LOGGERHEAD SEA TURTLE
(*CARETTA CARETTA*)

5-YEAR REVIEW:
SUMMARY AND EVALUATION

NATIONAL MARINE FISHERIES SERVICE
OFFICE OF PROTECTED RESOURCES
SILVER SPRING, MARYLAND
AND
U.S. FISH AND WILDLIFE SERVICE
SOUTHEAST REGION
JACKSONVILLE ECOLOGICAL SERVICES FIELD OFFICE
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NATIONAL MARINE FISHERIES SERVICE

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U.S. FISH AND WILDLIFE SERVICE

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1.0 GENERAL INFORMATION

1.1 Reviewers

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1.2. Methodology used to complete the review

Dr. Wallace J. Nichols was contracted by the Services to gather and synthesize information regarding the biology and status of the loggerhead sea turtle. This review was subsequently compiled by a team of biologists from the National Marine Fisheries Service's (NMFS) Headquarters Office and the U.S. Fish and Wildlife Service's (FWS) Southeast Regional Office and the Jacksonville Ecological Services Field Office. Our sources include the final rule listing this species under the Act; the recovery plan; peer reviewed scientific publications; unpublished field observations by the Services, State, and other experienced biologists; unpublished survey reports; and notes and communications from other qualified biologists. The draft status review was sent out for peer review to nine academic professionals with expertise on the species and its habitats. Peer reviewers were provided guidance to follow during the review process. Comments received from peer reviewers were incorporated into the status review document (see Appendix). The public notice for this review was published on April 21, 2005, with a 90 day comment period (70 FR 20734). A few comments were received and incorporated as appropriate into the 5-year review.

1.3 Background

1.3.1 FR Notice citation announcing initiation of this review

April 21, 2005 (70 FR 20734)

1.3.2 Listing history

Original Listing
FR notice: 43 FR 32800
Date listed: July 28, 1978
Entity listed: Species
Classification: Threatened

1.3.3 Associated rulemakings

Regulations Consolidation Final Rule: 64 FR 14052, March 23, 1999. The purpose of this rule was to make the regulations regarding implementation of the Endangered Species Act of 1973 (ESA) by NMFS for marine species more concise, better organized, and therefore easier for the public to use.

1.3.4 Review history

Plotkin, P.T. (Editor). 1995. National Marine Fisheries Service and U.S. Fish and Wildlife Service Status Reviews for Sea Turtles Listed under the Endangered Species Act of 1973. National Marine Fisheries Service, Silver Spring, Maryland. 139 pages.
Conclusion: Retain the listing as a threatened species wherever they occur.

FWS also conducted a 5-year review for the loggerhead in 1991 (56 FR 56882). In this review, the status of many species was simultaneously evaluated with no in-depth assessment of the five factors or threats as they pertain to the individual species. The notice stated that FWS was seeking any new or additional information reflecting the necessity of a change in the status of the species under review. The notice indicated that if significant data were available warranting a change in a species' classification, the Service would propose a rule to modify the species' status. No change in the loggerhead's listing classification was recommended from these 5-year reviews.

Mager, A.M., Jr. 1985. Five-year status reviews of sea turtles listed under the Endangered Species Act of 1973. U.S. Department of Commerce, NOAA, National Marine Fisheries Service, St. Petersburg, Florida. 90 pages.
Conclusion: Inadequate information available to assess whether the status had changed since the initial listing as threatened wherever it occurs (1978).

1.3.5 Species' recovery priority number at start of review

National Marine Fisheries Service = 5 (this represents a moderate magnitude of threat, a high recovery potential, and the presence of conflict with economic activities).
U.S. Fish and Wildlife Service (48 FR 43098) = 7C (this represents a monotypic genus with a moderate degree of threat, a high recovery potential, and the

potential for conflict with construction or other development projects or other forms of economic activity).

1.3.6 Recovery plans

Name of plan: Recovery Plan for U.S. [Atlantic] Population of Loggerhead Turtle (*Caretta caretta*)
Date issued: December 26, 1991

Name of plan: Recovery Plan for U.S. Pacific Populations of the Loggerhead Turtle (*Caretta caretta*)
Date issued: January 12, 1998

Dates of previous plans: Original plan date - September 19, 1984

2.0 REVIEW ANALYSIS

2.1 Application of the 1996 Distinct Population Segment (DPS) policy

2.1.1 Is the species under review a vertebrate?

Yes.

2.1.2 Is the species under review listed as a DPS?

No.

2.1.3 Is there relevant new information for this species regarding the application of the DPS policy?

Yes. Although at this time, based on the best available information, the Services believe the current listing is valid, we have information that indicates an analysis and review of the species should be conducted in the future to determine the application of the DPS policy to the loggerhead turtle. See Section 2.3 for new information since the last 5-year review and Section 4.0 for additional information.

2.2 Recovery Criteria

2.2.1 Does the species have a final, approved recovery plan containing objective, measurable criteria?

No. The "Recovery Plan for U.S. [Atlantic] Population of Loggerhead Turtle (*Caretta caretta*)" was signed in 1991, and not all of the recovery criteria are measurable. However, a revision of this plan is underway. The "Recovery Plan for U.S. Pacific Populations of the Loggerhead Turtle (*Caretta caretta*)" was signed in 1998, and while not all of the recovery criteria strictly adhere to all elements of the 2004 NMFS Interim Recovery Planning Guidance, they are still a useful measure of the species status. See Section 4.0 for additional information.

