropical Monitoring of Avian Productivity and Survivorship* (DFW): Surveys twice annually on Saipan to monitor trends in forest bird productivity
- *Christmas Bird Count* (DFW): Conducted by DFW staff and volunteers, the Count is conducted annually on Saipan, less frequently on Tinian and Rota, to monitor the presence and population trend of bird species during December/January, including wintering migrants.
- *Mariana Swiftlet* (DFW): Cave entrance/exit counts twice annually on Saipan to monitor long-term population trends
- *Rota white-eye* (DFW): Surveys twice annually to monitor the long-term population trend of this single-island endemic bird on Rota
- *Shorebird, Wader, and Water Bird* (DFW): Quarterly surveys to monitor long-term population trends of wetland-associated birds, including migrants and Mariana Common Moorhens, on Saipan

- *Wedge-tailed Shearwater* (DFW): Annual survey of Mañagaha nesting colony to monitor long-term population trend and productivity
- *Mariana Crow* (DLNR): Survey to estimate Rota population once every three years; annual survey to monitor population trends; annual nest monitoring; ongoing survival rate and mortality monitoring through radio tracking and band resighting
- *Seabirds* (DoN): Quarterly surveys of seabirds on Noos (FDM)
- *Mariana Common Moorhen*: Quarterly surveys on Lake Hagoi, Tinian (DoN); annual surveys on Rota and Tinian to monitor long-term population trends (DLNR)
- *Micronesian Megapode* (DoN): Five-year surveys to detect presence of megapode on the Tinian MLA
- *Island-wide Surveys* (USFWS/DFW): Variable point count surveys conducted on each island every 5-10 years to monitor long-term population trends, especially of forest birds

Mammals

- *Fanihi* (Mariana Fruit Bat) (DFW): Monthly colony counts and twice annual extra-colonial surveys to monitor long-term population trends on Rota; quarterly extra-colonial surveys on Saipan
- *Cetaceans* (DoN/NOAA): Annual surveys to monitor cetacean presence within the Mariana Island Range Complex, which extends from south of Guam to north of Pagan

Reptiles

- *Green Sea Turtle*: Annual nest monitoring on Saipan (DLNR) and Tinian (DoN), and less frequently on Rota (DLNR)

Invertebrates

- *Sea cucumber* (DFW): Occasional monitoring of edible sea cucumber populations on Saipan and Tinian to assess harvest impact

Habitats/Ecosystems*

- *Long-Term Marine Monitoring Program* (BECQ): Monitors trends in benthic cover and biological communities including fish, coral, macroalgae, and invertebrates at 50 permanent monitoring sites across Saipan, Tinian, and Rota. Sites encompass fore reef, lagoonal reef, and seagrass habitats. Sites are surveyed every two years.
- *Water Quality Sampling* (BECQ): Regular collection and analysis of samples from beaches on Rota, Tinian, and Saipan (including Mañagaha) to monitor water quality
- *Wetlands Datalayer* (BECQ): a GIS-based inventory of wetland location and type for Saipan, Tinian, and Rota
- *Coastal Change Analysis Program* (NOAA): raster-based land cover inventory of each island, including terrestrial and adjacent coastal areas, to monitor changes in habitat

- *Mariana Archipelago Reef Assessment and Monitoring Program* (NOAA): Every other year archipelago-wide collection of biological, physical/chemical, and mapping information for long-term coral reef ecosystem monitoring including benthic composition, water quality, and the condition, abundance, diversity and distribution of biological communities, especially fish and macroinvertebrates
- *Forest Inventory and Analysis* (USFS): Decadal systematic inventory of the forests of Rota, Tinian, and Saipan to estimate forest area, tree stem volume, biomass, carbon storage, tree damages, and the composition and percentage cover of understory vegetation species

*Some of these monitoring programs also address specific taxa, but are listed here to avoid redundancy.

Threats

- *Brown tree snake* (DFW/USGS/USFWS): Surveys conducted upon confirmation of a credible BTS sighting in the CNMI
- *Coconut rhinoceros beetle/Little fire ant* (USDA): Ongoing surveys to detect the potential introduction of these invasive insects

7.3.2 Effectiveness Measures

Conservation resources are limited. We need to allocate our resources effectively to achieve the goals and objectives we have identified in this Plan. For every conservation action that we consider for implementation, we will develop a project-specific results chain to illustrate how an action will produce outcomes that help us achieve our goals and objectives.

For example, conservation partners are actively translocating endemic bird SGCN from Saipan, Tinian, and Rota, where the threat of introduction of the invasive predator brown tree snake is very high, to northern islands that are nearly immune to the threat.

The results chain is therefore:

Action à Outcome à Threat à Goal

Translocation à Redundant Population à Brown Tree Snake à Endemic Bird SGCN

where the goal is to maintain a specific abundance (total #) and distribution (# of occupied islands) of each endemic bird SGCN, and the threat that compromises our ability to achieve the goal is potential brown tree snake predation. The threat is addressed by establishing redundant island populations, which we achieve through implementing the translocation action.

For each action implemented, we will develop measures of effectiveness of the action to produce the desired outcome and contribute to goal achievement. Effectiveness measures permit us to adapt our management approach. We can discontinue ineffective actions, modify actions to improve effectiveness, or expand the scope of actions if proven effective. For the translocation action example, post-translocation bird abundance estimates provide the measure of effectiveness of the conservation action, i.e. they indicate whether a redundant population was successfully established.

7.3.3 Monitoring Needs

Existing monitoring programs will meet many, but not all, of our needs for measures of progress toward Plan objectives and information to guide adaptive management. For some SGCN and habitats, baseline information is lacking, and monitoring protocols need to be developed. A primary barrier to developing protocols and implementing new monitoring programs is insufficient funding, especially for reptiles and invertebrates. Unless additional funding sources can be identified, we are unlikely to initiate new systematic monitoring programs; rather, we will conduct ad hoc surveys as funding permits, using repeatable methods. These surveys will provide important and useful information, but information gaps will remain that could potentially misrepresent the status of the SGCN or habitat.

Development of SGCN status monitoring protocols and collection of baseline information is needed for mangrove crab, Rota damselfly, and most marine invertebrate SGCN. Development of habitat monitoring protocols is needed for wetlands (in relation to nightingale reed-warbler and Mariana common moorhen needs), seagrass, and sea turtle foraging habitats.

For grey reef shark, terrestrial reptile SGCN, tree snail SGCN, and coconut crab, monitoring protocols are available, and occasional limited surveys have been implemented. For these SGCN, a systematic monitoring program is required but implementation is limited by lack of funding availability.

Additional SGCN-specific information about monitoring needs is included in the SGCN profiles in Chapter 8.

In some cases, monitoring data can serve multiple purposes, such as both a measure of SGCN status relative to Wildlife Action Plan objectives, and as a measure of effectiveness of a particular action. Some monitoring programs address multiple SGCN, such as bird point count surveys that monitor all forest bird SGCN. Given the limited funding available to create new monitoring programs, we will seek to develop and prioritize programs which can address multiple species or serve multiple purposes. We will also review and modify as needed existing monitoring programs to ensure that they continue to efficiently meet our needs.

7.4 Research Needs

For each SGCN, we identified the research required to meet or further refine the objective. These are described under individual SGCN profiles in Chapter 8. In addition, we here identify more general or ecosystem-based research needs that apply to many or all SGCN.

Conservation genetics

For both marine and terrestrial SGCN, we have incomplete knowledge of the phylogenetic relationships of most of our species. Conducting genetic analyses on populations across our islands would refine our understanding of the taxonomic status including degree of endemism of species and island subpopulations.

Marine connectivity

Knowledge of the larval sources and transport pathways of marine fish and invertebrate species, and of migratory pathways of migratory species including sea turtles and cetaceans, guides our conservation approach. Some species needs are best addressed through local conservation actions, while others may require international cooperation and conservation actions outside the CNMI. With improved understanding of the connectivity of marine species among CNMI islands and with island groups outside the CNMI, we can better prioritize our local conservation actions.

Invasive vine impacts

Invasive vines including scarlet gourd (Coccinia grandis) continue to spread in forests across the CNMI, but we have limited knowledge of the impacts on forest-dependent SGCN and habitat use. On a short timescale, forest-dependent SGCN may benefit or lose from vine invasion depending on their ecological response, e.g. if fruits of invasive vines are a preferred food source, or if forest stands with high vine abundance are preferred or avoided for nesting. However, we do not know how vine invasion alters forest regeneration. If vine invasion is resulting in permanent conversion of forest to non-forest habitats, then all forest-dependent SGCN are ultimately harmed.

Effects of conservation introductions

To address the threat of the potential introduction of brown tree snake to Saipan, Tinian, and Rota, several endemic bird SGCN have been translocated to Sarigan and Guguan over the last several years to establish safe, satellite populations. The Marianas Avifauna Conservation Plan (MAC Working Group 2014) outlines a timeline for continued translocations to Guguan and other northern islands. Post-translocation bird monitoring indicates that the translocations have been successful at establishing new populations. However, we need to explore if or how the bird introductions are influencing the ecosystems of the destination islands, including both positive and negative effects on other native species.

8 Species of Greatest Conservation Need Profiles and Priorities

Heading Descriptions

Scientific Name: Genus species subspecies (if applicable)
Class: Scientific class
Chamorro: Chamorro name
Carolinian: Carolinian name
English: English name
Endemism: Island region or islands of endemism
Federal ESA Status: Federal Endangered Species Act status
IUCN Red List Status: International Union for the Conservation of Nature concern status
CNMI Listing Status: CNMI Fish, Game, and Endangered Species Act status
Distribution: Range of species, especially in CNMI
Abundance: Species abundance, especially in CNMI
Preferred Habitat: Habitat(s) where species has the highest relative abundance
Ten Year Objective: Species objective to be met by 2025
Long-term Objective: Species objective going beyond 2025 (if applicable)
Priority Actions: Actions that must be implemented by 2025 to meet objectives
Other Actions: Additional actions that provide species benefits
Research Needed: Applied research needed to guide conservation and management
Monitoring Needed: Species-specific monitoring needs

Scientific Name	Class	Chamorro	Carolinian
Carcharhinus amblyrhynchos	Chondrichthyes	Halu'u	Limwe

English

Grey Reef Shark

Endemism

None

Federal ESA Status	IUCN Red List Status
None	Near Threatened

CNMI Listing Status

None

Distribution

From the Red Sea and Indian Ocean to the western and central Pacific; throughout the CNMI

David Burdick

Abundance

Common in the northern islands, rare in southern islands based on 2003, 2005, and 2007 NOAA-sponsored shallow water surveys; abundance at greater depths unknown

Preferred Habitat

Offshore banks and reefs, ~30-100m depth

Ten-Year Objective

Maintain or increase abundance around Saipan, Tinian, and Aguiguan; collect baseline information needed to refine the objective

Long-term Objective

Priority Actions

Determine specific abundance and distribution around Saipan, Tinian, and Aguiguan

Other Actions

Research Needed

Use baited underwater cameras/tagging to assess distribution and movements; evaluate relationship with fishing activities, i.e. fishing trophic effects, and potential accidental harvest or intentional persecution by fishermen

Monitoring Needed

Develop and implement a monitoring protocol

Scientific Name	Class	Chamorro	Carolinian
Cheilinus undulatus	Actinopterygii	Tanguisson	Maam

Julien Bidet/MDC Seamarc

English	
Napoleon Wrasse	
Endemism	
None	
Federal ESA Status	IUCN Red List Status
None	Endangered
CNMI Listing Status	
None	
Distribution	
Tropical Indo-Pacific to the central Pacific Ocean; within CNMI, possibly all islands but more common in areas with more developed coral reefs (i.e. Pagan and islands to the south)	
Abundance	
Uncommon, but not quantified	

Preferred Habitat

Adults, deeper waters of outer reef slopes; small post-settlement wrasse, lagoonal reefs with seagrass and corals; juveniles, staghorn coral thickets, seagrasses, sandy areas adjacent to corals, and mangroves

Ten-Year Objective

Maintain or increase abundance around Saipan; collect baseline information needed to refine the objective

Long-term Objective

Priority Actions

Measure abundance of juveniles in various habitats around Saipan (planned for 2016)

Other Actions

Research Needed

Collect basic information for the CNMI including stock assessment, population estimate, life history parameters, age structure, survivorship, etc.; determine population connectivity among Mariana Islands and with other Micronesian islands; evaluate potential harvest impacts

Monitoring Needed

Develop and implement a monitoring protocol

Scientific Name	Class	Chamorro	Carolinian
Chlorurus microrhinos	Actinopterygii	Laggua	Igan-wosh

English

Steephead Parrotfish

Endemism

None

Federal ESA Status	IUCN Red List Status
None	Least Concern

CNMI Listing Status

None

Distribution

Western Pacific; within CNMI, presumably all islands

Abundance

Relatively common on reefs, but not quantified

Preferred Habitat

Reef slope

Ten-Year Objective

Maintain or increase abundance around Saipan; collect information to refine the objective

Long-term Objective

Priority Actions

Determine abundance and habitat associations around Saipan; plan additional actions as needed based on research and monitoring results

Other Actions

Research Needed

Collect basic information for the CNMI including stock assessment, population estimate, life history parameters, age structure, maturity, mortality, etc.; determine connectivity among Mariana Islands and with other Micronesian islands; evaluate potential impact of harvest including trophic effects

Monitoring Needed

Extract catch size, frequency, and abundance from ongoing market surveys

Scientific Name	Class	Chamorro	Carolinian
Leptoscarus vaigiensis	Actinopterygii	Kabara	


Philippe Bourjon

English	
Seagrass Parrotfish	
Endemism	
None	
Federal ESA Status	IUCN Red List Status
None	Least Concern
CNMI Listing Status	
None	
Distribution	
Indo-Pacific; within CNMI, Saipan and possibly Tinian	

Abundance

Common, but not quantified

Preferred Habitat

Adults, seagrass beds such as within Saipan Lagoon; larvae and juveniles have been associated with drifting algae

Ten-Year Objective

Maintain the extent of seagrass habitat in the Saipan Lagoon

Long-term Objective

Priority Actions

Determine abundance and specific seagrass habitat associations around Saipan; plan additional actions as needed based on research and monitoring results

Other Actions

Research Needed

Collect basic information for the CNMI including stock assessment, population estimate, life history parameters, age structure, maturity, mortality, and more specific habitat associations and requirements; evaluate potential harvest impacts

Monitoring Needed

Map and quantify the extent of seagrass habitat (by species) in the Saipan Lagoon at least once every 10 years

Scientific Name	Class	Chamorro	Carolinian

English

Food Fish

Endemism

None

Federal ESA Status	IUCN Red List Status
NA	NA

CNMI Listing Status

NA

Distribution

Throughout CNMI

Abundance

Abundant

Preferred Habitat

All marine habitats

Ten-Year Objective

Stable or increasing CNMI-wide Annual Catch Limits (ACLs)

Long-term Objective

Priority Actions

Plan actions based on research and monitoring results

Other Actions

Research Needed

Downscale CNMI-wide ACLs to island-specific ACLs and evaluate whether the objective should be refined

Monitoring Needed

Starting in 2017, calculate 5-year and long-term trends in ACLs annually

Scientific Name	Class	Chamorro	Carolinian
Megapodius laperouse laperouse	Aves	Sasangat	Sasangal


Lainie Zarones, Sarigan

English	
Micronesian Megapode	
Endemism	
Marianas	
Federal ESA Status	IUCN Red List Status
Endangered	Endangered
CNMI Listing Status	
Threatened & Endangered	
Distribution	
On nearly all islands (12)	
Abundance	
10,886 in 2010	

Preferred Habitat

Native forest with understory

Ten-Year Objective

Increase the Aguiguan and Saipan populations to over 200 birds each

Long-term Objective

>2,650 birds distributed over 10 islands including 2 islands with >600 birds, 3 >300, 2 >200, and 3 islands >50 birds; federal delisting

Priority Actions

Forest restoration and enhancement on Aguiguan (i.e. goat control, Lantana shrub control, tree planting); based on research results, prioritize areas on Saipan for conservation and management

Other Actions

Advocate for an update to the 1998 USFWS Recovery Plan and formation of a recovery team; evaluate feasibility, risks, and benefits of translocating birds from a northern island to Saipan

Research Needed

Identify nesting sites and requirements to develop strategies to enhance productivity; evaluate the use of captive breeding to inform knowledge of nesting requirements; determine specific landscape and habitat associations on Saipan; assess the threat presented by rats, cats, and monitor lizards

Monitoring Needed

Island-wide population estimates on northern islands at least once every 10 years and on southern islands at least once every 5 years

Scientific Name	Class	Chamorro	Carolinian
Ardenna pacifica	Aves	Lifa'ru	Lifo'ro

English

Wedge-tailed Shearwater

Randy Harper/Marilyn Swift, Managaha

Endemism

None

Federal ESA Status	IUCN Red List Status
None	Least Concern

CNMI Listing Status

None

Distribution

Tropical Indo-Pacific; recorded from many Mariana Islands (9) but, with the exception of the Saipan/Managaha nesting colony, current nesting status is unknown

Abundance

118 active nests in Managaha colony fledged 86 birds in 2014; elsewhere in CNMI unknown

Preferred Habitat

Sandy soils for nesting burrows

Ten-Year Objective

Maintain existing nesting colonies; collect information to refine the objective

Long-term Objective

Priority Actions

Determine the location and status of additional current nesting colonies; prevent reintroduction of rats and cats to Managaha

Other Actions

Implement rat and cat control on islands/islets where appropriate

Research Needed

Conduct a literature review to identify historical nesting locations; identify areas with potential to attract new nesting colonies

Monitoring Needed

Continue annual nest monitoring of Managaha colony; conduct nesting colony surveys on northern islands at least once every ten years

Scientific Name	Class	Chamorro	Carolinian
Sula dactylatra personata	Aves	Lu'ao (talisai)	Amwo


Scott Vogt, Noos (FDM)

English	
Masked Booby	
Endemism	
None	
Federal ESA Status	IUCN Red List Status
None	Least Concern
CNMI Listing Status	
None	
Distribution	
Circumtropical; recorded from most Mariana Islands (11) but, with the exception of Noos (FDM), current nesting status is unknown	

Abundance

~100 birds on Noos, the largest known nesting site in the CNMI; elsewhere, unknown

Preferred Habitat

Cliffs and rocky islets for nesting

Ten-Year Objective

Maintain existing nesting colonies; collect information to refine the objective

Long-term Objective

Priority Actions

Determine the location and status of current nesting colonies; improve cooperation with U.S. Navy regarding management of Noos colony; compel the U.S. Navy to honor its commitment in the Mariana Islands Range Complex (MIRC) Record of Decision to eradicate rats on Noos

Other Actions

Implement rat and cat control on islands/islets where appropriate

Research Needed

Conduct a literature review to identify historical nesting locations; identify areas with potential to attract new nesting colonies

Monitoring Needed

Monitor nesting colonies at least once every 10 years

Scientific Name	Class	Chamorro	Carolinian
Fregata minor palmerstoni	Aves	Paya'ya	Asaf

English	
Great Frigatebird	
Endemism	
None	
Federal ESA Status	IUCN Red List Status
None	Least Concern
CNMI Listing Status	
None	
Distribution	
Tropical Indo-Pacific and Atlantic; recorded from most Mariana Islands (12) but current nesting status unknown	


female, Henry Fandel, Rota

Abundance
Unknown, but relatively uncommon
Preferred Habitat
Primarily nest in trees and shrubs, occasionally on bare ground
Ten-Year Objective
Maintain existing nesting colonies; collect information to refine the objective
Long-term Objective
Priority Actions
Determine the location and status of current nesting colonies
Other Actions
Implement rat and cat control on islands/islets where appropriate
Research Needed
Conduct a literature review to identify historical nesting locations; identify areas with potential to attract new nesting colonies
Monitoring Needed
Monitor nesting colonies at least once every 10 years

Scientific Name	Class	Chamorro	Carolinian
Gallinula chloropus guami	Aves	Pulattat	Gherel Bweel

English

Mariana Common Moorhen

Endemism

Marianas

Federal ESA Status	IUCN Red List Status
Endangered	Least Concern

CNMI Listing Status

Threatened & Endangered

Distribution

Saipan, Tinian, Rota, and Guam; extirpated Pagan

Lainie Zarones, Saipan

Abundance

154 Saipan in 2001; 24+ Tinian in 2013; 12+ Rota in 2015

Preferred Habitat

Golf course water features; wetlands

Ten-Year Objective

Implement consistent moorhen-targeted management of at least 75 wetland acres on Saipan/Tinian

Long-term Objective

300/75 acres protected and managed wetlands Saipan/Tinian, 300/75 birds Saipan/Tinian

Priority Actions

Prioritize wetlands for conservation and management based on research results; improve coordination between CNMI/Tinian agencies and US Navy on monitoring and management on Tinian; work with DPL and other regulatory agencies to manage publicly-owned wetlands for moorhens; prevent spread of water hyacinth to moorhen-occupied wetlands

Other Actions

Evaluate feasibility of reintroduction to Pagan; advocate for an update to the 1991 USFWS Recovery Plan to include delisting criteria, and form a recovery team

Research Needed

Rangewide population survey in cooperation with Guam DAWR and the U.S. military; improve wetland mapping for Saipan and Tinian; determine specific landscape and habitat associations; conduct wetland suitability assessment; determine nesting success and limiting factors such as predation; evaluate utility of new technologies such as drones and remote recording to improve monitoring

Monitoring Needed

Island-wide population estimates at least once every five years; develop and implement a habitat monitoring protocol

Scientific Name	Class	Chamorro	Carolinian
Gallicolumba xanthonura	Aves	Paluman kotbata	Apooka


male, Isaac Chellman

English	
White-throated Ground Dove	
Endemism	
Mariana Islands and Yap	
Federal ESA Status	IUCN Red List Status
None	Near Threatened
CNMI Listing Status	
None	
Distribution	
Most Mariana Islands (9) and Yap	
Abundance	
>18,000 birds	
Preferred Habitat	
Mixed forest; native forest; savannah	
Ten-Year Objective	
Maintain >18,000 birds across 9 islands	
Long-term Objective	
Priority Actions	
Prevent Brown Tree Snake introduction	
Other Actions	
Enhance critical island populations with introductions from an existing captive population	
Research Needed	
Monitoring Needed	
Population estimates on southern islands at least once every 5 years and on northern islands at least once every 10 years	

Scientific Name	Class	Chamorro	Carolinian
Ptilinopus roseicapilla	Aves	Paluman totut	Mwee'mwe

Isaac Chellman

English	
Mariana Fruit Dove	
Endemism	
Marianas	
Federal ESA Status	IUCN Red List Status
None	Endangered
CNMI Listing Status	
None	
Distribution	
Saipan, Tinian, Rota, and Aguiguan; birds translocated to augment a self-establishing population on Sarigan in 2012-2013	
Abundance	
>18,000 birds	

Preferred Habitat

Native forest

Ten-Year Objective

>18,000 birds across 6 islands

Long-term Objective

>18,000 birds across 7 islands by 2035

Priority Actions

Translocation to Agrigan; based on research results, prioritize areas on Saipan and Tinian for conservation and management; prevent brown tree snake introduction

Other Actions

Proactively develop captive breeding techniques

Research Needed

Determine specific landscape and habitat associations on Saipan and Tinian

Monitoring Needed

Island-wide population estimates at least once every 5 years on southern islands; post-introduction monitoring on Sarigan and Agrihan at least twice within 10 years of translocation

Scientific Name	Class	Chamorro	Carolinian
Aerodramus bartschi	Aves	Chachaguak	Leghe'kiyank

English	
Mariana Swiftlet	
Endemism	
Marianas	
Federal ESA Status	IUCN Red List Status
Endangered	Endangered
CNMI Listing Status	
Threatened & Endangered	
Distribution	
Saipan, Guam, and Aguiguan; extirpated from Tinian and Rota	

Nathan Johnson

Abundance
4,700 on Saipan in 2013; <300 on Aguiguan in 2002
Preferred Habitat
Caves for roosting and nesting; native forest for foraging
Ten-Year Objective
Achieve at least 3% average annual population growth on Aguiguan; reintroduce to Rota; maintain a stable population on Saipan
Long-term Objective
2,000 birds on Rota, 1,000 Aguiguan, 2,000 Saipan; federal delisting
Priority Actions
Forest restoration and enhancement on Aguiguan (i.e. feral goat control, Lantana shrub control, and tree planting); reintroduction to Rota; reduce disturbance at key Saipan caves through signage and/or gates; prevent introduction of brown tree snake; work with DPL to manage publicly-owned swiftlet caves
Other Actions
Advocate for an update to the 1991 USFWS Recovery Plan and formation of a recovery team
Research Needed
Evaluate monitoring approach given new available technologies; conduct a Saipan-wide survey assessing cave subpopulations that may contribute to a reintroduction program and/or that may benefit from measures to reduce disturbance; expand on past Rota feasibility study to evaluate additional caves for reintroduction
Monitoring Needed
Cave entrance/exit counts at least annually, but may change if a new protocol is adopted

Scientific Name	Class	Chamorro	Carolinian
Todiramphus albicilla albicilla	Aves	Sihek	Waaw


Isaac Chellman, Saipan

English	
Mariana Kingfisher ssp. albicilla	
Endemism	
Saipan, Tinian, and Aguiguan	
Federal ESA Status	IUCN Red List Status
None	Not Assessed
CNMI Listing Status	
None	
Distribution	
Saipan, Tinian, and Aguiguan	
Abundance	
>6,000 birds	
Preferred Habitat	
Forest; savannah	
Ten-Year Objective	
Maintain at least 6,000 birds across 3 islands	
Long-term Objective	
Priority Actions	
Prevent brown tree snake introduction	
Other Actions	
Proactively develop captive breeding techniques	
Research Needed	
Monitoring Needed	
Island-wide population estimates at least once every 5 years	

Scientific Name	Class	Chamorro	Carolinian
Todiramphus albicilla orii	Aves	Sihek	Waaw


Lainie Zarones, Rota

English	
Mariana Kingfisher ssp. orii	
Endemism	
Rota	
Federal ESA Status	IUCN Red List Status
None	Not Assessed
CNMI Listing Status	
None	
Distribution	
Rota only	
Abundance	
~4,000 birds (down from ~7,000 birds in 1982)	

Preferred Habitat

Forest; savannah

Ten-Year Objective

Maintain a population of ~4,000 birds

Long-term Objective

Priority Actions

Plan appropriate actions based on research results; prevent brown tree snake introduction

Other Actions

Proactively develop captive breeding techniques

Research Needed

Evaluate possible causes of population decline including competition with black drongo, predation by cats/rats, or an artifact of the monitoring protocol

Monitoring Needed

Rota-wide population estimates at least once every 5 years

Scientific Name	Class	Chamorro	Carolinian
Todiramphus albicilla owstoni	Aves	Sihek	Waaw


Lainie Zarones, Sarigan

English	
Mariana Kingfisher ssp. owstoni	
Endemism	
northern Mariana Islands	
Federal ESA Status	IUCN Red List Status
None	Not Assessed
CNMI Listing Status	
None	
Distribution	
Agrihan, Alamagan, Asuncion, Pagan, and Sarigan; possibly Guguan	
Abundance	
~4,300 birds	
Preferred Habitat	
Forest; savannah	
Ten-Year Objective	
Maintain 4,300 birds across 5 islands	
Long-term Objective	
Priority Actions	
Plan actions as needed based on research and monitoring results	
Other Actions	
Research Needed	
Conduct genetic analyses to confirm taxonomic status	
Monitoring Needed	
Island-wide population estimates at least once every 10 years	

Scientific Name	Class	Chamorro	Carolinian
Myzomela rubratra saffordi	Aves	Egigi	Tigh'par

English

Micronesian Honeyeater ssp. saffordi

Endemism

southern Mariana Islands

Federal ESA Status	IUCN Red List Status
None	Least Concern

CNMI Listing Status

None

Distribution

Rota, Tinian, Saipan, and Aguiguan

John Fraser, Saipan

Abundance

~105,000 birds

Preferred Habitat

Forest; savannah; residential developed

Ten-Year Objective

Maintain >100,000 birds across 4 islands

Long-term Objective

Priority Actions

Prevent brown tree snake introduction

Other Actions

Proactively develop captive breeding techniques

Research Needed

Conduct genetic analyses to confirm Mariana Islands taxonomic status

Monitoring Needed

Island-wide population estimates at least once every 5 years

Scientific Name	Class	Chamorro	Carolinian
Rhipidura rufifrons mariae	Aves	Naabak	Leteghi par


Lainie Zarones, Rota

English	
Rufous Fantail ssp. mariae	
Endemism	
Rota	
Federal ESA Status	IUCN Red List Status
None	Least Concern
CNMI Listing Status	
None	
Distribution	
Rota	
Abundance	
>38,000 birds with increasing population trend	
Preferred Habitat	
Forest	
Ten-Year Objective	
Maintain >38,000 birds on Rota	
Long-term Objective	
Priority Actions	
Prevent brown tree snake introduction	
Other Actions	
Research Needed	
Conduct genetic analyses to confirm Mariana Islands taxonomic status	
Monitoring Needed	
Island-wide population estimate at least once every 5 years	

Scientific Name	Class	Chamorro	Carolinian
Rhipidura rufifrons saipanensis	Aves	Naabak	Leteghi par

English

Rufous Fantail ssp. saipanensis

Endemism	
Saipan, Tinian, and Aguiguan	
Federal ESA Status	IUCN Red List Status
None	Least Concern
CNMI Listing Status	
None	
Distribution	
Saipan, Tinian, Aguiguan; introduced to Sarigan in 2013-2014	
Abundance	
>188,000 birds	

Preferred Habitat

Forest

Ten-Year Objective

>188,000 birds across 4 islands

Long-term Objective

>188,000 birds across 5 islands by 2035

Priority Actions

Prevent brown tree snake introduction

Other Actions

Proactively develop captive breeding techniques

Research Needed

Monitoring Needed

Island-wide estimates on southern islands at least once every 5 years; post-translocation monitoring on Sarigan at least twice within 10 years of introduction

Scientific Name	Class	Chamorro	Carolinian
Monarcha tatatsukasae	Aves	Chichurikan Tinian	Liteighi'par

Paul Radley, Tinian

English

Tinian Monarch

Endemism

Tinian

Federal ESA Status	IUCN Red List Status
None	Vulnerable

CNMI Listing Status

None

Distribution

Tinian; introduced to Guguan in 2015 with an additional translocation planned for 2016

Abundance

~91,000

Preferred Habitat

Forest

Ten-Year Objective

Maintain >90,000 birds on Tinian; establish new populations on two additional islands (Guguan and Agrigan)

Long-term Objective

>91,000 birds across 4 islands by 2030

Priority Actions

Establish new populations on Guguan and Agrihan; based on research results, prioritize areas on Tinian for conservation and management; prevent brown tree snake introduction

Other Actions

Proactively develop captive breeding techniques; cooperate with the military to better manage habitat within the MLA

Research Needed

Determine specific landscape and habitat associations on Tinian

Monitoring Needed

Tinian-wide population estimate at least once every 5 years; post-translocation monitoring at least twice within 10 years of introduction

Scientific Name	Class	Chamorro	Carolinian
Corvus kubaryi	Aves	Aga	Mwii'lup

English	
Mariana Crow	
Endemism	
Guam and Rota	
Federal ESA Status	IUCN Red List Status
Endangered	Critically Endangered
CNMI Listing Status	
Threatened & Endangered	
Distribution	
Rota only; extirpated from Guam	

Abundance

46 breeding pairs on Rota in 2013-2014 with a declining trend

Preferred Habitat

Native forest

Ten-Year Objective

>50 breeding pairs on Rota; establish a captive breeding program

Long-term Objective

At least 75 Rota breeding pairs

Priority Actions

Feral cat and rat control near nesting areas; augment wild population with captive reared birds; conduct outreach and education on Rota to build public support; educate community leaders and landowners about private property rights and ESA-protected species

Other Actions

Research Needed

Assess the effects of feral cat control on rat population levels

Monitoring Needed

Rota population estimate at least every three years; ongoing nest monitoring; ongoing survival rate and mortality monitoring through radio tracking and band resighting

Scientific Name	Class	Chamorro	Carolinian
Acrocephalus hiwae	Aves	Ga'ga karisu	Litchoghoi bwel

English

Nightingale Reed-warbler

Scott Vogt, Saipan

Endemism

Saipan and Alamagan

Federal ESA Status	IUCN Red List Status
Endangered	Critically Endangered

CNMI Listing Status

Threatened & Endangered

Distribution

Saipan and Alamagan; two closely-related species are likely extirpated from Aguiguan and Pagan

Abundance

2,742 Saipan in 2007, 946 Alamagan in 2010

Preferred Habitat

Tangantangan forest; wetlands; mixed forest

Ten-Year Objective

Establish a population on Agrigan; maintain Saipan abundance; increase Alamagan population to 1,200 birds

Long-term Objective

4,000 birds Saipan, 2,000 Alamagan, and sustainable populations on three additional islands; federal delisting

Priority Actions

Feral ungulate control on Alamagan; based on research results, prioritize areas on Saipan for conservation and management; forest restoration and enhancement on Aguiguan in preparation for future translocation; establish a new population on Agrigan; prevent brown tree snake introduction; develop a Saipan Habitat Conservation Plan

Other Actions

Advocate for an update to the 1998 USFWS Recovery Plan and formation of a recovery team; if the Aguiguan species (A. nijoi) is confirmed extinct, introduce to Aguiguan following forest restoration and enhancement

Research Needed

Determine specific landscape and habitat associations on Saipan, including relationship with nesting success/productivity; conduct a population viability analysis for Saipan; evaluate the threat of rat and cat predation including control alternatives

Monitoring Needed

Island-wide population estimate on Alamagan at least once every 10 years and on Saipan at least once every 5 years; develop and implement a habitat monitoring program for Saipan

Scientific Name	Class	Chamorro	Carolinian
Zosterops conspicillatus saypani	Aves	Nosa'/Chuchirika	Litchogh


Lainie Zarones, Saipan

English	
Bridled White-eye	
Endemism	
Marianas	
Federal ESA Status	IUCN Red List Status
None	Endangered
CNMI Listing Status	
None	
Distribution	
Saipan, Tinian, and Aguiguan; introduced Sarigan 2008-2009; initial release on Guguan in 2015	
Abundance	
>1 million birds	
Preferred Habitat	
Forest	
Ten-Year Objective	
Maintain >1 million birds total; establish populations on two additional islands (Sarigan, Guguan)	
Long-term Objective	
Over a million birds across 6 islands by 2030	
Priority Actions	
Complete introduction to Guguan; prevent introduction of brown tree snake	
Other Actions	
Proactively develop captive breeding techniques	
Research Needed	
Monitoring Needed	
Island-wide population estimates on southern islands at least once every 5 years; post-introduction monitoring on Sarigan and Guguan at least twice within 10 years of introduction	

