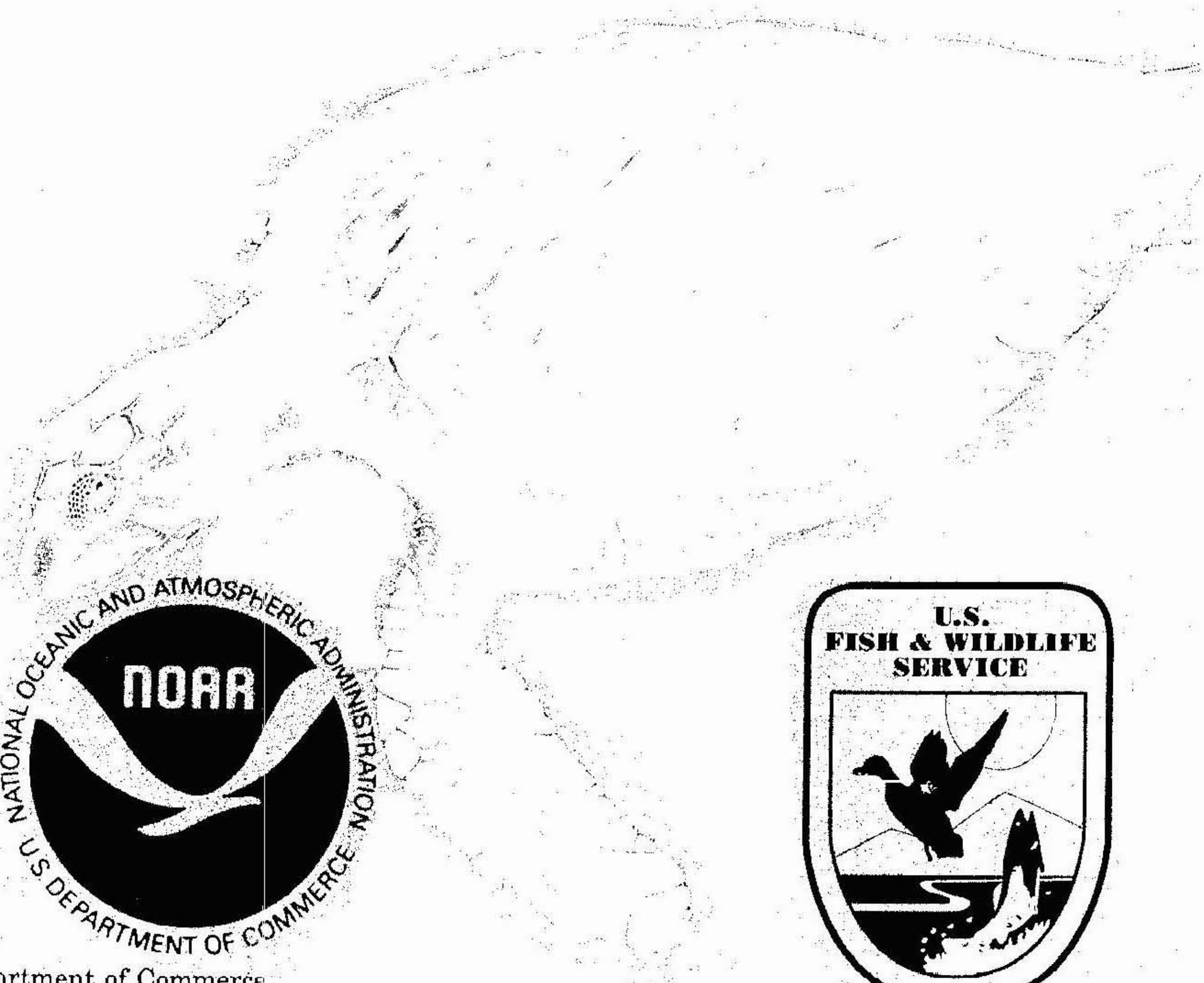
Recovery Plan for the

HAWKSBILL TURTLE
Eretmochelys imbricata

in the U.S. Carribean, Atlantic and Gulf of Mexico



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

RECOVERY PLAN FOR HAWKSBILL TURTLES IN THE U.S. CARIBBEAN SEA,
ATLANTIC OCEAN, AND **GULF OF MEXICO**

(Eretmochelys imbricata)

Prepared by

The Leatherback and Hawksbill Turtle Recovery Team

for

Southeast Region

U.S. Fish and Wildlife Service

Atlanta, Georgia

and

National Marine Fisheries Service

Washington, D. C.

Approved: ______________________________
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Date: 12/15/93

Recovery plans delineate reasonable actions that are believed to be required to recover or protect the species. Plans are prepared by the U.S. Fish and Wildlife Service (FWS) and the National Marine Fisheries Service (NMFS), sometimes with the assistance of recovery teams, contractors, state agencies, and others. Objectives will only be attained and funds expended contingent upon appropriations, priorities, and other budgetary constraints. Recovery plans do not necessarily represent the views, the official position, or the approval of any individuals or agencies other than the FWS and the NMFS, both of which are involved in the plan formulation. Recovery plans represent the official position of the FWS and the NMFS only after they have been signed as approved by the Regional Director or Assistant Administrator for Fisheries. Approved recovery plans are subject to modification as dictated by new findings, by changes in species status, and by the completion of recovery tasks.

Literature citations should read as follows:

National Marine Fisheries Service and U.S. Fish and. Wildlife Service. 1993. Recovery Plan for Hawksbill Turtles in the U.S. Caribbean Sea, Atlantic Ocean, and Gulf of Mexico. National Marine Fisheries Service, St. Petersburg, Florida.

Additional copies of this plan may be purchased from:

U.S. Fish and Wildlife Reference Service
5430 Grosvenor Lane
Suite 110
Bethesda, Maryland 208 14
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PREFACE

The original Recovery Plan for Marine Turtles was approved on September 19, 1984, by the Assistant Administrator for Fisheries, National Marine Fisheries Service. The plan outlined recovery needs for the loggerhead ***(Caretta caretta),*** green ***(Chelonia mydas),*** hawksbill ***(Eretmochelys*** imbricata) , leatherback *(Dermochelys* coriacea) , and Kemp's ridley ***(Lepidochefys ken@)*** sea turtles.

The U.S. Fish and Wildlife Service and the National Marine Fisheries Service share the responsibility for sea turtle recovery under the authority of the Endangered Species Act of 19'73, as amended. To better coordinate a recovery program for sea turtles, both Services agreedl to reassess current conservation efforts and consider the biological information that had become available since approval of the original recovery plan. To accomplish this, the Services created a Leatherback and Hawksbill Recovery Team. This revision was undertaken by the Leatherback and Hawksbill Turtle Recovery Team, which consisted of the following members:

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This revised plan is intended to serve as a guide that delineates and schedules those actions believed necessary to restore the hawksbill turtle as a viable, self-sustaining species. Some of the tasks described in the plan are well underway. The inclusion of these ongoing tasks represents an awareness of their importance and ,offers support for their continuation.

LIST OF ABBREVIATIONS

BIRNM	Buck Island Reef National Monunxnt
BVI	British Virgin Islands
CITES	Convention on International Trade in Endangered Species of Wild Fauna and Flora
COE	U.S. Army Corps of Engineers
EPA	U. S. Environmental Protection Agency
EQB.	Environmental Quality Board
FDEP	Florida Department of Environmental Protection
FWS	U.S. Fish and Wildlife Service
MMS	Minerals Management Service
NMFS	National Marine Fisheries Service
NPS	National Park Service
NWR	National Wildlife Refuge
PRDA	Puerto Rico Department of Agriculture
PRDNR	Puerto Rico Department of Natural Resources
SCS	Soil Conservation Service
USCG	United States Coast Guard
USN	United States Navy
USVI	United States Virgin Islands
VIDFW	Virgin Islands Division of Fish and Wildlife
VIDPNR	Virgin Islands Department of Planning and Natural Resources
VINP	Virgin Islands National Park
WIDECAST	Wider Caribbean Sea Turtle Recovery Team and Conservation Network
WWF.	World Widlife Fund

EXECUTIVE SUMMARY

Current Status: The hawksbill is listed as an endangered species throughout the world.. The most important nesting beaches within United States jurisdiction in the Caribbean Sea are on MOM Island,'Puerto Rico, and Buck Island Reef National Monument, St. Croix, United States Virgin Islands. Coastal development threatens nesting habitat. Illegal slaughter is a threat in Puerto Rico as well as in neighboring countries. International trade in hawksbill products threatens populations all over the world.

Goal: The recovery goal is to delist the species.

Recovery Criteria: The U.S. populations of hawksbill turtles can be considered for delisting if, over a period of 25 years, the following conditions are met:

(1) The adult female population is increasing, as evidenced by a statistically significant trend in the annual number of nests on at least five index beaches, including Mona Island and BIRNM.

(2) Habitat for at least 50 percent of the nesting activity that occurs in the USVI and Puerto Rico is protected in perpetuity.

(3) Numbers of adults, subadults, and juveniles are increasing, as evidenced by a statistically significant trend on at least five key foraging areas within Puerto Rico, USVI, and Florida.

(4) All priority one tasks have been successfully implemented.

Actions Needed: Six major actions are needed to achieve recovery:

(1) Provide long-term protection to important nesting beaches.
(2) Ensure at least 75 percent hatching success rate on major nesting beaches.
(3) Determine distribution and seasonal movements of turtles in all life stages in the marine environment.
(4) Minimize threat from illegal exploitation.
(5) End international trade in hawksbill products.
(6) Ensure long-term protection of important foraging habitats.

Date of Recovery: If funds are available to accomplish recovery tasks and if new information does not indicate other limiting factors, the aiticipated ylear of recovery is 2020.

Total Cost of Recovery:

Actions on nesting beaches: $3,200,000.00
Actions **in marine environment:** $9,650,000.00

INTRODUCTION

Geographic Scope: This plan is directed at recovery of hawksbill populations within the United States territorial waters of the Caribbean Sea, Atlantic Ocean, and Gulf of Mexico. The team recognizes that United States waters are important to hawksbills that nest outside the United States jurisdiction, but it is not within the scope of this plan to develop recovery criteria for these populations at their nesting beaches. .Recovery measures delineated in this plan are, however, intended to include all hawksbills within the United States Caribbean Sea, Atlantic Ocean, and Gulf of Mexico, regardless of where they nest.

Taxonomy: The hawksbill turtle was originally named ***Testudo imbricata*** by Linnaeus (1766). A specimen at the University of Uppsala in Sweden, bearing Linnaeus' No. 130, is probably the type (Smith and Smith 1979). Taxonomic reviews appear in Smith atid 'Smith (1979), Witzell (1983), and Pritchard and Trebbau (1984). Two subspecies ***(Eretmochelys imbricata imbricata*** in the Atlantic Ocean and ***Eretmochelys i. bissa*** in the Indian and Pacific oceans) are recognized by Smith and Smith (1979). However, criteria for distinguishing the two forms are unreliable (Pritchard and Trebbau 1984) and subspecific designations are rarely used. A complex pattern of phenotypic variation exists. Some widely separated populations appear highly similar in color and pattern, whereas other populations that occupy the same ocean basin show marked differences (Pritchard and Trebbau 1984). Common names for the hawksbill turtle include tortoise-shell turtle, Carey, caret, and tortue imbriquee.

Description: The following combination of characters distinguishes the hawksbill from other sea turtles: two pairs of prefrontal scales; thick, -posteriorly overlapping scutes on the carapace; four pairs of costal scutes (the anteriormost not in contact with the nuchal scute);; two claws on each flipper; and a beak-like mouth. In addition, when on land the hawksbil'l has an alternating gait, unlike the leatherback and green sea turtles.

The carapace is heart-shaped in very young turtles and becomes more elongate or subovate with maturity. The lateral and posterior carapace margins are sharply serrated in all but very old individuals. The epidermal scutes that overlay the bones of the shell are the tortoiseshell of commerce. The scutes are unusually thick and overlap posteriorly on the carapace in all but hatchlings and very old individuals. Carapacial scutes are often richly patterned with irregularly radiating streaks of brown and black on an amber background. The scutes of the plastron of Atlantic hawksbills are usually clear yellow, with little or no dark, pigmentation. The soft skin on the hawksbills' venter is cream or yellow and may be pinkish-orange in mature individuals. The scales of the head and forelimbs are dark brown or black and have sharply defined yellow borders. There are typically four pairs of inframarginal scales. 'The head is elongate and tapers sharply to a point. The lower jaw is V-shaped. TX! scales' of the head and forelimbs are dark brown or black and have yellow borders.