The recovery criteria for the two active recovery plans are identified below, along with several key accomplishments:

1991 Recovery Plan for U.S. [Atlantic] Population of Loggerhead Turtle (Caretta caretta):

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.
   - In North Carolina, South Carolina, and Georgia, an average of 5,151 nests per year were documented from 1989-2005, well below the total target of 12,800 nests per season for these three states. Standardized ground surveys of 11 North Carolina, South Carolina, and Georgia nesting beaches showed a significant declining trend of 1.9% annually in loggerhead nesting from 1983-2005. In addition, standardized aerial nesting surveys in South Carolina have shown a significant annual decrease of 3.1% from 1980-2002.
   - In Florida, the South Florida Nesting Subpopulation showed a decrease in nests of 22.3% over the 17-year period from 1989-2005. The Florida Panhandle Nesting Subpopulation showed a significant declining trend of 6.8% annually from 1995-2005. No trend in the annual number of nests was detected in the Dry Tortugas Nesting Subpopulation from 1995 to 2004 (excluding 2002 when surveys were not conducted); because of the annual variability in nest totals, a longer time series is needed to detect a trend.

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.
   - As of 2005, 1,581 km of nesting beaches where loggerheads nest were within conservation lands in public (Federal, state, or local government) ownership and privately owned conservation lands (e.g., non-profit conservation foundations) in Virginia, North Carolina, South Carolina, Georgia, Florida, Alabama, Mississippi, Louisiana, and Texas. However, the majority of loggerhead nesting occurs within the states of North Carolina, South Carolina, Georgia, Florida, and Alabama. In these five states, 1,033 km of nesting beaches were within conservation lands (public or private ownership).

3. All priority one tasks have been successfully implemented.
    - State regulations that prohibit or discourage some forms of coastal armoring exist in Florida, South Carolina, and North Carolina. However, efforts are still needed to review existing state regulations and modify or promulgate new regulations to minimize impacts on loggerhead nesting (task 1121).
    - The Archie Carr National Wildlife Refuge, located in Brevard and Indian River Counties, Florida, was established in 1991. The acquisition plan for the refuge set a goal for the purchase of 15.0 km within a 33-km stretch of beach. Currently 9 km (60%) of the 15.0 km of beach targeted for protection have been acquired by FWS and its partners, including the Florida Department of Environmental Protection, Brevard County, Indian River County, Richard King Mellon Foundation, The Conservation Fund, and The Nature Conservancy. With the addition of the previously established Sebastian Inlet State Park (5 km), a total of 14 km of oceanfront habitat is protected within the 33-km stretch. However, because Sebastian Inlet State Park was already established prior to the establishment of the Archie Carr National Wildlife Refuge, and therefore not factored into the acquisition goal of 15 km, a total of 6 km is needed to complete acquisition of the Archie Carr NWR (task 1141).
    - Index/standardized nesting beach surveys are conducted annually in North Carolina, South Carolina, Georgia, Florida, and Alabama to monitor trends in nesting activity (task 211).
    - Nest monitoring and nest protection efforts are ongoing at National Wildlife Refuges in Virginia, North Carolina, South Carolina, Georgia, Florida, and Alabama, as well as on other beaches throughout the species U.S. nesting range (task 212).
    - A Geographic Information System for the U.S. Atlantic and Gulf of Mexico that includes data layers on sea turtle sightings, fishing effort, sea turtle bycatch, and oceanographic conditions is under development (task 2211).
    - In-water population studies in the Maryland portion of the Chesapeake Bay have been supported (task 2211).
    - Population identification of loggerheads has been conducted using DNA analysis (task 2211).
    - Vital population assessment work is ongoing under the Sea Turtle Stranding and Salvage Network, including genetic sampling and population structure analysis (task 2211).
    - Regulations requiring year-round use of TEDs by most shrimp trawlers operating in southeastern U.S. waters were required after December 1992 and modifications to improve turtle exclusion have been codified (task 2221).

1998 Recovery Plan for U.S. Pacific Populations of the Loggerhead Turtle (Caretta caretta):

To consider de-listing, all of the following criteria must be met:

1. To the best extent possible, reduce the take in international waters (have and enforce agreements).
   - Interaction rates and mortality rates have been reduced in the U.S. Pacific swordfish-directed longline fleets by requiring large circle hooks combined with non-squid bait; proper handling of hooked and entangled loggerheads; use of disentangling and de-hooking equipment such as dip nets, line cutters, and de-hookers; and implementing closures when incidental take caps are reached.
   - Turtle behavior and physiology research has been conducted to understand longline gear and bait interactions and gear mitigation options.
   - In collaboration with numerous Pacific nations, experiments have been conducted to evaluate modifications to longline gear and fishing practices to reduce sea turtle interactions in Pacific Ocean nearshore and high seas longline fisheries.
   - TED outreach and training efforts with various foreign governments are ongoing.

2. All regional stocks that use U.S. waters have been identified to source beaches based on reasonable geographic parameters.
   - Stock home ranges have been identified and population identification has been conducted of foraging, stranded, and bycaught loggerheads using DNA analysis.

3. All females estimated to nest annually (FENA) at "source beaches" are either stable or increasing for over 25 years.
   - No known nesting occurs within the U.S. Pacific or U.S. territories in the Pacific. However, loggerhead population trends outside the U.S. Pacific have been examined and conservation strategies via stochastic simulation models have been designed and evaluated.