Scientific Name	Class	Chamorro	Carolinian
Zosterops rotensis	Aves	Nosa'	Litchogh


Lainie Zarones, Rota

English	
Rota White-eye	
Endemism	
Rota	
Federal ESA Status	IUCN Red List Status
Endangered	Critically Endangered
CNMI Listing Status	
Threatened & Endangered	
Distribution	
Rota only	
Abundance	
>14,000 birds	

Preferred Habitat

Higher elevation native forest

Ten-Year Objective

Maintain >14,000 birds total; establish a new population on Agrigan; petition USFWS to delist

Long-term Objective

Federal delisting

Priority Actions

Translocate to Agrigan; based on research, address threats from rats and drongos if necessary; petition USFWS to delist the species; prevent introduction of brown tree snake

Other Actions

Research Needed

Assess the potential impacts of rats and drongos on the population

Monitoring Needed

Rota-wide population estimate at least once every 5 years

Scientific Name	Class	Chamorro	Carolinian
Cleptornis marchei	Aves	Canario	Khanooriyo

Lainie Zarones, Saipan

English
Golden White-eye

Endemism
Saipan and Aguiguan

Federal ESA Status	IUCN Red List Status
None	Critically Endangered

CNMI Listing Status
None

Distribution
Saipan and Aguiguan; introduced on Sarigan in 2011-2012

Abundance
>87,000 birds

Preferred Habitat
Native forest

Ten-Year Objective
>87,000 birds across 3 islands

Long-term Objective
>87,000 birds total across 4 islands by 2035

Priority Actions
Based on research results, prioritize areas on Saipan for conservation and management; prevent brown tree snake introduction

Other Actions
Proactively develop captive breeding techniques

Research Needed
Detemine specific landscape and habitat associations on Saipan

Monitoring Needed
Island-wide population estimates on Saipan and Aguiguan at least once every 5 years; post-introduction monitoring on Sarigan at least twice within 10 years of introduction

Scientific Name	Class	Chamorro	Carolinian
Stenella longirostris longirostris	Mammalia	Toninos	Ghu

English	Spinner Dolphin
Endemism	None
Federal ESA Status	None
IUCN Red List Status	Data Deficient
CNMI Listing Status	None
Distribution	Around oceanic islands in the tropical Atlantic, Indian, and western and central Pacific east to about 145°W; in the CNMI, presumably all islands
Abundance	0.697 sightings/100km in 2010-2014 US Navy-contracted surveys
Preferred Habitat	Nearshore waters; occasionally enter Saipan Lagoon
Ten-Year Objective	Maintain a stable CNMI-wide population trend
Long-term Objective	
Priority Actions	Plan actions as needed based on monitoring results
Other Actions	
Research Needed	
Monitoring Needed	Ongoing surveys are contracted by US Navy through at least 2015

Scientific Name	Class	Chamorro	Carolinian
Emballonura semicaudata rotensis	Mammalia	Fanihin Liyang	Payesyes/Pai'Scheei

English

Pacific Sheath-tailed Bat

Endemism

Marianas

Federal ESA Status	IUCN Red List Status
Endangered	Endangered

CNMI Listing Status

Threatened & Endangered

Distribution

Aguiguan only; recently extirpated on Guam, Rota, and Saipan; prehistorically occurred on Tinian; possibly once occurred on Anatahan and Maug

Abundance

Less than 500 globally in 2008

Preferred Habitat

Caves for roosting and nesting; native forest for foraging

Ten-Year Objective

If determined feasible, establish a captive breeding program; achieve at least 3% average annual population growth on Aguiguan

Long-term Objective

>3,000 bats total; a 2nd population established (wild or captive) by 2030

Priority Actions

Forest restoration and enhancement on Aguiguan (i.e. feral goat control, Lantana shrub control, and reforestation); establish a captive population to safeguard against catastrophic events and to serve as a source for future reintroductions;

Other Actions

Advocate for development of a federal recovery plan and team formation

Research Needed

Reintroduction feasibility study; evaluate the utility of new technologies (e.g. thermal imaging, sonic recording) to improve monitoring

Monitoring Needed

Aguiguan population estimates at least once every 5 years

Scientific Name	Class	Chamorro	Carolinian
Pteropus mariannus mariannus	Mammalia	Fanihi	Pai'Scheei


Lainie Zarones, Rota

English	
Mariana Fruit Bat	
Endemism	
Marianas	
Federal ESA Status	IUCN Red List Status
Threatened	Endangered
CNMI Listing Status	
Threatened & Endangered	
Distribution	
Nearly all Mariana Islands (12)	
Abundance	
~5,400 globally	

Preferred Habitat
Native forest
Ten-Year Objective
Stable or increasing population on Rota; reduce # of poaching incidents on Saipan by 50%; achieve 3% average annual population growth on Aguiguan
Long-term Objective
Legal, sustainable availability as a food resource; stable or increasing population overall, and on 3 of 5 southern Marianas, and 6 of 8 northern islands; federal delisting
Priority Actions
Forest restoration and enhancement on Aguiguan; continue existing education, monitoring, and enforcement efforts on Rota; develop a comprehensive poaching reduction program on Saipan including outreach and education, community engagement, and increased enforcement; increase surveys on Saipan to identify colonies and deter poaching
Other Actions
Captive rearing and release; develop a comprehensive poaching reduction program for Aguiguan/Tinian; increase surveys on Tinian to identify colonies and deter poaching;
Research Needed
Evaluate Rota harvest feasibility including a comparison of farm raising vs. hunting alternatives;
Monitoring Needed
Island-wide population estimates across northern islands at least once every 10 years; Rota, Saipan, and Tinian surveys at least quarterly; Aguiguan survey at least annually; ongoing recording of conservation enforcement responses to poaching incidents

Scientific Name	Class	Chamorro	Carolinian
Emoia atrocostata	Reptilia	Achi'ak	

Bjorn Lardner, Guam

English	Littoral Skink
Endemism	Marianas
Federal ESA Status	None
IUCN Red List Status	Least Concern
CNMI Listing Status	None
Distribution	Tropical western Pacific; within CNMI, present on southern islands, Alamagan and Guguan; apparently absent from Pagan; status on other northern islands unknown
Abundance	"Reasonably common" at Unai Chulu but absent from other apparently suitable sites on Tinian; one skink caught in 40 trap hours, rocky shoreline habitat, Alamagan, 2000; three caught, 40 trap hours, Guguan, 2000
Preferred Habitat	Rocky shorelines with high energy tide pools
Ten-Year Objective	Maintain known distribution; collect information to refine the objective
Long-term Objective	
Priority Actions	Prevent spread of Curious Skink (Carlia ailanpalai) to new islands; determine abundance and distribution across all islands
Other Actions	
Research Needed	Evaluate the threat posed by Curious Skink; conduct genetic analyses to confirm Mariana Islands taxonomic status
Monitoring Needed	Conduct population surveys on northern islands at least once every 10 years and on southern islands at least once every 5 years

Scientific Name	Class	Chamorro	Carolinian
Emoia slevini	Reptilia	Achi'ak	

Lainie Zarones, Sarigan

English	
Mariana Skink	
Endemism	
Marianas	
Federal ESA Status	**IUCN Red List Status**
Endangered	Critically Endangered
CNMI Listing Status	
None	
Distribution	
Known present on Alamagan, Asuncion, Guguan, Pagan, and Sarigan; status unknown on Agrigan, Noos, Maug, and Uracas; extirpated from southern islands	

Abundance

Unknown on all islands except Pagan, where it is apparently extremely rare if not extirpated (Reed et al 2011)

Preferred Habitat

Native forest

Ten-Year Objective

Maintain known island distribution; collect information to refine the objective

Long-term Objective

Species recovery and federal delisting

Priority Actions

Determine the abundance and distribution across all islands

Other Actions

Control feral ungulates on Alamagan and Pagan; advocate for development of a federal recovery plan and team

Research Needed

Assess the status of non-native predators on occupied islands and islands with potential for reintroduction or translocation; conduct genetic analyses to confirm taxonomic status of Mariana populations; collect basic life history information, i.e. reproduction, habitat requirements, etc.

Monitoring Needed

Abundance estimates on occupied islands at least once every ten years

Scientific Name	Class	Chamorro	Carolinian
Perochirus ateles	Reptilia	Guali'ek	Galuuf

English	
Micronesian Gecko	
Endemism	
Micronesia	
Federal ESA Status	IUCN Red List Status
None	Endangered
CNMI Listing Status	
Threatened & Endangered	
Distribution	
Western Micronesia; in the CNMI, present on Rota, Tinian, and Saipan	

Abundance

Rare on Tinian (only one individual seen during relatively intense surveys on military lease lands in 2008); unknown on Rota and Saipan

Preferred Habitat

Native forest in the Marianas, although it occupies a broader range of habitats elsewhere

Ten-Year Objective

Maintain known island distribution; collect information to refine the objective

Long-term Objective

Priority Actions

Prioritize areas on Saipan and Tinian for conservation and management; prevent brown tree snake introduction

Other Actions

Research Needed

Determine abundance and habitat associations on occupied islands; evaluate threats including Oceanic Gecko (Gehyra oceanica); assess the status of Oceanic Gecko and other non-native predators across occupied islands and islands with potential for translocation; conduct genetic analyses to confirm taxonomic status of Marianas populations

Monitoring Needed

Abundance estimates at least once every 5 years

Scientific Name	Class	Chamorro	Carolinian
Eretmochelys imbricata bissa	Reptilia	Haggan karai	Wong maaw

English

Hawksbill Turtle


David Burdick

Endemism

None

Federal ESA Status	IUCN Red List Status
Endangered	Critically Endangered

CNMI Listing Status

Threatened & Endangered

Distribution

Circumtropical; in the CNMI, associated with southern islands, but little-studied in northern islands

Abundance

Relatively rare; 36 of 642 sea turtle captures made between 2006-2014 were hawksbills; no hawksbills were recorded nesting during the same period

Preferred Habitat

Coral reef areas for foraging and resting

Ten-Year Objective

Maintain extent and quality of foraging habitat

Long-term Objective

Federal delisting

Priority Actions

Map foraging habitat

Other Actions

Research Needed

Conduct genetic analyses to measure degree of isolation of the Marianas population; use satellite tagging to investigate migration patterns

Monitoring Needed

Develop and implement a habitat monitoring program

Scientific Name	Class	Chamorro	Carolinian
Chelonia mydas	Reptilia	Haggan	Wong mool

English

Green Sea Turtle

Endemism

Marianas*

Federal ESA Status	IUCN Red List Status
Proposed Endangered	Endangered

CNMI Listing Status

Threatened & Endangered

Distribution

Within CNMI, primarily associated with southern islands, but little-studied in northern islands; *based on Dutton et al. 2014, the Marianas host a distinct genetic stock

Abundance

>7 females/year nested on Saipan, Tinian, and Rota from 2006-2014 (other islands not surveyed); about 500 in-water captures of mostly juvenile turtles during same period

Preferred Habitat

Sandy beaches for nesting; coral reef areas for foraging and resting

Ten-Year Objective

Maintain suitability of all current nesting beaches; reduce poaching incidents by 50%; maintain extent and quality of foraging habitat

Long-term Objective

Have cultural take authorized; federal delisting

Priority Actions

Continue and expand outreach, education, and enforcement to reduce poaching; establish a community-based wildlife advisory board and implement appropriate management recommendations; map and quantify the extent and quality of foraging areas around the southern islands; continue nest monitoring to track nesting success and deter poaching; work with DPL and regulatory agencies to maintain nesting beach suitability

Other Actions

Re-structure the DLNR sea turtle program to be more responsive to the needs and concerns of the CNMI

Research Needed

Tag nesting females to determine migratory routes and destinations outside of nesting periods

Monitoring Needed

Continue annual nest monitoring on Rota, Saipan, and Tinian

Scientific Name	Class	Chamorro	Carolinian
Tripneustes gratilla	Echinoidea	Laun	Larr

English

Collector Urchin

Endemism

None

Federal ESA Status	IUCN Red List Status
None	Not Assessed

CNMI Listing Status

None

Distribution

Indo-West Pacific from East Africa to the Hawaiian Islands, except the Arabian Gulf, Pakistan and western India; within the CNMI, known in Saipan Lagoon; elsewhere unknown

Abundance

Unknown, but anecdotally reported formerly more common in Saipan Lagoon; 10-15 individuals detected in 21 person-hrs on one transect in Tanapag Lagoon in 2001

Preferred Habitat

Seagrass beds; rocky substrata

Ten-Year Objective

Maintain or increase abundance on Saipan; collect baseline information needed to refine the objective

Long-term Objective

Priority Actions

Determine abundance and specific habitat associations in areas accessible and inaccessible to harvest on Saipan

Other Actions

Research Needed

Assess potential species-specific impacts of land-based sources of pollution; evaluate potential harvest impacts

Monitoring Needed

Develop and implement a monitoring protocol

Scientific Name	Class	Chamorro	Carolinian
Birgus latro	Malacostraca	Ayuyu	Lyaf

English

Coconut Crab

Endemism

None

Federal ESA Status	IUCN Red List Status
None	Data Deficient

CNMI Listing Status

None

Distribution

Indo-West Pacific islands; within CNMI, most islands (11)

Abundance

Pagan catch per unit effort (CPUE) 0.004 in 2010; Aguiguan 0.20 in 2006; Tinian 0.03-0.11 in 2007; elsewhere unknown

Preferred Habitat

Forest within 6 km of ocean

Ten-Year Objective

>0.15 CPUE on all islands where it is present

Long-term Objective

Reintroduction to Alamagan

Priority Actions

Create a community-based wildlife advisory board and implement appropriate conservation and management recommendations; reduce poaching through a comprehensive program of outreach, education, and enforcement

Other Actions

Reintroduction on Alamagan following feral ungulate/pig control

Research Needed

Monitoring Needed

Population monitoring on southern islands at least annually, on northern islands at least every ten years

Scientific Name	Class	Chamorro	Carolinian
Cardisoma carnifex	Malacostraca	Akmangao	

English	
Mangrove Crab	
Endemism	
None	
Federal ESA Status	IUCN Red List Status
None	Not Assessed
CNMI Listing Status	
None	
Distribution	
Tropical Indo-West Pacific; in CNMI, known from Saipan, elsewhere unknown	


Lainie Zarones, Saipan

Abundance	Unknown, but anecdotally formerly more common on Saipan
Preferred Habitat	Mangroves and other moist to wet coastal habitats
Ten-Year Objective	Maintain or increase abundance on Saipan; collect baseline information needed to refine the objective
Long-term Objective	
Priority Actions	Determine abundance and specific habitat associations in areas accessible and inaccessible to harvest; map current distribution on Saipan
Other Actions	
Research Needed	Evaluate potential harvest impacts
Monitoring Needed	Develop and implement a monitoring protocol

Scientific Name	Class	Chamorro	Carolinian
Panulirus spp.	Malacostraca	Mahonggang	Yuurr

English

Spiny Lobsters

Endemism

None

Federal ESA Status	IUCN Red List Status
None	Least Concern

CNMI Listing Status

None

Distribution

Circumtropical and subtropical; in CNMI, P. penicillatus is presumed across all islands. The island distribution of P. versicolor and P. longipes bispinosus is unknown.

Panulirus pencillatus, John Fraser

Abundance

Within the CNMI, P. penicillatus is the most abundant species, comprising nearly all of the commercial catch. P. versicolor is very uncommon, and P. longipes bispinosus extremely rare. In-water abundance is unknown.

Preferred Habitat

Shallow, subtidal zone of reef slopes or rocky bottoms with clear water and high-energy waves (P. penicillatus); reef flats (P. longipes); exposed reef slopes to ~15m depth (P. versicolor) (Briones-Fourzan and Lozano-Alvarez 2013)

Ten-Year Objective

Maintain or increase abundance across Saipan, Tinian, and Rota; collect baseline information needed to refine the objective

Long-term Objective

Priority Actions

Determine abundance and distribution in areas accessible and inaccessible to harvest

Other Actions

Improve enforcement of harvest regulations

Research Needed

Assess potential species-specific impacts of land-based sources of pollution; evaluate potential species-specific harvest impacts; determine the distribution, presence, and relative abundance of spiny lobster species across the CNMI

Monitoring Needed

Ongoing monitoring of commercial catch; develop and implement a biological monitoring protocol

Scientific Name	Class	Chamorro	Carolinian
Vagrans egistina	Insecta		

English

Mariana Wandering Butterfly

Endemism

Marianas

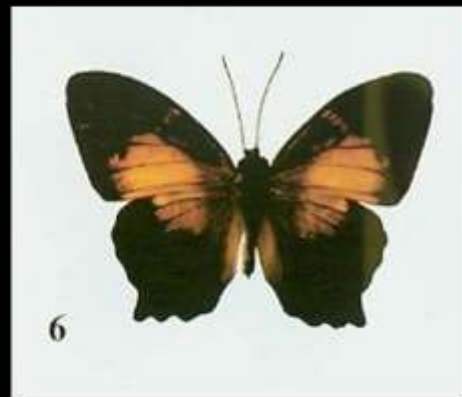
Federal ESA Status	IUCN Red List Status
Endangered	Not Assessed

CNMI Listing Status

None

Distribution

Formerly Guam and Rota



Reprinted from Schreiner and Nafus, "Butterflies of Micronesia"

Abundance

Possibly extinct; last seen on Guam in 1979; last seen at the I Chenchon Bird Sanctuary on Rota in 1995 (7 adult males)

Preferred Habitat

Requires host plant luluhut (Maytenus thompsonii), a forest understory shrub which is relatively abundant on Rota

Ten-Year Objective

Determine status on Rota

Long-term Objective

Priority Actions

Conduct intensive surveys of host plant populations across Rota to determine current status, then plan actions accordingly

Other Actions

Research Needed

Monitoring Needed

Scientific Name	Class	Chamorro	Carolinian
Ischnura luta	Insecta		

English	
Rota Damselfly	
Endemism	
Rota	

Federal ESA Status	IUCN Red List Status
Endangered	Not Assessed

Lainie Zarones, Rota

CNMI Listing Status
None
Distribution
Known from two streams in the Talakhaya watershed of Rota
Abundance
Unknown
Preferred Habitat
Freshwater streams
Ten-Year Objective
Maintain known stream habitat; collect information to refine the objective
Long-term Objective
Federal delisting
Priority Actions
Conduct comprehensive population and habitat surveys on Rota and Saipan to determine presence, abundance, distribution, and habitat associations
Other Actions
Research Needed
Monitoring Needed
Develop and implement population and habitat monitoring protocols

Scientific Name	Class	Chamorro	Carolinian
Tridacna spp.	Bivalvia	Hima	Tto/Shafeshaf

English

Native Giant Clams

Endemism

None

Federal ESA Status	IUCN Red List Status
None	

CNMI Listing Status

None

Distribution

Indo-Pacific. In CNMI, T. maxima and T. squamosa are presumed to occur across all islands.

Tridacna squamosa, David Burdick

Abundance

Highest density at Maug (0.405/100m2) in 2003, 2005, and 2007 NOAA-sponsored surveys; lowest density at Anatahan (0.004/100m2) due to ash from 2003 eruption; next lowest densities on inhabited southern islands

Preferred Habitat

Associated with coral reefs to ~20m depth. Species-specific habitat preferences within the CNMI are unknown.

Ten-Year Objective

Stable or increasing abundance on Saipan; collect information needed to refine the objective

Long-term Objective

Priority Actions

Determine abundance and distribution in areas accessible and inaccessible to harvest

Other Actions

Encourage publication of more recent NOAA monitoring results

Research Needed

Assess potential species-specific impacts of land-based sources of pollution; evaluate potential harvest impacts; determine connectivity of Saipan population with other populations

Monitoring Needed

Monitor abundance on Saipan at least once every five years

Scientific Name	Class	Chamorro	Carolinian
Gafrarium pectinatum	Bivalvia	Tapon/Amsun	Ai'mett/Ghatil

English

Pectinate Venus

Endemism

None

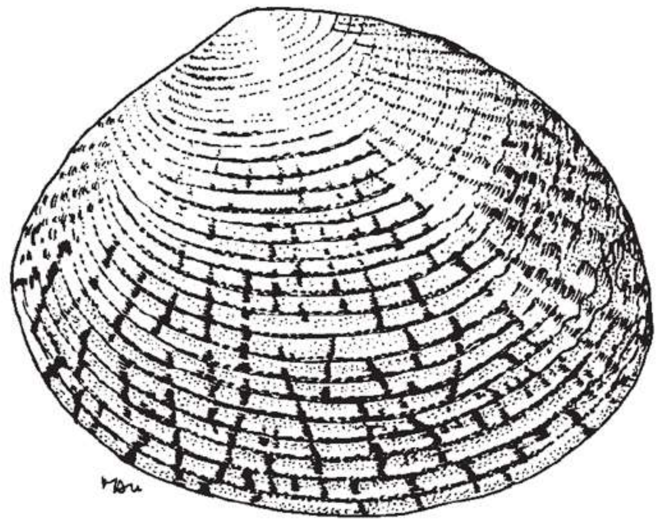
Federal ESA Status	IUCN Red List Status
None	Not Assessed

CNMI Listing Status

None

Distribution

Indo-West Pacific; within CNMI, primarily Saipan Lagoon



FAO

exterior of left valve

Abundance

Unknown

Preferred Habitat

Sandy bottoms; intertidal and shallow sublittoral waters to a depth of about 20 meters

Ten-Year Objective

Maintain or increase abundance in Saipan Lagoon; collect baseline information needed to refine the objective

Long-term Objective

Priority Actions

Determine abundance and specific habitat associations in areas accessible and inaccessible to harvest

Other Actions

Research Needed

Evaluate potential harvest impacts; assess potential impacts of land-based sources of pollution; determine taxonomic status and connectivity of Saipan population with others

Monitoring Needed

Develop and implement a monitoring protocol

Scientific Name	Class	Chamorro	Carolinian
Octopus cyanea	Cephalopoda	Gamson	Ghuus

English	
Day Octopus	
Endemism	
None	
Federal ESA Status	**IUCN Red List Status**
None	Not Assessed
CNMI Listing Status	
None	
Distribution	
Tropical Indo-Pacific; within CNMI, presumably all islands	

Abundance

Unknown, but commonly harvested

Preferred Habitat

Coral reefs, reef flats, and other rocky substrata to depths of 50 meters

Ten-Year Objective

Maintain or increase abundance on Saipan; collect baseline information needed to refine the objective

Long-term Objective

Priority Actions

Determine abundance and specific habitat associations in areas accessible and inaccessible to harvest

Other Actions

Research Needed

Evaluate potential harvest impacts

Monitoring Needed

Develop and implement a monitoring protocol

Scientific Name		Class	Chamorro	Carolinian
Cassis cornuta		Gastropoda	Do'gas prensa	Mwe'ell
English				
Horned Helmet				
Endemism				
None				
Federal ESA Status	IUCN Red List Status			
None	Not Assessed			
CNMI Listing Status				
None				
Distribution				
Indo-West Pacific; within CNMI, known from Saipan; elsewhere, unknown				

Didier Descouens

Abundance

Unknown

Preferred Habitat

Colonial in coral reef areas, sand and coral rubble bottoms, depths of 2-30 meters.

Ten-Year Objective

Maintain or increase abundance on Saipan; collect baseline information needed to refine the objective

Long-term Objective

Priority Actions

Determine abundance and specific habitat associations in areas accessible and inaccessible to harvest

Other Actions

Evaluate the impact of shell collecting

Research Needed

Assess potential species-specific impacts of land-based sources of pollution; evaluate potential impacts of harvest and shell collecting

Monitoring Needed

Develop and implement a monitoring protocol

Scientific Name	Class	Chamorro	Carolinian
Charonia tritonis tritonis	Gastropoda	Kulu	Sa'wi

Attacking crown-of-thorns starfish, Mark Michaels, Rota

English	
Triton's Trumpet	
Endemism	
None	
Federal ESA Status	IUCN Red List Status
None	Not Assessed
CNMI Listing Status	
None	
Distribution	
Tropical Indo-West Pacific; in CNMI, known from Sarigan, Maug and Saipan; elsewhere unknown	
Abundance	
Unknown	

Preferred Habitat

Coral reefs to depth of 30 meters

Ten-Year Objective

Maintain or increase abundance around Saipan; collect baseline information needed to refine the objective

Long-term Objective

Priority Actions

Determine abundance and specific habitat associations in areas accessible and inaccessible to harvest

Other Actions

Research Needed

Assess potential species-specific impacts of land-based sources of pollution; evaluate the potential impacts of harvest and shell collecting

Monitoring Needed

Develop and implement a monitoring protocol

Scientific Name	Class	Chamorro	Carolinian
Lambis lambis	Gastropoda	Toro	Li'yang


male, H. Zell

English	
Common Spider Conch	
Endemism	
None	
Federal ESA Status	IUCN Red List Status
None	Not Assessed
CNMI Listing Status	
None	
Distribution	
Indo-West Pacific; within CNMI, known from southern islands and Maug; other islands, unknown	

Abundance

Unknown

Preferred Habitat

Reef flats; coral-rubble bottoms; mangrove areas;
often occurring as colonies associated with fine red algae on which it feeds

Ten-Year Objective

Maintain or increase abundance on Saipan; collect baseline information needed to refine the objective

Long-term Objective

Priority Actions

Determine abundance and specific habitat associations in areas accessible and inaccessible to harvest

Other Actions

Research Needed

Assess potential species-specific impacts of land-based sources of pollution; evaluate potential impacts of harvest and shell collecting

Monitoring Needed

Develop and implement a monitoring protocol

Scientific Name	Class	Chamorro	Carolinian
Partula gibba	Gastropoda	Dengdeng	

English

Humped Tree Snail

Endemism

Marianas

Federal ESA Status	IUCN Red List Status
Endangered	Critically Endangered

CNMI Listing Status

None

Distribution

Alamagan, Pagan, Saipan, Sarigan, Tinian, and Guam; known from Anatahan, but status following 2003 volcanic eruption unknown; possibly extirpated Aguiguan

Michael Hadfield, American Memorial Park

Abundance

Abundant on Sarigan; two known colonies each on Tinian and Saipan; unknown Alamagan and Anatahan; found on two of 13 forest survey transects on Pagan in 2010

Preferred Habitat

Native or mixed forest with dense, humid understory

Ten-Year Objective

Maintain known distribution across islands; collect baseline information to refine the objective

Long-term Objective

Species recovery and federal delisting

Priority Actions

Prevent extirpation of known colonies on Saipan and Tinian (i.e. using predator/ungulate exclosures, rat trapping, and/or vegetation management); determine abundance, distribution, and habitat associations across all islands, including surveys for additional colonies on Saipan and Tinian; coordinate conservation efforts among CNMI/Tinian agencies, National Park Service on Saipan, and US Navy on Tinian; determine abundance,

Other Actions

Rat eradication on Sarigan; feral ungulate control on Alamagan and Pagan;

Research Needed

Develop a Habitat Suitability Index or other model to predict habitat suitability on southern islands; expand genetic analyses to resolve taxonomy for additional islands (i.e. Alamagan, Anatahan); determine food plants; evaluate threats posed by non-native predators including rats and flatworm Platydemus manokwari

Monitoring Needed

Develop and implement monitoring protocols appropriate for island populations with continuous distributions (i.e. Sarigan) and discrete colonies; conduct colony monitoring on Saipan and Tinian at least annually

Scientific Name		Class	Chamorro	Carolinian
Partula langfordi		Gastropoda	Dengdeng	
English				
Langford's Tree Snail				
Endemism				
Aguiguan				
Federal ESA Status	IUCN Red List Status			
Endangered	Critically Endangered			
CNMI Listing Status				
None				
Distribution				
Aguiguan				

Abundance
Possibly extinct; last observed on Aguiguan in 1996
Preferred Habitat
Native forest with dense, humid understory
Ten-Year Objective
Determine status on Aguiguan
Long-term Objective
Priority Actions
Forest restoration (i.e. goat control) on Aguiguan, followed by intensive searches several years post-restoration
Other Actions
Research Needed
Monitoring Needed

Scientific Name	Class	Chamorro	Carolinian
Partula undescribed species	Gastropoda	Dengdeng	

English	
Rota Partulid Snail	
Endemism	
Rota*	
Federal ESA Status	IUCN Red List Status
None	Not Assessed
CNMI Listing Status	
None	
Distribution	
Rota	

Abundance

At least 3 three colonies; overall declining population trend

Preferred Habitat

Native or mixed forest with a dense, humid understory

Ten-Year Objective

Maintain known colonies; collect information to refine the objective

Long-term Objective

Establish an additional population on a currently partulid-free island

Priority Actions

Conduct surveys for additional colonies including at historical locations; plan and implement protection and enhancement of colonies as appropriate (i.e. ungulate/predator exclosures, rat trapping, and/or vegetation management);

Other Actions

Evaluate the feasibility of captive breeding as a source for reintroduction and translocation; *encourage publication of existing research results that describe Rota-endemic species status; control deer on Rota

Research Needed

Evaluate status of non-native predators on candidate islands for introduction; develop a Habitat Suitability Index or other model to predict habitat suitability; determine food plants; evaluate threats posed by non-native predators including rats and flatworm Platydemus manokwari

Monitoring Needed

Develop and implement a colony monitoring protocol; conduct at least annual colony monitoring

Scientific Name	Class	Chamorro	Carolinian
Samoana fragilis	Gastropoda	Dengdeng	

English

Fragile Tree Snail

Endemism

Guam and Rota

Federal ESA Status	IUCN Red List Status
Endangered	Critically Endangered

CNMI Listing Status

None

Distribution

Guam and Rota

Lainie Zarones, Rota

Abundance

One known colony on Rota

Preferred Habitat

Native or mixed forest with dense, humid understory

Ten-Year Objective

Maintain known colonies; collect information to refine the objective

Long-term Objective

Species recovery and federal delisting

Priority Actions

Conduct surveys for additional colonies including at historical locations; plan and implement protection and enhancement of colonies as appropriate (i.e. ungulate/predator exclosures, rat trapping, and/or vegetation management)

Other Actions

Control deer on Rota

Research Needed

Evaluate status of non-native predators on candidate islands for introduction; develop a Habitat Suitability Index or other model to predict habitat suitability; determine food plants; evaluate threats posed by non-native predators including rats and flatworm Platydemus manokwari

Monitoring Needed

Monitor abundance and age structure of colonies at least annually

Scientific Name	Class	Chamorro	Carolinian
Turbo spp.	Gastropoda	Aliling pulan	Lifott maram

English	
Native Turban Snails	
Endemism	
Marianas*	
Federal ESA Status	IUCN Red List Status
None	NA
CNMI Listing Status	
None	
Distribution	
Tropical Pacific; within CNMI, presumably all islands. *Undescribed subspecies of T. petholatus and T. setosus are endemic to the Marianas (G. Paulay, unpublished data).	

