GREEN SEA TURTLE
(*Chelonia mydas*)
MANAGEMENT PLAN
FOR
ANDERSEN AIR FORCE BASE, GUAM

Prepared for

Andersen Air Force Base
36 CES Environmental Flight
18001 Arc Light Boulevard
Andersen AFB, GU 96929

and

Air Force Center for Environmental Excellence
HQ AFCEE/IWPH
25 E Street, Suite E-317
Hickam AFB, HI 96853-5330

Prepared by

engineering-environmental Management, Inc.
9449 Balboa Avenue, Suite 111
San Diego, California 92123

Contract No.: F41624-03-D-8599, Task Order 0081
Project No.: AJJY 62-1849
e^{2}M Project No.: 3100-081

May 2007

ACRONYMS AND ABBREVIATIONS

36 WG	36th Wing
AFB	Air Force Base
AFCEE	Air Force Center for Environmental Excellence
°C	degrees Celsius
CNMI	Commonwealth of the Northern Mariana Islands
DAWR	Guam Department of Agriculture, Division of Aquatic and Wildlife Resources
DoD	Department of Defense
e²M	engineering-environmental Management, Inc.
EOD	Exploded Ordinance Disposal
FY	Fiscal Year
GNWR	Guam National Wildlife Refuge
INRMP	Integrated Natural Resource Management Plan
IUCN	The World Conservation Union
km	Kilometers
m	Meters
MPA	Marine Preserve Area
MOU	Memo of Understanding
NGO	Non-Government Organization
NMFS-PIRO	National marine Fisheries Service-Pacific Islands Regional Office
NOAA	National Oceanic Atmospheric Administration
Plan	Green Sea Turtle Management Plan
STRP	Sea Turtle Recovery Plan
USAF	United States Air Force
USDA	United States Department of Agriculture
USGS	United States Geological Society
USFWS	United States Fish and Wildlife Service
VCO	Volunteer Conservation Officer
WPRFMC	Western Pacific Regional Fishery Management Council

Executive Summary

Air Force Center for Environmental Excellence (AFCEE) contracted engineering-environmental Management (e^2M) to prepare a Green Sea Turtle (*Chelonia mydas*) Management Plan (Plan) for Andersen Air Force Base (AAFB), Guam. The Plan was deemed necessary to evaluate the efficacy of current management practices and protocols and assess threats to the species and habitat. Overall, the purpose of the Plan is to act as a management tool to assist Federal resource managers in planning green sea turtle protection measures.

Guam's Department of Wildlife and Aquatic Resources (DAWR) has monitored sea turtle activity on the 26 miles of shoreline that make up AAFB beaches since 1984. Monitoring has primarily been conducted twice monthly by inshore-aerial surveys, and supplemented with surveys on the ground.

The highest incident of sea turtle nesting in Guam occurs at the exploded ordnance disposal (EOD) beach and on Cocos Island, though there is considerably less activity at EOD beach than at Cocos Island. At EOD beach, the highest distribution of recorded sea turtle activity was in 1993 when 17 occurrences occurred. Most of these, however, were recorded as false crawls. In 2000, 16 crawls were counted on AAFB beaches. In 2005, 11 occurrences of crawls, body pits, nesting, or hatchlings were documented at the EOD beach. Most recently, the 2006 season recorded 5 occurrences of turtles at Tarague Beach (as of August 2006). No activity was recorded at the EOD beach for calendar year 2006 (as of August 2006).

Sea turtle interactions or disturbances at AAFB could potentially include aircraft noise; loud activity at the EOD area or small arms range; loud noise at the beach restaurant (Bamboo Willies Restaurant) at Tarague Beach; security lighting at the picnic area at Tarague Beach; security lighting at the boy scout camping area; security lighting at the small arms range; ATV usage on the beaches; recreation/campers at the picnic areas at Tarague Beach; beach users walking on nests or damaging nests *in situ* with the post of a shade umbrella.

Identifying and understanding the complex natural resource challenges facing AAFB while maintaining the primary mission of national defense is the first step to developing a successful management program for AAFB. The most critical management goals for AAFB to implement to protect sea turtles include: reducing predation; reducing artificial lighting effects; establishing a curfew for campers in Tarague Basin; protecting strand and marine habitats; educating conservation officers, patrolling military officials, and visitors; and reducing marine debris.

THIS PAGE INTENTIONALLY LEFT BLANK

DRAFT GREEN SEA TURTLE MANAGEMENT PLAN
FOR
ANDERSEN AIR FORCE BASE, GUAM

TABLE OF CONTENTS

TABLE OF CONTENTS (CONTINUED)

APPENDICES

FIGURES

TABLES

1. Introduction

1.1 Purpose and Need for the Plan

Air Force Center for Environmental Excellence (AFCEE) contracted engineering-environmental Management (e^2M) under contract number F41624-03-D-8599-0081 to prepare a Green Sea Turtle (*Chelonia mydas*) Management Plan (Plan) for Andersen Air Force Base (AAFB), Guam. The Plan was deemed necessary to evaluate the efficacy of current management practices and protocols established for the protection of the species at AAFB; to evaluate current and historical nest success; to assess threats to habitat and nests, and terrestrial and in-water threats to adult, juvenile, and hatchling sea turtles; and to provide management goals and recommendations based on our findings.

Worldwide populations of the green sea turtle have dramatically declined in recent history, particularly in the Pacific Islands region. Twenty-six types of threats (worldwide) have been identified as having contributed to the decline of sea turtles. The biggest threat to green sea turtles is over harvesting, followed by loss of habitat and incidental take in fisheries (NMFS and USFWS 1998). Threats to sea turtles that have been identified on Guam include direct take, increased human presence, coastal construction, nest predation, and algae/sea grass/reef degradation (NMFS and USFWS 1998).

This Plan is intended to provide natural resource managers at AAFB with a comprehensive document identifying specific management strategies for AAFB to implement to protect the species and habitat within the context of the military mission.

1.2 Installation Location and Setting

Guam is in the western Pacific Ocean approximately 4,828 kilometers [km] southwest of Hawaii and 2,510 km southeast of Japan (**Figure 1-1**). Guam is a U.S. territory within the Mariana archipelago. The 290 km long Mariana archipelago encompasses 15 islands of the U.S. Commonwealth of the Northern Mariana Islands (CNMI) and the Territory of Guam, as well as numerous offshore banks (PIBHMC 2006). Geographically, Guam is the southernmost island in the arc.

Guam is approximately 48 km long and ranges from 6.4 km at the narrowest point to 12.8 km at the widest point (**Figure 1-2**). AAFB encompasses the northern end of the island. The entire installation is approximately 63.4 km^2 (15,463 acres), and has approximately 0.1 km^2 (26 acres) of shoreline. Any non-contiguous properties held by the U.S. Air Force (USAF) on Guam are not included in the installation size above.

More than 10 percent of Guam's coastline has been set aside in five marine preserve areas (MPAs). The older southern islands of the CNMI are volcanic in origin, but are nearly all covered with uplifted limestone from coral reefs (PIBHMC 2006).

1.3 Installation Mission

The 36th Wing (36 WG) is the host unit at AAFB. The major tenants units include the 734th Air Mobility Support Squadron, Navy Helicopter Combat Support Squadron 25, 750th Space Group, and the Guam Air National Guard. The primary mission of the 36 WG is to provide a U.S.-based war fighting platform for the deployment, reception, and throughput of air and space forces in the Asia-Pacific region. The 36 WG maintains manpower infrastructure to provide support for tactical and strategic peacetime, contingency,