4. Each stock must average 5,000 FENA (or a biologically reasonable estimate based on the goal of maintaining a stable population in perpetuity) over six years.
   - No known nesting occurs within the U.S. Pacific or U.S. territories in the Pacific.

5. Existing foraging areas are maintained as healthy environments.
   - Efforts to attain this goal are ongoing.

6. Foraging populations are exhibiting statistically significant increases at several key foraging grounds within each stock region.

- Aerial surveys in Baja California have been performed to quantify population density and habitat use of loggerhead turtles in off-shore waters; however, the duration of these surveys is insufficient to determine trends.

7. All Priority #1 tasks have been implemented.
   - Aerial surveys have been conducted to collect distribution and abundance data that will contribute to population assessments of loggerheads (task 2.1.2.1).
   - Migration routes and preferred oceanic habitats have been investigated by attaching satellite transmitters and tracking loggerheads from nesting beaches in Japan, from post-release in U.S. longline gear, and from foraging grounds off Baja California, Mexico (task 2.1.2.2).
   - Comparative studies of foraging, migration, and pelagic habitat use of turtles caught in the Hawaii-based longline fishery versus turtles caught via other situations have been conducted using satellite telemetry and oceanographic research (task 2.1.2.2).
   - Mortality from human activities in the Pacific Ocean has been estimated from NMFS observer data in the Hawaii-based longline fishery, California/Oregon drift gillnet fishery, and ongoing studies in Baja California (task 2.1.4.1).
   - Satellite telemetry has been used to investigate post-hooking survival of turtles incidentally captured in the Hawaii-based longline fishery (task 2.1.4.1).
   - Education and collaborative work with Mexican halibut set gillnet and bottom-set longline fisheries in Baja California were supported to reduce take of turtles (task 2.1.4.2).
   - Hawaii-based longline fishery participants have been educated about sea turtle mitigation requirements, including safe handling, gear removal, and release of turtles caught incidental to the fishery (task 2.1.4.2).
   - Fishery mitigation experiments have been conducted in Hawaiian longline and shoreline fisheries (task 2.1.4.2).
   - Support has been given to the Marshall Islands to build sea turtle conservation and management capacity (task 2.1.4.2).

8. A management plan designed to maintain stable or increasing populations of turtles is in place.
   - Not yet completed.

9. Ensure formal cooperative relationship with a regional sea turtle management program (SPREP).
   - The U.S. is a party to the South Pacific Regional Environment Program, which has goals to promote cooperation in the Pacific Islands region and to provide assistance to ensure sustainable development for present and future generations. Sea turtles are among the focal animal groups within this program.

10. International agreements are in place to protect shared stocks (e.g., Mexico and Japan).
    - The U.S. is a party to the Inter-American Convention for the Protection and Conservation of Sea Turtles, a binding agreement that has the potential to enhance the conservation of loggerhead turtles in U.S. Pacific waters and the western hemisphere.

2.3 Updated Information and Current Species Status

2.3.1 Biology and Habitat

The following section is not meant to be an exhaustive review of what is known about the loggerhead sea turtle. Rather, the section presents new information since the last status review that may indicate a change in species status or change in the magnitude or imminence of threats. In compiling this section, the best available information was used.

2.3.1.1 New information on the species' biology and life history:

This past decade has seen many technological advances and a diversity of research that have allowed us to better understand the biology of loggerheads, especially away from the nesting beach. With the extensive use of satellite transmitters and other data recorders, a significant new body of literature is now available on internesting and post-nesting movements, behavior, physiology, and habitat use, which has been valuable not only for a better understanding of loggerhead biology, but also for evaluating their exposure to and the impact of fishery bycatch. Molecular markers (i.e., mitochondrial DNA and microsatellites) have greatly advanced our understanding of the genetic structuring within and among ocean basins, both at the nesting beaches and at foraging grounds. Increased evaluation of bycatch worldwide has provided important insights into the conservation management of this species. Research conducted over the past decade is also leading to a greater understanding of demographic parameters such as age at maturity and survival rates. This five-year review incorporates relevant new information on loggerheads as an integral part of the review process in the sections that follow.

2.3.1.2 Abundance, population trends, and demographic features:

This section provides the best available information on abundance, population trends, and demographic features. Within the global range of the species, the primary data available are collected on nesting beaches, either as counts of nests, counts of nesting females, or a combination of both (either direct or extrapolated). In some cases nest count data are extrapolated to the number of nesting females within a season by dividing total nests by the average number of nests laid per female per season. In other cases, only the number of nests laid is provided. While this results in data that are not directly comparable, trends described for particular nesting beaches are useful, regardless of whether they describe trends in numbers of nest or numbers of nesting females. There is a paucity of information on abundance away from the nesting beaches, primarily because these data are, relative to nesting beach studies, difficult and expensive to obtain. Therefore, the primary information source for evaluating trends in global loggerhead populations is nesting beach data.

South Pacific Ocean

In the South Pacific Ocean, loggerhead nesting is almost totally restricted to eastern Australia and New Caledonia, and these nesting assemblages are not genetically distinct.

Until recently, eastern Australia supported one of the major global loggerhead nesting assemblages (Limpus 1985) and this population has been extensively studied. In 1977, an estimated 3,500 loggerheads nested annually in eastern Australia (Limpus and Reimer 1994). There has been a substantial decline at all nesting sites since that time. Now, less than 500 females nest annually, an 86% reduction in the size of the annual nesting population in 23 years (Limpus and Limpus 2003).