Abundance

Unknown, but subjectively considered "common" to "abundant" in 2000

Preferred Habitat

T. argyrostomus: coral reefs and lagoons; T. petholatus: shallow coral reefs and rocky shores, in relatively protected habitats to 40 m depth; T. setosus: shallow coral reefs

Ten-Year Objective

Maintain or increase abundance on Saipan; collect baseline information needed to establish an objective

Long-term Objective

Priority Actions

Determine abundance and specific habitat associations in areas accessible and inaccessible to harvest

Other Actions

Encourage publication of existing research results that clarify Marianas endemic subspecies status of T. petholatus and T. setosus

Research Needed

Assess potential species-specific impacts of land-based sources of pollution; evaluate potential impacts of harvest and shell collecting

Monitoring Needed

Develop and implement a monitoring protocol

Scientific Name	Class	Chamorro	Carolinian
Chicoreus ramosus	Gastropoda	Do'gas	Abwel

English

Branched Murex

Endemism

None

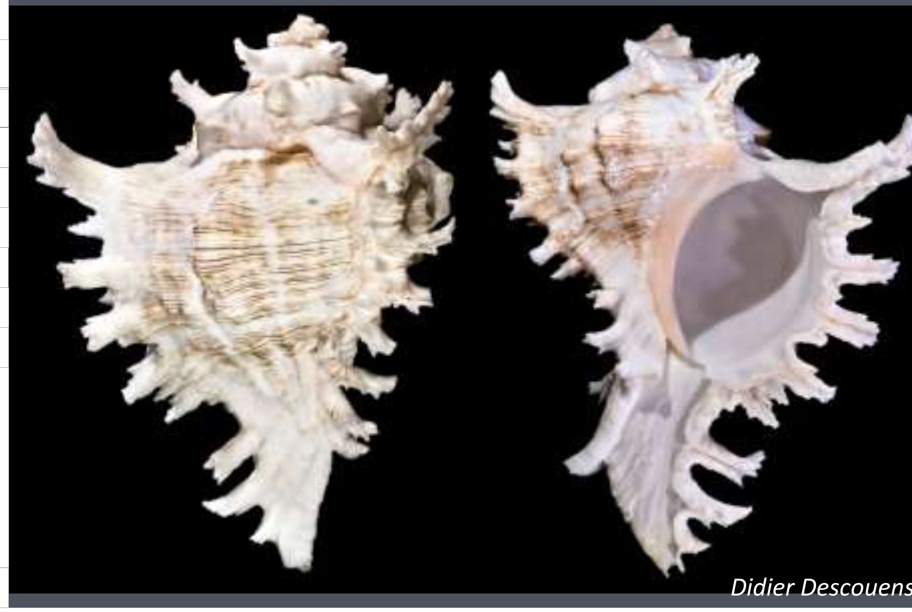
Federal ESA Status	IUCN Red List Status
None	Not Assessed

CNMI Listing Status

None

Distribution

Indo-West Pacific; in CNMI, known from Saipan, elsewhere unknown



Didier Descouens

Abundance

Unknown

Preferred Habitat

Coral reef areas to a depth of 10 meters; often on clean coarse sand and rubble bottoms in which large individuals partially bury themselves

Ten-Year Objective

Maintain or increase abundance on Saipan; collect baseline information needed to refine the objective

Long-term Objective

Priority Actions

Determine abundance and specific habitat associations in areas accessible and inaccessible to harvest

Other Actions

Research Needed

Assess potential species-specific impacts of land-based sources of pollution; evaluate potential impacts of harvest and shell collecting

Monitoring Needed

Develop and implement a monitoring protocol

Scientific Name	Class	Chamorro	Carolinian
Acropora globiceps	Anthozoa	Kuraling	Yeal

English	
A Coral (1)	
Endemism	
None	
Federal ESA Status	IUCN Red List Status
Threatened	Vulnerable
CNMI Listing Status	
None	
Distribution	
From the west Pacific to the central Pacific as far east as the Pitcairn Islands; within CNMI, known from southern islands; northern island distribution unknown	

David Burdick

Abundance
Tens of millions of colonies globally; unknown CNMI
Preferred Habitat
Upper reef slopes and reef flats, 0-8 meter depth
Ten-Year Objective
Maintain or increase abundance and distribution across CNMI; collect baseline information needed to refine the objective
Long-term Objective
Federal delisting
Priority Actions
Determine distribution and abundance across the CNMI
Other Actions
Research Needed
Assess potential species-specific impacts of land-based sources of pollution; evaluate feasibility of propagation and seeding
Monitoring Needed
Develop and implement a species-specific monitoring protocol

Scientific Name	Class	Chamorro	Carolinian
Acropora retusa	Anthozoa	Kuraling	Yeal

English	
A Coral (2)	
Endemism	
None	
Federal ESA Status	IUCN Red List Status
Threatened	Vulnerable
CNMI Listing Status	
None	
Distribution	
From the Red Sea and the Indian Ocean to the central Pacific; within CNMI, unknown	

Abundance	Millions of colonies globally; unknown in the CNMI
Preferred Habitat	Upper reef slopes, reef flats, and lagoons, 1-5 meter depth
Ten-Year Objective	Maintain or increase abundance and distribution across CNMI; collect baseline information needed to refine the objective
Long-term Objective	Federal delisting
Priority Actions	Determine distribution and abundance across the CNMI
Other Actions	
Research Needed	Assess potential species-specific impacts of land-based sources of pollution; evaluate feasibility of propagation and seeding
Monitoring Needed	Develop and implement a species-specific monitoring protocol

Scientific Name	Class	Chamorro	Carolinian
Seriatopora aculeata	Anthozoa	Kuraling	Yeal

English	
A Coral (3)	
Endemism	
None	
Federal ESA Status	IUCN Red List Status
Threatened	Vulnerable
CNMI Listing Status	
None	
Distribution	
From the west Pacific to the central Pacific as far east as the Pitcairn Islands; within the CNMI, unknown	

Abundance

10s of millions of colonies globally; unknown in the CNMI

Preferred Habitat

Reef slopes and reef flats, 0-8 meters depth

Ten-Year Objective

Maintain or increase abundance across the CNMI; collect baseline information needed to refine the objective

Long-term Objective

Federal delisting

Priority Actions

Determine distribution and abundance across the CNMI

Other Actions

Research Needed

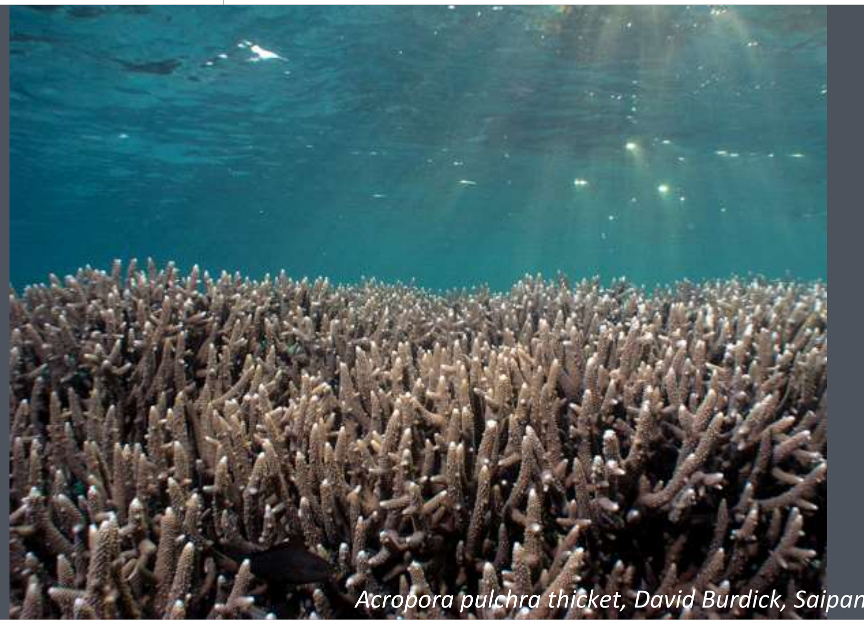
Assess potential species-specific impacts of land-based sources of pollution; evaluate feasibility of propagation and seeding

Monitoring Needed

Develop and implement a species-specific monitoring protocol

Scientific Name	Class	Chamorro	Carolinian
Acropora spp.	Anthozoa	Kuraling	Yeal

English	
All Staghorn Corals	
Endemism	
None	
Federal ESA Status	IUCN Red List Status
NA	NA
CNMI Listing Status	
NA	
Distribution	
Tropical and sub-tropical waters worldwide; throughout CNMI	



Acropora pulchra thicket, David Burdick, Saipan

Abundance	Many millions of colonies globally; in CNMI, abundant across southern islands, but cover has declined ~85% since 2013 (L. Johnston, pers comm). Less common in northern islands.
Preferred Habitat	Clear shallow waters with moderate to high wave energy, high oxygen concentration, and good light penetration
Ten-Year Objective	Maintain existing staghorn coral cover in southern islands; collect information needed to refine the objective
Long-term Objective	
Priority Actions	Develop a coral propagation and reef restoration program; prioritize sites and implement appropriate conservation and management
Other Actions	
Research Needed	Assess potential impacts of land-based sources of pollution; evaluate potential impacts of fish harvest on reef resilience.
Monitoring Needed	Continue existing coral monitoring program

9 PARTICIPATION

9.1 PURPOSE

The CNMI Wildlife Action Plan is intended to reflect broad input from the public, resource users, government agencies, non-governmental organizations (NGOs), biological experts, and other stakeholders. Each brings a different perspective on our conservation priorities, threats, and actions that should be taken. We used a variety of approaches to engage each of these stakeholder groups, and incorporated their input into the final Plan.

9.2 METHODS

9.2.1 Public

Starting in May 2014, DFW staff engaged in many one-on-one and small group interviews with individuals about the CNMI's conservation priorities and challenges. These informal conversations are an incredibly useful method of gathering useful insights into public opinion about conservation priorities and challenges, but need to be supplemented to find out whether the opinions offered could be generalized beyond that individual or small group.

Accordingly, we conducted public meetings on Tinian, Saipan, and Rota on the June 1, 2, and 4, 2015, respectively. A followup public meeting was held on Rota on November 12, 2015 and a drop-in Q&A session was held on Tinian December 3, 2015 during the formal public comment period for the draft Wildlife Action Plan.

The initial public meetings were designed for open-ended discussion about the CNMI's highest conservation priorities. The followup sessions were more structured, with an overview of the draft 2015 Wildlife Action Plan and an opportunity for discussion of specific concerns about the Plan. A followup meeting was not held on Saipan as the island residents were focused on rebuilding and recovery following Typhoon Soudelor on August 2nd.

Only a limited number of people can be reached through interviews or public meetings, and these might not be representative of broad public opinion. We therefore broadened our reach to include residents that might not have interest in participating in a public meeting, but who nonetheless have valuable input to offer regarding conservation issues. Between May 22nd and November 6th, 2015, a written and online survey was conducted to gauge broad public opinion about CNMI conservation issues. Participants were asked their opinion about the biggest conservation challenges that the CNMI is facing, and their ideas for actions that should be taken.

9.2.2 Government

In May 2015, we invited via letter the Governor, the island Mayors, the Senate President, and House Speaker to participate in the planning process. In June 2015, DFW staff met with the

Rota Mayor and DLNR Director to gather input in the planning process, and followed up with a meeting with the DLNR Director in November. Similar meetings were held with the Tinian Mayor's Chief of Staff and DLNR Director in June and December 2015.

DFW staff met with the Acting Governor's Chief of Staff in July 2015 and received assistance in organizing a meeting for department heads. On July 30, 2015, an overview of the plan process and a draft list of SGCN were presented for discussion. Office and agencies that participated included the Governor's Office, Lt. Governor's Office, Department of Public Safety, Mariana Visitors Authority, Historical Preservation Office, Department of Public Works, and Department of Fire and Emergency Management Services.

The July 30th meeting was intended to be a preliminary meeting to prepare for a day-long workshop with agency personnel to gather agency input for the Plan. The workshop scheduled for August 6, 2015 had to be cancelled in the wake of Typhoon Soudelor, which hit Saipan on August 2nd. Agencies temporarily closed, staff were displaced, and communications were hampered by the lack of power. The state of emergency declared after the typhoon continued through December. With agencies focused on typhoon recovery, re-scheduling of the agency workshop was not possible.

Special efforts were made to reach out to government agencies with conservation mandates. DFW staff met with BECQ leadership in June and July 2014 to discuss the Wildlife Action Plan and process, and to seek support from BECQ staff for the planning process. BECQ staff, especially the Marine Monitoring Team, provided significant input through the planning process. DFW staff also discussed the Wildlife Action Plan with local leadership from the CNMI Division of Forestry, National Park Service, and U.S. Fish and Wildlife Service.

9.2.3 Non-Governmental Organizations

While there are few conservation-oriented NGOs active in the CNMI, DFW staff sought and encouraged their participation.

DFW staff made a presentation at the November 2014 annual APASEEM conference about the Wildlife Action Plan and process, and invited participation. APASEEM shared DFW notices related to the Wildlife Action Plan on their website and Facebook page.

Mariana Islands Nature Alliance (MINA) and the Saipan Fishermen's Association were invited through email, phone, and in person to participate in the planning process. DFW and MINA staff met on May 28, 2015 to discuss MINA's perspectives on conservation issues as related to the Wildlife Action Plan. MINA also shared DFW notices related to the Wildlife Action Plan on their Facebook page.

9.2.4 Formal Comment Period

Upon release of the draft Wildlife Action Plan, an invitation to review the Plan and provide comment was widely advertised. The Plan was made available for download from the DFW website either in full or by chapter. Hard copies of the draft Plan were made available for review at the public libraries on Saipan, Tinian, and Rota, and at the DFW office on Saipan, the Tinian Mayor's Office, and Rota DLNR office.

The formal comment period was open from November 6 to December 6, 2015. The opportunity to provide comment was advertised through paid ads in the Saipan Tribune and Marianas Variety newspapers (print and online), KKMP radio, the DFW website and Facebook page, and through personal invitations to previous participants from the public, regional biological experts, government officials, and NGOs. On November 25, 2015, DFW staff made a presentation and invited comments from students in the Environmental Management course at Northern Marianas College. DFW staff participated in the KKMP morning radio show on Tuesday, Dec 1st to highlight the Plan and invite comments.

In addition to APASEEM, MINA, and the Saipan Fishermen's Association, several other NGOs were personally invited to comment on the draft Wildlife Action Plan during the formal comment period, including the Micronesia Conservation Trust, The Nature Conservancy-Micronesia, Tinian Cattlemen's Association, Pacific Bird Conservation, Marianas Apnea Spearfishing Club and Micronesica Bird Conservation.

9.3 RESULTS

9.3.1 Tinian

The comments of the seven attendees of the Tinian June 1st public meeting and one attendee of the December 3rd drop-in session are summarized below.

Concerns and needs:

- Habitats and populations on Tinian are changing. There seem to be fewer native birds, and more birds eating farmers' fruits. Scarlet gourd and other invasive plants are widespread. I'e' runs are more unpredictable.
- Overharvest/poaching is a problem, including donni sali and coconut crab.
- Corals and fish are not as abundant as in the past.
- Better laws and public education/information are needed.
- Better training opportunities for enforcement personnel are needed.
- Development: The tourism/casino industry is a threat if they initially propose 400 rooms, and then want to expand to 3,000 rooms. Fifty-four acres are leased for a large development project that will have terrestrial and marine impacts. There is no biosecurity plan in place, and the developers want to bring in their own equipment and workers.
- Need to improve biosecurity for invasive species. Policies need to be developed to address increased traffic by military activities.
- Military plans for expansion on Tinian

Species of concern:
Native birds, i'e' (juvenile trevally), Tinian monarch, hiyok (*A. lineatus*), juvenile rabbitfish (*S. spinus/S. argenteus*), donni sali, fanihi, haggan, ayuyu, tiao' (juvenile goatfish/*M. flavolineatus*), atulai (Bigeye Scad/*S. crumenopthalamus*)

Suggested actions:
Education: We need to know our native species, habitats, and ecosystems, and how we benefit from them. School curricula need to incorporate environmental education. Environmental career paths for students need to be available. Our lawmakers need education too.
Regulations and enforcement: We need laws with teeth. Local enforcement is understaffed, and officers need more access to resources and training.
Incentives for conservation: We need economic or other incentives to encourage citizens to use conservation practices.
Biosecurity/invasive species: We need a biosecurity plan. We need to know what invasive species we already have on which islands, including the northern islands.

9.3.2 Saipan

The comments of the five attendees of the Saipan June 2nd public meeting are summarized below.

Concerns:

- Agencies doing conservation work, including BECQ and DFW, lack support from the highest levels in government.
- Marine Protected Area no-take regulations are repeatedly violated.
- "Traditional" harvest practices need to be respected, but we are challenged by our multicultural society where traditional practices vary, and what is "traditional" is not easily defined.

Species of concern:
"Food fish", fanihi, and other traditionally harvested wild foods

Suggested Actions:
Education: We need signage on beaches explaining do's and don'ts. We need more outreach, especially through the public school system, i.e. including environmental education in the school curriculum.
Enforcement: Enforcement is understaffed. Laws and enforcement should be a last resort; we need more positive encouragement/incentives for good stewardship.

9.3.3 Rota

Fourteen people attended the June 4th public meeting, and 9 people attended the November 12th meeting. Comments are summarized below.

Answers, comments, and questions:

- A concern was raised about the effect of individual take restrictions on homestead development and the 20 or so plant species that USFWS is adding to the threatened/endangered species list.
- Does the Wildlife Action Plan address degradation of habitat for species?
- The people of Rota are concerned not only with Rota, but with all the islands in the CNMI. The military's plans to put bombing ranges on Tinian and Pagan limits and reduces options for everyone. One participant stated that he wants to move to Pagan one day.
- The concern was raised that researchers and scientists come to Rota to look at and study their environment without obtaining prior permission or even stating their intent. There is no apparent management of these activities. The results of studies leave with the investigators, and are not shared locally.
- What studies or updates as to the flora and fauna of the CNMI has DFW made? Are there any comprehensive studies of the species in all the CNMI?
- What recent studies or updates are there specifically for Pagan and FDM? What is DFW doing to monitor the military activities at FDM?
- The statement was made that the people of Rota are the most conservation-minded public in the CNMI.
- How is it that USFWS can just come to Rota without the government's knowledge of their presence or intent?
- Can the Wildlife Action Plan state that there is a need to develop regulations to address conservation issues? This pertains to enforcement as well.
- Can DFW provide updates on the status of Wildlife Action Plan accomplishments and activities?
- Can the Wildlife Action Plan call for interagency enforcement? A specific example is DFS acting on unregistered firearms.
- A concern was raised about disproportional assignment of conservation officers. Rota has the most species and yet has low enforcement resources.
- The apportionment of funding is not equitable between municipalities. The lack of monitoring and enforcement was called out as a serious weakness in the conservation effort.
- Data and population numbers of fanihi in conservation areas is needed. There may be sufficient population of fanihi on Rota to allow some level of harvest.
- There is a need to control the population of sali (Micronesian starling), which are a growing agricultural pest. Can this be designated as a game bird? It is edible, and allowing hunting of the species would address the problem.
- Research activities should be by permit, and the permits shared with the local agencies.
- Chachaguak (Mariana swiftlet) is extirpated from Rota. Can it be reintroduced without resulting in another threatened/endangered species listing for Rota that results in land use restrictions?

- A concern was raised that when funding is obtained to address conservation of a species of concern identified in the Wildlife Action Plan, that funding should be used for that specific species and not be mixed with other funds so that it ends up being applied to other species.
- A question was raised about how would the Wildlife Action Plan address surveys which result in a positive trend in a species population. "Would regulations be amended to address these changes?"
- Questions were made on the accomplishments of the previous Wildlife Action Plan and information derived from those activities.
- Discussions were also held on the possibility of the establishment of a national park and the possible ramifications of entering into an agreement with the National Park Service.
- A comment was also made on the lack of communication and collaboration between natural resource agencies and their district counterparts. An emphasis on improved collaboration and communication between CNMI-DFW personnel and DLNR Rota was expressed.
- Medicinal plants are commonly used on Rota according to traditional practices. Conservation of these plants are important. Participants expressed concern that ESA listings could reduce access.

9.3.4 Government

Concerns and suggestions of CNMI government officials generally mirrored those expressed by the public. However, multiple officials also expressed concerns that by identifying species as SGCN in the Wildlife Action Plan, the CNMI could potentially invite attention to species that the USFWS might later consider for ESA listing, which they considered undesirable.

9.3.5 Survey Results

Of the 295 surveys completed, 87% were from Saipan residents, 7% Tinian, and 5% Rota, which roughly represents the distribution of residents across these three islands (see Section 2.4). Most respondents (73%) were not familiar with the previous Wildlife Action Plan. Fishing/hunting/harvest (58%), climate change (57%), and development/zoning (52%) were most frequently identified as the most important issues affecting conservation of our wildlife, lands, and waters.

Survey results also indicated the overwhelming popularity of fishing in the CNMI, as nearly 3/4ths of respondents said that they fish, and nearly a quarter fish at least weekly.

The responses to the open-ended question, "What are your ideas for actions we can take to benefit our wildlife, lands, and waters?" generally echoed the sentiments expressed at public meetings, especially that we need more enforcement and education across our islands.

There were many responses that mentioned fishing within MPAs, but these comments were mixed. Some respondents suggested allowing fishing by local residents within MPAs, while others did not want fishing within MPAs, but instead advocated for increased enforcement to prevent illegal fishing.

9.3.6 Formal Comments

During the formal comment period, written comments were received from 7 individuals or entities. Four were from individuals that had previously participated in the planning process and had received a personal invitation to comment. An additional comment was received from an NGO that had not previously been involved in the planning process but was invited to comment, and the remaining two comments were from individuals that heard about the opportunity to comment through our advertising outreach. All submitted comments were from biologists with extensive Marianas field experience.

Commenters highlighted a variety of grammatical errors and misspellings, suggested many minor changes or additions for clarity, and provided additional pertinent references; nearly all of which were incorporated into the final Plan.

Commenters also made a variety of suggestions or recommendations for additional priorities or actions to take. Some of these had already been brought forward by the public and other partipants in the plan process. Each new recommendation was evaluated to determine if the recommendation significantly contributed to the objectives described in the Plan, and could feasibly be implemented within the next ten years. Most recommendations were integrated into the Plan. Those that were not are described here, with justification. The paraphrased comment or topic is in italics, followed by our response.

Moorhen captive breeding.

We first need a better understanding of the factors limiting moorhen populations before considering captive breeding.

Aga translocation to a northern island.

Experts have previously considered this action, but are concerned that the small size of northern islands may not provide sufficient habitat for a self-sustaining population.

The amount of "intact" (never cleared) native forest should be identified, as it is a highly endangered forest type.

Available vegetation classification data derived from remote sensing techniques do not quantify "intact" native forest, and sometimes do not distinguish between the different types of forest. Such a project would require on-the-ground mapping. While outside the scope of this edition of the plan, we recommend that the next iteration of the Wildlife Action Plan also prioritizes habitats/plant communities of greatest conservation need and develops associated objectives, including mapping and quantifying "intact" native forest.

Cuban slug on Rota.

Meaningful slug control may not be realistic. Efforts will focus on preventing spread of Cuban slug to other islands.

"Protection" for remaining high-quality forest areas on Rota, Saipan, and Tinian.
Creation of additional Conservation Areas is complicated and can be politically challenging. As no government officials or members of the public cited a need for new Conservation Areas, the feasibility of implementation is questionable.

"Food fish" should not be included as a SGCN.
"Food fish" are listed as a SGCN for social/cultural reasons, not biological. In every meeting with the public or government officials, fish were the first species mentioned in discussions, and concerns repeatedly mentioned. It was obvious that their concerns were not for one particular species, but rather that the people continue to have a sustainable food resource.

9.4 Participation Outcomes

9.4.1 Social/Cultural SGCN

The participation process was used to identify SGCN of particular social, economic, or cultural importance. Fanihi, haggan, and ayuyu had been identified as SGCN due to social/cultural importance in 2005, and continued to be mentioned as important today.

Even more frequently than the above species, issues regarding fish and fishing were consistently raised across all islands and in all discussions with the public, NGOs, and government officials. Many different fish species were mentioned, but from the context of discussions, it was clear that individuals were not concerned about a particular fish species, but rather have general concerns that the CNMI continues to support sustainable fisheries. This concern, along with the popularity of fishing as indicated in the public survey, supports the selection of "food fish" as a Species of Greatest Conservation Need. We define "food fish" as any fish species that is harvested for consumption, including but not limited to surgeonfish, jacks, wrasses, emperors, snappers, mullets, goatfish, parrotfish, groupers, and rabbitfish.

9.4.2 Enforcement and Education

Public input throughout the planning process resulted in many actions being added, modified, or priority re-assessed. Across all islands, public participants repeatedly expressed their desire to see stronger enforcement of conservation regulations, and more environmental education, including integration into the public school system curriculum. These suggestions were integrated into the Plan as general goals, and as species-specific objectives when relevant. Implementation will be particularly challenging as funding for enforcement and education has traditionally been limited.

9.4.3 Communication and Coordination

The planning process was a catalyst for DFW staff to initiate discussions with agencies and organizations including Rota and Tinian DLNR, the Division of Forestry, MINA, National Park Service, and others regarding shared conservation goals and interests. The results of these discussions were incorporated into the Plan, but perhaps more importantly, a dialogue was initiated which will greatly facilitate implementation over the next ten years. DFW intends to continue in a coordinating role as we work together to achieve our shared conservation goals.

10 The Next Ten Years

Our goals are lofty, and will require the contributions of many agencies, organizations, and individuals, not just the Division of Fish and Wildlife, if we are to be successful. The Division of Fish and Wildlife will continue to communicate with agencies, organizations, businesses, and the public to ensure that we remain goal-focused and recognize conservation opportunities. DFW communicates with partners and stakeholders through the agency website, social media, press releases, meetings, day-to-day conversations, and soon, an agency newsletter.

DFW will continue to play a coordinating role in Plan implementation, but working primarily behind the scenes. Our conservation partners and partnerships focus on specific projects and issues, rather than the entire Plan. Conservation partners in the CNMI are undertaking actions outlined in the previous and current Wildlife Action Plan, but their purpose is to accomplish a specific conservation goal, not necessarily to "implement the Wildlife Action Plan". Their priorities and actions were included in the Wildlife Action Plan because of their involvement in Plan development, rather than deriving their priorities from the Plan.

The Marianas Avifauna Conservation Working Group is a shining example of a successful issue-oriented partnership for conservation implementation in the CNMI. The partnership grew from mutual interest in conservation of endemic birds, and mutual recognition of a serious threat. The CNMI Division of Fish and Wildlife, Pacific Bird Conservation, the Association of Zoos and Aquariums, and U.S. Fish and Wildlife Service are working together to implement the "Marianas Avifauna Conservation Plan" (MAC Working Group 2014), with the goal of securing long-term persistence of CNMI endemic birds by establishing satellite populations in the northern islands. These populations act as insurance if the non-native predator brown tree snake should ever invade the southern islands.

Starting in 2008, bridled white-eye, golden white-eye, rufous fantail and Mariana fruit-dove populations have been established on Sarigan from five translocations of Saipan and Tinian birds, 2008-2013. To guide future actions, the effectiveness of each translocation has been monitored through periodic bird surveys starting immediately upon release, until monitoring data indicate that the population is established and self-sustaining.

Translocations have been successful, as evidenced by an estimate of Sarigan bridled white-eye population growth from the founder population of 100 birds in 2008-2009 to ~3,000 birds in 2012. In 2015, efforts shifted to Guguan, with the first translocation of Tinian monarch and bridled white-eye from Tinian. Another translocation of monarchs and white-eyes is planned for Guguan in 2016, as well as additional post-translocation monitoring on Sarigan.

Using this partnership as a model for successful conservation implementation, we will maintain, expand, and replicate partnerships and cooperation on other projects and issues of broad concern. Invasive species issues, both interdiction and management, are of interest to many potential partners and may provide focus for new partnerships.

Over the next ten years, we will focus on implementation. We do not plan to revise this Plan prior to 2025, but if changing circumstances dictate that an earlier formal review and revision are needed, we will act accordingly.

In 2020, at the midpoint of the Plan's intended lifespan, DFW will conduct an informal review of outcomes from the first 5 years. We will compile and evaluate monitoring results and new information. We will assess our progress toward Wildlife Action Plan goals and objectives. If progress is unsatisfactory, DFW will coordinate a meeting with relevant partners to discuss barriers to progress and ways we could adapt our approach going forward to 2025.

We anticipate that the next formal review and revision of the Wildlife Action Plan will begin in 2023. We will use the same, proven process that resulted in this 2015 Plan. DFW will hire or designate a Wildlife Action Plan coordinator. The coordinator will inform conservation partners that DFW is initiating an update to the Wildlife Action Plan and invite their participation. DFW will summarize outcomes from the 2015 Plan, including a summary of met and unmet goals and objectives. DFW will work with partners to compile new information on species, habitats and threats. DFW and partners will broadly advertise the opportunity for the public to provide input in the Wildlife Action Plan revision using agency and organization websites and social media pages, press releases, and formal and informal meetings. The coordinator will seek feedback from all stakeholders including DFW staff, conservation partners, and the public regarding perceived strengths and weaknesses of the Wildlife Action Plan over the last ten years, and recommendations for the Plan update. We anticipate a 2-year process to develop a new, 2025 CNMI Wildlife Action Plan.

This planning process, including the resulting document, positions the CNMI for conservation success. We have clearly articulated our goals and objectives, and outlined the actions needed to achieve them. Now let's get to work.

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FIGURES

Figure 1. Location of the Northern Mariana Islands. Reprinted from MAC Working Group 2014.

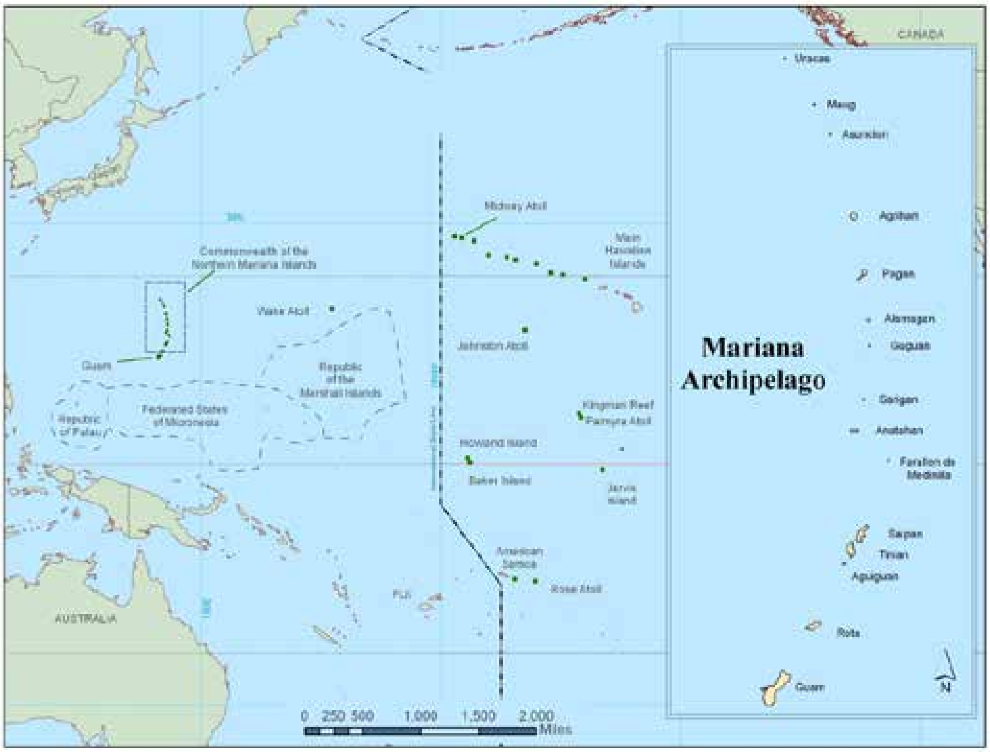


Figure 2. Annual precipitation and temperature pattern in the CNMI. Reprinted from Donnegan et al. 2011.

