

Recovery Plan for U.S. Pacific Populations
of the
Hawksbill Turtle
(Eretmochelys imbricata)



U.S. Department of Commerce
National Oceanic and Atmospheric Administration
National Marine Fisheries Service



U.S. Department of the Interior
U.S. Fish and Wildlife Service

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RECOVERY PLAN FOR U.S. PACIFIC POPULATIONS OF THE
HAWKSBILL TURTLE

(Eretmochelys imbricata)

Prepared by

Pacific Sea Turtle Recovery Team

for

National Marine Fisheries Service

Silver Spring, Maryland

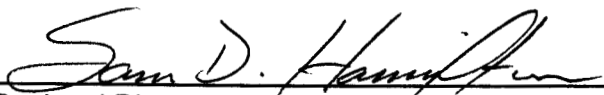
and

Pacific Region

U.S. Fish and Wildlife Service

Portland, Oregon


Approved: _____


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Date: _____

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Assistant Administrator for Fisheries, National Marine Fisheries Service

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Recovery plans delineate reasonable actions which are believed to be required to recover and/or protect the species. Plans are prepared by the National Marine Fisheries Service (NMFS) and the U.S. Fish and Wildlife Service (FWS), and sometimes with the assistance of recovery teams, contractors, State agencies and others. Objectives will only be attained and funds expended contingently upon appropriations, priorities and other budgetary constraints. Recovery plans do not necessarily represent the views nor the official positions or approvals of any individuals or agencies, other than those of NMFS and the FWS which were involved in the plan formulation. They represent the official positions of NMFS and the FWS only after they have been approved by the Assistant Administrator for Fisheries or the Regional Director. Approved recovery plans are subject to modification as dictated by new findings, changes in species status and the completion of recovery tasks.

Literature citations should read as follows:

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TABLE OF CONTENTS
(Hawksbill)

PREFACE iii

ACKNOWLEDGMENTS iv

LIST OF ABBREVIATIONS v

EXECUTIVE SUMMARY vi

I. INTRODUCTION 1

 A. Geographic Scope 1

 B. Historical and Cultural Background 4

 C. Taxonomy 5

 D. Species Description 5

 E. Population Distribution and Size 7

 Nesting Grounds 8

 Insular and Pelagic Range 11

 F. Status 13

 G. Biological Characteristics 14

 Migration and Movements 14

 Foraging Biology and Diet 16

 Growth 16

 Reproduction 17

 Offshore Behavior 20

 Health Status 21

 H. Threats 21

 Pacific Synopsis 22

 Regional Summaries 23

 U.S. West Coast 23

 American Samoa 23

 Hawaii 23

 Guam 24

 Republic of Palau 24

 Commonwealth of the Northern Mariana Islands (CNMI) 25

 Federated States of Micronesia (FSM) 25

 Republic of the Marshall Islands (RMI) 26

 Unincorporated Islands 26

 General Threat Information 29

 Nesting Environment 29

 1. Directed Take 29

 2. Increased Human Presence 30

 3. Coastal Construction 31

 4. Nest Predation 32

 5. Beach Erosion 33

 6. Artificial Lighting 33

7. Beach Mining	34
8. Vehicular Driving on Beaches	35
9. Exotic Vegetation	36
10. Beach Cleaning	36
11. Beach Replenishment	36
12. Other	36
Marine Environment	37
13. Directed Take	37
14. Natural Disasters	38
15. Disease and Parasites	39
16. Algae, Seagrass and Reef Degradation	39
17. Environmental Contaminants	40
18. Debris (Entanglement and Ingestion)	41
19. Fisheries (Incidental Take)	42
20. Predation	43
21. Boat Collisions	43
22. Marina and Dock Development	43
23. Dredging	44
24. Dynamite "Fishing"	45
25. Oil Exploration and Development	45
26. Power Plant Entrapment	45
27. Construction Blasting	45
I. Conservation Accomplishments	46
Legislation	46
Traditional Controls	46
Protected Areas	47
Other Plans and Regulations	49
Headstart and Hatchery Programs	49
Sea Turtle Conservation and Management Plans	50
Research and Education	50
Effectiveness of Conservation Accomplishments	51
II. RECOVERY	52
A. Recovery Objectives	52
B. Step Down Outline and Narrative for Recovery	53
III. REFERENCES CITED	66
IV. IMPLEMENTATION SCHEDULE	72

PREFACE

The National Marine Fisheries Service (NMFS) and the U.S. Fish and Wildlife Service (FWS) share responsibilities at the Federal level for the research, management, and recovery of Pacific marine turtle populations under U.S. jurisdiction. To accomplish the drafting of this recovery plan, NMFS appointed a team of professional biologists experienced with marine turtles in the Pacific region. This document is one of six recovery plans (one for each of the five species plus one for the regionally important population of the East Pacific green turtle).

While similar in format to previously drafted sea turtle recovery plans for the Atlantic, Caribbean, and Hawaii, the unique nature of the wider Pacific region required some modification of the recovery plan format. The geographic scope of the present plan is much larger than any previously attempted and considers areas from the western coastal United States extending to Guam. Furthermore, the amount of jurisdictional overlap between nations, commonwealths, territories and compact-of-free-association-states and their various turtle populations required a broader management perspective than has been attempted previously. Finally, sea turtles have not been studied as comprehensively in the Pacific as in other U.S. areas, and thus there are many areas in the Pacific where basic biological and ecological information must be obtained for management purposes. Thus, these plans have more extensive text on the general biology of the turtles, so that they might act as a resource to managers seeking a handy reference to the species. The plans are also subdivided into U.S. jurisdictional areas (i.e., the various territories and the commonwealth), so that local managers can address issues within their respective regions more easily.

Because of the previously noted aspects of marine turtle distribution in the Pacific (e.g., wide geographic range, multiple jurisdictions), the Recovery Team relied on the input and involvement of a large number of advisers, as can be noted by the lengthy Acknowledgments section. It is hoped that the resulting document is one that acts as a pragmatic guide to recovering the threatened and endangered sea turtle populations in the Pacific Ocean.

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LIST OF ABBREVIATIONS

CCL	curved carapace length
CITES	Convention on International Trade in Endangered Species of Wild Fauna and Flora
CNMI	Commonwealth of the Northern Mariana Islands
COE	U.S. Army Corps of Engineers
DAWR	Division of Aquatic and Wildlife Resources
EEZ	Exclusive Economic Zone
ENSO	El Niño - Southern Oscillation
EPA	U.S. Environmental Protection Agency
ESA	Endangered Species Act
ETP	Eastern Tropical Pacific
FENA	females estimated to nest annually
FSM	Federated States of Micronesia
FWS	U.S. Fish and Wildlife Service
HSWRI	Hubbs-Sea World Research Institute
IATTC	Inter-American Tropical Tuna Commission
INP	Instituto Nacional de Pesca
IUCN	International Union for the Conservation of Nature
MHI	Main Hawaiian Islands
MIMRA	Marshall Islands Marine Resource Authority
MMDC	Micronesian Mariculture Demonstration Center
MRMD	Marine Resources Management Division, Yap State government
mtDNA	mitochondrial DNA
NMFS	National Marine Fisheries Service
NOAA	National Oceanographic and Atmospheric Administration
NPS	National Park Service
NRCS	Natural Resources Conservation Service (Soil Conservation Service)
NWHI	Northwest Hawaiian Islands
PNG	Papua New Guinea
RMI	Republic of the Marshall Islands
SCL	straight carapace length
SDG&E	San Diego Gas & Electric
SPREP	South Pacific Regional Environment Program
TAMU	Texas A & M University
TED	Turtle Excluder Device
UNAM	Universidad Nacional Autónoma de México
USCG	U.S. Coast Guard
USVI	U.S. Virgin Islands
WIDECAST	Wider Caribbean Sea Turtle Conservation Network

EXECUTIVE SUMMARY

Current Status: The hawksbill turtle is listed as Endangered throughout its range. In the Pacific, this species is rapidly approaching extinction due to a number of factors, but the intentional harvest of the species for meat, eggs and the tortoiseshell and stuffed curio trade is of greatest impact. Increasing human populations and the concurrent destruction of the habitat are also of major concern for the Pacific hawksbill populations. In a review of the status of the species the members of Recovery Team (which is made up of biologists with extensive experience in the insular Pacific) were surprised and appalled at how few hawksbills are left in areas of once-high (or at least much greater) abundance. We believed that a lack of regular quantitative surveys of species distribution and population status contributed to the Team being previously unaware of how seriously depleted hawksbill populations had become in the Pacific. The status of this species is clearly of a highest concern for the Pacific and it is recommended that immediate actions be taken to prevent its extinction.

Goal: The recovery goal is to delist the species.

Recovery Criteria: To consider de-listing, all of the following 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 1,000 females estimated to nest annually (FENA) (or a biologically reasonable estimate based on the goal of maintaining a stable population in perpetuity) over six years.
- 3) All females estimated to nest annually (FENA) at "source beaches" are either stable or increasing for 25 years.
- 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 designed to maintain sustained populations of turtles is in place.
- 8) Ensure formal cooperative relationship with regional sea turtle management programs (South Pacific Regional Environment Program [SPREP]).
- 9) International agreements are in place to protect shared stocks.

Actions Needed: Eight major actions are needed to achieve recovery (not in order of priority):

- 1) Stop the direct harvest of hawksbill turtles and eggs, through education and law enforcement actions.

- 2) Reduce incidental mortalities of hawksbills by commercial and artisanal fisheries
- 3) Determine population size, status and trends through long-term regular nesting beach and in-water censuses
- 4) Identify stock home ranges using DNA analysis.
- 5) Support conservation and biologically viable management of hawksbill populations in countries that share U.S. hawksbill stocks.
- 6) Identify and protect primary nesting and foraging areas for the species.
- 7) Eliminate adverse effects of development on hawksbill nesting and foraging habitats.
- 8) Control non-native predators of eggs and hatchlings, e.g., mongoose, feral cats, and pigs, in the Hawaiian population.

RECOVERY PLAN FOR U.S. PACIFIC POPULATIONS OF THE HAWKSBILL TURTLE (*Eretmochelys imbricata*)

Prepared by the
U.S. Pacific Sea Turtle Recovery Team

I. INTRODUCTION

The scientific facts in this recovery plan have been gleaned from studies of remnant populations of what must once have been much larger numbers of sea turtles. Nesting and foraging distributions measured today are not necessarily the distributions that would have been found a hundred years ago or, if hawksbill populations are allowed to recover their numbers, what might be expected in the future. Measurements of adult body size and attributes associated with body size, such as clutch size and clutch frequency, are collected today from remnant populations consisting, perhaps, of younger animals that are smaller than normal. Descriptions of nesting beaches, nest site habitat, and foraging habitat must be held circumspect for similar reasons.

A. Geographic Scope

Defining the geographic range of a population of sea turtles in the Pacific Ocean is difficult. Sea turtles are highly migratory, and the life histories of all species exhibit complex movements and migrations through geographically disparate habitats. Because the U.S. Pacific Sea Turtle Recovery Team is required to focus on sea turtle populations that reside within U.S. jurisdiction, we must delineate what constitutes a population where individuals reside permanently or temporarily within U.S. jurisdiction and what actions must be taken to restore that population. This has proven to be quite challenging because sea turtles do not recognize arbitrary national boundaries and in most cases we have only limited data on stock ranges and movements of the various populations. In this recovery plan we have tried to make these judgements with the best information available, and to suggest means by which the United States can promote population recovery.

Geographic scope (from a U.S. jurisdictional perspective) for all six of the U.S. Pacific sea turtle recovery plans (written for five species and one regionally important population) is defined as follows: in the eastern Pacific, the west coast of the continental United States (Figure 1a); in the central Pacific, the state of Hawaii and the unincorporated U.S. territories of Howland, Baker, Wake, Jarvis, and Midway Islands, Johnston Atoll, Palmyra Atoll, and Kingman Reef; in Oceania, Guam, the Commonwealth of the Northern Mariana Islands (CNMI), and American Samoa (see Figure 1b). The U.S.-affiliated but independent nations of the Republic of the Marshall Islands (RMI), Federated States of Micronesia (FSM), and the Republic of Palau are also included. The FSM includes the states of Yap, Pohnpei, Chuuk, and Kosrae. While independent, all retain clearly defined administrative links to the United States in the areas of defense, natural resource management, and some regulatory issues. Thus, we include them here in an advisory capacity. Finally, where eastern Pacific sea turtles are held in common with Mexico, discussion of the status and recovery of these stocks will also include discussion of the resource under Mexican jurisdiction.

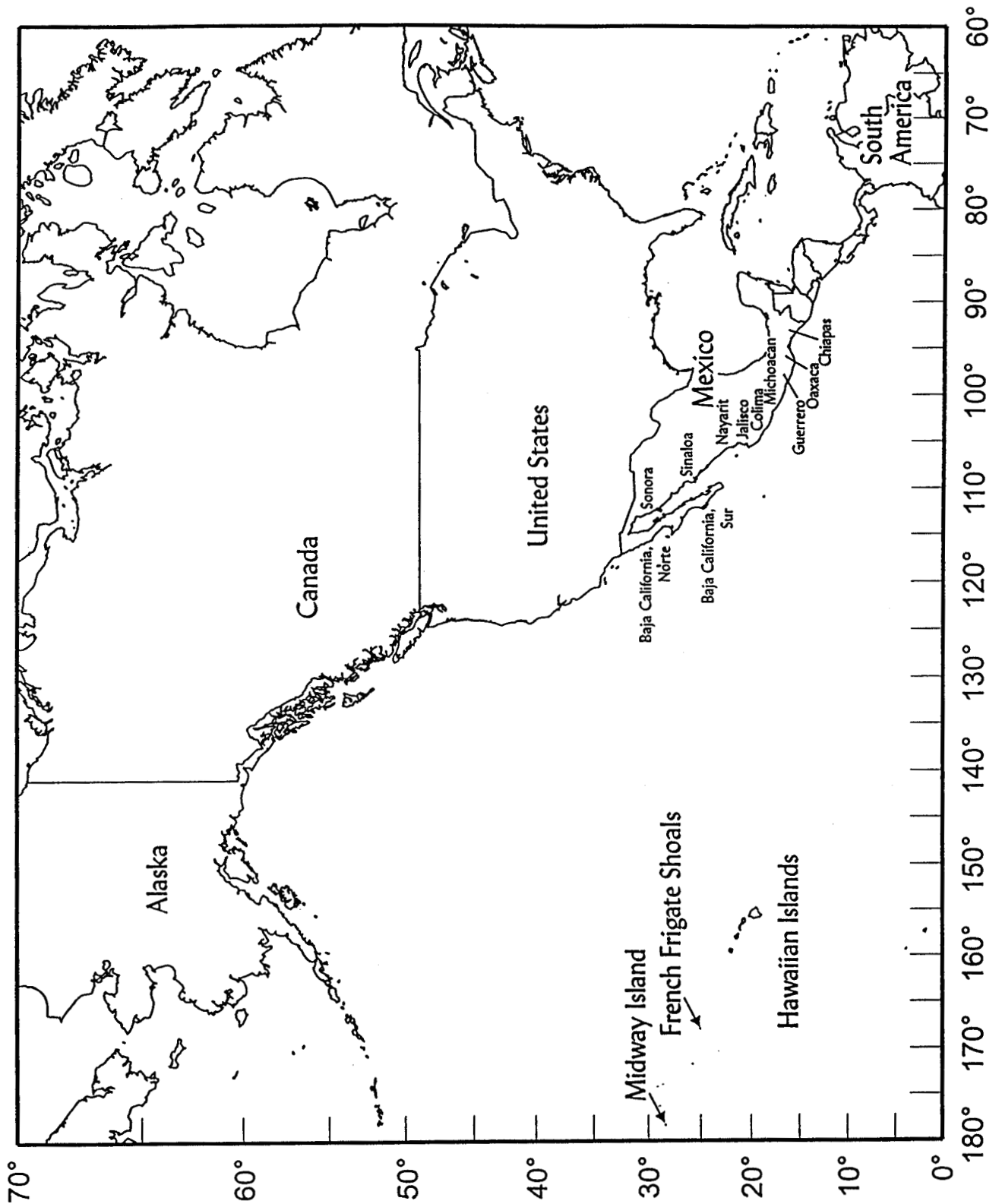
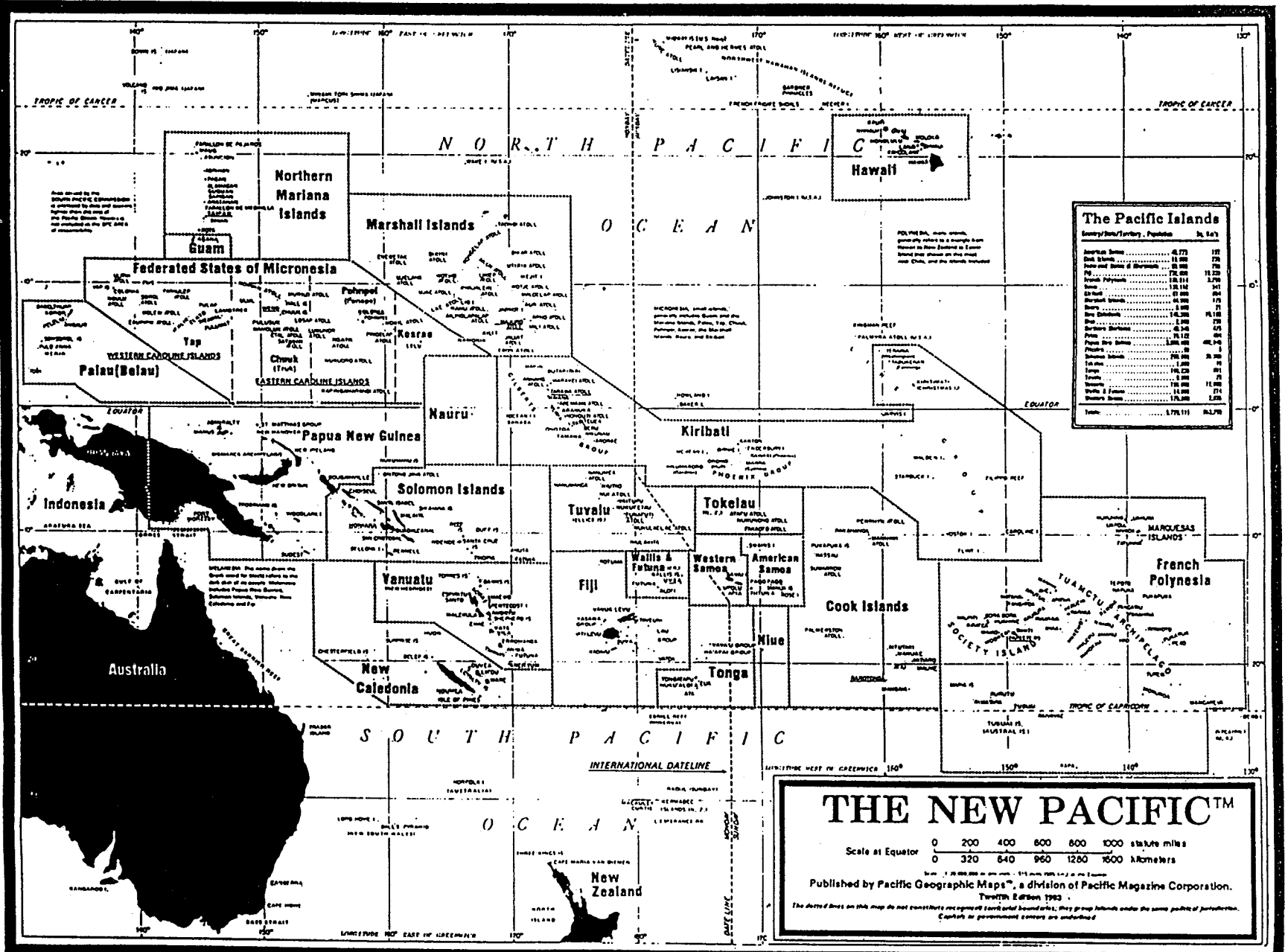


Figure 1a. Western coasts of the United States, Canada and Mexico (as well as Central and northern South America) constitute a shared habitat for Pacific sea turtles.

Figure 1b. The western Pacific constitutes a shared habitat for Pacific sea turtles.



In all cases where U.S. sea turtle stocks are held in common with other sovereign states, we have tried to suggest means by which the United States can support efforts at management of those stocks by those states. We recognize that other nations may have different priorities than the United States and we have sincerely attempted to avoid establishing policy for those nations.

As a result of the highly migratory behavior of adult turtles, and the shifting habitat requirements of post-hatchlings and juveniles, it is known that at least some of the populations of hawksbill turtles in this vast region cross international boundaries. The adjacent oceans and island-areas of Polynesia, Micronesia, Melanesia, and even the Philippines (including the South China Sea), Indonesia, Taiwan, and possibly the Bonin islands of Japan, may constitute shared habitats for hawksbill turtles. This is acknowledged in the following discussions.

B. Historical and Cultural Background

Johannes (1986) nicely summarizes the historical and cultural use of the hawksbill sea turtle, and much of what he wrote is applicable today.

For many years, the green sea turtle, *Chelonia mydas*, and the hawksbill turtle, *Eretmochelys imbricata*, have served a wide range of important functions in the lives of the inhabitants of [Micronesia, Hawaii, and American Samoa]. The eggs and flesh provided food. The shell of the hawksbill has been described as the "world's first plastic" and has served a wide variety of ornamental and practical uses. Turtle bones were used to make tools. Various parts of the turtle were used to make medicine. In addition, turtles have been (and still are on some islands) the focus of important religious or ceremonial practices.

[Today], it is not difficult to rank the different Pacific Island areas [presently or historically] under U.S. jurisdiction on a scale of departure from traditional dependence upon the sea, including sea turtles. Hawaii is clearly the most westernized, followed closely by Guam and American Samoa. The Northern Marianas are not far behind, with little evidence of significant dependence upon sea turtles.