Comparable nesting surveys have not been conducted in New Caledonia however, information from pilot surveys conducted in 2005, combined with oral history information collected in conjunction with those surveys, suggest that there has been a decline in loggerhead nesting (Limpus *et al*. 2006). Based on data from the pilot study, only 60-70 loggerheads nested on the four surveyed New Caledonia beaches during the 2004-2005 nesting season (Limpus *et al*. 2006).

North Pacific Ocean

In the North Pacific, loggerhead nesting is essentially restricted to Japan. From 1998-2000, approximately 2,500 nests were documented annually across Japan and, considering clutch frequency, it is probable that fewer than 1,000 females breed annually in Japan (Kamezaki *et al*. 2003). Matsuzawa (2006) provided updated information on annual nest numbers from 2001 through 2004 – 3,122, 4,035, 4,519, and 4,854 nests were documented, respectively. Thus, over the short-term, seven year period, nest numbers increased gradually. However, these data are not sufficiently long-term to conclude a trend.

Kamezaki *et al*. (2003) reviewed census data collected from most of the Japanese nesting beaches. Although most surveys were initiated in the 1980's and 1990's, some data collection efforts were initiated in the 1950's. Along the Japanese coast, nine major nesting beaches (>100 nests/season) and six "submajor" beaches (10-100 nests/season) were identified. Census data from 12 of these 15 beaches provide composite information on longer-term trends in the Japanese nesting assemblage. Using information collected on these beaches, Kamezaki *et al*. (2003) concluded a substantial decline (50-90%) in the size of the annual loggerhead nesting population in Japan in recent decades.

Atlantic Ocean

Ehrhart *et al*. (2003) compiled a review of the abundance and population status of loggerheads in the Atlantic Ocean and presented new information since the completion of the previous five-year review. This information, along with newer information available since Ehrhart's review, is summarized below.

In the eastern Atlantic, the Cape Verde Islands support the only known loggerhead nesting assemblage in this region, and it is of at least intermediate size (Fretey 2001). The vast majority of nesting occurs on Boavista, Sal, Santa Luzia, and Maio Islands, several thousand females are believed to nest annually in the archipelago (Monzon-Arguello *et al.* 2007; L.F. López-Jurado, personal communication, cited in Ehrhart *et al*. 2003).

In the eastern Bahamas, on the Cay Sal Bank, studies have verified a previously unknown loggerhead nesting assemblage depositing approximately 500-600 nests per season (Addison and Morford 1996, Addison 1997).

Significant nesting concentrations have been documented along the mainland coast of Brazil from the state of Rio de Janeiro north to the state of Sergipe, with peak nesting along the coast of Bahia. Prior to 1980, loggerhead nesting populations in Brazil were considered severely depleted. Recently, Marcovaldi and Chaloupka (2007) report a long-term increase in nesting abundance over a 16-year period from 1988 through 2003. A total of 4,837 nests were reported for the 2003/2004 nesting season (Marcovaldi and Chaloupka 2007).

Ehrhart *et al*. (2003) reviewed the status of loggerhead nesting on the islands of Jamaica and Hispaniola. In Jamaica, 210 nesting females were reported in 1984 (Royer 1984), but there have been no recent reports of nesting. In Hispaniola, loggerheads were once abundant in Haitian waters, and nesting was reported at low levels in the early 1980s;

however, in both Haiti and the Dominican Republic there is currently no confirmed nesting activity (Ottenwalder 1996; C. Diez, personal communication, cited in Ehrhart *et al*. 2003; F. Moncada-Gavilán, personal communication, cited in Ehrhart *et al*. 2003).

In Cuba, 250-300 loggerhead nests per year were estimated in the early 2000s for the entire island, with two-thirds of these occurring on the southwestern coast (F. Moncada-Gavilán, personal communication, cited in Ehrhart *et al*. 2003).

In 2000, the Turtle Expert Working Group (TEWG), convened by the U.S. National Marine Fisheries Service, estimated between 53,000-92,000 nests per year in the southeastern United States and the Gulf of Mexico, and estimated the total number of nesting females as 32,000-56,000. In addition, the TEWG (2000) corroborated that the Atlantic population is comprised of four different loggerhead nesting subpopulations based on mtDNA analyses (Bowen 1994, 1995; Bowen *et al*. 1993; Encalada *et al*. 1998). One additional nesting subpopulation has since been identified by Pearce (2001). The five currently identified nesting subpopulations in the North Atlantic are the Northern Nesting Subpopulation, South Florida Nesting Subpopulation, Dry Tortugas Nesting Subpopulation, Florida Panhandle Nesting Subpopulation, and the Yucatán Nesting Subpopulation. Additional nesting subpopulations may be identified as sampling efforts and subsequent genetic analyses are conducted.

The Northern Nesting Subpopulation (occurring from North Carolina through northeastern Florida) had an average of 5,151 nests per year from 1989-2005 (Georgia Department of Natural Resources (GDNR), unpublished data; North Carolina Wildlife Resources Commission (NCWRC), unpublished data; South Carolina Department of Natural Resources (SCDNR), unpublished data). Standardized ground surveys of 11 North Carolina, South Carolina, and Georgia nesting beaches showed a significant (P=0.01) declining trend of 1.9% annually in loggerhead nesting from 1983-2005 (M. Dodd, Georgia Department of Natural Resources, personal communication, 2006; M. Godfrey, North Carolina Wildlife and Marine Resources Commission, personal communication, 2006; S. Murphy, South Carolina Department of Natural Resources, personal communication 2006). In addition, standardized aerial nesting surveys in South Carolina have shown a significant annual decrease of 3.1% from 1980-2002 (SCDNR, unpublished data).

