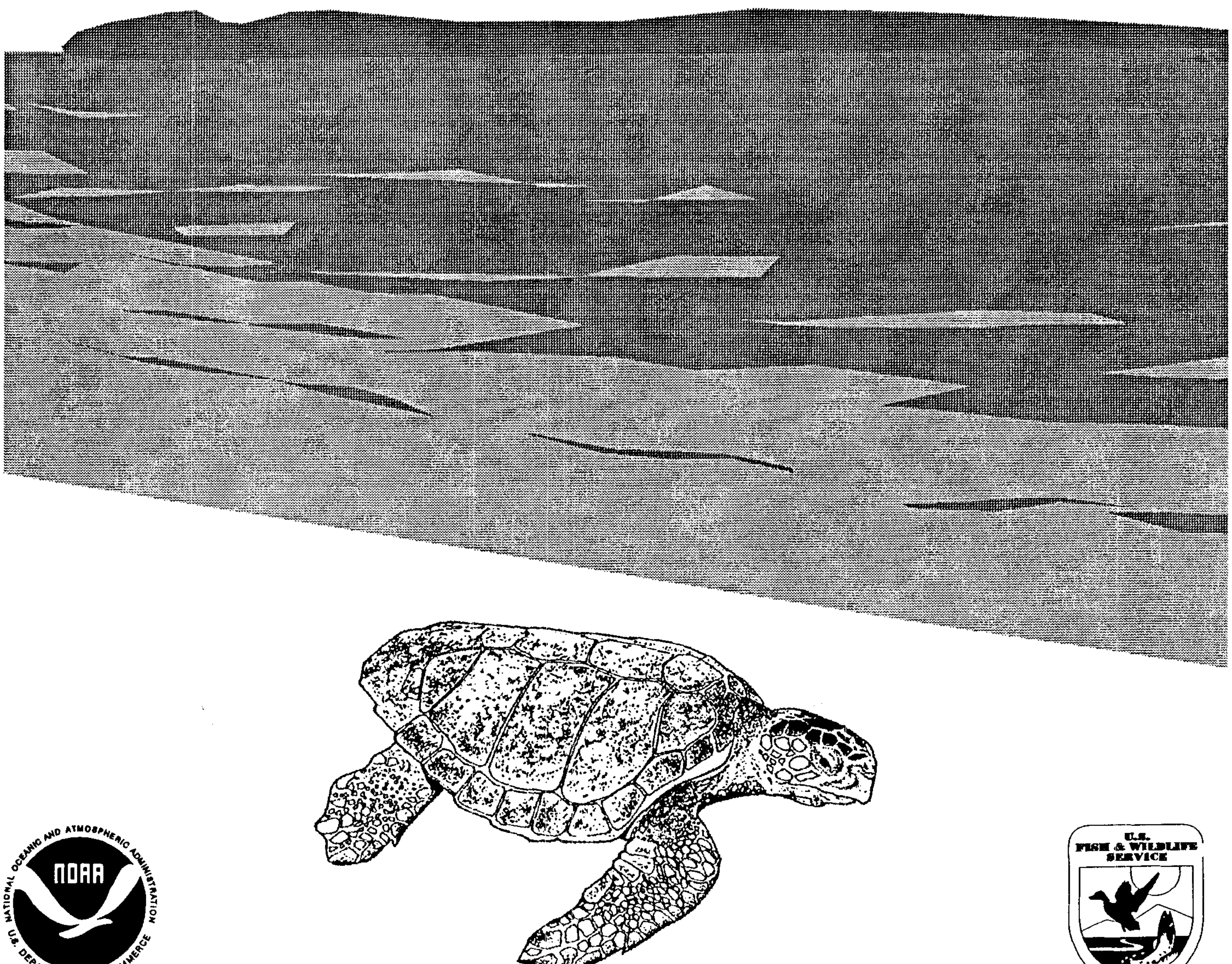
Recovery Plan for U.S. Population of

LOGGERHEAD TURTLE
Caretta caretta



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 U.S. POPULATION OF LOGGERHEAD TURTLE

(*Caretta caretta*)

Prepared by

The Loggerhead/Green Turtle Recovery Team

for

Southeast Region

U.S. Fish and Wildlife Service

Atlanta, Georgia

and

National Marine Fisheries Service

Washington, D.C.

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Approved: ______________________________
Regional Director, U.S. Fish and Wildlife Service

Date: October 31, 1991

Approved: ______________________________
Assistant Administrator for Fisheries, National Marine Fisheries Service

Date: December 26, 1991

Recovery plans delineate reasonable actions which are believed to be required to recover and/or protect the species. Plans are prepared by the U.S. Fish and Wildlife Service and National Marine Fisheries Service, and 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 nor the official positions or approvals of any individuals or agencies, other than the U.S. Fish and Wildlife Service and National Marine Fisheries Service involved in the plan formulation. They represent the official position of the U.S. Fish and Wildlife Service and National Marine Fisheries Service only after they have been signed by the Regional Director and Assistant Administrator for Fisheries, as approved. Approved recovery plans are subject to modification as dictated by new findings, changes in species status, and the completion of recovery tasks.

Literature citations should read as follows:

National Marine Fisheries Service and U.S. Fish and Wildlife Service. 1991. Recovery Plan for U.S. Population of Loggerhead Turtle. National Marine Fisheries Service, Washington, D.C.

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PREFACE

The original Recovery Plan for Marine Turtles was approved by the Assistant Administrator for Fisheries, National Marine Fisheries Service, September 19, 1984. The plan included the loggerhead (*Caretta caretta*), green turtle (*Chelonia mydas*), hawksbill (*Eretmochelys imbricata*), leatherback (*Dermochelys coriacea*), and Kemp's ridley (*Lepidochelys kempi*).

The U.S. Fish and Wildlife Service and National Marine Fisheries Service share the responsibility for sea turtle recovery under the authority of the Endangered Species Act of 1973, as amended. In an effort to better coordinate a recovery program for sea turtles, both Services recognized the need to reassess present conservation efforts and consider the new biological information available since approval of the original recovery plan. To accomplish this, the Services created a Loggerhead/Green Turtle Recovery Team, Leatherback/Hawksbill Recovery Team and a Kemp's Ridley Recovery Team. The Recovery Teams have developed separate species plans to provide greater focus and emphasize the uniqueness of individual species. This revision was undertaken by the Loggerhead/Green Turtle Recovery Team consisting of the following team members:

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This revised plan incorporates the new format that has become standard in recovery plans in recent years. It is intended to serve as a guide that delineates and schedules those actions believed necessary to restore the Atlantic green turtle as a viable self-sustaining element of its ecosystem. It is recognized that 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

ADNR	Alabama Department of Natural Resources
CITES	Convention on International Trade in Endangered Species of Flora and Fauna
CCAFS	Cape Canaveral Air Force Station
COE	U.S. Army Corps of Engineers
CPA	Canaveral Port Authority
CZM	Office of Coastal Zone Management
DOD	Department of Defense
EPA	U.S. Environmental Protection Agency
FDNR	Florida Department of Natural Resources
FPL	Florida Power and Light Company
FWS	U.S. Fish and Wildlife Service
GDNR	Georgia Department of Natural Resources
IUCN	International Union for the Conservation of Nature
KSC	Kennedy Space Center
LDWF	Louisiana Department of Wildlife and Fisheries
MARPOL	International Convention for the Prevention of Pollution from Ships
MDW	Mississippi Department of Wildlife, Fisheries and Parks
MMS	Minerals Management Service
NCDNR	North Carolina Department of Environment, Health, and Natural Resources
NMFS	National Marine Fisheries Service
NPS	National Park Service
SCCC	South Carolina Coastal Council
SCWMRD	South Carolina Wildlife and Marine Resources Department
TPW	Texas Parks and Wildlife Department
USAF	United States Air Force
USCG	United States Coast Guard
USMC	United States Marine Corps
USN	United States Navy
VMRC	Virginia Marine Resources Commission

EXECUTIVE SUMMARY

Current status: The loggerhead is federally listed as threatened worldwide. Nesting in the United States occurs primarily along North Carolina (1.0 percent), South Carolina (6.5 percent), Georgia (1.5 percent), and Florida (91 percent) beaches and accounts for approximately one-third of the world population. Nesting trends are declining in Georgia and South Carolina, unknown in North Carolina and appear stable in Florida. Coastal development threatens nesting habitat and populations while commercial fisheries and pollution pose significant threats in the marine environment.

Goal: The recovery goal is to delist the species in the United States once recovery criteria are met.

Recovery criteria: The southeastern United States population of the loggerhead can be considered for delisting if, over a period of 25 years, the following conditions are met:

1. The adult female population in Florida is increasing and in North Carolina, South Carolina and Georgia, it has returned to pre-listing nesting levels (NC = 800 nests/season; SC = 10,000 nests/season; GA - 2,000 nests/season).

2. At least 25 percent (560 km) of all available nesting beaches (2240 km) is in public ownership, is distributed over the entire nesting range and encompasses greater than 50 percent of the nesting activity.

3. 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 60 percent hatch success on major nesting beaches.
3. Implement effective lighting ordinances or lighting plans on all major nesting beaches within each State.
4. Determine distribution and seasonal movements for all life stages in marine environment.
5. Minimize mortality from commercial fisheries.
6. Reduce threat from marine pollution.

Date of recovery: If funds are available to accomplish recovery tasks and new information does not indicate other limiting factors, the anticipated date of recovery is 2015.

Total cost of recovery: *

Land acquisition:	$90,000,000
Actions on nesting beaches	$12,200,000
Actions in marine environment	$49,500,000

*$145,700,000 of these costs are shared with actions identified in the Green Turtle Recovery Plan.

PART I. INTRODUCTION

Taxonomy: The loggerhead was described by Linnaeus (1758) and named *Testudo caretta*. Over the next two centuries more than 35 names were applied to the species (Dodd, 1988), but there is now general agreement on *Caretta caretta* as the valid name. While Deraniyagala described an Indo-Pacific form as *C. gigas* in 1933, he revised that view in 1939 to hold that *gigas* was only a subspecies of *C. caretta* and the genus has generally been regarded as monotypic since that time. The subspecific designation of *gigas* has likewise been challenged persuasively (Brongersma, 1961; Pritchard, 1979; among others). Dodd (1988) has declared flatly that "the diagnostic characters used to distinguish *C. c. gigas* from *C. c. caretta* are not valid." Thorough synonymies and taxonomic reviews of this form are given most recently by Pritchard and Trebbau (1984) and Dodd (1988).

Description: The carapace of adult and subadult loggerheads is reddish-brown. The dorsal and lateral head scales and the dorsal scales of the extremities are also reddish-brown, but with light yellow margins that vary enough in extent to provide considerable disparity in appearance among individuals. The unscaled area of the integument (neck, shoulders, limb bases) are dull brown above and medium yellow laterally and ventrally. The plastron is also medium yellow. The thick, bony carapace is covered by non-imbricated horny scutes. There are 5 pairs of costals (pleurals), 11 or 12 pairs of marginals, 5 vertebrals and a nuchal (precentral) that is in contact with the first costal. Ventrally there are usually three pairs of poreless inframarginals, paired gulars, humerals, pectorals, abdominals, femorals and anals. An interanal is variable and inconstant. Mean straight carapace length (sCL) of adult southeastern United States loggerheads is about 92 cm; corresponding mean body mass is about 113 kg. Elsewhere adult loggerheads are somewhat smaller, on average, the most notable being those in Colombia (Kaufmann, 1975), Greece (Margaritoulis, 1982) and Tongaland (Hughes, 1975). Loggerheads rarely exceed 122 cm sCL and 227 kg mass in the modern day.

Hatchlings lack the reddish tinge and vary from light to dark brown dorsally. Both pairs of appendages are dark brown above and have distinct white margins. The plastron and other ventral surfaces may be described as dull yellowish tan and there is usually some brown pigmentation in the phalangeal portion of the web ventrally. At hatching mean body mass is about 20 g and mean sCL is about 45 mm. Hatchlings have three dorsal keels and two plastral ones.

Population Distribution and Size: The geographic distribution of *Caretta caretta* includes the temperate and tropical waters of both hemispheres. The species inhabits the continental shelves and estuarine environments along the margins of the Atlantic, Pacific and Indian Oceans. In the Western Hemisphere it ranges as far north as Newfoundland (Squires, 1954) and as far south as Argentina (Frazier, 1984) and Chile (Frazier and Salas, 1982). The nesting range is confined to lower latitudes, but loggerhead nesting is clearly concentrated in the north and south temperate zones and subtropics. Pritchard (1979) used the term "antitropical" to describe the aversion exhibited by loggerheads to beaches in Central America, northern South America and throughout the Old World Tropics. Notable exceptions to this rule would include the largest known nesting aggregation, on Masirah and the Kuria Muria Islands of Oman (Ross and Barwani, 1982) and perhaps, the recently reported nesting assemblage on the Caribbean coast of Quintana Roo (R. Gil, pers. comm.). Worldwide, about 88 percent of loggerhead nesting occurs in the southeastern United States, Oman, and Australia. In the western Atlantic the great bulk of the nesting occurs along the southeastern United States coast, with approximately 80 percent occurring in Brevard, Indian River, St. Lucie, Martin, Palm Beach and Broward Counties in Florida. There are also significant nesting assemblages in Georgia, South Carolina, North Carolina and along the Gulf Coast of southwest Florida.

It is not possible, at present, to estimate the size of the loggerhead population in United States territorial waters if one includes subadults. There is, however, general agreement with Meylan (1982) that enumeration of nesting females provides a useful index to population size and stability. The estimate of 14,150 females nesting per year in the southeastern United States given by Murphy and Hopkins (1984) and based on aerial survey data from 1983, was accepted by Mager (1985) and more recently by Ehrhart (1989) as the current best approximation. Given Murphy and Hopkins' (1984) stochastically derived mean number of nests per female (4.1), this figure provides an estimate of approximately 58,000 nests deposited per year in the Southeast. Based on more extensive ground and aerial surveys throughout the Southeast in recent years (1987 to 1990), it is estimated that approximately 50,000-70,000 nests are deposited annually (FDNR, unpubl. data; GDNR, unpubl. data; SCWMRD, unpubl. data; NCDNR, unpubl. data). These totals constitute about 35 to 40 percent of the loggerhead nesting known worldwide and clearly rank the southeastern United States aggregation as the second largest in the world, with the somewhat larger Oman assemblage being the only other truly large group remaining anywhere (Ross, 1982).