Figure 1-1. Location Map

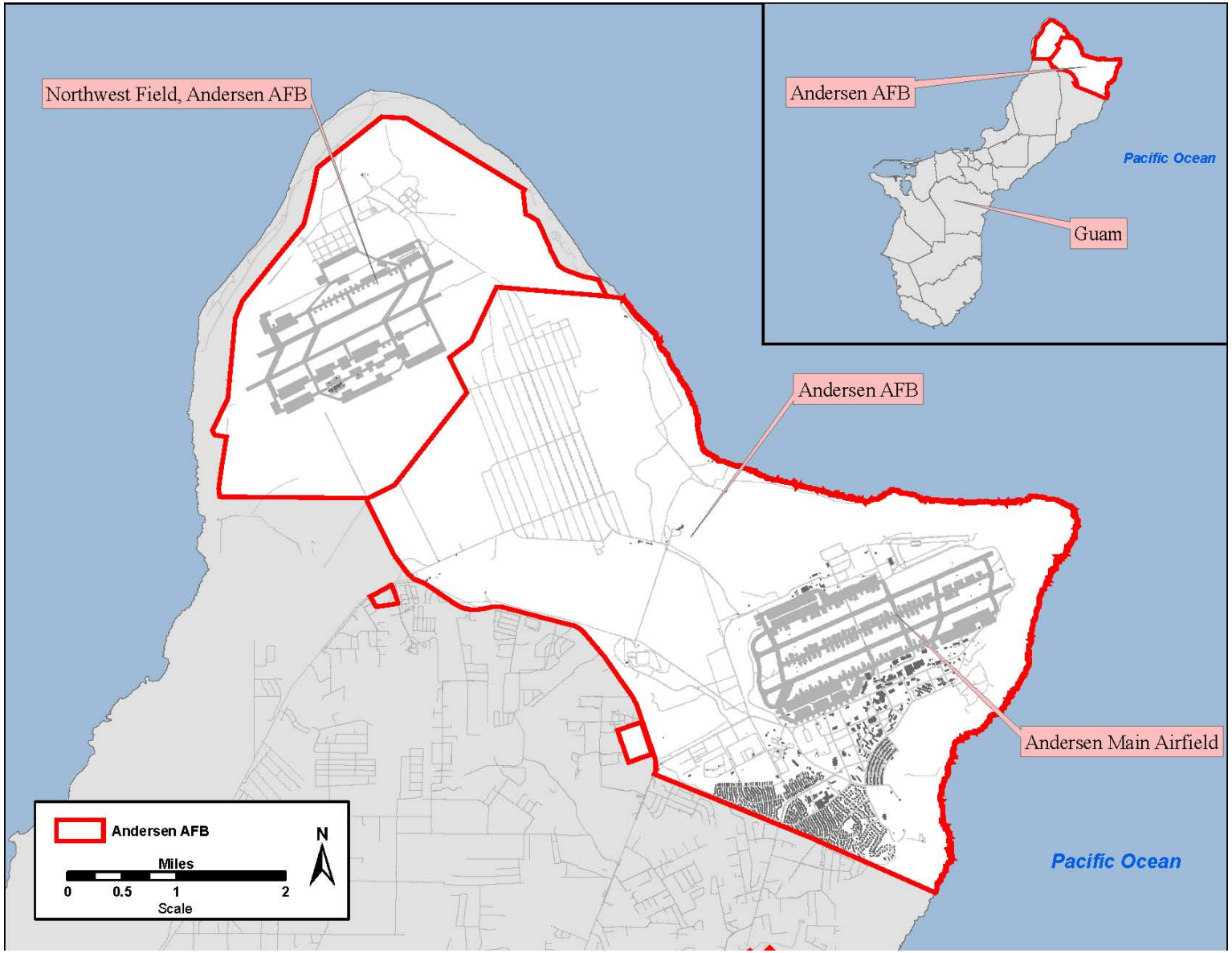

Figure 1-2. Location of Andersen AFB

and wartime deployment and employment operations, strategic airlifts, transient support, and staging operations. Guam serves as a stopping point for numerous aircraft enroute to Japan, Korea, and other Asian locations.

1.4 Climate

The climate of Guam is characterized as tropical marine with an annual mean high temperature of 30°C and an annual mean low temperature of 24°C with little variation in temperature between seasons (WRCC 2007). Average annual precipitation is 2,249 millimeters (mm) with the majority of rain falling in the wet season, July to October. Less rain and stronger winds typically occur during the dry season from January to April. The intervening months are transitional and can be wetter or drier depending on regional climate cycles (WRCC 2007). Tropical weather systems occur frequently in the Western Pacific and can rapidly escalate to typhoon strength with winds in excess of 119 kilometers per hour (kph). Typhoons can strike Guam during any month of the year, but the probability of tropical weather system formation in the Western Pacific is greatest between May and November (JTWC 2007).

1.5 Strand Vegetation

Strand vegetation on AAFB largely consists of the following: tree heliotrope (*Tournefortia argentea*), coconut palm (*Cocos nucifera),* ironwood (*Casuarina equisetifolia*), nonak (*Hernandia sonora*), silver bush (*Sophora tomentosa*), rosewood (*Thespesia populnea*), nigas (*Pemphis acidula*), beach morning glory (*Ipomoea pes-caprae*), fish kill tree (*Barringtonia asiatica*), *Guttarda speciosa*, half flower or fan flower (*Scaevola taccada*), and beach pea (*Vigna marina*) (Raulerson and Rinehart 1991, UOG 2007).

2. Natural History of the Green Sea Turtle (*Chelonia mydas)*

Adult green sea turtles average approximately 1 meter in length and can range in weight from 90 to 225 kilograms (kg). Size and weight can vary geographically, with adult populations in the Mariana archipelago typically ranging from approximately 113 to 158 kg.

Sea turtles are primarily a solitary species by nature, but have been known to congregate and forage on seagrass beds (*Halodule uninervis*)[1], or on nearshore reefs as juveniles and adults. Juvenile sea turtles are generally identified as those that are approximately 10 years old, with subadults ranging from 10 to 30 years old and sexually mature adults approximately 25 years and older. The typical life span of a green sea turtle is estimated to be approximately 80 years.

The typical diet of green sea turtle hatchlings is believed to consist of zooplankton and crustaceans. As the green sea turtles mature, they change to a strictly herbivorous diet, feeding on sea grass and algae. In the Mariana Islands, marine algae are believed to be the primary food source for green sea turtles, when available (SFSC 2001). In many areas, however, the sea turtles are known to prefer feeding on seagrasses instead of algae.

Adult sea turtles will migrate thousands of miles between their primary feeding area and their preferred nesting beach. They do not mate yearly, but will mate every 2, 3, or 4 years (USFWS 2006a). In Guam, peak nesting activity occurs from April to June; however, adult turtles have nested well outside of the peak nesting season, as early as January and as late as September. This has caused speculation that the region likely supports two nesting seasons. A small population of resident juvenile green and hawksbill (*Eretmochelys imbricata*) sea turtles are known to forage on seagrass beds at all times of the year in waters surrounding Guam.

Female sea turtles will drag themselves from the sea to the beach to nest at night. Their symmetrical track with a center tail drag mark is very distinguishable. Tracks average approximately 80 centimeters (cm) in width (Eglin AFB 2006). A female can lay as many as nine clutches in one season, but typically lays an average of three clutches with an inter-nesting average of approximately 13 days apart. Clutch size ranges from approximately 75 to 200 eggs per clutch, with an average clutch size of 100 eggs for green sea turtles that have historically nested on AAFB. Each clutch laid by a single female is usually laid on the same beach, and often times very near to the same location as previous clutches. Evidence strongly suggests all species of sea turtles will return to nest on their natal beach.

The female will often spend time on the beach finding the right location for her to nest, as is evident from an examination of tracks and body pits on the beach. She will dig a body pit and carefully excavate the sand with her back flippers to create an egg chamber. After the female deposits her clutch, the nest is covered first with the most recent sand removed from the nest, then progressively shallower sand. This methodical approach to nest covering is believed to take place to help properly regulate nest temperature. The female will completely camouflage the area with sand prior to leaving the beach. Females will commonly exhibit a behavior known as a false crawl. These unsuccessful nesting attempts can be attributed to a known factor, such as a disturbance, or many other unknown factors.

Sex determination of each egg does not occur until incubation, where the eggs are affected by external factors such as temperature and heat exchange. Recent findings indicate that warmer nest temperatures will produce females, and cooler nest temperatures will produce males. The pivotal temperature for a

[1] *Halodule uninervis* is one of the three species of sea grasses surrounding Guam and other nearby islands. The three sea grass species are listed in Guam's Species of Greatest Conservation Need report (DAWR 2005a).

green sea turtle nest, where an equal number of males and females are produced in the nest is 28.26°C, though this can vary by geographic region (Gulko and Eckert 2004).

Eggs will incubate approximately 60 days. Hatchlings will usually emerge at night and orient toward the brightest area, typically the horizon of the open ocean. They are known to float among driftlines in the open ocean, seeking food and protection for a number of years. As juveniles, they will return to coastal areas to forage. They will not be considered a sexually mature adult until approximately 25 years of age.

3. Regulations

3.1 *Chelonia mydas* Federally Listed Status

Chelonia mydas was federally listed as a protected species under the Endangered Species Act (ESA) on July 28, 1978 (43 Federal Register [FR] 32800) (**Appendix A**). Current U.S. Fish and Wildlife Service (USFWS) regulations designate breeding populations surrounding Florida and along the Pacific coast of Mexico as endangered; and all other populations (including populations surrounding Guam) as threatened (USFWS 2006b). Critical habitat for this species does not exist in Guam.

3.2 Applicable Regulations

Tables 3-1 through **3-3** outline international, Federal, and local regulatory directives or agreements that natural resource managers at AAFB can apply when addressing protection measures of the population of sea turtles nesting on AAFB.

Table 3-1. International Agreements

Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES) (1975)	This international agreement between countries was established to ensure that international trade of wild fauna and flora does not threaten their population density.
Convention on the Conservation of Migratory Species of Wild Animals of 1979	This international agreement addresses endangered species that travel from one government jurisdiction to another. This convention provides a framework on which to base future conservation agreements as well as a mechanism for governments to unilaterally conserve endangered migratory species (USFWS 2006c).

Table 3-2. Federal Regulations

Endangered Species Act of 1973, as amended, 16 United States Code [U.S.C.] 1531 et seq.	Provides federal protection for species that are considered under threat of extinction throughout all or a portion of their range.
Sikes Act of 1960 (16 U.S.C. 670a-670o as amended through Public Law [P.L.] 106-580, December 29, 2000)	The Sikes Act (Conservation and Rehabilitation Program on Military and Public Lands) of 1960, as amended, and the Sikes Improvement Act of 1997 provides for cooperation by the Department of the Interior (DOI) and Department of Defense (DOD) with state agencies in planning, development, and maintenance of fish and wildlife resources on military reservations throughout the United States.