The South Florida Nesting Subpopulation occurs from northeastern Florida through Pinellas County, Florida. A near complete census of this nesting subpopulation, undertaken from 1989 to 2006 reveals a mean of 65,460 loggerhead nests per year (approximately 15,966 females nesting per year) (Florida Fish and Wildlife Conservation Commission (FFWCC), unpublished data). During the majority of the 1990's, the South Florida Nesting Subpopulation showed an increase in numbers of nests of 3.6% annually from 1989-1998 (TEWG 2000) and the nesting assemblage was considered "stable or increasing" at that time (Witherington and Koeppel 2000). However, the most recent and longer time series data from the Florida Index Nesting Beach Survey Program, administered by FFWCC, show a significant decline in nesting. There has been a 22.3% decrease in the annual number of nests over the 17-year period from 1989-2005. In the past decade a decline of 39.5% has been reported (McRae 2006).

The Dry Tortugas Nesting Subpopulation occurs on several islands located west of Key West, Florida. A near complete census of this nesting subpopulation, undertaken from 1995 to 2004, excluding 2002, (9 years surveyed) reveals a mean of 246 nests per year (approximately 60 females nesting per year) (FFWCC, unpublished data). No surveys have been conducted since 2004. No trend in the number of nests laid was detected in the Dry Tortugas Nesting Subpopulation from 1995 to 2004 (excluding 2002 when surveys were not conducted); however, because of the annual variability in nest totals, a longer time series is needed to detect a trend.

The Florida Panhandle Nesting Subpopulation occurs along the northern Gulf Coast of Florida. A near complete census of this nesting subpopulation, undertaken from 1995 to 2006 reveals a mean of 910 nests per year (approximately 222 females nesting each year) (FFWCC, unpublished data). The Florida Panhandle Nesting Subpopulation showed a significant declining trend ($P=0.04$) of 6.8% annually from 1995 and 2005 (FFWCC, unpublished data).

The Yucatán Nesting Subpopulation (occurring in the eastern Yucatán Peninsula in Mexico) had a range of 903-2,331 nests from 1987-2001 along the central coast of Quintana Roo (Zurita *et al*. 2003). Zurita *et al*. (2003) reported a statistically significant increase in the number of nests laid on seven of the beaches in Quintana Roo, Mexico, from 1987-2001 where survey effort was consistent during the period. However, nesting since 2001 has declined and the previously reported increasing trend appears to have not been sustained (J. Zurita, personal communication, 2006).

Mediterranean Sea

The loggerhead turtle is the most common sea turtle species in the Mediterranean. The regionally established populations originate from the western Atlantic stock, which colonized the Mediterranean about 12,000 years ago, at the end of the last glacial period (Bowen *et al.* 1993). In addition to the regional nesting populations, a great many juvenile loggerheads originating from Atlantic nesting populations are encountered in the Mediterranean and especially in its western basin. An idea of the loggerhead abundance at sea can be drawn from their captures in longlines; Lewison *et al.* (2004) estimate at least 60,000-80,000 captures in 2000, mainly in the western Mediterranean. Aerial surveys conducted offshore the Spanish Mediterranean coast revealed an absolute abundance of 18,954 turtles (Gómez de Segura *et al.* 2006).

The great majority of loggerhead nesting in the Mediterranean has been reported from the eastern Mediterranean (i.e., east of Sicily Channel). Annual data from monitoring projects in Cyprus, Greece, Israel, Tunisia, and Turkey, reveal total annual nesting in the Mediterranean ranging from 3,375-7,085 nests per season (Margaritoulis *et al*. 2003). These are minimum numbers as a number of nests are made outside the monitored areas or in countries where monitoring is incomplete (e.g., Libya). Average annual nest numbers per country are 572 in Cyprus, 3,050 in Greece, 33 in Israel, 10 in Tunisia (Margaritoulis *et al*. 2003), and about 2,000 in Turkey (Canbolat 2004).

Approximately 25% of the documented loggerhead nesting in the Mediterranean occurs at Laganas Bay, Zakynthos Island, Greece (Margaritoulis 2005). Using standardized methodology, an average of 1,264 nests per season were recorded over a 22-year period (1984-2005) and 962 nests were recorded in 2006 (Margaritoulis *et al.* 2007). Analysis of nesting data at Laganas Bay since 1984 revealed no detectable trend, perhaps due to large annual fluctuations in nest numbers (Margaritoulis 2005, Koutsodendris *et al*. 2006).

Kyparissia Bay in western Peloponnesus, Greece, is the second most productive nesting beach in the Mediterranean, with an average of 620 nests per season (Margaritoulis and Rees 2001). Nesting surveys conducted from 1984-2006 revealed no detectable trend (Margaritoulis and Rees 2001; D. Margaritoulis, Sea Turtle Protection Society of Greece, unpublished data). Rethymno Beach on the Island of Crete, Greece, with an average of 350 nests/season is exhibiting a statistically significant decline over a 15-year period (1990-2004) (Margaritoulis *et al*. in press).

In Turkey, loggerhead nesting in Fethiye Beach, over a 12-year period (1993-2004), is declining (Ilgaz *et al.* 2007).