Status: The loggerhead was listed on July 28, 1978, as a threatened species under the Endangered Species Act of 1973. Internationally it is considered "Vulnerable" by the IUCN (Groombridge, 1982) and is listed in Appendix I of the Convention on International Trade in Endangered Species of Flora and Fauna (CITES). In a recent review, Ehrhart (1989), considered consequences of life tables and population models (Richardson and Richardson, 1982; Frazer, 1983; Crouse et al., 1987), mortality rates in the Southeast; population declines in South Carolina and Georgia; and Murphy and Hopkins' (1984) estimate of annual mean clutch production per female. Ehrhart concluded that the stock of loggerheads represented by females that nest in the Southeast is continuing to decline.

Biological Characteristics: The recent literature dealing with loggerhead biology is extensive and only a brief treatment is warranted here. However, a number of thorough synopses of loggerhead biology are currently available. The most recent and extensive is the work of Dodd (1988) but those of Pritchard and Trebbau (1984) and Groombridge (1982) are also very comprehensive and useful.

Habitat: As a generality, adult female loggerheads select high energy beaches on barrier strands adjacent to continental land masses for nesting. There is some evidence that steeply sloped beaches with gradually sloped offshore approaches are favored (Provancha and Ehrhart, 1987). After leaving the beach, hatchlings apparently swim directly offshore and eventually become associated with *Sargassum* and/or debris in pelagic drift lines that result from current convergences (Carr, 1986a; 1986b; 1987). The evidence suggests that when post-hatchlings become a part of the *Sargassum* raft community they remain there as juveniles, riding current gyres for several years and growing to 40 to 50 cm sCL. At that point they abandon the pelagic habitat, migrate to the near-shore and estuarine waters along continental margins and utilize those areas as the developmental habitat for the subadult stage. In most nearshore waters in the Southeast, adults and subadults appear to use the same habitat. In some of the inshore waters such as the Indian River Lagoon of east Florida the subadults are virtually isolated from the adults, whose foraging areas outside of the nesting season are apparently in the Bahamas, the Antilles or the Gulf of Mexico. Habitat selection is not well understood but it seems clear that adults can utilize a variety of habitats. Remote recoveries of females tagged in Florida indicate that many migrate to the Gulf of Mexico, often to the turbid, detritus-laden, muddy-bottom bays and bayous of the northern Gulf Coast. Still others apparently occupy the clear waters of the Bahamas and Antilles, with sandy bottoms, reefs and shoals that constitute a totally different type of habitat. Nothing is known of the relative periods of time that loggerheads may spend in these disparate habitats or of their propensity to move from one to another.

Diet: While the list of food items eaten by loggerheads is lengthy and includes invertebrates from eight phyla (Dodd, 1988), it is clear that subadult and adult loggerheads are, first and foremost, predators of benthic invertebrates such as gastropod and pelecypod molluscs and decapod crustaceans. Coelenterates and cephalopod molluscs are also taken by larger turtles but these invertebrates are especially favored by loggerheads in the pelagic stage. Most of the evidence for the latter statement comes from the island groups of the eastern Atlantic (van Nierop and den Hartog, 1984). Post-hatchling loggerheads evidently ingest macroplankton associated with "weed lines." In one of the few studies of post-hatchling food habits in the southeastern United States, Carr and Meylan (1980) found two species of small gastropods characteristic of the *Sargassum* raft community as well as fragments of crustaceans and the *Sargassum* plant itself. Although Brongersma (1972) listed Syngnathid fishes among loggerhead food items, this species is not a fish eater in any primary sense. Loggerheads may scavenge fish or fish parts or ingest fish incidentally in some circumstances.

Growth: While a number of workers have reported growth rates of post-hatchling and juvenile loggerheads in captivity (e.g., Witham and Futch, 1977), such information is totally lacking for these stages in the wild. In captivity young loggerheads can grow to about 63 cm CL and 37 kg in mass in 4.5 years (Parker, 1926). In wild subadults, Limpus (1979) has reported linear growth rates of 1.5 cm/yr in Australia and Mendonca (1981) has reported average linear growth rates of 5.9 cm/yr in Florida. It seems clear now that growth rates of subadults decrease with increasing carapace length (i.e. growth is not linear). Although they lacked data for loggerheads smaller than 53 cm sCL, Frazer and Ehrhart (1985) fitted growth data for Florida subadults to both logistic and van Bertalanffy curves and estimated age at maturity as 12 to 30 years.

Reproduction: It has been assumed for some time that, males migrate with females from distant foraging areas to the waters off nesting beaches and that courtship and mating take place there. The few reports concerning the seasonality of mating clearly place it in the late March-early June period (Caldwell, 1959; Caldwell *et al.*, 1959a; Fritts *et al.*, 1983). While a few adult males may remain off the Florida coast throughout the year (Henwood, 1987), most of them apparently depart by about mid-June, leaving the females to ascend the nesting beaches and deposit clutches throughout the summer. Nevertheless, courtship and mating are not well studied in loggerheads (or other sea turtles), and there is no doubt that this and virtually every other aspect of the biology of male loggerhead needs further research and clarification.

In the southeastern United States adult females begin to nest as early as late April (some years) and they continue to do so until early September. Nesting activity is greatest, however, in June and July. In Georgia, South Carolina and North Carolina the season generally begins in mid-May and ends by mid-August. Loggerheads are known to nest from one to seven times within a nesting season (Talbert *et al.*, 1980; Richardson and Richardson, 1982; Lenarz *et al.*, 1981; among others); the mean is approximately 4.1 (Murphy and Hopkins, 1984). The internesting interval varies around a mean of about 14 days. There is general agreement with Caldwell *et al.* (1959b) that females mate prior to the nesting season (and possibly only once) and then lay multiple clutches of fertile eggs throughout some portion of the nesting season. Mean clutch size varies from about 100 to 126 along the southeastern United States coast.

Loggerheads are nocturnal nesters, but exceptions to the rule do occur infrequently (Fritts and Hoffman, 1982; Witherington, 1986; among others). Although a definitive ethogram of loggerhead nesting behavior has yet to be published, good descriptive accounts have been given by Carr (1952); Litwin (1978) and Caldwell *et al.*, (1959a). Multi-annual remigration intervals of two and three years are most common in loggerheads, but the number can vary from one to six years (Richardson *et al.*, 1978; Bjorndal *et al.*, 1983). Natural incubation periods for United States loggerheads average from 53-55 days in Florida (Davis and Whiting, 1977; Witherington, 1986) to 63 and 68 days in Georgia (Kraemer, 1979) and North Carolina (Crouse, 1985), respectively. The length of the incubation period is inversely related to nest temperature (McGehee, 1979). Sex determination in loggerhead hatchlings is temperature dependent (Yntema, 1982; Yntema and Mrosovsky, 1980) and the species apparently lacks sex chromosomes (Standora and Spotila, 1985). Natural hatching success rates of 73.4 percent and 55.7 percent have been reported in South Carolina (Caldwell, 1959) and Florida (Witherington, 1986), respectively.

Movements: Loggerhead hatchlings engage in a "swimming frenzy" for about 20 hours after they enter the sea and that frenzy takes them about 22 to 28 kilometers offshore (Salmon and Wyneken, 1987). At some point thereafter they become associated with *Sargassum* rafts and/or debris at current gyres (Carr, 1986b). Upon reaching about 45 cm sCL, they abandon the pelagic existence and migrate to near-shore and estuarine waters of the eastern United States, the Gulf of Mexico and the Bahamas and begin the subadult stage. Little is known of their seasonal movements there, but Henwood (1987) has reported a tendency for subadults of the Port Canaveral (Florida) aggregation to disperse more widely in the spring and early summer. Also, Chesapeake Bay subadults are known to exhibit a variety of movements between waters of differing temperatures and salinities (Killingly and Lutcavage, 1983). As adults, loggerheads become migratory for the purpose of breeding. Recoveries of females tagged while nesting on the Florida east coast suggest widely dispersed foraging areas in the Gulf of Mexico, Cuba and elsewhere in the Greater Antilles, and the Bahamas (Meylan *et al.*, 1983). While conclusive evidence is lacking as yet, it is assumed that these females remigrate hundreds or thousands of kilometers at multi-annual intervals (see above) to nest on the good, high energy nesting beaches of east Florida. Bell and Richardson (1978) reported tag recoveries suggesting a "migratory path" from Georgia to Cape Hatteras, North Carolina and a single recovery of a Georgia tagged female on the Florida Gulf Coast (Tampa Bay). Little else is known of the scheduled travels of Georgia, South Carolina, and North Carolina nesters outside of the nesting season.

Threats - Nesting Environment

Beach Erosion: Erosion of nesting beaches can result in partial or total loss of suitable nesting habitat. Erosion rates are influenced by dynamic coastal processes, including sea level rise. Man's interference with these natural processes through coastal development and associated activities has resulted in accelerated erosion rates and interruption of natural shoreline migration.

Beach Armoring: Where beachfront development occurs, the site is often fortified to protect the property from erosion. Virtually all shoreline engineering is carried out to save structures, not dry sandy beaches, and ultimately results in environmental damage. One type of shoreline engineering, collectively referred to as beach armoring, includes sea walls, rock revetments, riprap, sandbag installations, groins and jetties. Beach armoring can result in permanent loss of a dry nesting beach through accelerated erosion and prevention of natural beach/dune accretion and can prevent or hamper nesting females from accessing suitable nesting sites. Clutches deposited seaward of these structures may be inundated at high tide or 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 (resulting in higher incidences of false crawls) 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 or to construct improperly sized and shaped egg cavities when inadequate amounts of sand cover these structures. Approximately 21 percent (234 km) of Florida's, 10 percent (18 km) of Georgia's and 10 percent (30 km) of South Carolina's beaches are armored (FDNR, unpubl. data; S. Murphy, pers. comm.; J. Richardson, pers. comm.).

Groins and jetties are designed to trap sand during transport in longshore currents or to keep sand from flowing into channels in the case of the latter. These structures prevent normal sand transport and accrete beaches on one side of the structure while starving neighboring beaches on the other side thereby resulting in severe beach erosion (Pilkey *et al.*, 1984) and corresponding degradation of suitable nesting habitat.

Drift fences, also commonly called sand fences, are erected to build and stabilize dunes by trapping sand moving along the beach and preventing excessive sand loss. Additionally, these fences can serve to protect dune systems by deterring public access. Constructed of narrowly spaced wooden or plastic slats or plastic fabric, improperly placed drift fences can impede nesting attempts and/or trap emergent hatchlings and nesting females.

Beach Nourishment: Beach nourishment consists of pumping, trucking or scraping sand onto the beach to rebuild what has been lost to erosion. Beach nourishment can impact turtles through direct burial of nests and by disturbance to nesting turtles if conducted during the nesting season. Sand sources may be dissimilar from native beach sediments and can affect nest site selection, digging behavior, incubation temperature (and hence sex ratios), gas exchange parameters within incubating nests, hydric environment of the nest, hatching success and hatchling emergence success (Mann, 1977; Ackerman, 1980; Mortimer, 1982; Raymond, 1984a). Beach nourishment can result in severe compaction or concretion of the beach. Trucking of sand onto project beaches may increase the level of compaction.

Significant reductions in nesting success have been documented on severely compacted nourished beaches (Raymond, 1984a). Nelson and Dickerson (1988) evaluated compaction levels at ten renourished east coast Florida beaches and concluded that 50 percent were hard enough to inhibit nest digging, 30 percent were questionable as to whether their hardness affected nest digging and 20 percent were probably not hard enough to affect nest digging. They further concluded that, in general, beaches nourished from offshore borrow sites are harder than natural beaches, and, while some may soften over time through erosion and accretion of sand, others may remain hard for 10 years or more. Nourished beaches often result in severe escarpments along the mid-beach and can hamper or prevent access to nesting sites. Nourishment projects result in heavy machinery, pipelines, increased human activity and artificial lighting on the project beach. These activities are normally conducted on a 24-hour basis and can adversely affect nesting and hatching activities. Pipelines and heavy machinery can create barriers to nesting females emerging from the surf and crawling up the beach, causing a higher incidence of false crawls (non-nesting emergences). 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 non-project beaches.

Beach nourishment projects require continual maintenance (subsequent nourishment) as beaches erode and hence their negative impacts to turtles are repeated on a regular basis. Beach nourishment projects conducted during the nesting season can result in the loss of some nests which may be inadvertently missed or misidentified as false crawls during daily patrols conducted to identify and relocate nests deposited on the project beach (Lund, 1973; R. Wolf, pers. comm.). Nourishment of highly eroded beaches (especially those with a complete absence of dry beach) can be beneficial to nesting turtles if conducted properly. Careful consideration and advance planning and coordination must be carried out to ensure timing, methodology and sand sources are compatible with nesting and hatching requirements.

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; Dickerson and

Nelson, 1989; Witherington and Bjorndal, 1991). Artificial beachfront lighting from buildings, streetlights, dune crossovers, vehicles and other types of beachfront lights have been documented in the disorientation (loss of bearings) and misorientation (incorrect orientation) of hatchling turtles (McFarlane, 1963; Philibosian, 1976; Mann, 1977; Ehrhart, 1983).

The results of disorientation or misorientation are often fatal. As hatchlings head toward lights or meander along the beach their exposure to predators and likelihood of desiccation is greatly increased. Misoriented hatchlings can become entrapped in vegetation or debris, and many hatchlings are 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). During the period 1989 to 1990, 37,159 misoriented hatchlings were reported to the Florida Department of Natural Resources. Undoubtedly a large but unquantifiable number of additional misorientation events occurred but were not documented due to obliteration of observable sign, depredation, entrapment in thick vegetation, loss in storm drains or obliteration of carcasses by vehicle tires.

The problem of artificial beachfront lighting is not restricted to hatchlings. Raymond (1984a) indicated that adult loggerhead emergence patterns were correlated with variations in beachfront lighting in south Brevard County, Florida, and that 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. Problem lights may not be restricted to those placed directly on or in close proximity to 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 United States, the negative effects of artificial lights are profound.