Fish and Wildlife Coordination Act, 16 U.S.C. 2901 - 2911; 94 Stat. 1322, P.L. 96-366	The purposes of this act are to recognize the vital contribution of our wildlife resources to the nation, and their increasing public interest and significance, and to provide that wildlife conservation receive equal consideration and be coordinated with other features of water-resource development programs through planning, development, maintenance, and coordination of wildlife conservation and rehabilitation (UNM 2006).
Executive Order 13089, Coral Reef Protection	Directs federal agencies to study, restore, and conserve United States coral reef ecosystems.
Lacey Act of 1900, amended in 1981	This act restricts the domestic trade of birds and other wildlife which could be injurious to protected wildlife.
International Convention for the Prevention of Pollution from Ships (MARPOL) (1990)	This law prevents a vessel from dumping plastic trash anywhere in navigable waters of the United States and restricts dumping of other garbage.

Table 3-3. Local Government Regulations and Cooperative Agreements

USFWS Cooperative Agreement	An agreement between USFWS and DAWR that allows Guam to implement endangered species recovery programs.
Cooperative Agreement for the Establishment of Guam National Wildlife Refuge (GNWR)	A cooperative agreement for the establishment and management of the GNWR was executed on March 10, 1994 by the USAF and USFWS to establish the AAFB refuge overlay unit.
Memorandum of Understanding (MOU) for the establishment and management of the GNWR	MOU between the USAF, U.S. Navy, and USFWS. The MOU provides a means by which each agency may participate in the management of the refuge.
Guam Endangered Species Act, 5 GCA 63208, P.L. 15 - 36	Law that allows for the adjudication of an endangered species list for Guam.
Guam Endangered Species Act, 5 GCA Chapter 63 §63101 - 63117	Legislation that protects hawksbill and green sea turtles under local Guam law (DAWR 2005a).
Game, Forestry, and Conservation, 5 GCA Chapter 63 PL 6-85	Law describing the authority of the Guam Department of Agriculture.
Protection of Wild Animals, 5 GCA 63121	List of species that are considered protected.
Fish, Game, Forestry and Conservation, 5 GCA, 63101-63117	Laws protecting Guam's fish resources (DAWR 2005a).

4. Federal and Local Agency Involvement

The following Federal and local agencies provide regulations, guidance documents, species recovery plans, and local regulations and oversight:

- Department of Defense (DOD), U.S. Air Force (USAF)
- Government of Guam, Department of Agriculture, Division of Aquatic and Wildlife Resources (DAWR)
- National Marine Fisheries Service (NMFS) (Pacific Islands Regional Office [PIRO])
- National Oceanic & Atmospheric Administration (NOAA)
- Western Pacific Regional Fishery Management Council (WPRFMC)
- U.S. Fish & Wildlife Service (USFWS)
- U.S. Department of Agriculture (USDA)
- United States Geologic Survey (USGS).

Other stakeholders might include:

- U.S. Pacific Sea Turtle Recovery Team
- University of Guam
- U.S. Customs and Quarantine
- Guam Port Authority
- International Coral Reef Initiative
- Coral Reef Task Force
- World Conservation Union (IUCN)
- Non-Government Organizations (NGOs), such as Ocean Conservancy, The Nature Conservancy, and others.

4.1 Existing Management Agreement

DAWR establishes and enforces fishery, wildlife, and conservation policy on Guam and, as such, is responsible for the sea turtle monitoring program islandwide. An agreement currently exists between DAWR and AAFB for DAWR to: 1) gain access to the installation to monitor sea turtle activity, and 2) provide AAFB with the sea turtle data they collect on AAFB beaches on a regular basis.

4.2 Haggan-Watch

DAWR established a sea turtle recovery program (STRP) to determine the extent of Guam's resident and nesting sea turtle populations and nesting habitats by conducting beach surveys and satellite tracking. The main objectives of the STRP are

1. To collect baseline population size, nesting information, demography (age and sex), genetic, and distribution information for sea turtles in and about Guam by

a. Conducting in-water captures, tagging, and sampling of both green and hawksbill turtles

b. Surveying beaches within eight regions on the coast of Guam, a minimum of once weekly, for sea turtle nesting activity for both green and hawksbill turtles; and tagging and sampling of both species while they are nesting.

2. To encourage stewardship of Guam's sea turtles by continuing the sea turtle outreach and educational program to the public to include the sea turtle volunteer program (Haggan-Watch), the production of posters, T-shirts, and hats showcasing the cultural importance of the sea turtle to Guam, and the distribution of these items to sea turtle volunteers, schools, and the community free of charge (DAWR 2006).

DAWR established the volunteer program Haggan-Watch in January 2005. DAWR and USFWS held five training sessions for volunteers in 2005 and two in March 2006. DAWR representatives estimate that approximately 20 military personnel or families participated in the volunteer program in 2005 (includes U.S. Navy and USAF military personnel and families). AAFB natural resource managers should coordinate with DAWR to attend the annual training. This is discussed further in the management recommendations section of the Plan. **Appendix B** presents a survey form used by Haggan-Watch volunteers.

During May 2005, DAWR conducted a short training for AAFB volunteer conservation officers (VCOs) to identify sea turtle tracks, explain the notification procedure if tracks are encountered, and generally become familiar with the sea turtles in the region. Subsequent to the training, AAFB requested a more detailed training program for VCOs, but this has not yet occurred (Wusstig 2006).

5. Species Recovery Plan and Recovery Actions

5.1 Recovery Objectives and De-listing Criteria

Recovery plans delineate reasonable actions which are believed to be required to recover and/or protect the species. The *Recovery Plan for U.S. Pacific Populations of the Green Turtle* (which includes the green sea turtle population in and about Guam) represents the official position of NMFS and USFWS. NMFS and USFWS share responsibilities at the federal level for the research, management, and recovery of Pacific marine turtle populations under U.S. jurisdiction. According to the recovery plan, the goal for the green sea turtle is to de-list the species. In order for the agencies to consider de-listing, all of the following recovery criteria must be met:

1. All regional stocks that use U.S. waters have been identified to source beaches based on reasonable geographic parameters.
2. Each stock must average 5,000 (or a biologically reasonable estimate based on the goal of maintaining a stable population in perpetuity) females estimated to nest annually (FENA) over six years.
3. Nesting populations at source beaches are either stable or increasing over a 25-year monitoring period.
4. Existing foraging areas are maintained as healthy environments.
5. Foraging populations are exhibiting statistically significant increases at several key foraging grounds within each stock region.
6. All priority # 1 tasks have been implemented.
7. A management plan to maintain sustained populations of turtles is in place.
8. International agreements are in place to protect shared stocks." (NMFS and USFWS 1998).

5.2 Recovery Outline for Enhancing Populations at Nesting Grounds

Within the recovery plan, guidelines for enhancing the reproductive ability of sea turtle populations at nesting grounds are included. They are:

1. Eliminating direct take of turtles and their eggs
2. Reduce direct take of turtles through public education and information
3. Increase enforcement of laws protecting turtles by law enforcement and the courts
4. Ensure that coastal construction activities avoid disruption of nesting and hatching activities
5. Reduce nest predation by domestic and feral animals
6. Reduce effects of artificial lighting on hatchlings and nesting females.
   - 6a. Quantify effects of artificial lighting on hatchlings and nesting females
   - 6b. Implement, enforce, evaluate lighting regulations or other lighting control measures where appropriate
7. Collect biological information on nesting turtle populations

7a. Monitor nesting activity to identify important nesting beaches, determine number of nesting females, and determine population trends

7b. Evaluate nest success and implement appropriate nest-protection measures on important nesting beaches

7c. Define stock boundaries for Pacific sea turtles

7d. Identify genetic stock type for major nesting beach areas

7e. Determine nesting beach origins for juvenile and subadult populations

7f. Determine the genetic relationship among Pacific green sea turtle populations (NMFS and USFWS 1998).

5.3 Recovery Outline for Protecting Nesting Grounds

Within the recovery plan, guidelines for protecting nesting habitat are included. They are:

1. Prevent the degradation of nesting habitats caused by sea walls, revetments, sand bags, other erosion-control measures, jetties, and breakwaters
2. Eliminate sand and coral rubble removal and mining practices on nesting beaches
3. Develop beach-landscaping guidelines which recommend planting of only native vegetation, not clearing stabilizing beach vegetation and evaluating the effects as appropriate
4. Ensure that beach replenishment projects are compatible with maintaining good quality nesting habitat
5. Implement nonmechanical beach-cleaning alternatives
6. Prevent vehicular driving on nesting beaches (NMFS and USFWS 1998).

5.4 Recovery Actions and Management Programs Implemented at AAFB

The following recovery actions have been implemented for the green sea turtle and other sea turtle species that may nest at AAFB:

1. Prevention of poaching and other human disturbance using patrols and law enforcement
2. Study of the ecology of the species
3. Monitoring of existing populations, and
4. Establishment of cooperative agreements for the protection of the species" (AAFB 2003).

6. Population Demographics

6.1 Archipelago Wide Distribution and Abundance

The 290 km long Mariana archipelago encompasses 15 islands of the U.S. CNMI and the Territory of Guam, as well as numerous offshore banks (PIBHMC 2006). Many of the Northern Mariana Islands are uninhabited, sparsely populated, or established as a nature preserve.

While intensive population studies of resident or nesting turtles have not occurred on many islands in the region, study intensity has been focused in the southern arc. Of all the islands in the arc, turtle density is reportedly highest on the island of Tinian (population reportedly consists of predominately resident juvenile turtles), despite its small size and limited foraging grounds, as compared with other islands in the region. Human population on Tinian is approximately 3,000 people. Saipan, Tinian, Aguijan, Rota, and Guam are known to have the highest turtle (and human) populations in the arc.