The hawksbill is a small to medium-sized marine turtle. Nesting females average about 87 centimeters (cm) in curved carapace length (Eckert 1992) and weight may be to **80** kilograms (kg) in the Caribbean (Pritchard *et a2.* 1983), with a record weight of

127 kg (Carr 1952). Hatchlings in the United States **Caribbean average about** 42 millimeters (mm) in straight carapace length and range in weight from 13.5 to 19.5 g (Hillis and Mackay 1989, Van Dam and Sarti 1989, Eckert **1992).**

Population Distribution and Size: The hawksbill occurs in tropical and subtropical seas of the Atlantic, Pacific, and Indian oceans. Detailed descriptions of .its worldwide distribution are given by Groombridge (1982), Witzell (1983), and Groombridge and Luxmoore (1989). The species is widely distributed in the Caribbean Sea and western Atlantic Ocean. Representatives of at least some life history stages regularly occur in southern Florida and the northern Gulf of Mexico (especially Texas), in the **Greater and Lesser Antilles, and along the** Central American mainland south to Brazil. **In United States' jurisdiction in the** Caribbean Sea, hawksbills are most common in Puerto Rico and **its associated islands** (particularly Mona, Culebra, and Vieques) and in the USVI. The species is recorded in the continental U.S. from all the Gulf states and from along the eastern seaboard as far north as Massachusetts, but sightings north of Florida are rare.

Hawksbills are observed in Florida with some regularity in the waters near the Florida Keys and on the reefs off Palm Beach County (Lund 1985), where, the warm Gulf Stream current passes close to shore. According to DeSola (1932), before their numbers were reduced by overfishing, the Florida Keys were once considered the world's finest fishing grounds for the hawksbill turtle.

Texas is the ***only*** other state where hawksbills are sighted with any regularity. A total of 77 observations, most involving posthatchlings and juveniles, have been recorded there between 1972 and 1984 (Amos 1989). These **small** turtles are believed to originate from nesting beaches in Mexico (Hildebrand 1987, Amos 1989).

Within U.S. jurisdiction in the Caribbean Sea, nesting occurs principally on beaches in Puerto Rico and the USVI. The most important sites are Mona Island (Puerto Rico) and Buck Island (St. Croix, USVI). Nesting also occurs on other beaches of St. Croix, Culebra Island, Vieques Island, mainland Puerto Rico, St. John, and St. Thomas.

Within the continental United States, nesting is restricted to the southeastern coast of Florida (Volusia through Dade counties) and the Florida Keys (Monroe County) (Meylan 1992). Nesting by hawksbills has been recorded several times on Soldier Key, a small, mangrove-fringed islet in Biscayne Bay (Dade County) (DeSola 1932, Dalrymple ***et al.*** **1985). The only** reported nesting in Manatee County on the west coast of Florida (Conley and Hoftian 1987) was not adequately documented. Low levels of nesting are suspected to occur in the Marquesas and **Dry** Tortugas, but these areas have not been adequately surveye&-

Throughout their range, hawksbills typically **nest at low densities; aggregations consist of a** few dozen, at most a few hundred individuals. This is in contrast to green turtles and loggerhead turtles which nest by the thousands or tens of thousands at concentrated sites. The largest known nesting concentrations in the Caribbean are in the Yucatan Peninsula of

Mexico (Meylan 1989), where approximately 800 to 1000 nests are made each year between Isla Holbox (Quintana Roo) and Isla Carmen (Campeche) (Richard Byles, pers. comm., cited in Eckert 1992). This corresponds to approximately 178 to 222 turtles, given an estimated average of 4.5 nests per female per **season** (Corliss ***et al.*** 1989). Other important (but relatively small) nesting beaches in the Caribbean region are located in Belize, Nicaragua, Panama, Venezuela, Antigua, and the Grenadines. Hawksbills are also known to nest in Cuba, possibly in significant numbers, but population estimates are not available. With few exceptions, all of the countries in the Caribbean report fewer than 100 females nesting annually (Meylan 1989).

Estimates of the size of nesting populations are available for only a few localities. Richardson (1990) reported that an average of 160 nests were made annually on Mona Island during seven years of monitoring (1974, 1984 to 1989). This corresponds to approximately 36 nesting females per year. A total of 196 nests were recorded on the island in 1990 (Van Dam ***et al.*** 1991). Approximately 65 to 125 nests are made annually on BIRNM, St. Croix, USVI (Eckert 1992). Since research began in 1988, between 15 to 30 female hawksbills have been recorded nesting on BIRNM each year. The number of known nests each year in Florida between 1979 and 1990 (FDEP, Statewide Nesting Survey Data Base) varied from zero to two.

Status: The hawksbill is listed as endangered by the International Union for the Conservation of Nature and Natural Resources and is listed in Appendix 1 of the Convention on International Trade in Endangered Species of Wild Fauna and Flora (Groombridge 1982). It is also listed as endangered throughout its range under the Endangered Species Act of 1973, as amended (USFWS 1989). Groombridge and Luxmoore (1989) carried out an exhaustive review of the worldwide conservation status of the hawksbill turtle and concluded that the species is suspected or known to be declining in 38 of the 65 geopolitical units for which nesting density estimates are available. They noted severe declines in the western Atlantic Ocean and Caribbean region, as did Meylan (1989), who reported that current nesting levels may be far lower than previously estimated. Despite protective legislation, international trade in tortoiseshell and subsistence use of meat and eggs continue unabated in many countries and pose a significant threat to the survival of the species in this region.

In the United States Caribbean, there is evidence that hawksbill nesting populations have been severely reduced during the 20th century (Eckert 1992). At present, they are not believed to be declining, but neither are there signs of recovery, despite over a decade of protection. The most recent status review of the species in the United States recognized that numerous threats still exist for United States populations and recommended that the hawksbill remain listed as endangered throughout its range (Eckert 1992).

Biological Characteristics:

The biology of the hawksbill has been extensively reviewed (Car-r et *al,* 1966, **Witzell** 1983, Meylan **1984a,** Pritchard and Trebbau 1984, and Eckert 1992). Only a brief overview is presented here.

Habitat: Hawksbills use different habitats at different stages of their life cycle. Sightings (Hornell 1927, Gunter **1981),** strandings (Vargo *et al,* 1986, Carr 1987, Amos 1989) and gut-content analyses (Meylan 1984b) suggest that posthatchling hawksbills occupy the pelagic environment, taking shelter in weedlines that accumulate at convergence zones. Sargassum and floating debris such as Styrofoam, tar droplets, and plastic bits--common components of weedlines-are consistently found in the stomachs of posthatchling hawksbills that strand in Texas **(Plotkin** and Amos 1988). **Thus,** it seems likely that weedlines in the Gulf of Mexico serve as habitat for hawksbills that enter United States. waters from nesting beaches in Mexico and Central America. Posthatchlings from beaches in the United States are presumed to occupy weedlines in the Atlantic Ocean.

Hawksbills reenter coastal waters when they reach approximately 20 to 25 cm carapace length. Coral reefs are widely recognized as the resident foraging habitat of juveniles, subadults, and adults. This habitat association is undoubtedly related to their diet of sponges, organisms that need solid substrate for attachment. The ledges and caves of the reef provide shelter for resting both during the day and night. Hawksbills are found around rocky outcrops and high-energy shoals, which are optimum sites for sponge growth. Hawksbills are known to inhabit mangrove-fringed bays and estuaries, particularly along the eastern shore of continents where coral reefs are absent (Carr 1952). In Texas, juvenile hawksbills are associated with stone jetties (Hildebrand 1987, Amos 1989).

Hawksbills nest on low- and high-energy beaches in tropical oceans of the world, frequently sharing the high energy beaches with green turtles. Both insular and mainland nesting sites are known. Hawksbills will nest on small pocket beaches and, because of their small body siie and great agility, can traverse fringing reefs that limit access by other species. They exhibit a wide tolerance for nesting substrate type. Nests are typically placed under vegetation.

Diet: Very little is known about the diet of posthatchling hawksbills in the pelagic environment. Eggs of pelagic fish, pelagic species of ***Sargassum,*** and various floating debris such as tar droplets, Styrofoam, and plastic have been identified (Meylan 1984b).

Although a wide variety of benthic organisms have been recorded from **digestive tracts,** sponges are the principal diet of hawksbills once they enter shallow coastal waters and begin feeding on the **bottom** **(Meylan** 1988). Quantitative studies have focused on the Caribbean, but there is evidence that spongivory is a worldwide feeding habit. It is unquestionably a highly unusual one, being shared by only about a dozen other vertebrates. A high degree of feeding selectivity is indicated by the consumption of a limited number of sponge species.

Sponge predation by hawksbills may influence reef succession and diversity by freeing up space on the reef for settlement by benthic organisms. The hawksbill's highly specific diet, and its dependence on filter-feeding, hard-bottom communities make it vulnerable to deteriorating conditions on coral reefs.

Growth: Few data are available on the growth rates of wild hawksbill turtles. Most information has come from a study involving recaptures of 32 turtles (size range: 39.5 to 87.5 cm curved carapace length) on the Great Barrier Reef (Limpus 1992). Mean growth rates ranged from 0.06 cm/year (yr) for two adults, to 2.17 cm/yr for immature turtles ranging in size from 50 to 60 cm initial curved carapace length. The study concluded that hawksbills recruiting onto the reef at 35 cm in length would begin breeding 31 years later. Because the time required for these turtles to reach 35 cm is unknown, the actual age at sexual maturity is not known.

Boulon (1983) reported an average growth rate of 0.28 cm straight carapace length per month (3.36 cm/yr) for hawksbills ranging in size from 27.4 to 60.7 cm in St. Thomas (USVI). In the southern Bahamas, growth rates of four wild juvenile hawksbills ranged from 2.4 to 5.9 cm/yr (Bjorndal and Bolten 1988). Growth rates of adult females on the nesting beach in Costa Rica averaged 0.3 cm/yr (Bjorndal *et al.* 1985).

The few data available suggest slow growth and an advanced age at sexual maturity, as has been demonstrated for several other species of sea turtles. Rates of growth vary among different size classes (Limpus 1992) and seem to decrease considerably after sexual maturity is reached.

Reproduction: The 6-month nesting season of the hawksbill is longer than that of other sea turtles. Most nests on BIRNM, are made from July to October (Hillis 1990). On Mona Island the peak season is August to October (Richardson 1990). Courtship and mating apparently begin somewhat earlier, and may occur either along the migratory route or off the nesting beach. Nesting in the Caribbean is principally nocturnal, although rare daytime nesting is known. Nesting behavior, described by Carr *et al.* (1966), follows the general sequence of that of other species of sea turtles: emergence from the sea, site selection, site: clearing and body pit construction, egg chamber construction, egg laying, filling in the egg chamber, disguising the nest site, and returning to sea. The entire process takes approximately 1 to 3 hours.

Hawksbills nest an average of 4.5 times per season (Corliss *et al.* 1989, Van Dam and Sarti 1990) at intervals of approximately 14 days. Earlier estimates of two to three pests per season reported at various projects around the world probably resulted from incomplete beach coverage. As many as 12 clutches may be produced by a single female in one season (Melucci *et al.* 1992). Not all emergences or nesting attempts result in eggs being laid. On Mona Island, an average of two emergences per successful nest was calculated; one female was observed making as many as 11 digging attempts on a single emergence (Kontos 1988). The ratio of crawls to nests varies geographically depending on local conditions, making site-specific information necessary for accurate interpretation of aerial survey data. On **the** basis of limited information, **2-** and **3-year** remigration intervals appear to predominate; annual nesting by the hawksbill has not been recorded in the Caribbean.

Hawksbills have strong philopatry for their nesting beaches (Bjomdal et ***al.*** 1985, Richardson, pers. **comm.,** cited in Eckert **1991),** and are capable of returning to specific beach areas (Carr and Stancyk 1975, Diamond 1976, Lund 1985, Melucci et ***al.*** 1992). The extent to which site fiiixity is expressed among and within populations, or even by individuals over time, remains to be quantified.

Clutch size is directly correlated with carapace length **(Hirth** 1980) and varies markedly throughout the range of the species. In Florida and the United States Caribbean, clutch size is approximately 140 eggs, and several records exist of over 200 eggs per nest. Eggs are approximately 40 mm in diameter and take about 60 days to hatch. Hatching success at nesting beaches in the United States. is **approximately** 80 percent (Van Darn and **Sarti** 1990, **Hillis** 1990). Hawksbills are suspected to exhibit temperature-dependent sex determination, as do other sea turtles, but data are limited (Dalrymple ***et al.*** 1985). Detailed studies on this important aspect of the biology of the species are underway.'