Only in the Caroline (Palau, Yap, Chuuk, Ponape) and Marshall Islands do sea turtles still play essential roles in the lives of significant numbers of people. And even here this dependence is far from universal. Sea turtles do not appear to be essential to either cultural or nutritional well-being on most high islands or district population centers. Even in the Palau Archipelago, where an impressive reservoir of expertise concerning sea turtles suggests their former importance [including the very important role of toluk in Palauan society], only a very few handicraft makers would suffer, I suspect, if turtles became unavailable today. Here, as around many high islands, turtles are now hunted more or less like deer, for sport. A turtle for the pot is now an occasional treat, not an essential ingredient in Palauan life.

It is mainly among some of the remoter low islands of Micronesia that sea turtles remain important. McCoy (1982) and Pritchard (1982[b]) point out that turtles contribute significantly to the cultural stability of some of the peoples of the central Caroline Islands and to their independence of the outside world. 'The estimated maximum contribution to the protein (intake), perhaps 40 pounds per person per year, is not nearly as important as the cultural role described,' (McCoy 1982).

The work of McCoy and others suggests that traditional taboos and ceremonies relating to the taking and consumption of turtles have almost certainly contributed to smaller numbers being taken than would otherwise have been the case. But these traditions are fading. Moreover, island population pressures in Micronesia are increasing rapidly. On Satawal, for example, the population has doubled since the end of World War II (McCoy 1982). These factors, coupled with the introduction of technology which makes

sea travel faster and easier, all put increasing pressure on turtle stocks. The need for measures to conserve them thus also increases.

Therein lies a dilemma. The people of those islands on which turtles play a vital cultural role would suffer if turtles were denied them. But there will eventually be no turtles left if harvest rates continue to accelerate. At what point does the survival of a turtle stock dictate the implementation of conservation measures that are painful to those who depend upon turtles? No amount of study, in isolation, of subsistence use of turtles can answer this question. It requires, in addition, an understanding of sea turtle population dynamics more sophisticated than any that exists for any sea turtle stock in the world today.¹

C. Taxonomy

Carr (1952) proposed subspecific separation of the Atlantic and Indo-Pacific types based on coloration and carapace shape. The Indo-Pacific subspecies, *E. i. squamata* Agassiz (*E. i. bissa* by others), is solid black on the dorsal surface of the flippers and head, and the carapace is more heart-shaped (Witzell 1983). The Atlantic hawksbill, *E. i. imbricata* (Mertens and L. Muller), is less black on the dorsal surface of the flippers and head, and the carapace is more straight-sided and narrowly tapered posteriorly (Witzell 1983). There is considerable argument in the scientific literature as to the validity of Carr's proposal (Witzell 1983) and very little consensus among authors as to whether there should be more or fewer subspecific designations within the species.

Genetic sequencing and PCR (polymerase chain reaction) techniques are now being used to differentiate hawksbill populations worldwide and to provide information on taxonomic variation in nesting or foraging assemblages of the Indo-Pacific *E. imbricata squamata* (D. Broderick, Univ. of Queensland, pers. comm.) or the *E. i. imbricata* of the western North Atlantic (Bass 1994, Bass et al. 1996). Nesting populations are highly structured genetically throughout the Pacific (Solomon Islands, Malaysia, northeastern Australia, western Australia) and beyond to Saudi Arabia (D. Broderick, pers. comm.) and the Caribbean (Bass 1994). Mitochondrial DNA (mtDNA) analysis of turtles from four major Australian rookeries - two on the west coast and two in the northeast - showed significant differences between the two areas, while there was no significant difference between turtles nesting at the two western rookeries (100 km apart) or the two northeastern rookeries (750 km apart) (Broderick et al. 1994). However, D. Broderick (pers. comm.) suggests using the term "stocks" rather than separate subspecies, especially at the management level, because this is where population changes will be detected.

For the purpose of this recovery plan, a single taxonomic entity, *Eretmochelys imbricata*, within the Pacific shall be assumed until additional genetic information on zoogeographic distribution is received.

D. Species Description

Hawksbills are recognized by their relatively small size (carapace length less than 95 cm), narrow head with tapering "beak," thick, overlapping shell scutes, and strongly serrated posterior margin of the carapace. In addition, *Eretmochelys imbricata* may be distinguished from *Chelonia*

¹ N.B. Johannes did not cover Kosrae in his survey because significant numbers of turtles were no longer present by the time of his writing.

mydas (green turtle) by the transverse division of the prefrontal scales into two pairs (these scales are elongate and undivided in *Chelonia*) (Pritchard and Trebbau 1984).

Hatchlings

Hatchlings look similar to hatchling loggerheads, but are distinguished by the presence of four pairs of costal scutes, rather than five. Hawksbill hatchling coloration is uniform; the carapace and the top of the head and neck are tan; the sides and bottom of the head and neck, including the beak, are dark grey; the dorsal and ventral sides of the fore flippers are grey with a whitish fringe around the posterior edge; the dorsal and ventral sides of the hind flippers and plastron are dark grey with two whitish ridges posteriorly on the plastron (Witzell and Banner 1980). The average straight carapace length (SCL) of Palauan hatchlings from two nests is as follows (Sato 1991): nest #1, mean=3.95 cm, S.D.=0.07, n=103; nest #2, mean = 3.90 cm, S.D.=0.06, n=102. A sample of 235 hatchlings from Western Samoa had a mean carapace length (S.L.) of 3.9 cm and a range of 3.8-4.1 cm (Witzell and Banner 1980). These Pacific Ocean hatchling measurements are slightly smaller than for Atlantic Ocean hatchlings (Costa Rica: mean=4.2 cm, range=3.9-4.6, n=41 (Carr et al. 1966); Colombia: mean 4.2 cm, range=3.9-4.4, n=25 (Kaufmann 1967). The mean weight of 120 hatchlings from the Solomon Islands was 13.2 g (Vaughan 1981).

Juveniles

According to Witzell and Banner (1980) juvenile coloration is often variable, particularly the carapace, which ranges from light brown to black with varying amounts of distinct yellow streaks and blotches. The color variation becomes noticeable at about five months old when the head and dorsal flipper scales are black with whitish margins and the plastron is whitish with many brown blotches. The ventral side of the flippers has scattered black scales.

Adults

The carapace of adult turtles is dark brown with faint yellow streaks and blotches; the scales on the dorsal side of the flippers and head are dark brown to black with yellow margins; the ventral side of the flippers and the plastron are pale yellow, with scattered dark scales on the flippers (Witzell and Banner 1980).

Curved carapace length (CCL) is measured with a flexible tape measure laid over the curve of the carapace and is defined as the distance along the midline from the junction of the skin and carapace above the neck to the most posterior edge of the supracaudal scute. The CCL of 22 nesting females from Campbell Island (Torres Strait, Australia) was 83.16 cm (S.D. = 3.88, range = 75.5 - 92.5) (Limpus et al. 1983). The CCL of 43 nesting females from the Solomon Islands was 84.6 cm (range = 60.0 - 95.5) (Vaughan 1981). The average weight (n=38) of 20 nesting females from Campbell Island (Torres Strait) was 51.55 kg (range = 38.5 - 68.0) (Limpus et al. 1983) and of 40 Solomon Island nesting females was 146 lbs. (66.4 kg) (range = 92 - 170 lbs., 41.8-77.3 kg) (McKeown 1977). Witzell (1985) noted that the carapace length [and probable weight] of Melanesian (Solomon Islands; Torres Strait) hawksbills is smaller than Caribbean (Costa Rica; Guyana) animals and larger than Indian Ocean (Oman; South Yemen) animals.

The relationship between SCL and CCL for a sample of 22 nesting females from the Campbell Island rookery in Australia (Limpus et al. 1983) is:

$$\text{SCL} = 0.79(\text{CCL}) + 10.57 \quad r = 0.97$$

In the same study, the relationship between CCL and weight after nesting for a sample of 22 nesting females from the Campbell Island rookery in Australia (Limpus et al. 1983) is:

$$\log_{10}\text{weight} = 2.90(\log_{10}\text{CCL}) - 3.85 \quad r = 0.82$$

E. Population Distribution and Size

Hawksbill turtles are circumtropical in distribution, generally occurring from 30°N to 30°S latitude within the Atlantic, Pacific, and Indian Oceans and associated bodies of water. Along the eastern Pacific rim, hawksbills were apparently common to abundant as recently as 50 years ago in nearshore waters from Mexico to Ecuador, particularly the east coast of Baja California Sur in the vicinity of Concepción Bay and Paz Bay, Mexico (Cliffon et al. 1982). Today, the hawksbill is rare to nonexistent in most localities; there are no known nesting beaches remaining on the Pacific coast of Mexico (Cliffon et al. 1982). Hawksbills may still represent a rare nesting species along Pacific Central America, but there has been no documented nesting in recent years (Cornelius 1982).

Within the Central Pacific, nesting is widely distributed but scattered and in very low numbers. Foraging hawksbills have been reported from virtually all of the island groups of Oceania, from the Galapagos Islands in the eastern Pacific to the Republic of Palau in the western Pacific (Witzell 1983; Pritchard 1982a,b). Along the far western and southwestern Pacific, hawksbills nest on the islands and mainland of southeast Asia, from China and Japan, throughout the Philippines, Malaysia, and Indonesia, to Papua New Guinea (PNG), the Solomon Islands (McKeown 1977) and Australia (Limpus 1982).

It is most important to keep in mind when contrasting nesting and foraging populations that close proximity of nesting and foraging animals does not imply genetic or regional relatedness (Limpus 1989b). Foraging turtles observed in a lagoon probably do not relate directly to the potential for nesting on adjacent beaches, and vice-versa. In other words, foraging lagoonal turtles should not be expected to repopulate depleted nesting stocks on adjacent beaches. For example, genetic markers were used to estimate the contribution of various Caribbean hawksbill nesting beaches to a foraging population of mixed ages at Mona Island, Puerto Rico (Bowen et al. 1996). It was found that the foraging turtles were not composed primarily of hawksbills derived from the Mona Island nesting population but were drawn from other nesting populations throughout the Caribbean (hundreds of kilometers distance) but not from as far away as Brazil (7,000 km distance). Therefore, juveniles on developmental habitat and adult females on their foraging home range, both from the same genetic stock, are likely to be geographically distant from each other and from their natal beach. Additional tagging and genetic surveys will be needed to further define the unrelatedness (or relatedness) of proximal groups of foraging and nesting sea turtles.

Nesting Grounds

The largest remaining concentrations of nesting hawksbills occur on remote oceanic islands of Australia (Torres Strait) and the Indian Ocean (Republic of the Seychelles), but additional nesting concentrations of significance likely exist in other areas not yet sufficiently surveyed. This is particularly true of remote beaches in the Solomon Islands, PNG, Indonesia, and Malaysia. Visual evidence of hawksbill nesting is the least obvious among the sea turtle species, because hawksbills often select remote pocket beaches with little exposed sand to leave traces of revealing crawl marks. For example, a single site in Antigua in the Caribbean Sea, described initially as having "moderate nesting activity," has, after six years of intensive tagging, been found to support approximately 100 adult females using the 250 m beach (Hoyle and Richardson 1993). The diffuse and discrete nature of nesting by this species has made estimating Pacific population size almost impossible.

Throughout the vastness of Micronesia, the nesting picture for hawksbills appears grim. If the Republic of Palau represents the highest hawksbill nesting activity known in the region, with conceivably as few as 20 nesting females per year, then all of Micronesia with its thousands of islands and atolls may not support collectively more than a few hundred nesting females per year. The situation is hardly better in the Central and South Pacific. The island of Hawaii remains a bright hope, with an unexpected number of nesting hawksbills recently discovered and the environmental mandates are in place for absolute protection of animals, eggs and nesting habitat.

U.S. West Coast

No known nesting.

Hawaii

In Hawaii, hawksbills nest only on main island beaches, primarily along the east coast of the island of Hawaii. Two of these sites (Halape and Apua Point) are in the Hawaii Volcanoes National Park (Balazs et al. 1992, Katahira et al. 1994). Other beaches on Hawaii with recorded hawksbill nesting include Kamehame, Punaluu, Horseshoe, Ninole, Kawa and Pohue. Not all of the presently known hawksbill beaches have nesting each year. Kamehame Point on Hawaii and a black sand beach at the river mouth of Halawa Valley at the east end of Molokai are the most consistently used beaches. In surveys from 1989-1993, eighteen hawksbills were tagged and 98 nests documented. Nesting occurred from late May with hatching completed by early December. Peak nesting activity occurs from late July to early September (Katahira et al. 1994). There are no measurable trends in stock numbers, either up or down.

There are no modern-day records of nesting hawksbills or their occurrence in nearshore marine habitats anywhere in the Northeastern Hawaiian Islands. However, according to some early historical accounts, hawksbills may have occupied this region in past centuries.

American Samoa

In many areas of Oceania, local residents are unable to differentiate between the two nesting sea turtle species, hawksbill and green. Thus, a recent survey by Tuato'o-Bartley et al. (1993) was also unable to differentiate nesting activity of the two species from interviews in American Samoa.

Since hawksbills were the only nesting species found on Western Samoa (Witzell and Banner 1980) and nesting green turtles are usually found on remote sandy islands such as Rose Atoll (Balazs 1982), it is assumed that much of the anecdotal information on nesting activity on the larger islands of American Samoa relates to hawksbills.

Based on interviews, Tuato'o-Bartley et al. (1993) estimated 50 nesting females per year on Tutuila and 30 nesting females per year on the Manu'a island group of Ofu, Olosega and Ta'u, using an average 2.8 nesting turtles per active beach. Most of these may represent hawksbills, according to the previous discussion. However, since local people almost always seem to underestimate individual fecundity (numbers of clutches per female), the actual number of turtles nesting at Tutuila and Manu'a could be significantly lower than Tuato'o-Bartley's estimates. On Rose Atoll, most or all of the nesting activity is restricted to green sea turtles (Balazs 1982; Tuato'o-Bartley et al. 1993). A three-year survey (1990-1992) at Swain's Atoll yielded only one (possibly green turtle) nesting activity - thus it is likely that there is no hawksbill nesting on that atoll (P. Craig, Office of Wildlife Resources, Gov. American Samoa, pers. comm.). Witzell and Banner (1980) identified a rather precise nesting season for hawksbills in Western Samoa from October to June, with peak nesting activity in January and February, although respondents to the Tuato'o-Bartley survey indicated nesting activity throughout the year.

There are no data on trends in American Samoa, but numbers of hawksbills in Western Samoa are thought to have declined considerably within historic times, primarily due to over exploitation of eggs and nesting females (Groombridge 1982). In the survey by Tuato'o-Bartley et al. (1993), most villagers on Tutuila and the Manua group believed nesting trends (assumed to be hawksbill) were down significantly in their lifetime.

Guam

Nesting hawksbills were virtually extirpated from Guam prior to U.S. involvement and the keeping of nesting records. In November 1991, Gerald Davis (Guam Dept. of Wildlife Resources) discovered a hawksbill nest on Guam. Prior to this record, there were no confirmed records of hawksbills nesting on the island of Guam. Hawksbill nesting is apparently rare on Guam, although nesting hawksbills leave minimal crawl traces, and not all beaches on the island are properly surveyed for sea turtle nesting activity.

Republic of Palau

Groombridge (1982) reports that hawksbills in Palau occur in relative abundance, "with nesting reported on many islands." However, a steady decline in numbers of nests and nesting females has been obvious to many knowledgeable observers over the last half century (Pritchard 1982a,b), and the situation is getting worse. Residents are nearly unanimous in their opinion that nesting numbers are down significantly during their lifetimes. Noah Idechong, Director of the Palau Conservation Society, estimates that there were 75 to 100 nesting hawksbill turtles in Palau five years ago, but today that number could be 45 or lower. (N. Idechong, pers. comm.). Recent surveys by Maragos (1992), Atkinson and Guilbeaux (1992), Maragos et al. (1994), and Guilbeaux et al. (1994) suggest far fewer nesting females than previously expected, perhaps less than 20-50 individuals per year in all of Palau.

The Rock Islands in the southern lagoon of Palau (Koror State) have been known for many years to be the most important nesting area for hawksbills in the Palauan Archipelago. These islands are generally small, eroded, uplifted limestone remnants with steep sides and infrequent sandy beaches. Thirty or more beaches in the area can support nesting, including the Ngerukewid Islands (comprising the Seventy Island Nature Reserve) and four other important nesting sites at Omekang, Kmekumer, Ngkesiil, and Ulong. Nesting occurs throughout the year, with modest increases in nesting activity in December-January and July-August, inferred from nesting records collected by the Micronesian Mariculture Demonstration Center (MMDC) as part of a headstart program for hawksbills in the Rock Islands (Maragos 1991). From these records, Maragos reported an average of 58 nests found per year (1982-1990), of which 76% were identified as "nests without eggs" or nests that were illegally poached.

During a survey beginning in December 1990 and running for several months, 57 hawksbill nesting tracks were recorded in the Rock Islands during 22 survey trips by boat primarily to 19 beaches (Sato and Madriasau 1991). At the end of the survey period (29 October 1991), 87 nesting tracks were recorded during 37 survey trips, and 39 nests had already been stolen by poachers (Sato 1991). Atkinson and Guilbeaux (1992) reported 14 nests during 25 survey days from 16 June to 28 July 1992 on primarily 17 beaches historically favored by hawksbills in the same area. Guilbeaux et al. (1994) repeated a similar survey from 1 February to 24 March 1994 and reported 19 nests during 50 survey days on 11 beaches.

In summary, the annual number of nests in the Rock Islands might approach one hundred under the most favorable of circumstances. This would represent 20-25 nesting females per season, assuming 4-5 nests per turtle per season. If 40% of adult female hawksbills return to nest each year, given an average remigration interval of 2.5 years for the population, then approximately 50-60 adult females might remain in the Rock Island nesting population today. This is far fewer than previously expected and in keeping with rough estimates by N. Idechong (Div. Marine Resources, Palau, pers. comm.) and others (listed above) for all of the Palauan Archipelago.

There is little to no evidence of hawksbill nesting reported for Tobi and Sonsoral States, known collectively as the Southwest Islands (Pritchard 1982b). A recent expedition by the Palau Bureau of Natural Resources and Development corroborates the Pritchard report (Geermans 1992). No recent nesting has been reported for Babeldaob or the northern islands of Kayangel (Maragos et al. 1994).

Commonwealth of the Northern Mariana Islands (CNMI)

There are no reports of hawksbills nesting in the CNMI (Pritchard 1982a). This is partly because beaches are scarce on the remote islands in the north of the Mariana Archipelago, partly because there is a long history of occupation on the more southern islands of Saipan, Rota, and Tinian, and partly because almost no hawksbill nesting surveys of small pocket beaches have ever been done in remote areas of the CNMI. However, lack of evidence does not rule out the possibility of hawksbills nesting at low levels at unknown locations. Since virtually no hawksbill nesting is known for this island chain, no trends are possible. If present, status is precarious because of the low numbers.

Republic of the Marshall Islands (RMI)

Information on hawksbill nesting in the RMI is scarce. This is probably due more to lack of surveys than lack of nesting. In a recent report Puleloa and Kilma (1992) suggest that nesting of hawksbills on Wotje Atoll may occur regularly. Specific occurrences of nesting at Wotje were noted from the “summer” of 1991 on the southwest beach of Wotje Islet, and in 1989 a nesting was attempted on Nibung Islet.

Federated States of Micronesia (FSM)

Little information exists, but all evidence suggests, at best, marginal nesting. Occasionally, hawksbill turtles have been observed nesting on some of the more remote uninhabited islands. Hawksbill nestings are considered to be infrequent and at extremely low densities (S. Kolinski, Marine Resources Management Division [MRMD], Yap State Government, pers. comm.). If hawksbills are nesting in the RMI or FSM, their numbers are precariously low and very much at risk. Historical trends are down, according to local residents. The presence of foraging animals in Micronesian waters is reported commonly, but does not necessarily indicate local nesting. These animals may originate from nesting beaches in Australia, PNG, Indonesia, and the Solomons. (see Introduction, Population, Distribution and Size)

Unincorporated U.S. Island Territories

There is no record of hawksbills nesting.

Insular and Pelagic Range

Stock assessments of insular and pelagic populations are rarely available, and objective analyses of such statistics, even when available, are nearly impossible because of the complexity of sea turtle life history behavior. There are almost no quantitative estimates, historically or currently, of the number of foraging hawksbills in Pacific waters. There have been no studies concerning the frequency of foraging animals by size or age class, or concerning whether there is a segregation of size classes within lagoons and along barrier reef faces.

It has been noted that members of a foraging population gather together from many different natal beaches, forming a composite group of individuals representing a diversity of genetic types from a wide geographic area (Bowen et al. 1996, D. Broderick and C. Limpus, pers. comm.). Furthermore, juvenile sea turtles pass through a variety of foraging habitats during their life cycle (Carr 1986), and so it should be expected that smaller hawksbills would be entering a foraging population as larger individuals leave, causing a continual turnover within the population inhabiting a particular foraging area. Since 30-50 years remains the best guess for age at reproductive maturity for Indo-Pacific hawksbills (see Growth), the individuals entering the foraging population in question may reflect successful reproduction several decades in the past at remote nesting beaches hundreds and possibly thousands of kilometers distance from the foraging population. Changes in numbers of foraging animals may represent local harvest pressures but may also represent a delayed response of many years to excessive take of eggs or nesting adults elsewhere in the Pacific.

The above scenario could in fact be occurring at the present time in such areas as the Solomon Islands. D. Broderick and C. Limpus (pers. comm.) have noted that the populations of nesting hawksbills in the Solomon Islands must “in the recent past have numbered in the tens of thousands” in order to have produced the volume of tortoiseshell gathered from those islands in the mid-20th century, and the harvest continues today. The tens of millions of hatchlings produced from such vast nesting assemblages could easily have provided in the past, and may still be providing today, the observed recruitment of large juvenile hawksbills to foraging populations in such remote areas as Palau Lagoon, the atolls of FSM, or even the reefs of American Samoa. Continuing take of adults and eggs has now reduced the Solomon populations from tens of thousands of nesting females to hundreds, and the effect on far flung foraging populations of juvenile turtles may yet to be felt.

Clearly, exact numbers and precise linkages between hatchling production and foraging populations are not available, particularly concerning historical numbers of animals, but investigators have more than accurately painted the demise of Pacific sea turtle populations, including the hawksbill, in broad brush strokes. The damage will certainly affect, now and into the future, the structure of foraging populations discussed in the following sections on insular and pelagic range.