In a 2001 study, an estimated 351 individual green sea turtles were observed via 448 sightings in 27 surveys covering approximately 59 percent of Tinian's shoreline and outer reef (SFSC 2001). A comparison of observed turtle species activities within the region (Tinian and islands within the arc south of Tinian) suggests that the CNMI should presently be classified as primary resident green sea turtle habitat with a minor green sea turtle nesting component (SFSC 2001). While this statement might highlight the importance of foraging areas, it is important not to downplay the fact that turtles nesting onshore, incubating nests, and emerging hatchlings face more threats and suffer more impacts than in-water turtles.

A significant quantity of long-term species data is necessary for species de-listing, such as foraging population demographics, growth rates and survivorship, food preference, local and long-range migration, and genetic structure, among many other factors. As a long-term archipelago goal, the criteria for de-listing a species covered under the ESA should be recognized, which mandates an extensive understanding of local and regional turtle abundances, dynamics, and habitat characteristics, including carrying capacities and habitat stabilities (NMFS and USFWS 1998).

On all of the islands in the CNMI, poaching is prohibited by the CNMI Division of Fish and Wildlife, however, as in most places worldwide, it occurs among indigenous people.

6.2 Islandwide Distribution and Abundance

Locally, the DAWR establishes and enforces fishery, wildlife, and conservation policy. The peak nesting season of green sea turtles on Guam generally ranges from April through June, however, nesting occurs well outside of this range, indicating there might actually be two nesting seasons. DAWR representatives conduct surveys by air approximately twice per month. During the inshore-aerial surveys, fishing efforts and catch from reefs are primarily monitored. Sightings of in-water sea turtles and crawls on beaches are also documented.

Islandwide, evidence of turtles foraging on seagrass beds primarily occurs in Cocos Lagoon and within the Achang Reef Flat Preserve. Nesting on Guam primarily occurs on Cocos Island. There are several other beaches where active nesting occurs annually, including the beach at AAFB, Guam National Wildlife Refuge (GNWR), and at naval station Apra Harbor.

Since sea turtle population studies began on Guam in 1975, the highest recorded season of nesting was in 1997, when 67 nests were recorded islandwide. These data include nesting by green and hawksbill sea turtles. In some years (1977 through 1982 and 1987 through 1989) no nesting activity was recorded, however, there is a high likelihood that this reflects a lack of surveys rather than a lack of nests (DAWR 2000). In general, from 1975 to 2000, most of the nesting occurred at exploded ordnance disposal (EOD) beach on AAFB and on the lagoon side of Cocos Island (DAWR 2000). Data were not available during the years 2001, 2002, 2003, and 2004. Any assessment of long-term population trends on Guam should include a caveat identifying the uncertainties and unknowns in the dataset.

Green sea turtles have been sighted in-water throughout the area during all months of the year, particularly during December to February and May to June. There were a total of 783 in-water turtle sightings during surveys from 1975 through 1979 (Pritchard 1982) (NMFS and USFWS 1998).

According to a prioritization threat checklist for green sea turtles in the western and central Pacific Ocean presented in the *Recovery Plan for U.S. Pacific Populations of the Green Turtle*, **Tables 6-1** and **6-2** outline the threats to sea turtles that have been identified within Guam.

Table 6-1. Prioritized Sea Turtle Threats to the Nesting Environment in Guam

Threat to Nesting Environment		Prioritized Threat in Guam
1	Direct take – eggs	1
1a	Direct take – turtles	1
2	Increased human presence	1
3	Coastal construction	1
4	Nest predation	2
5	Beach erosion	?
6	Artificial lighting	P
7	Beach mining	?
8	Beach vehicle driving	P
9	Exotic vegetation	-
10	Beach cleaning	-
11	Beach replenishment	-

Notes:
1 = major problem
2 = moderate problem
3 = minor problem
- = not current problem
? = unknown
P = known problem, but extent unknown

Table 6-2. Prioritized Sea Turtle Threats to the Marine Environment in Guam

Threat to Marine Environment		Prioritized Threat in Guam
1	Direct take	1
2	Natural disasters	P
3	Disease/parasites	?
4	Algae/sea grass/reef degradation	2
5	Environmental contaminants	?
6	Debris (entangle/ingest)	?
7	Fisheries (incidental take) (domestic waters)	?
7b	Fisheries (incidental take) (international waters)	?
8	Predation	?
9	Boat collisions	-
10	Marina/dock development	?
11	Dredging	?
12	Dynamite "fishing"	P
13	Oil exploration/development	-
14	Power plant entrapment	-
15	Construction blasting	-

Notes:
1 = major problem
2 = moderate problem
3 = minor problem
- = not current problem
? = unknown
P = known problem, but extent unknown

Within the nesting environment, direct take of eggs and turtles and habitat loss are well known challenges facing the conservation of the species in Guam. With the exception of the direct take of turtles in the marine environment, so many unknowns are listed in the prioritization tables above it is not possible to accurately assess marine conditions for turtles. Globally, as in Guam, harvesting is the single biggest cause of sea turtle decline.

> "The effectiveness of conservation efforts in Guam [and Palau, Federated State of Micronesia (FSM), Commonwealth of the Northern Mariana Islands (CNMI) and the Republic of the Marshall Islands (RMI)] are so inadequate that all nesting populations of both the green and hawksbill are likely to be extirpated from the islands within the next twenty years if not sooner. No amount of research, tagging, regulatory actions and protected areas designation will succeed in reversing this trend unless the turtle and egg

> harvesters are educated or convinced enough to cease or drastically curtail harvesting activities. It will be virtually impossible for enforcement measures to reverse these trends by themselves; Pacific islanders are not accustomed to fining or confiscating gear of friends and neighbors or imprisoning violators. Massive education and public pressure will be essential to save the sea turtle stocks from complete collapse throughout most of the recovery region." (NMFS and USFWS 1998).

Of the islands in the region, however, it should be noted that sea turtle population recovery efforts in Guam appear to be the most established in the region and have the highest likelihood of benefiting sea turtles in this region.

6.3 AAFB Distribution and Abundance

Historically, as discussed above, the EOD beach at AAFB and Cocos Island have had the highest incident of sea turtle nesting. **Table 6-3** summarizes nests recorded strictly at AAFB from June 1984 until June 2006. Data were not available from 1985 though 1990, 1992, 1994, and 2002 through 2004.

Considering the available data provided by DAWR, nesting activity was only documented at the EOD beach from 1991 until 1997 and again in 1999, 2000, and 2005. The highest distribution of recorded sea turtle activity was in 1993 when 17 occurrences occurred at the EOD beach. Most of these, however, were recorded as false crawls. In 2000, 16 crawls were counted on AAFB beaches (AAFB 2003). "In fiscal years 2001 and 2002, funding was provided by AAFB to DAWR to track turtle activity on and near AAFB" (AAFB 2003). No turtle activity was reported on AAFB beaches during 2001 (AAFB 2003). Data were not available for turtle activity on nesting beaches at AAFB in 2002, 2003, and 2004. In 2005, 11 occurrences of crawls, body pits, nesting, or hatchlings were documented at the EOD beach. Most recently, the 2006 season recorded 5 occurrences of turtles at Tarague Beach (as of August 2006). No activity was recorded at the EOD beach. **Appendix D** presents DAWR data sheets for sea turtle nests on AAFB beaches in 2005.

Table 6-3. Recorded Sea Turtle Activity on Andersen Air Force Base
June 1984 – June 2006

Species	Activity	Location of Activity	Year	Month/Day	Nest Data, Description, or Additional Information
Hawksbill	Nesting	Between Urunao and Tarague	1984	June to July	Unknown, sighting unconfirmed
Hawksbill	Nesting	Between Urunao and Tarague	1984	June to July	Unknown, sighting unconfirmed
Hawksbill	Nesting	Between Urunao and Tarague	1984	June to July	Unknown, sighting unconfirmed
Green	Nesting	Tarague Beach	1984	June to July	Unknown hatched on July 15, 1984
Green	Nesting	Between Urunao and Tarague	1984	June to July	Unknown
Green	Nesting	Between Urunao and Tarague	1984	June to July	Unknown
Green	Nesting	Between Urunao and Tarague	1984	June to July	Unknown
Green	Nesting	Between Urunao and Tarague	1984	June to July	Unknown
Green	Nesting	Between Urunao and Tarague	1984	June to July	Unknown
Green	Nesting	AAFB (EOD)	1991	August 9	False nest
Green	Nesting	AAFB (EOD)	1991	July 10	False nest
Green	Nesting	AAFB (EOD)	1991	July 15	False nest
Green	Nesting	AAFB (EOD)	1991	June 5	False nest
Green	Nesting	AAFB (EOD)	1991	June 27	118 eggs in nest, 114 hatched on August 29, 1991
Green	Nesting	AAFB (EOD)	1991	May 29	False nest
Green	Nesting	AAFB (West EOD)	1993	April 12	104 hatched on June 15, 1993
Green	Nesting	AAFB (EOD)	1993	April 13	False crawl
Green	Nesting	AAFB (EOD)	1993	April 26	False crawl
Green	Nesting	AAFB (EOD)	1993	April 26	False crawl
Green	Nesting	AAFB (EOD)	1993	April 26	False crawl
Green	Nesting	AAFB (EOD)	1993	April 26	False crawl
Green	Nesting	AAFB (EOD)	1993	April 26	False crawl