Beach Cleaning: Beach cleaning refers to the removal of both abiotic and biotic debris from developed beaches. There are several methods employed including mechanical raking, hand raking and picking up debris by hand. Mechanical raking can result in heavy machinery repeatedly traversing nests and potentially compacting sand above nests and also results in tire ruts along the beach which may hinder or trap emergent hatchlings. Mann (1977) suggested that mortality within nests may increase when externally applied pressure from beach cleaning machinery is common on soft beaches with large grain sand. Mechanically pulled rakes and hand rakes can penetrate the surface and disturb the sealed nest or may actually uncover pre-emergent hatchlings near the surface of the nest. In some areas collected debris is buried directly on the beach, and this can lead to excavation and destruction of incubating egg clutches. Disposal of debris near the dune line or on the high beach can cover incubating egg clutches and subsequently hinder and entrap emergent hatchlings and may alter natural nest temperatures. In some areas, mechanical beach cleaning is the sole reason for extensive nest relocation.

Increased Human Presence: Residential and tourist use of developed (and developing) nesting beaches can result in negative impacts to nesting turtles, incubating egg clutches and hatchlings.

The most serious threat caused by increased human presence on the beach is the disturbance to nesting females. Night-time human activity can cause nesting females to abort nesting attempts at all stages of the behavioral process. Murphy (1985) reported that disturbance can cause turtles to shift their nesting beaches, delay egg laying, and select poor nesting sites. Heavy utilization of nesting beaches by humans (pedestrian traffic) may result in lowered hatchling emergence success rates due to compaction of sand above nests (Mann, 1977), and pedestrian tracks can interfere with the ability of hatchlings 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).

Recreational Beach Equipment: 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 sea approach of hatchlings. The documentation of false crawls at these obstacles is becoming increasingly common as more recreational beach equipment is left in place nightly on nesting beaches. Additionally, there are documented reports of nesting females becoming entrapped under heavy wooden lounge chairs and cabanas on south Florida nesting beaches (J. Hoover, pers. comm.; S. Bass, pers. comm.). The placement of recreational beach equipment directly above incubating egg clutches may hamper hatchlings during emergence and can destroy eggs through direct invasion of the nest (C. LeBuff, pers. comm.).

Beach Vehicular Driving: The operation of motor vehicles on nesting beaches for recreational purposes is permitted in northeast Florida (portions of Nassau, St. John's, Flagler and Volusia Counties), northwest Florida (Walton and Gulf Counties), and North Carolina (Emerald Isle, Cape Lookout National Seashore, Cape Hatteras National Seashore and Currituck Banks). While some areas restrict night driving, others permit it. Driving on beaches at night during the nesting season can disrupt the nesting process and result in aborted nesting attempts. The negative impact on nesting females in the surf zone may be particularly severe. Vehicle headlights can disorient or misorient emergent hatchlings, and vehicles can strike and kill hatchlings attempting to reach the ocean. The tracks or ruts left by vehicles traversing the beach interfere with the ability of hatchlings to reach the ocean. The extended period of travel required to negotiate tire tracks and ruts may increase the susceptibility of hatchlings to stress and depredation during transit to the ocean (Hosier *et al.*, 1981; M. Evans, pers. comm.). Driving directly above incubating egg clutches can cause sand compaction which may decrease nest success and directly kill pre-emergent hatchlings (Mann, 1977). In many areas, beach vehicular driving is the sole cause for nest relocation. Additionally, vehicle traffic on nesting beaches contributes to erosion, especially during high tides or on narrow beaches where driving is concentrated on the high beach and foredune.

Exotic Dune and Beach Vegetation: Non-native vegetation has invaded many coastal areas and often outcompetes native species such as sea oats, railroad vine, sea grape, dune panic grass and pennywort. The invasion of less stabilizing vegetation can lead to increased erosion and degradation of suitable nesting habitat. Exotic vegetation may also form impenetrable root mats which can prevent proper nest cavity excavation, invade and desiccate eggs or trap hatchlings.

The Australian pine (*Casuarina equisetifolia*) is particularly detrimental. Dense stands of this species have taken over many coastal strand areas throughout central and south Florida. Australian pines cause excessive shading of the beach which would not otherwise occur. Studies in Florida suggest that nests laid in shaded areas are subjected to lower incubation temperatures which may alter the natural hatchling sex ratio (Marcus and Maley, 1987; Schmelz and Mezich, 1988). Fallen Australian pines limit access to suitable nest sites and can entrap nesting females. Davis and Whiting (1977) reported that nesting activity declined in Everglades National Park where dense stands of Australian pine took over native beach berm vegetation on a remote nesting beach. Conversely, along highly developed beaches, nesting may be concentrated in areas where dense stands of Australian pines create a barrier to intense beachfront and beach vicinity lighting (S. Bass, pers. comm.).

Nesting Depredation: A variety of natural and introduced predators such as raccoons, feral hogs, foxes, ghost crabs and ants prey on incubating eggs and hatchling sea turtles. The principal predator is the raccoon (*Procyon lotor*). Raccoons are particularly destructive and may take up to 96 percent of all nests deposited on a beach (Davis and Whiting, 1977; Hopkins and Murphy, 1980; Stancyk *et al.*, 1980; Talbert *et al.*, 1980; Schroeder, 1981; Labisky *et al.*, 1986). Prior to hog control efforts, up to 45 percent of all nests deposited at the Canaveral Air Force Station, Florida, were depredated by feral hogs (FDNR, unpubl. data). In Georgia, on Ossabaw and St. Catherine's Island, an estimated 90 percent of all nests were lost to feral hogs prior to the implementation of predator control programs (GDNR, unpubl. data). In addition to the destruction of eggs, certain predators may take considerable numbers of hatchlings just prior to or upon emergence from the sand.

Nest Loss to Abiotic Factors: Nest loss due to erosion or inundation and accretion of sand above incubating nests appear to be the principal abiotic factors which may negatively affect incubating egg clutches. While these factors are often widely perceived as contributing significantly to nest mortality or lowered hatching success, few quantitative studies have been conducted (Mortimer, 1989). Studies on a relatively undisturbed nesting beach by Witherington (1986) indicated that excepting a late season severe storm event, erosion and inundation played a relatively minor role in destruction of incubating nests. Inundation of nests and accretion of sand above incubating nests as a result of the late season storm played a major role in destroying nests from which hatchlings had not yet emerged. Severe storm events (e.g., tropical storms and hurricanes) may result in significant nest loss, but these events are typically aperiodic rather than annual occurrences. In the southeastern United States, severe storm events are generally experienced after the peak of the hatching season and hence would not be expected to affect the majority of incubating nests. Erosion and inundation of nests are exacerbated through coastal development and shoreline engineering. These threats are discussed above under beach armoring.

Poaching: In the United States, killing of nesting female loggerheads is infrequent. However, in a number of areas, egg poaching and clandestine markets for eggs are not uncommon. During the period 1983 to 1989 the Florida Marine Patrol made 29 arrests for illegal possession of turtle eggs (figure not apportioned by species).

Threats - Marine Environment

Oil and Gas Exploration, Development and Transportation: 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. 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. Exploration and oil development on live bottom areas may disrupt foraging grounds by smothering benthic organisms with sediments and drilling muds (Coston-Clements and Hoss, 1983). Oil and tar are also released into the marine environment during pumping of bilges on large vessels. In a review of available information on debris ingestion, Balazs (1985) reported that tar balls were the second most prevalent type of abiotic debris ingested by marine turtles.

Dredging: The effects of dredging are evidenced through direct destruction or degradation of habitat and incidental take of marine turtles. Channelization of inshore and nearshore habitat and the disposal of dredged material in the marine environment can destroy or disrupt resting or foraging grounds (including grass beds and coral reefs) and may affect nesting distribution through the alteration of physical features in the marine environment (Hopkins and Murphy, 1980). Hopper dredges are responsible for incidental take and mortality of marine turtles during dredging operations. During a three month period in 1980 in the Port Canaveral, Florida, channel, dredging operations were responsible for the mortality of at least 71 sea turtles (Magnuson et al., 1990). These high levels of incidental take have not generally been documented during dredging operations in subsequent years. Maintenance dredging of the Kings Bay, Georgia, channel during 1987 to 1988 resulted in the mortality of at least 18 sea turtles during a 1 year period (Magnuson et al., 1990). During the dredging of Brunswick harbor and the entrance channel in 1991 at least 20 sea turtles were killed during a three month period (T. Henwood, pers. comm.). Other types of dredges (clamshell and pipeline) have not been implicated in incidental take.

Marina and Dock Development: The development of marinas and private or commercial docks in inshore waters can negatively impact turtles through destruction or degradation of foraging habitat. Additionally, this type of development leads to increased boat and vessel traffic which may result in higher propeller and collision related mortality. Fueling facilities at marinas can result in the discharge of oil and gas into sensitive estuarine habitat.

Pollution: The effects of pollutants resulting from industrial, agricultural or residential sources are difficult to evaluate. Pesticides, heavy metals and PCB's have been detected in turtles (including eggs), but levels which result in adverse effects have not been quantified (Nelson, 1988).

Trawl Fisheries: Of all commercial and recreational fisheries conducted in the United States, shrimp trawling is the most damaging to the recovery of marine turtles. The estimated number of loggerheads killed annually by the offshore shrimping fleet in the southeastern United States Atlantic and Gulf of Mexico is 5,000 to 50,000 (Magnuson et al., 1990). Incidental capture and drowning in shrimp trawls is believed to be the largest single source of mortality on juvenile through adult stage marine turtles in the southeastern United States. Most of these turtles are juveniles and subadults, the age and size classes most critical to the stability and recovery of marine turtle populations (Crouse *et al.*, 1987). Quantitative estimates of turtle take by shrimp trawlers in inshore waters have not been developed, but the level of trawling effort expended in inshore waters along with increasing documentation of the utilization of inshore habitat by loggerhead turtles suggest that capture and mortality may be significant. Trawlers targeting species other than shrimp tend to use larger nets than shrimp trawlers and probably also take sea turtles, although capture levels have not been developed. These fisheries include, but are not limited to bluefish, croaker, flounder, calico scallops, blue crab and whelk. Of these, the bluefish, croaker and flounder trawl fisheries likely pose the most serious threats (T. Henwood, pers. comm.). The harvest of *Sargassum* by trawlers can result in incidental capture of post-hatchlings and habitat destruction (Schwartz, 1988).

Purse Seine Fisheries: Several purse seine fisheries operate in the Gulf of Mexico and Atlantic, including those targeting menhaden and sardines. Turtles may be taken in these fisheries, but the level of take and percent mortality is currently unquantified.

Hook and Line Fisheries: Several thousand commercial vessels are engaged in hook and line fisheries which target various species including coastal species, reef fish and pelagic species. In addition to commercial take, the recreational fishery is extensive. Turtle captures on hook and line gear are not uncommon, but the level of take and percent mortality are unknown. It is assumed that most turtles are released alive, although ingested hooks and entanglement in associated monofilament/steel line have been documented as the probable cause of death in some stranded turtles.

Gill Net Fisheries: Gill nets are utilized both in inshore and offshore areas for various species and may be stationary or drifting. Mesh size is dependent on the size of the fish which are targeted but the gear is considered non-selective in the species impacted (T. Henwood, pers. comm.). Trammel nets are modified gill nets set in panels of webbing of variable mesh size. Marine turtles are vulnerable to entanglement and drowning in gill and trammel nets, especially when this gear is left unattended. Turtle mortality resulting from the use of gill nets set for sturgeon in South Carolina and North Carolina have been documented (Ulrich, 1978; Crouse, 1982). In response to a reduced sturgeon population, the State of South Carolina has prohibited gill netting for sturgeon since 1986. Of particular concern are the gill net and trammel net fisheries off the Florida east-central coast. These fisheries, primarily targeting king mackerel, pompano and shark have undergone recent expansion in the number of vessels and level of fishing effort (Schaefer *et al.*, 1987). Stranding patterns of turtles in this area indicate that significant numbers of turtles may be killed incidental to these fisheries.

Pound Net Fisheries: Pound nets are fished extensively in the inshore bays and sounds of North Carolina, Virginia, New York and Rhode Island. In Virginia, pound nets have been identified as a leading cause of marine turtle mortality (Lutcavage and Musick, 1985). Mortality was principally caused by entanglement and drowning in the leader portion of the gear and was dependent on mesh size, net location and environmental parameters. In North Carolina, most pound nets have leads constructed of small mesh (13 to 20 cm). Results of preliminary investigations indicate that mortality in these nets may be infrequent (Epperly and Veishlow, 1989). Similarly, in New York, most turtles are released alive from pound nets and entanglement in leaders appears infrequent (V. Burke, pers. comm.).

Longline Fisheries: Longline fisheries have increased dramatically over the past several years. Species targeted in these fisheries include tuna, shark and swordfish. Witzell (1987) estimated that 330 turtles were incidentally captured in the Gulf of Mexico and Atlantic by the Japanese tuna longline fleet during 1978 to 1981. Due to increased effort and expansion of longline fisheries in recent years, it is believed that longline fisheries may be exerting a major negative impact on marine turtle recovery (T. Henwood, pers. comm.).

Trap Fisheries: Traps are commonly used in the capture of crabs, lobster and reef fish. Traps vary in size and configuration but all are attached to a surface float by means of a line leading to the trap. Turtles can become entangled in trap lines below the surface of the water and subsequently drown. In other instances, stranded turtles have been recovered entangled in trap lines with the trap in tow. Loggerhead turtles may be particularly vulnerable to entanglement in trap lines because of their attraction to, or attempts to feed on, species caught in the traps and epibionts growing on traps, trap lines and floats. The impact of this gear on loggerhead populations has not been quantified.

Boat Collisions: Propeller and collision injuries to marine turtles from boats and ships are not uncommon. In 1986, 1987 and 1988 respectively, 5.8 percent (111), 7.3 percent (175), and 9.0 percent (179) of all stranded turtles reported along the United States Gulf of Mexico and Atlantic were documented as having sustained some type of propeller or collision injuries, although it is unknown what percentage of these injuries were post-mortem versus ante-mortem (Schroeder and Warner, 1988; Teas and Martinez, 1989). These types of injuries are recorded at higher frequencies in areas where recreational boating and vessel traffic is intense, such as south Florida and the Florida Keys.

Power Plant Entrapment: The entrainment and entrapment of turtles in saltwater cooling intake systems of coastal power plants has been documented in New Jersey, North Carolina, Florida and Texas (Roithmayr and Henwood, 1982; Ernest *et al.*, 1989; S. Manzella, pers. comm.; T. Henson, pers. comm.; R. Schoelkopf, pers. comm.). Average annual incidental capture rates for most coastal plants from which captures have been reported amount to several turtles per plant per year. One notable exception is the St. Lucie nuclear power plant located on Hutchinson Island, Florida. During a 15-year period of operation (May 1976 to December 1990), 2,193 sea turtles (all species) have been removed from the intake canal. While most of these turtles are released alive, the mortality rate is approximately 7.0 percent (Applied Biology, Inc., unpubl. data). Most captures have been loggerheads, though green turtles are not uncommon.