U.S. West Coast

There are no confirmed hawksbill sightings in recent history from the U.S. West Coast.

Hawaii

In 20 years of netting and hand-capturing turtles at numerous nearshore sites in the Hawaiian Islands only eight hawksbills (all immatures) have been encountered. Capture sites have included Kiholo Bay and Kau (Hawaii), Palouu (Molokai) and Makaha (Oahu). A few immature hawksbills have also been recovered stranded throughout the island chain (G. Balazs, NMFS, pers. comm.).

American Samoa

According to Tuato'o-Bartley et al. (1993), hawksbills are more common than green turtles around Tutuila with 83% of 29 turtles observed as hawksbills. The opposite is true at Rose Atoll where 94% are green turtles.

Guam

A small population of foraging animals can be found in this area. There are no meaningful changes in foraging trends.

Republic of Palau

Foraging hawksbills can be found regularly in lagoons and associated reefs (Pritchard 1982b). Pritchard noted that hawksbills may be seen virtually every day in the Palau Lagoon by a competent SCUBA diver and that immature hawksbills were reported to be numerous in the Kayangel Lagoon at the northern end of the Palau system. There is reference to a personal

communication by Robert Owen, conservation officer for Micronesia from 1949 to 1978, that hawksbills have exhibited a gradual but steady decline over this period of time (Pritchard 1982b), but it is not clear if Owen is referring to nesting adults or foraging juveniles.

The highest concentrations of foraging hawksbills noted recently were reported in the lagoon at Helen Atoll (Geermans 1992) and the lagoon of the main Palau islands, especially off the Rock Islands in the southern part of the lagoon (Maragos 1991, Geermans and Farago 1993, Marsh et al. 1992). Hawksbills also forage in lower numbers along many of the other coastlines and reefs in the Republic of Palau (Maragos et al. 1994).

Commonwealth of the Northern Mariana Islands (CNMI)

There is no information on the distribution of hawksbills in the waters of the CNMI.

Republic of the Marshall Islands (RMI)

Foraging populations are found at Wotje Atoll and are likely found on other northern atolls (S. Eckert, Hubbs-Sea World Research Institute, pers. comm.). A few subadults were spotted swimming in the lagoons of some of the seven northern Marshall atolls surveyed in 1988 (Thomas 1989; Maragos 1994).

Federated States of Micronesia (FSM)

Foraging populations are reported at Oroluk Atoll (J. Maragos, East-West Center, pers. comm.). Quantitative information is not available.

Unincorporated U.S. Island Territories

No records of foraging turtles are available from these areas.

F. Status

The hawksbill is threatened with extinction throughout its range. It is considered universally endangered in the International Union for the Conservation of Nature (IUCN) Red Data Book (Groombridge 1982) and is included in Appendix I of the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES) ("most endangered"). The hawksbill is protected as an endangered species under the U.S. Endangered Species Act (ESA) for Pacific territories (Guam, American Samoa) and commonwealths (CNMI) of the United States and for certain independent states (FSM, RMI, Palau) through cooperative agreements. Anecdotal observations throughout Micronesia, from across the Pacific, and from other tropical oceans of the world are in near total agreement that current stock sizes are significantly below historical numbers. Although quantitative historical records are few, dramatic reductions in numbers of nesting and foraging hawksbills have apparently occurred in Micronesia (Johannes 1986; Pritchard 1982a) and Pacific Mexico just south of California (Cliffon et al. 1982) since World War II, largely because of increased access to remote nesting beaches by indigenous fishermen equipped with spear guns, outboard motors, SCUBA, and other high-tech fishing gear (Johannes 1986; Pritchard 1982a and 1981b). Market pressures from Asia, sustained by a vast fleet of Taiwanese and other

fishing vessels of various national origins, are overwhelming the existing stocks. Most important of all, hawksbills are threatened by a pervasive tortoiseshell trade, which continues particularly in southeast Asia and Indonesia even though the once lucrative Japanese markets were closed in 1994.

G. Biological Characteristics

Migration and Movements

While hawksbills were long considered to be the most "local" of the sea turtle species, maintaining a close regional proximity to juvenile foraging areas used during growth to maturity (Carr 1952; Bustard 1979; Witzell 1983; Kamezaki 1987; Frazier 1984) the presumption of "local-ness" in hawksbills likely reflects a lack of tagging information about this elusive species rather than an observation on actual hawksbill behavior. In actuality, we do not know if hawksbills maintain smaller home ranges than do other sea turtle species, and we should guard against insupportable paradigms that could bias research objectives or management priorities. Some recent evidence suggests that adult hawksbills undertake post-nesting season migrations analogous to those of other species (see Migration and Movements - Adults). Hawksbills could prove to be as international as green turtles and loggerheads in their home-range movements.

Hatchlings

Our understanding of neonate hawksbill movements at sea is speculative, and almost nothing is known of such movements in the Pacific. There seems to be little doubt that hatchlings of most, if not all, sea turtle species (except *Natator depressus*) seek a pelagic environment for the first year or years of their life. During this "lost year" their whereabouts are unknown (Carr 1986). Hatchling hawksbills possess dark coloration on both dorsal and ventral surfaces, indicating cryptic coloration that could prove useful for disappearing among inanimate floating objects and within drift lines of flotsam and jetsam. The overall dark, nondescript coloration may possibly mimic dead leaves floating offshore from forested nesting beaches.

Loggerhead turtle hatchlings use *Sargassum* drift lines for a pelagic developmental habitat (Carr 1986) in the Atlantic, and the same has been suggested for *Eretmochelys* in the Atlantic and Caribbean, based on the dark coloration of the hawksbill hatchlings. However, nothing is known about the pelagic whereabouts of Pacific hawksbill hatchlings (truly, a "missing year"). A similar phenomenon of extensive floating algal mats concentrated into drift lines has not been reported in the tropical Pacific, but an equivalent structural habitat, if found, would be the most logical place in which to look for these young animals. The direction and velocity of ocean currents passing close to Pacific nesting beaches should indicate the direction and distance traveled by pelagic neonate hawksbills.

Juveniles

When a juvenile hawksbill converts from a pelagic surface feeder to a benthic reef feeder, it apparently "finds" a foraging territory within which it will stay until otherwise displaced (Limpus 1992). We do not know how far a pelagic juvenile travels to reach a preferred benthic habitat or how it chooses such a habitat. Juvenile hawksbills recruit to a specific southern Great Barrier

Reef feeding area at a minimum size of 35.0 cm CCL (Limpus 1992). An approximate minimum size of 25 cm CCL was calculated for a population of juvenile foraging hawksbills at Mona Island (Puerto Rico), with a single modal range of 23.9-59.3 cm for 42 of the 48 wild-caught individuals, the remaining six animals being significantly larger (63.1-87.3 cm CCL) (van Dam and Diez 1994).

Pritchard and Trebbau (1984) have made the interesting observation that two size classes (approximately 20 cm and 35 cm) appear most frequently in the stuffed turtle trade. If so, Pritchard's 20 cm size class is missing from the Australian study but must be in reach of turtle hunters in other areas of the world. The size distribution of 63 nearshore hawksbills in the U.S. Virgin Islands (USVI; eastern Caribbean) is unimodal (mean = 41.3 cm SCL; range 21.4-67.6 cm), with no evidence of a 20-cm size class (Boulon 1994).

As a hawksbill grows from a juvenile to an adult, it is believed to shift its foraging territory to optimize its growth, probably moving from a shallow water habitat to a deep water habitat as it becomes physically capable of deeper dives. Juveniles and adults are usually not found feeding in the same area (Limpus 1992) except where vertical relief of the sea floor can accommodate the foraging requirements of both juvenile and adult hawksbills in close proximity to each other, such as Mona Island in the Caribbean Sea (Kontos 1987; Richardson 1990). It is assumed that juvenile hawksbills are not migratory but remain in close proximity to their preferred foraging habitat throughout the year. The location of this habitat may change over two or three decades of the juvenile stage. It is not known how far or in what direction a juvenile hawksbill moves to locate its preferred adult foraging habitat.

Adults

Tag recoveries must always be interpreted with caution, for such records tell where and how individual turtles are captured rather than where the population is dispersed. However, a number of long-range tag returns of several hundred kilometers or more (Bjorndal et al. 1985; Nietschmann 1972) indicate that adult hawksbills are capable of migrating across distances between nesting beaches and foraging grounds comparable to what has been observed in greens and loggerheads. An adult female tagged in its foraging ground in the Torres Strait was observed nesting 322 days later in the Solomon Islands, a distance of over 1,650 km (Pritchard and Trebbau 1984). Another female traveled 1,400 km from the Solomon Islands to its foraging grounds in Papua New Guinea (Parmenter 1983). A single adult female from the Antigua, eastern Caribbean, nesting population has been located on her foraging territory at the south end of St. Kitts-Nevis, a distance of approximately 90 km from her nesting beach (J. Richardson, pers. comm.). Tag return data (Pritchard and Trebbau 1984) and recent genetic studies (Bowen et al. 1996) suggest that individual foraging areas support hawksbills from distant breeding populations rather than just from nearby rookeries

Clearly, the hawksbill has the potential to be a long range migrant. It is likely that adult hawksbill movements will prove to be similar to that of Australian loggerhead turtles (C. Limpus, pers. comm.), whereby individual adults perform regular migratory movements among a preferred nesting beach, a breeding ground and a persistent foraging territory. The distances between these territorial foci (boundary markers of a home range) vary greatly and appear to be of random length among individuals.

Hawksbills are known to leave the area of the nesting beach after the final nest of the season is laid; three of seven turtles radio-tagged at Buck Island, St. Croix (northeastern Caribbean) left

the vicinity after their final nest (the disposition of the other four turtles is unknown, because they were no longer carrying transmitters) (Starbird 1993). In another example of post-nesting migration, two hawksbill females, also from Buck Island, were equipped with satellite-linked transmitters and their post-nesting migrations monitored. Both turtles moved hundreds of kilometers from Buck Island. However, due to the poor quality of the satellite fixes it is difficult to know their exact locations (M. Vaughn, pers. comm.). It is likely that the nesting females return directly to their preferred foraging habitat, wherever that may be.

The geographic proximity of an adult's foraging habitat in relation to its natal beach is not known, and the same must be said for juveniles as well. Once a foraging or nesting site is chosen, hawksbills tend to be persistent in the continuing use of that site. However, hawksbills can move long distances. Thus, it must be assumed that the nesting and foraging animals observed in such localities as the Republic of Palau or Saipan have potential home ranges extending throughout the islands of Micronesia and Melanesia and even the waters of the Philippines, Indonesia and Australia. The existing ambiguity concerning movements and migrations of Pacific hawksbills can only be clarified with extensive tagging programs.

Foraging Biology and Diet

Until quite recently, hawksbills have been classified as opportunistic feeders on a wide variety of marine invertebrates and algae (Carr and Stancyk 1975; Witzell 1983). However, Balazs (1978) reported that the stomach and intestine of a Hawaiian hawksbill were completely filled with three kinds of unidentifiable sponges. Within the last few years, Meylan (1988) and others (Vicente 1994) have confirmed that hawksbills appear to be specialist sponge carnivores, selecting just a few genera of sponges throughout the Caribbean Sea for their principal diet. There are very few vertebrates capable of digesting sponges without being injured by the sponges' silicate spicules (needles), but hawksbills apparently can. Much of the other material found in hawksbill stomachs appears to have been ingested coincidentally while the animal was feeding on sponges. Neonates in captivity appear to do well on a diet of *Sargassum* weed (Pritchard and Trebbau 1984), which supports the theory of a pelagic existence within *Sargassum* mats for the first year or so of life (see Migration and Movements). A shift from pelagic to benthic feeding would, by necessity, be associated with a concomitant shift in diet from *Sargassum* (with its associated flora and fauna) to sponges.

Growth

Pritchard and Trebbau (1984) have provided an extensive review of growth rates of captive hawksbills. Hatchlings in captivity with saturation feeding reach a carapace length of about 20 cm in one year and 35 cm in two years. Similar growth rates are available for Palauan hatchlings for about 250 days of captivity (Sato 1991) and for Solomon Island hatchlings for about 500 days of captivity (McKeown 1977). More importantly, six of the Palauan headstart turtles (range of CCL=18.3-44.4 cm at time of release) have been recaptured after times in the wild ranging from 10-56 months (Sato 1991). Growth of these animals in the wild ranged from 1.5-7.2 cm per year (mean = 5.2 cm/yr).

Limpus (1992) has gathered exceedingly valuable data on the growth rates of wild juvenile hawksbills (n=41) from the southern Great Barrier Reef, ranging in SCL from 40-90 cm. Mean annual growth of these animals ranged for the most part between 1-2 cm per year. Boulon (1994)

has recaptured 15 wild juvenile hawksbills (mean SCL = 44.5 cm; range 27.4-60.7 cm) after periods of 3 to 20 months. The growth (increase in SCL) of these animals averaged 0.28 cm/month (range 0.03-0.66 cm/month) or about 3-4 cm per year. The four animals exhibiting the fastest growth were growing at about 6 cm/year.

Hatchlings in captivity can reach a carapace length of 50 cm in four to five years. Growth rates of captive and wild sea turtles may be described by a negative exponential function. In other words, hatchlings grow quickly, and older turtles grow relatively less and less per year as they approach mature size. Adult nesting females exhibit insignificant growth from year to year (Limpus 1992). Because wild sea turtles grow so slowly as they approach adult body size, estimates of age to maturity range over several decades (Frazer 1986). Age to maturity is not known and has not been calculated (estimated) for hawksbills, but Limpus (1992) predicted that Australian hawksbills "will be decades old at first breeding" and that 30-50 years is the best guess (C. Limpus, pers. comm.) until more precise analytical techniques are developed.

Reproduction

There is much discussion in the literature as to which months of the year are the most important for nesting, but this is almost certainly the result of experimental bias due to small sample sizes. A rough monthly estimate of numbers of hawksbill nests per survey in the Rock Islands of Palau ranged from 0.6 to 1.8, indicating year-round nesting with a possible bi-modal season (December-February and June-August) (Maragos 1991). The nesting season in northern Australia is described as "protracted" with much of the nesting observed from December to March (Limpus 1980). The predominant nesting months for hawksbills in Puerto Rico and the USVI are June to November, although some nesting can be observed for every month of the year (Witzell 1983; Richardson 1990). On Buck Island, St. Croix, USVI the nesting season has varied widely from season to season over the last ten years (Hillis and Mackay 1989). Such variation may be attributable to the small size of the nesting population (and may be typical for most hawksbill nesting populations today). If there are only a few animals in a nesting population, they may arrive in random clumps, causing the apparent nesting season to vary widely from year to year.

Once a female reaches her preferred nesting beach, she probably remains in close proximity to that beach during the 14-day intervals between consecutive nests. Seven radio-tagged nesting females at Buck Island, St. Croix, remained within approximately two kilometers of the nesting beach during their internesting intervals. Each turtle remained within a small area separate from the other turtles (< 0.5 km in diameter) and moved little from that area (Starbird 1993).

Hawksbills usually select a nest site within the cover of woody vegetation, although some will occasionally nest in grass or open sand if the preferred cover is not accessible. Fifty-three of 70 nests (75%) on Campbell Island (northeastern Australia) were placed under shrubs or trees, while 16 nests (23%) were in grass (Limpus et al. 1983). A preferred nesting habitat in the Pacific is a low energy sand beach with woody vegetation like *Scaevola*, *Pisonia*, *Casuarina*, *Pandanus*, *Callophyllum*, *Cordia* and the coconut palm. However, suitable nesting habitat can be extremely variable, from high energy ocean beaches shared by green turtles (Carr and Stancyk 1975) to tiny pocket beaches several meters wide contained within the crevice of a cliff wall such as those in the Rock Islands of Palau.

The nest is usually located within a few meters of the high water line, although some nests are occasionally placed so close to the water's edge that they are flooded by storms and spring tides (Ryder et al. 1989). The mean distance from the high water line for 91 Caribbean hawksbill nests in Antigua was approximately 5 m (range 0-20 m) (Ryder et al. 1989). Palauan hawksbill nests are often placed within the forest edge, because the beaches are very narrow and the forest canopy extends over the water. Although sand beaches with easy access are preferred, hawksbills are capable of nesting in thick forest litter and within soils that range from sand to gravel. Access to the nesting beach may be open or over rocks, stone ledges, or reef.

The condition of the substrate appears to be a less important factor for successful nesting than the proximity of the vegetative cover to the water's edge. Some well used nesting beaches have no exposed sand, with the woody vegetation growing to the water's edge, as is the case in Palau. In contrast, a potentially good nesting beach in Antigua is rarely used because the vegetation line is set back 30 m from the water's edge (Ryder et al. 1989); the turtles nest on either side of this beach where the vegetation is more proximate to the water. However, hawksbills at Sandy Point, St. Croix, regularly crawl 30 m across open sand to reach acceptable nesting habitat (K. Eckert Wider Caribbean Sea Turtle Conservation Network [WIDECAST], pers. comm.). A similar situation occurs on the Palauan island of Omekang which has a large sand spit at its southern end.

The hawksbill nesting sequence has been extensively documented (Witzell 1983; Pritchard and Trebbau 1984) and resembles the general pattern for all of the sea turtle species. Individuals usually take at least one hour to find a suitable nest site and complete the laying sequence. They are not easily deterred by the presence of thick root mats or limestone rubble commonly found on small Caribbean beaches, sometimes spending up to two hours making numerous trial excavations until an adequate site is found. Hawksbills commonly excavate three or more nest chambers before a suitable one is finally accepted. Since each turtle does its part to "till the soil" during the digging process, breaking roots and excavating small rocks, it can be assumed that large numbers of nesting females using the same beach over many years would unconsciously assist each other in keeping the substrate loose and "diggable," thereby decreasing the frequency of aborted nest hole excavations and the time spent on the beach by each nesting turtle. A sample of 45 hawksbill nests from Campbell Island (Australia) had 25.7 cm (range 11-46 cm) of sand as overburden above the clutch. The average depth of the clutch was 43.2 cm (range 35-60 cm) (Limpus et al. 1983).

There is much variation in clutch size from site to site (Witzell 1983). Maragos (1991) estimated 130 eggs per clutch for Palauan hawksbills. An average of 131.8 (range 89-192) eggs per clutch was measured for 47 nests from Campbell Island (Limpus et al. 1983). The average for eastern Caribbean animals appears to be closer to 150 eggs per clutch (Corliss et al. 1989), with a single clutch of 215 eggs recorded. Clutch size is apparently related to the body size of the nesting female (Witzell 1985), with the larger Caribbean hawksbills laying the largest clutches, the smaller Indian Ocean animals laying the smallest, and the Pacific hawksbills being somewhere in the middle. A sample of 470 eggs (10 eggs from each of 47 clutches) from Campbell Island, Australia, averaged 3.6 cm in diameter (range 3.2-4.1) and 26.0 g. (19.5-32.5) per egg (Limpus et al. 1983).

Incubation is approximately 60 days, with much variation from nest to nest and from site to site (Bjorndal et al. 1985; Corliss et al. 1989; Witzell 1983). Incubation period for five clutches from Campbell Island was 55 days (range 52-57 days) (Limpus et al. 1983). Mean hatching success

for non-depredated nests on most beaches appears to be close to 80% (Witzell 1983; Corliss et al. 1989), but a wide range of hatching success is known to occur.

The phenomenon of temperature modulated sex ratios has been documented for hawksbills (Mrosovsky et al. 1992). Eggs from Jumby Bay, Antigua (eastern Caribbean) were incubated at an array of constant temperatures. The pivotal temperature (50% of each sex produced) for the sample was estimated to be 29.2°C. Sand temperatures at nest depth were also recorded over two nesting seasons. Although sand temperatures were sometimes higher than the pivotal level, more often they were lower. On this basis, it is unlikely that Antiguan hatchlings from this beach have the highly female-biased sex ratios reported for some other reptiles. A natural clutch of hawksbill eggs deposited in Dade County, Florida, well north of the normal hawksbill nesting range, produced no viable young (Dalrymple et al. 1985). Incubation temperatures for the clutch were approximately five degrees below the pivotal temperature measured by Mrosovsky, and all embryos with distinguishable gonads were male.

The modal number of nests per turtle in a single season is three on Campbell Island (Limpus et al. 1983). In the eastern Caribbean (Antigua), the modal number is five, with a range of four to six (Corliss et al. 1989). Estimates in the literature of fewer seasonal clutches per turtle (Witzell 1983) are probably the result of inadequate beach coverage by the research team, and this has proven to be true for most of the other species of sea turtles as well (Tucker 1989).

The modal internesting interval (days between consecutive clutches) is 15 days (range 13-17) at Campbell Island, Australia (Limpus et al. 1983). This interval is 14 days in Antigua (Corliss et al. 1989) and Buck Island, USVI (Hillis and Mackay 1989), and this compares favorably with results from elsewhere in the U.S. Caribbean, such as Mona Island (Kontos 1987; Richardson 1990). However, the mean for a sample of 28 internesting intervals from Costa Rica is 16 days (Bjorndal et al. 1985) and 19 days for five intervals from Nicaragua (Nietschmann 1972), suggesting that western Caribbean hawksbills may have a significantly longer internesting interval relative to eastern Caribbean animals. Genetic studies might corroborate this difference.

There are few population figures for hawksbill remigration intervals, although the literature is replete with anecdotal observations on one or a few animals. An intensive survey of nesting hawksbills at Jumby Bay, Antigua, has discovered considerable variation among multiple-year remigration patterns within the same population and no evidence of annual remigration (J. Richardson, pers. comm.). For example, following two seasonal cohorts for six years (seven seasons) from the same nesting beach, the 1987 cohort of 22 animals (51 recorded remigration intervals) exhibited 84% for two-year intervals and 16% for two-year intervals (mean of 2.16 years) and no intervals over three years. The 1988 cohort of 38 animals (49 intervals) exhibited only 43% two-year intervals, but it has shown 47% three-year intervals, 8% four-year intervals and one six-year interval (mean of 2.71 years). Using parameters such as the remigration interval to look for differences between populations can be productive only if done objectively and with large sample sizes.