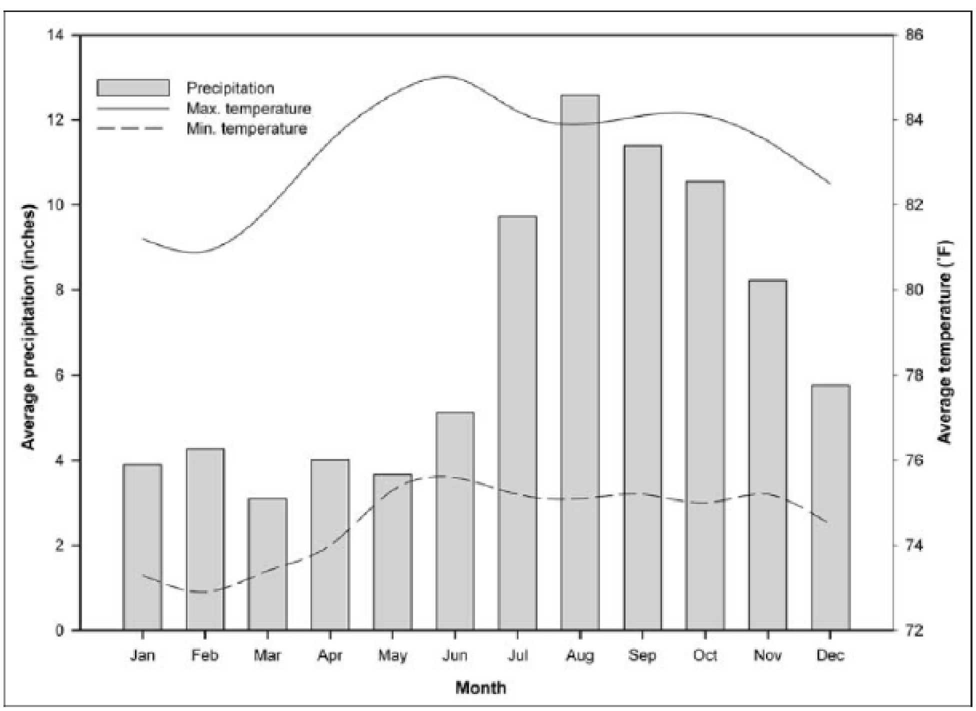


Figure 3. Rota Topography and Protected Areas

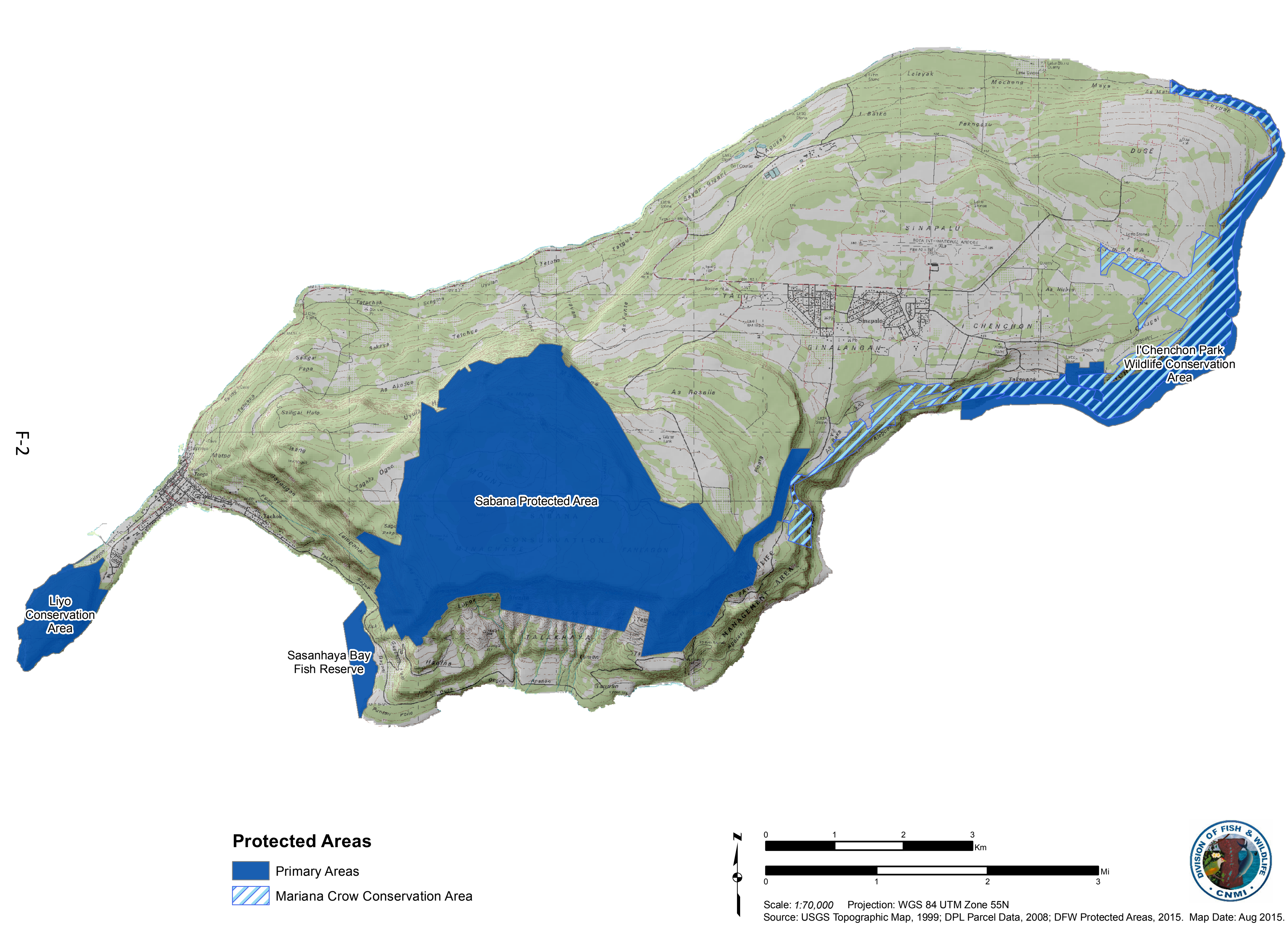


Figure 4. Tinian Topography and Protected Areas

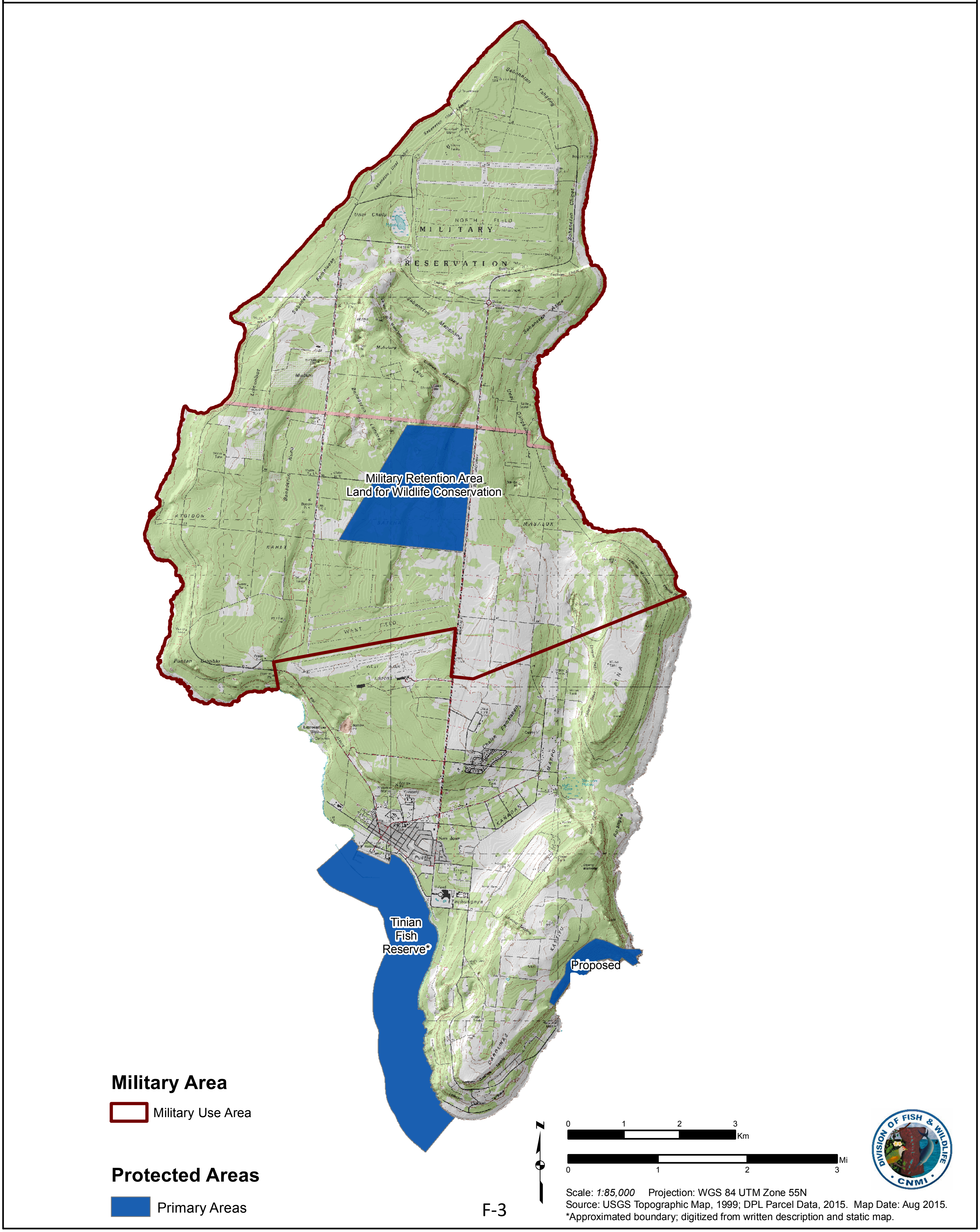


Figure 5. Saipan Topography and Protected Areas

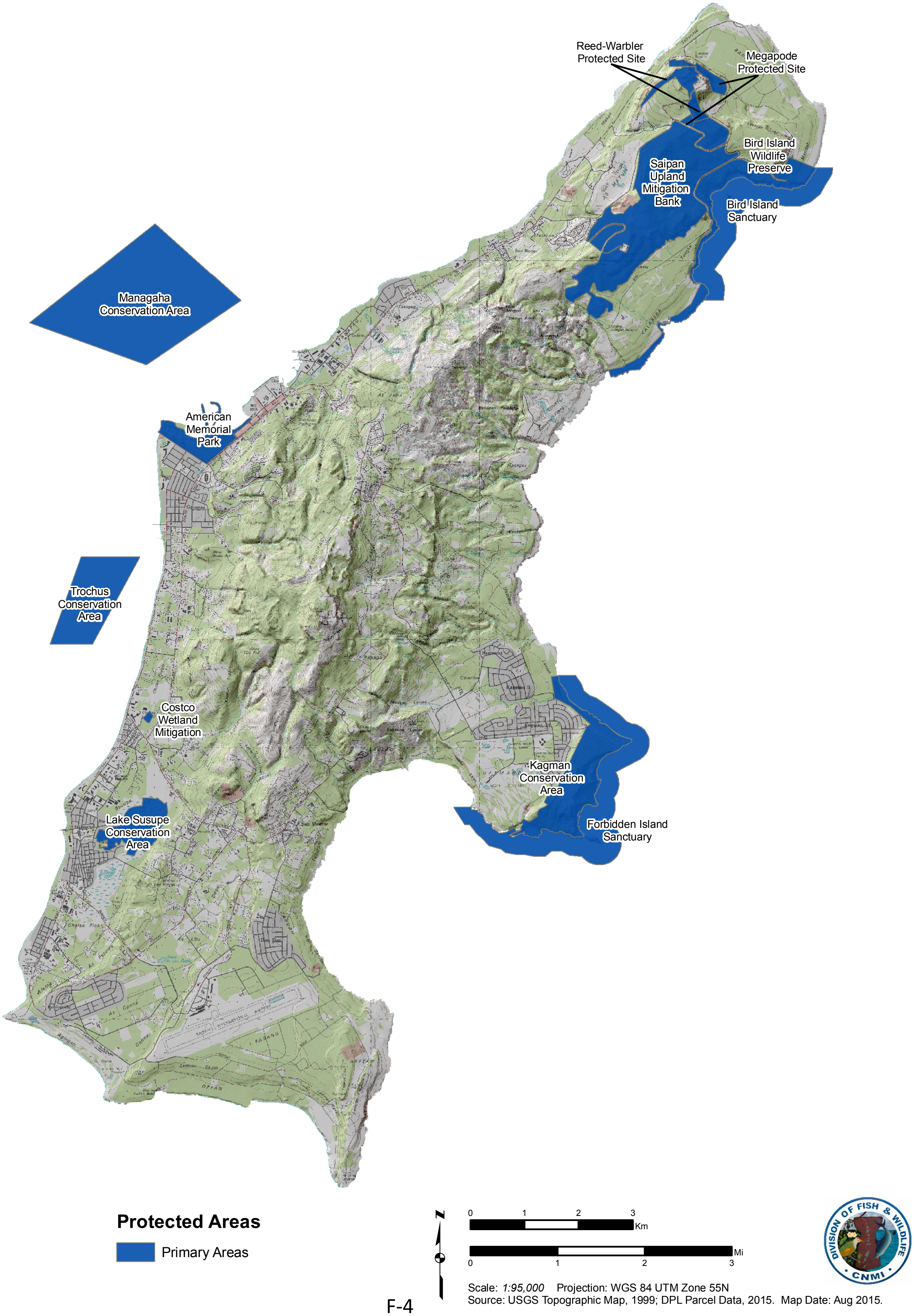


Figure 6. Native forest, Rota. Photo by Isaac Chellman.

Figure 7. Native forest, Sarigan. Photo by Lainie Zarones.

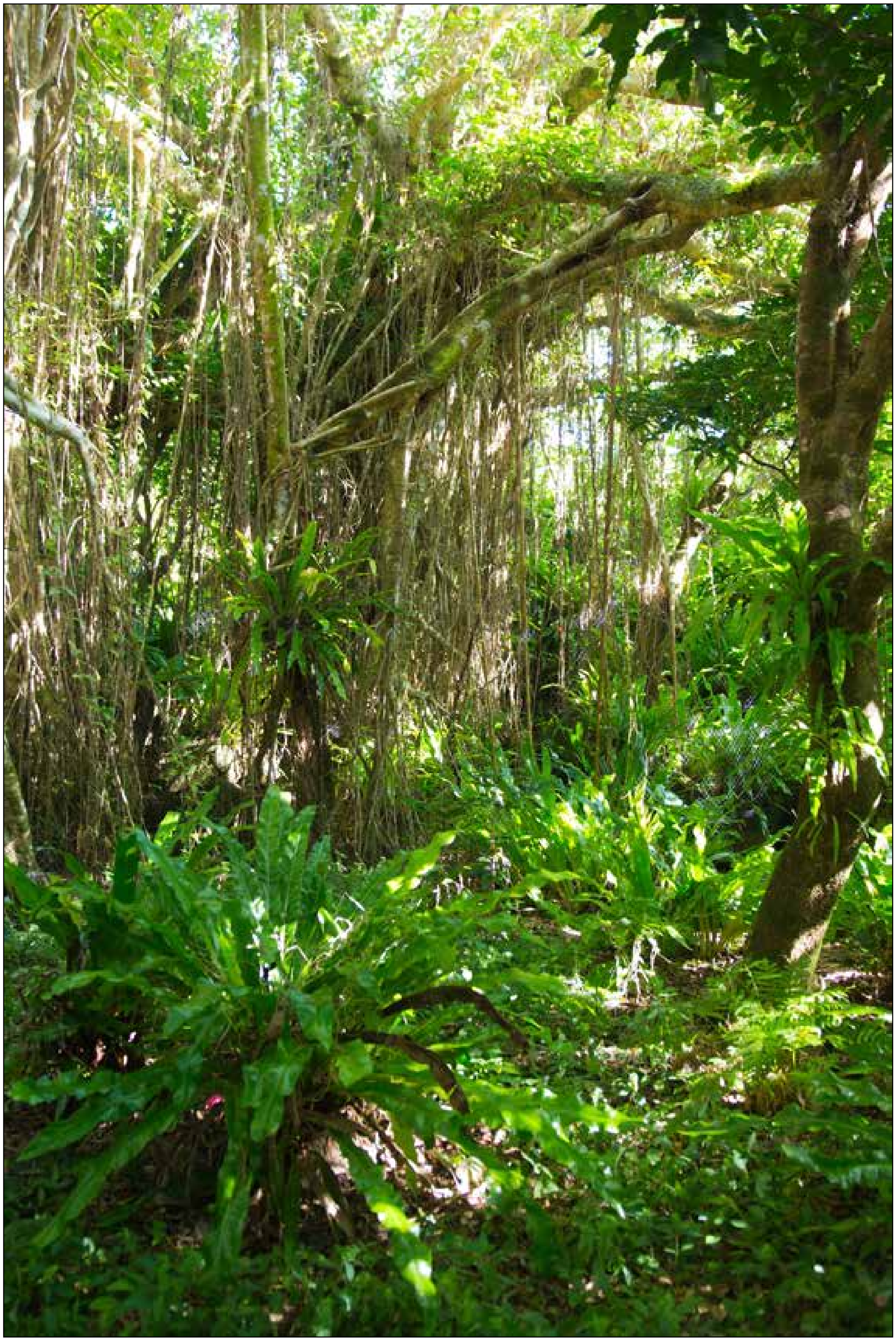


Figure 8. Mixed forest. Photo by Isaac Chellman.

Figure 9. Tangantangan, Tinian.

Figure 10. Agroforest, Tinian. Photo by Michael Constantinides.

Figure 11. Developed habitat, Saipan. Note the scattered trees throughout. Photo by Isaac Chellman.

Figure 12. Tinian pasture, a savannah habitat.

Figure 13. Wetland habitats, Saipan. Top, little egrets at Lake Susupe. Bottom, a typical *Phragmites*-dominated wetland adjacent to Joeten Superstore. Photos by John Fraser.

Figure 14. Man-made wetland, Saipan. Photo by John Fraser.

Figure 15. Rocky shoreline habitat near Forbidden Island, Saipan. Photo by David Burdick.

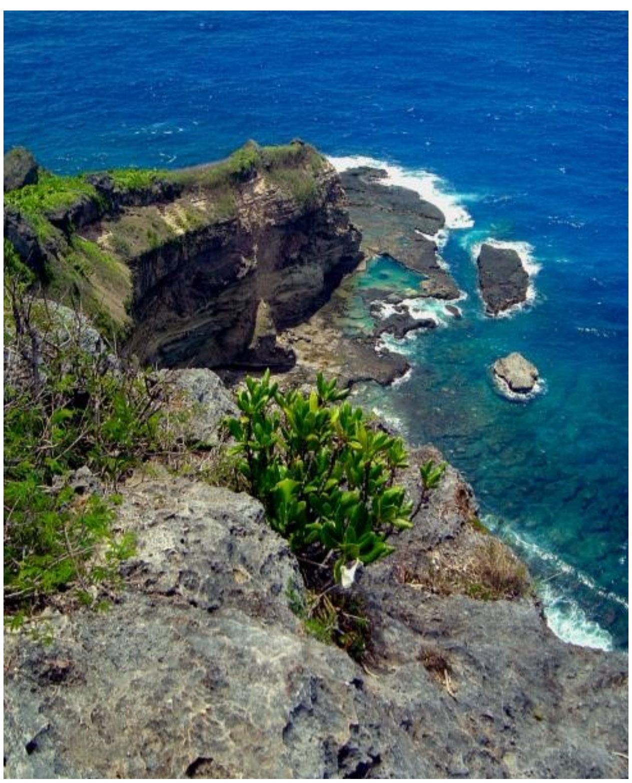


Figure 16. Sandy beach habitat at Obyan Beach, Saipan. Photo by David Burdick.

Figure 17. A narrow band of beachstrand vegetation at Obyan Beach, Saipan. Photo by David Burdick.

Figure 18. Mangrove forest, Lower Base, Saipan. Photo by Lainie Zarones

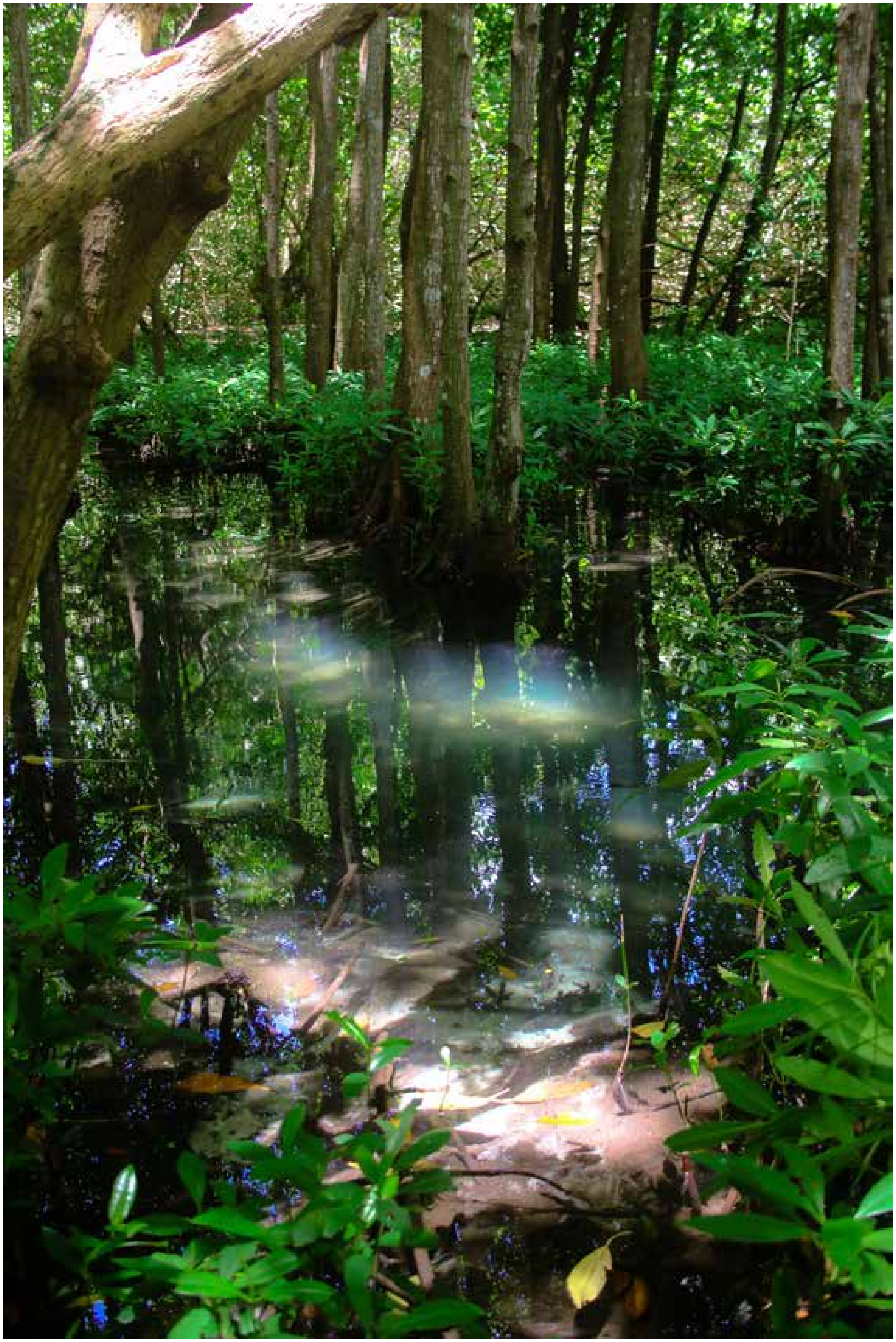
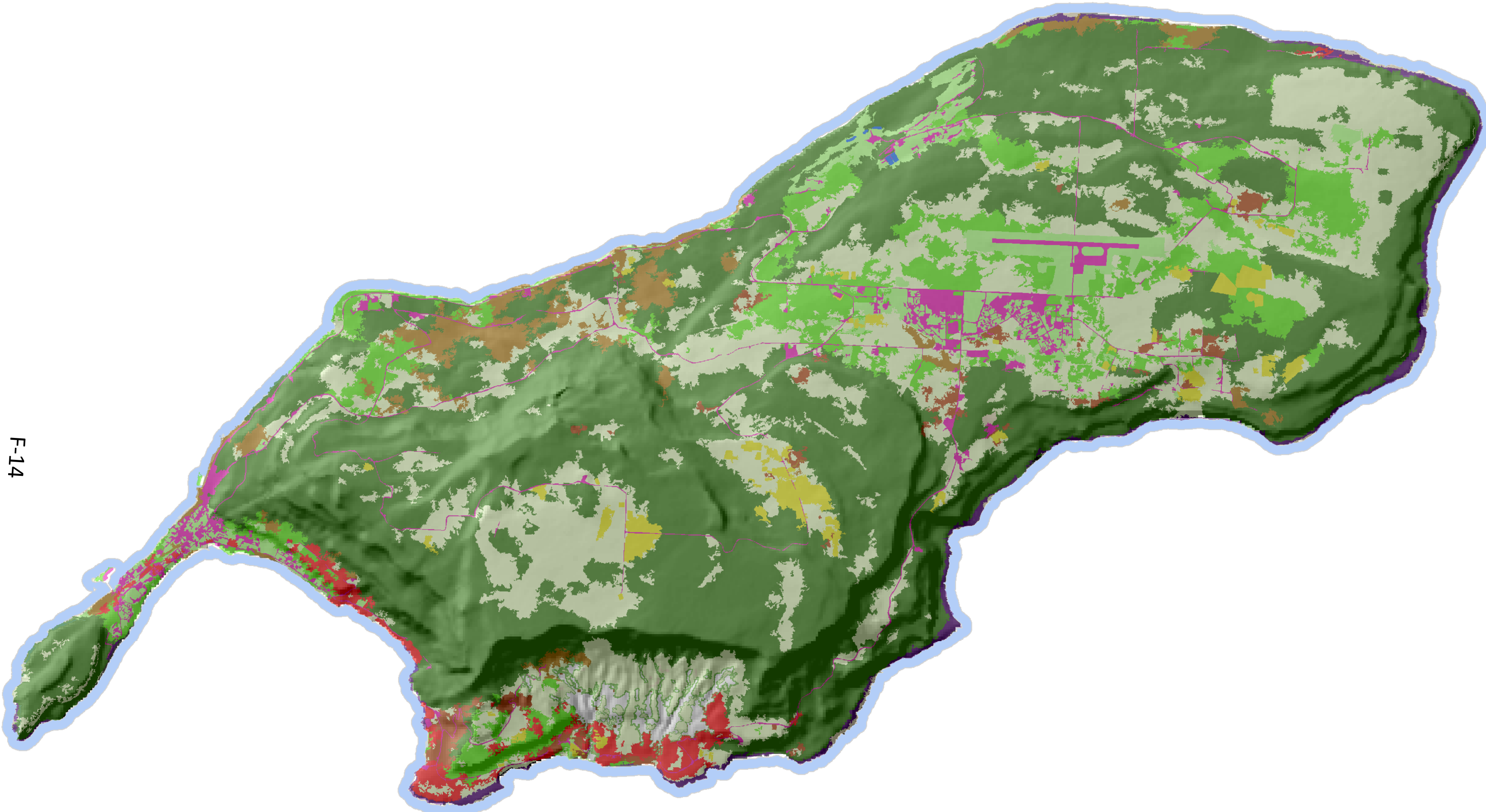


Figure 19. Rota Terrestrial Habitats



Land Cover Classes

- Native Limestone Forest
- Ravine Forest
- Mixed Introduced Forest
- Tangantangan
- Barren/Sandy Beach/Bare Rocks
- Agroforest
- Agroforest -- Coconut
- Cropland
- Strand
- Other Shrub and Grass
- Urban Vegetation
- Urban and Built-up
- Water

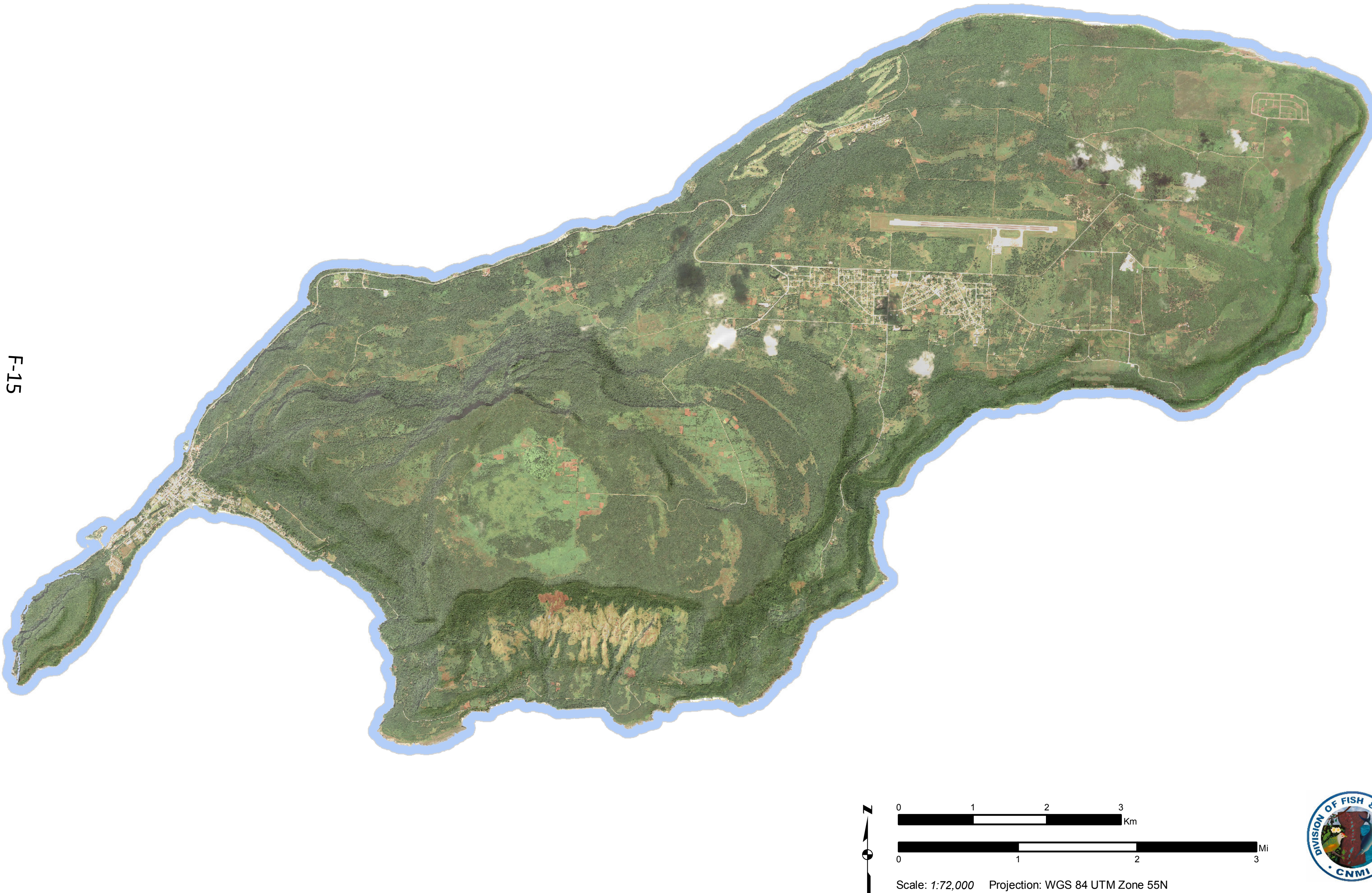
N

0 1 2 3 Km

0 1 2 3 Mi

Scale: *1:70,000* Projection: WGS 84 UTM Zone 55N
Source: USDA Forest Service Rota Vegetation, 2006. Map Date: Aug 2015.

Figure 20. Rota Satellite Imagery

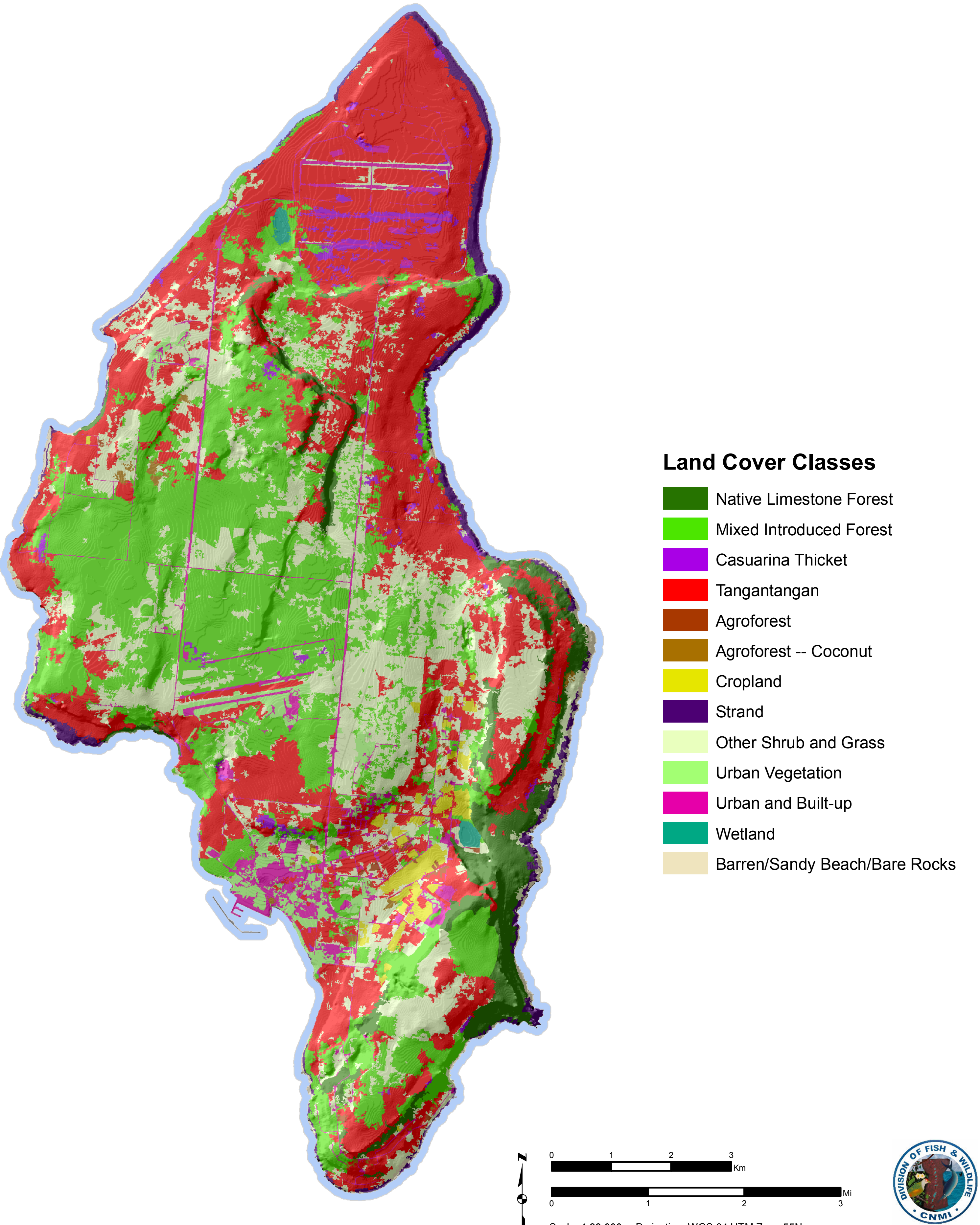


Scale: *1:72,000* Projection: WGS 84 UTM Zone 55N
Source: WorldView-2 Satellite Imagery from USDA, 2014. Map Date: Aug 2015.

Figure 21. Tinian Satellite Imagery

Scale: *1:85,000*   Projection: WGS 84 UTM Zone 55N
Source: WorldView-2 Satellite Imagery from USDA, 2013. Map Date: Aug 2015.

Figure 22. Tinian Terrestrial Habitats



Scale: *1:83,000* Projection: WGS 84 UTM Zone 55N
Source: USDA Forest Service Tinian Vegetation, 2006. Map Date: Aug 2015.

Figure 23. Saipan Terrestrial Habitats

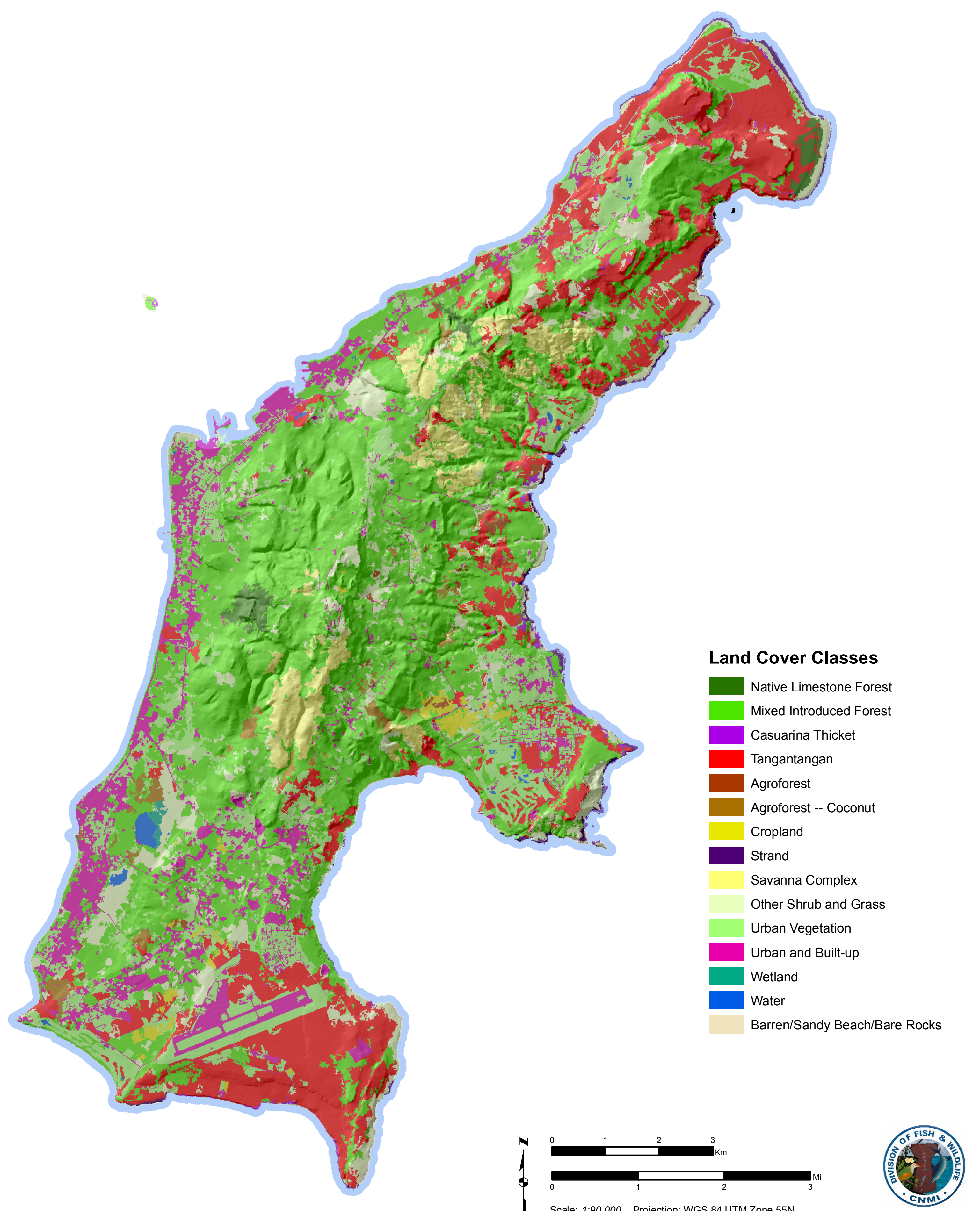


Figure 24. Saipan Satellite Imagery

Scale: *1:90,000* Projection: WGS 84 UTM Zone 55N
Source: WorldView-2 Satellite Imagery from USDA, 2013. Map Date: Aug 2015.