Movements: Very little is known of the movement patterns of posthatchling hawksbills, although their occupation of the pelagic environment is relatively well documented. Posthatchlings in Texas waters are presumed to have been passively transported there by currents that pass along Mexico. The movement patterns of hatchlings entering the sea from United States beaches are unknown.

Immature hawksbills show evidence of residency on specific feeding grounds (Nietschmann 1981, **Limpus 1992),** but developmental migrations may occur with changes in habitat occupation **(Limpus** 1992). Immature hawksbills tagged in the USVI have been recovered in eastern Puerto Rico, the British West Indies, St. Martin, and St. Lucia, representing travel distances of 95 km, 46 km, 185 km, and 650 km, respectively **(Boulon** 1989). Other recaptures of immature hawksbills have documented the long-distance travel of an 11 kg hawksbill from Great Inagua, Bahamas, to the Turks and Caicos Islands (Bjomdal ***et al.*** 1985) and the migration of a **subadult** hawksbill from Brazil to Dakar, Senegal, a distance of 3680 km (Marcovaldi and Filippini 1991). The purpose and regularity of migrations by immature hawksbills deserve further study.

Recoveries of tagged adult hawksbills suggest that some populations or groups within a population undertake reproductive migrations **(Meylan** 1982, **1984a,** Bjomdal ***et al.*** 1985). Migrations have been documented of adult females from beaches in Costa Rica to feeding grounds in Nicaragua, and from Nicaragua feeding grounds to a beach in Jamaica. An adult male tagged on the foraging grounds in Nicaragua was recovered in Panama **(Meylan** 1982). **Marquez** (pers. **comm.)** reported the travel of a **hawksbill** from Isla Mujeres, Mexico, to **Bani, Dominican Republic, a distance of 2925 km. Indirect evidence of migration** by hawksbills was provided by Limpus (1992), who described a population of immature hawksbills in the Great Barrier Reef that reside at least 1400 km from any regular hawksbill nesting site.

Threats - Nesting Environment

Illegal Exploitation: The greatest threat to hawksbills while on nesting beaches is poaching. Egg poaching is a particularly serious problem in Puerto Rico (Matos 1987) and occurs in St. Thomas and St. Croix (R. Boulon, pers. comm.). While on the beaches, adult females are killed for tortoiseshell. Better surveillance by law enforcement and volunteer groups is believed to be reducing the levels of take. Hawksbills that use the remote beaches on Mona and Culebra islands are vulnerable to poaching. Hawksbills that use Piñones (a beach close to San Juan, Puerto Rico) are taken, in spite of the fact that Piiiones has been given one of the largest PRDNR ranger contingents deployed on any Puerto Rican beach. Although the rate of poaching may be limited on any given beach, the overall effect is an enormous drain on hawksbill populations.

Beach Erosion: Hawksbill nesting beaches are usually small and the sand builds up over long periods of time. Storms periodically remove the sand, but it is usually replaced by wind and wave action. Storms may cause trees to fall which hinder the hawksbills from reaching nesting habitat. BIRNM's nesting beaches were severely degraded in this manner by Hurricane Hugo in 1989. BIRNM staff selectively removed fallen trees and debris and constructed sand ramps in the steep berms to provide access to high-density nesting areas. Normal, periodic erosion cycles may remove and replace large areas of a nesting beach, such as occurs at Sandy Point NWR, St. Croix. The overall effect is to clean and renourish the nesting beach. Occasionally, vulnerable nests may need to be relocated in such areas. Hawksbill nests are regularly relocated at Humacao, Piñones, Mona Island, and Caja de Muertos, Puerto Rico. Natural processes of beach erosion are not generally a significant threat to hawksbills.

Erosion Control Methods: Problems are caused by humans placing immovable structures on ephemeral shorelines. Beaches naturally recede and replenish but real estate boundaries are fixed. Where beachfront development occurs, the site is often fortified to protect the property from erosion. The purpose of virtually all shoreline engineering is to save structures, not dry sandy beaches, and ultimately causes environmental damage. Beach armoring includes sea walls, rock revetments, riprap, sandbag installations, groins, and jetties. Approximately 21 percent (234 km) of Florida's beaches are armored (FDEP, unpubl. data). Although not quantified, beach armoring is extensive in some regions of Puerto Rico but rare in the USVI. Beach armoring may result in the permanent- loss of a dry nesting beach by accelerating erosion and preventing natural beach or dune accretion. It may prevent or hamper nesting females from reaching suitable nesting sites. Clutches deposited1 seaward of these structures may be inundated at high tide or may be washed out entirely by increased wave action near the base of these structures. As these structures fail and break apart they spread debris on the beach, which may further impede access to suitable nesting sites and trap hatchlings and nesting turtles. Sandbags are particularly susceptible to rapid failure and result in extensive debris on nesting beaches. Rock revetments, riprap, and sand bags can cause nesting turtles to abandon nesting attempts. When inadequate amounts of sand cover these structures, turtles attempting to nest may construct improperly sized and shaped egg cavities.

Groins and jetties are designed to trap sand during transport in longshore currents. Jetties keep sand from flowing into channels. These structures prevent normal sand transport and accrete beaches on one side of the structure while starving beaches on the other side. Severe beach erosion may result (Pilkey et al. 1984).

Beach nourishment entails pumping, trucking, or scraping sand onto the beach to rebuild what has been lost to erosion. It is a common practice in Florida but is much less common. in Puerto Rico and the USVI. Beach nourishment can affect turtles by burying nests and, if conducted during the nesting season, by disturbing nesting turtles. The sand used in beach nourishment may be dissimilar from native beach sediments and can affect nest site selection, digging behavior, incubation temperature (and hence sex ratios), gas exchange within incubating nests, hydric environment of the nest, hatching success, and hatchling emergence: success (Mann 1977, Ackerman 1980, Mortimer 1982, Raymond 1984a). Beach nourishment may cause severe beach compaction or concretion. Trucking sand onto project beaches may increase the level of compaction.

Heavy machinery, pipelines, increased human activity, and artificial lighting are usually associated with beach nourishment projects. Beach nourishment activities are normally conducted day and night and may create barriers for nesting females. Increased human activity on the project beach at night may cause further disturbance to nesting females. Artificial lights along the project beach and in the nearshore area of the borrow site may deter nesting females and disorient or misorient emergent hatchlings from adjacent beaches.

Sand Mining: Removal of sand for construction aggregate or renourishment of other beaches is a serious threat to nesting beaches throughout the Caribbean. In Puerto Rico, sand may be mined on private property (for example, private properties at Añasco and Rincon) or sold by the government from public beaches under a directive of "wise resource management" (for example, public beaches at Arecibo and Isabela). However, sand is often removed from protected beaches by the local citizens. It is illegal in the USVI to mine sand below the high tide line, but, until this important nesting beach was purchased and protected as a National Wildlife Refuge in 1984, sand was being mined from Sandy- Point, St. Croix.

The physics of sand dynamics on tropical beaches is poorly understood. Most sand is calcareous, originating from fragments of calcareous algae and mollusks, the feeding of parrotfish on coral, and the result of grinding wave action. The supply is limited and not easily replaced from other sources. The sand on a beach is resupplied from accumulations of subtidal sand, and the two sources are in constant equilibrium. Mined beach sand will not be replaced until offshore supplies build in quantity, a process that could take decades. If offshore sand deposits are mined, beach sand moves offshore to replace the subtidal supply. Wind moves beach sand to berms and beach forest communities which provide appropriate habitat for hawksbill nesting. Accumulated sand in areas above the high tide-line provides the reserve for beach sand that is lost when shorelines recede. Sand mining of any type almost always affects the balance of sand deposits, with deleterious effects for nesting sea turtles.

Landscaping: Hawksbill nesting is scattered among many small beaches. Most of these beaches are privately owned and may be extremely valuable as hotel sites. Hawksbill recovery will depend on development that is sensitive to the needs of nesting hawksbills. Houses built close to the water's edge create many potential impediments to nesting turtles. Native vegetation is often cleared and replaced with exotic species. Sand is replaced with garden soils. Beaches are exposed to strong winds, allowing the winds to transport the sand away from the nearshore habitat preferred by the hawksbills for nesting. The thermal regime may be altered for incubating eggs, affecting hatching success and natural sex ratios. In some areas, the shrubbery is so removed from the waterline that nesting turtles are unwilling to cross the exposed space.

Not all landscaping efforts need be detrimental. Setbacks can be established for buildings and other structures. Native vegetation can be protected behind the high-water line, even if patches are all that remain. Vegetation can serve as corridors, leading nesting turtles to suitable nesting habitat farther back from the high-water line. Garden walls can be used to separate landscaped areas behind the walls from natural plant communities in front of the walls. Vegetation can screen disruptive lights. Without planning, landscaping is usually detrimental; with proper planning, landscaping can be supportive of nesting hawksbills while still being pleasant for humans.

Several species of plants can be lethal to the development and hatching of sea turtle eggs. Casaurina is planted for beach erosion control, shade, and wood production. The roots grow fast, rendering habitat unfit for nesting. Sea oats (*Uniola*) are commonly planted on northern beaches to enhance dune growth. On tropical beaches, however, the roots of this exotic grass may be lethal to hawksbill eggs.

Artificial Lighting: Extensive research has demonstrated that the principal component of the sea-finding behavior of emergent hatchlings is a visual response to light (Daniel and Smith 1947, Hendrickson 1958, Carr and Ogren 1960, Ehrenfeld and Carr 1967, Mrosovsky 1978, Dickerson and Nelson 1989, Witherington and Bjorndal 1991). Artificial beachfront lighting from buildings, streetlights, dune crossovers, vehicles, and other sources has been documented as causing the disorientation (loss of bearings) and misorientation (incorrect orientation) of hatchling turtles, including hawksbills (McFarlane 1963, Philibosian 1976, Mann 1977, Ehrhart 1983). On Sandy Point NWR, hawksbill and leatherback hatchlings are strongly attracted, especially on moonless nights, to the lights of Frederiksted (several km to the northeast). Another example are the Hotel Palmas del Mar parking lot lights at Humacao, Puerto Rico. These lights regularly disorient or misorient hawksbill hatchlings.

The results of disorientation or misorientation are often fatal. As hatchlings head toward lights or meander along the beach, their exposure **to** predators and the likelihood of desiccation are greatly increased. Misoriented hatchlings can become entrapped in vegetation or debris, and in Florida loggerhead hatchlings are frequently found dead on nearby roadways and in parking lots after being struck by vehicles. Hatchlings that successfully **find the** water may be misoriented after entering the surf zone or while in nearshore waters. Intense artificial lighting can even draw hatchlings back out of the surf (Daniel and Smith 1947, Carr and Ogren 1960).

The problem of artificial beachfront lighting is not restricted **to hatchlings.** Nesting **turtles** can also be misoriented by lights. A leatherback died after **traveling inland toward a security** light on Anegada, BVI (Eckert and Lettsome 1988). In June 1992, a nesting loggerhead was killed by an automobile as it wandered onto Highway **A1A** at Patrick Air Force Base, misoriented by lights from the west side of the highway. Raymond (1984b) reported that adult loggerhead emergence patterns were correlated with variations in beachfront lighting in southern Brevard County, Florida. Nesting females avoided areas where beachfront lights were the most intense. Witherington (1986) noted that loggerheads aborted nesting attempts at a greater frequency in lighted areas. More recently, Witherington (1992) determined that broad-spectrum artificial lights significantly reduced loggerhead and green turtle nesting activity. In addition to the lights on or near the nesting beaches, the background glow associated with intensive inland lighting, such as that emanating from nearby large metropolitan areas, may deter nesting females and disorient or misorient hatchlings navigating the nearshore waters. Cumulatively, along the heavily developed beaches of the southeastern continental U. S., **Puerto Rico,** and USVI, the adverse effects from artificial lights may be profound.