Similarly, it is difficult to measure annual survivorship of a population of nesting hawksbills because of the problems associated with sampling and the ability to "see" or find a returning turtle on a subsequent nesting season or know if a turtle is dead or alive if not seen at the nesting beach. In other words, absence of a tagged turtle during a nesting season does not mean the turtle is dead, but the presence of the turtle on the beach proves that it is not dead. Thus, only

a minimum annual survivorship parameter can be calculated for a population, and most published values have been calculated in error and are unreasonably low.

Saturation tagging of Antiguan hawksbills over six years (1987-1994) has produced surprisingly high minimum survival estimates (J. Richardson, pers. comm.). For example, 95% of the 1987 cohort (20/21 individuals) returned during subsequent nesting seasons, providing a minimum annual survivorship value of 0.98 for this group of primarily two-year remigrants over a period of three years (1987-1990). In comparison, the 1988 nesting cohort has exhibited a minimal annual survivorship of 0.92 for a similar length of time (1988-1991), and the 1989 cohort is at 0.94 (1989-1992). With occasional long remigration intervals of five-years and six-years still appearing, these annual survivorship values are continuing to rise, although slowly. Regardless of the differences between cohorts, however, survivorship values such as these are consistently and significantly higher than the 0.80 annual survivorship estimates generally accepted for other populations, including nesting hawksbills on Cuban beaches.

If left alone by people, annual survivorship of nesting adults could be very high, approaching 0.99, thereby explaining the precipitous declines observed in nesting populations when the adult females have been harvested from the beach. Under normal circumstances, adult hawksbills [and other sea turtle species] must reproduce for many years, even decades, in order for a few of the offspring to survive to replace the adults and maintain the population at stable levels. For example, an average Antiguan hawkbill from a population with 0.95 annual survivorship would be expected to live for 13 years as an adult and produce 4,000 eggs during her five to six active nesting seasons (J. Richardson, pers. comm.). If she and others are harvested at the end of their first or second nesting season, she and they will fail to meet their quota, and the population will probably decline.

Offshore Behavior

Hawksbills are typically found feeding in the vicinity of rock or reef habitats in shallow tropical waters with little turbidity (Witzell 1983). This characteristic of the species is related to its preference for feeding on encrusting organisms, particularly certain sponges (see Foraging Biology and Diet). The narrow, pointed beak of the hawkbill provides a useful tool for picking selected food items from cracks in the coral substrate. Hawksbills are found associated with a variety of reef structure types, including both patch reefs and steep reef slopes.

There is some evidence that hawkbill populations distribute themselves by size class according to the depth of the foraging habitat. Adult hawksbills are usually not found in shallow marine habitats near land (except to nest), whereas small juveniles (carapace length of 25-55 cm) are rarely found far from the most shallow coral reef systems. When a young hawkbill converts from a pelagic ocean feeder to a benthic reef feeder, it apparently "finds" a foraging territory within which it will stay until otherwise displaced. As the animal grows from juvenile to adult, it will shift its territory to optimize foraging conditions, probably moving from a shallow water habitat to a deep water habitat as it becomes physically capable of deeper dives.

In the vicinity of Antigua and Barbuda, adult hawksbills are most commonly observed associated with the 20-100 fathom contour (120-600 ft; 37-183 m) where the continental shelf drops precipitously to abyssal depths (J. Fuller, pers. comm.). This steeply sloping habitat may indicate a combination of conditions preferred by the adults. On Mona Island, Puerto Rico,

precipitous cliffs extend hundreds of feet below the surface, allowing the association of both adult and juvenile foraging turtles within close proximity to each other (Kontos 1987). These animals also appear to be associated with benthic feeding areas, with the deeper territories being used by the larger animals.

Although deep diving in hawksbills has not been studied, it is probable that much of the Caribbean down to 100 m or more provides a foraging habitat for the adult turtles, particularly since sponges grow well to this depth. The dominant sponge communities in the Caribbean are found at a range of depths from 125 ft to 250 ft (38-76 m) (J. Porter, Univ. of Georgia, pers. comm.).

Health Status

There is almost no information available on the health status of hawksbill sea turtles, individuals or populations. Various reports in the literature describe commensal barnacles and intestinal trematode worms (summary by Witzell 1983), but possible debilitation in the host turtles resulting from the infection is not mentioned. Hawksbills tend to support more barnacles on the carapace than other tropical nesting species. On the other hand, there appears to be proportionally fewer examples of obvious shark damage, such as missing flippers and damaged carapaces, compared to other sea turtle species (P.C.H. Pritchard, Florida Audubon Society, pers. comm.). Fibropapilloma, a tumor disease often reported in green turtles, has not been detected in the hawksbill.

H. Threats

This section presents a brief overview of threats to hawksbills in the Pacific basin, followed by summaries of major threats in each U.S.-affiliated area. A third section then presents more detailed information specific to each island group.

"Threats" to sea turtles are broadly defined as any factor that jeopardizes the survival of turtles or impedes the recovery of their populations. Twenty-seven threats have been identified, but it is readily apparent that all are not equally important and that threats in one Pacific area may not be relevant in another area. Consequently, each island group was evaluated separately based on information received from the Recovery Team and Technical Advisors. Table 1 lists the 27 threats and ranks their significance. Definitions of the threats are provided in subsequent text.

When viewing Table 1, it should be recognized that there are limitations inherent in this tabulation. First, generalizations are made. Some island groups, such as the Republic of Palau, consist of over 500 islands; consequently, the data presented in Table 1 are limited to a general statement about conditions for the group as a whole. Similarly, most of the island groups possess both sparsely inhabited remote islands and heavily inhabited main islands. The distribution of turtles and the kinds of threats they face would obviously differ in these two types of islands. Specific information about individual islands, if available, is presented in 'General Threat Information'. Second, there are data limitations. For most islands, information about turtle threats is sparse (see Pacific Synopsis).

Pacific Synopsis

Because the hawksbill is virtually unknown along coastal waters of the U.S. Pacific continental coast, this section will deal almost exclusively with the U.S.-affiliated insular Pacific. The eight U.S.-affiliated island groups in the Pacific consist of over 5,000 islands spread across a region twice the size of the continental United States. Although the area is vast and the islands are diverse, several generalizations can be made about sea turtles and threats in the study area. The U.S.-affiliated islands are inhabited primarily by two species, green and hawksbill turtles. To a large extent both species are subject to the same threats, thus this section may blur the division between threats faced by each individual species. Green turtles have historically been used for food, and hawksbills for trade (tortoiseshell crafts), and to a lesser extent, for food. Hawksbills are not valued as highly for food, possibly due to sporadic fatal poisonings from their occasional toxicity and poor taste, however their eggs are readily consumed.

A fundamental problem in the Pacific region is that, with few exceptions, there is a serious shortage of information on all aspects of turtle ecology. For many areas, the most basic information (e.g., population size, nesting beaches, distribution, migration patterns) is extremely rudimentary. While this lack of data may not be classified as a direct threat to the turtles themselves, it will certainly hamper effective recovery efforts for them. For example, lack of information will slow the protection of important nesting habitat because some beaches have not yet been identified.

Based on knowledgeable accounts, hawksbill populations have declined dramatically in the Pacific islands. By far the most serious problem these turtles face is the harvest by humans. This is illustrated in Table 1 which shows that the harvest of turtles on nesting beaches and in coastal water is identified as a major threat in most of the eight U.S.-affiliated islands groups reviewed in this report. In general it can be said that hawksbill nesting populations rarely survive the occurrence of human populations.

Turtles have been harvested for centuries by native inhabitants of the Pacific region. In modern times, however, a severe overharvest has resulted from a variety of factors, among which is the loss of traditional restrictions that had limited the numbers of turtles taken by island residents. Brought about by modernized hunting gear, and easier boat access to remote islands where turtles nest, extensive commercial exploitation has replaced subsistence harvest for turtle products in both domestic markets and international trade, and is maintained by inadequate regulations and education. One often-mentioned aspect of this problem is the pillage of wildlife on remote islands by supply ships and commercial fishing crews.

Other than harvest, the major problems are those associated with habitat losses due to rapid expansion of resident human populations and/or increased tourism development. Another potential problem is the incidental take of turtles in distant-water fisheries, but data are generally incomplete for this threat.

As a generalization, the eight U.S.-affiliated islands can be divided into three groups based on their major turtle threats or problems: (1) Urbanized islands (Hawaii, CNMI, Guam) where the major threats are habitat loss and problems associated with rapidly expanding tourism, (2) rural or developing islands (American Samoa except Rose Atoll, the Republic of Palau, the inhabited islands of CNMI, FSM, and RMI) where human consumption and the lack of basic biological information about turtle stocks prevail, and (3) Protected, uninhabited or military-use islands (the unincorporated islands, Rose Atoll, the uninhabited islands of CNMI, FSM and RMI, and Hawaiian

islands) where threats are probably more limited but biological information about turtle stocks is needed.

Regional Summaries

U.S. West Coast

Primary turtle threats: **N/A**

There are no records of nesting by or at-sea sightings of hawksbills.

American Samoa

Primary turtle threats: **directed take**
 increased human presence

The main islands of American Samoa are steep volcanic islands with limited land suitable for human habitation and agriculture. The fast-growing human population (54,000 people, 3.7% growth rate, doubling time = 19 years) is concentrated along the southern coastline of Tutuila Island where significant pre-emption of former turtle nesting beaches has occurred due to village expansion and the placement of the island highway. Although only a rough estimate, turtle populations have seriously declined and now may number only about 120 nesting females (greens and hawksbills, combined) per year. Basic biological information (e.g., nesting and feeding areas, nesting seasons, population size) is not available. This lack of information, and the harvest of any turtles and eggs encountered, are the major threats to turtle recovery in American Samoa.

Hawaii

Primary turtle threats: **increased human presence**
 beach erosion
 nest predation

The Hawaiian Archipelago consists of 132 islands spread over 2450 km. Most of the 1.2 million inhabitants and six million annual visitors live in the eight Main Hawaiian Islands (MHI) which account for 99% of the State's land mass. Hawaii supports populations of both green and hawksbill turtles, which differ in abundance and nesting distribution. Approximately 200-500 female green turtles nest annually in NWHI, while about 20-30 female hawksbills nest annually in MHI. There is a shortage of information on all aspects of hawksbill life history in MHI. The main threats at present to the recovery and conservation of this stock are the loss of nesting and foraging habitat, and nest predation (e.g., by mongooses). In the marine environment, hawksbills are subject to the pressures of nearshore tourist development such as resorts, marinas, and aquatic recreational activities.

Guam

Primary turtle threats: **directed take**
 coastal construction

There is limited information available regarding turtle threats in Guam. The Division of Aquatic and Wildlife Resources (DAWR), in past correspondence, indicated that the two principal threats are thought to be habitat destruction and harvest. Habitat destruction has resulted mainly from construction and development due primarily to growing tourism. In 1990, over 740,000 tourists visited the island and their numbers are expected to increase. On the northern portion of Guam, where the majority of nesting habitat occurs, the military base has limited public access and development, but landowners in the Uruno area are attempting to develop their land as well, which would put some of the last nesting sites in danger. Another important effect of development is sedimentation which has damaged Guam's coral reefs, and presumably, food sources for hawksbills.

Turtles were traditionally taken by residents for celebrations, and current reports indicate that illegal harvesting still occurs. Poaching also occurs by immigrants, fishing crews, and tourists, especially those from areas where they are accustomed to eating turtles legally. The language problem for non-English speaking immigrants and lack of knowledge about local regulations has caused the majority of such problems. Incidental catch of turtles in coastal waters by commercial fishing vessels probably also occurs.

Republic of Palau

Primary turtle threats: **directed take**
 increased human presence
 (overnight camping, shelter construction)

By far the greatest threat in Palau is the harvest of nesting hawksbills and their eggs in the Rock Islands and the hunting of hawksbills in coastal areas throughout Palau. Harvest is legal for certain sizes (≥ 27 in. CCL) of turtles captured in the water during seven months of the year. However, turtles are taken year-round whenever encountered. Fifteen thousand residents dwell on the northern islands of Koror, Baobeldaob, and Peleliu. Tourism brings thousands more to dive on Palau's magnificent reefs, and the numbers are growing at exponential rates. Affluence has fueled a proliferation of fast, seaworthy boats, abundant gasoline, and SCUBA equipment, such that access to remote areas is now commonplace, even to the Southwest Islands of Sonsorol and Tobi States. There is evidence of overnight camping on most hawksbill nesting beaches in the Rock Islands. A vigorous market exists in tortoiseshell for traditional purposes and jewelry sold to tourists. The number of stores selling jewelry has increased noticeably with independence gained in October 1994, and the volume of sales has also increased. The end result is that Palau is entering a period of ever more rapid development and growth, with dwindling refugia for hawksbill sea turtles and a rapidly expanding market for sea turtle meat, eggs, tortoiseshell, and turtle by-products. There are insufficient management controls and little enforcement of existing laws.

Commonwealth of the Northern Mariana Islands (CNMI)

Primary turtle threats: directed take

The Mariana Archipelago consists of 15 major islands, stretching approximately 675 km from Guam to Farallon de Pajaros. The islands are politically divided into two governing bodies: Guam (a U.S. Territory) and the CNMI which includes the remaining islands. In CNMI, Saipan, Tinian and Rota are the largest islands and contain over 95% of the total population. Saipan is the major business and tourist center for CNMI. The ten islands north of Saipan are relatively small, isolated and sparsely inhabited, primarily due to active volcanic activity.

Sea turtles are considered a traditional food and are readily taken on nesting beaches or in coastal waters. Nesting seasons and sites, as well as feeding areas, are well known to the indigenous fishermen. Due to the rapidly expanding development on Saipan, Tinian and Rota, hotels and human activities are beginning to dominate beaches possibly used by nesting turtles. Beach surveys are necessary to evaluate the extent to which coastal construction will threaten remaining sea turtle populations.

Federated States of Micronesia (FSM)

Primary turtle threats: directed take

There is very little information on hawksbill turtle populations in the FSM, making difficult the assessment of threats. FSM consists of over 600 islands, 65 of which are inhabited. Turtle threat information from FSM is presently limited to Yap State, the westernmost constituent of FSM. Yap State includes the four closely associated high islands of Yap (commonly referred to as Yap proper), three raised coralline islands and 12 coral atolls. In 1987, the total population of Yap State was about 10,000, far below former highs estimated at 26,000-50,000.

Turtles and turtle eggs have been exploited in Yap State for as long as people have inhabited these islands. Turtles continue to play a subsistence role and are an important part of traditional culture. A common perception among the people is that, over the years and despite annual fluctuations, there has been a gradual decline in the number of turtles visiting or residing within this region.

Traditional systems regarding turtles vary somewhat throughout the islands. Some of these systems appear to restrict the level of human interaction with turtles, though conservation of the resource does not appear to have been a motivating factor. In general, the people of Yap State have taken advantage of greater abilities to harvest turtles and turtle eggs through the use of introduced foreign technologies and materials. Today, over-harvesting, coupled with the gradual loss of a number of traditional practices related to the taking of turtles and turtle eggs, appears to be the main threat to turtle populations. Turtles tagged in YAP and recovered in the Philippines and Majuro, RMI indicate that the FSM is dealing with a shared resource. In order to recover this population, turtle conservation must be pursued in these countries as well.

Republic of the Marshall Islands (RMI)

**Primary turtle threats: directed take
 increased human presence**

There is limited information available regarding turtle threats in the 34 atolls and large islands of RMI. The consumption of nesting turtles and their eggs appears to be the single-most important source of mortality to turtles. Turtle harvest has expanded to all of the atolls, with Majuro and the Southern Islands purchasing turtles caught from the Northern Islands where they nest. There is little or no control over the harvest on any of the islands, although informal control comes from the owner of the land (upon which the turtles are nesting). The turtles are primarily harvested from the nesting beaches and are generally taken for celebrations. Turtle eggs are regularly eaten. Also, eggs are hatched and the young kept as pets. In some cases the practice of raising young is mistakenly believed to be a good conservation practice. The harvest of nesting turtles and their eggs is illegal, but few know of these regulations. Rapid human population growth (4% per year) and affluence (boats, advanced fishing gear) will exacerbate the situation. Likewise coastal construction on several atolls may degrade beach nesting sites. Poaching by foreign fishermen is possibly a serious threat on the uninhabited atolls of Bokaak, Bikar, Taka, Jemo, Erikub, Ailinginae and Rongrik.

Unincorporated Islands (Wake, Johnston, Kingman, Palmyra, Jarvis, Howland, Baker, Midway)

Primary turtle threats: none

The unincorporated islands consist of protected islands in the National Wildlife Refuge system (Howland, Baker, Jarvis), islands with military facilities (Wake, Johnston, Palmyra), and one island with no permanent land (Kingman). Some are used by nesting green turtles, and all probably provide marine feeding grounds for green and perhaps hawksbill turtles. Other than Johnston Atoll which is inhabited by 800-1,000 people, few or no people live on the other islands. While there are presently no major threats to sea turtles, little is known about the biology of the turtles in this region.

Midway, at the northwest end of the Hawaiian chain is presently under U.S. Navy jurisdiction, but the naval station is being closed. Midway and the other unincorporated islands may revert to the jurisdiction of the state of Hawaii.

TABLE 1. Threat checklist for hawksbill sea turtles in the U.S. Pacific Ocean.

Codes 1 = major problem
2 = moderate problem
3 = minor problem

- = not current problem
? = unknown
P = known problem but extent unknown

Threat	U.S. West Coast	Amer. Samoa	Hawaii	Guam	Palau	CNMI	FSM	RMI	Un-incorp. ¹	
Nesting Environment										
1	Directed take - eggs	-	1	-	P	1	?	1	1	-
	Directed take - turtles	-	1	-	P	1	?	1	1	-
2	Increased human presence	-	1	1	P	1	?	-	1	-
3	Coastal construction	-	2	3	1	3	?	-	P	-
4	Nest predation	-	-	1	-	3	-	-	-	-
5	Beach erosion	-	3	2	-	3	-	3	2	-
6	Artificial lighting	-	2	3	-	3	-	-	-	-
7	Beach mining	-	3	-	-	-	-	-	-	-
8	Beach vehicle driving	-	-	3	-	-	?	-	-	-
9	Exotic vegetation	-	-	?	-	-	-	-	-	-
10	Beach cleaning	-	-	-	-	-	-	-	-	-
11	Beach replenishment	-	-	-	-	-	-	-	-	-
12	Other			3 ^a		3 ^b				
Marine Environment										
13	Directed take	-	1	2	1	1	1	1	1	-
14	Natural disasters	-	P	3	-	-	-	?	3	?
15	Disease/parasites	-	?	?	?	?	?	?	?	?
16	Algae/Seagrass/reef degradation	-	2	3	2	3	3	3	3	-
17	Environmental contaminants	-	2 ^c	P	P	?	?	3	-	3
18	Debris (entangle/ingest)	-	P	3	?	-	?	P	3	3
19	Fisheries (incidental take)									
	-domestic waters	-	-	3	P	P	P	P	P	P
	-international	-	?	3	P	P	P	P	P	P

^aLava flows on beach

^bDebris on beach

^cPago Pago harbor

Threat		U.S. West Coast	Amer. Samoa	Hawaii	Guam	Palau	CNMI	FSM	RMI	Un-incorp. ¹
20	Predation	-	?	?	?	?	?	?	?	?
21	Boat collisions	-	-	3	-	-	-	-	-	-
22	Marina/dock development	-	-	3	?	P	?	-	3	-
23	Dredging	-	-	P	-	-	-	?	-	-
24	Dynamite "fishing"	-	-	-	-	-	-	1 ^d	-	-
25	Oil exploration/development	-	-	-	-	-	-	-	-	-
26	Power plant entrapment	-	-	-	-	-	-	-	-	-
27	Construction blasting	-	-	-	-	-	3	-	3	-

^dChuuk Lagoon

1. Wake Johnston, Kingman, Palmyra, Howland, Baker, and Jarvis islands

General Threat Information with comments on specific U.S. jurisdictions.

This section provides supportive information used to rank the 27 turtle threats listed in Table 1. Each threat is defined and then evaluated separately for each of the eight U.S.-affiliated island groups. The first 12 threats pertain to the turtles' nesting environment, the latter 15 to the marine environment.

Nesting Environment

1. Directed Take

The harvest of sea turtles and/or their eggs for food or any other domestic or commercial use constitutes a widespread threat to these species. Removing breeding adults from a population can accelerate the extinction of local stocks, and the persistent collection of eggs guarantees that future population recruitment will be reduced. This category includes only the harvest of sea turtles (typically nesting females) and their eggs on land. For hawksbills, many adults are taken for the shell, which has a commercial value, rather than for food. (Hawksbills generally are considered to taste poor, and infrequently are toxic to humans). Harvest at sea is discussed in a later section. (see Recovery - Section 1.1.1)

U.S. West Coast: Not a current problem.

American Samoa: Turtle harvest is the most significant source of mortality in the Territory. Turtles and their eggs, when found, are consumed. The concept of turtle conservation faces several difficulties in contemporary American Samoa. For example, most people are unaware that it is illegal to take sea turtles within the Territory. Public acceptance of conservation issues is a challenging problem. Although many people acknowledge that there are considerably fewer turtles on their beaches than when they were children, few indicated concern for the future of turtles. Some residents expressed the view that turtles were placed in the ocean by God for man to take, and others felt that if they did not take the turtle, someone else would. Another aspect of the problem is that villagers may keep hatchlings as pets, which eventually die.

Hawaii: Hawksbills nest at several sites in the MHI. All together, there may be only a dozen hawksbills nesting annually on all beaches combined.

Guam: While regular nesting is not well documented for Guam, the take of nesting turtles (primarily green) in Guam is occurring and may include hawksbills as well.

Republic of Palau: Directed take of turtles and eggs is a major problem in Palau, but documented examples are rare. J. Maragos, in summarizing field records collected from 1982-1990 by Palau's MMDC, reported that 76% of the nesting records in the Rock Islands were identified as "nests without eggs" or nests that were illegally poached (Maragos 1991). Guilbeaux (pers. comm.) reported a conversation with a resident of Anguar in 1992 who described the taking of a nesting female by a passing motorist from a beach proximate to the road. During a survey by the Division of Marine Resources of nesting beaches in the Ngerukewid Island Wildlife Preserve, tracks in the sand indicated that a nesting turtle and its eggs were taken in 1994. The problem is greater than these few examples indicate.