Figure 25. Anatahan Land Cover, 2005

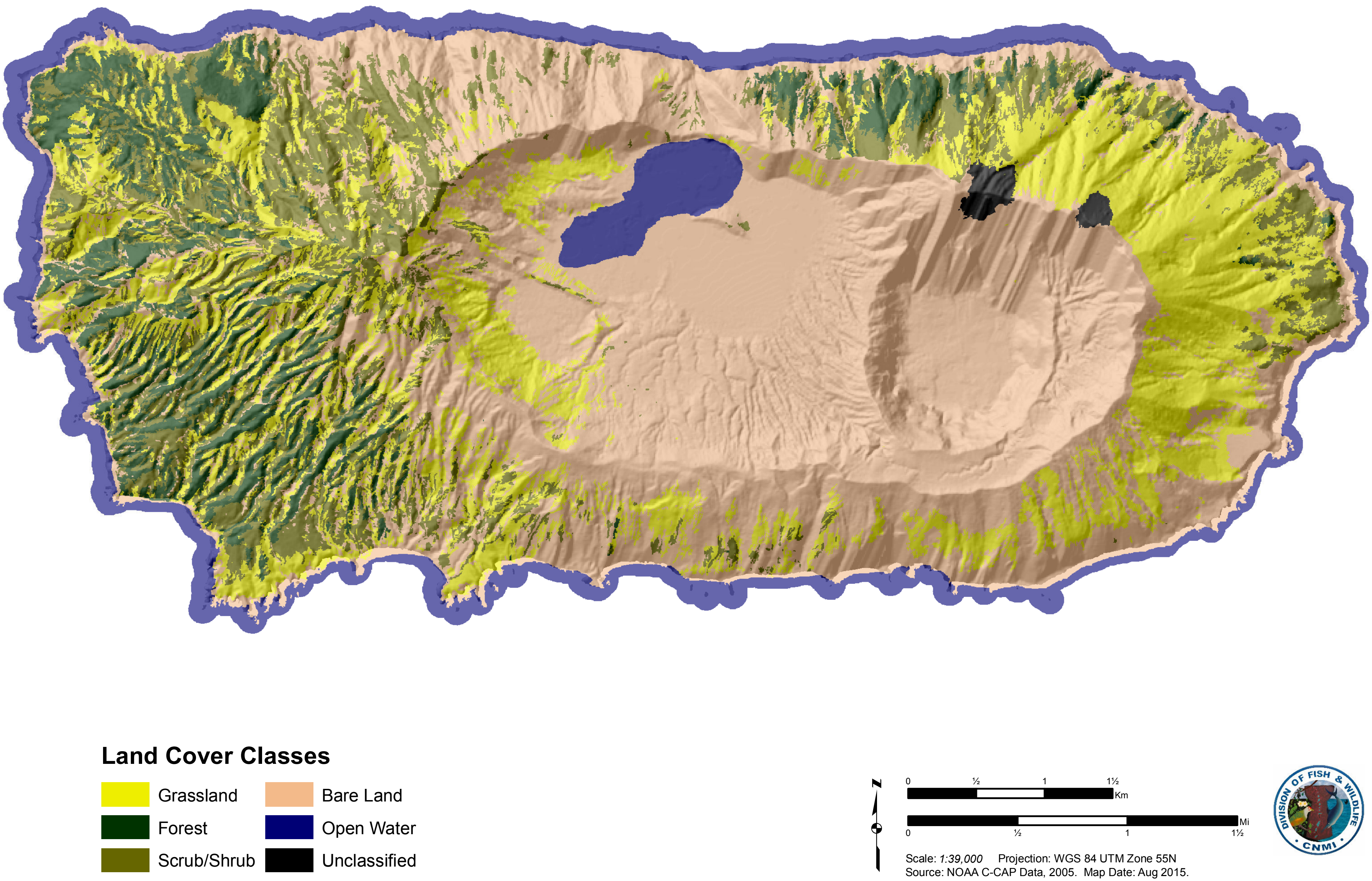
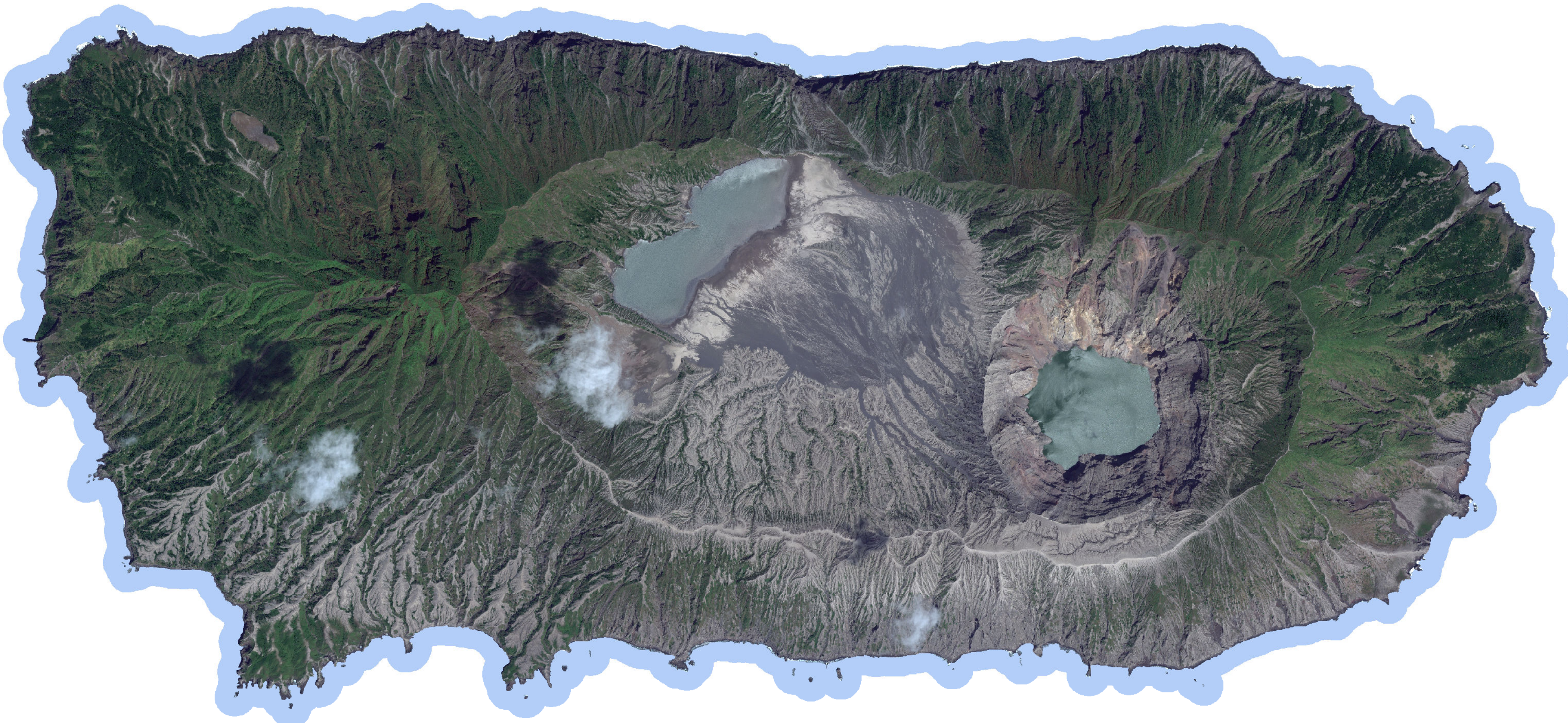


Figure 26. Anatahan Satellite Imagery



N

0	½	1	1½ Km

0	½	1	1½ Mi

Scale: *1:39,000*   Projection: WGS 84 UTM Zone 55N
Source: WorldView-2 Satellite Imagery from USDA, 2012. Map Date: Aug 2015.

Figure 27. Anatahan post-eruption, 2003.

Figure 28. Anatahan in recovery, 2015. Photo by Lainie Zarones.

Figure 29. The three primary coral reef types associated with oceanic volcanic islands, including fringing reefs, barrier reefs, and atolls. Graphic by the U.S. Geological Survey.

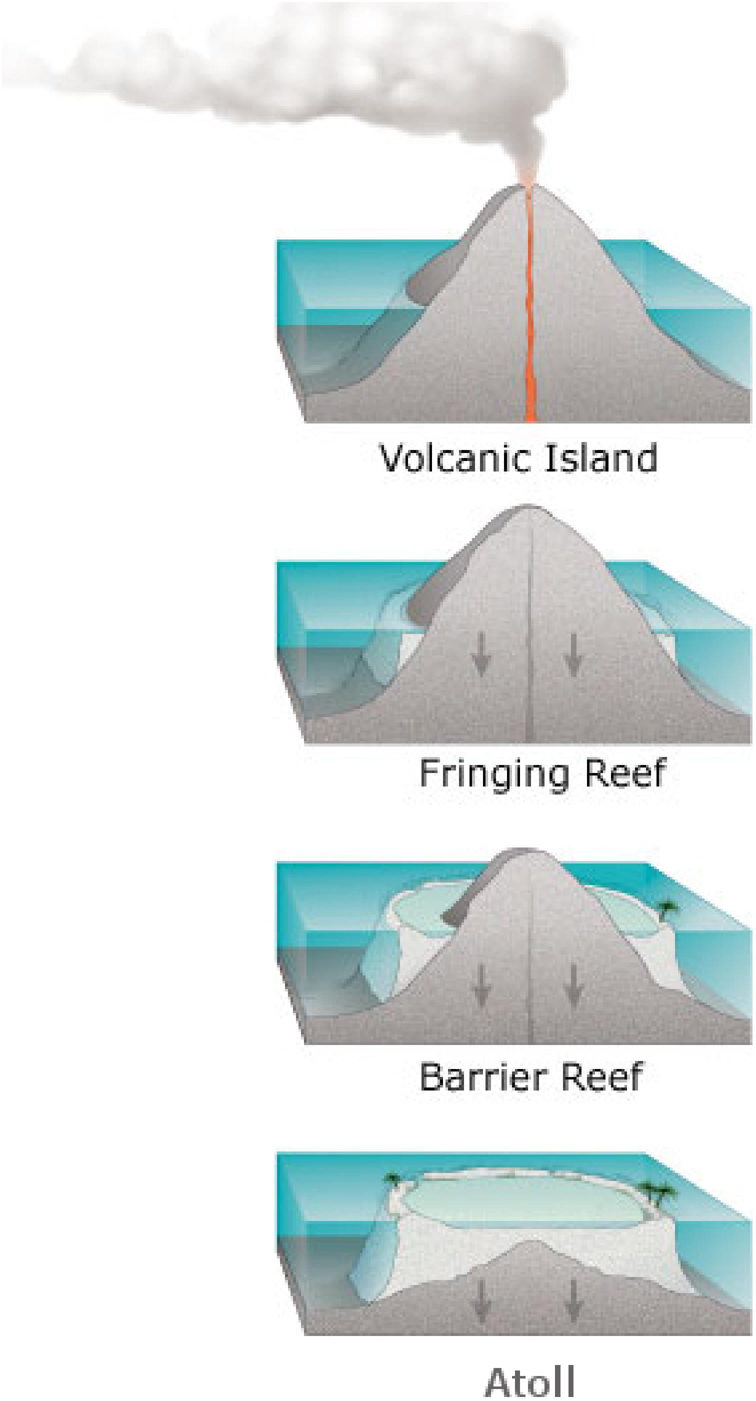


Figure 30. A veneering community at Uracas, with little to no reef development atop the steeply sloping volcanic rock substrate (top) and an apron fringing reef at Maug with significant reef development that has not yet reached sea level equilibrium (bottom). Photos provided by Robert Schroeder/NOAA PIFSC-CRED (top) and Bernardo Vargas-Angel/NOAA PIFSC-CRED

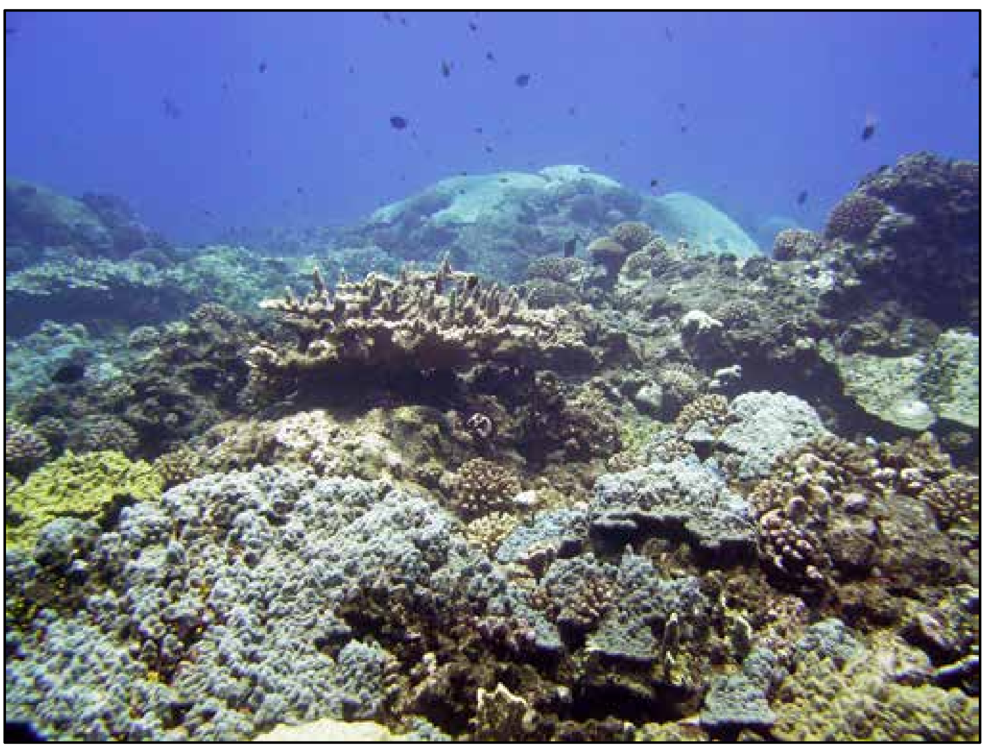


Figure 31. A narrow platform fringing reef along the north coast of Rota (top) and the barrier reef system at Saipan (bottom).

Figure 32. Bathymetric map depicting the offshore reef features, Supply Reef and the Ahyi Seamount, between the islands of Uracas (Farallon de Pajaros) and Maug (top) and the flooded volcanic crater at Maug (bottom). The bathymetric map was reproduced from Figure 18.2.3a in Brainard et al. (2012).

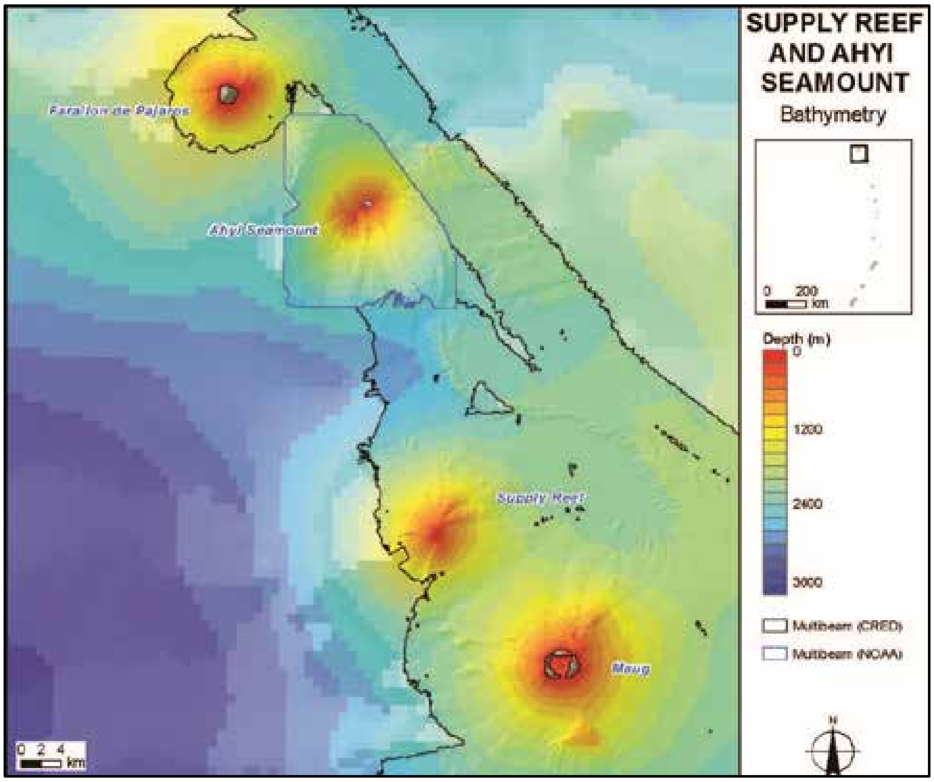


Figure 33. Reef zones associated with platform fringing reefs. Graphic modified from Figure 2 in NOAA NCCOS 2004a.

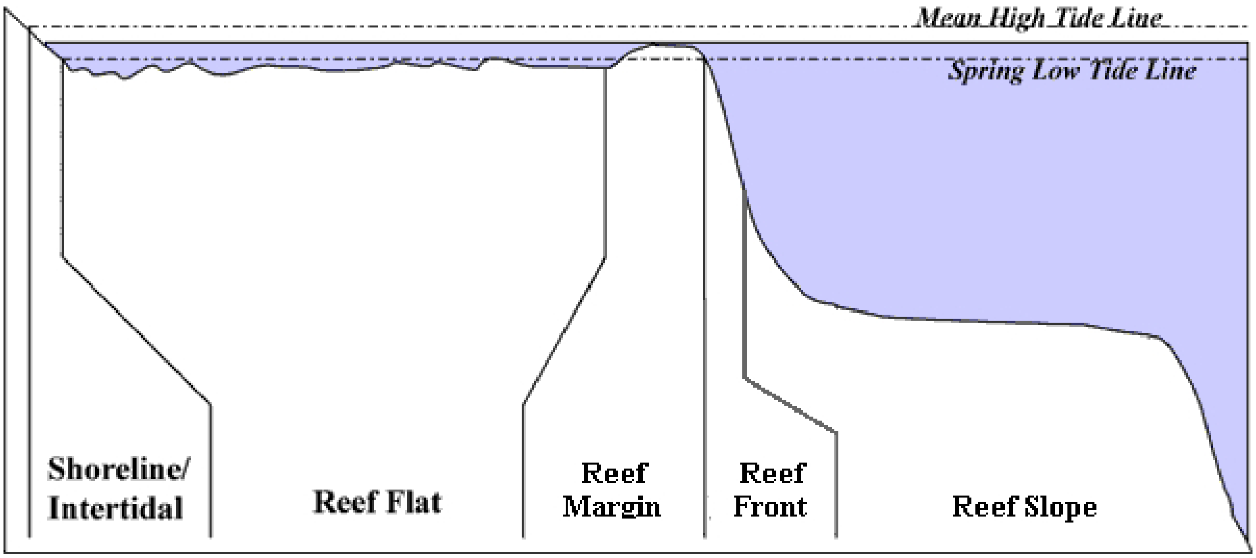


Figure 34. Reef zones associated with barrier reefs. Graphic modified from Figure 1 in NOAA NCCOS 2004a.

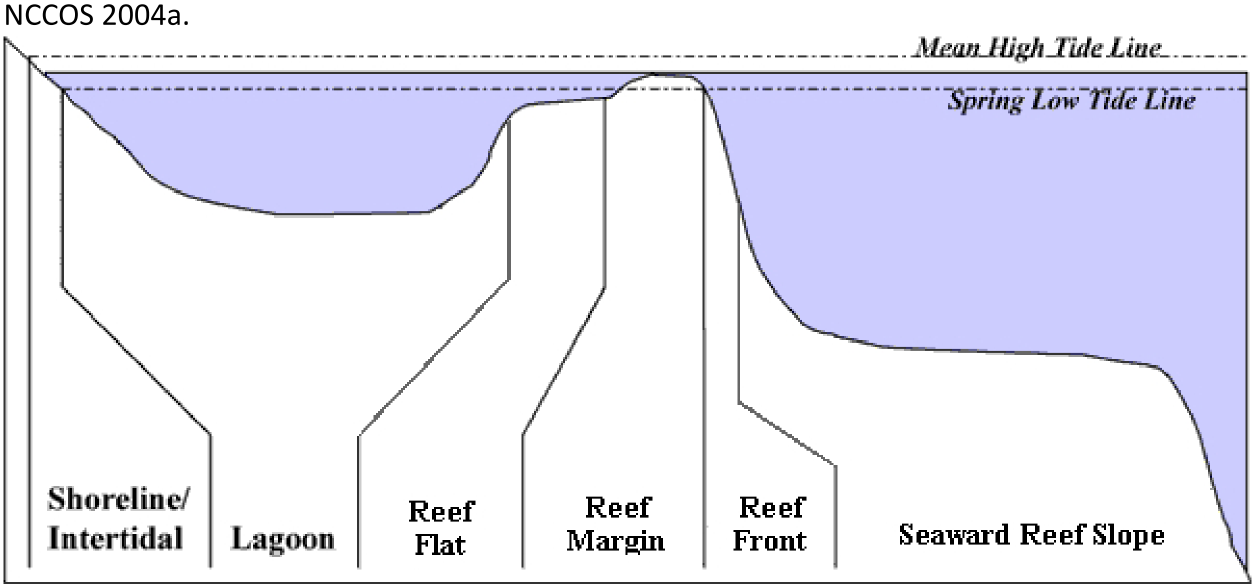


Figure 35. The shoreline intertidal zone (top) and inner reef flat platform zone (bottom) at Pacpac Beach, Saipan.

Figure 36. The outer reef flat platform zone (top) and reef margin zone (bottom) at Pacpac Beach, Saipan.

Figure 37. The reef front zone (top) and reef slope zone (bottom) at Pacpac Beach, Saipan.

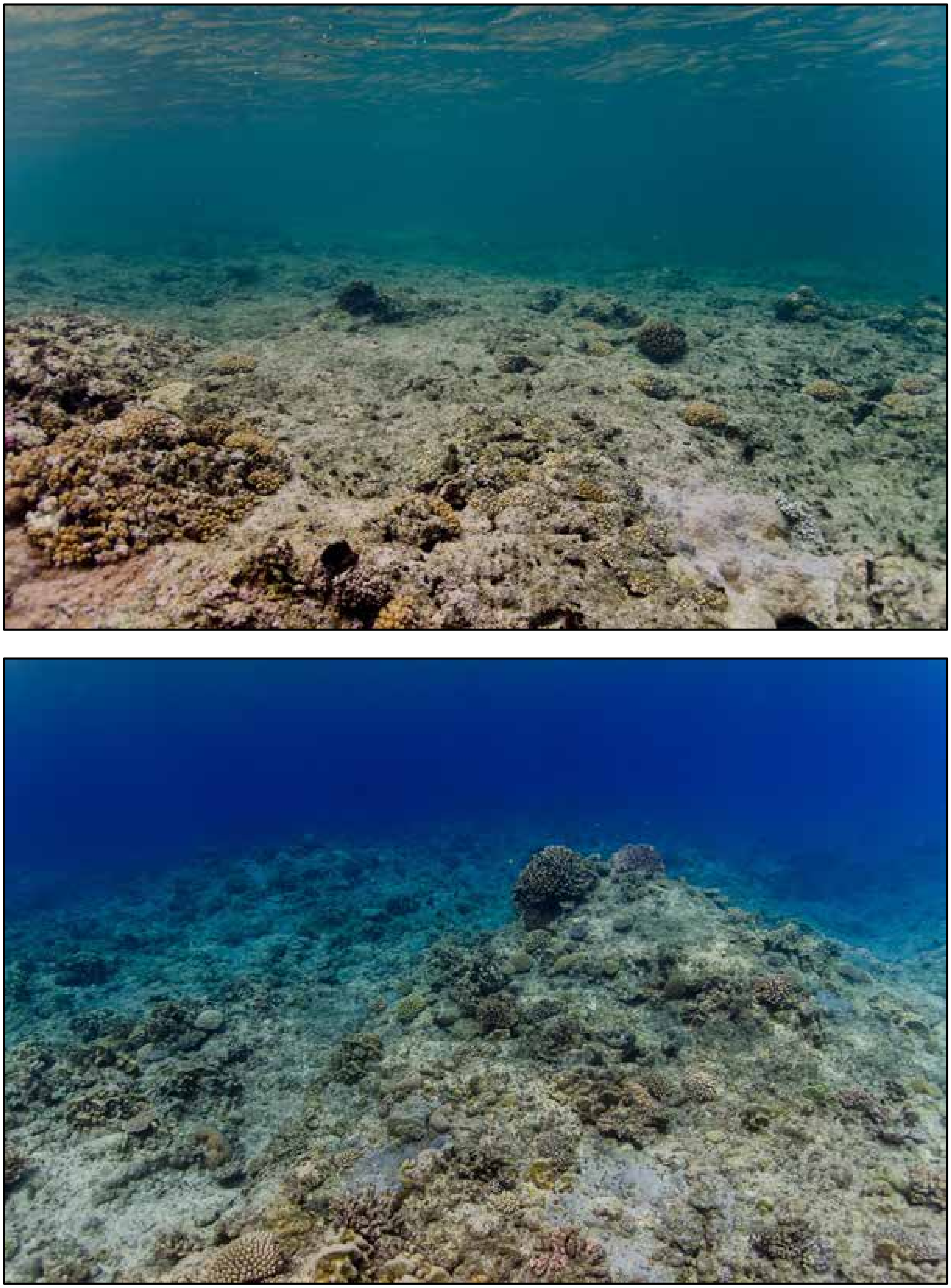


Figure 38. Seagrass (*Halodule uninervis*) reef flat habitat (top) and macroalgae-dominated pavement on the reef flat platform (bottom) at Pacpac Beach, Saipan.

Figure 39. *Acropora* cf. *pulchra* on the reef flat platform at Pau Pau Beach, Saipan (top) and turf algae-dominated pavement habitat on the inner reef flat at Bird Island, Saipan (bottom).

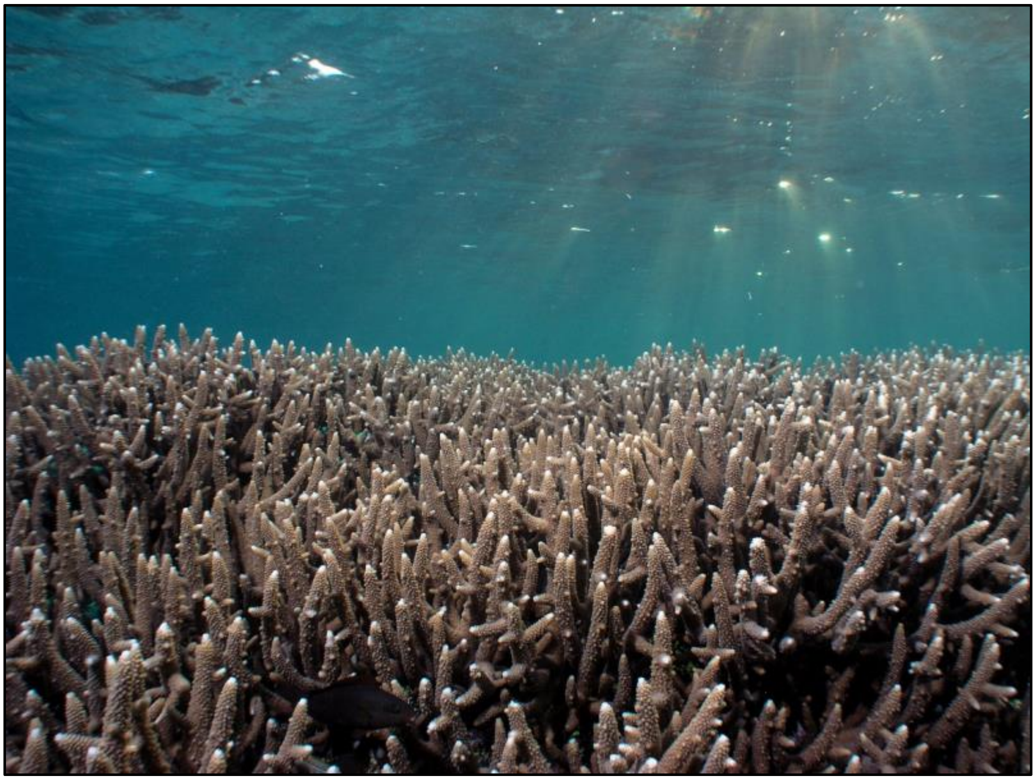


Figure 40. Massive *Porites*-dominated habitat at the seaward extent of the reef flat at Bird Island, Saipan (top) and sandy lagoon habitat in Saipan Lagoon (bottom).

Figure 41. *Isopora palifera*-dominated habitat at the lagoonward extent (top) and turf algae- and small massive *Porites*-dominated habitat at the shallow seaward extent (bottom) of the barrier reef flat platform near Mañagaha Island in Saipan Lagoon.

Figure 42. Subaerially exposed *Acropora digitifera* colonies along the upper reef margin at Obyan Beach, Saipan (top), and coral-, crustose coralline algae-, and turf algae-dominated habitat along the lower reef margin at Pacpac Beach, Saipan (bottom)

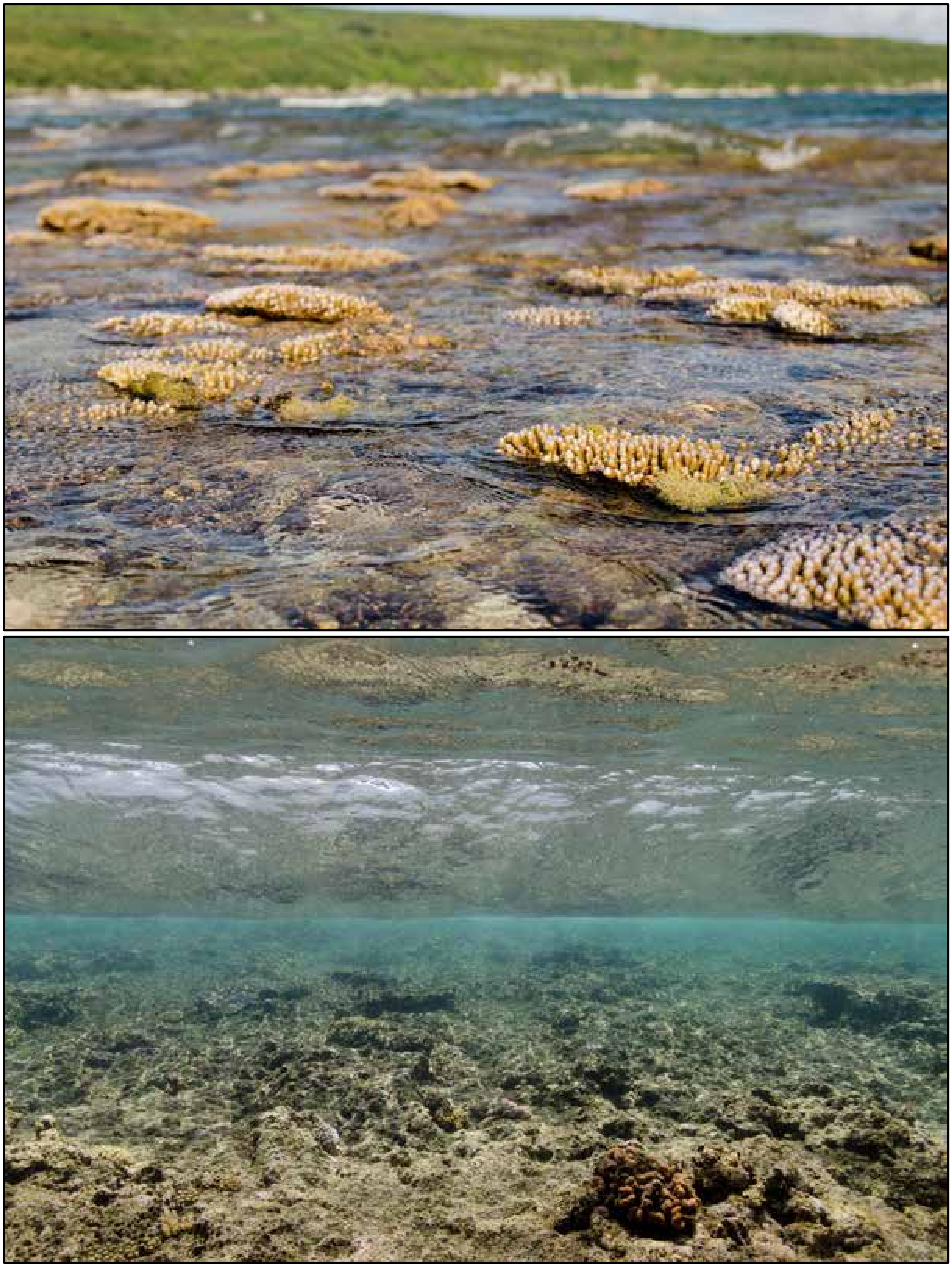


Figure 43. Turf algae-, crustose-coralline algae- and low-encrusting coral-dominated channel and buttress (spur and groove) habitat in the reef front at Pacpac Beach, Saipan (top) and coral-dominated habitat at the lower extent of the reef front near Boy Scout Beach, Saipan (bottom).

Figure 44. *Porites rus*-dominated aggregated reef habitat along the reef slope near Boy Scout Beach, Saipan (top) and a complex, diverse coral-dominated habitat along the shallow, gently-sloping seaward reef slope of a patch reef in southwest Tinian (bottom).

Figure 45. A macroalgae-dominated reef slope habitat with sparse coral coverage along the northwest coast of Rota (top) and a diverse coral-dominated habitat along a reef front in Rota (bottom).