Recent surveys conducted during the 2000-2004 nesting seasons on the Ionian coast of Calabria in southern Italy have documented a small nesting assemblage of loggerheads; a total of 25 nests were recorded on 200 km of coastline. However, an undetermined number of nests were likely missed since the monitoring period only included the core nesting period and the northern sector was not sufficiently patrolled (Mingozzi *et al*. 2006).

In the southern Mediterranean, an approximate 3-week long survey, during peak nesting season, was conducted in Libya in 1995. A total of 176 nests over 50 beach segments totaling 142 km between the Egyptian border and Sirte were recorded (Laurent *et al*. 1995). Two other surveys, conducted under the same methodology, covered the remaining Libyan coast from Sirte to the Tunisian border and revealed less intense loggerhead nesting (Laurent *et al.* 1999). Despite the lack of complete quantification, the Libyan coast appears to host nesting levels of regional importance. In 2005 three beach segments totaling 15 km, were monitored regularly from 12 July to 24 September, and revealed 176 nests (Hamza *et al*. 2006).

Recent surveys in Lebanon have indicated important loggerhead nesting at El-Mansouri beach (1.4 km), close to the Israeli border (37 nests were documented from 15 June to 18 July 2002) (Newbury *et al.* 2002).

Indian Ocean

Loggerhead nesting has been documented in the southwestern, northern, and eastern Indian Ocean. Comprehensive nesting surveys to determine status and trends is lacking at most locations throughout the region. Baldwin *et al.* (2003) provided the most comprehensive assessment of regional nesting abundance and trends to date and concluded that the trend of six nesting assemblages was unknown, two were probably decreasing, and only one, the Tongaland, South Africa population, was increasing.

In the southwestern Indian Ocean the highest concentration of nesting occurs on the coast of Tongaland, South Africa, where surveys and management practices were instituted in 1963 (Baldwin *et al*. 2003). Standardized surveys along a 56km stretch of nesting beach indicate an increasing nesting trend from 1966 through 1999, with an average number of nesting females of 428 per year over the period 1989-1999 (Hughes 1999). Loggerhead nesting occurs elsewhere in South Africa, but sampling is not consistent and no trend data are available. The total number of females nesting annually in South Africa is estimated between 500-2,000 (Baldwin *et al.* 2003). In Mozambique, surveys have been instituted much more recently, likely less than 100 females nest annually and no trend data are available (Baldwin *et al.* 2003). Similarly, in Madagascar, loggerheads have been documented nesting in low numbers, but no trend data are available and they remain threatened by subsistence harvest of eggs and adults (Rakotonirina 2001).

The northern Indian Ocean hosts the largest nesting assemblage of loggerheads in the eastern hemisphere; the vast majority of these loggerheads nest in Oman (Baldwin *et al*. 2003). Nesting occurs in greatest density on the island of Masirah, Oman; the number of emergences ranges from 27-102/km/night (Ross 1998). Nesting densities have complicated the implementation of standardized nesting beach surveys, and precise nesting numbers remain unknown. Extrapolations resulting from partial surveys and tagging in 1977-1978 provided broad estimates of 19,000-60,000 females nesting annually at Masirah Island, while a more recent partial survey in 1991 provides an estimate of 23,000 nesting females at Masirah Island (Baldwin 1992; Ross 1979, 1998; Ross and Barwani 1982). A reinterpretation of these estimates, assuming 50% nesting success (as compared to 100% in the original estimates), resulted in an estimate of 20,000 to 40,000 females nesting annually (Baldwin *et al*. 2003). Trends in nesting cannot be determined due to the lack of standardized, long-term survey data (Baldwin *et al*. 2003), although since 2005 the Ministry of Regional Municipalities, Environment and Water Resources has begun efforts to standardize and expand survey efforts to be able to monitor trends and determine actual nesting population size (E. Possardt, FWS, personal communication, 2007). In addition to Masirah Island, loggerhead nesting occurs on additional beaches in Oman. For example, over 3,000 nests per year have been recorded on the Al-Halaniyat Islands, while along the mainland of the Arabian Sea about 2,000 nests are deposited per year (Salm 1991, Salm *et al*. 1993). In Yemen, on Socotra Island, 50-100 females were estimated to have nested in 1999 (Pilcher and Saad 2000).

Loggerhead nesting is rare elsewhere in the northern Indian Ocean and in some cases is complicated by inaccurate species identification (Shanker 2004, Tripathy 2005). A small number of nesting females use the beaches of Sri Lanka every year; however, there are no records that Sri Lanka has ever been a major nesting area for loggerheads (Kapurusinghe 2006). Loggerheads have been reported nesting in low numbers in Myanmar, however, these data may not be reliable because of mis-identification of species (Thorbjarnarson *et al*. 2000).

In the eastern Indian Ocean, loggerhead nesting is restricted to western Australia (Dodd 1988). Western Australia constitutes the largest nesting population in Australia (Wirsing *et al*., unpublished data, cited in Natural Heritage Trust 2005). Dirk Hartog Island, in Australia, hosts about 70-75% of nesting individuals in the eastern Indian Ocean (Baldwin *et al*. 2003). Surveys have been conducted on the island for the duration of six nesting seasons between 1993/1994 and 1999/2000 (Baldwin *et al*. 2003). An estimated 800-1,500 loggerheads nest annually on Dirk Hartog Island beaches (Baldwin *et al*. 2003).