Underwater Explosions: The use of underwater explosives for the removal of abandoned oil platforms, military activities and oil exploration can injure or kill turtles and may destroy or degrade habitat. During a 3-year period (1986 to 1988) observers reported one injured or dead turtle during the removal of 103 offshore oil structures in the Gulf of Mexico. Of eight turtles deliberately exposed to underwater explosions at distances varying between 229 m and 915 m from the detonation site, five were rendered unconscious (Klima *et al.*, 1988).

Offshore Artificial Lighting: The effects of offshore lighted structures on the orientation of hatchling turtles is not completely understood. These lights may attract hatchlings and interfere with proper offshore orientation, and may make them more susceptible to predation (deSilva, 1982).

Entanglement: Turtles are affected to an unknown but potentially significant degree by entanglement in persistent marine debris, including discarded or lost fishing gear (Balazs, 1985). Loggerhead turtles have been found entangled in a wide variety of materials including steel and monofilament line, synthetic and natural rope, plastic onion sacks and discarded plastic netting materials (Balazs, 1985; Plotkin and Amos, 1988). Monofilament line appears to be the principal source of entanglement for loggerheads in United States waters. Records from Florida indicate that some entanglement results from netting and monofilament line which has accumulated on both artificial and natural reefs. These areas are often heavily fished, resulting in snagging of hooks and discarding of lines. Turtles foraging and/or resting in these areas can become entangled and drown (FDNR, unpubl. data). The alignment of persistent marine debris along convergences, rips and driftlines, and the concentration of young sea turtles along these fronts increases the likelihood of entanglement at this life history stage (Carr, 1987).

Ingestion of Marine Debris: Marine turtles have been found to ingest a wide variety of abiotic debris items such as 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 (in press) revealed that both loggerhead 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 at low levels of ingestion. Persistence of the material in the gut lasted from a few days to 4 months (Lutz, in press). Of particular concern is the co-occurrence of persistent marine debris and the early life history pelagic stages of loggerhead turtles along convergences. Young turtles are dependent upon these driftlines for their food supply, and hence the likelihood of debris ingestion is increased (Carr, 1987). While quantitative data on population effects are undetermined, the impacts of debris ingestion are considered serious.

Poaching: Illegal directed harvesting of juvenile and adult loggerhead turtles in the waters of the continental United States and United States Caribbean is uncommon, but no estimates of the level of take exist. During the period 1983 to 1989, the Florida Marine Patrol made three arrests for illegal possession of whole turtles and 25 arrests for illegal possession of turtle parts within Florida (figures are not apportioned by species).

Predation: Predation of hatchling and very young turtles is assumed to be significant and predation of subadult through adult stage turtles is assumed less common, but valid estimates of mortality due to predation at various life history stages are extremely difficult, if not impossible to obtain, and have not been determined. Hatchlings entering the surf zone and pelagic stage hatchlings may be preyed upon by a wide variety of fish species and to a lesser extent, marine birds. Stancyk (1982) in an extensive literature review reported predators of juvenile and adult turtles to include at least six species of sharks, killer whales, bass and grouper. Tiger sharks appear to be the principal predator of subadult and adult turtles. While stranded turtles may exhibit shark inflicted injuries, caution must be exercised in attributing a cause of death as these wounds can be inflicted post-mortem.

Diseases and Parasites: There is little information available to assess the comprehensive effects of disease and/or parasites on wild populations of marine turtles. The vast majority of diseases and conditions which have been identified or diagnosed in sea turtles are described from captive stock, either turtles in experimental headstart programs or mariculture facilities (Wolke, 1989). One notable exception is the identification of the disease spirorchidiasis, resulting from infection with intravascular trematodes (Wolke *et al.*, 1982). The observable external characteristics of this disease, however, are not exhibited in the majority of loggerhead carcasses that strand along the Atlantic and Gulf of Mexico coasts.

Conservation Accomplishments - Nesting Environment

Management to mitigate the effects of naturally occurring events such as erosion and vegetation, and a variety of man-induced factors mentioned in the previous section, usually consists of relocating nests to higher sites on the dune, or into a hatchery. This was once a common practice throughout the southeast region. More recently the emphasis of management is to be far less manipulative with the nests and hatchlings. Table 1 contains a listing of most of the major Federal, State and private nest survey and protection projects along the southeast coast.

Acquisition of high density nesting beaches between Melbourne Beach and Wabasso Beach, Florida, is underway to establish the Archie Carr National Wildlife Refuge. Approximately 25 percent of the loggerhead nesting in the United States occurs along this 33 km stretch of beach. The State of Florida purchased the first parcel specifically for the refuge in July 1990. Federal acquisition began in 1991. When completed the refuge will protect up to 16 km of nesting beach. As of September 1991 the 860-acre refuge is approximately 25 percent complete due in large part to previous County and State purchases under the State of Florida's Save Our Coast Program.

Table 1. Major loggerhead nest survey/protection projects in the southeastern United States, 1985 to 1990. Includes consistently monitored survey areas reporting greater than 100 nests annually. Not all beaches were surveyed during the entire 6-year period.

Project	Beach length (km)	Number of nests	Conservation measure(s)*
Baldhead Island, NC	19.3	95-281	S/NR
Sand/South Islands, SC	8.0	111-373	S/NR/NS/PR
Cape Romain NWR, SC	8.0	796-1361	S/NR/PR
Kiawah Island, SC	15.0	84-268	S/NR/NS
Edisto Island, SC	18.3	111-553	S/NR/NS/PR
Otter Island, SC	4.3	70-196	S/NR/NS/PR
Hunting Island, SC	7.0	105-175	S/NR
Fripp Island, SC	6.0	51-176	S/NR/NS
Pritchard's Island, SC	4.0	57-176	S/NR/NS
Bay Point, SC	5.0	131-195	S/NR/NS/PR
Hilton Head, SC	29.0	115-160	S/NR
Blackbeard Island NWR, GA	11.2	110-234	S/NR/NS/PR
Ossabaw Island, GA	15.2	56-114	S/NS/PR
Cumberland Island NS, GA	28.0	158-172	S
Flagler County Beaches, FL	29.0	75-326	S
New Smyrna Beach, FL	16.1	166-206	S/NR
Canaveral National Seashore, FL	37.4	1670-3925	S/NS
Merritt Island NWR, FL	9.6	993-1791	S/PR
Cape Canaveral AFS, FL	21.0	1284-2115	S/PR
Patrick AFB, FL	7.0	923-1459	S
Melbourne Beach, FL	21.0	8864-14328	S/PR
Sebastian Inlet SRA, FL	4.8	513-921	S/PR
Wabasso Beach, FL	8.0	1197-1256	S
Vero Beach, FL	7.0	199-349	S/NR
Hutchinson Island, FL	36.5	4637-6711	S
St. Lucie Inlet SP, FL	4.3	289-432	S/PR
Hobe Sound NWR, FL	5.3	1202-1732	S/PR
Town of Jupiter, FL	12.1	2640-6431	S
Juno Beach, FL	8.1	2790-4664**	S
J.D. MacArthur SP, FL	2.9	496-1062	S/PR
Delray Beach, FL	3.5	138-288	S/NR
City of Boca Raton, FL	8.0	874-1100	S/NR/NS
Broward County Beaches, FL	38.6	1244-2283	S/NR/NS
Miami Area Beaches, FL	16.9	64-182	S/NR
Manasota Key, FL	18.9	312-884	S/NR
Casey Key, FL	8.2	107-459	S/NR
Sanibel Island, FL	18.5	110-137	S
Wiggins Pass Area Beaches, FL	6.4	106-215	S/NS
Keewaydin Island, FL	7.2	96-137	S/NR/NS

* S=Survey, NR=Nest Relocation, NS=Nest Screening, PR=Predator Removal

** 1989-1990 data only

Perhaps the most frustrating habitat protection effort is trying to minimize or eliminate the construction of seawalls, rip-rap, groins, sand bags and improperly placed drift or sand fences. State and Federal laws designed to protect the beach and dune habitat include: Coastal Barrier Resources Act of 1982 (Federal), Coastal Areas Management Act of 1974 (North Carolina), Beachfront Management Act of 1990 (South Carolina), Shore Assistance Act of 1979 (Georgia) and Coastal Zone Protection Act of 1985 (Florida). These have had varying degrees of success at maintaining suitable nesting sites for loggerheads. The Governor and Cabinet of the State of Florida approved a Beach Armoring Policy on December 18, 1990. This policy prohibits armoring along a 32 km stretch of high density nesting beach between Melbourne Beach and Wabasso Beach and restricts armoring elsewhere to structures threatened by a 5-year return interval storm event.

Beach nourishment is a better alternative for sea turtles than seawalls and jetties. When beach nourishment was done mostly in the summer, all nests had to be moved from the beach prior to nourishment. Now FWS and State natural resource agencies review beach nourishment projects to ensure appropriate timing of nourishment during the nesting and hatching season. Beaches where compaction after nourishment is a problem are plowed to a depth of 92 cm to soften the sand so that it is useable for nesting turtles (Nelson and Dickerson, 1987). Progress is being made toward better timing of projects and sand quality.

Progress is also being made by many states, counties and towns to prevent disorientation and misorientation of hatchlings (Ernest *et al.*, 1987; Shoup and Wolf, 1987). In Florida, lighting ordinances have been passed by the following counties: Nassau, Flagler, Volusia, Brevard, Indian River, St. Lucie, Martin, Palm Beach, Broward, Collier, Charlotte, Sarasota and Lee. Over 20 towns or cities have also passed ordinances on Florida's east coast. Georgetown County passed the first lighting ordinance in South Carolina. Under the new South Carolina Beachfront Management Act of 1990, guidelines were approved which will require all coastal communities to have lighting ordinances. The USAF has developed and is implementing lighting plans for launch complexes and other facilities at Cape Canaveral Air Force Station in Florida.

The most longstanding beach management program has been to reduce destruction of nests by natural predators, such as raccoons and feral predators, such as hogs. Between 6 and 8 percent of loggerhead nesting occurs on National Wildlife Refuges along the southeastern coast. Several refuges have ongoing predator control programs (See Table 1).

Because of more attention to the status of sea turtles, human take is not the problem it once was on United States beaches, although this is still a major problem in other countries. The isolated cases of nest poaching receive immediate attention from FWS law enforcement and State conservation officers. Loss of eggs to human poaching does not represent the high mortality factor it once did.

In addition to implementing management on nesting beaches, there has been extensive research into the effects of this management on sea turtle populations. Specifically, the most important aspect in recent years is the effect of incubation temperature on the sex ratio of hatchlings reared in styrofoam boxes (Yntema and Mrosovsky, 1980; Morreale *et al.*, 1982; Standora and Spotila, 1985). Use of these boxes has been discontinued as a standard practice. Studies have been completed to compare the sex ratios and pivotal temperatures of loggerheads on natural beaches throughout their range in the United States (Mrosovsky, 1988).

Long-term tagging studies have determined many population attributes for nesting loggerheads (Richardson, 1982). Research on hatchling orientation and nesting behavior and how various wavelengths of light affect them is providing needed information to managers (Witherington and Bjorndal, 1991; Witherington, in press).

The status of loggerheads is being determined by monitoring the various life stages on the beach to evaluate current and past management practices. This is being done by counting how many nests are laid, how many of these successfully hatch and the production of hatchlings reaching the ocean.

The number of nesting females is determined by knowing the rangewide nesting effort and dividing by the average number of nests a female lays each season (Hopkins and Richardson, 1984). Nests can be counted by both aerial and ground surveys. Estimates of nesting females were made from rangewide aerial surveys made in 1980 (Powers, 1981), 1982 (Thompson, 1983) and 1983 (Murphy and Hopkins, 1984). Standardized aerial surveys of the South Carolina coast have been conducted since 1980 (Hopkins-Murphy and Murphy, 1988). Standardized ground surveys on index beaches are underway throughout the Southeast by the FWS, State agencies and by private groups and universities. Index beaches include 80 percent of the nesting in Florida, 75 percent in Georgia and 60 percent in North Carolina. Because of slow growth rates and subsequent delayed sexual maturity, all monitoring will need to be conducted over a long period of time to establish population trends for loggerheads.

Conservation Accomplishments - Marine Environment

Managing sea turtles in the water lags behind efforts on the beach due to limited access to turtles, lack of information on habitat usage by different age classes and cost. Therefore, most efforts to preserve marine and estuarine habitats are regulatory in nature.

The U.S. Coast Guard has contingency plans for the containment, recovery and minimization of damage from spillages of oil and hazardous substances, as well as major disasters (J. Schmidtman, pers. comm.). But trying to prevent bilge pumping, industrial discharges, and chemical and oil spills in the marine environment is a very difficult problem.

In 1978, NMFS implemented a gear development program which would prevent the drowning of turtles in shrimp trawls. The first device was large mesh webbing across the mouth of the net which proved to be ineffective. Subsequently, a cage-like design installed within the trawl, called a turtle excluder device (TED) was developed. Concurrent with the government's action, new designs were built by individual shrimpers. Seven types of TEDs have been certified for use by NMFS. Lack of widespread use of these devices on a voluntary basis resulted in regulations requiring their use. The final regulations were published in June 1987. After legal, congressional and administrative delays, the regulations went into effect in September 1989. South Carolina promulgated emergency State regulations requiring TEDs in State waters in June 1988 and implemented permanent regulations in 1989. Florida implemented emergency State regulations in February 1989, after unprecedented numbers of strandings the previous fall. Florida implemented permanent Statewide year-round regulations in June 1990. The State of Georgia developed TED regulations which went into effect in November 1990.

Incidental catch mortality from the Atlantic sturgeon fishery was reduced in South Carolina by an earlier ending of the sturgeon fishing season. Later, because of reduced stocks of sturgeon, the season was closed entirely. This all but eliminated early spring strandings of sea turtles in South Carolina (S. Murphy, unpubl. data).

The number of sea turtle carcasses reported in the Chesapeake Bay is declining, not because of changes in gear, but due to economics. In the 1930's, pound nets numbered about 3,000 in the bay. The deep water nets are more expensive now, and the number of nets have decreased by an order of magnitude (J. Musick, pers. comm.).