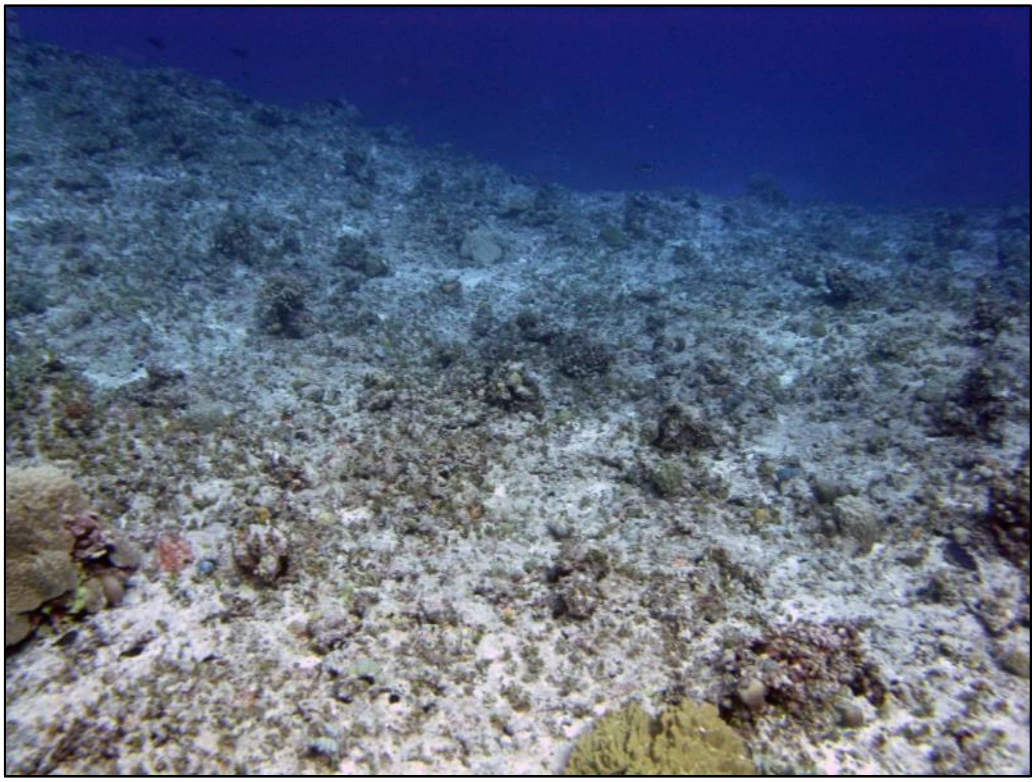


Figure 46. A low-relief, turf algae-dominated large boulder habitat with sparse coral growth on a reef slope at Uracas (top) and a macroalgae-dominated habitat comprised primarily of *Halimeda* spp. and *Asparagopsis taxiformis* at Pagan (bottom). Photos provided by Bernardo Vargas-Angel/NOAA PIFSC-CRED.

Figure 47. Limited-to-moderate reef development, dominated by corals and turf algae, on volcanic rock substrate along the reef slope at Agrigan (top) and Guguan (bottom). Photos by Peter Houk.

Figure 48. Significant reef development on the outer reef slope of Maug, dominated by hard corals (top) and dense *Porites rus* growth along the slope inside the caldera at Maug (bottom). Photos provided by Bernardo Vargas-Angel/NOAA PIFSC-CRED.

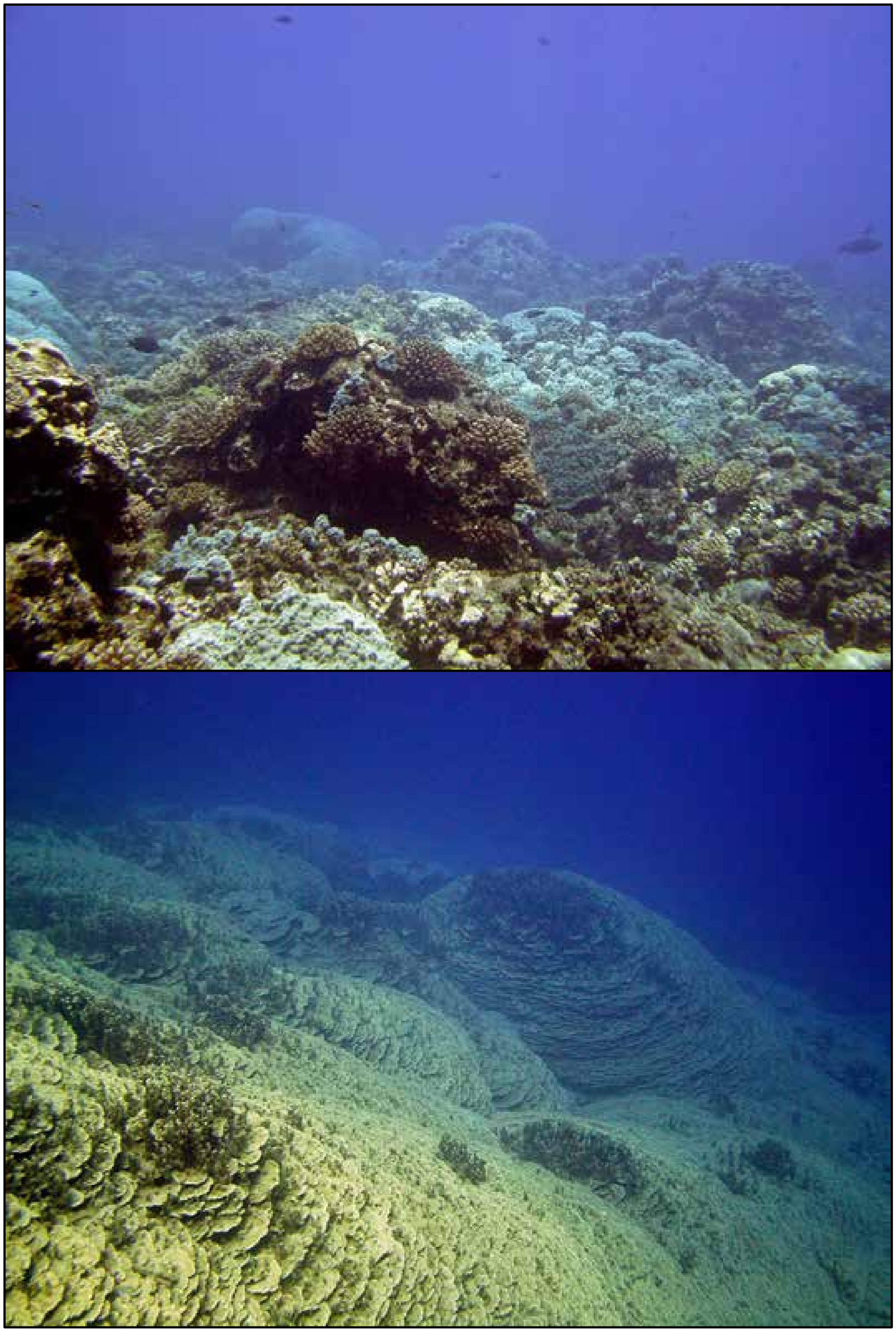


Figure 49. Limited reef development, dominated by corals and turf algae, on volcanic rock substrate along on the outer reef slope of Alamagan (top) and an unusually well-developed, coral-dominated reef community along the reef slope at Asuncion (bottom). Photos provided by John Starmer (top) and Peter Houk (bottom).

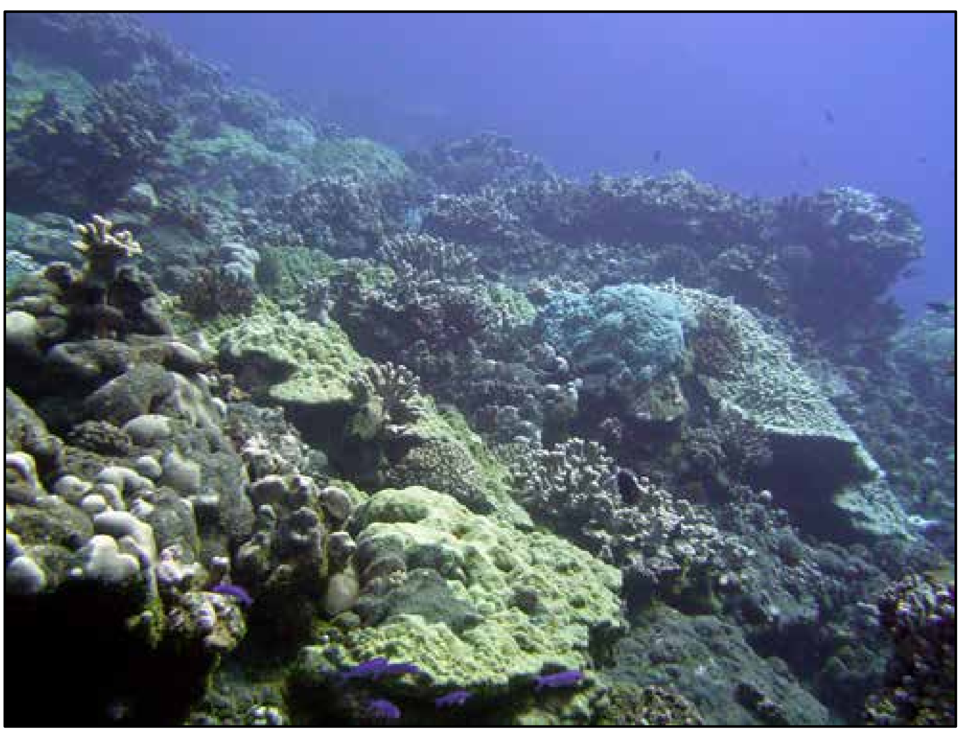
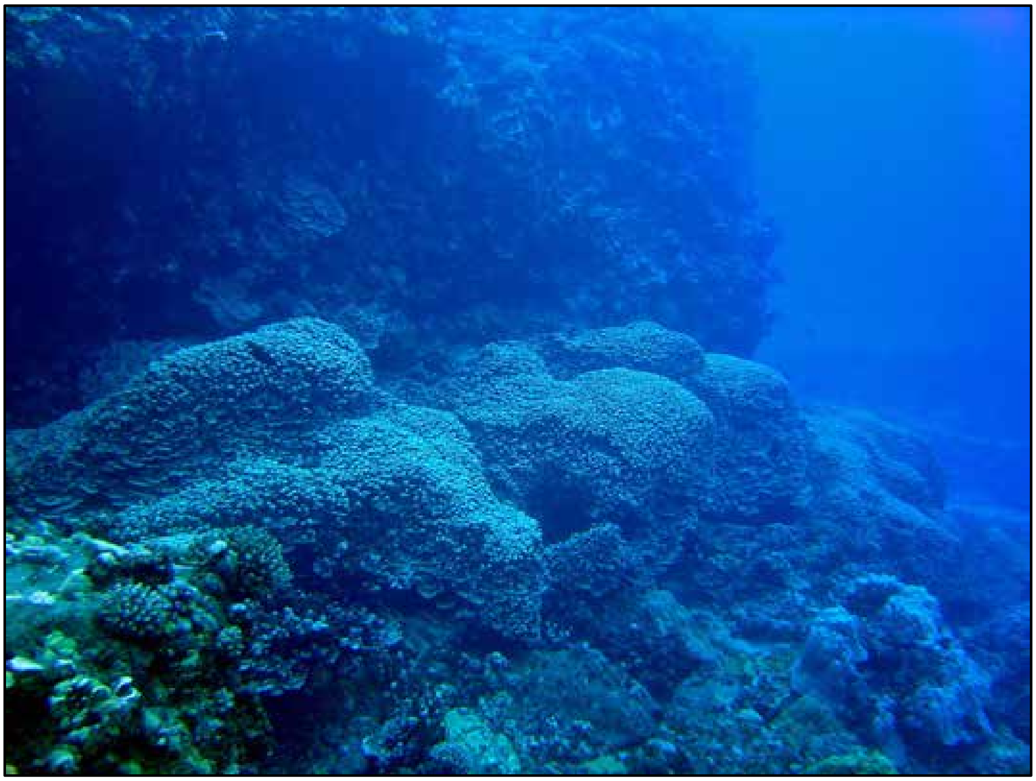


Figure 50. A stand of the coral, *Porites rus*, along a steep reef slope (top) and turf algae-dominated boulders with very sparse coral cover along the reef slope (bottom) at Sarigan. Photos by Peter Houk.



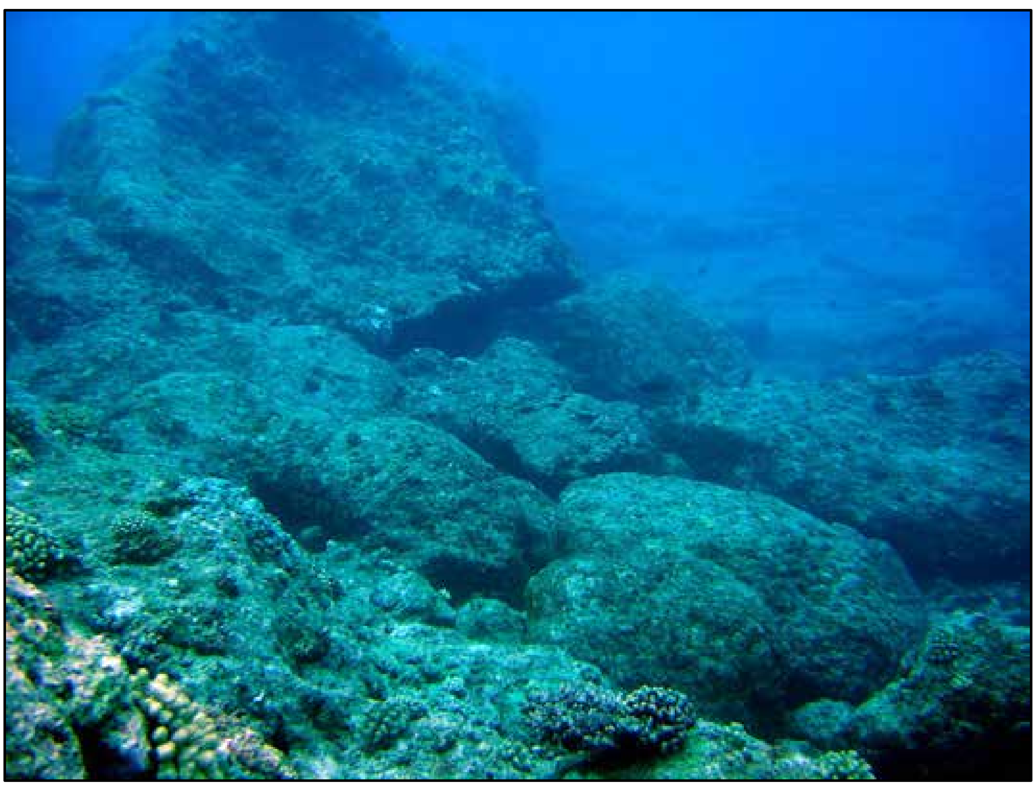


Figure 51. Dense, but low-diversity, coral growth (mainly *Pocillopora* spp. and *Millepora platyphylla*) at Supply Reef (top) and *Pocillopora* spp. colonies along a steep slope at Zealandia Bank (bottom). Photos provided by Peter Houk (top) and NOAA PIFSC-CRED (bottom).

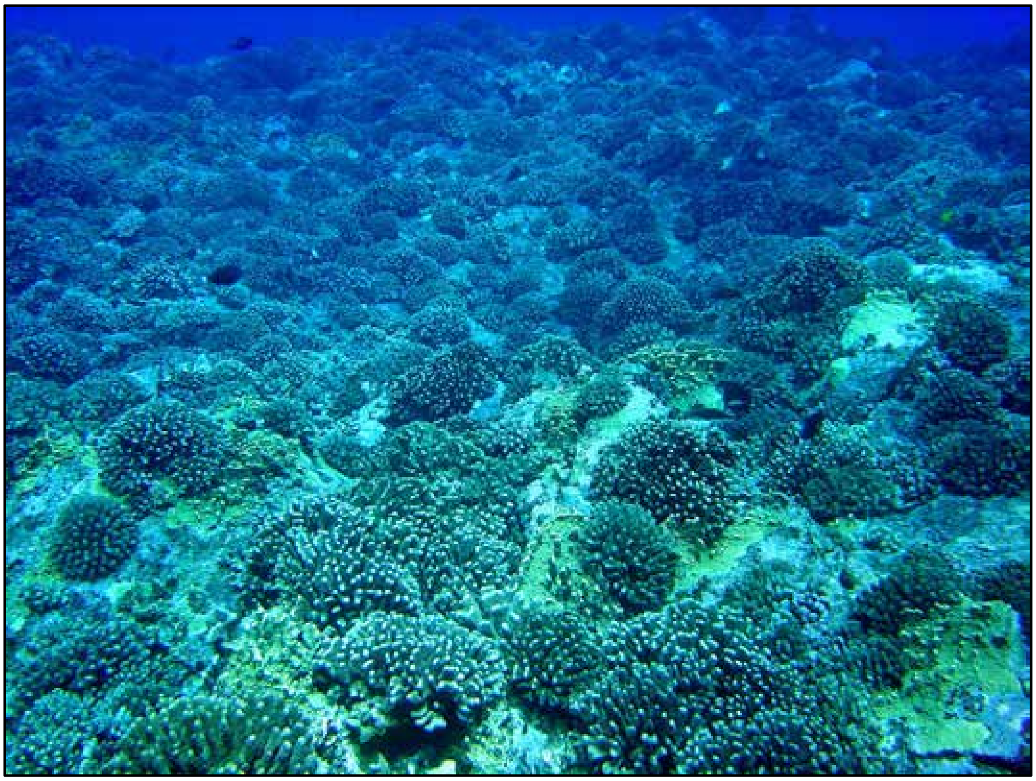


Figure 52. Overall habitat complexity from towed-diver surveys of reef slope habitats conducted during the 2003, 2005, and 2007 MARAMP expeditions. Modified from Figure 3.2g in Brainard et al. (2012).

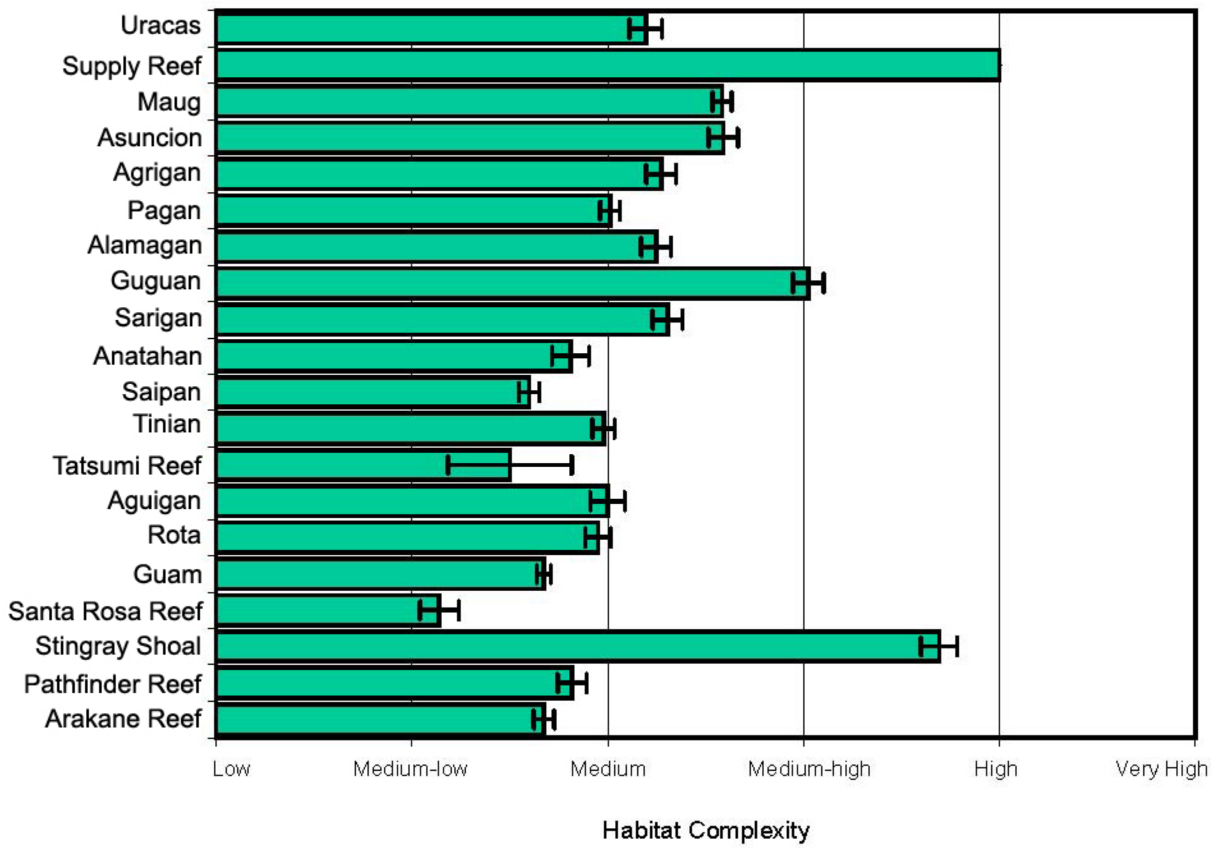


Figure 53. Shallow (<30 m depth) coral reef/hardbottom and unconsolidated sediment habitat around Rota

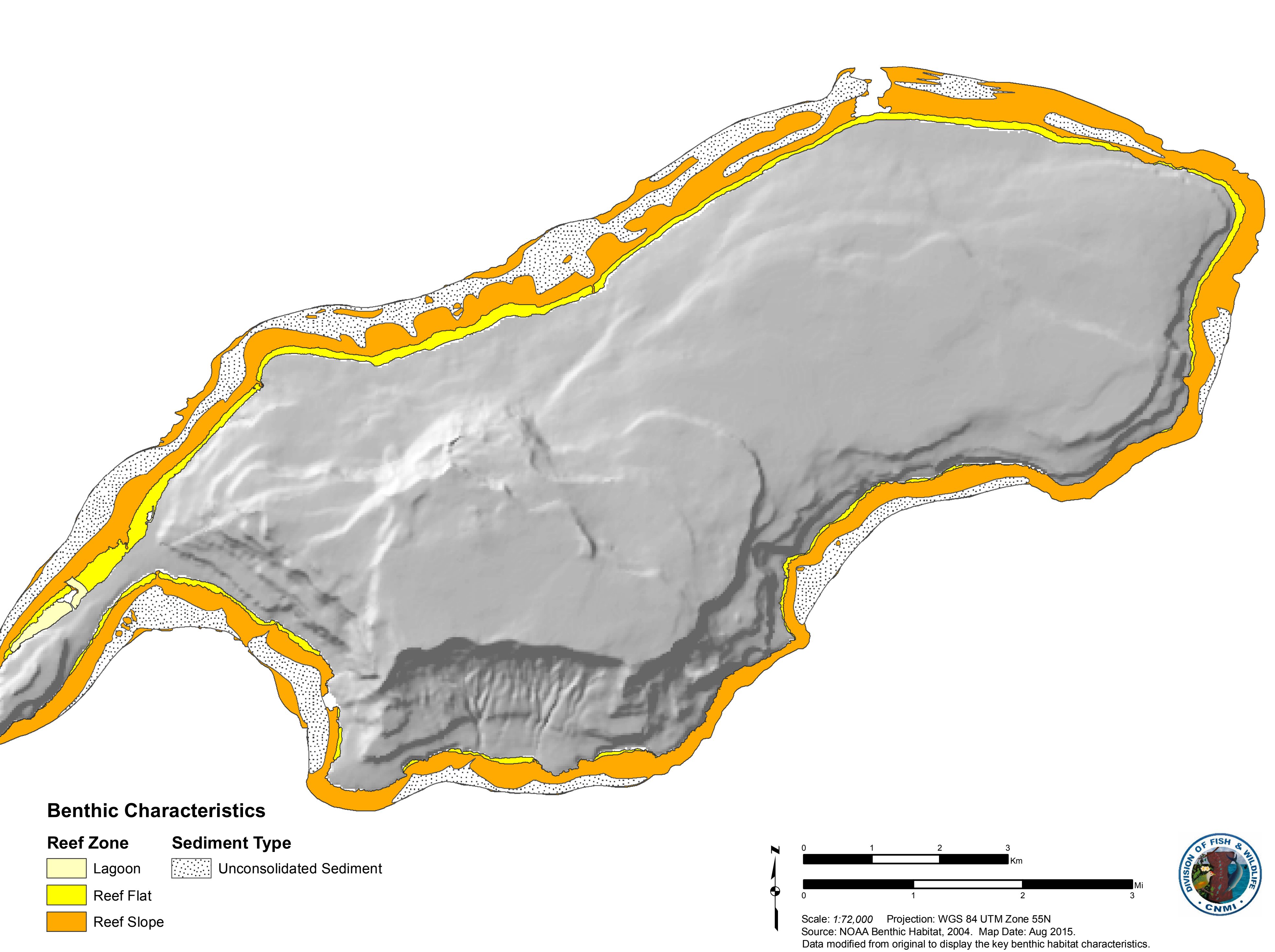


Figure 54. Shallow (<30 m depth) coral reef/hardbottom and unconsolidated sediment habitat around Tinian

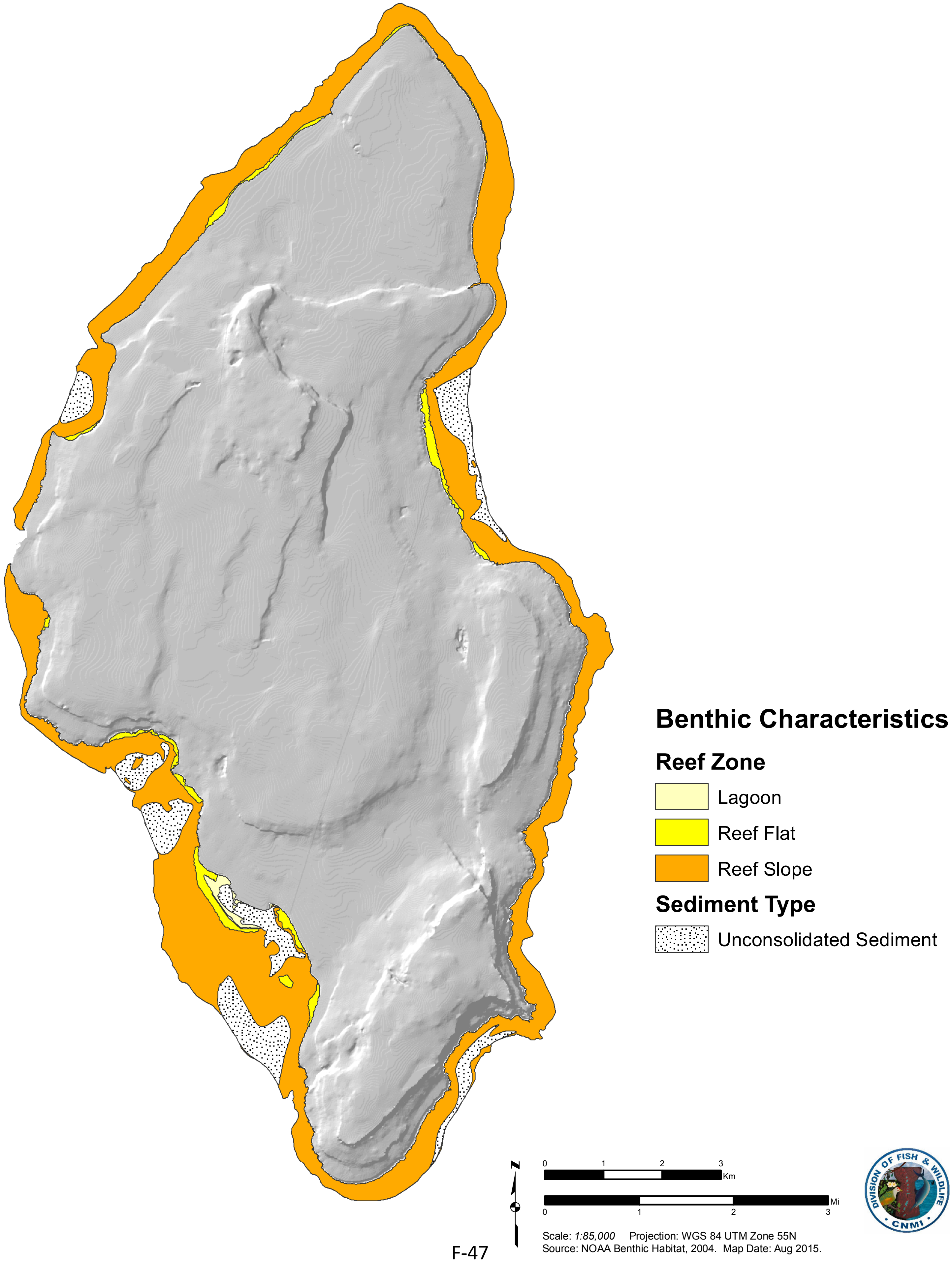


Figure 55. Shallow (<30 m depth) coral reef/hardbottom and unconsolidated sediment habitat around Saipan

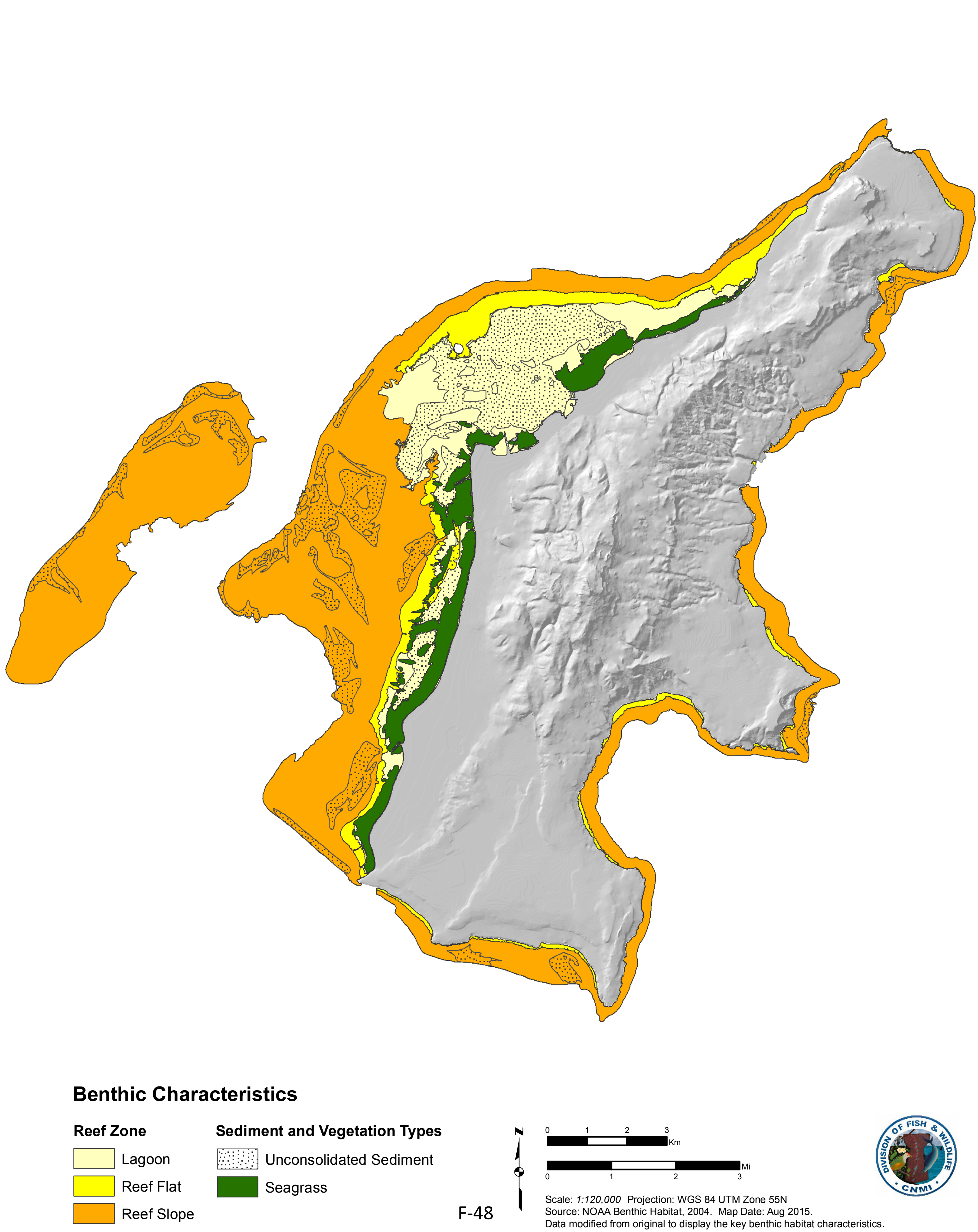


Figure 56. Mean percent cover of live and stressed hard corals from towed-diver and Rapid Ecological Assessment surveys of reef slope habitats conducted during the 2003, 2005, and 2007 MARAMP expeditions. Surveys of stressed coral cover were not conducted in 2003. Error Bars indicate the standard error (± 1 SE). Modified from Figure 3.4.1a in Brainard et al. (2012).

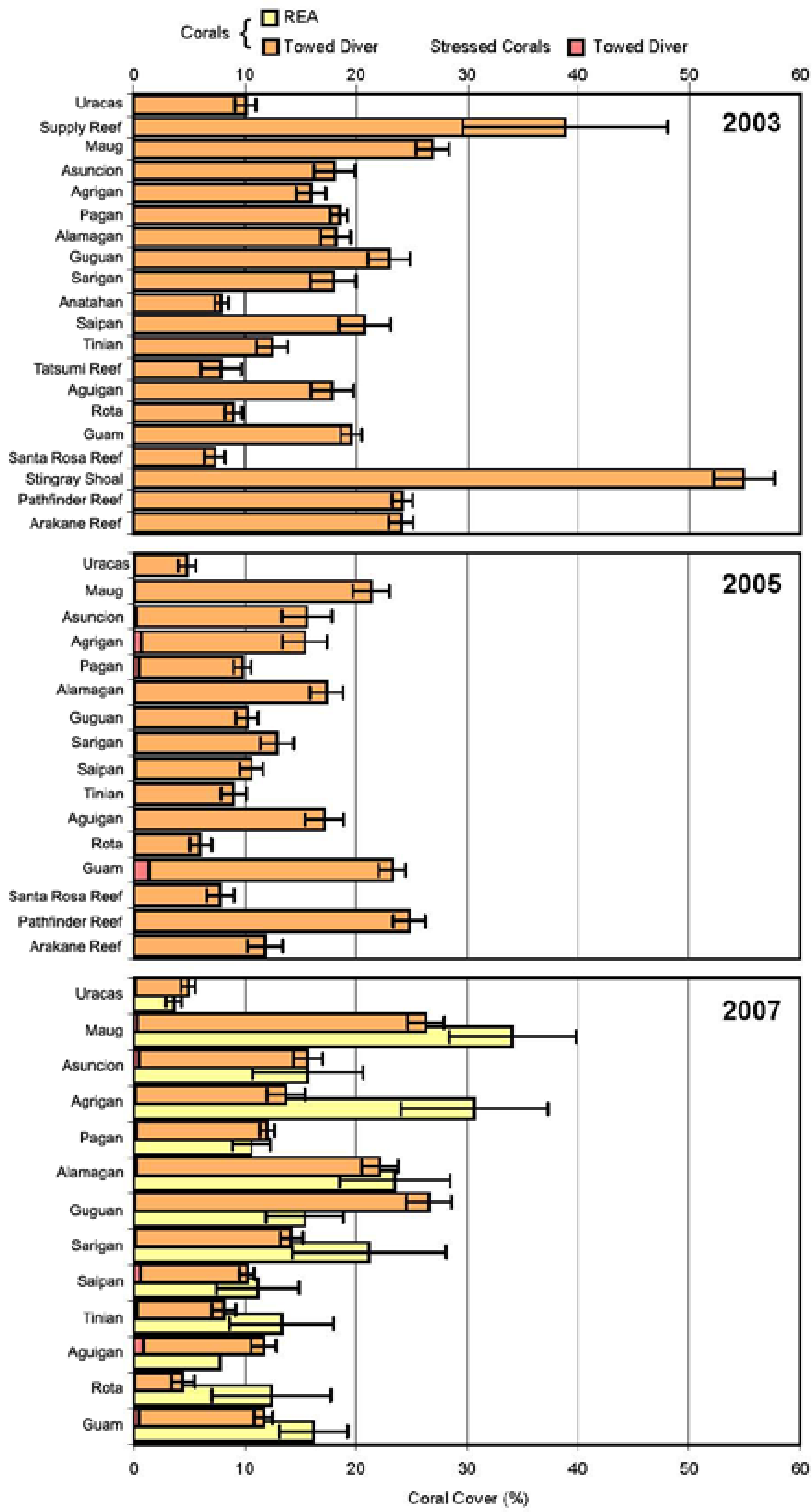


Figure 57. The Archipelagic Benthic Condition Index for 2005 and 2007, based on NOAA MARAMP towed-diver surveys of seaward reef slopes. The index values represent the status of benthic communities for each island/offshore reef relative to other islands/offshore reefs across the archipelago. Reproduced from Figure 3.10b in Brainard et al. (2014).