The volume of worked tortoiseshell is considerable, but there are no records as to the source of the raw material. It could have come from nesting turtles. Little can be said about the specifics of this activity without more information.

CNMI: There is no data on the harvest of nesting hawksbills and eggs, however this is probably due more to a general lack of information than lack of harvest.

FSM: While the take of hawksbills is a known and probably severe problem, quantified data is unavailable.

RMI: While the take of hawksbills is a known and probably severe problem, quantified data is unavailable.

Unincorporated: Not a current problem.

2. Increased Human Presence

Human populations are growing rapidly in many areas of the insular Pacific and this expansion is exerting increasing pressure on limited island resources. Threats to sea turtles include increased recreational and commercial use of nesting beaches, the loss of nesting habitat to human activities (e.g., pig pens on beaches), beach camping and fires, an increase in litter and other refuse, and the general harassment of turtles. Related threats, such as coastal construction, associated with increasing human populations are discussed separately. (see Recovery - Sections 1.1, 1.2)

U.S. West Coast: Not a current problem.

American Samoa: Continued incremental loss of nesting habitat occurs due to varied activities of a rapidly expanding human population. American Samoa has one of the fastest growth rates in the world; the doubling time is only 19 years.

Hawaii: A major problem for hawksbills in the MHI due to increased damage of reef habitats and destruction or disturbance of nesting areas. Fishermen, campers and other uncontrolled beach goers constitute a significant threat to hawksbill and their nests in the MHI.

Guam: Habitat destruction is a major threat to Guam turtles. Guam had over 740,000 tourists in 1990. With tourism expected to increase, the number of hotels and other beachfront development and usage will also increase.

Republic of Palau: Very few, if any, nesting beaches in the Rock Islands of Palau are free of human disturbance. Although most of the nesting beaches are on uninhabited islands, they are receiving increasing use from daytime tourists and nighttime camping. Some have summer homes, such as Ngemilis and Ulong. Many others have semi-permanent shelters or other signs of overnight use. An increase in outboard motor boats has provided a larger number of local citizens the means to camp among the remote Rock Islands, offshore and onshore of the nesting beaches. The Ngerukewid Island Wildlife Preserve remains protected, but permission has recently been granted for motor yachts, sailboats and live-aboards to moor overnight in certain other areas

within the Rock Islands. The number of live-aboard dive boats has been limited to three vessels, and precautions are being taken by Koror State to control dumping of sewage in the shallow lagoon.

CNMI: Nesting habitat along the sand beaches of the Saipan Lagoon is rapidly disappearing due to the "uncontrolled" development occurring along this area.

FSM: Many small nesting beaches in Chuuk lagoon have been abandoned, most likely due to increased human presence.

RMI: Minor problem except on Majuro Atoll, where population encroachment on nesting beaches is a growing problem.

Unincorporated: Generally a minor problem.

3. Coastal Construction

The most valuable land on most Pacific islands is often located along the coastline, particularly when it is associated with a sandy beach. Construction is occurring at a rapid rate and is resulting in a loss of sea turtle nesting areas. In this section, construction-related threats to the region's sea turtle nesting beaches are discussed, including the construction of buildings (hotels, houses, restaurants), recreational facilities (tennis courts, swimming pools), or roads on the beach; the construction of sea walls, jetties, or other armoring activities that can result in the erosion of adjacent sandy beaches; clearing stabilizing beach vegetation (which accelerates erosion and can also make the beach less attractive to hawksbill turtles who prefer to nest in the shelter of shrubbery); and the use of heavy construction equipment on the beach, resulting in sand compaction or beach erosion. (see Recovery - Sections 1.1.2, 1.2)

U.S. West Coast: Not a current problem.

American Samoa: Development is increasing along the coastline (houses, stores, beach armoring), particularly along the island highway where the human population is concentrated. Some progress is being made to evaluate proposed developments whereby all activities undergo a permitting process. Coastlines adjacent to villages and roadways are being armored to protect from storm erosion, but most of these areas are narrow rock or sand beaches (due to previous placement of the road) and probably provide little suitable nesting habitat.

Hawaii: Currently a minor problem for hawksbills in the MHI, because most land adjacent to nesting beaches is located on National Park lands, state lands leased for agricultural purposes, and a county park as well as private lands. However, potential for development exists on all but National Park beaches, and has recently been considered in close proximity to at least two beaches, including the main nesting beach of Kamehame.

Guam: Habitat destruction is a major threat to Guam turtles. Guam had over 740,000 tourists in 1990. With tourism expected to increase, the number of hotels and other beachfront development and usage will also increase.

Republic of Palau: Generally not a problem, with the possible exception of picnic shelters and weekend homes in the Rock Islands.

CNMI: Not a current problem.

FSM: Not a current problem.

RMI: Not a current problem, except on Majuro Atoll where coastal construction is increasing to accommodate a growing urban population.

Unincorporated: Generally a minor problem, except at Johnston Atoll where seawall construction has preempted use of beaches by nesting turtles.

4. Nest Predation

The loss of eggs to non-human predators is a severe problem in some areas. These predators include domestic animals, such as cats, dogs and pigs, as well as wild species such as rats, mongoose, birds, monitor lizards, snakes, and crabs, ants and other invertebrates. (see Recovery - Section 1.1.3)

U.S. West Coast: Not a current problem.

American Samoa: Not a current problem.

Hawaii: Perceived a major problem. Feral predators include mongooses, cats, dogs, birds, rats and feral pigs.

Guam: Not a known problem.

Republic of Palau: Predation by pigs is a potential problem on turtle beaches north of Baobeldaob (Ngerkeklau, Ngerechur) and by dogs on the nesting beaches at Merir Island in the Southwest islands. This represents primarily a threat to green turtle nests, with only occasional hawksbill nesting activity. However, the permanent presence of dogs on Babelomekang poses a distinct threat to hawksbill nests. There is no information on the possible threat of rats which occur on many of the hawksbill nesting beaches in the Rock Islands, including Babelomekang where “a whole verminous parade [was seen] traipsing boldly through a mass of dead palm fronds” (P. Theroux, pers. comm.).

CNMI: Unknown.

FSM: Impacts are area dependent. Some predation of nests occurs in YAP State .

RMI: Not thought to be a problem with the possible exception of predation by stray dogs and pigs along the shoreline of Majuro and perhaps other atolls. However, it should be noted that Polynesian rats have been identified as a problem for green turtles. On atolls where both green and hawksbills nest, rat predation is likely a problem for hawksbills.

Unincorporated: Apparently a minor problem.

5. Beach Erosion

Weather events, such as storms, and seasonal changes in current patterns can reduce or eliminate sandy beaches, degrade turtle nesting habitat, and cause barriers to adult and hatchling turtle movements on affected beaches. (see Recovery - Section 1.2.1, 1.1.5.2)

U.S. West Coast: Not a current problem.

American Samoa: Recent weather records indicate that a severe tropical storm or hurricane hits somewhere in the Samoan island chain approximately every three years, causing extensive erosion. A predicted rise in sea level due to global warming would increase erosion problems.

Hawaii: Moderate problem. Hurricane storm waves, tsunamis and coastal subsidence are known to cause erosion problems.

Guam: Not a current problem.

Republic of Palau: Occasional storm erosion occurs, particularly on the narrow beaches of the Rock Islands.

CNMI: Not thought to be a threat to hawksbill populations.

FSM: Minor problem, although severe tropical storms and typhoons are not uncommon for this region. Seasonal changes in wind direction (which occur towards the end of the main nesting season -- late July/early August) result in the erosion of beaches. Yap State's low coralline atolls are extremely vulnerable to rises in sea levels and will be adversely affected by greenhouse gas emissions, if current hypotheses are correct.

RMI: Moderate problem. Shoreline erosion occurs naturally on many islands in the atolls of the Marshalls due to storms, sea level rise and from ENSO's (El Niño - Southern Oscillation) and currents. On the outer atolls erosion has been aggravated by airfield and dock development, as well as by urban development on Majuro and Kwajalein Atoll.

Unincorporated: Not a current problem.

6. Artificial Lighting

Hatchling sea turtles orient to the sea using a sophisticated suite of cues primarily associated with ambient light levels. Hatchlings become disoriented and misdirected in the presence of artificial lights behind (landward of) their hatching site. These lights cause the hatchlings to orient inland, whereupon they fall prey to predators, are crushed by passing cars, or die of exhaustion or exposure in the morning sun. Nesting adults are also sensitive to light and can become disoriented after nesting, heading inland and then dying in the heat of the next morning, far from the sea. Security and street lights, restaurant, hotel and other commercial lights, recreational lights

(e.g., sports arenas), and village lights, especially mercury vapor, misdirect hatchlings by the thousands throughout the Pacific every year. (see Recovery - Sections 1.1.2, 1.1.4)

U.S. West Coast: Not a current problem.

American Samoa: Possibly a problem in coastal villages, although there are no documented cases of disoriented turtle hatchlings.

Hawaii: A minor problem for hawksbills in the MHI.

Guam: No information.

Republic of Palau: Campfires are a problem on nesting beaches. For example, at a beach on Urukthapel in the Rock Islands, campers in 1995 gathered hatchling sea turtles, presumably hawksbills, that were attracted to their campfire (M. Guilbeaux, pers. comm.). The hatchlings were released in the water, but the conservation effort met with little success as the turtles kept coming out of the water toward the campfire. It can be assumed that any lights, such as mantle lanterns associated with camps on nesting beaches, would disorient emerging hatchlings in a similar manner.

Three live-aboard dive boats are now in operation which moor at night in the Rock Islands, occasionally in view of nesting beaches (M. Guilbeaux, pers. comm.). Bright lights associated with these large vessels could be expected to disorient hatchlings, possibly attracting them to the vessels along with predaceous fish known to feed on other prey species attracted to the same lights.

CNMI: Not a current problem.

FSM: Not a current problem.

RMI: Not a current problem.

Unincorporated: Minor problem.

7. Beach Mining

Sand and coral rubble are removed from beaches for construction or landscaping purposes. The extraction of sand destabilizes the coastline (e.g., reduces protection from storms), removes beach vegetation through extraction or flooding and, in severe cases, eliminates the beach completely. When mining occurs on or behind a nesting beach, the result can be the degradation or complete loss of the rookery. In addition, females can become confused when they emerge from the sea only to find themselves heading down slope into a depression formed by mining activities; too often the outcome is that the female returns to the sea without laying her eggs. Even when eggs are successfully deposited, reduced hatch success results if nests are flooded or excavated during mining. (see Recovery - Section 1.2.2)

U.S. West Coast: Not a current problem.

American Samoa: Despite educational attempts and enactment of protective laws, the tradition of removing sand and coral rubble from shorelines continues at a surprisingly high rate for a small island with limited beaches (about 100+ cubic yards/week). However, the impact to turtles is probably not significant because affected beaches are usually those along the island roadway, and most of these beaches are too narrow (due to road placement) to be suitable for turtle nesting. In some areas, shoreline erosion, exacerbated by beach mining, jeopardizes the island highway however.

Hawaii: Not a current problem.

Guam: No information.

Republic of Palau: Not a current problem.

CNMI: Not a current problem.

FSM: Not a current problem.

RMI: Not a current problem.

Unincorporated: Not a current problem.

8. Vehicular Driving on Beaches

Driving on the beach causes sand compaction and rutting, and can accelerate erosion. Driving on beaches used by nesting turtles can crush incubating eggs, crush hatchlings in the nest, and trap hatchlings after they emerge from the nest cavity and begin their trek to the sea. In the latter case, hatchlings are exposed to exhaustion and predators when they fall into and cannot climb out of tire ruts that are typically oriented parallel to the sea. (see Recovery - Section 1.2.6)

U.S. West Coast: Not a current problem.

American Samoa: Not a current problem. In some areas (e.g., Sailele), a non-paved village road crosses upper beach areas where turtles may nest, but such areas are already heavily impacted by the villages and there is generally no available space to re-route the road.

Hawaii: A minor problem for hawksbills nesting in the MHI however, a serious problem at Punaluu and Kawa on the island of Hawaii.

Guam: No information.

CNMI: Although beach driving is a pastime on Saipan, the impacts are unknown.

Other areas: Not a current problem.

9. Exotic Vegetation

Introduced species can displace native dune and beach vegetation through shading and/or chemical inhibition. Dense new vegetation shades nests, potentially altering natural hatchling sex ratios. Thick root masses can also pose a threat by entangling eggs and hatchlings, or by preventing access by gravid females. (see Recovery - Section 1.2.3)

Republic of Palau: The dense planting of coconut trees and ornamental shrubs is a problem on some of the Rock Island beaches used by nesting hawksbills. These beaches are also popular picnic and camping sites for visitors and residents.

Hawaii: An unknown problem for Hawaii. *Ipoemea* (sp.) vines are known to invade hawkbill nests and cause mortality.

All other areas: Not a current problem.

10. Beach Cleaning

Removing accumulated seaweeds and other debris from a nesting beach should be accomplished by hand-raking only. The use of heavy equipment can crush turtle eggs and hatchlings and can remove sand vital to eggs incubating below. (see Recovery - Section 1.2.5)

All areas: Not a current problem.

11. Beach Replenishment

The nourishment or replacement of beaches diminished by seawalls, storms, or coastal development can reduce sea turtle hatching success by deeply burying incubating eggs or depositing substrate (generally from offshore deposits) that is not conducive to the incubation of sea turtle eggs. Females coming ashore to nest may be obstructed by machinery, pipelines, etc. (see Recovery - Section 1.2.4)

All areas: Not a current problem.

12. Other

Hawaii: Lava flows and tsunamis on the Big Island sometimes destroy nesting beaches.

Republic of Palau: Drift debris sometimes blocks access by females.

Marine Environment

13. Directed Take

The harvest of sea turtles for food or any other domestic or commercial use constitutes a widespread threat to these species. In particular, the exploitation of large juveniles and adults can accelerate the extinction of local and regional stocks. This category includes only the harvest of sea turtles at sea. Harvest of on the nesting beach was discussed in a previous section. (see Recovery - Section 2.1)

U.S. West Coast: Not a current problem.

American Samoa: Turtle harvest is the most significant source of mortality in the Territory. Turtles and their eggs, when found, are consumed. The concept of turtle conservation faces several difficulties in contemporary American Samoa. For example, most people are unaware that it is illegal to take sea turtles within the Territory. Public acceptance of conservation issues is a challenging problem. Although many people acknowledge that there are considerably fewer turtles on their beaches than when they were children, few indicated concern for the future of turtles. Some residents expressed the view that turtles were placed in the ocean by God for man to take, and others felt that if they did not take the turtle, someone else would. Another aspect of the problem is that villagers may keep hatchlings as pets, which eventually die.

Hawaii: A moderate problem in Hawaiian waters. In the past turtles have been taken using spears, harpoons, nets, grappling hooks, firearms from shore, underwater bang sticks, nooses, and by hand capture. Illegal poaching continues.

Guam: Directed harvest is one of the major threats to turtles in Guam. Turtles were traditionally taken by residents for celebrations, and current reports indicate that illegal harvesting still occurs. Poaching also occurs by immigrants, fishing crews, and tourists, especially those from areas where they are accustomed to eating turtles legally. The language problem for non-English speaking immigrants and lack of knowledge about local regulations has caused the majority of such problems. When turtle poachers are convicted, all gear and vehicles (car, boat) are confiscated and fines and/or penalties are levied.

Republic of Palau: Although harvested turtles are taken off nesting beaches, additional turtles are taken in nearshore waters year-round. As was the case for nesting turtles taken at the beach, the volume of worked tortoiseshell is considerable, and there are no records as to the source of the raw material. Little can be said about the specifics of this activity without more information.

CNMI: In CNMI, knowledge of existing regulations does not inhibit many people from eating turtles or their eggs. Sea turtles are considered a traditional food item and are hunted illegally to this day. Federal laws protecting turtles are known, but hotly contested by the public. CNMI Customs Officers routinely confiscate turtle handicrafts (combs, jewelry, etc.) at the airport. Confiscation of turtle products is the extent of prosecution. Most of the turtle products originate from the Republic of Palau (Belau) or FSM.

FSM: Turtle harvest is the most significant source of mortality within the region. In general, both turtles and eggs are consumed if encountered (direct take varies from island to island based on rights to the resource). People also raise hatchlings as pets which generally die in captivity, but the impact of this is thought to be minimal to the overall population.

Laws dealing with the harvesting of turtles and eggs are in desperate need of revision. Both present and future laws will remain unenforceable and unagreeable to the people unless the people themselves enact and enforce them at the community level. A few islands (Elato, Lamotrek, Satawal) have introduced their own regulations regarding the take of turtles (such as waiting until after a nesting turtle lays eggs before harvesting it). However, harvest effort for the turtle continues to rise while turtle nesting levels continue to fall at nearby islands where mostly green turtles are harvested (West Fayu, Pikelot).

Yap's Marine Resources Management Division (MRMD) has, in cooperation with specified island residents, been collecting data on the number of turtles caught and consumed throughout the outer islands. Most of the outer islands within the state have generally sent in this type of information. These data have not yet been analyzed. The MRMD of Pohnpei State (FSM) is compiling similar information at Oroluk Atoll.

The introduction and use of motorized boats has increased people's ability to reach islands where turtles generally nest. Travel by traditional methods of transportation (outrigger canoes) was and is restricted by weather patterns, the length of the voyages, etc. Motorized craft have allowed for an extended travel season as well as for an increased frequency of visits to the uninhabited islands.

RMI: Some turtles are taken by snorkelers in nearshore waters.

Unincorporated: Like many other uninhabited islands take by unauthorized visitors is a problem.

14. Natural Disasters

Natural phenomena, such as cyclones, can contribute to the mortality of turtles at sea, particularly in shallow waters. Disease epidemics and other debilitating conditions that affect prey items (sea grass, coral, sponges, reef invertebrates) can also cause harm to sea turtle populations. Storms can alter current patterns and blow migrating turtles off course into cold water. Unseasonal warm water incursions from subtropical regions into the northeastern Pacific, known as "El Niño" events, may cause hawksbills to migrate north where they "cold stun" once they encounter colder water. El Niño events can also cause reduced food production for some turtle species which can reduce growth and fecundity. (see Recovery - Sections 2.1.6., 2.1.7, 2.2.1, 2.2.2)

U.S. West Coast: Not a current problem.

American Samoa: Mortality due to natural disasters is unknown. Recent weather records indicate that a severe tropical storm or hurricane hits somewhere in the Samoan islands every three years on average.

Hawaii: Probably a minor problem. Turtles have been reported thrown ashore by tsunamis.

Guam: Not thought to be a problem, although Guam is in an area that is regularly hit with typhoons.

Republic of Palau: Not thought to be a problem.

CNMI: Not thought to be a problem, although CNMI is in an area that is regularly hit with typhoons.

FSM: Mortality due to natural disasters is unknown. A recent typhoon (1990/1991) nearly devastated some of the outer islands, but the impact to turtles in those regions is unknown.

RMI: Minor problem.

Unincorporated: Unknown.

15. Disease and Parasites

There are few data to assess the extent to which disease or parasitism affects the survivability of hawksbills in the wild. (see Recovery - Section 2.1.6)

All Areas: Unknown.

16. Algae, Seagrass and Reef Degradation

Hawksbills depend upon sea grass and/or coral reef habitats for food and refuge. The destruction or degradation of these habitats is a widespread and serious threat to the recovery of depleted hawksbill stocks. The general degradation of these habitats can be affected by eutrophication, sedimentation, chemical poisoning, collecting/gleaning, trampling (fishermen, skin and SCUBA divers), anchoring, etc. Chlorine bleach has been used for reef fishing in isolated cases (M. Guilbeaux, pers. comm.), and is destructive practice that kills everything alive on the effected reefs. (see Recovery - Section 2.2)

U.S. West Coast: Not a current problem.

American Samoa: A general degradation of coral reef habitats on the south side of Tutuila Island is occurring, due to both human impacts (particularly sedimentation resulting from erosion on steep agriculture slopes) and natural disturbances (recent hurricane damage). There are no known seagrass beds in the Territory, although some may occur in nearby Western Samoa.

Hawaii: Many reefs have been degraded due to past coastal construction and sedimentation, non-point source pollution and overfishing/overuse.

Guam: Sedimentation, overfishing and overuse have damaged Guam's coral reefs.

Republic of Palau: Reefs near Koror have been degraded by coastal construction and along the coasts of southern Baobeldaob due to land clearing and road construction. Although minor to moderate impact at present, planned road projects, golf courses and urban development could greatly accelerate soil erosion and reef degradation.

CNMI: Saipan's coral reef ecosystem, located along the western side of Saipan, is currently being impacted by terrigenous runoff and nutrient loading associated with sewage discharge from the Sadog Tasi Water Treatment Plant. Actual impacts to the reef are not known, but some sections of the reef system appear to be dying. Other islands do not have a well-developed fringing reef system or extensive seagrass meadows.

FSM: Coral reefs in all four urban centers (Lelu-Tofol in Kosrae, Kolonia in Pohnpei, Chuuk lagoon in Chuuk and Colonia in Yap) have been extensively degraded from urbanization (coastal construction, fortification, landfills, garbage disposal, sewage disposal, dredging etc.).

RMI: Reefs at Kwajelein and Majuro are being destroyed by coastal construction, landfills and eutrophication. Previously serious damage to reefs at Bikini, Enewetok and Mili occurred.

Unincorporated:

17. Environmental Contaminants

Chemical pollutants, such as petroleum, sewage, pesticides, solvents, industrial discharges, and agricultural runoff are responsible for an unquantified level of sea turtle mortality each year. Environmental contamination also harms biologically important nearshore ecosystems, including seagrass, coral, mangrove, and algae communities. The declining productivity of seagrass and coral communities, in particular, can be hazardous to sea turtles that depend on these systems for nutrition and shelter. (see Recovery - Section 2.2.4)

U.S. West Coast: Not a current problem.

American Samoa: In populated and agricultural areas on the main island of Tutuila, some degradation of coastal waters is occurring due to silt-laden runoff from land and nutrient enrichment from cannery discharges and human/pig wastes. A more serious pollution problem occurs in Pago Pago Harbor where both fish and sediments are grossly contaminated with heavy metals, PCBs, pesticides, and petroleum products. A health risk analysis indicated that the concentration of lead alone may reach levels that cause mental retardation in people who regularly consume fish from the harbor. Petroleum spills have been common occurrences in the harbor for the past 25 years. Additionally, in November 1993, a commercial long-line fishing vessel ran aground at Rose Atoll National Wildlife Refuge spilling about 100,000 gallons of fuel as well as oil and ammonia. Preliminary surveys indicated damage to corals, giant clams and other invertebrates.