Fewer loggerheads (approximately 150-350 per season) are reported nesting on the Muiron Islands; however, more nesting loggerheads are reported here than on North West Cape (approximately 50-150 per season) (Baldwin *et al*. 2003). Although data are insufficient to determine trends, evidence suggests the nesting population in the Muiron Islands and North West Cape region was depleted before recent beach monitoring programs began (Nishemura and Nakahigashi 1990, Poiner *et al*. 1990, Poiner and Harris 1996). This depletion has been attributed to European feral red fox populations (*Vulpes vulpes*), which have been known to prey on turtle eggs (R. Prince, Western Australia Department of Environment and Conservation, and P. Mack, Coral Bay Loggerhead Turtle Recovery Program, personal communications, 2006). The fox populations have recently been eradicated on Dirk Hartog and Muiron Islands (Baldwin *et al*. 2003).

2.3.1.3 Genetics and genetic variation:

Pacific Ocean

Bowen *et al*. (1995) identified two genetically distinct nesting stocks in the Pacific - a northern hemisphere stock nesting in Japan and a southern hemisphere stock nesting primarily in Australia. This study also identified an apparent presence of Australian origin individuals at foraging areas in the North Pacific, as indicated by a few individuals sampled as bycatch in the North Pacific that had a mtDNA haplotype only found in Australia (Bowen *et al*. 1995). More recently, Hatase *et al*. (2002) detected this common Australian haplotype at low frequency at Japanese nesting beaches. This finding, taken together with preliminary results from microsatellite (nuclear) analysis confirms that loggerheads inhabiting the north Pacific originate from nesting beaches in Japan (P. Dutton, NMFS, unpublished data). LeRoux *et al*. (2007) report additional genetic variation in north Pacific loggerheads based on analyses using new mtDNA primers designed to target longer mtDNA sequences. These findings indicate the possibility of finer scale population structuring in north Pacific loggerheads.

In the southern hemisphere, mtDNA analysis of samples from the New Caledonia nesting population does not indicate that this rookery is genetically distinct from the eastern Australia rookeries (M. Boyle, James Cook University, unpublished data). Work is underway with additional sequence data that may resolve finer scale structure, if it exists (P. Dutton, NMFS, personal communication, 2007).

Atlantic Ocean

Genetic analyses concluded since the last five-year review indicate five demographically independent groups in the western North Atlantic, corresponding to nesting beaches/nesting regions found in Florida and Mexico (see Section 2.3.1.2) (Bowen 1994, 1995; Bowen *et al*. 1993; Encalada *et al*. 1998; Pearce 2001; TEWG 2000). These nesting assemblages are vulnerable to extirpation due to low gene flow among them and the strong fidelity between nesting individuals and their natal beaches (Bowen *et al*. 1993). Loggerheads originating from nesting beaches in the western south Atlantic (Brazil) are genetically distinct from those originating in the western north Atlantic (Encalada *et al.* 1998; L.S. Soares, Projeto TAMAR, unpublished data). Loggerhead genetic structure in the eastern Atlantic, originating from nesting beaches along the west Africa coast, is currently under study.

Mediterranean Sea

Studies corroborate that the Mediterranean nesting population is genetically distinct from the western Atlantic population (Bowen *et al*. 1993; Laurent *et al*. 1993, 1998). In addition, a recent study analyzing samples from several nesting areas across the eastern Mediterranean has confirmed a complex genetic structure within the Mediterranean, with at least four independent population units (Carreras *et al*. 2007).

A portion of the juveniles found foraging in both the eastern and western basins of the Mediterranean Sea originate from the western Atlantic population (Basso and Cocco 1986; Bolten *et al*. 1992; Manzella *et al*. 1988). Approximately 53-55% of the juvenile loggerheads in both the western and eastern basins are derived from the Mediterranean nesting populations, and the rest are derived from the western Atlantic, while larger juveniles and adult loggerheads (possibly in the neritic stage) are all comprised of the Mediterranean population (Laurent *et al*. 1998).

Indian Ocean

The population genetic structure of loggerheads in the Indian Ocean is not as well understood as it is in other parts of the species global range. The South African nesting assemblage is genetically distinct and may include nesting assemblages in Mozambique. Nesting assemblages in Oman and Yemen also represent a distinct genetic stock. The genetic structure and relationship of loggerheads nesting in Madagascar and Sri Lanka remains unknown (SWOT 2006).

2.3.1.4 Taxonomic classification:

Kingdom: Animalia
Phylum: Chordata
Class: Reptilia
Order: Testudines
Family: Cheloniidae
Genus: *Caretta*
Species: *caretta*
Common name: Loggerhead sea turtle

2.3.1.5 Spatial distribution:

Pacific Ocean

Loggerheads can be found throughout tropical to temperate waters in the Pacific; however, their breeding grounds include a restricted number of sites in the north Pacific and south Pacific waters. Within the North Pacific, loggerhead nesting beaches are found only in Japan (Kamezaki *et al*. 2003). In the South Pacific, nesting beaches are restricted to eastern Australia and New Caledonia (Limpus and Limpus 2003).

Nesting occurs along the mainland of Australia from South Stradbroke Island to Bustard Head, and on the islands of the Capricorn Bunker Group and Swain Reefs, and on Bushy Island (Limpus and Limpus 2003). Within this area, five rookeries account for 70% of nests in eastern Australia: (1) Mon Repos, (2) Wreck Rock, (3) mainland and Wreck Island, (4) Erskine Island, and (5) Tryon Island (Limpus and Reimer 1994). Nesting individuals tagged on the coast of eastern Australia have been recorded foraging in New Caledonia, Queensland, New South Wales, Northern Territory, Solomon Islands, Papua New Guinea, and Indonesia (Limpus and Limpus 2003).