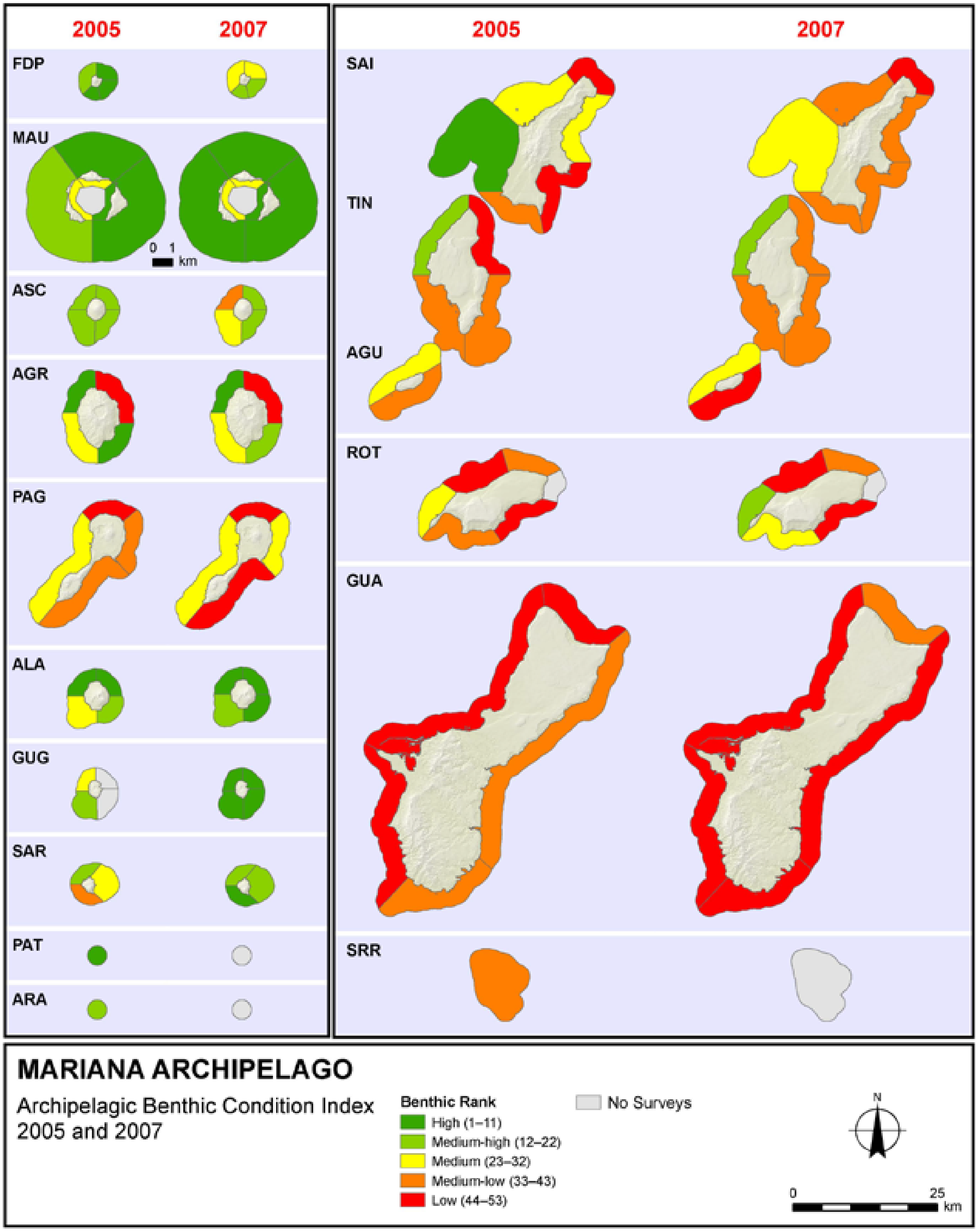


Figure 58. The eroding skeletons of coral colonies possibly killed during the 2013 or 2014 coral bleaching events, which were linked with anomalously high sea surface temperatures in the waters of the CNMI.

Figure 59. Extensive bleaching affecting various taxa at Maug (top) and recent bleaching-associated mortality of *Pocillopora* spp. at Anatahan in 2014. Photos courtesy CNMI Bureau of Environmental and Coastal Quality.

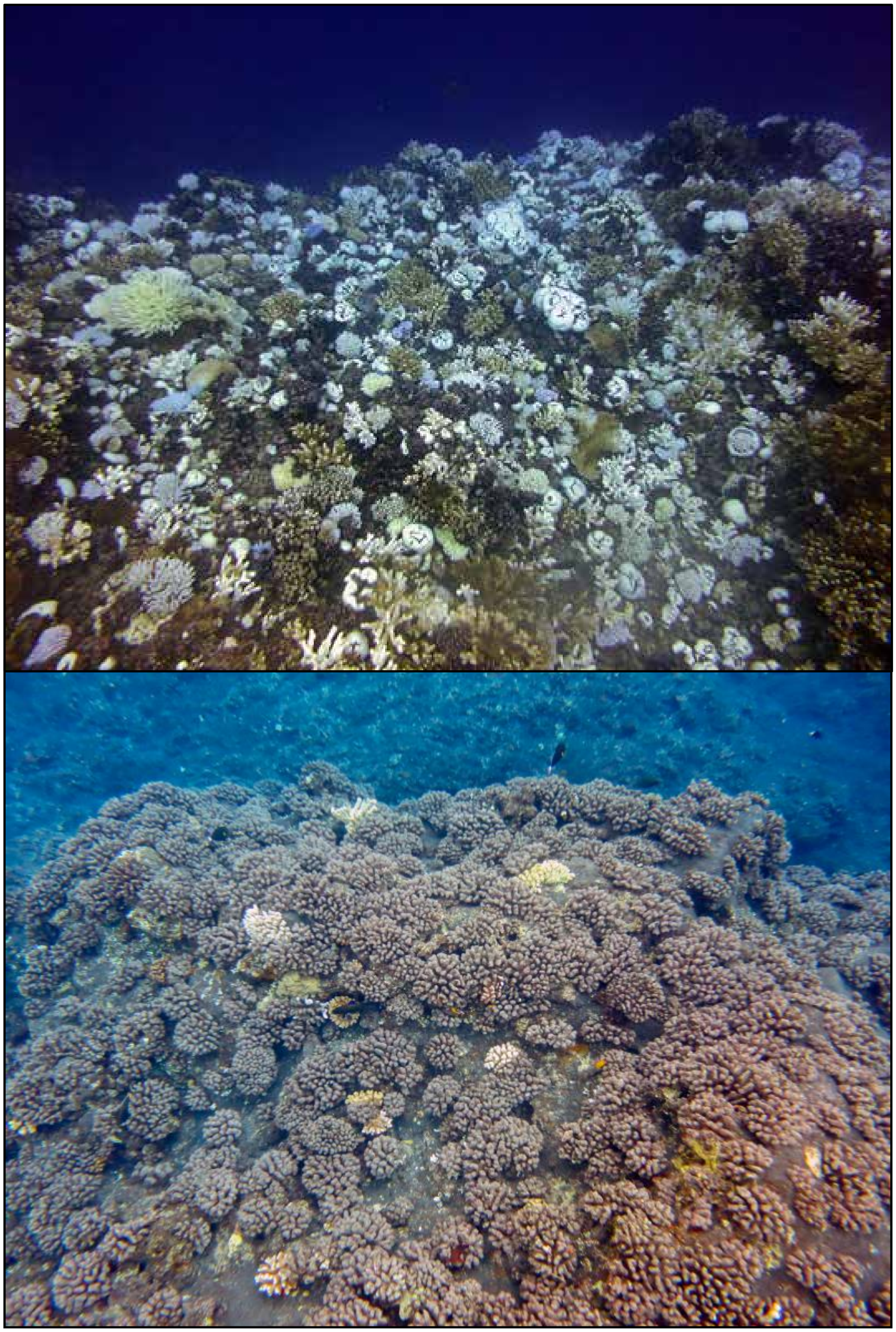
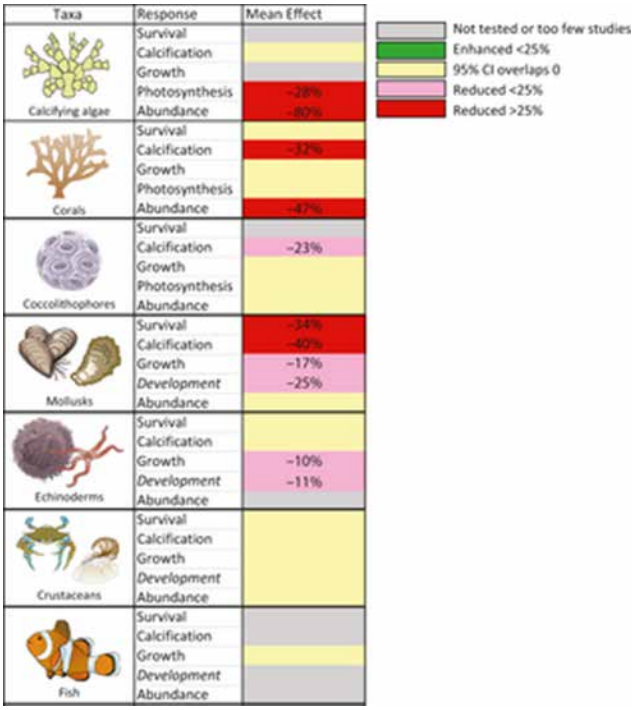


Figure 60. Effects of ocean acidification on key taxonomic groups. Modified from Kroeker et al. 2013.



APPENDICES

A. SPECIES NAMES REFERRED TO IN THE TEXT

B. REGIONAL BIOLOGICAL EXPERTS PROVIDING INPUT

C.1. BIOSCORING CHEAT SHEET

C.2. BIOSCORES OF ALL EVALUATED SPECIES

C.3. REFERENCES FOR BIOSCORES

D.1. THREAT ASSESSMENT CHEAT SHEET

D.2. SUMMARY OF THREAT RANKINGS OF ALL EVALUATED TERRESTRIAL SPECIES

D.3. SUMMARY OF THREAT RANKINGS OF ALL EVALUATED MARINE SPECIES

APPENDIX A. SPECIES NAMES REFERRED TO IN THE TEXT

Scientific Name	English	Chamorro	Carolinian
Acacia confusa	Formosan Koa	Sosugi Formosa	Serepa
Acanthaster planci	Crown-of-Thorns Seastar		
Acanthocybium solandri	Wahoo		
Acanthopleura gemmata	Jewelled Chiton		
Acanthurus spp.	Surgeonfish	Hiyok	
Acrocephalus hiwae	Nightingale Reed-warbler	Ga'ga karisu	Litchoghoi bwel
Acropora globiceps	A stony coral	Kuraling	Yeal
Acropora retusa	A stony coral	Kuraling	Yeal
Acropora spp.	Staghorn corals	Kuraling	Yeal
Acrostichum aureum	Golden Leather Fern		
Actinopyga mauritiana	Surf Redfish	Balate	Ppaleppal
Adenanthera pavonina	Bead Tree	Colales	
Aerodramus bartschi	Mariana Swiftlet	Chachaguak	Leghe'kiyank
Aglaia mariannensis	Mapunyao	Mapunyao	
Anous minutus marcusi	Black Noddy	Fahang dikike'	Rees
Aidia cochinchinensis	Sumak	Sumak	
Albezia lebbeck	Siris Tree	Kalaskas	Schepil Kalaskas
Anous stolidus pileatus	Brown Noddy	Fahang dankolo	She'e'lap
Antigonon leptopus	Chain-of-love	Cadena de Amor	
Aplonis opaca aeneus	Micronesian Starling	Sali	Mwii
Aplonis opaca guami	Micronesian Starling	Sali	Mwii
Ardenna pacifica	Wedge-tailed Shearwater	Lifa'ru	Lifo'ro
Arothron spp.	Puffers		
Artocarpus altilis	Breadfruit (unseeded)	Lemai	
Astreopora spp.	Star corals		
Balanus spp.	Barnacles		
Barringtonia asiatica	Fish-kill tree	Puteng	
Barringtonia racemosa	Powder-puff Tree	Lagansát	
Birgus latro	Coconut Crab	Ayuyu	Lyaf
Blechnum orientale	Centipede Fern		
Bohadschia spp.	Sea cucumbers		
Boiga irregularis	Brown Tree Snake	Kolepbla	
Bos taurus	Cow	Baka	
Bruguiera gymnorrhiza	Mangle	Mangle Machu	
Bryopsis spp.	Green macroalgae		
Canavalia spp.	Jack-beans		
Canis familiaris	Dog	Ga’lagu	
Capra hircus	Goat	Chiba	
Caranx spp.	Jacks		
Carcharhinus amblyrhynchos	Grey Reef Shark	Halu'u	Limwe

Carcharhinus falciformis	Silky Shark		
Carcharhinus galapagensis	Galapagos Shark		
Carcharhinus melanopterus	Blacktip Reef Shark		
Cardisoma carnifex	Mangrove Crab	Pang'lao Echung	
Carica papaya	Papaya	Trokon Papaya	
Carlia ailanpalai	Curious Skink	Guali'ek Halam Tano	
Cassia fistula	Golden-shower	Canafistula	
Cassis cornuta	Horned Helmet	Do'gas prensa	Mwe'ell
Cassytha filiformis	Love-vine	Agasi	
Casuarina equisetifolia	Ironwood	Gagu	
Caulerpa spp.	Seaweeds		
Cerbera dilatata	Grey Milkwood	Chuti	
Charonia tritonis	Triton's Trumpet	Kulu	Sa'wi
Cheilinus undulatus	Napoleon Wrasse	Tanguisson	Maam
Chelonia mydas	Green Sea Turtle	Haggan	Wong mool
Chicoreus ramosus	Branched Murex	Do'gas	Abwel
Chlorodesmis fastigiata	Turtleweed		
Chlorurus microrhinos	Steephead Parrotfish	Laggua	Igan-wosh
Chromolaena odorata	Bitter Bush	Masigsig	
Chrysopogon aciculatus	Golden Beardgrass	Inifuk	
Chthamalus spp.	Barnacles		
Citrus spp.	Citruses	Trokon Magsum	
Cleptornis marchei	Golden White-eye	Canario	Khanooriyo
Coccinia grandis	Scarlet Gourd		
Cocos nucifera	Coconut	Niyok	
Coenobita spp.	Hermit crabs	Umang	
Corvus kubaryi	Mariana Crow	Aga	Mwii'lup
Coryphaena hippurus	Mahi	Dofen	
Crenimugal crenilabis	Fringelip Mullet		
Cryptoblepharus poecilopleurus	Oceanic Snake-eyed Skink	Achi'ak	
Cynometra ramiflora	Cynometra	Gulos	
Cyperus spp.	Sedges		
Dardanus spp.	Hermit crabs	Umang	
Delonix regia	Flame Tree	Arbol del Fuego	Nfayarbaw
Desmodium triflorum	Creeping Tick Trefoil	Agsom	
Diadema savignyi	Long-spined Urchin		
Dicranopteris linearis	Old World Forked Fern		
Digitaria spp.	Crabgrasses	Umok	
Discocalyx megacarpa		Otot	
Echinometra spp.	Rock-boring sea urchins		
Echinostrephus aciculatus	Needle-spined Urchin		
Echinothrix diadema	Blue-black Urchin		
Egretta sacra	Pacific Reef-heron	Chuchuko atilong	Ghe're'scho'l

Eichhornia crassipes	Water Hyacinth		
Elaeocarpus joga		Joga	
Emballonura semicaudata rotensis	Pacific Sheath-tailed Bat	Fanihin Liyang	Payesyes/Pai'Scheei
Emoia atrocostata	Littoral Skink	Achi'ak	
Emoia caeruleocauda	Pacific Blue-Tail Skink	Achi'ak	
Emoia slevini	Mariana Skink	Achi'ak	
Enhalus acoroides	Broadblade Seagrass		
Eretmochelys imbricata bissa	Hawksbill Turtle	Haggan karai	Wong maaw
Erythrina variegata var. *orientalis*	Coral Tree	Gaogao	
Eugenia palumbis		Agatelang	
Favia spp.	Stony corals	Kuraling	Yeal
Favites abdita	Larger Star Coral	Kuraling	Yeal
Felis catus	Cat	Katu	
Fregata minor palmerstoni	Great Frigatebird	Paya'ya	Asaf
Ficus prolixa	Banyan	Nunu	
Ficus tinctoria	Dyer’s Fig	Hodda	
Fimbristylis cymosa	Button Sedge		
Fimbristylis spp.	Fimbry Sedges		
Galeocerda cuvier	Tiger Shark		
Gallus gallus	Red Junglefowl		
Gafrarium pectinatum	Pectinate Venus	Tapon/Amsun	Ai'mett/Ghatil
Gallicolumba xanthonura	White-throated Ground Dove	Paluman kotbata	Apooka
Gallinula chloropus guami	Mariana Common Moorhen	Pulattat	Gherel Bweel
Gempylus serpens	Snake Mackerel		
Globicephala spp.	Pilot Whales		
Gonaxis kibweziensis			
Goniastrea retiformis	Lesser Star Coral		
Goniopora spp.	Flowerpot corals		
Grapsus spp.	Rock crabs	Agaaf	
Gygis alba candida	White Tern	Chunge'	Geeghi
Guamia mariannae		Paipai	
Guettarda speciosa	Zebrawood	Panao	
Heliopora coerulea	Blue Coral		
Halimeda spp.	Green macroalgae		
Halodule uninervis	Narrowleaf Seagrass		
Halophila minor	Hartog Seagrass		
Halymenia spp.	Red macroalgae		
Hemidactylus frenatus	Common House Gecko	Guali'ek	Galuuf
Heritiera littoralis		Hufa	
Hernandia sonora	Lantern Tree	Nonak	
Heterospathe elata	Sagisi Palm	Palma Braba	
Hibiscus tiliaceus	Beach Hibiscus	Pago	
Holothuria atra	Lollyfish		

Holothuria leucospilota	Black Sea Cucumber		
Holothuria whitmaei	Black Teatfish		
Intsia bijuga		Ifit	
Ipomoea spp.	Morning glories		
Ipomoea pes-caprae	Beach Morning Glory	Alalak Tasi	
Ischnura luta	Rota Damselfly	Dulalas Luta	Dulalas Luuta
Isopora palifera	Catch Bowl Coral		
Ixobrychus sinensis	Yellow Bittern	Kakkak	Kakkaak
Katsuwonus pelamis	Skipjack Tuna	Kachó	
Kyphosus spp.	Rudderfishes		
Lambis	Common Spider Conch	Toro	Li'yang
Lampris guttatus	Moonfish		
Lantana camara	Lantana		
Leiaster leachi	Velvety Seastar		
Lepidodactylus lugubris	Mourning Gecko	Guali'ek	Galuuf
Leptastrea purpurea	Crust Coral		
Leptoria phrygia	Least Valley Coral		
Leptoscarus vaigiensis	Seagrass Parrotfish	Kabara	
Lethrinus spp.	Emperors		
Leucaena leucocephala	Tangantangan	Tangantangan	
Linckia guildingi	Common Comet Star		
Liagora spp.	Red algae		
Lobophyllia spp.	Lobed brain corals		
Lobophytum spp.	Devil’s hand corals		
Lutjanus spp.	Snappers	Mafuté	
Makaira mazara	Pacific Blue Marlin		
Mammea odorata		Chopak	
Mangifera indica	Mango	Mangga	
Megapodius laperouse	Micronesian Megapode	Sasangat	Sasangal
Melanocetus johnsonii	Deep Sea Anglerfish		
Melanolepis multiglandulosa		Alum	
Merremia tuberosa	Wood Rose	Alarrak	
Microdictyon spp.	Green algae		
Mimosa invisa	Giant Sensitive Plant		
Miscanthus floridulus	Swordgrass	Nette	
Mojarra spp.	Mojarras		
Monarcha tatatsukasae	Tinian Monarch	Chichurikan Tinian	Liteighi'par
Montipora spp.	Rice corals		
Morinda citrifolia	Indian Mulberry	Lada	
Muntingia calabura	Calabura	Mansanita	
Musa spp.	Bananas	Chotda	
Myzomela rubratra asuncionis	Micronesian Honeyeater	Egigi	Tigh'par
Myzomela rubratra saffordi	Micronesian Honeyeater	Egigi	Tigh'par

Nactus pelagicus	Pacific Slender-toed Gecko	Guali'ek	Galuuf
Naso spp.	Surgeonfish	Patgon Hugupao	
Neisosperma oppositifolia		Fago	
Nephrolepis spp.	Swordferns		
Ochrosia mariannensis	Lipstick Tree	Langiti	
Octopus cyanea	Day Octopus	Gamson	Ghuus
Ocypode ceratophthalma	Horned Ghost Crab	Hagu'ui	Arigh
Onychoprion fuscatus oahuensis	Sooty Tern	Giree'girak	Meshe'gua
Onychoprion lunatus	Grey-backed Tern		
Operculina ventricosa	Paper Rose	Alalag	
Oreochromis mossambica	Red Tilapia		
Oryctes rhinoceros	Coconut Rhinoceros Beetle		
Pandanus dubius	Pandanus	Pahong	
Pandanus tectorius	Pandanus	Kafu	
Panicum spp.	Panicgrasses		
Panulirus longipes bispinosus	Longlegged Spiny Lobster	Mahonggang	Yuurr
Panulirus pencillatus	Pronghorn Spiny Lobster	Mahonggang	Yuurr
Panulirus spp.	Spiny lobsters	Mahonggang	Yuurr
Panulirus versicolor	Painted Spiny Lobster	Mahonggang	Yuurr
Partula gibba	Humped Tree Snail	Denden	
Partula langfordi	Langford's Tree Snail	Denden	
Partula undescribed species	Rota Partulid Snail	Denden	
Patelloida spp.	Limpets		
Pavona spp.	Stony corals	Kuraling	Yeal
Pennisetum spp.	Fountaingrasses		
Perochirus ateles	Micronesian Gecko	Guali'ek	Galuuf
Persea spp.	Avocados	Alageta	
Phaethon lepturus dorotheae	White-tailed Tropicbird	Fagpi-apa'ka	Su'ghu'bwesch
Phaethon rubricauda melanorhynchos	Red-tailed Tropicbird	Fagpi	Su'ghu'bwesch
Phragmites karka	Tall Reed	Karisu	
Physter microcephalus	Sperm Whale		
Pipturus argenteus	Silvery Pipturus	Amahadyan	
Pisonia grandis		Umumu	
Pithecellobium dulce	Monkeypod	Kamachili	Ghamasiligh
Platydemus manokwari	New Guinea Flatworm		
Pocillopora damicornis	Cauliflower Coral		
Porites spp.	Stony corals	Kuraling	Yeal
Porites rus	Hump Coral		
Pouteria obovata	Northern Yellow Boxwood	Lala	
Premna obtusifolia	False Elder	Ahgao	
Psammocora spp.	Stony corals	Kuraling	Yeal
Psychotria mariana		Aplokateng	

Pteropus mariannus	Mariana Fruit Bat	Fanihi	Pai'Scheei
Ptilinopus roseicapilla	Mariana Fruit Dove	Paluman totut	Mwee'mwe
Ramphotyphlops braminus	Brahminy Blindsnake	Ulo'attilong	
Rattus spp.	Rat	Cha'ka	
Rhipidura rufifrons mariae	Rufous Fantail	Naabak	Leteghi par
Rhipidura rufifrons saipanensis	Rufous Fantail	Naabak	Leteghi par
Rusa marianna	Philippine Deer	Binadu	
Ruvettus pretiosus	Oilfish		
Samoana fragilis	Fragile Tree Snail	Denden	
Sarcophyton spp.	Toadstool corals		
Sargassum spp.	Brown macroalgae		
Scaevola taccada	Half Flower	Nanaso	
Seriatopora aculeata	A stony coral	Kuraling	Yeal
Sida acuta	Broom Grass	Escobilla	
Siganus spp.	Rabbitfish	Mañahak	
Sinularia spp.	Leather corals		
Spathodea campanulata	African Tulip Tree		Apär
Spathoglottis spp.	Ground orchids		
Sphyraena spp.	Barracudas	Alon Laiguan	
Stenella attenuata	Pantropical Spotted Dolphin		
Stenella longirostris	Spinner Dolphin	Toninos	Ghu
Sternula albifrons sinensis	Little Tern		
Stichopus chloronotus	Greenfish		
Stichopus horrens	Beche-de-mer		
Sula dactylatra personata	Masked Booby	Lu'ao (talisai)	Amwo
Sula leucogaster plotus	Brown Booby	Lu'ao	O'mwo'o'bwesch
Sula rubripes	Red-footed Booby	Lu'ao talisai	Amwo
Suncus murinus	Musk Shrew	Cha'ak	
Sus scrofa	Pig	Babui	
Synapta maculata	Spotted Worm Sea Cucumber		
Taratichthys steindachneri	Sickle Pomfret		
Tectus niloticus	Topshell		
Terminalia catappa	Tropical Almond	Talisai	
Thelenota ananas	Prickly Redfish		
Thespesia populnea	Rosewood	Banalo	
Thunnus albacares	Yellowfin Tuna	Makuró	
Todiramphus albicilla	Mariana Kingfisher	Sihek	Waaw
Todiramphus albicilla orii	Mariana Kingfisher	Sihek	Waaw
Todiramphus albicilla owstoni	Mariana Kingfisher	Sihek	Waaw
Tournefortia argentea	Velvet Leaf	Hunik	
Trapezia spp.	Guard crabs		
Trema orientalis	Charcoal Tree	Agaunai	Tal Amama
Tridacna maxima	Small Giant Clam	Hima	Tto

Tridacna spp.	Giant clams	Hima	Tto/Shafeshaf
Tridacna squamosa	Fluted Giant Clam	Hima	Shafeshaf
Tripneustes gratilla	Collector Urchin	Laun	Larr
Turbinaria spp.	Brown Algae		
Turbo argyrostomus	Silver-mouthed Turban	Aliling pulan	Lifott maram
Turbo petholatus undescribed subspecies	Tapestry Turban	Aliling pulan	Lifott maram
Turbo setosus undescribed subspecies	Rough Turban	Aliling pulan	Lifott maram
Turbo spp.	Turban snails	Aliling pulan	Lifott maram
Vagrans egistina	Mariana Wandering Butterfly	Ababbang	Libweibwogh
Valonia spp.	Macroalgae		
Vigna marina	Beach Pea		
Wasmannia auropunctata	Little Fire Ant		
Xylocarpus moluccensis	Cannonball Tree	Lalamyok	
Zosimus aeneus	A reef crab		
Zosterops conspicillatus saypani	Bridled White-eye	Nosa'/Chuchirika	Litchogh
Zosterops rotensis	Rota White-eye	Nosa'	Litchogh

APPENDIX B. REGIONAL BIOLOGICAL EXPERTS THAT PROVIDED INPUT

The degree of input of these individuals varied from answering a few questions related to their area of expertise, to full participation in the planning process from species evaluation through review of the complete draft Plan.

Name	Affiliation	Taxon
David Benavente	CNMI Bureau of Environmental and Coastal Quality	Marine
Julia Boland	U.S. Fish and Wildlife Service	Bats
Kevin Brindock	Naval Facilities Engineering Command Marianas	Mariana Swiftlet
Trey Dunn	CNMI Division of Fish and Wildlife	Marine
Peter Dutton	National Oceanic and Atmospheric Administration	Sea Turtles
Neal Evenhuis	Bishop Museum	Insects
Karen Frutchey	National Oceanic and Atmospheric Administration	Sea Turtles
John Gourley	Micronesian Environmental Services	Marine
Michael Hadfield	University of Hawaii-Manoa	Land Snails
Marie Hill	National Oceanic and Atmospheric Administration	Marine Mammals
John Iguel	CNMI Bureau of Environmental and Coastal Quality	Marine
Steven Johnson	CNMI Bureau of Environmental and Coastal Quality	Marine
Lyza Johnston	CNMI Bureau of Environmental and Coastal Quality	Marine
Shelly Kremer	U.S. Fish and Wildlife Service	Birds
Allan Ligon		Marine Mammals
Steve McKagan	National Oceanic and Atmospheric Administration	Marine
Ross Miller	University of Guam	Insects
Todd Miller	CNMI Division of Fish and Wildlife	Marine
Aubrey Moore	University of Guam	Insects
Ryan Okano	CNMI Bureau of Environmental and Coastal Quality	Marine
Erin Oleson	National Oceanic and Atmospheric Administration	Marine Mammals
Patrick Opay	National Oceanic and Atmospheric Administration	Sea Turtles
Jill Peiffer	Northern Arizona University	Golden White-eye
Dan Polhemus	U.S. Fish and Wildlife Service	Insects
Paul Radley	CNMI Division of Fish and Wildlife	Birds
Robert Reed	U.S. Geological Survey	Terrestrial Reptiles
Mike Richardson	U.S. Fish and Wildlife Service	Insects
Gordon Rodda	U.S. Geological Survey, retired	Terrestrial Reptiles
Sean McDuff	CNMI Division of Fish and Wildlife	Marine
David Sischo	Hawaii Division of Forestry and Wildlife	Land Snails
Barry Smith	University of Guam, formerly	Land Snails
Tammy Summers	Rainbow Connection Research	Sea Turtles
Mike Tenorio	CNMI Division of Fish and Wildlife	Marine
Mike Trianni	National Oceanic and Atmospheric Administration	Marine
Frank Villagomez	CNMI Division of Fish and Wildlife	Marine
Scott Vogt	Naval Facilities Engineering Command Pacific	Reptiles, Coconut Crab
Gary Wiles	Guam Division of Aquatic and Wildlife Resources (former)	Bats
Lainie Zarones	CNMI Department of Lands and Natural Resources	Birds

Appendix C.1. Bioscoring "cheat sheet"

Biological Vulnerability Ranking – Categories and Scores

1. **Population Size***

Throughout the range of the taxon, the estimated number of adults, or the estimated number of colonies of sessile colonial animals.

a)	0-500 individuals	10 pts
b)	501-1,000 individuals, or population size is unknown but suspected to be small	8
c)	1,001-3,000 individuals	6
d)	3,001-10,000 individuals	4
e)	10,001-50,000 individuals, or population size is unknown but suspected to be large	2
f)	>50,000 individuals	0

2. **Population Trend***

Overall trend in number of individuals throughout taxon's range over the last 2 decades (or other appropriate time interval considering taxon's generation time). If population trend is unknown, consider trends in the availability and condition of the taxon's habitat as indicative of population trend.

a)	Population size known to be decreasing	10 pts
b)	Trend unknown but population size suspected to be decreasing	8
c)	Population formerly experienced serious declines but is presently stable or increasing	6
d)	Population size stable or suspected to be stable or increasing	2
e)	Population size known to be increasing	0

3. **Range Size***

The number of islands with which the taxon is associated during the season when distribution is most restricted

a)	One island	20 pts
b)	Two islands	16
c)	3 islands	14
d)	4 islands	12
e)	5-15 islands	10
f)	>15 islands	0

* If a distinct breeding population which includes all local individuals is widely-recognized by the scientific community (e.g. "Indo-Pacific population"), and published information is available, then that species is ranked based on the status of the particular breeding population, rather than the entire global population.

4. **Reproductive Potential**

Ability of the taxon to recover from serious declines in population size

A. Average number of offspring per adult female (or hermaphroditic adult) per year that survive to sexual maturity. If survivorship is unknown, the average number of eggs or live young produced/adult female/year.

a)	<1 offspring/female/year	5 pts
b)	1-9 offspring/female/year	3
c)	10-100 offspring/female/year	1
d)	>100 offspring/female/year	0

B. Minimum age at which females typically first reproduce

a)	>8 yr	5 pts
b)	4-8 yr	3
c)	2-3 yr	1
d)	<2 yr	0

5. **Specialization**

Degree to which the taxon is dependent upon certain ecological or environmental requirements which may result in increased vulnerability of the taxon

If requirements are not met:

a)	Highly specialized: no substantial adjustment to address the limitation; the affected population will significantly decline (>50% over 10 years or 3 generations).	10 pts
b)	Moderately specialized: some adjustment to address the limitation; the affected population will moderately decline (10-50% over 10 years or 3 generations).	5
c)	Not specialized: affected population adjusts to address the limitation with little or no decline (<10% over 10 years or 3 generations).	0

"Specialization" has a stricter definition here than the general use of the term in ecology. For the purpose of vulnerability scoring, the "specialization" must increase the vulnerability of the species. For example, many species exhibit aggregating behavior, which biologists would commonly refer to as a behavioral specialization. If a species is targeted for harvest, and the aggregating behavior renders it more susceptible to capture, it should be scored as specialized (either high or moderate depending on specific circumstances). However, if an aggregating species is not targeted for harvest, then the aggregating behavior may not increase population vulnerability and the species would therefore be scored as "not specialized".

General examples of specializations:

- Reproductive: Sea turtles' association with a preferred beach for nesting
- Behavioral: Cave-roosting bats that require access and lack of disturbance at the roosting site
- Habitat: Anemonefish that require anemones as a habitat component
- Dietary: Monarch butterflies that feed exclusively on milkweeds
- Environmental: Corals that require water temperature or pH within a narrow range

Appendix C.2. Bioscores for all evaluated species. Scores are followed by the information source ID in parentheses. Information sources are found in Appendix C.3.