Beach Cleaning: Beach cleaning refers to the removal of debris from developed beaches. Large expanses of open sand may be cleaned with mechanical devices to a depth of several inches. The top of a clutch of hawksbill eggs is often no more than 4 to 6 inches below the surface of the sand and hawksbill nests on resort beaches are often subject to damage from raking and cleaning. The Hotel **Palmas del** Mar beach at **Humacao** and the public beach at **Piñones,** Puerto Rico receive intensive cleaning that threatens hawksbill nests. Wind erosion is another threat exacerbated by beach cleaning. The complete removal of leaf litter and herbaceous vegetation on a beach allows prevailing winds to move sand to areas outside of the prime nesting area, and the vegetated nearshore berm may be lowered by 3 or more feet. On a cleaned beach in Antigua, the wind has moved the sand more than a hundred feet back from the shoreline. Today, limestone bedrock is too close to the surface to permit turtle nesting on several historic nesting areas.

Increased Human Presence: ‘Residential and tourist use of developed (and **developing)** nesting beaches can negatively affect nesting turtles, incubating egg clutches, and hatchlings. The most serious threat caused by increased human presence on the beach is the disturbance of nesting females. Nighttime human activity can cause nesting females to abort nesting attempts at any stage of the process. Disturbance has caused loggerhead turtles to shift to other nesting beaches, delay egg laying, and select poor nesting sites. Female hawksbills ascending a beach to nest are easily deterred by the presence of people, noise, and flashlights. Turtles frightened from a protected public beach may go to an adjacent beach., where they may be more vulnerable to poaching. Pedestrian traffic in the nesting area can also break and destroy vegetation and crush eggs. Pedestrian tracks can hinder hatchlings; efforts to reach the ocean (Hosier *et al.* 1981). Campfires and the use of flashlights on nesting beaches misorient hatchlings and can deter nesting females (Mortimer 1979). Hatchlings have been drawn into campfires. A campfire placed over a hawksbill nest will kill the developing embryos or preemergent hatchlings.

The placement of physical obstacles (e.g., lounge chairs, cabanas, umbrellas, hobie cats, canoes, small boats, and beach cycles) on nesting beaches can hamper or deter nesting attempts and interfere with incubating egg clutches and the seaward movement of hatchlings. The placement of recreational beach equipment directly above incubating egg clutches may hamper hatchlings during their emergence and can destroy eggs through direct invasion of the nest. Nesting females gravitate to dark horizons when seeking a nest site, whether the horizon be a beach forest or a cabana. Hawksbills may nest in the shadow of a chair or umbrella on the open beach. If the structure is removed, the nest is no longer protected from direct sunlight and the nest may get too hot.

Beach Vehicular Driving: Beaches are often viewed as a playground for off-road vehicles. The vehicles cause sand compaction which decreases hatchling success (Mann 1977) or crush pre-emergent hatchlings. Vehicles can strike and kill hatchlings while they are crawling to the ocean. Vehicle tire ruts also interfere with the ability of hatchlings to traverse the beach to the ocean (Hosier *et al.* 1981). Vehicles on the beach is a serious problem on Sandy Point NWR (Basford et. al. 1988), Mandahl and Caret Bays, St. Thomas (Bureau of Environmental Enforcement Officers, pers. comm.), Manchenil Bay, St. Croix, and northeastern Puerto Rico (P.J. Rivera-Lugo and H.C. Horta, pers. comm.). In both the USVI and Puerto Rico this activity is illegal, yet it persists.

Nest Depredation: A variety of natural and introduced predators (for instance, hogs, mongooses, ghost crabs, and ants) prey on hawksbill eggs and hatchlings. Until eradicated in 1987, mongooses were destroying up to 55 percent of all nests on BIRNM (Small 1982). Prior to extensive live trapping, mongooses were destroying an estimated 24 percent of all turtle eggs in 1980 and 1981 on St. John, USVI. Feral hogs destroyed 44 to 100 percent of all hawksbill nests deposited outside of fenced areas on Mona Island, Puerto Rico, during 1985 to 1987 (Kontos 1985, 1987, 1988).

Threats - Marine Environment

Entanglement at Sea: The extent to which hawksbills are killed or debilitated after becoming entangled in marine debris has not been quantified, but it is believed to be a serious and growing problem. Of the 25 sea turtles found entangled in debris on the Texas coast during 1986 and 1987, 24 percent were juvenile hawksbills (Plotkin and Amos 1988). Hawksbills (predominantly juveniles) have been reported entangled in monofilament gill nets, “fish nets,” fishing line, and synthetic rope; in most cases flippers were lost as a result, and in one case the animal was recovered with a piece of plastic onion bag entangled around its neck (Balazs 1985). In July 1992, a juvenile hawksbill, entangled in monofilament fishing: line, was found dead near the Green Cay Marina breakwater.

In the United States Caribbean, a juvenile hawksbill was entangled in a mooring buoy line and released unharmed at BIRNM in 1990. A person snorkeling reported to the National Park Service in 1991 that a juvenile hawksbill was found entangled in discarded monofilament fishing line; the line was wound around both thereef and the turtle, and the turtle was barely able to surface to breathe. It was released alive (Z. Hillis, pers. comm.). In Puerto Rico, juvenile and adult hawksbills have been found entangled in jute bags, ropes, fishing line, and shoestrings (with tennis shoe attached!) (B. Pinto, pers. comm.). In some of the cases, the stranded turtle had not been associated with line or netting, but had deep scars that clearly resulted from entanglement.

Ingestion of Marine Debris: Marine turtles have been found to ingest a wide variety of abiotic debris (plastic bags, raw plastic pellets, plastic and Styrofoam pieces, tar balls, and balloons). Effects of debris ingestion can include direct obstruction of the gut, absorption of toxic byproducts, and reduced absorption of nutrients across 'the gut wall (Balazs 1985). Studies conducted by Lutz (pers. comm.) revealed that both loggerheads and green turtles actively ingested small pieces of latex and plastic sheeting. Physiological data indicated a possible interference in energy metabolism or gut function, even when only small quantities of debris were ingested. The material persisted in the gut for time periods that ranged from a few days to four months (Lutz, pers. comm.).

Balazs (1985) summarized published incidents of the ingestion of debris by hawksbills and reported that 88.9 percent of the articles recovered were plastic bags, plastic and Styrofoam particles, and tar. Most (91 percent) of the hawksbills were juveniles. Carr and Stancyk (1975) reported plastic and man-made litter in the stomachs of hawksbills from Costa Rica. In Puerto Rico, plastic bags have been found in stranded turtles (B. Pinto, pers. comm.).

Commercial and Recreational Fisheries: Incidental catch in the finfish fisheries may be an important cause of mortality. The Sea Turtle Stranding and Salvage Network (Atlantic and Gulf of Mexico coasts of the United States) reported 27 stranded hawksbills in 1988, 35 in 1989, 61 in 1990 (when an unusually large number of post-hatchlings washed ashore in Texas), and 33 in 1991 (W. Teas, pers. comm.). Hawksbills typically comprise less than 1.5 percent of total sea turtle strandings (Schroeder and Warner 1988, Teas and Martinez 1989). Gill nets, longlines, and shrimp trawls capture turtles in Gulf of Mexico waters (Hildebrand 1987) and hawksbills strand on the Texas coast during all months of the year (Schroeder and Warner 1988, Teas and Martinez 1989, 1992). Three small hawksbills were recently caught in nylon gill nets (3.5 to 4 inch mesh) set on the north side of St. Croix (C. Farchette, pers. comm.). In Puerto Rico, hawksbills are captured by a variety of fishing gear, including driftnets, gillnets, seines, and spearguns. For example, in early 1992, a driftnet killed four hawksbills and two dolphins in deep water south of Puerto Rico. Gillnets and seines are widely deployed and are a particularly serious problem. These nets are sometimes set specifically for sea turtles and rays. Spearfishing is also widespread around Puerto Rico, Culebra, Vieques, Mona Island, and associated islets (B. Pinto, pers. comm.).

Watercraft Collisions: In 1987, at BIRNM, a propeller nearly severed the head of a juvenile hawksbill (Z. Hillis, pers. comm.). In June 1992, a boat hit and killed a juvenile male hawksbill in Cabo Rojo. The increased use of jet skis (often called personal watercraft) may cause frequent collisions.

Sedimentation and Siltation: In Puerto Rico, damage to coral reefs and other shallow water benthic systems by sedimentation and siltation has not been assessed. These factors are known to be a serious problem in other areas. In some cases, coral reefs have been nearly completely destroyed by siltation. Damage from dredging has occurred mainly along the: southern coast. The construction of docking facilities also contributes to the sedimentation problem (B. Pinto, pers. comm.).

Agricultural and Industrial Pollution: The effects of pollutants resulting from industrial or agricultural sources are difficult to evaluate. Pesticides, heavy metals and PCB's have been detected in turtles (including eggs), but levels that result in adverse effects have not been quantified (Nelson 1988). Sandy Point NWR is downcurrent from the Cruzan Rum discharge of by-products and wastes from the rum distillery. This discharge chronically affects the water around Sandy Point NWR. What effect, if any, this has on sea turtles i.s unknown. The specific effects of marine pollution on hawksbills, their eggs, and their prey have yet to be determined.

Sewage: In early 1992, there were two cases of raw sewage washing up on the nesting beach at Sandy Point NWR (Greg Hughes, pers. comm.). For several months in 1992, there were no functioning sewage treatment plants on St. Croix. Raw sewage was dumped directly into nearshore waters, such as Christiansted Harbor (M. Coulston, pers. comm.). In Puerto Rico, sewage effluent is commonly discharged into local rivers that discharge the sewage to the sea. There is a new regional treatment plant in Humacao (eastern Puerto Rico) that discharges tertiary-treatment waste about a half-mile offshore. Monitoring of the discharge should be initiated.

Illegal Exploitation: The total amount of illegal capture of hawksbills is not known, but it is believed to be a major problem. It is well known, for example, that some fishermen opportunistically capture hawksbills in United States waters with nets and spears. The primary source of hawksbill mortality in Puerto Rican waters is believed to be poaching at sea (Benito Pinto, pers. comm.)

Oil and Gas Exploration, Development, Transportation, and Storage: Experimental and field results reported by Vargo *et al.* (1986) indicate that marine turtles would be at substantial risk if they encountered an oil spill or large amounts of tar in the environment. The Caribbean Stranding Network has treated several hawksbills for burns on the eyes, face, and neck resulting from contact with gasoline spilled or released at sea. Physiological experiments indicate that the respiration, skin, some aspects of blood chemistry and composition, and salt gland function of marine turtles are significantly affected (Vargo *et al.* 1986). Spills in the vicinity of nesting beaches are of special concern and could place nesting adults, incubating egg clutches (Fritts and McGehee 1989), and hatchlings at significant risk. Anywhere that shipping or petroleum processing occurs upwind or upcurrent of a nesting beach, the potential exists for an oil spill or discharge to foul the beach.

The recent oil spills in the U.S. Caribbean shows the serious nature of this threat. In September 1989, following Hurricane Hugo, a 42,000-gallon spill of heavy crude oil from the Water and Power Authority facility in Christiansted, St. Croix, left southern beaches heavily oiled. Pelican Cove, a hawksbill nesting beach, was buried under 0.3 m of crude oil. Between March 1991 and March 1992, two more spills,' both outside of U.S. waters, threatened U.S. nesting beaches.

On March 6, 1991, thirteen km north of Nevis, the Trinidad-registered barge Vestabella, loaded with about 560,000 gallons of Number 6 fuel oil, sank in 600 meters (m) of water after a towing cable snapped. The initial oil slick was more than 30 miles long (Simmonds 1991). Soon thereafter, tar balls and tar sheets began appearing on St. Thomas, St. Croix, Culebra, Vieques, and the main island of Puerto Rico and a hawksbill soaked in oil was found dead near Guayama on the southern coast of Puerto Rico (B. Pinto, pers. comm.).

One year later, on March 15, 1992, a pipe ruptured during ship-to-shore pumping of #6 fuel oil to a transfer station at St. Eustatius Terminal on the west coast of St. Eustatius, Netherlands Antilles. One hundred barrels of oil were released to the sea in a slick that moved northwest across the rich fishing grounds of the Saba Bank. Heavy seas broke up the slick before it entered United States waters, but tar balls eventually fouled the coast of Puerto Rico (Z. Hillis, pers. comm.). Tar balls of unidentified origin are also occasionally observed in U.S. Caribbean waters. Since 1990, this phenomenon has become increasingly common in waters surrounding BIRNM (Z. Hillis, pers. comm.).

Anchoring and Vessel Groundings: The hawksbill's dependence on coral reefs for shelter and food links its well-being to the condition of reefs. Hawksbill turtles find shelter under coral ledges and feed on sponges and other reef organisms (Witzell 1983, Meylan 1988). Destruction of reefs caused by ships anchoring, striking, or grounding on them is a growing problem. Many small boats have ran aground on shallow reefs off the north shore of St. John (C. Rogers, pers. comm.).