Species	Activity	Location of Activity	Year	Month/Day	Nest Data, Description, or Additional Information
Green	Nesting	AAFB (100 yds West of EOD)	1993	February 24	False crawl
Green	Nesting	AAFB (EOD)	1993	March 26	False crawl
Green	Nesting	AAFB (EOD)	1993	May 13	Unknown hatched
Green	Nesting	AAFB (EOD)	1993	May 13	False crawl
Green	Nesting	AAFB (EOD)	1993	May 21	111 Eggs
Green	Nesting	AAFB (EOD)	1993	Unknown	Unknown hatched on July 30, 1993
Green	Nesting	AAFB (EOD)	1993	Unknown	Unknown hatched on August 2, 1993
Green	Nesting	AAFB (EOD)	1993	Unknown	Unknown hatched on August 24, 1993
Green	Nesting	AAFB (EOD)	1993	Unknown	Unknown hatched on August 24, 1993
Green	Nesting	AAFB (EOD)	1993	Unknown	Unknown hatched on August 24, 1993
Green	Nesting	AAFB (EOD)	1995	April 4	Hatched on May 27, 1993 35 egg shells on beach
Green	Nesting	AAFB (EOD)	1995	April 19	False crawl
Green	Nesting	AAFB (EOD)	1995	June 1	False crawl
Green	Nesting	AAFB (EOD)	1995	June 1	Two false crawls
Green	Nesting	AAFB (EOD)	1995	March 24	False crawl
Green	Nesting	AAFB (EOD)	1995	March 24	Two false crawls
Green	Nesting	AAFB (EOD)	1995	March 24	Three false crawls
Green	Nesting	AAFB (EOD)	1996	August 1	False crawl
Green	Nesting	AAFB (EOD)	1996	August 1	Unknown hatched on September 28, 1996
Green	Nesting	AAFB (EOD)	1996	August 1	False crawl
Green	Nesting	AAFB (EOD)	1996	August 1	Unknown hatched September 25, 1996
Green	Nesting	AAFB (EOD)	1997	April 23	Hatched/30 egg shells found on beach
Green	Nesting	AAFB (EOD)	1997	March 13	False crawl
Green	Nesting	AAFB (EOD)	1997	March 13	False crawl

Species	Activity	Location of Activity	Year	Month/Day	Nest Data, Description, or Additional Information
Hawksbill	Dead	AAFB (EOD)	1997	March 13	Desiccated on beach, cause of death unknown
Green	Nesting	Jinapsen Beach, Ritidian Point	1998	July 28	False crawl
Green	Nesting	Jinapsen Beach, Ritidian Point	1998	July 2	89 Eggs
Green	Nesting	Jinapsen Beach, Ritidian Point	1998	June 17	92 Eggs
Green	Nesting	AAFB (EOD)	1999	April 16	False crawl
Green	Nesting	AAFB (EOD)	1999	April 23	Nested with eggs, one false dig
Green	Nesting	AAFB (EOD)	1999	May 13	Expected
Green	Nesting	AAFB (EOD)	2000	June 28	False crawl* Satellite tagged, Iconel tagged
No sea turtle activity recorded in 2001 at AAFB (AAFB 2003).					
Green	Crawls/ Nesting	AAFB (EOD)/CATM	2005	July 17	Aerial survey identified 6 crawls on shore of AAFB EOD
Green	Crawls/ Nesting	AAFB (EOD)	2005	July 18	DAWR conducted site visit (after aerial survey) and found additional 3 crawls and body pits
Green	Egg casings found	AAFB (EOD)	2005	July 25	Egg casings observed above nest. Nest excavation found a total of 63 eggs (19 hatched, 7 not hatched, 37 pipped and dead)
Green	Hatchlings found	AAFB (EOD)	2005	July 29	Hatchling tracks observed above a nest. Nest excavation found a total of 101 eggs (98 hatched, 2 not hatched, 1 dead hatchling)
Green	Clutch Data	AAFB (EOD)	2005	September 28	73 days after noticed DAWR conducted clutch data GPS N 13.36.10.9 E. 144.54.50.4 Nest excavation found a total of 107 eggs (96 hatched, 4 not hatched/no embryo, 4 not hatched with embryo, 1 full term not hatched)
Green	Clutch Data	AAFB (EOD)	2005	September 28	73 days after notice DAWR conducted clutch data GPS N 13.36.10.9 E. 144.54.50.4 Nest excavation found a total of 90 eggs (85 hatched, 4 not hatched/no embryo, 1 full term not hatched

Species	Activity	Location of Activity	Year	Month/Day	Nest Data, Description, or Additional Information
Green	Clutch Data	AAFB (EOD)	2005	September 28	73 days after notice N 13.36.10.9 E 144.54.50.0 Excavated areas around potential nest, determined to be false
Green	Clutch Data	AAFB (EOD)	2005	September 28	73 days after notice DAWR conducted clutch data GPS N 13.36.11.4 E 144.54.49.6 Nest excavation found a total of 108 eggs, all hatched
Green	Clutch Data	AAFB (EOD)	2005	September 28	73 days after notice DAWR conducted clutch data GPS N13.36.11.6 E144.54.49.1 Excavated areas around potential nest, determined to be false
Green	Clutch Data	AAFB (EOD)	2005	September 28	73 days after notice DAWR conducted clutch data GPS N13.36.00.5 E144.55.32.4 Nest excavation found a total of 127 eggs (124 hatched, 1 not hatched, 2 full term not hatched
Green	Clutch Data	AAFB (EOD)	2005	October 10	Clutch inspection (no findings provided)
Green	Crawls/Pits	AAFB (Tarague Beach)	2006	February 17	Two sets of tracks: GPS 13.37.03.5 144.54.04.5 / 13.37.05.3 144.54.03.3. Observed 3 body pits
Green	Crawls/Nest	AAFB (Tarague Beach)	2006	March 20	Two sets of tracks and body pit: N13.14.28.5 E144 .39.20.5
Green	Crawl/Nest	AAFB (Tarague Beach)	2006	March 23	Crawl, appeared to have nested GPS N13.37.05.4 E144.54.03.1
Green	Clutch Data	AAFB (Tarague Beach by Sirena Beach)	2006	June 5	Conducted clutch data on nest from 3-20-06 Nest excavation found 82 eggs (51 hatched, 31 undeveloped) GPS N13.37.058 E144.54.0731
Green	Clutch Data	AAFB (Tarague Beach by Sirena Beach)	2006	June 5	Conducted clutch data on nest from 3-20-06 (no findings provided)
Green	Clutch Data	AAFB (Tarague Beach by Sirena Beach)	2006	June 5	Conducted clutch data on nest from 3-20-06 (possible false crawl, unclear if nest found)

Species	Activity	Location of Activity	Year	Month/Day	Nest Data, Description, or Additional Information

Source of Data: With the exception of data for 2001, all of the data in the table was provided by J. Gutierrez, DAWR Fisheries Supervisor, and S. Wusstig, DAWR Aquatic and Wildlife Technician II.

Notes:

Green = Chelonia mydas

Hawksbill = Eretmochelys imbricate

Nest = Confirmed lay.

False Crawl = Evidence of turtle emerging onto beach, but no evidence of lay.

Body Pit = Evidence of turtle emerging onto beach, potential evidence that turtle may or may not have attempted to nest.

Clutch Data = After evidence of hatchlings emerge from a nest, manual excavation of the nest was conducted to assess hatch success and assist any hatchlings remaining in nest.

* = The 2003 AAFB INRMP indicates that in 2000, AAFB counted one active nest and 16 crawls. However, the spreadsheet provided by DAWR indicates one false crawl at AAFB beaches in 2000.

7. Potential Interactions, Impacts, and Anthropogenic Threats Aboard AAFB

The USAF has a philosophy of cooperation and coordination with federal and local agencies to protect species and habitat within the context of the military mission.

In a north-to-south direction, the beaches on AAFB are Tarague, Scout, Sirena, and the EOD Beach (**Figure 7-1**). Jinapsen Beach, north of Tarague, is not a part of AAFB, however access to the privately owned beach is attained only through AAFB.

7.1 Evaluation of Potential Mission-Related Interactions and Impacts

Due to the remote nature of the beaches at AAFB, turtle interactions or disturbances that might be directly caused by the mission are limited to potentially include:

1. Aircraft noise
2. Any noise or loud activity at the EOD area or small arms range.

Takeoff and approach for aircraft is limited in the evening, when it is most common for adult turtles and emerging hatchlings to be on the beach. Loud noise or disturbances at the EOD or small arms range are also likely to be limited, as range firing activities are typically not conducted at night.

7.2 Evaluation of Potential Non-Mission-Related Interactions and Impacts

Turtle interactions or disturbances on AAFB not caused by the mission may include:

1. Loud noise at the beach restaurant (Bamboo Willies Restaurant) at Tarague Beach,
2. Security lighting at the picnic area at Tarague Beach
3. Security lighting at the Boy Scout camp/Sirena pavilions
4. Security lighting at the small arms range
5. ATV usage on the beaches
6. Recreation/campers/picnickers at the picnic areas at Tarague Beach
7. Beach users walking on nests or damaging nests *in situ* with the post of a sun umbrella.

Daytime beach users will typically use Tarague Beach, which provides the easiest accessibility, is staffed with lifeguards, and generally has a wider, more inviting beach with less limestone formations making swimming easier. Scout and Sirena Beaches are less used and do not offer lifeguards. Public access to the beach directly in front of the EOD is prohibited.