In consultation with the COE, FDNR and the NMFS, modifications of dragheads are being tested to minimize turtle mortality from dredges. Each dredging project undergoes a Section 7 consultation as required under the authority of the Endangered Species Act. As a result of these Section 7 consultations, dredging contractors are often required to have observers onboard and the timing of the projects is usually designed to avoid as many turtle encounters as possible.

Research into methods of preventing turtles from entering the intake pipes at power plants proved unsuccessful. Turtles that are entrapped at the St. Lucie plant are captured, tagged and released.

On December 31, 1987, the United States 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. Not only does this mark the first effort in United States law to address the problem of plastic debris in the oceans, but the ratification of Annex V enables the law to come into force internationally. According to United States law, 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 United States (O'Hara *et al.*, 1988)

Directed research has been done to document habitat use and behavior of sea turtles in nearshore waters; a few examples follow. Hopkins and Murphy (1980) used sonic and radio transmitters to study habitat use and internesting behavior of 39 adult female loggerhead turtles. In 1985, 1986 and 1989, Murphy and Hopkins-Murphy (1990) radio-instrumented 31 adult female loggerheads prior to nesting and relocated them 64 km from their nesting beach to determine if they would accept an alternate beach or home to their previous nesting area. Juvenile and subadult loggerheads were also radio tracked in Chesapeake Bay to document habitat use, surface time and daily movements (Byles, 1988). Netting studies in the Indian River, Florida, are providing information on habitat use by juvenile loggerheads (L. Ehrhart, pers. comm.). Distribution, size and species composition are being determined in the inshore waters of North Carolina by means of aerial survey, sightings from ferry boats and the public, and cooperating pound net fishermen (Epperly and Veishlow, 1989).

Because of turbid waters near shore, assessing turtle stocks by pelagic aerial survey is probably not feasible. Information on the distribution of sea turtles over the continental shelf has until recently been from casual observations and most were anecdotal. Since 1978, four pelagic aerial surveys in the southeast region have been completed during which sea turtles were counted (Fritts *et al.*, 1983; Thompson and Shoop, 1984; Lohoefener *et al.*, 1988; SCWMRD, unpubl. rept.). The most recent aerial survey conducted in the northern Gulf of Mexico was funded by MMS to assess turtle/platform associations (Lohoefener et al., 1988). These flights have provided information on the geographic and seasonal distribution of sea turtles.

Information from vessels is largely opportunistic. It was through incidental capture that the winter hibernaculum for sea turtles in the Canaveral ship channel was discovered (Ogren and McVea, 1982). The NMFS is also conducting interviews and netting surveys in the Gulf of Mexico (L. Ogren, pers. comm.). Catch per unit effort (CPUE) and rates of mortality provide a reasonable estimate of the number of captures and mortality when used with fishing effort statistics. These data provide information on seasonal abundance and distribution over wide geographic areas (Henwood and Stuntz, 1987).

A regional data collection effort was begun in 1980 to monitor mortality. This voluntary stranding network from Maine to Texas is coordinated by the NMFS and serves to document the geographic and seasonal distribution of sea turtle mortality (Schroeder, 1987). Since 1987, four index zones have been systematically surveyed. It is clear that strandings represent an absolute minimum mortality. However, they can be used as an annual index to mortality and are an indication of the size distribution of turtles being killed. They can also provide valuable biological information on food habits, reproductive condition and sex ratios.

Accomplishments - Information and Education

Public support for sea turtle conservation effort is essential for the long-term success of conservation programs. This is particularly true when conservation measures are controversial or expensive. To heighten public awareness and understanding of sea turtle conservation issues a number of educational activities and efforts are underway. For example, personnel conducting turtle projects often advise tourists on what they can do to minimize disturbance to nesting turtles, protect nests and rescue misoriented hatchlings. Likewise, State and Federal parks which conduct public awareness sea turtle interpretive walks provide information to visitors. Florida DNR has developed guidelines for organized sea turtle interpretive walks in order to minimize any disturbance to nesting turtles while still allowing them to be viewed by the public. Many beaches have been posted with signs informing people of the laws protecting sea turtles and providing either a local or a hotline number to report violations.

Private conservation organizations such as the Center for Marine Conservation, Greenpeace and National Audubon Society and Federal and State agencies have produced and distributed a variety of audio-visual aids and printed materials about sea turtles. These include: the brochure "Attention Beach Users", a booklet (Raymond, 1984b) on the various types of light fixtures and ways of screening lights to lessen their effects on hatchlings, "Lights Out" bumper stickers and decals, a coloring book, video tapes, slide/tape programs, full color identification posters of the eight species of sea turtles, and a hawksbill poster. Florida Power and Light Company also has produced a booklet (Van Meter, 1990) with general information on sea turtles.

Recent reviews of sea turtle conservation efforts in the southeastern United States appear in Hopkins-Murphy (1988) and Possardt (1991).

PART II. RECOVERY

A. Recovery Objectives

The southeastern United States population of the loggerhead can be considered for delisting if, over a period of 25 years, the following conditions are met:

1. The adult female population in Florida is increasing and in North Carolina, South Carolina, and Georgia, it has returned to pre-listing nesting levels (NC = 800 nests/season; SC = 10,000 nests/season; GA = 2,000 nests/season). The above conditions must be met with data from standardized surveys which will continue for at least 5 years after delisting.

2. At least 25 percent (560 km) of all available nesting beaches (2240 km) is in public ownership, distributed over the entire nesting range and encompassing at least 50 percent of the nesting activity within each State.

3. All priority one tasks have been successfully implemented.

B. Stepdown 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 the Southeast. Although nesting occurs on over 2,250 km of beaches, development pressures are so great, cumulative impacts will result in increased degradation or destruction of nesting habitat and eventually lead to a significant population decline if not effectively combated.

111. Ensure beach nourishment projects are compatible with maintaining good quality nesting habitat. (also see 216)

Beach nourishment can improve nesting habitat in areas of severe erosion and is a preferred alternative to beach armoring. The quality of material should be similar to that on local natural beaches.

1111. Implement and evaluate tilling as a means of softening compacted beaches.

Poor quality material deposited on nesting beaches can result in compaction of sand on nesting beaches. This can cause increased numbers of false crawls and aberrant nests, increased digging times for nesting females and, in some cases, broken eggs from clutches deposited in too shallow an egg chamber. Where beach compaction exceeds local natural conditions tilling to a depth of 77 to 92 cm should be used to soften beaches. The effectiveness of tilling in softening beaches should also be fully evaluated by the COE to determine the persistence of beach softening, frequency of tilling required, and the best mechanical method for beach softening.

1112. Evaluate the relationship of sand characteristics (including aragonite) and hatch success, hatchling fitness and sex ratios, and nesting behavior.

Gas diffusion could be affected by sand grain shape, size and compaction and alter hatch success. Sand color and moisture influence temperature and can affect hatchling sex determination. The effect of importing non-native materials such as aragonite to United States beaches for beach nourishment adds additional unknowns which could conceivably affect hatchlings and should be discouraged until fully evaluated.

1113. Reestablish dunes and native vegetation.

Dune restoration and revegetation with native plants should be a required component of all renourishment projects. This will enhance beach stability and nesting habitat and require less frequent renourishment activities.

1114. Evaluate sand transfer systems as alternative to beach nourishment.

Sand transfer systems can diminish the necessity for frequent beach renourishment and thereby reduce disruption of nesting activities and eliminate sand compaction. The construction and operation of these systems must be carefully evaluated by the COE to ensure important nearshore habitats are not degraded or sea turtles injured or destroyed.

112. Prevent degradation of nesting habitat from seawalls, revetments, sand bags, sand fences or other erosion control measures.

Seawalls, revetments, and sand bags have already destroyed or degraded many miles of nesting habitat on the southeast Atlantic coast. Beach armoring still occurs, however, either illegally or through devices such as sandbags which are still allowed. The filling and burial of long plastic bags to protect coastal property is a common practice in Florida and has occurred in other States. These buried bags are hard and exacerbate erosion when uncovered by storm events and prevent nesting when uncovered or buried too close to the sand surface.

1121. Evaluate current laws on beach armoring and strengthen if necessary.

State regulations prohibiting or discouraging some forms of beach armoring now exist in Florida, Georgia, South Carolina and North Carolina. FDNR, GDNR, SCCC, and NCDNR should review current State regulations related to beach construction and ensure seawalls, revetments, sandbags and other armoring measures contributing to the degradation of nesting habitat are prohibited.

1122. Ensure laws regulating coastal construction and beach armoring are enforced.

Illegal beach armoring occurs, and all too frequently no effective action is taken by enforcement agencies to ensure the perpetrator removes the material and restores the habitat. Illegal beach armoring can cumulatively cause significant degradation of nesting habitat. FDNR, GDNR, SCCC, and NCDNR must frequently monitor beaches and maintain strict enforcement when violations are observed.

1123. Ensure failed erosion control structures are removed.

Failed erosion control structures such as uncovered plastic bags or tubes and fragmented concrete or wooden structures degrade nesting habitat and deter nesting activities. FDNR, GDNR, SCCC and NCDNR should ensure failed structures are removed from nesting beaches.

1124. Develop standard requirements for sand fence construction.

Sand fences can effectively build dune systems and improve nesting habitat, however improperly designed sand fences can trap nesting females or hatchlings and prevent access to suitable nesting habitat. FDNR, GDNR, SCWMRD, SCCC, NCDNR and FWS should develop and evaluate sand fencing designs and establish standard requirements for sand fence construction.

113. Evaluate and implement measures to enhance important nesting habitat where erosion or tidal inundation destroy over 40 percent of nests in a typical year (without relocation).

Some important nesting beaches now suffer severe erosion as a result of previous river diversions, inlet maintenance or jetty construction. Limited safe locations for beach hatcheries in some situations place constraints on nest relocation programs. Nest relocation programs at best should be considered as a short-term measure to protect nests in these situations with primary efforts directed towards habitat restoration.

1131. Evaluate dune restoration or other measures to mitigate erosion on Cape Island, S.C.

Diversion of the natural drainage of the Santee River in the 1940's has caused a severe erosion problem at Cape Island. About 25 percent of all nesting in South Carolina occurs on Cape Island. Fifty to 80 percent of the nests would be lost to tidal inundation or erosion without nest relocation. The FWS relocates 300-600 nests each year to hatcheries. Suitable sites for self-release beach hatcheries are more scarce each year. Consequently dune restoration and other measures to enhance nesting habitat should be evaluated and implemented by FWS and COE.

1132. Identify other important nesting beaches experiencing greater than 40 percent nest loss from erosion and implement appropriate habitat restoration measures.

FDNR, GDNR, SCWMRD, NCDNR, and FWS should review all important nesting beaches and identify those with 40 percent or more nest loss due to erosion or tidal inundation. Habitat restoration plans should be developed and implemented for identified nesting beaches.

114. Acquire or otherwise ensure the long-term protection of important nesting beaches.

1141. Acquire in fee title all undeveloped beaches between Melbourne Beach and Wabasso Beach, Florida.

Approximately 25 percent of all loggerhead nesting in the United States occurs along this 33 km mile stretch of nesting beach. Development and public use threatens the habitat and nesting activities. The FWS and FDNR should acquire a buffer strip in fee title that at least extends from mean high water west to highway AIA to ensure the long-term protection of this nesting habitat. An ocean to river buffer along the narrow barrier island would be preferable. Conservation easements should be acquired on developed properties where fee title acquisition is not possible.

1142. Evaluate the status of the high density nesting beaches on Hutchinson Island, Florida, and develop a plan to ensure its long-term protection.

Approximately 10 percent of loggerhead nesting in United States occurs along this 32 km beach. Development is degrading nesting habitat and public use is causing significant disturbance to nesting activities. FDNR and FWS should evaluate the threats and take appropriate measures including acquisition to ensure long-term protection.

1143. Evaluate status of other undeveloped beaches which provide important habitat for maintaining the historic nesting distribution and develop a plan for long-term protection.

FDNR, GDNR, SCWMRD, NCDNR and FWS should evaluate other nesting beaches in the Southeast which contribute significantly to the historic nesting distribution to ensure permanent protection.

115. Remove exotic vegetation and prevent spread to nesting beaches.

Australian pine trees shade nests and can alter natural hatchling sex ratios. Australian pines also aggressively replace native dune and beach vegetation through shading and chemical inhibition and consequently exacerbate erosion and loss of nesting habitat. Erosion can topple trees and leave exposed roots which can entrap nesting females.

Removal of exotics such as is ongoing at St. Lucie Inlet State Park, Florida, and Hobe Sound NWR, Florida should continue. FDNR, FWS, and NPS should identify other important nesting beaches where exotic vegetation is degrading nesting habitat and work with responsible parties to restore natural vegetation.

12. Protect marine habitat.

Available sea turtle habitat has been significantly reduced over the past century. Among the factors contributing to this loss of habitat are coastal development and industrialization, increased commercial and recreational vessel activities, river and estuarine pollution, channelization, offshore oil and gas development and commercial fishing activities. If present trends continue, the cumulative loss of suitable habitat could reduce the likelihood of recovery of the species.

121. **Identify important habitat.**

Loggerheads are opportunistic foragers occurring throughout the warm waters of the continental shelf. They frequently feed around coral reefs, rocky places, and old boat wrecks, and often enter bays, lagoons and estuaries. Little information on habitat preference of specific age/size/sex classes is available. To effectively protect the species, NMFS should consider habitat research to be of high priority.

122. **Prevent degradation and improve water quality of important turtle habitat.**

Coastal development and associated changes in land utilization have led to severe degradation of habitat through contamination and/or loss of food sources in estuarine and marine waters. Declines in water quality resulting from industrial pollution, channel dredging and maintenance, harbor activities, farm runoff and sewage disposal, have rendered large water bodies marginally habitable. The EPA and State environmental regulatory agencies must ensure that established minimum water quality standards are enforced. Land utilization decisions and associated construction projects should be carefully considered by local governments, states, CZM, NMFS, FWS, EPA, COE, and other regulatory and permitting agencies.

123. **Prevent destruction of habitat from fishing gears and vessel anchoring.**

Bottom tending fishing gears can be destructive to a wide variety of habitats. Coral reefs are particularly vulnerable to destruction from roller rig trawling gear because corals may be crushed by the weight of rollers and trawls. Seagrass, sponge and other live bottom habitats can also be scoured by trawling gear. Anchoring vessels in sensitive habitats may also be destructive. NMFS should evaluate the potential loss of habitat from these activities and take appropriate actions to ensure long-term protection of reefs and other important habitats.