The anchors and anchor chains of cruiseships and yachts are destroying portions of coral reefs in the USVI, Puerto Rico, the BVI, Cayman Islands, Belize, and elsewhere. The number of cruiseships visiting the Caribbean rose from 35 in 1982 to 82 in 1987. There are few restrictions on anchoring anywhere in the Caribbean. Even in VINP, where federal regulations prohibit damaging coral reefs, ships are destroying reefs, probably on a daily basis. In addition, damage is also caused by the indiscriminate anchoring of recreational, diving, and fishing boats and this may be one of the greatest threats to hawksbill habitat.

On February 15, 1985, the 350-foot *M/V* A. Regina ran aground off the east coast of Mona Island in federally designated hawksbill Critical Habitat. The wreck spilled diesel oil, extensively damaged the reef, produced a considerable suspension of sediment, and littered the beaches with oil and debris (Cintron and Cintron 1987). On August 25, 1985, a hawksbill emerged to nest on Playa Sardinera on Mona Island with oil on her flippers, plastron, tail, cloaca, head, and throat; she was unsuccessful in her nesting attempt and did not return (Kontos 1985).

In October 1988, the 440-foot cruise ship *Windspirit* illegally dropped anchor west of Francis Bay on the north side of St. John in the VINP and Biosphere Reserve. The anchor and chain obliterated 283 square meters of coral reef. In October 1990, the anchor chain of the 438-foot cruise ship *Seabourne Pride* uprooted and overturned at least 42 boulders, some were 3 m in diameter, of living coral in the Biosphere Reserve.

In March 1991, a 45-foot steel-hulled sailboat, the *Margaret,* carrying produce from the Dominican Republic to St. Croix, grounded on the northwest corner of the barrier reef surrounding BIRNM. The ship remained on the reef for two days and created a scar more than 100 feet long by 12 feet wide through the barrier reef. More than 1500 square feet of reef were destroyed by the boat's grounding and subsequent removal (Z. Hillis, pers. comm.).

International Trade: International commerce in hawksbill shell (commonly called "tortoiseshell" or "bekko") may be the most significant factor endangering hawksbill populations worldwide. Japanese imports of raw bekko between 1970 and 1989 totalled 713,850 kg from more than 670,000 turtles [Milliken and Tokunaga 1987 (updated to 1989 by Greenpeace 1989)]. Milliken and Tokunaga (1987) noted that to maintain these levels of importation, an annual slaughter of at least 28,000 hawksbills was required. Between 1970 and June 1989, Japan imported 368,318 kg of bekko from more than 250,000 hawksbills from the wider Caribbean (Canin 1989). In addition, from 1970 to 1987, Japan imported1 more than 587,000 stuffed hawksbills (Greenpeace 1989).

Because of the migratory nature of hawksbills, this trade threatens the species throughout the Caribbean basin. The problem is exacerbated by turtles being caught illegally in CITES nations and subsequently "laundered" for export through non-CITES nations. For example, Japan's 1988 bekko imports from Jamaica, Haiti, and Cuba represent about 13,400 hawksbills. It is unlikely that these turtles originated from the waters of those countries (Greenpeace 1989).

For several reasons, despite the protection conferred by CITES, legal and illegal trade continues to be a major problem. First, while 115 nations have ratified CITES (USFWS 1992), some have exercised their right to take exemption to treaty provisions as they pertain to sea turtles. When Japan ratified CITES in 1980, it placed a reservation on the hawksbill and several other reptile species, effectively exempting itself from the ban on their trade (Greenpeace 1989). Likewise, Cuba took reservations on hawksbills and green turtles (WWF 1990).

Secondly, some countries, such as Indonesia, which ratified CITES in 1979, ignore their obligations as CITES parties and openly trade in Appendix I species. According to Japanese Customs statistics, stuffed hawksbills from Indonesia accounted for nearly half of all "worked bekko" imports between 1979 and 1986 (Milliken and Tokunaga 1987). Other CITES parties clandestinely participate in the trade by falsifying export documents for the country of origin. For example, Japanese Customs records indicate that in 1990, 2505 kg of bekko was received from Antigua, which has not signed CITES. However. Antiguan authorities contend it is impossible that any export occurred,, especially an export representing nearly 2,000 hawksbills (J. Fuller, pers. comm.).

Finally, some countries that supply hawksbill products do not belong to CITES. For example, between 1970 and June 1989, Haiti exported bekko from more than 2,000 hawksbills (Greenpeace 1989).

While Japan is the major importer, there is significant trade within the Caribbean in response to demand created by sales to tourists. Despite full domestic protection, tortoiseshell items are available in the USVI. In 1984, two commercial shipments of sea turtle jewelry (valued at $500) were seized. In 1986, forty-three pieces of jewelry were seized and in 1988, $150 worth of tortoiseshelljewelry boxes were forfeited in 1988 (Eckert 1992). In early 1992, about $150 worth of tortoiseshell jewelry, allegedly imported from Jamaica, was confiscated from a St. Croix airport store (Greg Hughes, USFWS, *in litt.*, May 12, 1992). In June 1992, the Jewelry Factory (Christiansted, St. Croix) was openly selling tortoiseshell earrings that were allegedly imported from the Dominican Republic (K. Eckert, pers. obs.). In La Paragera, Puerto Rico, tortoiseshell jewelry valued at approximately $200 was seized by NMFS from a gift shop. A Federal investigation determined that the jewelry had been imported by a Colombian distributor and purchased at a jewelry show in San Juan (M. Christian, NMFS, *in litt.*, March 3 1, 1992).

Other Threats: In nearshore waters, hawksbills are periodically captured in the cooling water intakes of industrial facilities, such as Florida Power and Light Company's St. Lucie Power Plant on Hutchinson Island. Between March 1976 (when the St. Lucie Plant opened) and November 1988, six hawksbills were captured (Ernest et *al.* 1989). As of June 1, 1992, three more had been captured. All were released unharmed (E. Martin, pers. comm.). Another threat is the illegal use of explosives for fishing. This fishing method is frequently used off the southeastern coast of Puerto Rico and has caused the destruction of coral reef habitat (B. Pinto, pers. comm.).

CONSERVATION ACCOMPLISHMENTS

The most important hawksbill conservation achievement in recent years was Japan's decision to end import of hawksbill shell by 1993 and to drop its CITES reservations on sea turtles by July 1, 1994. Because Japan is the largest importer of stuffed hawksbills and hawksbill shells in the world, this decision should significantly diminish the future demand for the species.

The two most important hawksbill nesting beaches in the United States Caribbean are now fully protected. BIRNM, St. Croix, USVI, became part of the NPS in 1962. Mona Island, Puerto Rico, was established as a Natural Reserve under the protection of the PRDNR in 1980. In addition, Isla Culebrita was transferred to Culebra NWR in 1982. Sandy Point NWR (a 2.4-km beach at Sandy Point, St. Croix) was established in 1984.

Several government agencies have implemented regulatory measures that increase protection for sea turtles. On December 3 1, 1987, the U.S. ratified Optional Annex V of the International Convention for the Prevention of Pollution from Ships, also known as the MARPOL Protocol. Annex V prohibits the dumping of all plastic wastes, including plastic packaging materials and fishing gear, from all ships at sea. It is now illegal for any ship of any size to dump plastic trash in the oceans, bays, rivers, and other navigable waters of the U.S. (O'Hara *et al.'* 1988).

In the early 1980's, fishery regulations were amended in Puerto Rico to ban nets with greater than 4-inch mesh. In 1985, regulations allowing fines of up to $5,000 were passed to aid the management and regulation of endangered species in Puerto Rico. Although USVI has no restrictions on net mesh size, the capture of marine turtles is illegal and fishing with set nets has virtually ceased.

In the USVI, the Coastal Zone Management Commissions have imposed lighting and monitoring restrictions on projects being built adjacent to nesting beaches (C. Ehle-Jewet, pers. comm.). In 1986, it became illegal to drive vehicles or ride horses on beaches in the USVI.

In 1988, the NPS initiated a study of the hawksbill nesting population at BIRNM to monitor long-term trends. In 1991, the FWS collaborated with the NPS in a study of hawksbill post-nesting migrations and movements at BIRNM. In 1991, the NPS also used radio and sonic telemetry to study internesting movements, and the NPS initiated nesting surveys of hawksbill beaches on St. John, USVI.

Since 1986, a nesting-behavior study has been conducted at Humacao under the auspices of PRDNR. A similar study has been initiated on Caja del Muertos. Since 1990, with USN support, PRDNR has been tagging hawksbills on Vieques.

Since 1981, VIDFW has conducted a hawksbill tag and recapture program off St. Thomas., In 1985, this work was extended to St. John and, in 1987, to Culebra in cooperation with the Caribbean Islands NWR. This program has provided information on growth rates, foraging behavior, and movement of turtles.

Between 1980 and 1985, FWS and NPS attempted to eradicate the mongoose from BIRNM. On Mona Island, fences have been erected on several nesting beaches to protect nests from. hogs.

Actions have been taken to reduce the causes of coral reef destruction. The VINP has begun installing mooring buoys in park waters to reduce damage from anchoring. In 1989, the park prohibited anchoring by boats more than 225 feet long and restricted anchoring by boats measuring 150 to 225 feet to less sensitive areas in Francis Bay. The *M/V A. Regina,* which grounded on a reef at Mona Island in 1988, was removed in 1990, and a 1.5-million-dollar trust fund was set up to monitor long-term effects.

A substantial effort is being made by government and non-government agencies and private: individuals to increase public awareness of sea turtle conservation issues. Federal and State agencies and private conservation organizations, such as the Center for Marine Conservation, Greenpeace, and National Audubon Society, have produced and distributed a variety of audio-visual aids and printed materials about sea turtles. These include a booklet on the various types of light fixtures and ways of screening lights to lessen their effects on hatchlings (Raymond 1984b), the brochure "Attention Beach Users, " "Lights Out" bumper stickers and decals, a coloring book, video tapes, slide and tape programs, full-color identification posters of the eight species of sea turtles, and a hawksbill poster. Florida Power and Light Company has also produced a booklet (Van Meter 1992) containing general information on sea turtles.

In the USVI, the St. Croix Environmental Association, the University of the Vi&in Islands Extension Service, the VIDFW, FWS, and NPS are actively involved in circulating newsletters and information packages and in presenting slide shows and seminars. EARTHWATCH has supported projects in Puerto Rico and in the USVI. Projects on Sandy Point NWR, St. Croix, and Culebra, Puerto Rico, have brought attention to sea turtle conservation and have generated local involvement and awareness. In both locations, the general public has become aware of the problems facing the species and has developed a protectionist attitude, a sharp contrast to the previous attitude of exploitation.

In the USVI, school children are being introduced to the problems that sea turtles face and to how people can help them. Problems associated with plastics in the ocean have also been brought to the public's attention via news releases, public service announcements, and television programs. In Puerto Rico, presentations on sea turtle biology are made at school levels from kindergarten to college. Projects on the east coast of Puerto Rico and in Culebra have involved many segments of the community, including volunteers, the Chelonia Society, Boy Scouts, 4-H groups, and various other clubs.

PART II. RECOVERY

A. Recovery Objectives

Hawksbill turtles within U.S. jurisdiction in the Caribbean Sea, Atlantic. Ocean, and Gulf of Mexico can be considered for delisting if, within 25 years, the following conditions are met:

(1) The adult female population shows a sustained increase, measured by a sustained and statistically significant increase in the annual number of nests on at least five index beaches, including Mona Island, Puerto Rico, and BIRNM, USVI.

(2) Nesting habitat for at least 50 percent of the nests in Puerto Rico and the USVI is protected in perpetuity.

(3) The adult, subadult, and juvenile populations show a sustained increase, measured by a sustained and statistically significant increase in adults, subadults, and juveniles using at least five key foraging areas in Puerto Rico, USVI, and Florida.

(4) All priority one tasks have been successfully implemented.

B. Step-down Outline and Narrative

1. Protect and manage habitats.

11. Protect and manage nesting habitat.

Coastal development has already destroyed or degraded many miles of nesting habitat in Puerto Rico and the USVI. Because of their cumulative impact, development pressures will eventually lead to a significant population decline.