Lighting and noise are known to disturb emerging adult sea turtles attempting to nest and emerging hatchlings. To help alleviate this problem, security lighting could be on a motion sensor in Tarague basin. It should be recognized, however, that movements of feral pigs (*Sus scrofa*) and Philippine deer (*Cervus mariannus*) could illuminate the area frequently. Additional information on the movement of these species through Tarague Basin would be required to better assess the feasibility of motion sensors.

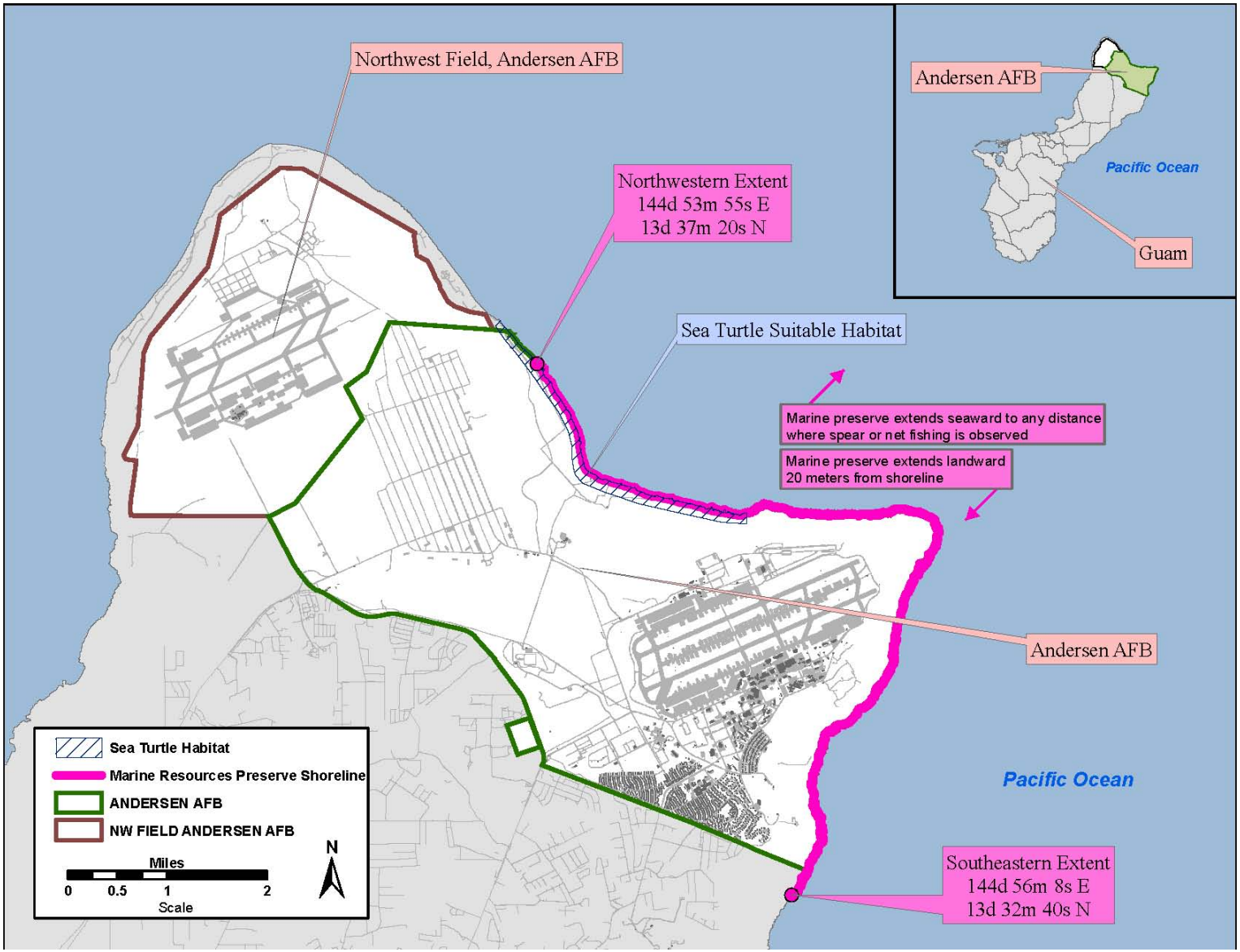

Figure 7-1. Andersen Air Force Base Beaches and Marine Preserve

7.3 Specific Cases of Interactions on AAFB

There is no record that the mission of the USAF or that beach users have directly impacted an adult turtle attempting to nest, or caused the mortality of eggs, or pre-emergent, or emerging hatchlings on AAFB beaches. There is a high likelihood, however, that both mission-related and non-mission-related interactions have occurred, and the interaction either went unknown or natural resource managers were not notified.

A paintball park and a horse stable were recently suggested for Tarague Basin, however, AAFB personnel decided not to pursue them. The current recreation director on AAFB understands that these two activities would adversely affect adult and nesting turtles and does not have any plans to significantly upgrade Tarague Basin (Steirs 2006). Keeping Tarague Basin in a natural setting is one key to protecting the species and preserving the resources.

7.4 Potential Future Interactions

Planned upgrades for Tarague Basin include the addition of approximately 5 to 10 picnic tables, 2 beach side fire pits, and 2 cliff side fire pits. These upgrades are proposed for the picnic area around the beach restaurant (Steirs 2006).

The USAF plans to establish and operate the U.S. Pacific Command's Intelligence, Surveillance, Reconnaissance, and Strike Capabilities (ISR)/Strike at AAFB from fiscal year (FY) 2007 to FY 2016. This action will reportedly cause an increase in air traffic of 45 percent, with 13 percent of flight operations expected to occur at night during active times for sea turtles (AAFB 2007). Additional studies would be required to assess the effect this program would have on nesting sea turtles. AAFB is planning to conduct noise studies throughout the phased development of this study and should include studies to assess the impact, if any, on the population of sea turtles nesting on AAFB.

7.5 Anthropogenic Threats and Natural Stressors

On AAFB beaches, sea turtles could face the following threats:

- Impacts caused by nighttime beach camping in the picnic area (e.g., noise, light pollution, interference with an emerging turtle on the beach) (**Figure 7-2**)
- Light pollution/artificial lighting (**Figures 7-3** and **7-4**)
- Noise
- Entanglement and ingestion of marine debris
- All-terrain vehicles (ATVs) and any vehicles/cars creating ruts in the sand (**Figure 7-5**)
- Nest predation
- Nest inundation
- Erosion
- Typhoons
- *In situ* nest disturbance

Figure 7-2. View depicting one of the camping and picnic areas within the strand in Tarague Basin.

Figure 7-3. View of eight pole-mounted lights at Tarague Basin. View is facing east, with the beach restaurant (Bamboo Willies Restaurant) at the right edge of the photo. The angle of several of the lights illuminates the beach at night.

Figure 7-4. View depicting the angle of lights in Tarague Basin. View is facing northwest looking toward Ritidian Point. The angle of several of the lights illuminates the beach at night.

Figure 7-5. View looking southeast toward Sirena Beach. Note ATV/vehicle path starting at bottom left corner of photo (area that is void of coral rubble).

- Excessive nest heating
- Runoff/sedimentation.

The primary turtle threats in Guam are

- Direct take
- Increased human presence
- Coastal construction
- Nest predation
- Algae/sea grass/reef degradation.

In past correspondence DAWR indicated that the two principal threats to sea turtles in Guam are thought to be habitat destruction and harvest. Habitat destruction has resulted mainly from construction and development of the shoreline due primarily to growing tourism. In 1990, more than 740,000 tourists visited the island and their numbers are expected to increase. On the northern portion of Guam where the majority of nesting occurs, the military base has limited public access and development. Nearby landowners in the Uruno area have already developed their land, likely putting some of the last nesting sites in danger. Another effect of development is sedimentation which has damaged Guam's coral reefs and, presumably, food sources for turtles (NMFS and USFWS 1998). Islandwide predation by crabs, feral dogs, stray cats, and pigs is a well-documented problem.

The use of vehicles on the beach is prohibited to protect sea turtle nests, prevent alteration to the natural topography of the coastal areas, and prevent tire ruts on the beach (AAFB 2003). **Figure 7-5**, however, depicts evidence of the use of ATVs on AAFB beaches observed during a site visit in August 2006.

7.6 Traditional Chamorro Harvest of Sea Turtles

The Chamorro name for the green sea turtle is haggan, and for the hawksbill sea turtle it is haggan karai. Turtle meat and turtle eggs were once prized food sources on Guam. Traditional harvests of sea turtles were primarily for local consumption at fiestas, weddings, funerals, and christenings. Along with the Chamorro, many indigenous people worldwide continue to eat turtle meat and turtle eggs. As was similar in other areas of the region, the ancient Chamorro used the carapace of sea turtles to create money, as well as for jewelry and for decorative purposes.

In more recent times, poaching of sea turtles has been known to occur on Guam, due to the traditional demand for its meat (DAWR 2005b). There is also poaching by immigrants, fishing crews, and tourists, especially those from areas where they are accustomed to eating turtles legally. The presence of local enforcement curtails most unauthorized take on Guam, and arrests have been made in the past (DAWR 2005b). Because the beaches and coastal areas at AAFB are protected, harvesting is not a concern.

8. AAFN Strand Description

Beaches on AAFB include Tarague, Scout, Sirena, and EOD. Of these, the most suitable habitat for nesting sea turtles on AAFB is at the EOD Beach, followed by Tarague Beach. Scout and Sirena beaches have suitable areas for turtles to come ashore, but these areas appear to have the most limestone formations at the shoreline which prevent easy access for emerging sea turtles in some areas (**Figure 8-1**). The shoreline of Jinapsen Beach, north of Tarague Beach, is not included in AAFB property. Jinapsen Beach appears to have several suitable areas for turtles to come ashore.