Hawaii: Pollution near urban areas is a potential problem.

Guam: Sewage discharges and hazardous waste associated with military operations are a problem.

Republic of Palau: Untreated sewage disposal is a problem around Koror State and near urban areas, such as Malakal Harbor.

CNMI: With the exception of sewage, environmental contamination is not documented. One potential source of contamination is the unregulated Puerto Rico landfill in the Saipan Lagoon adjacent to American Memorial Park. This landfill was originally a U.S. military dump which the Trust Territory continued to use. Recent efforts by the government to relocate the dump to the Marpi area have met with some success, and if additional funds are generated. Other islands may also have "hazardous waste" areas, most likely associated with World War II activities.

With respect to sewage, Saipan has two wastewater treatment plants at Agingan Point and the Sadog Tasi. The Agingan Point plant discharges untreated sewage into the ocean between Saipan and Tinian. The area of discharge is a dynamic current area and is adjacent to deep waters. The Sadog Tasi plant adequately treats all sewage (secondary level) before discharging into the Saipan Lagoon near Charlie Dock, the main shipping port. However, the outfall has been damaged and is in need of repair.

The current wastewater treatment plant situation does not appear to be a direct threat to sea turtles; however, it may affect habitat and food. In addition, a cumulative effect of general habitat degradation could be occurring from the numerous drainage ditches which empty into the lagoon.

FSM: A seemingly large number of fishing boats and other vessels have grounded on Yap State reefs and spilled fuel. The effects of this are unknown. Garbage dumps are overflowing and contaminating nearshore waters in Chuuk and Pohnpei, and to a lesser extent, Kosrae.

RMI: Garbage dumps are overflowing and contaminating nearshore waters and coral reefs in Ebeye (Kwajalein) and Majuro. There has been a long history of contamination by military activities at Kwajalein.

Unincorporated: Some hazardous waste dumps at Palmyra Atoll abandoned by the U.S. military in 1960 are contaminating lagoon waters.

18. Debris (Entanglement and Ingestion)

The entanglement in and ingestion of marine debris threatens the survival of hawksbills in the Pacific. Such debris includes not only discarded or abandoned fishing gear (lines, ropes, nets), but also plastic bags, plastic sheets, "6-pack" rings, tar balls, styrofoam, and other refuse that might ensnare or be consumed by a sea turtle. Severely entangled individuals can neither submerge to feed nor surface to breathe; they may lose a limb to the offending net or fishing line, or attract a predator with their struggling. Stranding data and necropsies provide evidence that some turtle mortalities have resulted from ingested garbage, such as plastic or tar. Death or debilitation can also result from poisoning or from obstruction of the esophagus. (see Recovery - Section 2.1.3)

U.S. West Coast: Not a current problem.

American Samoa: Possible problem in nearshore waters due to local practice of discarding garbage into streams and onto beaches. Entanglement in fishing gear is not a current problem in coastal waters of the inhabited islands because there are virtually no commercial fisheries in the Exclusive Economic Zone (EEZ). Debris-related problems in offshore waters are unknown. However, potential problems with entanglement exist. In October 1993 a commercial longline fishing vessel ran aground at Rose Atoll, spilling a considerable amount of fishing line.

Hawaii: Thought to be a minor problem.

Guam: No information.

Republic of Palau: Not a current problem.

CNMI: A possible threat, however there have been no reports of turtle deaths due to debris entanglement or ingestion.

FSM: Unknown impact. Debris is dumped freely and frequently off boats and ships (including government ships). Landfill areas are practically nonexistent in the outer islands and have not been addressed adequately on Yap proper. The volume of imported goods (including plastic and paper packaging) appears to be consistently increasing. Some people have observed plastic debris mixed in with the gut contents of harvested turtles, but the extent of this problem is unknown. Elsewhere in the FSM sanitary landfills are poorly managed in the urban centers creating the possibility of turtles ingesting garbage.

RM: Minor problem, except at Ebeye and Majuro where garbage waste is constantly seen floating in lagoon and ocean waters due to inadequate landfill containment.

Unincorporated: Minor problem.

19. Fisheries (Incidental Take)

Sea turtles are accidentally taken in several commercial, subsistence and recreational fisheries. These include bottom trawls, off-bottom trawls, purse seines, haul seines, beach seines, bottom longlines, surface long-lines, hook and line, gillnets, and driftnets. Mortality associated with entanglement in active and abandoned fishing gear has not been fully quantified, but is very likely to involve tens of thousands of Pacific sea turtles each year. (see Recovery - Section 2.1.4)

U.S. West Coast: Not a current problem.

American Samoa: Subsistence gillnets set along the shoreline occasionally catch turtles in Pala Lagoon and probably elsewhere. Catches farther offshore in the EEZ are not a current problem because little fishing occurs there. However, limited tagging data indicate that Samoa's turtles migrate great distances in the South Pacific, so impacts of distant fisheries must be considered. Bycatch of turtles in these fisheries is not known.

Hawaii: Incidental catches of hawksbill turtles occur, primarily in nearshore gillnets. Driftnet fisheries in offshore waters in the North Pacific have taken many turtles in the past although

hawksbills have not been documented in this take. In 1990, the total bycatch of turtles in these fisheries was 6,100 turtles (at least 1,700 of which were dead), mostly loggerheads, followed by leatherbacks and green turtles.

Guam: The harvest of turtles through bycatch probably occurs within Guam's EEZ. Laws prohibiting this are hard to enforce because there is only a single Coast Guard vessel available for Guam. A large amount of longline fishing for tuna occurs just beyond the EEZ, and this is also expected to pose a threat to turtles.

Other areas: Incidental catches by offshore fleets and in international waters are unknown, but probably represent a moderate to serious threat, especially on uninhabited atolls where fishermen often land and kill/harvest large quantities of wildlife. Because of the lack of unbiased observers on the majority of these fishing vessels, it is impossible to quantify this "incidental take".

20. Predation

Few predators, with the notable exception of orcas (killer whales), large sharks, and marine crocodiles, can consume a full-size sea turtle. Predation on small juvenile size classes is believed to be relatively high and, again, the species most often implicated are coastal and pelagic sharks.

All areas: Unknown impact.

21. Boat Collisions

Sea turtles can be injured or killed when struck by a boat, especially if struck by an engaged propeller. Recreational equipment, such as jet skis, also poses a danger through collision and harassment. (see Recovery - Section 2.1.4, 2.1.5, 2.1.7)

All areas: Unknown but probably inconsequential, except in Hawaii where serious injuries and mortalities have been documented.

22. Marina and Dock Development

The ongoing and future development of marina and docking facilities pose direct and indirect threats to sea turtles. Direct consequences can be seen when foraging grounds and nesting beaches are dredged or otherwise permanently altered in the process of construction and maintenance. Altered current patterns and increased levels of ship traffic, pollution, and general activity which act to displace or injure local sea turtles constitute indirect and cumulative impacts that should also be considered. (see Recovery - Sections 1.2.1, 2.2)

U.S. West Coast: Not a current problem.

American Samoa: Not a current problem.

Hawaii: A minor problem for hawksbills in the MHI.

Guam: U.S. Army Corps. of Engineers (COE) has completed docks at Agann and Agat and there may be additional boat docks constructed, improved, or permitted in the future at Merizo.

Republic of Palau: Recent dock construction at Ngetpang, Ngerchelong and Melekeok degraded coral reefs and seagrass beds. Other docks are planned. Dock construction at Angaur, however, did not degrade nearby reefs or seagrass meadows.

CNMI: The major shipping area on Saipan is Garapan Dock, an outdated structure from World War II. Construction to expand and modernize the dock facilities are in progress.

FSM: A dock extension project is currently underway on Yap proper but it is not thought to pose problems for turtles around that island. Several sites in Chuuk lagoon are proposed for dock construction or improvements.

RMI: Minor problem. Recent dock construction at Ine and Arno villages at Arno Atoll degraded nearby coral reefs. Many other docks for the outer Atolls are in the planning stages with some possibly funded by foreign aid. Docks are also under construction at Bikini Atoll.

Unincorporated: Not a current problem.

23. Dredging

Active dredging machinery (especially hopper dredges) can injure or kill sea turtles, and channelization may alter natural current patterns and sediment transportation. Coral reef and sea grass ecosystems may be excavated and lost, and suspended materials could smother adjacent coral and seagrass communities. (see Recovery - Section 2.2.5)

U.S. West Coast: Not a current problem.

American Samoa: Not a current problem.

Hawaii: Possible though an intermittent problem.

Guam: Not a current problem.

Republic of Palau: Not a current problem.

CNMI: Very little dredging is done in CNMI waters. The Tinian harbor facilities, originally constructed by the U.S. military, have been under discussion for rehabilitation, however, no proposal has been submitted for review. The harbor area is known to contain turtles, so minimizing impacts to sea turtles will become part of the permitting process if this project is approved.

No dredging activities are known for the remaining Islands.

FSM: Impact unknown. A limited amount of dredging occurs on a fairly regular basis around Yap proper. Recently, dredging occurred in Yap proper in an effort to widen one channel and establish another.

RMI: Not a current problem.

Unincorporated: Not a current problem.

24. Dynamite "Fishing"

The use of explosives to stun or kill fish destroys coral, degrades or eliminates foraging habitat and refugia for all sea turtle species as well as kills turtles directly. (see Recovery - Section 2.2.7)

U.S. West Coast: Not a current problem.

FSM: In Chuuk lagoon, dynamite fishing is widespread and has damaged about 10% of the reef.

All other areas: Dynamite fishing is outlawed in many areas but occasionally occurs.

25. Oil Exploration and Development

Oil exploration and development poses direct and indirect threats to sea turtles. A rise in transport traffic increases the amount of oil in the water, such as from bilge pumping, as well as the likelihood of a major spill. Oil spills, such as those resulting from blow-outs, ruptured pipelines, or tanker accidents, can kill sea turtles. Indirect consequences include destruction of foraging habitat by drilling, anchoring, and pollution. (see Recovery - Section 2.2.8)

All areas: Not a current problem.

26. Power Plant Entrapment

Entrapment in the water intake mechanisms of power generating facilities can result in death to sea turtles of all size classes.

All areas: Not a current problem.

27. Construction Blasting

Blasting can injure or kill sea turtles in the immediate area. The use of dynamite to construct or maintain harbors, break up reef and rock formations for improved nearshore access, etc. can decimate coral reefs, eliminating food and refuge for sea turtles. Some types of dynamiting have minimal impact to marine life, such as placing explosive in pre-drilled holes (drilling and shooting) prior to detonation. This is a standard practice to secure armor rock. (see Recovery - Section 2.2.7)

RMI: Charges are used to fracture rock used in construction projects on Ebeye and could pose a danger if used incautiously.

CNMI: Charges are used to fracture rock used in construction projects on Saipan and could pose a danger if used incautiously.

All other areas: Not a current problem.

I. Conservation Accomplishments

Legislation

At present, ESA applies only to actions taken within the Territory of Guam, State of Hawaii, Territory of American Samoa, CNMI, and the eight unincorporated U.S. islands (Midway, Wake, Johnston, Palmyra, Kingman, Jarvis, Howland, and Baker) within the geographic area covered by this recovery plan. The RMI, FSM and Republic of Palau are independent countries no longer subject to U.S. environmental jurisdiction, including the ESA, for activities conducted within these countries. Export of sea turtles or their products to the United States is prohibited, under CITES.

Protected Species Statutes in the Republic of Palau

National law bans the take of all sea turtle eggs, hatchlings, and nesting adults on all Palauan beaches at all times. Currently, the take of hawksbills with a CCL of 27 inches or less is prohibited at all times, and larger animals are restricted from take during the five-month closed season of December to January and June to August. In addition, the States of Koror, Ngeremlengui and Kayangel have expressed the need and may now be taking action to establish state-level regulations for protecting hawksbill sea turtles found within their jurisdictional areas, including northern Ngeremeduu Bay, Kayangel, and Ngeruangel Atoll where nesting sea turtles and eggs are being taken. Unfortunately, protective measures are proving very difficult to enforce throughout Palau, as there is a segment of the population that has not been convinced of the need to take such laws and regulations seriously. Without a strong cooperative effort between Palau federal government and the traditional leadership of Palau's States, enforcement of existing conservation measures will remain next to impossible, with little beneficial effect accruing to the conservation of Palau's hawksbill sea turtles at the present time or in the foreseeable future.

Traditional Controls

For hundreds, if not thousands of years, the traditional societies of the Mariana, Caroline, Marshall, Samoan, and Hawaiian Islands exerted controls over the taking of sea turtles, especially at nesting beaches. These controls have been effectively eliminated from the Hawaiian, Mariana, and American Samoan Islands due to a combination of colonial takeover by western powers and transition from subsistence to cash economics. These changes eroded the power of ruling clans and introduced modern technologies that led to rapid depletion of turtle stocks.

Only in the Marshall, FSM, and Palau are traditional controls still in effect, although only at rural or uninhabited atolls away from the urban centers. The introduction of a western "elected" political system to these islands has challenged traditional authorities and further eroded protection of sea turtles. Landowners in parts of the Marshalls and FSM still claim ownership of adjacent reef areas which discourages taking of turtles by other groups. The FSM, Palau, and Marshall Islands also established "pantry reserves" at uninhabited atolls near inhabited atolls. Examples of these include Ngeruangel Atoll and Fanna Island in Palau, Gaferut, Pikelot, and West Fayu in the FSM; and Bokaak and Bikar in the Marshalls. These so-called "traditional reserves" were only visited by sailing canoes during favorable weather conditions in the old days. However, these reserves are now much more accessible due to availability of the outboard motor, modern skiffs, and modern navigation equipment. Modern supply boats and patrol boats also have easy

access to these islands. Most of the uninhabited islands are now being rapidly depleted of their nesting sea turtles and many of these sites are the last remaining nesting populations of sea turtles in their respective countries.

Protected Areas

Republic of Palau

Until recently Palau has had the only designated protected area in Micronesia, the Ngerukuid Nature Reserve, also known as the 70-islands Nature Reserve located within Koror State. Reserve status has worked to protect nesting hawksbills and their eggs on the six beaches within the Reserve for the last several decades, particularly during daylight hours. However, the Reserve is small, and the illegal take of nesting turtles and eggs at night has been clearly documented by the Palau Division of Marine Resources as significant over the last ten years (see Section on Nesting Environment - Directed Take). The Division of Conservation and Entomology has six conservation officers for all of Palau. There are, in addition, Koror state marine rangers willing and able to patrol the Reserve with authority to detain but not to arrest. Poachers, therefore, are rarely apprehended, and prosecution of illegal acts within the reserve is rare. As a result, effectiveness of the Ngerukuid Nature Reserve as hawksbill conservation preserve is less than its potential.

Guam

The Government of Guam is proposing the establishment of Territorial Reserves to protect wildlife including sea turtles, but so far no reserves that protect sea turtles have been established by the Territorial Government. However the U.S. Fish and Wildlife Service (FWS), the U.S. Navy, and the U.S. Air Force (USAF) have all established protected areas in Guam. The Andersen Air Force Base 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 or eggs.

American Samoa

The American Samoa Government cooperatively has established a National Marine Sanctuary with National Oceanographic and Atmospheric Administration (NOAA) at Fagatele Bay, Tutuila. Beaches at Fagatele appear suitable for turtle nesting although no data are available. Certainly foraging and nesting sea turtles would be afforded protection in the sanctuary due to its inaccessibility from nearest villages.

The U.S. National Park Service (NPS) has recently established a new National Park in American Samoa with three units: SW Ofu, Central Ta'u and northern Tutuila. The Ofu unit which includes beaches and a coral reef along the SW Coast of Ofu will likely afford protection to sea turtles, since the coast is only sparsely inhabited. The Ta'u unit may protect foraging sea turtles of the remote south coast of Ta'u. The northern Tutuila unit includes several bays, beaches and potential foraging and nesting habitat for sea turtles. Several villages claim subsistence access to resources in the Park and along the entire northern coastline. It remains to be seen whether the new National Park will promote the conservation of sea turtle populations in American Samoa.

Rose Atoll is a National Wildlife Refuge and administered by the U.S. FWS. The refuge affords protections for nesting turtles on the beaches of the atoll, and potential foraging habitat for turtles on the atoll's reefs and lagoon. The American Samoa Government's DAWR co-administers the Refuge.

CNMI

The government of the CNMI has not established protected areas in the Commonwealth although Managaha Island and reefs off western Saipan and the three Maug Islands have been candidate parks for some time. The CNMI government is presently evaluating a number of candidate protected areas through the Commonwealth, some of which may benefit nesting of foraging sea turtles.

RMI

No reserves or protected areas have been established although several were recommended in the Northern Marshall's by Thomas et al. (1989) and Maragos (1994).

FSM

No reserves or protected areas have been established in the FSM. Oroluk was recommended as a reserve although it has yet to be established.

Unincorporated Islands

Howland, Jarvis, Baker and Johnston are national wildlife refuges administered by the U.S. FWS although Johnston is jointly administered by the U.S. Department of Defense (Air Force and Army). Wake is the northernmost of the Marshall Islands (Marshallese name Enen Kio) claimed by the United States and administered as an Air Force station. The Air Force has established small wildlife management areas on the uninhabited parts of the atoll. Midway Atoll is a Naval Air Station that is about to be closed. Sand Island and Eastern Islands on Midway support beaches and potentially important nesting habitat for turtles. The lagoon supports potentially important foraging habitat for turtles. The future use of Midway at this time (July 1995) is not known, but the prospect is the designation of the entire atoll as a wildlife refuge of the state of Hawaii.

Palmyra is an uninhabited and privately owned atoll of U.S. sovereignty. The owners are proposing residential and resort development of a portion of the atoll and refuge status for the remainder. The U.S. FWS is interested in Palmyra as a potential National Wildlife Refuge. The atoll supports important feeding and nesting habitat for green turtles. The U.S. Department of the Interior technically administers Palmyra while the U.S. Navy claims territorial waters around the atoll as a Naval Defensive Sea. These designations afford some conservation value to sea turtles.

Kingman Reef supports no permanently vegetated land, but sandspits present on the atoll may be valuable resting and nesting habitat for turtles while the lagoon may support foraging habitat for turtles. The Navy claims Kingman as a Naval Defensive Sea which discourages access and affords some protection for turtles.

Hawaii

Hawaii supports a large number of protected areas throughout the archipelago. Kure Atoll at the northwest end of the chain is a wildlife refuge of the state of Hawaii and potentially important to nesting and foraging sea turtles. The northwest atolls and islands between Pearl and Hermes to the northwest and Kaula to the southeast are part of the Hawaiian National Wildlife Refuge complex administered by the FWS with assistance from the National Marine Fisheries Service (NMFS). The complex includes the most important nesting habitat for green turtles at French Frigate Shoals in the geographic areas covered by the present plan and many of the other atolls, island reefs and lagoons in the complex afford important turtle foraging and nesting habitat for sea turtles.

The state of Hawaii administers a system of state parks and Marine Life Conservation Districts throughout the main islands, and one coastal natural area preserve on Maui. The National Park Service's Hawaii Volcanoes National Park includes coastal areas on the southeast coasts of Hawaii and Maui islands. Honaunau and Pu'u Kohola are also national parks with coastal areas along the west coast of Hawaii Island. All of these areas afford protection for foraging and nesting sea turtles in Hawaii.

Other Plans and Regulations

The governments of Hawaii, Guam, American Samoa, and the Northern Marianas all administer coastal zone management programs sponsored by NOAA. These plans are authorized by legislation or executive orders and include policies to protect coastal zone resources including beaches, reefs and lagoons - habitats important to nesting and foraging sea turtles. These governments also administer a system of coastal zone permits to control development and promote sustainable and multiple uses of coastal resources including conservation. Federal activities within designated coastal zones must also achieve consistency with state or territorial coastal zone management plans. None of the other areas have established functional coastal zone management plans yet although Kosrae and Yap in the FSM are close.

Development in nearshore coastal waters is also controlled through permit programs administered by the COE (discharge of dredge or fill materials and work in navigable waters) and the U.S. Environmental Protection Agency (EPA; for sewage treatment plants and outfalls). State and territorial permits are also administered by the state of Hawaii (Conservation District Use Permits) and the FSM, RMI and Palau (earthmoving permits). The CNMI and Guam may also have comparable permits. The state of Hawaii also administers a state-level endangered species act which affords protection to sea turtles in state waters and beaches.

Headstart and Hatchery Programs

Palau's MMDC, now renamed the Belau Mariculture Demonstration Center, and predecessor organizations established a hawksbill turtle hatchery and head start program in the late 1960's that continued operation until 1991. Assessments of the facility were requested in 1991 by the Palau government (Maragos 1991; Sato 1991). Egg and hatchling mortality was high in captivity. Released hatchlings and headstarted yearlings could not be followed and, therefore, were not monitored to measure the effectiveness of the program. There were no documented returns of reproductively viable adults to the Palau hawksbill population. Eggs were removed from nesting

beaches, possibly disrupting imprinting by the hatchlings and other events in the life cycle of the animals necessary for their return as reproductive adults. For these reasons, Maragos (1991) recommended termination of the program. Sato (1991), representing the interests of the Japan Tortoiseshell Association, a financial sponsor of the program, did not concur. The Palau Division of Marine Resources terminated the headstart and hatchery program in late 1991. A major concern affecting this decision was the dwindling degree of nesting activity on the beaches of the Rock Islands and the concern that the hatchery and headstart program could be contributing unwittingly to the continuing demise of Palau's hawksbills. On the positive side, the hatchery and headstart program provided opportunities for residents and visitors to tour the facility and learn much about turtles.

Sea Turtle Conservation and Management Plans

Hawaii: The NMFS, Honolulu Laboratory, has prepared a sea turtle conservation plan for Hawaiian sea turtles (Balazs et al.1992) and ecological profiles. These reports have served as important educational sources and interim guidance to help in the recovery of Hawaiian sea turtles.