111. Identify important nesting beaches.

BIRNM, USVI, and Mona Island, Puerto Rico, are the two most important hawksbill nesting beaches currently known within United States jurisdiction in the Caribbean Sea. A total of 150 to 250 nests are constructed annually on these two islands. Because of the hawksbill's proclivity for nesting within the vegetation adjacent to small isolated beaches, significant unreported or undetected additional nesting may also occur on other beaches in Puerto Rico, USVI, and the Florida Keys. FDEP, PRDNR, VIDFW, and FWS should initiate comprehensive nesting surveys of all potential nesting areas to identify hawksbill nesting beaches and to assess their relative importance. Historically important hawksbill nesting beaches should also be identified.

112. Ensure the long-term protection of important nesting beaches.

The long-term protection of nesting habitat on Mona Island (Commonwealth Natural Reserve), Puerto Rico, and on BIRNM (NPS National Monument), USVI, is assured. Most beaches on St. John, USVI, are also protected as part of the VINP. Elsewhere, coastal development is a threat to nesting habitat throughout the hawksbill's nesting range. As important nesting beaches are identified (Task 111), FDEP, PRDNR, VIDPNR, and FWS should acquire or otherwise ensure their long-term protection.

113. Develop beach-landscaping guidelines and evaluate effects as appropriate.

Construction of stone walls, a common landscape practice, can create barriers to nesting habitat. Altering coastline vegetation can affect hatching success and hatchling sex ratios. Exotic plant species that have undesirable characteristics relative to sea turtle conservation needs are often planted. Extensive or exposed root systems can prevent turtles from digging nests or may entrap nesting females. Removal of vegetation for landscaping can exacerbate the loss of sand by promoting wind erosion. FWS, VIDPNR, and PRDNR should develop beach-landscaping guidelines that recommend the use of native species and proper placement of stonewalls to avoid degrading nesting habitat.

114. Prevent the degradation of nesting habitat caused by seawalls, revetments, sand bags, other erosion-control measures, jetties, and breakwaters.

Seawalls, revetments, and sand bags have already destroyed or degraded many miles of nesting habitat along the United State's southeastern Atlantic coast and in some regions of Puerto Rico. However, legal and illegal beach armoring still occurs. Filling and burying of long plastic bags to protect coastal property is common in Florida and has occurred in other states. These buried bags are hard and exacerbate erosion when they are uncovered by storms, and they prevent nesting when uncovered or when buried too close to the surface. Jetties and breakwaters alter sand transport and can cause severe erosion of adjacent beaches.

Regulations prohibiting or discouraging some types of beach armoring exist in Florida. FDEP, PRDNR, and VIDPNR should review current state regulations related to beach construction and ensure that seawalls, revetments, sandbags, and other armoring measures contributing to the degradation of nesting habitat are prohibited. COE and FWS should ensure that proposed jetties or breakwaters are not permitted if they will result in the degradation of hawksbill nesting habitat.

115. Ensure that beach-nourishment projects are compatible with maintaining good-quality nesting habitat.

Depositing poor quality material on nesting beaches can result in compaction of sand. Compacted sand can cause an increased number of non-nest crawls and aberrant nests, increased digging times for nesting females and, in some cases, broken eggs from clutches deposited in egg chambers that are too shallow. Gas diffusion can be affected by sand-grain shape and size, as well as by beach compaction, and can alter egg hatching success. Sand color and moisture influence temperature and can affect hatchling sex determination. Beach nourishment should occur only outside of sea turtle nesting season. COE, FWS, FDEP, VIDPNR, and PRDNR should ensure that nourishment projects only use material similar to that of the local beaches. If beach compaction exceeds that of natural local beaches, tilling should be employed prior to the nesting season to soften the nourished beaches.

116. Eliminate sand-mining practices on nesting beaches.

Legal and illegal sand mining and construction in Puerto Rico and the USVI are major contributors to beach degradation. PRDNR and VIDPNR should take the necessary measures to enact, enforce, and monitor appropriate sand-mining and coastal-construction regulations. Regulations should establish appropriate setbacks for developments or, where appropriate, should require walkways to protect the integrity of sand dunes and littoral vegetation.

12. Protect marine habitat, including foraging habitats.

Hawksbills inhabit coastal waters, particularly those with well-developed reefs. Reefs have been abused and degraded. Among the contributing factors are coastal development and industrialization, increased commercial and recreational vessel activities (including anchoring), open-ocean dumping of contaminants, river and estuarine pollution, channelization, offshore oil development, and commercial fishing activities. If present trends continue, the cumulative loss of suitable habitat will reduce the likelihood that the species can recover.

121. Identify important marine habitats.

Hawksbills larger than about 22 cm straight carapace length are known to feed principally on sponges associated with coral reefs and other hard-bottom habitats, but information on the location of specific foraging areas is extremely limited. These areas need to be: identified. The habitat requirements of smaller hawksbills need to be identified. PRDNR, VIDFW, NMFS, FWS, FDEP, and other interested resource agencies should support this research.

122. Ensure the long-term protection of marine habitat.

Key hawksbill foraging habitats should be protected by designating them as National Marine Sanctuaries or as State, territorial or commonwealth aquatic preserves or sanctuaries. NMFS, NPS, FDEP, VIDPNR, and PRDNR should ensure that existing sanctuaries or aquatic preserves provide the appropriate level of protection for hawksbill foraging habitat and that newly identified foraging habitats are nominated and established as national parks, sanctuaries, or aquatic preserves.

123. Prevent the degradation or destruction of marine habitats caused by boat groundings and anchoring.

Boats anchoring or striking reefs cause long-term damage. Reefs grow slowly and it takes a long time for recovery. The reefs habitat potential is decreased by boating activities that disrupt the food web associated with coral-reef habitats. Reef areas in the vicinity of bays are particularly susceptible to recreational boat accidents. To ensure the long-term protection of coral reefs, PRDNR, VIDPNR, FDEP, NMFS, and NPS should evaluate the potential loss of habitat from these boating activities and take the appropriate actions (including removal of grounded vessels and installation of moorings).

124. Assess **the long-term effects that vessel groundings have upon foraging habitats.**

Wave action causes' grounded vessels to rock and gradually crush reefs surrounding the vessel. The sediment generated detrimentally affects adjacent reefs. Because recovery of coral reefs is a long-term process, PRDNR, VIDFW, NMFS, and FWS should monitor the extent of damage associated with grounded vessels.

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

Dredging projects may have greater impacts on habitat than the obvious mechanical destruction. Dredging and disposal of silt, clay, or other materials generate enormous amounts of suspended sediments that may severely damage adjacent corals and seagrasses. Additionally, the disposal of dredged materials in offshore disposal sites usually smothers existing flora and fauna. The COE, EPA, and VIDPNR should carefully consider the environmental consequences before permitting any new dredging projects or designating new offshore disposal sites.

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

The adverse effects of coastal construction, upland erosion, and siltation on coral reefs are well documented. These problems disrupt vital trophic processes and reduce productivity and species diversity. The regulatory agencies must ensure that established minimum water quality standards are enforced. Land-use decisions and associated projects should be carefully considered by local governments, States, territories, NMFS, FWS, EPA, COE, and other regulatory and permitting agencies.

127. Prevent the degradation of reef **habitat caused** by sewage and **other pollutants.**

Increased industrial and urban development in the Florida Keys and the Caribbean is creating problems concerning the disposal of industrial wastes and sewage. Large amounts of industrial waste is being dumped offshore, and sewage is being pumped offshore through pipelines. Similarly, upstream water-treatment plants could compound this problem if operational standards are not maintained. This contamination can directly and indirectly (by decreasing water quality) affect the health of reefs. Caribbean reef habitats have already been damaged by siltation and sewage. EPA, PRDNR, VIDPNR, FWS, and NMFS should take the appropriate measures to ensure that water-quality standards are enforced.

128. Prevent **the degradation of reef habitat caused by oil exploration, development, refinement, and transshipment activities.**

Oil-refinery activities along the coasts of Puerto Rico, the USVI, and the Gulf of Mexico threaten habitats with vessel traffic, pumping bilges, marine pollution, and spills, including those associated with transferring oil from tankers to onshore facilities. Oil exploration and development activities planned for the northern coast of Puerto Rico and in the Gulf of Mexico may degrade sea turtle habitats. Of particular concern are the effects of oil spills, drilling, mud disposal, disposal of other toxic materials, pipeline networks associated with oil fields, onshore production facilities, increased vessel traffic, domestic garbage disposal, and explosive removal of obsolete platforms. PRDNR, VIDPNR, FDEP, MMS, COE, FWS, and the oil and gas industry should take appropriate actions to ensure that known sources of pollution and toxic-waste disposal are eliminated. Additional precautions are needed to prevent oil spills. Oil Spill Response Teams to deal with spills should be supported. The teams should be familiar with important, sea turtle nesting and marine habitat.

129. Identify other threats to marine habitat and take appropriate! actions.

Coral reefs and associated coastal habitats may be subject to other threats that would render them unsuitable for supporting hawksbill populations. For example, the numbers of recreational divers illegally harvesting coral and "live rock" are increasing. Reefs are also indirectly affected by chemicals used to capture fish for the aquarium trade. In Florida, a large commercial trade has developed to provide "live rock" for aquaria. PRDNR, VIDPNR, FDEP, FWS, NMFS, and other appropriate agencies should be vigilant of the general status of coastal habitats so that they can immediately identify threats and take appropriate actions.

2. **Protect and manage populations.**

21. Protect and manage turtles on nesting beaches.

Predators, poaching, tidal inundation, artificial lighting, catastrophic events, and human activities on nesting beaches diminish reproductive success. Monitoring of nesting activities is necessary to evaluate the effectiveness of appropriate nest-protection measures and to determine trends in the nesting population.

211. Monitor nesting activity on important nesting beaches with standardized index surveys.

With the exception of BIRNM, hawksbill nesting surveys are not conducted on a regular basis. Also, the frequency with which surveys are made, the experience and training of surveyors, and the methods of reporting data are inconsistent. Consequently, regionwide population trends cannot be determined. FWS, PRDNR, VIDFW, and NPS should develop a standardized nest-survey method. At least five index beaches should be monitored.

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

Nesting and hatching success on beaches located on State, territorial, commonwealth, or Federal lands, or other important nesting beaches, should be evaluated. Appropriate nest-protection measures should be implemented by FWS, NPS, FDEP, PRDNR:, and VIDFW to ensure at least an average **75** percent hatch rate. Efforts should be to reduce the effects of tidal inundation, beach erosion, predation, vehicle and foot traffic, and catastrophic events on hatching success. Efforts to combat hog predation on Mona Island should be continued and expanded. The least manipulative: method to enhance nest success should be employed to avoid interfering with known or unknown natural biological processes. **In the case of beach erosion and frequent tidal erosion, there is no alternative but to relocate nests to higher and safer beach zones. Artificial incubation should be avoided. Hatcheries, or individual. nest screens or fences, should allow hatchlings to escape the night of hatching. Nest-protection efforts on Mona Island and BIRNM should strive for the highest possible hatching success.**

213. Reduce effects of artificial lighting on hatchlings and nesting **females.**

Upon emerging from the nest, hatchlings may be disoriented or misoriented by artificial lights along the beach and mortality may result. Recent studies of loggerheads and green turtles have demonstrated that artificial lights significantly deter nesting activities.

2131. Determine effects of artificial lighting on hatchlings and nesting females.

Lighting from coastal development could be misorienting or disorienting hatchlings and could be lessening their chances for survival. Most research has been done on loggerheads and green turtles. Investigations of lighting effects on nesting and hatchling hawksbills should be supported by FWS, PRDNR, and VIDFW.

2132. Implement, enforce, and evaluate lighting regulations or other lighting control'measures where appropriate.

In areas where lighting regulations have been adopted **and** enforced, hatchling disorientation has been reduced. All coastal counties and communities with nesting **beaches** should adopt ordinances that are in effect from August through February. Prevailing coastal-development trends represent an ever-increasing threat to nesting areas in Puerto Rico and the USVI. FWS and NMFS should encourage and provide necessary technical information to commonwealth and territorial resource agencies so that appropriate lighting regulations can be enacted.

2133. Enforce "take" provisions of Endangered Species Act of 1973 relative to hatchling disorientation.

Federal lighting regulations promulgated under the authority of the Endangered Species Act may be required to ensure recovery of the species.