Figure 8-1. Suitable habitat looking northwest at Scout Beach. Note limestone formations at the shoreline in this photo which can deter an emerging sea turtle.

8.1 Conservation Accomplishments by AAFB Providing Protection to Sea Turtles

- AAFB transferred land to establish the GNWR.
- A horse stable and a paintball park were proposed in Tarague Basin, however, AAFB decided against constructing these recreation facilities.
- The goal for Tarague Basin is to maintain it as a natural setting, with recreation activities (swimming, hiking trails, camping, and picnicking) being the focus of the area.
- AAFB has not granted land owners at Jinapsen Beach exclusive access to their property.
- AAFB developed a marine preserve off their coastal waters which provides security to the installation but also protects the barrier reef system. The area off of AAFB was originally

designated as a marine preserve and managed by AAFB in 1973. The preserve, called the Pati Point Marine Preserve, is the largest of the five marine preserves on Guam, and contains 20 km^2 (approximately 4,900 acres) of reef environment. The preserve includes narrow reef flats edged by steep fore reefs with a variety of coral species. Limited access to the preserve provides some level of protection; however, enforcement of regulations is difficult. Under the territorial marine preserve designation, only hook-and-line fishing from shore is allowed for all species of fish in the preserves (DAWR 2005a).

"The AAFB beach reserves on the north coast of Guam afford protection to nesting sea turtles. Moreover, military installations discourage public access to their lands and waters which in effect serves as an enforcement mechanism against unauthorized harvest of turtles and eggs" (NMFS and USFWS 1998).

- AAFB continually recruits conservation officers, which assist in controlling the ungulate population known to predate on nests and hatchlings.
- AAFB recruits 'marine patrol' conservation officers, which assist in monitoring Tarague Basin beaches for turtle activity. Data is shared with DAWR (Mitton 2007).

9. Management Recommendations

Identifying and understanding the complex natural resource challenges facing AAFB while maintaining the primary mission of national defense is the first step to developing a successful management program. The most critical management goals for AAFB to implement include:

1. Reduce predation on nests.
2. Reduce predation on emerging hatchlings.
3. Evaluate measures to reduce the effects of artificial lighting on hatchlings and nesting females.
4. Provide annual training for volunteer conservation officers, patrolling military officials, and other affected AAFB personnel.
5. Facilitate better communication between AAFB, DAWR, and Haggan-Watch volunteers.
6. Restrict vehicle and ATV usage.
7. Educate recreational users.
8. Develop a curfew for campers in Tarague Basin.
9. Protect habitat.
10. Reduce the effects of entanglement and ingestion of marine debris.
11. Assess conditions of the AAFB Marine Preserve.

Table 9-1 below provides the rationale for each management strategy and details for implementation.

9.1 Implementation Schedule and Cost Estimate

Each of the management goals presented in **Table 9-1** are listed in the implementation schedule and cost estimate table (**Table 9-2**). Priority rankings are based on the objective opinion of the authors and were derived from an evaluation of the available data and assumptions made within this Plan. Potential management concerns and recommendations for the objectives in the table will vary due to several factors, and should be approached from an adaptive management perspective, where a learning-oriented, multiple-party approach to the management of these complex conservation problems should be attempted.

Strategy in **Table 9-2** defines how to achieve the objective or management goal, implementation duration provides an estimate for the length of time for the objective to be met, and estimated cost refers to the total expenditure necessary to achieve the objective. Some of the strategies listed in **Table 9-2** would require a permit for scientific purposes obtained from the USFWS, and would likely be implemented with DAWR and various AAFB personnel.

Table 9-1. Management Goals and Rationale

	Management Goal	Rationale
1	Prevent nest predation.	Aboard AAFB, nest predation occurs primarily by feral pigs. To a lesser degree, predation also occurs by crabs, dogs, feral cats, monitor lizards and rats. Although actual data are not available, the historic data suggests that predation by feral pigs and coconut crabs are likely significant contributors of poor recovery on AAFB beaches. Because the AAFB beaches have limited accessibility, nests should be flagged for visual identification, or the location of the nest recorded using sub-meter accuracy global positioning system (GPS). Nests should be protected from predators during the incubation period using wire mesh screens or similar forms of protection. Nests should be regularly monitored throughout incubation and nightly at 45 - 75 days post-deposition.
2	Prevent hatchling predation.	The most important factor in measuring the long-term success and recovery of the beach is by protecting hatchlings emerging from nests, and recovering and assisting those that are not able to emerge. Predation of hatchlings can occur from feral pigs, coconut crabs, fire ants, dogs, feral cats, monitor lizards, rats, seabirds, bats, and other native and non-native skinks, lizards, etc. In addition, artificial lighting can easily disorient hatchlings that focus on the brightest spot on the horizon, which under natural conditions would be the ocean. Should artificial lighting disorient hatchlings, the unnecessary time spent attempting to reach the water allows them to become easy prey. Nests should be monitored nightly at 45 - 75 days post-deposition to assist hatchling emergence.
3	Evaluate artificial lighting impacts in Tarague Basin.	Eight pole-mounted lights are located in Tarague Basin, four of which illuminate a portion of the beach. Under natural conditions, hatchlings typically emerge from nests at night and move toward the brightest, most open horizon, the ocean. However, when artificial light sources illuminate the beach, they become the brightest spot on the horizon and attract hatchlings toward the wrong direction, making them more vulnerable to predators, desiccation, entrapment in debris or vegetation, and exhaustion (USFWS 2000). Incandescent, high-pressure sodium, quartz, and mercury vapor lights are common lights in parking areas and at buildings. These types of lights emit high levels of blue and green wavelengths and consequently present the greatest potential for deterring nesting activities and causing hatchling disorientations (USFWS 2000). Studies have shown that green and hawksbill hatchlings demonstrate a strong preference for short-wavelength light. Green and hawksbill turtles were most strongly attracted to light in the near-ultraviolet to yellow region of the spectrum and were weakly attracted or indifferent to orange and red light (USFWS 2000). Shielded, low-pressure sodium lights, which are monochromatic and emit only yellow wavelengths, should be used at any illuminated area in close proximity to the beach. In addition, the use of motion sensors on

	Management Goal	Rationale
		lights should be evaluated. Native trees and shrubs can help prevent illuminating the beach when lighting is necessary. Shielding of the light source, screening with vegetation, placing lights at lowered elevations and in some cases the use of limited-spectrum low-wavelength lighting (e.g., low-pressure sodium vapor lights) are possible solutions to beach lighting problems (NMFS and USFWS 1998). Artificial lighting compatible with other nesting beach requirements can be found at http://store.starrynightlights.com/tufrli.html (**Appendix C**).
3a	Evaluate artificial lighting impacts at Scout Beach and at the small arms range.	One pole-mounted light is located at the Scout Beach pavilion and at the small arms range. Lighting in these areas should be quantified before corrective actions are implemented (see discussion above).
4	Provide annual training.	The recovery effort will be hampered if conservation officers and military personnel who will be guarding, patrolling, or working at the EOD and nearby beaches are not trained in the effects of disturbance on sea turtles, identification of tracks and related protocol, and a formal chain of command to contact natural resource managers and DAWR. Annual training for these personnel could simply consist of a standard notification procedure should tracks be observed, and an understanding to keep people away from the area until biologists or trained Haggan-Watch volunteers assess the area. Because military personnel change frequently, this training should emphasize basic facts and a standard contact protocol.
5	Facilitate communication.	Advanced coordination is required for nonmilitary to access the installation, particularly restricted areas, and at night. DAWR representatives have indicated that access has been denied to Haggan-Watch volunteers in the recent past both at the main gate and at the beach in front of the EOD. At the start of the official sea turtle season, guards should be notified and DAWR should stay in close contact with natural resource managers at AAFB to ensure easier access. An annual fish and wildlife collaboration meeting should be called by AAFB and attended by agencies, volunteers, technicians, biologists, and managers.
6	Restrict motorized vehicles.	Tire ruts created by vehicles or ATVs can prevent hatchlings from accessing the water, and make them more susceptible to predation. ATV tracks have been observed on parts of the AAFB beach, but are reportedly infrequently used. Because the AAFB beaches are not monitored on a daily basis, crawls and nesting activity can go unnoticed and ATV usage can negatively impact turtle activity. In addition, ATVs used for patrol by AAFB security guards appear to use the same path on the beach, thus creating deeper tire ruts. All motorized vehicles should be prohibited from operating on the beach.