Palau: The Republic of Palau requested assistance with preparation of a sea turtle conservation plan after closing the MMDC turtle hatchery and headstart program. A draft plan was prepared (Maragos 1992) and submitted for review. Subsequently, additional studies were sponsored to contribute additional information to the plan (Atkinson and Guilbeaux 1992, Geermans 1992, Geermans and Honigman 1992, Guilbeaux 1992, Guilbeaux et al.1994, Di Rosa 1992). A final sea turtle conservation plan has not been completed as of 1995.

Research and Education

The South Pacific Regional Environment Programme (SPREP), with headquarters in Apia, Western Samoa, funds a regional sea turtle conservation program with support for research, public education, brochures, and other activities which benefit all species of sea turtles in the insular Pacific. 1995 was declared "The Year of the Sea Turtle" by SPREP, with a major conservation awareness program in effect throughout the region.

The NMFS in Hawaii and SPREP in Apia, Western Samoa, have sponsored generalized research on sea turtles in the Pacific to promote conservation. Tagging of adult nesting sea turtles at many beaches in the tropical insular Pacific is being sponsored by the SPREP regional sea turtle conservation program with technical assistance from NMFS. Genetic research on tropical Pacific sea turtles is being conducted in Australia by the Queensland Department of Fisheries and Wildlife Resources and in Hawaii by the NMFS Honolulu Laboratory. Posters and educational pamphlets are widely distributed via SPREP throughout the recovery plan region, promoting conservation and research. Additional educational programs at the government and school level are also active on some island groups, such as American Samoa (P. Craig, pers. comm.).

Effectiveness of Conservation Accomplishments

The historic abuse of hawksbill nesting populations throughout Micronesia has been so pervasive over the last hundred years of foreign domination, such that there are not enough hawksbills left in most of the study areas (CNMI, FSM, RMI, Guam, unincorporated islands) to measure the effectiveness of conservation accomplishments. In Palau and American Samoa, some hawksbills remain, but conservation actions are still insufficient to stem the decline of resident nesting populations. Because a small, remnant population of nesting hawksbills survives within Palau's Rock Islands, this area is of great concern, perhaps the last hope for the future of any Micronesian hawksbills in the next half century. Despite the incomplete nature of information and studies, it must be assumed that nesting at virtually all historic nesting grounds is either already gone or declining toward extirpation and perhaps regional extinction. Foraging hawksbill populations are also at risk throughout all areas covered in this plan, except perhaps the unincorporated U.S. islands that remain safe because of restricted access to military installations and wildlife reservations.

Hawaii is the exception to all of the above. The recent discovery of significant numbers of nesting hawksbills on the Hilo coast of Hawaii is perhaps the only positive sign in an otherwise bleak picture. With virtual protection and an aggressive management plan in place, the Hawaiian hawksbills stand the best chance for recovery, although genetic studies indicate that these animals should not be expected to provide recruitment to depleted nesting beaches in other areas of Polynesia and Micronesia.

The success of conservation efforts in Hawaii is due largely to effective enforcement of the ESA, effective public education and research, the curtailing of illegal harvest of adult turtles and their eggs, and the establishment of protected areas. Conservation efforts need to be increased significantly in those island groups where direct harvest of the adults continues at nesting beaches without abatement and, where inadequacies persist concerning the enforcement of regulations already enacted.

Most importantly, educational efforts have been unsuccessful in changing the behavior of those islanders who conduct or condone the harvests. Harvesting has been the single biggest cause of sea turtle declines, particularly the taking of nesting females. Conservation efforts must focus on the education of the harvesters to convince them to curtail or cease their harvesting efforts. For all intents and purposes, nesting hawksbill populations have already been lost in FSM, CNMI, Guam, and the RMI; only fragments remain. Even with absolute protection of these fragments, it will take many decades or even centuries to recover stocks in these depleted areas of the Pacific. Conservation efforts in Palau continue to be so ineffective that the remaining nesting population of hawksbills in the Rock Islands is in danger of extirpation within the next twenty years, if not sooner. No amount of research, tagging, regulatory actions and designation of protected areas will succeed in reversing this trend unless the harvesters of nesting turtles and eggs are made to realize the ultimate consequences of their activity and drastically curtail their harvest efforts. It will be virtually impossible for enforcement to reverse this trend by itself; 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 all of the recovery region.

II. RECOVERY

A. Recovery Objectives

Goal: The recovery goal is to delist the species.

Recovery Criteria: To consider de-listing, all of the following 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 1,000 FENA (or a biologically reasonable estimate based on the goal of maintaining a stable population in perpetuity) over six years.
- 3) All females estimated to nest annually (FENA) at "source beaches" are either stable or increasing for 25 years.
- 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 designed to maintain sustained populations of turtles is in place.
- 8) Ensure formal cooperative relationship with regional sea turtle management program (SPREP).
- 9) International agreements are in place to protect shared stocks.

Rationale: Determining quantifiable values that can be used to determine when a sea turtle stock is recovered is quite difficult. The recovery team has tried to make such recommendations as listed above based on best available information with the following conceptual guidelines:

- 1) The minimum nesting stock must equal a size that could not easily be eliminated by a single catastrophic event ("natural" or "man induced").
- 2) Nesting population trends should be long enough to minimize the effects of natural fluctuations in numbers that are characteristic of sea turtle populations. Generally this time period is equal to the estimated one generation time for each species.
- 3) Habitats are adequate to support population growth once threats have been reduced or eliminated.
- 4) If a species is to be considered for delisting, a plan must already be in force for maintaining

the population in stable or increasing condition. The team was concerned that if a species was delisted, and no management plan was already in force, that the species may be driven back toward extinction too rapidly for resource management agencies to implement such plans.

B. Step Down Outline and Narrative for Recovery

1 NESTING ENVIRONMENT

1.1 Protect and manage turtles on nesting beaches.

It is prudent to preserve the capacity of a population to recover from a depleted state by protecting nesting females, their nests and hatchlings and to preserve the quality of the nesting area. The killing of gravid females, poaching of nests, predation (native and feral), destruction of the habitat through mining, destruction of vegetation, artificial lighting, development, and increased human use all degrade the ability of depleted populations to recover. The following tasks are designed toward enhancing the reproductive ability of sea turtle populations at the nesting grounds.

1.1.1 Eliminate directed take of turtles and their eggs.

Direct take of nesting turtles and their eggs has been identified as a primary threat to Pacific sea turtle populations. Eliminating this threat is required if populations are to recover.

1.1.1.1 Reduce directed take of turtles through public education and information.

While increased law enforcement will be effective in the short term, without support of the local populace, regulations will become ineffective. Education of the public as to the value of conserving sea turtles, is a very effective way of sustaining recovery efforts and providing support for enforcement of management regulations

1.1.1.2 Increase enforcement of laws protecting turtles by law enforcement and the courts.

Lack of adequate support for law-enforcement activities which protect sea turtle populations is common, yet it must be understood that enforcement is as important as any other resource management activities. Enforcement, judicial and prosecutorial personnel must receive adequate resources as well as instruction about sea turtles and the importance of protecting turtle populations.

1.1.2 Ensure that coastal construction activities avoid disruption of nesting and hatching activities.

Coastal construction must be monitored to minimize impact on turtle beaches, both during construction, particularly during the nesting and hatching season and in the long-term. Construction equipment must not be allowed to operate on the beach, remove sand from the beach, or in any way degrade nesting habitat. Nighttime

lighting of construction areas should be prohibited during nesting and hatching seasons. While important for all species, it is particularly important to avoid the removal of vegetation from hawksbill nesting beaches, because hawksbill females typically nest underneath such vegetation. In the long-term, structures should not block the turtle's access to the beach, change beach dynamics, or encourage human activities that might interfere with the nesting process.

1.1.3 Reduce nest predation by domestic and feral animals.

Feral animals such as the Polynesian Rat (*Rattus exulans*), dogs and mongooses pose a severe threat to turtle nests and hatchlings. It is important that feral predators be controlled or eliminated from nesting areas. Domestic animals such as pigs or dogs can also threaten turtle nests and hatchlings, and should be controlled near nesting areas. In particular, domestic dogs should not be allowed to roam turtle nesting beaches unsupervised.

1.1.4 Reduce effects of artificial lighting on hatchlings and nesting females.

Because sea turtles (especially hatchlings) are extremely attracted to artificial lighting, lighting near nesting beaches should be placed in such a manner that light does not shine on the beach. If not, turtles may become disoriented and stray from their course.

1.1.4.1 Quantify effects of artificial lighting on hatchlings and nesting females.

It is important to quantify the impact of existing lighting in terms of nesting success and hatchling survival so that pragmatic mitigation can be applied. Also such study can be used to guide the development of effective lighting ordinances.

1.1.4.2 Implement, enforce, evaluate lighting regulations or other lighting control measures where appropriate.

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. Such measures should be required by law and enforced.

1.1.5 Collect biological information on nesting turtle populations.

The collection of basic biological information on nesting is critical for making intelligent management decisions. Monitoring nesting success can help to identify problems at the nesting beach or elucidate important areas for protection. Analyzing population recruitment can help in understanding population status.

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

Important nesting beaches (based on actual number of nests) must be identified for special protection. Nesting beaches need to be identified by standardized surveys during the nesting season. Informational surveys with local residents and officials should be conducted to determine current or historical nesting beaches.

One of the most crucial techniques for determining the status of sea turtle populations and for evaluating the success of management or restoration programs is long-term monitoring of annual nesting on key beaches. The surveys must be done in a standardized and consistent manner with experienced personnel. Since female turtles show fidelity to nesting beaches, long term beach censusing provides a ready means for assessing these maternally isolated populations. However, because of long maturity times for turtles, quantifying trends in population sizes and effectiveness of any restoration program may take a generation time (20+ years) to be reflected in the annual numbers of nesters. Monitoring should thus be recognized as a long-term undertaking.

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

One of the simplest means to enhance populations is by increasing hatchling production at the nesting beach. The first step to such an enhancement program is to determine the nesting / hatching success and to characterize factors which may limit that success. Once those limiting factors are determined, protection or mitigation measures can be implemented. If nests must be moved to prevent loss from erosion or other threats, natural rather than artificial incubation should be employed.

- 1.1.5.3 Define stock boundaries for Pacific sea turtles.

Because sea turtles exhibit a unique genetic signature for each major nesting assemblage, and because nesting assemblages provide an easily censused means of monitoring population status, it is useful to use genetic analysis methods to determine stock boundaries for sea turtle populations. It also enables managers to determine which stocks are being impacted by activities far removed from the nesting beaches, and thus prioritize mitigation efforts.

- 1.1.5.3.1 Identify genetic stock type for major nesting beach areas.

A “genetic survey” to establish the genetic signature of each nesting population must be established, before stock ranges can be determined. Such surveys are relatively simple as they require only a small blood sample from a statistically viable number of females within each nesting population.

1.1.5.3.2 Determine nesting beach origins for juvenile and subadult populations.

Because nesting populations can form the basis for stock management, it is important to be able to pair juvenile and subadult turtles with their stock units by genetic identification. DNA analyses have begun to provide scientists and managers with this sort of data.

1.1.5.3.3 Determine the genetic relationship among Pacific hawksbill populations.

The need for such study is critical to successful management of a sea turtle population as it enables resource managers to identify the entire (and often overlapping) range of each population. This type of population study can also detail the genetic diversity and viability of the populations.

1.2 Protect and manage nesting habitat.

The nesting habitat must be protected to ensure future generations of the species. Increased human presence and coastal construction can damage nesting habitat resulting in reduced nest success or reduced hatchling survival.

Once key nesting beaches are identified, they may be secured on a long-term basis in an assortment of ways. These may include conservation easements or agreements, lease of beaches, and in some cases, fee acquisition. Certain beaches may be designated as natural preserves. In some cases education of local residents may serve to adequately secure nesting beaches.

1.2.1 Prevent the degradation of nesting habitats caused by sea walls, revetments, sand bags, other erosion-control measures, jetties and breakwaters.

Beach armoring techniques that beach residents use to protect their beachfront properties from wave action may actually degrade nesting habitats by eroding beaches and preventing nesting by preventing access to nesting sites or preventing digging of the nest on the site. Guidelines on the proper placement of stonewalls must be proposed. Jetties and breakwaters impede the natural movement of sand and add to erosion problems in neighboring beaches. Regulations regarding beach construction and beach armoring should be reviewed to ensure that such measures are restricted or prohibited if adverse impacts to nesting are anticipated.

1.2.2 Eliminate sand and coral rubble removal and mining practices on nesting beaches.

Beach mining severely affects a nesting beach by reducing protection from storms, destroying native vegetation directly or indirectly and may completely destroy a nesting beach. Protective legislation and public education must be used to protect the substrate of the beaches.

- 1.2.3 Develop beach-landscaping guidelines which recommend planting of only native vegetation, not clearing stabilizing beach vegetation and evaluating the effects as appropriate.

Non-native vegetation may prevent access to nesting site, prevent adequate nest digging, exacerbate erosion or affect hatchling sex ratios by altering incubation temperatures. Native vegetation, however, plays an important role in stabilizing the beach and creating the proper microclimate for nests. While important for all species, it is particularly important to avoid the removal of vegetation from hawksbill nesting beaches, because hawksbill females typically nest underneath such vegetation. Guidelines for residents concerning the most appropriate plant species and the importance of a native plant base should be encouraged.

- 1.2.4 Ensure that beach replenishment projects are compatible with maintaining good quality nesting habitat.

Sand on sea turtle beaches has particular properties which affect hatching success (ie. compaction, gas diffusion, temperature). Any addition or replacement of sand may change these properties and make it more difficult for females to nest or reduce hatchling success. As such, beach replenishment projects should be carefully considered, use materials similar to the native sands and be carried out outside the nesting season.

- 1.2.5 Implement non-mechanical beach cleaning alternatives.

Hand raking of beach debris, rather than using heavy machinery, should be encouraged on nesting beaches where cleaning is done for aesthetic reasons. The use of heavy machinery can adversely affect hatchlings directly and their nesting habitat.

- 1.2.6 Prevent vehicular driving on nesting beaches.

Driving on active nesting beaches should be forbidden. Vehicles cause destabilization of beaches, threaten incubating nests and leave tire ruts that hatchlings have difficulty crossing.

2 MARINE ENVIRONMENT

- 2.1 Protect and manage hawksbill populations in the marine habitat.

Protection of turtles in the marine environment is a priority that is often overlooked as enforcement is difficult and quantification of the problem problematic. However, 99% of a turtle's life is spent at sea, thus recovery must include significant efforts to protect turtles at that time.

- 2.1.1 Eliminate directed take of turtles.

Direct take of turtles was identified as a severe threat to population recovery in the Pacific Ocean and must be eliminated if sea turtles are to recover.

2.1.1.1 Reduce directed take of turtles through public education and information.

While increased law enforcement will be effective in the short term, without support of the local populace, regulations will become ineffective. Education of the public as to the value of conserving sea turtles, is a very effective way of sustaining recovery efforts and providing support for enforcement of management regulations. (Also see Section 4).

2.1.1.2 Increase or maintain the enforcement of protective laws on the part of law enforcement and the courts.

One of the major threats identified for turtle populations in the Pacific was the illegal harvest of turtles both on the nesting beach and in the water. Rigorous efforts in law enforcement should be undertaken immediately to reduce this source of mortality. Such efforts need to include training of enforcement personnel in the importance of protecting turtles, as well as supplying such personnel with adequate logistical support (boats, communication and surveillance equipment etc.). Judges and prosecutors must also be educated in the importance of these matters. Trade in sea turtle jewelry and other curio must also be restricted.

2.1.2 Determine distribution, abundance, and status in the marine environment.

In its review of information on sea turtle populations in the Pacific, the Recovery Team found that lack of accurate information on distribution and abundance was one of the greatest threats to sea turtle populations. Most existing information is anecdotal or obsolete and where new information is available, it uniformly indicates that hawksbill populations are vastly smaller than commonly believed. We consider that gathering of basic information on distribution and abundance should take a very high priority in the recovery of Pacific hawksbill populations.

2.1.2.1 Determine the distribution and abundance of post-hatchlings, juveniles and adults.

While little is known about the distribution of nesting beaches for the hawksbill, even less is understood about distribution of foraging adult and juvenile populations. Quantitative surveys of foraging areas to determine hawksbill abundance, and to identify essential habitat is of significant importance for restoration of hawksbill populations.

2.1.2.2 Determine adult migration routes and interesting movements.

Like all species of sea turtle (with the possible exception of the Flatback turtle, *Natator depressus*), hawksbills migrate from foraging grounds to nesting beaches. These migrations often mean that the turtles move through a variety of political jurisdictions where regulations regarding the

stewardship of the species may vary. To preclude the problem of contradictory management strategies by these various jurisdictions, it is important to determine the migration routes hawksbills follow between nesting and foraging areas. Satellite telemetry studies of both males and females are needed.

- 2.1.2.3 Determine growth rates and survivorship of hatchlings, juveniles, and adults, and age at sexual maturity.

Understanding the rates of growth and survivorship of turtle populations is crucial to the development of appropriate population models. Such models are important in understanding population status and how best to efficiently apply management efforts, in restoring depleted populations. For example, the application of stage based modeling (Crouse et al. 1987) indicated that not enough effort was being expended on protecting juvenile sized loggerhead sea turtles in the southeastern United States and that without such protection, extensive nesting beach protection was having less positive benefit. A similar approach to understanding hawksbill populations should be undertaken, and used to guide restoration policy.

- 2.1.2.4 Identify current or potential threats to adults and juveniles on foraging grounds.

Little is known about threats to foraging populations of hawksbills. Studies on such threats should be undertaken immediately.

- 2.1.3 Reduce the effects of entanglement and ingestion of marine debris.

Entanglement due to abandoned or unmonitored fishing gear, as well as the ingestion of man-made debris is a significant problem in the marine environment.

- 2.1.3.1 Evaluate the extent to which sea turtles ingest persistent debris and become entangled.

Quantification of the extent to which sea turtles are impacted by marine debris should be undertaken as a first step to mitigating or preventing such impacts. The benefits of such work are that it allows the prioritization of recovery activities and it allows the activities to be efficiently targeted at the problem.

- 2.1.3.2 Evaluate the effects of entanglement and ingestion of persistent debris on health and viability of sea turtles.

Because of the remote nature of turtle/debris interactions, the acute and chronic effects of such interaction are not often understood. Turtles may not die immediately after ingesting certain materials, but may become debilitated. Studies to further understand the impacts of such interactions, and what age classes are affected most severely, should be undertaken

immediately. As with quantifying the extent to which sea turtles ingest debris, such a program allows recovery efforts to be more efficient.

- 2.1.3.3 Formulate and implement measures to reduce or eliminate persistent debris and sources of entanglement in the marine environment.

Once the problem of marine debris has been identified and quantified, it is important to implement (and enforce) a program to reduce the amount of debris in the marine environment, ie. removing the problem entirely, as contrasted to mitigating the problem.

- 2.1.4 Monitor and reduce incidental mortality in the commercial and recreational fisheries.

For some areas, incidental take in fisheries has been identified as a severe threat. These mortalities are often associated with international fleets operating on the high seas, but for the coastal dwelling hawksbill it is probably most significant in nearshore waters. Monitoring of turtle take by fisheries is extremely important for two reasons. First, it allows resource managers a means to quantify the extent of the problem, and by the very act of monitoring, tends to cause commercial fishermen to be more aware of the concern over incidental take, and thereby encourage reduced take. The choice method for monitoring take is through the use of an unbiased observer program. Voluntary logbooks have not proven a reliable technique for quantifying incidental catch in commercial fisheries. Implementation of mortality reduction activities include the use of Turtle Excluder Devices (TED) in shrimp trawler fisheries. Finally a serious but unquantified problem is that of fisheries vessels stopping illegally at uninhabited islets and atolls and killing turtles. This can be curtailed only by education of fishermen, and increased enforcement on the seas and in the courts.

- 2.1.5 Eliminate the harassment of turtles at sea through education and enforcement.

Activities such as “petting” turtles and chasing them while snorkeling and scuba diving, water skiing, jet skis, vessel traffic, and vessel anchoring may disturb or displace turtles. These factors should be regulated or controlled to eliminate negative impacts, especially in sensitive and high density foraging and resting areas.

- 2.1.6 Study the impact of diseases on turtles.

Little is known about diseases in sea turtles, but there has been recent evidence that it may be a limiting factor in certain populations. Disease origin and transmission may not be limited to the marine environment.

- 2.1.6.1 Investigate parasites and other infectious agents.

A variety of other diseases and parasites may be affecting sea turtles. The prevalence of such infections, their impact on sea turtles, and modes of

transmissions need to be studied. Parasites include internal parasites such as blood flukes, external parasites such as leeches (*Ozobranchus*) and burrowing barnacles (*Stephanolepas*), and certain bacterial infections such as *Vibrios*.

2.1.7 Maintain and/or develop carcass stranding network.

Stranding networks are operated generally by volunteers who monitor beaches for stranded animals. Such networks can be useful for alerting managers to incidents causing high mortality, such as increased fishery take or disease problems, as well as providing some basic biological data.

2.1.8 Centralize administration and coordination of tagging programs.

In general, government resource management agencies can provide the continuity required to coordinate tagging programs. The responsibility of any such agency is that they act as a central distribution point for tags, tagging training and database management. It is critically important that the coordinating agency: 1) provides adequate staff to keep the program organized and respond to tag returns immediately, and 2) remain in existence for many years (20+). Without such a commitment, tagging programs have very limited usefulness, and before initiation of such a program it should be considered carefully on its scientific merits. It must be remembered that sea turtles are long-lived animals, and the most valuable information yielded by any tagging program comes from turtles which have carried identification tags for many years. Short-term tagging projects are at best very limited in the information they yield and at worst are nothing more than a form of undue harassment to the turtles.

Centralization of tag records is useful as it makes the most efficient use of limited personnel resources, allows standardization of techniques, and can act as a screening mechanism to ensure that tagging is done for valid scientific reasons.

2.2 Protect and manage marine habitat, including foraging habitats.

Hawksbills inhabit a variety of marine habitats, although we are most familiar with their coastal reef habitat. Increased human presence in this and other sea turtle habitats have contributed to reef degradation, primarily by coastal construction, increased recreational and fisheries use, and increased industrialization. Habitat loss and degradation must be prevented or slowed.