214. Ensure that law-enforcement activities prevent the illegal exploitation and harassment of sea turtles.

Illegal exploitation can be a significant source of mortality for sea turtles in most life stages. Also, harassment can adversely affect nesting females and cause a reduction in nesting activity and increased likelihood that nesting females will be displaced to unsuitable beaches. FWS should work closely with PRDNR, VIDPNR, NMFS, and NPS to intensify law-enforcement efforts to curb the incidence of poaching and harassment. FWS and NMFS should increase their law enforcement staff by at least two special agents for each agency in both the USVI and Puerto Rico. Efforts should be taken by NMFS and FWS personnel to better inform and educate judges and Federal prosecutors about the seriousness of the illegal exploitation of hawksbills.

215. Determine the natural sex ratios of hatchlings.

Incubation temperature determines the sex of hatchling sea turtles. Sex ratios of hatchlings on beaches throughout the nesting range should be determined (without sacrificing hatchlings) over several years for comparison with the sex ratios being produced by nest relocation programs. FWS, PRDNR, and VIDFW should support the studies. Transects should be established to monitor the natural temperature regimes on appropriate nesting beaches. A standardized protocol for temperature monitoring should be developed by the FWS, commonwealth, or territorial resource agencies and should be adopted when nests are relocated.

216. Determine the genetic relationships among Caribbean hawksbill nesting populations.

The extent of migration and genetic mixing among nesting populations is unknown. Information on the genetic relationships among Caribbean populations is essential for maintaining genetic diversity, evaluating recovery objectives, and assessing the viability of hawksbill populations.

217. Determine nesting beach origins for juvenile and subadult populations.

To determine the beaches where hawksbills are and are not successful in producing hatchlings, we need to know the "home" beach of wild juvenile and subadult hawksbills. This information will be important if turtles among nesting beaches differ in behavior or ranges. Recent genetic research using mtDNA analyses to assess genetic structure of other species of sea turtles indicates that this approach may provide the necessary data. FWS, NMFS, FDEP, PRDNR, and VIDFW should support this research.

218. Ensure that coastal construction activities are designed to avoid disruption of nesting and hatching activities.

Coastal construction can significantly disrupt nesting activities. Relocating nests reduces hatching-success rates and alters hatchling sex ratios. The COE, FWS, and appropriate State, commonwealth, or territorial agencies should ensure that beach construction activities are not permitted during the peak of the nesting season (July through October) on key nesting beaches.

219. Implement nonmechanized beach-cleaning alternatives.

The adverse effects of mechanized beach-cleaning include sand compaction, alteration of nest site microenvironment, and hatchling mortality prior to emergence. The PRDNR, FDEP, and VIDPNR should prohibit mechanized beach-cleaning practices on key nesting areas.

22. Protect and manage hawksbill populations in the marine environment.

To adequately protect and enhance the survival of hawksbills, we need to know the abundance and spatial and temporal distribution of hawksbills in the marine environment. We need to identify sources of mortality. As sources of mortality are identified, steps can be taken to reduce or eliminate their effects on populations.

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

To recover the hawksbill, it is critical for resource managers to know when, where, and in what abundance hawksbills may occur during the various stages of their life cycles.

2211. Determine the distribution and abundance of posthatchlings, juveniles, and adults.

Although hawksbills are principally reef dwellers, little is known about their distribution and numbers, and the habitat features that influence these spatial and demographic patterns. The first step is to design a survey protocol for hawksbills in marine habitats. The conclusion is to obtain valid data for a long period of time. FWS, FDEP, PRDNR, and VIDFW should support development of the survey protocol and the subsequent abundance assessments.

2212. Determine adult migration routes and internesting movements.

Researchers have studied nesting migrations by tagging turtles on nesting and subsequent tag returns. Hawksbills have been not been tagged as extensively as other species because of their diffuse nesting distribution. Movements of adult males, which may or may not have the same migratory behavior as the females, have not been studied. Satellite telemetry may be used to study hawksbill movements. Research should first study whether attachment of satellite tags alters hawksbill behavior. Once it is proven that the tags do not alter hawksbill's natural behavior, then NMFS, FWS, PRDNR, VIDFW, and other interested resource agencies should support well designed research.

2213. **Determine growth rates and survivorship of hatchlings, juveniles, and adults, and age at sexual maturity.**

Information on survivorship rates is essential to conservation of sea turtles. Research results have shown that sea turtle population demographics are sensitive to low survival rates during juvenile, subadult, and adult life stages. Estimating survival rates requires knowledge of natural growth rates, sex ratios, and age at sexual maturity. The most recently developed techniques to determine sex and reproductive physiology need to be used. FWS, NPS, NMFS, FDEP, PRDNR, and VIDFW should support this needed research.

2214. Identify the present or potential threats to adults and juveniles on **foraging grounds.**

Threats to hawksbills in reef habitats are not well known, primarily because there is little information on hawksbill. movement patterns and distribution. **As** important foraging habitats are identified, threats must be assessed to ensure that hawksbills are protected. **MMFS, FWS,** and other State, commonwealth, or territorial resource agencies should study hawksbill abundance, distribution, and identify threats to the species.

222. Monitor and reduce incidental mortality in the commercial and recreational fisheries.

Hawksbills are incidentally taken by several commercial and recreational fisheries. Fisheries known or suspected to incidentally capture hawksbills include those using gill nets, traps, driftnets, hooks, beach seines, spear guns, and nooses. PRDA, PRDNR, VIDFW, FDEP, NMFS, and FWS should quantify the extent of the incidental mortality and take the appropriate actions to limit incidental take.

223. Reduce the effects of entanglement and ingestion of marine debris.

The problems of marine animals ingesting debris (plastic, latex products, tar balls, and Styrofoam) and entangling in marine debris have received considerable attention in recent years. Post-hatchling sea turtles are particularly vulnerable to ingestion of persistent materials. Entanglement in nets, ropes, and monofilament lines is a source of mortality for sea turtles in all life history stages.

2231. **Evaluate the extent to which sea turtles ingest persistent debris.**

Limited information is available on the frequency with which sea turtles become entangled in or ingest debris. Stranding data and necropsies have shown that hawksbills have died from ingested debris. Stranded turtles have been found entangled in lost or discarded netting, monofilament lines, and ropes. NMFS, FWS, PRDNR, VIDFW, EPA, and the southeastern coastal States should increase efforts to document cases of entanglement and ingestion, the extent of marine debris, the sources of the debris, and the impacts of these materials on hawksbill turtles in various life stages.

2232. **Evaluate the effects** of ingestion **of persistent debris on, health and viability of sea turtles.**

Turtles that do not die after ingesting plastics, hydrocarbons, or other toxic substances are often debilitated. Hatchiings are believed to congregate in areas, such as driftlines, where debris concentrate. Research should evaluate the effects of ingesting debris, particularly for hatchlings during early life stages. **NMFS,** MMS, and EPA should fund the needed research.

2233. **Formulate and implement measures to reduce or eliminate persistent debris in the marine environment.**

Debris may originate **from land** or sea, primarily through careless disposal of nonbiodegradable refuse. Sources of these materials are transport vessels, cruiseships, military vessels, commercial and recreational fishermen, oil and gas platforms, beachgoers, and even dumping in inland creeks, streams, and rivers. To eliminate the problem, the public, military, and businesses involved (e.g., cruiselines, petroleum companies) must be educated about the long-term consequences of using the oceans and inland waters as garbage dumps. Point sources of pollution must be identified and **eliminated by** EPA, Coast Guard, State agencies, or qther Federal agencies. Appropriate agencies should vigorously enforce MARPOL and state regulations PRDNR, FDEP, VIDFW, and NMFS should promulgate regulations **prohibiting** the abandonment of fishing gear and should **impose severe penalties**.

224. **Maintain carcass stranding network.**

Volunteers and contract personnel survey many beaches for stranded sea turtles. Stranding data from the sea turtle stranding and salvage network are **received** and summarized by **the** NMFS Miami Laboratory. These data provide an index of sea turtle mortality and basic biological information. To ensure comprehensive coverage, NMFS, FWS, PRDNR, and VIDFW should support the stranding surveys in Puerto Rico and USVI.

225. Increase **law-enforcement efforts to reduce illegal exploitation.**

Illegal fishing for sea turtles is believed to be a reason for the decline of hawksbill populations. These activities are prevalent in waters near Puerto Rico and are notoriously common near MOM Island and Cayo Berberia in southern Puerto Rico. **PRDNR, VIDFW,** NMFS, and FWS should increase law-enforcement efforts to arrest and prosecute fishermen taking sea turtles. Enforcement actions must include the illegal commerce in hawksbill jewelry and curios.

226. Centralize administration and coordination of tagging programs.

Sea turtle researchers **commonly tag** turtles encountered during their research projects and usually maintain independent tagging data bases. As a result, data is lost or information transfer is slow. **A** central data base should be established. A condition of the required Federal permits should stipulate that the central database will be used. NMFS and FWS should fund and maintain the data base.

2261. Centralize tag-series records.

A centralized tag-series data base is needed to ensure that recaptured tagged turtles are promptly reported to the person who initially tagged the animal. The tag-series data base would include a list of all tags that have been placed on wild sea turtles and the name and address of the researcher. NMFS and FWS should establish and maintain the data base.

227. **Ensure proper care of sea turtles in captivity.**

Hawksbills are maintained in captivity for rehabilitation or research. Proper care will ensure that the maximum number of rehabilitated1 turtles are returned to the wild and that a minimum number are retained for research.

2271. Develop standards for the care and maintenance of sea turtles, including diet, water quality, tank s&e, and treatment of injury and disease.

None of these requirements have been scientifically evaluated to determine the best captive conditions for hawksbills. PRDNR, VIDFW, FWS, and NMFS should support the necessary research to develop the criteria. These criteria should be published, and permit-holders should be required to meet these criteria. PRDNR, VIDFW, FDEP, **FWS,** and NMFS should regularly inspect permitted facilities for compliance with permit requirements. FWS and NMFS should publish a manual on the diagnosis and treatment of diseases of captive sea turtles. This manual should also include treatment for common injuries.

2272. **Establish a catalog of all captive sea turtles to enhance use for research and education.**

Sea turtles are currently being held in captivity at over 50 facilities. To diminish the need for removing additional specimens from the wild, the FWS and NMFS should ensure that captive specimens are conserved.

2273. **Designate rehabilitation facilities.**

FWS and NMFS, in coordination with the appropriate State, commonwealth or territorial agencies, should designate rehabilitation facilities. Designation should be based on **the** availability of veterinary personnel with expertise in reptilian care and on the institution's ability to comply with the care and maintenance standards developed in step **2271** above. Prior to its designation as a rehabilitation facility, each facility should be inspected by a team that includes NMFS, FWS and appropriate State, commonwealth or territorial resource agencies. Inspections should be conducted at least annually thereafter.

3. Public information and education.

Sea turtle conservation requires long-term public support over a large geographic area. The public must be informed of the issues and facts, particularly when conservation measures conflict with human activities such as commercial fisheries, beach development, and public use of nesting beaches. Public education **is** the foundation upon which a long-term conservation program will ultimately succeed or fail.

31. **Develop and provide slide programs and information leaflets on sea turtle conservation for the general public and for special-interest groups.**

The FWS has developed a bilingual slide and tape program on sea turtle conservation. The FWS should update the program, create a videofilm version, and make the presentation available to relevant public institutions. The FWS, State, commonwealth, and territorial resource agencies should continually develop, update, and supply the public (especially groups such as resort and beach managers, recreational divers, architects, developers, the fishing industry, and schools) with informational brochures on sea turtle ecology and conservation. A brochure should be written specifically to inform travelers about the effects the tortoiseshell trade has on hawksbills and request that they do not buy stuffed turtles or jewelry made from shell. This pamphlet should be distributed by travel agencies which sell trips to the Caribbean, and by cruise ships traveling in the Caribbean.

32. **Develop a brochure with recommendations concerning beachfront lighting.**

Lighting ordinances require that lights be shut off or modified to prevent direct lighting of the nesting beach. However, it is not always clear what types of light, screening, or shading work best. The FWS, NMFS, and state, commonwealth or territorial resource agencies should jointly develop and publish a brochure or booklet with up-to-date recommendations about lighting fixtures, lights, shading modifications, etc.

33. **Develop public-service announcements regarding sea turtle nesting, artificial-lighting problems, entanglement, and waste disposal.**

Professionally produced public-service announcements on radio and TV would promote awareness of the importance of coastal-lighting ordinances and recommendations concerning disposal of waste and debris. Public-service announcements would generate greater support through understanding. The FWS, State, commonwealth, and territorial resource agencies should develop high-quality public-service announcements that could be used throughout the United States Caribbean.