	Management Goal	Rationale
7	Educate recreational users.	A kiosk/informational display identifying species that could inhabit the beaches of AAFB should include public education information about sea turtles. Educating the public on the value of conservation is an effective way of sustaining recovery efforts and providing support for islandwide enforcement of management regulations (NMFS and USFWS 1998).
8	Enforce curfew in Tarague Basin.	Two camping areas are located in Tarague Basin, at the picnic area at Tarague Beach and at the pavilion at Scout Beach. According to recreation data provided in the 2003 AAFB INRMP, there are 50 campsites located on 10 acres at Tarague Beach. The campsites in Tarague Beach have a current usage estimate of 4,000 - 5,500 visitors per year[2]. Based on a maximum carrying capacity of 12 people per site per day, this allows for 102,971 campers per year. There is one large campsite designated only for Boy Scouts at Scout Beach. Estimates are not available for the Boy Scout campsite. The volume of people allowed at Tarague Beach campsites, and to a lesser degree the Boy Scout campsite, has the potential to significantly disrupt sea turtle activity. Although campers are prohibited from camping on the beach, there is a high likelihood that they visit the beach after sunset. A curfew limiting noise, lighting, and beach activity should be established for campers. A reasonable curfew for campers could be from 2100 hours to sunrise. Campers should be provided with an explanation of why the curfew was established and the importance of complying with the curfew.
9	Protect habitat.	Suitable sea turtle nesting habitat is present at Jinapsen Beach. This area of shoreline should be monitored for sea turtle activity and the resources should be managed by natural resource managers. Direct access to Jinapsen Beach is not available, these property owners gain access to their property through Tarague Basin. Historic sea turtle nesting data are not available to assess the level of turtle activity on this beach. As with camping in Tarague Beach, the activity of the property owners will likely unknowingly disturb nesting turtles. Nests are not protected and have likely been predated on by feral pigs and coconut crabs, among others. AAFB should work with these property owners to develop cooperative agreements or to acquire the land.

[2] Use estimates were based on 10% over 1988 levels. Data were obtained from Table 4, Summary of Outdoor Recreation Resources, provided in AAFB INRMP prepared in 2003 (AAFB 2003).

	Management Goal	Rationale
10	Reduce marine debris.	A significant amount of marine debris, oftentimes nets, fishing line and rope, has been observed on AAFB beaches (Brown 2006). The shoreline of AAFB is a high surf area where fishing gear drifts ashore. Sea turtles that are foraging offshore and those coming ashore to nest can become entangled in or ingest marine debris. Natural resource managers should coordinate closely with AAFB grounds maintenance or the recreation director to develop a scheduled beach cleanup by employees or volunteers. The type and quantity of debris found should be documented and reported to Environmental Flight.
11	Monitor the condition of the AAFB Marine Preserve.	Baseline qualitative and quantitative studies of the biota and status of the reef at the AAFB marine preserve were conducted by Steven S. Amesbury et al., of the University of Guam in 1993, 1994, and 1995 (**Appendix E**). One effect of coastal development is runoff and sedimentation, which damages coral reefs, and presumably, food sources for turtles (NMFS and USFWS 1998). While this is not a concern at AAFB beaches, it could become a concern should adjacent property owners at Jinapsen Beach further develop their land. Algae, sea grass, and reef degradation could become a significant concern. A survey of the reef in the marine preserve should be periodically conducted to assess any changes in species composition or environmental impacts caused by siltation, sewage, contaminants, or other pollutants. A copy of the baseline study conducted by UOG in 1994 is included in **Appendix E**.

THIS PAGE INTENTIONALLY LEFT BLANK

10. List of Preparers

This Plan has been prepared under the direction of AAFB. The individuals who contributed to the preparation of this document are listed below.

Karen Stackpole
engineering-environmental Management, Inc. (e^2M)
M.S. Environmental Science and Education
B.S. Biology
A.S. Agriculture
Years of Experience: 9

Brian Hoppy
engineering-environmental Management, Inc. (e^2M)
B.A. Environmental Science
Years of Experience: 16

Nancy Jepsen
engineering-environmental Management, Inc. (e^2M)
M.S. Management
B.S. International Business
Years of Experience: 7

Shawn Gravatt
engineering-environmental Management, Inc. (e^2M)
M.E.S. Environmental Policy/Analysis
B.S. Earth Sciences
Years of Experience: 10

Dan Savercool
engineering-environmental Management, Inc. (e^2M)
M.S. Biological Oceanography
B.S. Zoology/Marine Science
A.A.S. Natural Resources Conservation
Years of Experience: 25

Suanne Collinsworth
engineering-environmental Management, Inc. (e^2M)
M.S. Environmental Sciences and Engineering
B.S. Geology
Certificate of Water Quality Management
Years of Experience: 8

Louise Baxter
engineering-environmental Management, Inc. (e^2M)
M.P.A. Public Administration
B.S. Political Science
Years of Experience: 12

THIS PAGE INTENTIONALLY LEFT BLANK

11. References

AAFB 2003 — Integrated Natural Resource Management Plan (INRMP) Andersen Air Force Base, Guam. December 2003. Department of the Air Force, 36th Air Base Wing, Civil Engineer Squadron.

AAFB 2007 — *Final Environmental Impact Statement Establishment and Operation of an Intelligence, Surveillance, Reconnaissance, and Strike Capability, Andersen Air Force Base, Guam*. January 2007. Department of the Air Force, Pacific Air Forces, Hickam Air Force Base, Hawaii

Amesbury et. al 1995 — *Andersen Air Force Base Marine Resources Preserve Baseline Survey of Marine Resources, Third Survey, June 1994*. May 31, 1995. Steven S. Amesbury, Paul R. Chirichetti, and Jynessa Dutka-Gianekki, University of Guam Marine Laboratory Environmental Survey Reoport No. 30.

Brown 2006 — Matt Brown, Guam National Wildlife Refuge. Interviewed 23 August, 2006

DAWR 2000 — Job Progress Report Research Project Segment (period October 1, 1999 to September 30, 2000) Guam DAWR. http://www.guamdawr.org/reports/fy00/FY00_turtlesfinal.pdf. Accessed 7 August, 2006

DAWR 2005a — *Guam Comprehensive Wildlife Conservation Strategy* (GCWCS), September 26, 2005. Guam DAWR. http://www.guamdawr.org/Conservation/gcwcs2/GuamCWCSChapter1-2.pdf and http://www.guamdawr.org/Conservation/gcwcs2/GuamCWCS%20Chapter3.pdf

DAWR 2005b — Guam Department of Agriculture Division of Aquatic and Wildlife Resources (DAWR). June 2005. http://www.guamdawr.org/aquatics/turtles/view. Accessed 6 November, 2006.

DAWR 2006 — Guam Department of Agriculture Division of Aquatic and Wildlife Resources (DAWR) Semi-Annual Progress Report (period covering 3/1/2005 to 8/31/2005)

Eglin AFB 2006 — *Eglin Air Force Base and Sea Turtle Nesting: A Successful Story* www.umich.edu/~esupdate/library/97.09-10/helmstetter.html)

Accessed 10 October, 2006

Gulko and Eckert 2004 — David Gulko and Karen Eckert, 2004. *Sea Turtles, an Ecological Guide*

JTWC 2007 — Joint Typhoon Warning Center (JTWC). http://www.wrcc.dri.edu/cgi-bin/cliMAIN.pl?pignas. Accessed 8 January, 2007

Mitton 2007 — Nancy Mitton, AAFB Wildlife Biologist. Personal Communication 10, April 2007.

NMFS and USFWS (1998)	National Marine Fisheries Service and U.S. Fish and Wildlife Service. 1998. Recovery Plan for U.S. Pacific Populations of the Green Turtle (*Chelonia mydas*). National Marine Fisheries Service, Silver Spring, MD. http://ecos.fws.gov/docs/recovery_plans/1998/981201e.pdf. Accessed 7 August, 2006
PIBHMC 2006	Pacific Islands Benthic Habitat Mapping Center. http://www.soest.hawaii.edu/pibhmc/pibhmc_cnmi.htm. Accessed 18 October, 2006
Pritchard 1982	Pritchard P.C.H. *Marine Turtles of Micronesia*. 1982.
Raulerson and Rinehart 1991	Raulerson, Lynn and Rinehart, Agnes. *Trees and Shrubs of the Northern Mariana Islands*. 1991
SFSC 2001	Southwest Fisheries Science Center Administrative Report H-01-06C. December 2001. *Sea Turtles and Their Marine Habitats at Tinian and Aguijan, with Projections on Resident Turtle Demographics in the Southern Arc of the Commonwealth of the Northern Mariana Islands*. http://www.pifsc.noaa.gov/adminrpts/2000-present/SWFC_Admin_Report_01-06C.pdf. Accessed 24 October, 2006.
Steirs 2006	Ray Steirs, AAFB Outdoor Recreation Director. Interviewed 22 August, 2006.
UNM 2006	Federal Wildlife and Related Laws Handbook. http://ipl.unm.edu/cwl/fedbook/fwca.html. Accessed 26 October, 2006
UOG 2007	University of Guam. http://www.uog.edu/cals/site/POG/scipn.html. Accessed 8 January, 2007.
USFWS 2000	Patrick Air Force Base, Brevard County, Florida. 2000. Revised Biological Opinion. http://www.nofs.navy.mil/about_NOFS/staff/cbl/LPSnet/USFWS.pdf
USFWS 2006a	North Florida Office Green Sea Turtle (Fact Sheet). http://www.fws.gov/northflorida/SeaTurtles/Turtle%20Factsheets/green-sea-turtle.htm. Accessed 18 October, 2006
USFWS 2006b	Species Profile, Sea Turtle, Green. http://ecos.fws.gov/species_profile/servlet/gov.doi.species_profile.servlets.SpeciesProfile?spcode=C00S. Accessed 6 October, 2006
USFWS 2006c	Laws Protecting Sea Turtles. http://www.fws.gov/archiecarr/laws.html. Accessed 24 October, 2006
WRCC 2007	Western Regional Climate Center. http://www.wrcc.dri.edu/cgi-bin/cliMAIN.pl?pignas. Accessed January, 2007
Wusstig 2006	Shawn Wusstig, Department of Aquatic and Wildlife Resources. Interviewed 24 August, 2006.