124. **Prevent destruction of marine habitat from oil and gas activities.**

Oil and gas activities may negatively impact sea turtle habitat during exploration, development, production and abandonment phases. Of particular concern are impacts of oil spills, drilling mud disposal, disposal of other toxic materials, pipeline networks associated with oil and gas fields, onshore production facilities, increased vessel traffic, domestic garbage disposal and explosive removal of obsolete platforms. MMS, COE, 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. A response team to deal with spills should be established.

125. Prevent destruction of habitat from dredging activities.

Channel dredging projects may have greater impacts on habitat than the obvious mechanical destruction of the channel bottom. Channelization can alter natural current patterns, disrupt sediment transport, and suspended materials from dredging may severely damage adjacent corals and seagrasses. Additionally, disposal of dredged materials in offshore disposal sites usually smothers existing flora and fauna. The COE and EPA should continue to carefully consider the environmental consequences before permitting any new channel dredging projects or designating new offshore disposal sites.

2. Protect and manage population.

21. Protect and manage populations on nesting beaches.

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

211. Monitor trends in nesting activity by means of standardized surveys.

Nesting surveys are undertaken on the majority of nesting beaches. However, in the past, beach coverage from year to year varied, as did the frequency of surveys, experience and training of surveyors and data reporting. Consequently, no regionwide determination of nesting population trends has been possible with any degree of certainty.

FWS, FDNR, GDNR, SCWMRD, and NCDNR should continue to refine standardized nest survey criteria, identify additional index survey beaches to be monitored, continue to conduct training workshops for surveyors, and implement or continue appropriate aerial or ground surveys. This is essential to gather a long-term data base on nesting activities from North Carolina to Florida which can be used as an index of nesting population trends throughout the nesting range of the species.

212. Evaluate nest success and implement appropriate nest protection measures.

Nesting and hatching success on beaches occurring on State or Federal lands and all other important local or regional nesting beaches should be evaluated. Appropriate nest protection measures should be implemented by FWS, FDNR, GDNR, SCWMRD, NCDNR or appropriate local governments or organizations to ensure greater than 60 percent hatch rate. Until recovery is ensured, however, projects on all Federal and State lands and key nesting beaches such as

Hutchinson Island, Jupiter Island, Juno Beach, and Melbourne Beach, Florida, should strive for a higher rate of hatching success. In all cases the least manipulative method should be employed to avoid interfering with known or unknown natural biological processes. Artificial incubation should be avoided. Where beach hatcheries are necessary, they should be located and constructed to allow self release and hatch rates approaching 90 percent should be attained. Nest protection measures should always enable hatchling release the same night of hatching.

213. Determine influence of factors such as tidal inundation and foot traffic on hatching success.

Tidal inundation can diminish hatch success depending on frequency, duration and developmental stage of embryos. Many nests are relocated due to the perceived threat from tides. The extent to which eggs can tolerate tidal inundation needs to be quantified to enable development of guidelines for nest relocation relative to tidal threats. The effect of foot traffic on hatching success is unknown although many beaches with significant nesting also have high public use. FWS should support research and in conjunction with FDNR, GDNR, SCWMRD and NCDNR develop recommendations for nest protection from tidal threat and foot traffic, if appropriate.

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

Hatchlings orient primarily to the blue-green wavelengths to find the ocean and consequently many artificial lights disorient or misorient hatchlings, indirectly leading to high hatchling mortality. Recent studies have demonstrated that artificial lights also significantly deter nesting activities.

2141. Determine hatchling orientation mechanisms in the marine environment and assess dispersal patterns from natural (dark) beaches and beaches with high levels of artificial lighting.

While phototropic orientation is the hatchling sea finding mechanism, orientation mechanisms in the marine environment need further clarification. If light is the primary determinant, lighting from coastal development could be altering hatchling dispersal patterns on some nesting beaches and lowering survivorship. This could be significant in areas such as Cape Canaveral where lighting from the Kennedy Space Center, Canaveral Air Force, Port Canaveral and Cocoa Beach, Florida, contribute to a significant background glow. The USAF, KSC and Port Canaveral should support studies to evaluate the impact of lighting on Cape Canaveral hatchling dispersal and survivorship. Other important nesting beaches which may be influenced by coastal lighting should be evaluated by appropriate State resource agencies and coastal communities.

2142. Implement and enforce lighting ordinances.

Where lighting ordinances have been adopted and enforced such as Brevard County, Florida, hatchling disorientation and misorientation have been drastically reduced. All coastal counties and communities with nesting beaches should adopt ordinances May through October. Many incorporated communities within Broward and Palm Beach Counties, Florida, are particularly problematic because of the high density nesting beaches and the lack of effective lighting regulations.

2143. Evaluate extent of hatchling disorientation and misorientation on all important regional nesting beaches.

FWS, appropriate State resource agencies, and counties should evaluate hatchling disorientation and misorientation problems on all important regional nesting beaches. Many lighting ordinance requirements do not become effective until 11 p.m., whereas over 30 percent of hatchling emergence occurs prior to this time (Witherington et al., 1990). FWS, State resource agencies, and county governments should also support research to gather additional quantitative data on hatchling emergence times and nesting times on representative beaches throughout the Southeast to support the most effective time requirements for lighting ordinances.

2144. Evaluate need for Federal lighting regulations.

Where local lighting ordinances have not been implemented or are ineffective, Federal regulations should be promulgated under authority of the Endangered Species Act for important nesting beaches.

2145. Develop lighting plans at Port Canaveral, Kennedy Space Center, Cape Canaveral Air Force Station and Patrick Air Force Base, Florida.

Cape Canaveral is one of the four most important nesting beaches in the United States with over 10 percent of all nesting activity. Launch and support facilities at Canaveral and lighting at Patrick AFB are responsible for hatchling disorientation and misorientation on Merritt Island National Wildlife Refuge and Air Force beaches. Lights from the KSC, USAF facilities and Port Canaveral may be altering natural hatchling dispersal from Cape Canaveral. The KSC, USAF and the Port should develop lighting plans to reduce and eliminate hatchling disorientation and misorientation.

2146. Prosecute individuals or entities responsible for hatchling disorientation and misorientation under the Endangered Species Act or appropriate State laws.

Hatchling disorientation and misorientation from artificial lights can cause high mortality and be the major source of hatchling mortality on some nesting beaches if not controlled. Law enforcement efforts should be focused where lighting ordinances are not being implemented or enforced on major nesting beaches and where flagrant and repeated violations are not corrected.

215. Control vehicular traffic during nesting and hatching season.

Vehicular traffic can clearly destroy nests, kill hatchlings and disturb nesting turtles. Nest relocation is not an acceptable permanent solution to vehicular traffic. Driving exists on some Florida and North Carolina beaches, including national and State parks. NPS, FDNR and NCDNR should evaluate the effect of vehicular traffic on nesting activities including the need to relocate nests and develop a plan to phase out beach driving on important local or regional nesting beaches (except emergency or permitted research vehicles).

216. Ensure beach nourishment and coastal construction activities are planned to avoid disruption of nesting and hatching activities.

These activities can cause significant disruption of nesting activities during the nesting season when viewed cumulatively over the nesting range. Nest relocation can involve manipulation of large numbers of nests which can result in lowered hatch success and altered hatchling sex ratios and therefore is not an acceptable alternative to altering the timing of projects. The COE, FWS and appropriate State agencies should ensure beach nourishment and other beach construction activities are not permitted during the nesting season on local or regionally important nesting beaches.

217. Ensure law enforcement activities eliminate poaching and harassment.

Poaching, while not a significant cause of nest loss regionally, is occasionally a local problem. Intentional and unintentional disturbance and harassment of nesting turtles is, however, an increasing problem on many beaches. FWS should work closely with FDNR, GDNR, SCWMRD and NCDNR to identify problem areas and focus intensive law enforcement efforts to eliminate poaching and deter harassment of nesting turtles.

218. Determine natural hatchling sex ratios.

It is well documented that incubation temperature determines hatchling sex. Sex ratios of hatchlings on natural beaches throughout the nesting range should be determined over several years in order to evaluate nest relocation programs which could be altering natural sex ratios. FWS, FDNR, GDNR, SCWMRD and NCDNR should support necessary research and evaluate all nest relocation projects to ensure natural sex ratios are not altered. Research should include establishment of temperature transects on representative beaches throughout the Southeast. A standardized protocol for temperature monitoring should be developed by FWS and State resource agencies to accomplish this.

219. Define geographical boundaries of breeding aggregations.

It is not known whether loggerhead nesting populations along the southeastern United States coast and Gulf of Mexico represent separate breeding aggregations or are one large breeding population. This has direct management implications. If nesting populations are segregated even loosely into demes, smaller populations in GA, SC, and NC and west coast Florida would be even more vulnerable to extirpation. FWS should support research to define breeding populations within and outside the United States. As a management approach and until otherwise determined, it should be assumed that nesting populations are segregated.

22. Protect and manage populations in the marine environment.

Management and protection of sea turtles in the marine environment is a difficult task. The foremost problem in management and conservation of sea turtles is the lack of basic biological information. To adequately protect and enhance survival of sea turtles, we must know where they occur, in what numbers, at what times; and what factors contribute to mortality. As sources of mortality are identified, steps can be taken to reduce or eliminate their impacts on populations.

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

In efforts to recover threatened or endangered species, it is necessary to ensure the survival of all life stages. In the case of sea turtles which exhibit great longevity, it is important to protect all age classes so that a sufficient number of individuals survive to reach sexual maturity. To effectively enhance survival, the most critical information needed is when, where and in what abundance, turtles may occur over the various stages of their life cycles.

2211. Determine seasonal distribution, abundance, population characteristics and status in bays, sounds and other important nearshore habitats.

Loggerheads occur throughout the warm waters of the United States continental shelf, but little is known about specific habitat requirements or habitat fidelity, seasonal distribution and abundance, movements or growth. Research is needed to identify areas and times of turtle abundance, and to answer basic biological questions about the species. Some important areas that should be studied include, among others: Cedar Key, Florida Bay, and Indian/Banana River in Florida; Chandeleur Islands in Louisiana; Chesapeake Bay in Virginia and Maryland; and inshore waters of Georgia, South Carolina, and North Carolina. Knowledge of when and where turtles may occur will allow NMFS to take appropriate steps to protect various life stages. NMFS, FWS, COE, MMS and other Federal and State agencies should assist in providing needed information.

2212. Determine navigation mechanisms, migratory pathways, distribution and movements between nesting seasons.

Nesting migrations and subsequent dispersal of post-nesting females have been studied principally through tagging on nesting beaches. Movements and distribution of adult males and juveniles, which may or may not migrate with the females, have been virtually unstudied.

Female turtles are known to return to nest in the same general areas at 2-, 3- and 4-year intervals throughout their reproductive lives. Mechanisms which allow turtles to navigate over great distances and to exhibit nesting beach fidelity are poorly understood. Research is needed to determine how turtles navigate, (olfactory, magnetic, visual) and what factors could negatively influence this ability. NMFS, COE, MMS, FWS and other interested State and Federal agencies should fund appropriate research.

2213. Determine present or potential threats to loggerheads along migratory routes and on foraging grounds.

Loggerhead foraging habitat appears to be highly correlated with the occurrence of crabs and mollusks. Unfortunately, these food items are most abundant in nearshore waters where commercial and recreational fishing, dredging, oil and gas activities and vessel traffic occur. Threats to migrating turtles are virtually unknown, because we have little information on pathways or mechanisms of migration. Before action can be taken to eliminate threats to sea turtles, we must know what factors may impinge on the survival of turtle stocks. Research is needed to determine when and where turtles may occur, and what activities in these areas may negatively impact recovery of the species. NMFS, FWS, COE, MMS and other State and Federal agencies should fund needed research.

2214. Determine breeding population origins for United States juvenile/subadult populations.

To effectively manage sea turtle stocks and to determine the efficacy of nest protection activities, it would be advantageous to have a means of determining the origin of juvenile and subadult turtles. Such knowledge could be of major importance if progeny from specific nesting beaches exhibit different behavior, movements or foraging ranges, than turtles from other beaches. Such differences could result in high mortality in some nesting populations, and low mortality rates in other populations. Appropriate Federal and State agencies should fund this research.

2215. Determine growth rates, sex ratios, age at sexual maturity and survivorship rates of hatchlings, juveniles and adults.

Knowledge of the age at sexual maturity is necessary if managers are to know when nest protection programs can be expected to show results if successful. Extrapolation of growth rate data using growth equations currently provides the best although an indirect method to estimate age at sexual maturity. Growth data can also be used to assess and compare habitat quality. Direct aging methods using annuli in bones or other body parts may ultimately provide a better alternative and needs further research. Data on survivorship rates will be difficult to obtain for most life stages. To the extent that this information can be collected however, it will enable managers to more fully evaluate management strategies utilizing more accurate predictive population models.

222. Monitor and reduce mortality from commercial and recreational fisheries.

Sea turtles are incidentally taken in several commercial and recreational fisheries. For example, an estimated 5,000 to 50,000 loggerheads were killed annually during commercial shrimp fishing activities prior to TED requirements. Other fisheries known or suspected to incidentally capture turtles include those employing bottom trawls, off-bottom trawls, purse seines, bottom longlines, hook and line, gill nets, traps, haul seines, pound nets, beach seines and surface longlines.

2221. Implement and enforce TED regulations in all United States waters at all times.

Regulations requiring shrimp trawlers greater than 25 feet in length to use TEDs in offshore waters during certain months of the year went into effect on May 1, 1989. Boats less than 25 feet must either use TEDs or restrict tow times to 90 minutes. On May 1, 1990, inshore regulations went into effect. While these regulations are expected to have a positive impact on survival of the species, certain areas and times of the year have no TED requirement. To provide the maximum protection to sea turtles, NMFS should amend the regulations to require TEDs in all waters at all times, and ensure that all regulations are enforced. Appropriate State resource agencies should implement State year-round TED regulations for all State waters from North Carolina to Texas.

2222. Provide technology transfer for installation and use of TEDs.

Some shrimp fishermen refuse to use TEDs and have made no attempt to learn about them. If improperly installed or adjusted, turtle mortality and shrimp losses can be expected until nets are properly tuned. NMFS, Sea Grant and State agencies should assist the industry in technology transfer for installation and use of TEDs. This service by Federal and State agencies should aid in the smooth transition to use of this new equipment, and will ensure adequate protection of turtles.