34. **Ensure that facilities permitted to hold and display captive sea turtles have appropriate informational displays.**

Over 50 facilities are permitted to hold sea turtles for rehabilitation, research, and public education. These provide valuable opportunities for public education. Dissemination of accurate information on basic biology of sea turtles and conservation threats should be required of all permittees. All facilities should be visited by FWS, NMFS, PRDNR, FDEP, and VIDFW to ensure compliance.

35. Develop informational displays at international airports in Miami, Dallas, San Juan, and the U.S. Virgin Islands.

Airports in New York, Miami, Dallas, San Juan, and the USVI handle a significant portion of travelers originating from countries in the Caribbean basin and South America, where restrictions on possession of endangered sea turtles are not enforced or do not exist. Informational displays are popular with the public and provide tremendous opportunities for public education. PRDNR, VIDFW, NMFS, the U.S. Customs Service, and FWS should develop the informational displays that convey sea turtle conservation messages. Placement of displays should be coordinated with airport and customs officials to ensure the displays are visible to the greatest number of travelers.

36. Post informal signs at public-access points on important nesting beaches.

Public-access points along important nesting beaches provide excellent opportunities to provide the public with guidelines for compatible public use of the nesting beach, and to develop public support. FDEP, FWS, NPS, PRDNR, and VIDFW should develop and post educational and informational signs on important nesting beaches.

37. Develop criteria and recommendations for public participation in sea turtle recovery and research activities.

Public participation in research and recovery activities can be an effective educational tool. Criteria must be developed by FWS, NMFS, State, commonwealth, and territorial resources agencies to permit such participation. Criteria should address group size, frequency of visitation, and nature of participation.

4. International Cooperation

41. Ratify Protocol to Cartagena Convention concerning specially protected areas and wildlife.

Parties to the Convention for the Protection and Development of the Marine Environment of the Wider Caribbean (Cartagena Convention) adopted the Protocol for Specially Protected Areas and Wildlife in January 1990. Annex II prohibits the taking, possession, killing, or commercial trade in certain species, their eggs, parts, or products. All six sea turtle species in the wider Caribbean are included under Annex II. Annex II prohibits the disturbance of the species, particularly during periods of breeding, incubation, aestivation or migration, as well as during other periods of biological stress. Ratification by the 19 parties to the Convention will implement the provisions of the Protocol within the member countries (however, the parties have the option of entering reservations within 90 days). The Protocol could provide: increased protection of sea turtles within many of the member countries. The **FWS** and NMFS should work with the State Department to encourage ratification by the U.S. and other western Atlantic countries.

42. Foster CITES **memberships of all non-member Caribbean countries, compliance with CITES requirements, and removal of sea turtle trade reservations of member nations.**

The most important factor endangering hawksbill populations is **international** commerce in tortoiseshell. The CITES is a comprehensive wildlife treaty signed by over 110 countries, including the U.S., that regulates, and in some cases prohibits, commercial import and export of wild animal and plant species that are threatened by trade. Of the 28 countries within the wider Caribbean, and in the potential foraging range of hawksbill nesting populations that are in U.S. jurisdiction, 21 are signatories of CITES. Of the Caribbean signatories, Cuba, St. Vincent, and the Grenadines have reservations allowing them to legally continue international trade in hawksbill products. Japan is the single largest importer of hawksbill products and about half of their imports come from the wider Caribbean. Between 1970 and 1989, Japan imported 368,318 kg of bekko from the wider Caribbean alone, which is the equivalent of more than a quarter of a million turtles. Japan, a signatory of CITES, also holds reservations on the hawksbill, although it has agreed to give up these reservations by July 1, 1994. Cuba is Japan's major legal source **of** hawksbill shell. The State Department and Department of Interior should actively work with the wider Caribbean nations to encourage CITES membership of nonmember nations, the removal of sea turtle trade reservations, and compliance with CITES requirements.

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

Hawksbills sometimes make long-distance migrations. Foraging grounds **for** adults, juveniles, and subadults of U.S. hawksbills are largely unknown. Therefore, the long-term preservation of these populations will not be accomplished by protection in areas under U.S. jurisdiction alone. Ultimately, a comprehensive hawksbill conservation plan will have to encompass essential habitats outside of the U.S. Once these habitats and conservation strategies are identified, the **NMFS** and FWS should develop cooperative international agreements and programs with the appropriate foreign governments.

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III. IMPLEMENTATION SCHEDULE

Priorities in column 4 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.

GENERAL CATEGORIES FOR IMPLEMENTATION SCHEDULES

Information Gathering - I or R (research)

1. Population status
2. Habitat status
3. Habitat requirements
4. Management techniques
5. Taxonomic studies
6. Demographic studies
7. Propagation
8. Migration
9. Predation
10. Competition
11. Disease
12. Environmental contaminant
13. Reintroduction
14. Other information

Management - M

1. Propagation
2. Reintroduction
3. Habitat maintenance and manipulation
4. Predator and competitor control
5. Depredation control
6. Disease control
7. Other management

Acquisition - A

1. Lease
2. Easement
3. Exchange
4. Withdrawal
5. Fee title
6. Other

Other - 0

. Information and education
. Law enforcement
. Regulations
. Administration

IMPLEMENTATION SCHEDULE

Hawksbill Turtle (Recovery Priority Number 1)

General Category	Plan Task	Task Number	Priority	Task Duration	Responsible Agency	Estimated Fiscal Year Costs: Current	FY 2	FY 3	FY 4	FY 5	Comments/Notes
R - 2	Assess long-term impacts from vessel grounding.	124	3	Continuing	NMFS, FWS, PRDNR						Routine
M-3	Prevent degradation of marine habitats from dredging or disposal.	125	2	Continuing	COE, NMFS, PRDNR, VIDPNR						
M-3, O-3	Prevent degradation of marine habitats from upland erosion and siltation.	126	1	Continuing	PRDNR, VIDFW, Fws, EPA, SCS						
M-3	Prevent degradation of reef habitat from pollutants.	127	1	Continuing	NMFS, PRDNR, FDEP, VIDFW, EPA, EQB, USCG						
	Prevent degradation of reef habitat from oil refining activities.	128	3	Continuing	USCG, NMFS, PRDNR, FDEP, COE, MMS, FWS						
I-2	Identify other threats to marine habitats.	129	3	Continuing	NMFS, PRDNR, FDEP						
I-1	Monitor trends in nesting activity,	211	1		NPS PRDNR VIDFW FWS FDEP		25 15 5 10 5	25 15 5 10 5	25 15 5 10 5	25 15 5 10 5	

IMPLEMENTATION SCHEDULE

Hawksbill Turtle (**Recovery** Priority Number 1)

General Category	Plan Task	Task Number	Priority	Task Duration	Responsible Agency	Estimated Fiscal Year Costs					Comments/Notes
						Current	FY2	FY 3	FY 4	FY 5	
M-4, M-7	Evaluate nest success and implement nest protection measures.	212	1	Continuing	NPS PRDNR VIDFW FWS		5 10 5 5	5 10 5 5	5 10 5 5	5 10 5 5	
R-14	Determine effects of artificial lighting on hatchlings and nesting females.	2131	2	2 Years	FWS, PRDNR, VIDFW		15	15			
M-7, O-3, o-2	Implement, enforce, and evaluate lighting ordinances and promulgate Commonwealth and Territorial lighting regulations.	2132	2	Continuing	Puerto Rico and U.S. Virgin Islands coastal cities, PRDNR, VIDFW, Fws						Routine
o-2	Enforce Endangered Species Act.	2133	2	Continuing	FWS, NMFS						
o-2	Prevent poaching on nesting beaches.	214	1	Continuing	FWS, NMFS, PRDNR, VIDFW, FDEP						
R-6	Determine natural **hatchling** sex ratios.	215	3	3 Years	FWS				20	20	
R-1 ,**R-5**	Determine genetic relationships of Caribbean populations.	216	2	3 - 5 Years	FWS, NMFS			50	**50**	50	

IMPLEMENTATION SCHEDULE

Hawksbill Turtle (Recovery Priority Number 1)

General Category	Plan Task	Task Number	Priority	Task Duration	Responsible Agency	Estimated Fiscal Year Costs					Comments/Notes
						Current	FY 2	FY3	FY4	FY 5	
M-4, M-7	Evaluate nest success and implement nest protection measures.	212	1	Continuing	NPS PRDNR VIDFW FWS		5 10 5 5	5 10 5 5	5 10 5 5	5 10 5 5	
R-14	Determine effects of artificial lighting on hatchlings and nesting females.	2131	2	2 Years	FWS, PRDNR, VIDFW		15	15			
M-7, o-3, o-2	Implement, enforce, and evaluate lighting ordinances and promulgate Commonweatth and Territorial lighting regulations.	2132	2	Continuing	Puerto Rico and U.S. Virgin Islands coastal cities, PRDNR, VIDFW, Fws						Routine
o-2	Enforce Endangered Species Act.	2133	2	Continuing	FWS, NMFS						
o-2	Prevent poaching on nesting beaches.	214	1	Continuing	FWS, NMFS, PRDNR, VIDFW, FDEP						
R-6	Determine natural **hatchling** sex ratios.	215	3	3 Years	FWS				20	20	
R-1 ,R-5	Determine genetic relationships of Caribbean populations.	216	2	3-5 Years	FWS, NMFS			50	**50**	50	

IMPLEMENTATION SCHEDULE

Hawksbill Turtle (Recovery Priority Number 1)

General Category	Plan Task	Task Number	Priority	Task Duration	Responsible Agency	Estimated Fiscal Year Costs					Comments/Notes
						Current	FY 2	FY 3	FY 4	FY 5	
R-l, R-14, M-7	Determine nesting beach origins.	217	1	5-7 Years	FWS, NMFS, FDEP, PRDNR, VIDFW		100	loo	100	100	
M-7	Ensure coastal construction activities avoid nesting and hatching periods.	218	3	Continuing	FWS, COE, PRDNR, VIDFW, FDEP						Routine
	Implement non-mechanized beach cleaning alternatives.	219	2	Continuing	PRDNR, FDEP, VIDFW						Costs Unknown
R-14	Determine post-hatchling, juvenile, and adult distribution and abundance.	2211	2	10-15 Years	NMFS, FWS, PRDNR, VIDFW, FDEP		loo	100	100	100	Costs for all agencies
R-8, R-14	Determine migration routes and intemesting movements.	2212	2	5 Years	NMFS, FWS, PRDNR, VIDFW, FDEP		100	100	100	100	
R-l, R-14	Determine growth rates, age at sexual maturity, survivorship rates.	2213	2	10-15 Years	NMFS, FWS, VIDFW, PRDNR, FDEP		100	100	100	100	
x-14, o-3	Monitor and reduce incidental: mortality from fisheries.	222	3	Continuing	NMFS, VIDFW, PRDNR, FDEP						Routine

IMPLEMENTATION SCHEDULE

Hawksbill Turtle (Recovery Priority Number. 1)

General Category	Plan Task	Task Number	Priority	Task Duration	Responsible Agency	Estimated Fiscal Year Costs: Current	FY 2	FY 3	FY 4	FY 5	Comments/Notes
R-12, R-14	Evaluate effects from persistent marine debris.	223 1	2	Continuing	NMFS, VIDFW, PRDNR, FDEP, EPA						Routine
I-14		2232	3	3-5 Years	NMFS, VIDFW, PRDNR, FDEP, MMS, FWS		50	50	50	50	
O-3, M-7	Implement measures to reduce amount of marine debris.	2233	3	Continuing	USCG, NMFS, EPA, PRDNR, VIDFW, FDEP						
M-7	Maintain **carcass** stranding network.	224	2	Continuing	PRDNR, **VIDFW, FWS,** NMFS						
O-24	Increase law enforcement to reduce poaching.	225	1	Continuing	NMFS, FWS, PRDNR		200	**200**	200	**200**	
O-4	Centralize tag series records.	2261	3	Continuing	FWS, NMFS						Costs are identified in loggerhead **&** green turtle recovery plans.
R-14, M-7	Develop standards for captive hawksbills.	2271	3	5 Years	FWS, NMFS			20	20	20	
M-7	Establish catalog for all captive sea turtles.	2272	3	Continuing	NMFS, FWS						Routine
	Designate rehabilitation facilities.	2273	3	Continuing	NMFS, FWS						
O-1	Provide education materials.	31	2	Continuing	All		10	10	10	10	All agency costs