2.2.1 Identify important marine habitats.

These areas may include hatchling (pelagic algal mats), juvenile (benthic reefs) and adult (seagrass, coral reefs and sponge habitats) foraging areas and migratory range for all age classes. (Many of these areas will first need to be identified through actions in Section 2.1.2.1 and 2.1.2.2.)

2.2.2 Ensure the long-term protection of marine habitat.

Once marine habitats are identified, sea turtle range, refugia and foraging habitats (*Sargassum* beds, coral reefs and sponge habitats) need to be protected to ensure longterm survival for the species. Habitats identified as important or critical should be designated as marine sanctuaries or preserves, while others may require close monitoring. The public needs to be educated on the importance of preserving these habitats.

- 2.2.3 Assess and prevent the degradation or destruction of reefs caused by boat groundings, anchoring, and trampling by fishermen and divers.

Physical harm done by boat hulls, anchors and persons on coral reefs can be a serious threat to reef habitats, particularly in heavily-used bays. Given that reefs recover slowly from physical damage, appropriate actions such as providing boat moorings and removal of grounded vessels should be undertaken.

- 2.2.4 Prevent the degradation of reef habitat caused by environmental contaminants such as sewage and other pollutants.

Protect reef habitats by reducing offshore dumping of industrial waste and offshore sewage outfalls. High water quality standards must be established and maintained for inland water treatment plants.

- 2.2.5 Prevent the degradation or destruction of marine habitats caused by dredging or disposal activities.

Dredging causes mechanical destruction of reefs, adds suspended sediments that may damage corals and seagrasses and disposal of dredged materials smothers existing flora and fauna.

- 2.2.6 Prevent the degradation or destruction of important habitats caused by upland and coastal erosion and siltation.

These processes, often made worse by coastal construction, adversely affect coral reefs by disrupting vital trophic processes, reducing productivity and reducing species diversity. Minimum water standards upstream must be maintained. Land-use decisions must take this into account and associated projects where erosion and siltation occur must be monitored.

- 2.2.7 Prevent the degradation or destruction of reefs by dynamite fishing and construction blasting.

Blasting of any nature physically damages reefs and may kill turtles. It must be monitored and/or restricted.

- 2.2.8 Prevent the degradation of reef habitat caused by oil transshipment activities.

Oil spills from tankers are a possible threat both to coastal and pelagic habitats. Also, groundings or collisions of tankers and other petroleum industry vessels may

physically damage reefs, perhaps more so than other vessels because of their sheer size. The oil and gas industry should take necessary preventative measures (e.g., double hulled tankers). Oil spill response teams should be identified for all likely areas. (see Recovery - Section 2.2.3)

2.2.9 Identify other threats to marine habitat and take appropriate actions.

Such threats to sea turtle habitat that do not fit in the previous sections or new threats must be considered and addressed. Such threats may include commercial and recreational illegal take of coral and “live rock” for aquaria, as well as take of tropical fish for aquaria. Chemicals used to capture the fish may indirectly affect reefs.

3 ENSURE PROPER CARE IN CAPTIVITY.

Captive care of sea turtles is common in the Pacific. Some of this care is in the form of formal rearing programs and other captive care is more casual, such as rearing turtles as pets (although this is illegal in Guam, CNMI and American Samoa) The latter should be discouraged, even where permitted. Depending on the scale of such activities such captivity can be harmful to the wild population due to excess take from the wild, or from the potential introduction of exotic diseases or unfit genetic stocks to the wild population. Captive care should be carefully regulated to minimize such problems, and all release programs should rigorously monitor the status of released turtles to insure their proper integration into the wild. It should be noted that to be deemed successful, captive-reared turtles that have been released to the wild should be shown not only to survive in the wild but should also successfully reproduce. If released turtles do not reproduce, such populations will never be self sustaining.

3.1 Develop standards for the care and maintenance of sea turtles, including diet, water quality, tank size, and treatment of injury and disease.

Standards should be developed by NMFS or other appropriate agencies. Once developed, these criteria should be published and set as requirements for any sea turtle holding facility. Facilities that comply with the criteria will receive permits to hold turtles and be inspected for compliance. A manual for diagnosis and treatment of sea turtle diseases should be compiled, published and distributed to holding facilities.

3.2 Establish a catalog of all captive sea turtles to enhance use for research and education.

The FWS and NMFS should establish a catalog of turtles at all known facilities.

3.3 Designate rehabilitation facilities.

FWS, NMFS and other appropriate agencies should designate these facilities based on the above criteria. Designation should be based on availability of appropriate veterinary personnel, compliance with standards of care and annual inspections. Recommendations should be made on when and where hatchlings or adults should be released.

4 INTERNATIONAL COOPERATION

4.1 Support existing international agreements and conventions to ensure that turtles in all life-stages are protected in foreign waters.

Considering that hawksbills migrate outside of U.S. territorial waters during at least part of their life cycle, an effective recovery plan must include supporting existing cooperative agreements with other nations to protect the species. Existing agreements include CITES (see next section, adopted 1973), the Convention on Nature Protection and Wildlife Preservation in the Western Hemisphere (adopted 1940), the ASEAN Agreement on the Convention of Nature and Natural Resources (adopted 1985), the Convention for the Protection of the Natural Resources and Environment of the South Pacific Region (SPREP convention, adopted 1986), as well as a number of conventions concerning marine pollution (Eckert, 1993). Out of the SPREP convention, the South Pacific Regional Marine Turtle Conservation Programme was created to specifically implement a regional approach to the species protection. Agreements and conventions that are effective must continue to be supported.

4.2 Encourage ratification of the CITES for all non-member Pacific countries, compliance with CITES requirements, and removal of sea turtle trade reservations held by member nations.

CITES is a comprehensive wildlife treaty signed by many countries that regulates and prohibits commercial import and export of wild plant and animal species that are threatened by trade. In the north Pacific signatories include 18 countries (Eckert, 1993). It is one of the most powerful international agreements concerning threatened species, and particularly relevant to hawksbill sea turtles who are threatened by a large tortoiseshell trade. The U.S. State Department, Department of Commerce and Department of Interior should work with Pacific nations to encourage non-member countries to become signatories, convince countries who still hold reservations on hawksbills to drop these reservations, and demand compliance with CITES requirements on sea turtles from all signatories.

4.3 Develop new international agreements to ensure that turtles in all life-stages are protected in foreign waters.

New agreements must be outlined by the FWS and NMFS, and pursued by the State Department and Department of the Interior. Eastern Pacific nations should be encouraged to ratify the Regional Agreement for Investigation and Management of Marine Turtles of the American Pacific which was not put into place after being drafted in 1986.

4.4 Develop or continue to support informational displays in Republic of Palau, Guam, Hawaii, American Samoa, Northern Marianas, the Marshall Islands, the FSM and other airports which provide connecting legs for travelers to the area.

Airports are particularly good avenues for information about illegal trade in tortoise and tortoiseshell paraphernalia, as well as general information on sea turtle conservation. If travelers don't purchase the items, the market for them may decrease. Agencies such as NMFS, FWS and the U.S. Customs Service should collaborate on display content and

placement.

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IV. IMPLEMENTATION SCHEDULE

The Implementation Schedule outlines management and research actions and estimated costs for the U.S. Pacific hawksbill turtle recovery program, as set forth in this recovery plan. It is a guide for meeting the objectives discussed in Part II of this plan. This schedule indicates wherever possible, task priority, task numbers, task descriptions, duration of tasks, the agencies responsible for committing funds, and lastly, estimated costs. The agencies responsible for committing funds are not, necessarily, the entities that will actually carry out the tasks. The actions identified in the implementation schedule, when accomplished, should protect habitat for the species, stabilize the existing populations, and increase the population sizes and numbers. Monetary needs for all parties involved are identified to reach this point, whenever feasible

Priorities in column 3 of the following Implementation Schedule are assigned as follows:

Priority 1 -

An action that must be taken to prevent extinction or to prevent the species from declining irreversibly in the foreseeable future.

Priority 2 -

An action that must be taken to prevent significant decline in species population/habitat quality or some other significant negative impact short of extinction.

Priority 3 -

All other actions necessary to provide for full recovery of the species.

KEY to Implementation Table Abbreviations:

CNMI	=	Commonwealth of the Northern Mariana Islands
COE	=	U.S. Army Corp of Engineers
DOC	=	U.S. Department of Commerce
DOI	=	U.S. Department of Interior
DOS.	=	U.S. Department of State (primarily as a conduit for negotiations and support for tasks in other political jurisdictions)
EPA	=	U.S. Environmental Protection Agency
FSM	=	Federated States of Micronesia
FWS	=	U.S. Fish & Wildlife Service
NA	=	Not applicable
NMFS	=	National Marine Fisheries Service
NRCS	=	Natural Resources Conservation Service (Soil Conservation Service)
RMI	=	Republic of the Marshall Islands
USN	=	U.S. Navy

**IMPLEMENTATION SCHEDULE/U.S. PACIFIC
Hawksbill (*Eretmochelys imbricata*)**

General Task Categories	Plan Task	Priority ^A	Task Duration	Agencies Responsible ^B	Estimated Fiscal Year Costs \$ K					Comments/Notes
					Current	FY2	FY3	FY4	FY5	
1.1 Protect & manage turtles on nesting beaches 1.1.1 Eliminate directed take of turtles and their eggs	<u>1.1.1.1</u> Reduce directed take through public education & information	1	Continuing	FWS, NMFS, Hawaii, American Samoa, Guam, Palau, CNMI, RMI, FSM, Unincorp. Territories, DOS	75	75	75	75	75	Provide support for international information exchange forum ¹
	<u>1.1.1.2</u> Law enforcement-prevent illegal exploitation & harassment	1	Continuing	FWS, Hawaii, American Samoa, Guam, Palau, CNMI, RMI, FSM, Unincorp. Territories, DOS, NMFS	75	75	75	75	75	
1.1 Protect & manage turtles on nesting beaches (<i>cont.</i>)	<u>1.1.2</u> Ensure coastal construction activities do not disrupt nesting & hatching activities	1	Continuing	COE, FWS, Hawaii, American Samoa, Guam, Palau, CNMI, RMI, FSM, Unincorp. Territories, DOS, NMFS						No specific costs - part of ongoing program activities

¹ Also includes Task 2.1.1.1. Duplicative of Tasks 1.1.1.1 in green turtle plan

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^B The lead agency is listed first .

**IMPLEMENTATION SCHEDULE/U.S. PACIFIC
Hawksbill (*Eretmochelys imbricata*)**

General Task Categories	Plan Task	Priority ^A	Task Duration	Agencies Responsible ^B	Estimated Fiscal Year Costs \$ K					Comments/Notes
					Current	FY2	FY3	FY4	FY5	
1.1 Protect & manage turtles on nesting beaches (<i>cont.</i>)	1.1.3 Reduce nest predation by domestic & feral animals	1	Continuing	FWS, Hawaii, American Samoa, Guam, Palau, CNMI, RMI, FSM, Unincorp. Territories, DOS, NMFS	150	150	150	200	200	Review after 10 years
1.1 Protect & manage turtles on nesting beaches (<i>cont.</i>)	1.1.4.1 Quantify effects of artificial lighting	2	2 years			50	50			
1.1.4 Reduce effects of artificial lighting on hatchlings & nesting females	1.1.4.2 Implement, enforce, evaluate lighting regulations or other lighting control measures	2	Continuing							No additional costs - part of program activities
1.1 Protect & manage turtles on nesting beaches (<i>cont.</i>)	1.1.5.1 Monitor nesting activity, identify important nesting beaches, determine population trends	1	Continuing		50	250	150	150	150	Re-evaluate funding after 5 years
1.1.5 Collect biological information on nesting populations	1.1.5.2 Evaluate nest success, implement nest-protection measures	1	Continuing		50	150	150	150	150	Re-evaluate funding after 5 years

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**IMPLEMENTATION SCHEDULE/U.S. PACIFIC
Hawksbill (*Eretmochelys imbricata*)**

General Task Categories	Plan Task	Priority ^A	Task Duration	Agencies Responsible ^B	Estimated Fiscal Year Costs \$ K					Comments/Notes
					Current	FY2	FY3	FY4	FY5	
1.1 Protect & manage turtles on nesting beaches (<i>cont.</i>) 1.1.5 Collect biological information on nesting populations (<i>cont.</i>) 1.1.5.3 Define stock boundaries	<u>1.1.5.3.1</u> Identify stock type for major nesting beach areas	1	10 years	NMFS, FWS, DOS	100	100	100	100	100	Costs included for Tasks 1.1.5.3.1-1.1.5.3.3
	<u>1.1.5.3.2</u> Determine nesting beach origins-juvenile & subadult populations	1	10 years							
	<u>1.1.5.3.3</u> Determine genetic relationship among populations	1	10 years	FWS, NMFS						
1.2 Protect & manage nesting habitat	<u>1.2.1.</u> Prevent degradation due to erosion-control measures, jetties & breakwaters	2	Continuing	COE, FWS, Hawaii, American Samoa, Guam, Palau, CNMI, RMI, FSM, Unincorp. Territories, DOS, NMFS						No costs - carried out by in-country resource/regulating agencies
	<u>1.2.2</u> Eliminate sand, coral rubble removal & mining practices	1	Continuing							

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**IMPLEMENTATION SCHEDULE/U.S. PACIFIC
Hawksbill (*Eretmochelys imbricata*)**

General Task Categories	Plan Task	Priority ^A	Task Duration	Agencies Responsible ^B	Estimated Fiscal Year Costs \$ K					Comments/Notes
					Current	FY2	FY3	FY4	FY5	
1.2 Protect & manage nesting habitat (cont.)	1.2.3 Develop, evaluate natural beach-landscaping guidelines	2	5 years	FWS, Hawaii, American Samoa, Guam, Palau, CNMI, RMI, FSM, Unincorp. Territories, DOS		10	10	10	10	
	1.2.4 Ensure replenishment projects maintain quality habitat	3	NA	COE, FWS, Hawaii, American Samoa, Guam, Palau, CNMI, RMI, FSM, Unincorp. Territories, DOS, NMFS						
	1.2.5 Implement non-mechanical beach cleaning alternatives	NA	NA							
	1.2.6 Prevent vehicular driving on nesting beaches	3	Continuing	FWS, Hawaii, American Samoa, Guam, Palau, CNMI, RMI, FSM, Unincorp. Territories, DOS						No costs - carried out by in-country resource/regulating agencies

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**IMPLEMENTATION SCHEDULE/U.S. PACIFIC
Hawksbill (*Eretmochelys imbricata*)**

General Task Categories	Plan Task	Priority ^A	Task Duration	Agencies Responsible ^B	Estimated Fiscal Year Costs \$ K					Comments/Notes
					Current	FY2	FY3	FY4	FY5	
2.1 Protect & manage populations in marine habitat 2.1.1 Eliminate directed take of turtles	<u>2.1.1.1</u> Reduce directed take through education, information	1	Continuing	FWS, NMFS, U.S. West Coast, Hawaii, American Samoa, Guam, Palau, CNMI, RMI, FSM, Unincorp. Territories, DOS						Costs included in Task 1.1.1.1
	<u>2.1.1.2</u> Increase/maintain enforcement reduce exploitation	1	Continuing	FWS, NMFS, USCG, DOS	25	100	100	100	100	Costs duplicative of Task 2.1.1.2 in green turtle plan
2.1 Protect & manage populations in marine habitat (<i>cont.</i>) 2.1.2 Determine distribution, abundance, status	<u>2.1.2.1</u> Determine distribution, abundance posthatchlings, juveniles, adults	1	20 years	NMFS, FWS	30	100	100	100	100	Costs duplicative of Task 2.1.1.2 in green turtle plan
	<u>2.1.2.2</u> Determine adult migration, internesting habitats	1	5 years				100	150	150	
	<u>2.1.2.3</u> Determine growth rates, survivorship, age sexual maturity	1	10 years					300	100	100

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**IMPLEMENTATION SCHEDULE/U.S. PACIFIC
Hawksbill (*Eretmochelys imbricata*)**

General Task Categories	Plan Task	Priority ^A	Task Duration	Agencies Responsible ^B	Estimated Fiscal Year Costs \$ K					Comments/Notes
					Current	FY2	FY3	FY4	FY5	
2.1 Protect & manage populations in marine habitat (<i>cont.</i>) 2.1.2 Determine distribution, abundance, status (<i>cont.</i>)	<u>2.1.2.4</u> Identify current threats adults, juveniles on foraging grounds	1	5 years	NMFS, FWS	50	50	50	50	50	
2.1 Protect & manage populations in marine habitat (<i>cont.</i>) 2.1.3 Reduce effects of entanglement & ingestion marine debris	<u>2.1.3.1</u> Evaluate extent ingestion of persistent debris & entanglement	2	Continuing	NMFS, EPA, FWS		10	10	10	10	
	<u>2.1.3.2</u> Evaluate effects ingestion persistent debris & entanglement	2	3 years				100	100	100	
	<u>2.1.3.3</u> Reduce, eliminate persistent debris & entanglement	2	Continuing	NMFS, EPA, USCG						No additional costs. Part of program activities

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**IMPLEMENTATION SCHEDULE/U.S. PACIFIC
Hawksbill (*Eretmochelys imbricata*)**

General Task Categories	Plan Task	Priority ^A	Task Duration	Agencies Responsible ^B	Estimated Fiscal Year Costs \$ K					Comments/Notes
					Current	FY2	FY3	FY4	FY5	
2.1 Protect & manage populations in marine habitat (<i>cont.</i>)	2.1.4 Monitor, reduce incidental mortality in commercial, recreational fisheries	2	Continuing	NMFS, U.S. West Coast, Hawaii, American Samoa, Guam, Palau, CNMI, RMI, FSM, Unincorp. Territories		40	40	40	40	
	2.1.5 Eliminate harassment of turtles at sea/ education/ enforcement	2	Continuing	NMFS, U.S. West Coast, Hawaii, American Samoa, Guam, Palau, CNMI, RMI, FSM, Unincorp. Territories, FWS (as appropriate to beach habitat)	30	30	30	30	30	Costs duplicative of Tasks 2.1.5 in green turtle plan
	2.1.6 Study the impact of diseases on turtles	3	Continuing							
	2.1.6.1 Investigate parasites and other infectious agents	3	Continuing							Tasks will be pursued if population studies indicate diseased or sick turtles
	2.1.7 Develop/ maintain carcass stranding network	2	Continuing	NMFS, FWS	5	5	5	5	5	Includes all sea turtle species

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**IMPLEMENTATION SCHEDULE/U.S. PACIFIC
Hawksbill (*Eretmochelys imbricata*)**

General Task Categories	Plan Task	Priority ^A	Task Duration	Agencies Responsible ^B	Estimated Fiscal Year Costs \$ K					Comments/Notes
					Current	FY2	FY3	FY4	FY5	
2.1 Protect & manage populations in marine habitat (<i>cont.</i>)	2.1.8 Centralize tagging program and tag-series records	1	Continuing	NMFS, FWS		60	60	60	60	Total funds for all species
2.2 Protect & manage marine habitat	2.2.1 Identify important habitat	1	20 years	NMFS, FWS, U.S. West Coast, Hawaii, American Samoa, Guam, Palau, CNMI, RMI, FSM, Unincorp. Territories						Should be coordinated with Tasks 2.1.2.1. & 2.1.2.2. Funds included in these tasks
	2.2.2 Ensure long-term protection	1	Continuing							Part of ongoing program activities
	2.2.3 Assess & prevent degradation or destruction of reefs by boating, diving activities	1	Continuing	NMFS, FWS, DOS						Part of ongoing program activities
	2.2.4 Prevent degradation reefs by pollution	1	Continuing	NMFS, EPA, USCG, DOS						Part of ongoing program activities

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**IMPLEMENTATION SCHEDULE/U.S. PACIFIC
Hawksbill (*Eretmochelys imbricata*)**

General Task Categories	Plan Task	Priority ^A	Task Duration	Agencies Responsible ^B	Estimated Fiscal Year Costs \$ K					Comments/Notes
					Current	FY2	FY3	FY4	FY5	
2.2 Protect & manage marine habitat (<i>cont.</i>)	<u>2.2.5</u> Prevent degradation or destruction of reefs by dredge or disposal	1	Continuing	COE, NMFS, DOS						Part of ongoing program activities
	<u>2.2.6</u> Prevent degradation or destruction by coastal erosion, siltation	1	Continuing	FWS, EPA, NRCS, DOS						Part of ongoing program activities
	<u>2.2.7</u> Prevent degradation or destruction of reefs by blasting	1	Continuing	NMFS, COE, USN, Hawaii, American Samoa, Guam, Palau, CNMI, RMI, FSM, Unincorp. Territories						Part of ongoing program activities
	<u>2.2.8</u> Prevent degradation of reefs by oil transshipment	2	Continuing	USCG, NMFS, EPA						Part of ongoing program activities
	<u>2.2.9</u> Identify other threats, take action	2	Continuing	NMFS, EPA, USCG						Part of ongoing program activities
3 Ensure proper care in captivity	<u>3.1</u> Develop captive standards	3	2 year	NMFS, FWS		35	15			

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**IMPLEMENTATION SCHEDULE/U.S. PACIFIC
Hawksbill (*Eretmochelys imbricata*)**

General Task Categories	Plan Task	Priority ^A	Task Duration	Agencies Responsible ^B	Estimated Fiscal Year Costs \$ K					Comments/Notes
					Current	FY2	FY3	FY4	FY5	
3 Ensure proper care in captivity (<i>cont.</i>)	3.2 Catalog captive turtles for research, education	3	2 year	NMFS, FWS		10	10			* Includes all sea turtle species
	3.3 Designate rehab facilities	3	1 year				25			* Includes all sea turtle species
4 International cooperation	4.1 Support agreements, conventions, protect in foreign water	1	Continuing	FWS, NMFS, DOS, DOI, DOC		100	100	100	100	*This includes all sea turtle species and Task 4.2 & 4.3
	4.2 CITES membership, compliance	1	Continuing							
	4.3 Develop new agreements to protect in foreign waters	1	Continuing	NMFS, DOS, DOI, DOC						
	4.4 Display information at airports	2	5 years	FWS, NMFS, West Coast USA, Hawaii, American Samoa, Guam, Palau, CNMI, RMI, FSM, Unincorp. Territories		15	15	15	15	Includes all species

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