2223. Maintain the Sea Turtle Stranding and Salvage Network.

Most accessible United States beaches in the Atlantic and Gulf of Mexico are surveyed for stranded sea turtles by volunteer or contract personnel. Through the Sea Turtle Stranding and Salvage Network, stranding data are archived and summarized by the NMFS Miami Laboratory. These data provide an index of sea turtle mortality, and are thought to be a cost effective means of evaluating the effectiveness of the TED regulations. These data also provide basic biological information on sea turtles and are useful in determining other sources of mortality. NMFS and FWS should continue systematic stranding surveys of index areas and support and augment the network. Periodic review of efficacy of surveys should be conducted.

2224. Continue nesting population study at Little Cumberland and Cumberland Island, Georgia.

A nesting population study has been underway on these islands since 1964. Because of the long-term nature of the study, and the comprehensive tagging and survey protocol which has been employed, it is the only nesting beach in the United States with adult female survivorship data. This population is declining largely as a result of the heavy mortality from nearshore shrimp activities throughout the nesting season. Because this is the only population with known adult female survivorship data, these data precede the TED requirements, and shrimping mortality affects the nesting population directly, it is a unique opportunity to assess the effectiveness of TED uses directly on a nesting population with a minimum time lag. FWS and/or NMFS should continue funding of this project.

2225. Evaluate impacts of *Sargassum* harvest on hatchlings and implement appropriate measures to avoid incidental take of hatchlings and destruction of pelagic habitat.

Sargassum harvest by surface trawling vessels operating off North Carolina is known to result in the incidental capture of loggerhead hatchlings. The potential significance of this activity may be great since hatchlings from nesting beaches all along the east coast are likely transported in *Sargassum* by the Gulf Stream, past North Carolina and across the Atlantic to developmental habitat in the eastern Atlantic. The extent of the harvest and impacts to hatchlings and their pelagic habitat need to be fully investigated by NMFS and NCDNR. Appropriate protective measures should be developed and implemented within 1 year of the completion of the investigation.

2226. Identify and monitor other fisheries that may be causing significant mortality.

In addition to shrimp trawls, other types of fishing equipment have been implicated in the deaths of sea turtles. Of particular concern are bottom trawling gear, gill nets, driftnets and longlines. NMFS recently conducted an internal ESA Section 7 consultation on the potential impacts to sea turtles of all types of fishing equipment in the Southeast, and recommended that observer coverage be initiated to document take in several fisheries. This observer coverage should be implemented immediately by NMFS or appropriate State resource agencies.

2227. Promulgate regulations to reduce fishery related mortality.

If any fisheries are found to result in significant take of sea turtles, regulations to protect turtles should be published by NMFS and appropriate State resource agencies.

223. Monitor and reduce mortality from dredging activities.

The COE is congressionally mandated to maintain United States navigational channels. To ensure that authorized channel depths are sustained, periodic dredging is required. Some types of dredges, particularly the hopper dredge, have been shown to take sea turtles, and on a cumulative basis, this take is believed to be significant.

2231. Monitor turtle mortality on dredges.

Turtle mortality can be documented by screening the inflows/outflows on a hopper dredge, by observation aboard a clamshell dredge, or by observing the discharge of a pipeline dredge. Presently, NMFS believes that few, if any, turtles are impacted by clamshell or pipeline dredges, but that the hopper dredge is a major problem. NMFS should require observer coverage and appropriate screening on all hopper dredge operations to document take and associated mortality.

2232. Evaluate modifications of dredge dragheads or devices to reduce turtle captures, and incorporate effective modifications or devices into future dredging operations.

Recent COE and NMFS experiments and photography of operating hopper dredges indicate that suction is greatest directly beneath the draghead. This suggests that turtles taken by hopper dredges must be resting on the bottom in the path of the dredge, and that mortality could be eliminated if turtles could be moved 60 to 90 cm up or to either side. COE and NMFS gear specialists are attempting to design a "turtle deflector device" which will push turtles out of the dredge path. This research should be continued until an effective device is perfected.

2233. Determine seasonality and abundance of sea turtles at dredging localities, and ensure that dredging is restricted to time periods with the least potential for turtle mortality.

Channels requiring maintenance dredging and in which turtles are suspected to reside should be surveyed by the COE or Navy prior to dredging to determine when, where and how many turtles are present. To minimize the impacts to sea turtles, all dredging activities should be conducted during times of lowest turtle densities.

224. Monitor and prevent adverse impacts from oil and gas activities.

Oil can alter respiration, severely damage skin, interfere with or stop salt gland function and ultimately lead to the death of turtles. Tar balls pose a particularly serious threat to post-hatchlings and small juveniles since tar balls are frequently eaten and accumulate in the same driftlines which these life stages inhabit.

2241. Determine the effects of oil and oil dispersants on all life stages.

Oil spills resulting from blowouts, ruptured pipelines, tanker accidents, or other accidents could have a major impact on the recovery of listed sea turtles. As evidenced by the recent Exxon catastrophe in Alaska, Federal and industry ability to respond to a major spill is woefully lacking. Therefore, it is essential that we have knowledge of the effects of oil and oil dispersants on all sea turtle life stages to allow adequate assessment of risks and implementation of contingency plans should a major oil spill occur. MMS, FWS, NMFS and the oil and gas industry should fund appropriate research.

2242. Ensure that impacts to sea turtles are adequately addressed during planning of oil and gas development.

In assessing the potential impacts of oil and gas activities, it is necessary to look beyond the exploration, development, production and abandonment of single wells, and consider the industry as a whole. In the Gulf of Mexico alone, there are 4,500 existing offshore structures and thousands more projected over the next 20 years. These structures are linked by miles of underwater pipelines, and are supported by fleets of vessels and aircraft. Production and storage facilities onshore supply refined products for tanker transport and land transport throughout the country. The chances of isolated accidents, when considering the existing infrastructure, are very high. Additionally, the cumulative impacts of chronic discharges from thousands of independent structures could be significant. Explosive removal of structures during the abandonment phase of these activities has also been identified as a potential source of mortality to sea turtles. NMFS, MMS, FWS, and the oil and gas industry should take whatever actions are necessary to ensure that adequate precautions are taken to avoid impacts to sea turtles.

2243. Determine sea turtle distribution and seasonal use of marine habitats associated with oil and gas development areas.

Oil and gas activities occur over vast areas of the Gulf of Mexico and southern North Atlantic. Recent technological advances have made it possible to conduct exploration and development activities in deeper waters. Despite the continuing offshore movement of the industry, little effort has been expended in determining distribution, abundance and seasonality of various life stages of sea turtles in offshore waters. MMS and NMFS should fund needed research to evaluate the effects of oil and gas activities on the recovery of sea turtles in offshore waters.

225. Reduce impacts from entanglement and ingestion of persistent marine debris.

Ingestion of marine debris and entanglement of marine organisms in discarded nets, monofilament lines and ropes has received considerable attention in recent years. Young, pelagic-stage turtles are particularly vulnerable to ingestion of persistent materials. Additionally, entanglement in nets, ropes, and monofilament lines may be a source of mortality to all life history stages.

2251. Evaluate the extent of entanglement and ingestion of persistent marine debris.

Limited information on the frequency of entanglement and ingestion of marine debris by sea turtles is available. Stranding data and necropsies have provided evidence that some turtle mortality has resulted from ingestion of debris. Additionally, stranded turtles have been entangled in lost or discarded netting, monofilament lines and ropes. NMFS, FWS and EPA should expand efforts to document cases of entanglement and ingestion, the extent of marine debris in United States waters, sources of these contaminants, and the impacts of these materials to various life stages of sea turtle populations.

2252. Evaluate the effects of ingestion of persistent marine debris on health and viability of sea turtles.

In addition to mortality resulting from ingestion of plastics, hydrocarbons, or other toxic substances, debilitating non-lethal impacts are possible. Research is needed to evaluate the long term effects of ingestion of marine debris, particularly with regard to hatchlings during early life stages. These turtles are believed to congregate in areas of debris concentration such as driftlines. NMFS, and EPA should fund this research.

2253. Determine and implement appropriate measures to reduce or eliminate persistent marine debris in the marine environment.

Marine debris may originate from land or sea, primarily through careless disposal of non-biodegradable refuse. Suspected sources of these materials are large transport vessels pumping bilges and discarding garbage, commercial and recreational fishermen, oil and gas platforms, beachgoers and cruiseliners. To eliminate the problem, the public must be educated on the long-term consequences of using the oceans as a garbage dump. Point sources of pollution must be identified and eliminated by EPA, Coast Guard, State and Federal agencies. Appropriate agencies should vigorously enforce MARPOL regulations. NMFS should promulgate regulations governing abandonment of fishing gear, and impose severe penalties for discarding these materials.

226. Evaluate mortality from recreational and commercial motor vessels.

The National Academy of Sciences estimates 50 to 500 loggerheads may be killed annually by boat strikes (Magnuson *et al.*, 1990). Between 1987 and 1989, 6 to 9 percent of stranded sea turtles along the United States Gulf of Mexico and Atlantic had evidence of injuries sustained by boat strikes. While some injuries may occur post mortem, the prevalence of sea turtles with injuries suggests a significant problem in some locations. Coastal State resource agencies and NMFS should evaluate available data and develop better assessment methods to determine if measures such as speed regulations are needed in specific localities.

227. Maintain law enforcement efforts to reduce poaching in United States waters.

Illegal directed fishing for sea turtles in United States waters is not believed to be a major problem. However, incidental take and subsequent consumption of turtles may be a larger problem than suspected among certain groups of fishermen. NMFS, FWS, and State resource agencies should increase law enforcement efforts to arrest and prosecute fishermen possessing sea turtles illegally.

228. 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. The lack of centralization for administering these tagging data bases often results in confusion when tagged turtles are recaptured, and delays in reporting of recaptures to the person originally tagging the turtle. NMFS and FWS should investigate the possibilities of establishing a centralized tagging data base.

2281. Centralize tag series records.

A centralized tag series data base is needed to ensure that recaptured tagged turtles can be promptly reported to persons who initially tagged the animal. The tag series data base would include listings of all tag series that have been placed on sea turtles in the wild including the name and address of the researcher placing these tags on turtles. This would eliminate problems in determining which researcher is using which tag series or types of tags, and would preclude unnecessary delays in reporting of tag returns. NMFS and/or FWS should establish and maintain this data base.

2282. Centralize turtle tagging records.

In addition to the need for a centralization of tag series records, there are advantages in developing a centralized turtle tagging data base. Such a data base would allow all turtle researchers to trace unfamiliar tag series or types to their source, and also to have immediate access to important biological information collected at the time of original capture. The major disadvantage is that this data base would require frequent editing and updating, and would be costly and somewhat time consuming to maintain. It would also make it possible for unethical researchers to exploit the work of others, while providing no guarantees that such contributions would be acknowledged. NMFS and FWS should determine whether such a data base can be established and is feasible to maintain.

229. Ensure proper care of sea turtles in captivity.

Loggerheads are maintained in captivity for rehabilitation, research or educational display. Proper care will ensure the maximum number of rehabilitated turtles can be returned to the wild and a minimum number removed from the wild for research or education purposes.

2291. Develop standards for care and maintenance including diet, water quality and tank size.

None of these requirements has been scientifically evaluated to determine the best possible captive conditions for loggerheads. The FWS and NMFS should support the necessary research to develop these criteria particularly relating to diet. These criteria should be published and required for any permit to hold sea turtles in captivity. FWS, NMFS and appropriate State resource agencies should inspect permitted facilities at least annually for compliance with permit requirements.

2292. Develop manual for treatment of disease and injuries.

FWS and NMFS should determine disease problems associated with captive sea turtles and publish a manual on the diagnosis and treatment of such diseases. This manual should also include treatment for common injuries. This will improve rehabilitative success and captive care of research and display specimens.

2293. Establish catalog for all captive sea turtles to enhance utilization for research and education.

Currently captive sea turtles are being held at over 50 facilities. The FWS and NMFS should establish a catalog and act as a clearing house to ensure captive specimens are utilized efficiently to diminish the need for removing additional specimens from the wild.

2294. Designate rehabilitation facilities.

FWS and NMFS in coordination with the appropriate State agencies should designate rehabilitation facilities for Atlantic and Gulf Coast states. Designation should be based on availability of veterinary personnel with expertise or experience in reptilian care and the institution's ability to comply with care and maintenance standards developed in step 2291 above. Each facility should be inspected by a team including a NMFS, FWS, and appropriate State representative prior to its designation as a rehabilitation facility. Inspections should be conducted at least annually thereafter.

3. Information and education.

Sea turtle conservation requires long-term public support over a large geographic area. The public must be factually informed of the issues 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 succeed or fail.

31. Provide slide programs and information leaflets on sea turtle conservation for general public.

The FWS has developed a bi-lingual slide tape program on sea turtle conservation and should keep the program current and available for all public institutions. The FWS and State resource agencies should continually update and supply the public with informational brochures on sea turtle ecology and conservation needs.

32. **Develop brochure on recommended lighting modifications or measures to reduce hatchling disorientation and misorientation.**

Most lighting ordinances require lights be shut off or modified to prevent direct lighting on the nesting beach. However, it is not always clear what types of light, screening or shading work best and the appropriate use of low pressure sodium lights needs to be clearly explained. The FWS, NMFS and State resource agencies should jointly develop and publish a brochure or booklet with recommended lighting fixtures, lights, shading modifications and operational constraints.

33. **Develop public service announcements (PSA) regarding the sea turtle artificial lighting conflict, and disturbance of nesting activities by public nighttime beach activities.**

A professionally produced public service announcement for radio and TV would provide tremendous support and reinforcement of the many coastal lighting ordinances. It would generate greater support through understanding. The FWS, and State resource agencies should develop a high quality PSA which could be used throughout the Southeast during the nesting season.

34. **Ensure 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. Many are on public display and afford opportunities for public education. Display of accurate information on the basic biology and conservation problems should be a requirement of all permittees. All facilities should be visited by FWS, NMFS and the State permitting agencies to ensure captive sea turtles are being displayed in a way to meet these criteria.

35. **Develop standard criteria and recommendations for sea turtle nesting interpretive walks.**

Sea turtle walks are popular with the public and afford tremendous opportunities for public education or, if poorly conducted, misinformation. State permitting agencies and the FWS should develop standards for permittees conducting walks. These objective criteria should be used to evaluate sea turtle walks to ensure they are professional, provide accurate biological information, convey an accurate conservation message, and are a positive experience. Just as importantly they should not cause unnecessary or significant disturbance to nesting turtles.