Class	Scientific Name	English Name	Population Size	Trend	Range	Age at Maturity	Offspring	Specialization	Total Score
Chondrichthyes	*Carcharhinus amblyrhynchos*	Grey Reef Shark	2 (46)	8 (46)	0 (37)	5 (88)	3 (88)	5 (7)	23
Actinopterygii	*Cheilinus undulatus*	Napoleon Wrasse	2 (90)	10 (90)	0 (90)	5 (21)	0 (25)	5 (7)	22
Actinopterygii	*Chlorurus microrhinos*	Steephead Parrotfish	2 (46)	8 (46)	0 (46)	3 (101)	0 (7)	5 (7)	18
Actinopterygii	*Leptoscarus vaigiensis*	Seagrass Parrotfish	2 (26, 46)	8 (46)	0 (12)	0 (101)	0 (7)	10 (74)	20
Aves	*Megapodius laperouse laperouse*	Micronesian Megapode	2 (4)	2 (4)	10 (4)	0 (52)	3 (52)	10 (7)	27
Aves	*Ardenna pacifica*	Wedge-tailed Shearwater	0 (46)	10 (46)	0 (46)	3 (6)	5 (6)	0 (7)	18
Aves	*Phaethon lepturus dorotheae*	White-tailed Tropicbird	0 (46)	10 (46)	0 (46)	1 (7)	5 (82)	0 (7)	16
Aves	*Phaethon rubricauda melanorhynchos*	Red-tailed Tropicbird	2 (46)	2 (46)	0 (46)	0 (6)	5 (6)	0 (7)	9
Aves	*Sula dactylatra personata*	Masked Booby	2 (46)	8 (46)	0 (46)	3 (43)	5 (43)	0 (7)	18
Aves	*Sula leucogaster plotus*	Brown Booby	0 (46)	8 (46)	0 (46)	1 (6)	3 (6)	0 (7)	12
Aves	*Sula sula rubripes*	Red-footed Booby	0 (46)	8 (46)	0 (46)	1 (6)	5 (6)	0 (7)	14
Aves	*Fregata minor palmerstoni*	Great Frigatebird	0 (46)	8 (46)	0 (46)	5 (107)	5 (6)	0 (7)	18
Aves	*Ixobrychus sinensis*	Yellow Bittern	0 (46)	8 (46)	0 (49)	1 (6)	3 (49)	0 (7)	12
Aves	*Egretta sacra sacra*	Pacific Reef-heron	0 (46)	2 (46)	0 (46)	0 (42)	3 (69)	0 (7)	5
Aves	*Gallinula chloropus guami*	Mariana Common Moorhen	10 (100)	2 (17, 100)	16 (100)	0 (99)	3 (102)	5 (7)	36
Aves	*Sternula albifrons sinensis*	Little Tern	0 (46)	10 (46)	0 (46)	1 (6)	3 (6)	0 (7)	14
Aves	*Onychoprion lunatus*	Grey-backed Tern	0 (46)	8 (46)	0 (46)	3 (6)	5 (6)	0 (7)	16
Aves	*Onychoprion fuscatus oahuensis*	Sooty Tern	0 (46)	8 (46)	0 (46)	3 (6)	5 (6)	0 (7)	16
Aves	*Anous stolidus pileatus*	Brown Noddy	0 (46)	2 (46)	0 (46)	1 (6)	5 (6)	0 (7)	8
Aves	*Anous minutus marcusi*	Black Noddy	0 (46)	2 (46)	0 (46)	1 (6)	5 (6)	0 (7)	8
Aves	*Gygis alba candida*	White Tern	0 (46)	2 (46)	0 (46)	3 (6)	5 (6)	0 (7)	10
Aves	*Gallicolumba xanthonura*	White-throated Ground Dove	2 (5, 14, 15, 16, 29, 30, 31, 67, 68)	10 (16)	10 (49)	0 (6)	3 (49)	0 (7)	25
Aves	*Ptilinopus roseicapilla*	Mariana Fruit Dove	2 (5, 14, 15, 16)	10 (15, 16)	12 (49)	0 (6)	5 (49)	0 (7)	29
Aves	*Aerodramus bartschi*	Mariana Swiftlet	4 (51)	6 (32)	12 (51)	0 (111)	3 (51)	5 (7)	30
Aves	*Todiramphus albicilla albicilla*	Mariana Kingfisher	4 (5, 14, 15)	2 (5, 14, 15)	14 (45)	0 (6)	3 (50)	0 (7)	23
Aves	*Todiramphus albicilla orii*	Mariana Kingfisher	4 (16)	10 (16)	20 (45)	0 (6)	3 (50)	0 (7)	37
Aves	*Todiramphus albicilla owstoni*	Mariana Kingfisher	4 (4, 29, 30, 31, 68, 114)	2 (4, 29, 114)	10 (45)	0 (6)	3 (50)	0 (7)	19
Aves	*Myzomela rubratra asuncionis*	Micronesian Honeyeater	2 (4, 29, 30, 31, 68, 114)	2 (4, 29)	10 (45)	0 (63)	3 (89)	0 (7)	17
Aves	*Myzomela rubratra saffordi*	Micronesian Honeyeater	0 (5, 14, 15, 16)	10 (15, 16)	14 (45)	0 (63)	3 (89)	0 (7)	27

Class	Scientific Name	English Name	Population Size	Trend	Range	Age at Maturity	Offspring	Specialization	Total Score
Aves	*Rhipidura rufifrons mariae*	Rufous Fantail	2 (5, 16)	0 (5, 16)	20 (22)	0 (7)	3 (49)	0 (7)	25
Aves	*Rhipidura rufifrons saipanensis*	Rufous Fantail	0 (14, 15)	10 (14)	14 (22)	0 (7)	3 (49)	0 (7)	27
Aves	*Monarcha tatatsukasae*	Tinian Monarch	2 (15)	10 (15)	20 (15)	0 (6)	3 (50)	0 (7)	35
Aves	*Corvus kubaryi*	Mariana Crow	10 (61)	10 (61, 116)	20 (116)	1 (71)	5 (116)	0 (7)	46
Aves	*Acrocephalus hiwae*	Nightingale Reed-warbler	4 (4, 14)	10 (14)	16 (14)	0 (6)	3 (72)	0 (7)	33
Aves	*Zosterops conspicillatus saypani*	Bridled White-eye	0 (5, 14, 15)	2 (5, 14, 15)	14 (95)	0 (6)	3 (3)	0 (7)	19
Aves	*Zosterops rotensis*	Rota White-eye	2 (16)	6 (16)	20 (95)	0 (6)	3 (3)	0 (7)	31
Aves	*Cleptornis marchei*	Golden White-eye	0 (5, 14)	10 (14)	16 (95)	0 (6)	5 (77)	0 (7)	31
Aves	*Aplonis opaca aeneus*	Micronesian Starling	2 (4, 29, 30, 31, 68, 114)	2 (4)	10 (45)	0 (6)	3 (49)	0 (7)	17
Aves	*Aplonis opaca guami*	Micronesian Starling	0 (5, 14, 15, 16)	0 (5, 14, 15, 16)	12 (45)	0 (6)	3 (49)	0 (7)	15
Mammalia	*Stenella longirostris longirostris*	Spinner Dolphin	2 (46)	8 (46)	0 (75)	3 (78)	5 (78)	0 (7)	18
Mammalia	*Emballonura semicaudata rotensis*	Pacific Sheath-tailed Bat	10 (112)	0 (112)	20 (112)	0 (7)	5 (112)	5 (112)	40
Mammalia	*Pteropus mariannus mariannus*	Mariana Fruit Bat	4 (103, 106)	10 (103, 106)	10 (103)	0 (103)	5 (103)	5 (103)	34
Reptilia	*Cryptoblepharus poecilopleurus*	Oceanic Snake-eyed Skink	2 (46)	2 (46)	0 (118)	0 (7)	3 (118)	0 (7)	7
Reptilia	*Emoia atrocostata*	Littoral Skink	2 (46)	2 (46)	0 (118)	0 (2)	3 (118)	10 (7)	17
Reptilia	*Emoia caeruleocauda*	Pacific Blue-Tail Skink	2 (46)	2 (46)	0 (118)	0 (2)	3 (118)	0 (7)	7
Reptilia	*Emoia slevini*	Mariana Skink	2 (46)	10 (118)	10 (84)	0 (2)	3 (118)	0 (7)	25
Reptilia	*Hemidactylus frenatus*	Common House Gecko	2 (46)	2 (46)	0 (118)	0 (7)	3 (118)	0 (7)	7
Reptilia	*Lepidodactylus lugubris*	Mourning Gecko	2 (84)	2 (7)	0 (118)	0 (11)	3 (118)	0 (7)	7
Reptilia	*Nactus pelagicus*	Pacific Slender-toed Gecko	2 (46)	2 (46)	0 (118)	0 (7)	3 (118)	0 (7)	7
Reptilia	*Perochirus ateles*	Micronesian Gecko	2 (103)	8 (46)	0 (118)	0 (7)	3 (118)	0 (7)	13
Reptilia	*Ramphotyphlops braminus*	Brahminy Blindsnake	2 (7)	2 (7)	0 (118)	0 (7)	3 (118)	0 (7)	7
Reptilia	*Eretmochelys imbricata bissa*	Hawksbill Turtle	8 (110)	10 (110)	0 (60)	5 (8)	5 (87)	10 (7)	38
Reptilia	*Chelonia mydas* Marianas population	Green Sea Turtle	6 (58, 59, 110)	10 (98)	10 (98)	5 (8)	5 (65)	10 (7)	46
Echinoidea	*Tripneustes gratilla*	Collector Urchin	0 (18)	8 (62)	0 (62)	0 (62)	0 (62)	5 (7)	13
Holothuroidea	*Actinopyga mauritiana*	Surf Redfish	0 (56)	10 (56)	0 (56)	0 (44)	0 (44)	5 (7)	15
Holothuroidea	*Holothuria whitmaei*	Black Teatfish	2 (56)	10 (56)	0 (56)	0 (7)	0 (93)	5 (7)	17
Malacostraca	*Coenobita spp.*	Land Hermit Crab spp	0 (24)	8 (7)	0 (13)	0 (73)	0 (73)	5 (7)	13
Malacostraca	*Birgus latro*	Coconut Crab	2 (46)	10 (34)	0 (34)	5 (92)	0 (34)	0 (7)	17
Malacostraca	*Cardisoma carnifex*	Mangrove Crab	2 (7)	8 (7)	0 (13)	3 (115)	0 (20)	10 (13)	23
Malacostraca	*Grapsus tenuicrustatus*	Rock Crab	2 (7)	8 (7)	0 (13)	0 (23)	0 (23)	0 (7)	10
Malacostraca	*Ocypode ceratophthalma*	Horned Ghost Crab	2 (7)	8 (7)	0 (91)	0 (47)	0 (7)	5 (7)	15

Class	Scientific Name	English Name	Population Size	Trend	Range	Age at Maturity	Offspring	Specialization	Total Score
Malacostraca	*Panulirus longipes bispinosus*	Longlegged Spiny Lobster	2 (46)	8 (46)	0 (79)	3 (38)	0 (40)	5 (7)	18
Malacostraca	*Panulirus pencillatus*	Pronghorn Spiny Lobster	2 (46)	8 (46)	0 (79)	1 (19)	0 (19)	5 (7)	16
Malacostraca	*Panulirus versicolor*	Painted Spiny Lobster	2 (46)	2 (46)	0 (79)	3 (38)	0 (108)	5 (7)	12
Malacostraca	*Panulirus spp.*	All Panulirus Lobsters	2 (46)	8 (46)	0 (79)	3 (38)	0 ()	5 ()	18
Insecta	*Vagrans egistina*	Mariana Wandering Butterfly	10 (105)	10 (105)	20 (105)	0 (7)	0 (7)	10 (105)	50
Insecta	*Ischnura luta*	Rota Damselfly	8 (7)	8 (7)	20 (80)	0 (86)	0 (86)	10 (80)	46
Bivalvia	*Tridacna maxima*	Small Giant Clam	2 (76)	10 (76)	0 (76)	5 (53)	5 (27)	5 (7)	27
Bivalvia	*Tridacna squamosa*	Fluted Giant Clam	2 (76)	10 (76)	0 (76)	3 (83)	5 (27)	5 (7)	25
Bivalvia	*Tridacna spp.*	All Giant Clams	2 (76)	10 (76)	0 (76)	5 (52)	5 (27)	5 (7)	27
Bivalvia	*Gafrarium pectinatum*	Pectinate Venus	2 (7)	8 (7)	0 (7)	0 (70)	0 (7)	5 (7)	15
Cephalopoda	*Octopus cyanea*	Day Octopus	2 (81)	8 (7)	0 (81)	0 (81)	0 (81)	5 (7)	15
Gastropoda	*Cassis cornuta*	Horned Helmet	2 (33)	10 (33)	0 (33)	1 (7)	0 (7)	10 (33)	23
Gastropoda	*Charonia tritonis tritonis*	Triton's Trumpet	2 (35)	10 (35)	0 (35)	1 (7)	0 (117)	5 (7)	18
Gastropoda	*Lambis lambis*	Common Spider Conch	2 (10)	10 (10)	0 (10)	3 (10)	0 (48)	5 (7)	20
Gastropoda	*Partula gibba*	Humped Tree Snail	8 (41, 96)	10 (41, 96)	10 (96)	0 (28)	1 (28)	5 (7)	34
Gastropoda	*Partula langfordi*	Langford's Tree Snail	10 (96)	10 (96)	20 (96)	0 (28)	1 (28)	5 (7)	46
Gastropoda	*Partula undescribed species*	Rota Partulid Snail	8 (9.5, 64)	10 (9.5)	20 (94)	0 (28)	1 (28)	5 (7)	44
Gastropoda	*Samoana fragilis*	Fragile Tree Snail	8 (104)	10 (104)	16 (104)	0 (28)	1 (28)	5 (7)	40
Gastropoda	*Turbo argyrostomus*	Silver-mouthed Turban	2 (54)	8 (54)	0 (39)	3 (57)	0 (55)	5 (7)	18
Gastropoda	*Turbo petholatus* Marianas subspecies	Tapestry Turban	2 (54)	8 (54)	10 (39)	3 (57)	0 (55)	5 (7)	28
Gastropoda	*Turbo setosus* Marianas subspecies	Rough Turban	2 (54)	8 (54)	10 (39)	3 (57)	0 (55)	5 (7)	28
Gastropoda	*Turbo spp.*	All Turbo Snails	2 (54)	8 (54)	10 (39)	3 (57)	0 (55)	5 (7)	28
Gastropoda	*Chicoreus ramosus*	Branched Murex	2 (66)	8 (66)	0 (66)	1 (7)	0 (66)	5 (7)	16
Anthozoa	*Acropora globiceps*	A Coral (1)	0 (1)	10 (1)	0 (1)	3 (109)	0 (109)	10 (1)	23
Anthozoa	*Acropora retusa*	A Coral (2)	0 (1)	10 (1)	0 (1)	3 (109)	0 (109)	10 (1)	23
Anthozoa	*Seriatopora aculeata*	A Coral (3)	0 (1)	10 (1)	0 (1)	0 (97)	0 (97)	5 (1)	15
Anthozoa	*Acropora spp.*	All Staghorn Corals	0 (109)	10 (1)	0 (109)	3 (109)	0 (109)	10 (7)	23

Appendix C.3. References for bioscores.

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Appendix D.1. Threat assessment "cheat sheet"

Threat Assessment Ratings and Criteria

Scope

Scope is the proportion of the species within the CNMI that can reasonably be expected to be affected by the threat within 10 years with continuation of current circumstances and trends (Table 1). Current circumstances and trends include both existing as well as potential new threats. The ten-year time frame can be extended for some longer-term threats, such as global warming, that need to be addressed today. For species, scope is measured as the proportion of the species' population in the CNMI affected by the threat.

For the CNMI, scope typically is a measure of where the threat is occurring, i.e. which islands are affected by the threat. Scope can also refer to the timing or seasonality of a threat.

Table 1. CNMI scoring of the scope of threats

Very High	Affects all or most **(71-100%)** of the total population or occurrences
High	Affects much **(31-70%)** of the total population or occurrences
Moderate	Affects some **(11-30%)** of the total population or occurrences
Low	Affects a small **(1-10%)** proportion of the total population or occurrences

Severity

Within the scope (i.e. where and when the threat is active), severity is the level of damage to the species from the threat that can reasonably be expected with continuation of current circumstances and trends (including potential new threats)(Table 2). Severity of threats is assessed within a ten-year or three generation time-frame, whichever is longer (up to 100 years).

For species, severity is often measured as the degree of reduction of the species' population. Surrogates for adult population size (e.g., area) should be used with caution, as occupied areas, for example, will have uneven habitat suitability and uneven population density.

Table 2. CNMI scoring of the severity of threats

Very High	Within the scope, the threat is likely to reduce the species population by **71-100%**
High	Within the scope, the threat is likely to reduce the species population by **31-70%**
Moderate	Within the scope, the threat is likely to reduce the species population by **11-30%**
Low	Within the scope, the threat is likely to reduce the species population by **1-10%**
Note: Severity is assessed within a 10-year or 3-generation time frame, whichever is longer (up to 100 years).	

Irreversability

Irreversability (permanence) is the degree to which the effects of a direct threat can be reversed and the species affected by the threat restored (Table 3). Irreversability applies to the negative effects of the threat on the species, not the threat itself. In other words, some threats cannot be stopped, so irreversibility refers to how difficult it would be to mitigate the negative effects of the threat on the species.

It is important to note that the use of the irreversibility rating is largely in respect to prioritizing potential threats. If a threat is looming that will cause irreversible damage, then it makes sense to try to address that threat (i.e. brown tree snake introduction). However, if the threat has already occurred and the irreversible damage has already taken place, then it may not make sense to prioritize that threat for action (i.e. certain extant feral animal populations).

Table 3. CNMI scoring of irreversibility of threats

Very High	Effects of the threat cannot be reversed and it is very unlikely the species can be restored, and/or it would take more than 100 years to achieve this (e.g., wetlands converted to a shopping center).
High	Effects of the threat can technically be reversed and the species restored, but it is not practically affordable and/or it would take 21-100 years to achieve this (e.g., wetland converted to agriculture).
Moderate	Effects of the threat can be reversed and the species restored with a reasonable commitment of resources and/or within 6-20 years (e.g., ditching and draining of wetland).
Low	Effects of the threat are easily reversible and the species can easily be restored at a relatively low cost and/or within 0-5 years (e.g. off-road vehicles trespassing in wetland).

Appendix D.2. Summary of threat rankings of all evaluated terrestrial species

Threats Across Terrestrial Species	Micronesian Megapode	Wedge-tailed Shearwater	White-tailed Tropicbird	Red-tailed Tropicbird	Masked Booby	Brown Booby	Red-footed Booby
Brown Tree Snake	Medium		Medium	Medium	Medium	Medium	Medium
Invasive vines	High						
Commercial development (e.g. resorts)	Medium	Low					
Volcanic activity	High	Medium	Medium	Medium	Medium	Medium	Medium
Military expansion	Low	Low	Low	Low	Low	Low	Low
Typhoons (climate change)	Medium	Low	Low	Low	Low	Low	Low
Altered precipitation patterns (climate change)							
Curious Skink, Carlia ailanpalai							
Sea level rise (climate change)		Low					
Feral ungulates/deer	Low						
New invasive ants (i.e. little fire ant)	Medium		Medium	Medium	Medium	Medium	Medium
Marine debris		Medium	Medium	Medium	Medium	Medium	Medium
Poaching/human persecution							
Invasive flatworm, Platydemus manokwari							
Oceanic Skink, Gehyra oceanica							
Residential development	Low						
Cat predation	Medium						
Agricultural homestead development	Low						
Non-native insects							
Temperature rise (climate change)							
Wildfire	Low						
Pesticide use							
Rats		Medium	Medium	Medium	Medium	Medium	Medium
Incompatible recreational use (human disturbance)		Low					
Unsustainable or unknown harvest							
Black drongos							
Cockroaches							
Invasive snail, Euglandina rosea							
Shrew, Suncus marinus							
Vegetation encroachment							
Artificial lighting							
Monitor lizards							
Overall Threat Status	High	Medium	Medium	Medium	Medium	Medium	Medium

Threats Across Terrestrial Species	Great Frigatebird	Yellow Bittern	Pacific Reef-heron	Mariana Common Moorhen	Grey-backed Tern	Sooty Tern	Brown Noddy	Black Noddy
Brown Tree Snake	Medium	High		High	Medium	Medium	Medium	Medium
Invasive vines		High						
Commercial development (e.g. resorts)		Medium	Low	Medium				
Volcanic activity	Medium		Medium		Low	Medium	Medium	Medium
Military expansion	Low	High	Low	Medium	Low	Low	Low	Low
Typhoons (climate change)	Low	Medium	Medium		Low	Low	Low	Low
Altered precipitation patterns (climate change)				Medium				
Curious Skink, Carlia ailanpalai								
Sea level rise (climate change)			Medium					
Feral ungulates/deer		Low						
New invasive ants (i.e. little fire ant)	Medium				Medium	Medium	Medium	
Marine debris	Medium		High		Medium	Medium	Medium	Medium
Poaching/human persecution								
Invasive flatworm, Platydemus manokwari								
Oceanic Skink, Gehyra oceanica								
Residential development		Medium		Medium				
Cat predation				Medium				
Agricultural homestead development		Medium		Low				
Non-native insects								
Temperature rise (climate change)								
Wildfire		Low						
Pesticide use				Medium				
Rats	Medium				Medium	Medium	Medium	Medium
Incompatible recreational use (human disturbance)			Low					
Unsustainable or unknown harvest								
Black drongos								
Cockroaches								
Invasive snail, Euglandina rosea								
Shrew, Suncus marinus								
Vegetation encroachment				Low				
Artificial lighting								
Monitor lizards								
Overall Threat Status	Medium	High	Medium	High	Medium	Medium	Medium	Medium

Threats Across Terrestrial Species	White Tern	White-throated Ground Dove	Mariana Fruit Dove	Mariana Swiftlet	Collared Kingfisher ssp. albicilla	Collared Kingfisher ssp. orii (Rota)	Collared Kingfisher ssp. owstoni
Brown Tree Snake	Medium	Very High	Very High	High	High	Very High	
Invasive vines		High	High				
Commercial development (e.g. resorts)		Low	Medium	Medium	High		
Volcanic activity	Medium	Medium					High
Military expansion	Medium	Medium	Medium		High		Medium
Typhoons (climate change)	Low	Medium	Low	Low	High	High	Medium
Altered precipitation patterns (climate change)							
Curious Skink, Carlia ailanpalai							
Sea level rise (climate change)							
Feral ungulates/deer		Medium	Medium	Low			
New invasive ants (i.e. little fire ant)							
Marine debris	Medium						
Poaching/human persecution							
Invasive flatworm, Platydemus manokwari							
Oceanic Skink, Gehyra oceanica							
Residential development		Low	Medium	Low			
Cat predation							
Agricultural homestead development		Low	Low				
Non-native insects							
Temperature rise (climate change)							
Wildfire		Low	Low				
Pesticide use				Low		Medium	
Rats				Low	Medium	Medium	Medium
Incompatible recreational use (human disturbance)				Low			
Unsustainable or unknown harvest							
Black drongos						Medium	
Cockroaches				Medium			
Invasive snail, Euglandina rosea							
Shrew, Suncus marinus							
Vegetation encroachment							
Artificial lighting							
Monitor lizards							
Overall Threat Status	Medium	High	High	Medium	High	High	Medium

Threats Across Terrestrial Species	Micronesian Honeyeater ssp. asuncionis	Micronesian Honeyeater ssp. saffordi	Rufous Fantail ssp. mariae (Rota)	Rufous Fantail ssp. saipanensis	Tinian Monarch	Mariana Crow
Brown Tree Snake		Very High	Very High	Very High	Very High	Very High
Invasive vines		High	Medium	High	High	High
Commercial development (e.g. resorts)		High		High	High	Medium
Volcanic activity	Medium					
Military expansion	Medium	Low		High	High	
Typhoons (climate change)	Low	Medium	Medium	Medium	Medium	Medium
Altered precipitation patterns (climate change)						
Curious Skink, Carlia ailanpalai						
Sea level rise (climate change)						
Feral ungulates/deer			Low			Medium
New invasive ants (i.e. little fire ant)						
Marine debris						
Poaching/human persecution						High
Invasive flatworm, Platydemus manokwari						
Oceanic Skink, Gehyra oceanica						
Residential development		Medium		Medium	Medium	Medium
Cat predation		Medium	Low	Medium		High
Agricultural homestead development		Medium	Low	Medium	Medium	Low
Non-native insects						
Temperature rise (climate change)						
Wildfire		Low	Low	Low	Low	Medium
Pesticide use						
Rats						
Incompatible recreational use (human disturbance)						
Unsustainable or unknown harvest						
Black drongos						
Cockroaches						
Invasive snail, Euglandina rosea						
Shrew, Suncus marinus						
Vegetation encroachment						
Artificial lighting						
Monitor lizards						
Overall Threat Status	Medium	High	High	Very High	Very High	Very High

Threats Across Terrestrial Species	Nightingale Reed-warbler	Bridled White-eye	Rota White-eye	Golden White-eye	Micronesian Starling ssp. aeneus	Micronesian Starling ssp. guami	Pacific Sheath-tailed Bat
Brown Tree Snake	Very High	Very High	Very High	Very High			
Invasive vines	High	High	High	High			
Commercial development (e.g. resorts)	High	High		Medium			
Volcanic activity	Low				Low		
Military expansion		Medium			Medium	Medium	
Typhoons (climate change)	Medium	Medium	High	Low	Low	Medium	Medium
Altered precipitation patterns (climate change)							
Curious Skink, Carlia ailanpalai							
Sea level rise (climate change)							
Feral ungulates/deer			Medium	Medium			Low
New invasive ants (i.e. little fire ant)							
Marine debris							
Poaching/human persecution	Low						
Invasive flatworm, Platydemus manokwari							
Oceanic Skink, Gehyra oceanica							
Residential development	Low	Medium		Medium			
Cat predation							
Agricultural homestead development	Low	Medium	Low	Low			
Non-native insects							
Temperature rise (climate change)							
Wildfire	Low	Low	Low	Low			
Pesticide use			Medium				
Rats							
Incompatible recreational use (human disturbance)	Low						Low
Unsustainable or unknown harvest							
Black drongos							
Cockroaches							
Invasive snail, Euglandina rosea							
Shrew, Suncus marinus							
Vegetation encroachment							
Artificial lighting							
Monitor lizards							
Overall Threat Status	High	High	High	High	Low	Medium	Low

Threats Across Terrestrial Species	Mariana Fruit Bat	Oceanic Snake-eyed Skink	Littoral Skink	Pacific Blue-tailed Skink	Mariana Skink	Common House Gecko	Mourning Gecko	Pacific Slender-toed Gecko
Brown Tree Snake	High	High						High
Invasive vines	Medium				High			High
Commercial development (e.g. resorts)								
Volcanic activity	Low	Low		Low	High	Low	Low	Low
Military expansion	Medium			Low		Low		Medium
Typhoons (climate change)	Medium							
Altered precipitation patterns (climate change)								High
Curious Skink, Carlia ailanpalai		High	Very High	High				High
Sea level rise (climate change)		Medium	High					
Feral ungulates/deer	Medium				Medium			Medium
New invasive ants (i.e. little fire ant)								
Marine debris								
Poaching/human persecution	Medium							
Invasive flatworm, Platydemus manokwari								
Oceanic Skink, Gehyra oceanica								
Residential development								
Cat predation								
Agricultural homestead development	Low							Low
Non-native insects								
Temperature rise (climate change)								
Wildfire								Low
Pesticide use								
Rats								
Incompatible recreational use (human disturbance)								
Unsustainable or unknown harvest								
Black drongos								
Cockroaches								
Invasive snail, Euglandina rosea								
Shrew, Suncus marinus				Medium				
Vegetation encroachment								
Artificial lighting								
Monitor lizards								
Overall Threat Status	High	High	High	Medium	High	Low	Low	High

Threats Across Terrestrial Species	Micronesian Gecko	Brahminy Blindsnake	Green Sea Turtle (terrestrial only)	Hermit Crab Coenobita spp.	Coconut Crab	Mangrove Crab	Rock Crab Grapsus spp.
Brown Tree Snake	Very High						
Invasive vines	High				Medium		
Commercial development (e.g. resorts)	Medium		High	Medium	Medium	Medium	
Volcanic activity					Medium		
Military expansion	Medium		Low				
Typhoons (climate change)							
Altered precipitation patterns (climate change)	High						
Curious Skink, Carlia ailanpalai							
Sea level rise (climate change)			Medium			Very High	Medium
Feral ungulates/deer							
New invasive ants (i.e. little fire ant)			Low		High		
Marine debris							
Poaching/human persecution			High	Low	High	Low	Low
Invasive flatworm, Platydemus manokwari							
Oceanic Skink, Gehyra oceanica	Very High						
Residential development	Medium				Low		
Cat predation							
Agricultural homestead development	Low						
Non-native insects			Low				
Temperature rise (climate change)			High				
Wildfire							
Pesticide use							
Rats							
Incompatible recreational use (human disturbance)			Medium				
Unsustainable or unknown harvest				Low	Medium	Low	Low
Black drongos							
Cockroaches							
Invasive snail, Euglandina rosea							
Shrew, Suncus marinus							
Vegetation encroachment			Low				
Artificial lighting			Low				
Monitor lizards			Low				
Overall Threat Status	Very High	None	High	Low	High	High	Low

Threats Across Terrestrial Species	Ghost Crab Ocypode spp.	Mariana Wandering Butterfly	Rota Damselfly	Humped Tree Snail	Langford's Tree Snail	Rota partulid snail	Fragile Tree Snail
Brown Tree Snake							
Invasive vines				Medium	Medium	Medium	Medium
Commercial development (e.g. resorts)	High			Medium		Medium	Medium
Volcanic activity				High			
Military expansion	Low			Low			
Typhoons (climate change)				Low	Low	Low	Low
Altered precipitation patterns (climate change)			Medium	High	High	High	High
Curious Skink, Carlia ailanpalai							
Sea level rise (climate change)	Medium						
Feral ungulates/deer			Low	High			High
New invasive ants (i.e. little fire ant)				Low		Medium	Medium
Marine debris							
Poaching/human persecution	Low						
Invasive flatworm, Platydemus manokwari				Medium			Very High
Oceanic Skink, Gehyra oceanica							
Residential development				Low		Medium	Medium
Cat predation							
Agricultural homestead development				Low		Low	Low
Non-native insects		High					
Temperature rise (climate change)							
Wildfire			Low	Low		Low	Low
Pesticide use							
Rats				Medium	Medium	High	High
Incompatible recreational use (human disturbance)							
Unsustainable or unknown harvest	Low						
Black drongos							
Cockroaches							
Invasive snail, Euglandina rosea				Medium			
Shrew, Suncus marinus							
Vegetation encroachment							
Artificial lighting							
Monitor lizards							
Overall Threat Status	Medium	Medium	Low	High	High	Very High	Very High

Appendix D.3. Summary of threat rankings of all evaluated marine species

Threats Across Marine Species	Grey Reef Shark	Napoleon Wrasse	Steephead Parrotfish	Seagrass Parrotfish	Spinner Dolphin	Hawksbill Turtle (marine only)	Green Sea Turtle (marine only)	Collector Urchin	Surf Redfish	Black Teatfish	Longlegged Spiny Lobster P. longipes
Ocean acidification (climate change)			Medium					Very High	Medium	Medium	Very High
Temperature rise (climate change)			Medium								Very High
Unsustainable or unknown harvest		Medium	Low	Low				Very High	Medium	Medium	High
Poaching/illegal harvest	Low	Medium	Medium	Low		Low	High	Very High	Low	Low	High
Land-based sources of pollution		Low	Low	Low	Low			Medium	Low	Low	Medium
Military expansion					Low	Low	Low		Medium	Medium	Medium
Typhoons (climate change)											
Trophic effects of fishing	Low										
Incompatible recreational use				Low							
Marine debris					Medium	Low	Low				
Commercial shipping activities						Low	Low				
Dredging					Low						
Boat strikes					Low						
Commercial development (e.g. resorts)											
Sea level rise (climate change)											
Overall Threat Ranking	Low	Medium	Medium	Low	Low	Low	Medium	Very High	Medium	Medium	Very High

Threats Across Marine Species	Pronghorn Spiny Lobster P. pencillatus	Painted Spiny Lobster P. versicolor	Small Giant Clam T. maxima	Fluted Giant Clam T. squamosa	Pectinate Venus	Day Octopus	Horned Helmet	Triton's Trumpet	Common Spider Conch
Ocean acidification (climate change)	Very High	Very High	Very High	Very High	Very High	High	Very High	Very High	Very High
Temperature rise (climate change)	Very High	Very High	Very High	Very High		High			
Unsustainable or unknown harvest	High	High			High	Low	High	High	Very High
Poaching/illegal harvest	High	High	High	High	Medium	Low	Medium	Medium	High
Land-based sources of pollution	Medium	Medium	High	High	High	Medium	Medium	Medium	Medium
Military expansion	Medium	Medium	Low	Low		Medium	High	High	High
Typhoons (climate change)			High	High					
Trophic effects of fishing			Medium	Medium					
Incompatible recreational use			Low	Low	Medium				
Marine debris									
Commercial shipping activities			Low	Low					
Dredging			Low	Low					
Boat strikes									
Commercial development (e.g. resorts)									
Sea level rise (climate change)									
Overall Threat Ranking	Very High	Very High	Very High	Very High	High	High	High	High	Very High

Threats Across Marine Species	Silver-mouthed Turban T. argyrostomus	Tapestry Turban T. petholatus	Rough Turban T. setosus	Branched Murex	Acropora globiceps coral	Acropora retusa coral	Seriatopora aculeata coral	All staghorn corals
Ocean acidification (climate change)	Very High	Very High	Very High	Very High	Very High	Very High	Very High	Very High
Temperature rise (climate change)					Very High	Very High	Very High	Very High
Unsustainable or unknown harvest	Very High	Very High	Very High	Very High				
Poaching/illegal harvest	High	High	High	Medium				
Land-based sources of pollution	Medium	Medium	Medium	Medium	High	High	High	Very High
Military expansion	High	High	High	High	Low	Low	Low	
Typhoons (climate change)					High	High	Medium	High
Trophic effects of fishing					High	High	High	High
Incompatible recreational use					Low	Low	Low	Low
Marine debris								
Commercial shipping activities					Low	Low	Low	Low
Dredging					Low	Low	Low	Low
Boat strikes								
Commercial development (e.g. resorts)								
Sea level rise (climate change)								
Overall Threat Ranking	Very High	Very High	Very High	Very High	Very High	Very High	Very High	Very High