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

Public access points to important nesting beaches provide excellent opportunities to inform the public of necessary precautions for compatible public use on the nesting beach and to develop public support through informational and educational signs. NCDNR, SCWMRD, GDNR, FDNR, FWS, NPS and other appropriate organizations should post such educational and informational signs on important nesting beaches as appropriate.

4. International cooperation.

41. Develop international agreements to ensure protection of life stages which occur in foreign waters.

There is compelling evidence that post-hatchling loggerheads from United States nesting beaches spend several years as juveniles in a transatlantic developmental stage. In the eastern Atlantic (Madeira, Azores and Canary Islands) small juveniles (<40 cm) are exploited for curios and food. Larger juveniles are common throughout the Bahamas where exploitation for food also is common. Populations in coastal waters of Cuba and Hispaniola likely originate from United States populations. Protecting loggerheads on United States nesting beaches and in United States waters therefore is not sufficient alone to ensure the continued existence of loggerheads. The NMFS and FWS should develop cooperative international agreements and programs with the governments of the Bahamas, Portugal, Cuba, Haiti, Dominican Republic, Spain and other countries where loggerheads originating from United States nesting populations occur.

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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 a 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. Management agreement
4. Exchange
5. Withdrawal
6. Fee title
7. Other

Other - O

1. Information and education
2. Law enforcement
3. Regulations
4. Administration

IMPLEMENTATION SCHEDULE

Loggerhead Turtle (Recovery Priority#7C)

General Category	Plan Task	Task Number	Priority	Task Duration	Responsible Agency	Estimated Fiscal Year Costs $000 Current	Fy 2	Fy 3	Fy 4	Fy 5	Comments/ Notes
M-3	Implement and evaluate beach tilling	1111	3	continuing	COE						No estimate; costs to be borne by specific nourishment projects
R-3	Evaluate sand characteristics relative to hatch success and nesting behavior	1112	2	4 years	COE		35	35	35	35	
M-3	Re-establish dunes and native vegetation on beach nourishment projects	1113	2	continuing	COE						No estimate; costs to be borne by specific nourishment projects
M-3, R-3	Evaluate sand transfer systems	1114	3	continuing	COE						Routine
O-3, M-3	Evaluate current laws on beach armoring	1121	1	continuing	FDNR, GDNR, SCCC, NCDNR						Routine
O-3, M-3	Enforce laws regulating coastal construction	1122	1	continuing	FDNR, GDNR, SCCC, NCDNR						Routine
M-3	Ensure failed erosion control measures are removed	1123	2	continuing	FDNR, GDNR, SCCC, NCDNR						Routine
M-3	Develop standard requirements for sand fence construction	1124	3	1 year	FDNR, GDNR, SCCC, NCDNR FWS						Routine; by 1-93
M-3	Evaluate and mitigate erosion on Cape island, SC	1131	2	3 - 5 years							No estimate for mitigation costs which are dependent on results of evaluation recommendations

IMPLEMENTATION SCHEDULE

Loggerhead Turtle (Recovery Priority#7C)

General Category	Plan Task	Task Number	Priority	Task Duration	Responsible Agency	Estimated Fiscal Year Costs $000 Current	Fy 2	Fy 3	Fy 4	Fy 5	Comments/ Notes
M-3	Identify other important nesting beaches with severe erosion	1132	3	continuing	FDNR, GDNR, SCC, NCDNR, FWS						Routine; mitigation costs to be determined after evaluation of any identified beaches
M-3, A-2 A-3, A-6	Acquire nesting beaches between Melbourne and Wabasso Beach, FL	1141	1	5 years	FWS FDNR	2 M 10 M	15 M 10 M	10 M 10 M	10 M 10 M	10 M 5 M	Total estimated costs of acquisition = 90M
M-3, A-2 A-3, A-6	Evaluate status of Hutchinson Island, FL and develop long-term protection plan	1142	2	2 years	FDNR FWS						Costs will be associated with acquisition if identified in protection plan; recommendations by 1-91
M-3	Evaluate status of other important nesting beaches	1143	2	1 year	FDNR GDNR SCWMRD						Routine
M-3	Remove exotic vegetation at Hobe Sound NWR, FL, St. Lucie State Park, FL and other important nesting beaches	115	3	continuing	FWS FDNR NPS	5 5	5 10	5 10	5 10	5 10	
R-2, R-3	Identify important marine foraging habitat	121	2	10-15 years	NMFS, FDNR, NCDNR, GDNR, TPW, ADNR, LDWF, VMRC SCWMRD, MDW						Funds are identified under 2211 because of research overlap with population studies
M-3, O-3	Prevent degradation and improve water quality of important marine habitat	122	3	continuing	NMFS, EPA, COE, FWS, CZM, coastal resource agencies						Routine
M-3, O-3	Prevent habitat degradation from fisheries gear	123	3	continuing	NMFS, coastal resource agencies						Routine

IMPLEMENTATION SCHEDULE

Loggerhead Turtle (Recovery Priority#7C)

General Category	Plan Task	Task Number	Priority	Task Duration	Responsible Agency	Estimated Fiscal Year Costs $000 Current	FY 2	FY 3	FY 4	Fy 5	Comments/ Notes
M-3	Prevent habitat destruction from oil and gas activities	124	3	continuing	MMS, COE, FWS						Routine
M-3	Prevent habitat destruction from dredging	125	3	continuing	COE, EPA, FWS						Routine
I-1	Monitor trends in nesting activity	211	1	continuing	FWS	150	200	200	200	200	Costs include activities in 212 and 2144
					FDNR	50	100	100	100	100	
					GDNR	10	20	20	20	20	
					SCWMRD	10	20	20	20	20	
					NCDNR	10	20	20	20	20	
					USAF	50	50	50	50	50	
					USMC						No estimate
					NPS	60	60	60	60	60	
					FPL	50	50	50	50	50	
					Dade Co., FL						No estimate
					Jupiter Isl., FL						No estimate
					Boca Raton, FL						No estimate
					Juno, FL						No estimate
I-1, M-4	Evaluate nest success and implement nest protection measures	212	1	continuing	same as 211						Costs included in 211
R-14, M-7	Determine influence of tidal inundation and foot traffic on hatch success	213	2	4 years	FWS			20	20		
					FDNR				20	20	
R-14, M-7	Determine hatchling orientation mechanisms and dispersal patterns	2141	2	2 years	USAF	110					
					KSC			75			
					CPA			25			
					NMFS						
					FWS						
M-7, O-3	Implement and enforce lighting ordinances	2142	2	continuing	NC, SC, GA, and FL coastal counties and cities						No estimate

IMPLEMENTATION SCHEDULE

Loggerhead Turtle (Recovery Priority#7C)

General Category	Plan Task	Task Number	Priority	Task Duration	Responsible Agency	Estimated Fiscal Year Costs $000 Current	FY 2	FY 3	FY 4	Fy 5	Comments/ Notes
I-14, M-7	Evaluate extent of hatchling disorientation on important regional nesting beaches	2143	2	5 years	FWS, FDNR; SCWMRD, GDNR, NCDNR, NC, SC, GA, and FL coastal counties and cities	30	30	30	30	30	
O-3	Evaluate need for Federal lighting regulations	2144	3		FWS						Routine
M-7	Develop lighting plans for Cape Canaveral region and Patrick AFB, FL	2145	2	4 years	DOD KSC CPA						No estimate; complete by FY 92 No estimate; complete by FY 93 No estimate; complete by FY 93
O-2	Prosecute parties responsible for hatchling disorientation	2146	3	continuing	FWS NMFS						Routine
M-7, O-3	Control vehicular traffic during nesting and hatching season	215	3	5 years	FDNR NPS NCDNR						Routine
O-2	Ensure coastal construction activities avoid disruption of nesting/hatchling activities	216	3	continuing	COE FDNR GDNR SCWMRD NCDNR FWS						Routine
O-2	Ensure law enforcement activities eliminate poaching and harassment	217	3	continuing	FWS FDNR GDNR SCWMRD NCDNR						Routine
R-14	Determine natural hatchling sex ratios	218	3	10 years	FWS FDNR GDNR						Costs included in 211

IMPLEMENTATION SCHEDULE

Loggerhead Turtle (Recovery Priority#7C)

General Category	Plan Task	Task Number	Priority	Task Duration	Responsible Agency	Estimated Fiscal Year Costs $000 Current	FY 2	FY 3	FY 4	Fy 5	Comments/ Notes
R-1, M-7	Define breeding aggregations	219	3	5 years	FWS		150	150	150	150	
R-1	Determine seasonal distribution, abundance, pop. characteristics, and status in inshore and nearshore waters	2211	1	15-20 years	NMFS, MMS, COE, FWS, FDNR, TPW, GDNR, SCWMRD, NCDNR		2 M	2 M	2 M	2 M	Total cost for all agencies
R-3, R-8, R-14, M-7	Determine navigation mechanisms, migratory pathways, distribution and movements	2212	2	5 years	NMFS FWS MMS COE		250	250	250	250	Total cost for all agencies
R-1, M-7	Determine threats along migratory routes and on foraging grounds	2213	2	continuing	NMFS FWS COE MMS						No estimate
R-14, M-7	Determine breeding population origins for U.S. juvenile/subadult populations	2214	3	5 years	NMFS FWS State resource agencies						Costs included in 219
R-1, R-6	Determine growth rates, age at sexual maturity, survivorship rates	2215	2	10-20 years	NMFS, FWS, State resource agencies		200	200	200	200	Additional costs included in 2211
O-2, O-3 M-7	Implement and enforce TED regulations	2221	1	continuing	NMFS State resource agencies						Routine
O-3	Provide technology transfer for installation and use of TEDS	2222	3	continuing	NMFS State sea grant agencies						Routine

IMPLEMENTATION SCHEDULE

Loggerhead Turtle (Recovery Priority#7C)

General Category	Plan Task	Task Number	Priority	Task Duration	Responsible Agency	Estimated Fiscal Year Costs $000 Current	FY 2	FY 3	FY 4	Fy 5	Comments/ Notes
I-1, I-14	Maintain sea turtle stranding network	2223	2	continuing	NMFS, FWS coastal State resource agencies						
I-1, I-14 M-7	Nesting pop. study Cumberland Island, GA (TED evaluation)	2224	3	continuing	NPS FWS	10	12	12	12	12	
I-14, O-3	Evaluate impacts of *Sargassum* harvest on hatchlings and implement appropriate measures	2225	2	2-3 years	NMFS NCDNR		10	10	10		
I-1, I-14 M-7	Monitor other fisheries causing mortality	2226	2	4-5 years	NMFS State resource agencies		120	120	120	120	
O-3, M-7	Promulgate regulations to reduce fishery related mortality	2227	2	continuing	NMFS State resource agencies						Routine
I-14, M-7	Monitor turtle mortality on dredges	2231	2	continuing	COE NMFS						No estimate; COE responsible for costs and NMFS for oversight
I-14, M-7	Evaluate modifications of dredge dragheads or devices to reduce turtle captures	2232	2	continuing	COE NMFS						No estimate; COE responsible for costs
I-1, M-7	Determine seasonality and abundance of turtles at dredging localities	2233	2	continuing	COE USN NMFS						No estimate; COE responsible for costs; costs included in estimates in 2211
R-14	Determine effects of oil and dispersants on all life stages	2241	2	continuing	MMS NMFS FWS industry						No estimate, MMS and industry responsible for costs

IMPLEMENTATION SCHEDULE

Loggerhead Turtle (Recovery Priority#7C)

General Category	Plan Task	Task Number	Priority	Task Duration	Responsible Agency	Estimated Fiscal Year Costs $000 Current	FY 2	FY 3	FY 4	Fy 5	Comments/ Notes
O-4, M-7	Ensure impacts are addressed during planning of oil and gas development	2242	3	continuing	MMS NMFS industry						Routine
R-1, M-7	Determine sea turtle distribution and seasonal use of marine habitats associated with oil and gas development	2243	3	3-5 years	MMS NMFS						Costs included in estimates in 2211
R-1, R-12	Evaluate extent of entanglement/ingestion of persistent marine debris	2251	2	10 years	NMFS EPA	30	100	100	100	100	
R-12	Evaluate effects of ingestion of persistent marine debris on health and viability	2252	2	5 years	NMFS EPA		50	50	50	50	
M-7, O-3	Implement measures to reduce or eliminate persistent marine debris	2253	2	continuing	EPA USCG USN State environmental agencies						No estimate
I-14, O-3	Evaluate mortality from recreational and commercial boats	226	2	3 years	NMFS State resource agencies						
O-2	Maintain law enforcement efforts to reduce poaching in United States waters	227	3	continuing	NMFS						Routine
I-14, O-4	Centralize tag series records	2281	3	1 year	NMFS FWS						Routine
I-14, O-4	Centralize turtle tagging records	2282	3	continuing	NMFS FWS		50	50	50	50	

IMPLEMENTATION SCHEDULE

Loggerhead Turtle (Recovery Priority#7C)

General Category	Plan Task	Task Number	Priority	Task Duration	Responsible Agency	Estimated Fiscal Year Costs $000 Current	FY 2	FY 3	FY 4	Fy 5	Comments/ Notes
R-14, M-7 O-3	Develop standards for care and maintenance of captive sea turtles	2291	3	5 years	NMFS FWS			20	20	20	
R-11, M-6	Develop manual for treatment of disease	2292	3	1 year	NMFS FWS			30			
M-7	Establish catalog for all captive sea turtles	2293	3	continuing	NMFS FWS						Routine
M-7	Designate rehabilitation facilities	2294	3	continuing	NMFS FWS						Routine
O-1	Provide slide programs/ information leaflets	31	3	continuing	FWS NMFS State resource agencies						Routine
O-1, M-7	Develop brochure on recommended lighting modifications	32	3	1 year	FWS NMFS						Routine
O-1, M-7	Develop PSA on artificial lighting problem	33	3	1 year	FDNR FWS		10 10				
O-1	Ensure permitted facilities display turtles with educational displays	34	3	continuing	FWS NMFS State resource agencies						Routine
O-1, M-7	Develop criteria for sea turtle interpretative walks	35	3	1 year	FWS FDNR						Routine
O-1, M-7	Post educational/informational signs on important nesting beaches	36	3	continuing	NCDNR SCWMRD GDNR FDNR						Routine
M-7, O-8	Develop international agreements	41	2	continuing	FWS NMFS						Routine