Important loggerhead nesting locations in Japan include Yakushima, and Miyazaki, Minabe, and Atsumi beaches on the mainland. However, about 40% of all loggerhead nesting in Japan occurs at three primary nesting beaches on Yakushima (Kamezaki *et al*. 2003). Important post-nesting hotspots have been identified in the East China Sea (Balazs 2006), while satellite tracking of juvenile loggerheads indicates the Kuroshio Extension Bifurcation Region to be an important pelagic foraging hotspot for juveniles (Polovina *et al*. 2006). Other important juvenile foraging hotspots have recently been identified off the coast of Baja California Sur, Mexico (Pittman 1990, Peckham and Nichols 2006). Foraging Pacific loggerheads are also known to migrate to Chile and Peru (Shigueto *et al*. 2006).

Atlantic Ocean

In the western north Atlantic, the overwhelming majority of loggerhead nesting is concentrated along the coasts of the United States from North Carolina through Florida. Additional important nesting beaches are found along the eastern Yucatan peninsula, at Cay Sal Bank in the eastern Bahamas (Addison and Morford 1996, Addison 1997), on the southwestern coast of Cuba (F. Moncada-Gavilán, personal communication, cited in Ehrhart *et al*. 2003), and along the coasts of Central America, Colombia, Venezuela, and the eastern Caribbean Islands. In the western south Atlantic, loggerheads nest in signficant numbers only in Brazil. In the eastern Atlantic loggerheads nest in the Cape Verde Islands (L.F. López-Jurado, personal communication, cited in Ehrhart *et al*. 2003) and along the west Africa coast.

As post-hatchlings, loggerheads hatched on U.S. beaches migrate offshore and become associated with *Sargassum* habitats, driftlines, and other convergence zones (Carr 1986). The oceanic juvenile stage in the North Atlantic has been primarily studied in the waters around the Azores and Madeira (Bolten 2003). In Azorean waters, satellite telemetry data and flipper tag returns suggest a long period of residency (Bolten 2003), whereas turtles appear to be moving through Madeiran waters (Dellinger and Freitas 2000). Other concentrations of oceanic juveniles exist in the Atlantic (e.g., in the region of the Grand Banks off Newfoundland), but data on these assemblages are very limited (Bolten 2003).

After departing the oceanic zone, neritic juvenile loggerheads in the western North Atlantic inhabit continental shelf waters from Cape Cod Bay, Massachusetts, south through Florida, the Bahamas, Cuba, and the Gulf of Mexico (neritic refers to the inshore marine environment from the surface to the sea floor where water depths do not exceed 200 meters). Estuarine waters, including areas such as Long Island Sound, Chesapeake Bay, Pamlico and Core Sounds, Mosquito and Indian River Lagoons, Biscayne Bay, Florida Bay, and numerous embayments fringing the Gulf of Mexico, comprise important inshore habitat. Along the Atlantic and Gulf of Mexico shoreline, essentially all shelf waters are inhabited by loggerheads.

Habitat preferences of non-nesting adult loggerheads in the neritic zone differ from the juvenile stage in that relatively enclosed, shallow water estuarine habitats with limited ocean access are less frequently used. Areas such as Pamlico Sound and the Indian River Lagoon, regularly used by juveniles, are only rarely frequented by adult loggerheads. Estuarine areas with more open ocean access, such as Chesapeake Bay in the northeast U.S., are more frequently used by adults, primarily during warmer seasons. Shallow water habitats with large expanses of open ocean access, such as Florida Bay, provide year-round resident foraging areas for significant numbers of male and female adult loggerheads. Offshore, adults primarily inhabit continental shelf waters, from New York south through Florida, the Bahamas, Cuba, and the Gulf of Mexico. Seasonal use of mid-Atlantic shelf waters, especially offshore New Jersey, Delaware, and Virginia, during summer months and offshore shelf waters, such as Onslow Bay (off the North Carolina coast), during winter months has been documented (GDNR, unpublished data; SCDNR, unpublished data). Shelf waters along the west Florida coast, the Bahamas, Cuba, and the Yucatán Peninsula have been identified, using satellite telemetry, as important resident areas for South Florida Nesting Subpopulation adult female loggerheads (Foley *et al*. in press).

Mediterranean Sea

Loggerhead turtles are widely distributed in the Mediterranean Sea. However, nesting is almost entirely confined to the eastern Mediterranean basin, with the main nesting concentrations in Cyprus, Greece, and Turkey (Margaritoulis *et al*. 2003). In addition, nesting has been verified in Libya, although a better quantification is needed (Laurent *et al*. 1995).

Minimal to moderate nesting also occurs in other countries throughout the Mediterranean including Egypt, Israel, Italy, Lebanon, Syria, and Tunisia (Margaritoulis *et al*. 2003). Recently, significant nesting has been recorded in the western Mediterranean basin, namely in Spain, Corsica, and in the Tyrrhenian Sea (Italy) (Bentivegna *et al.* 2005, Delaugerre and Cesarini 2004, Tomas *et al.* 2002).

In Cyprus, nesting occurs mainly on beaches of the western coast and Chrysochou Bay (Demetropoulos and Hadjichristophorou 1989), as well as along the northern coast (Broderick and Godley 1996). Seventeen important loggerhead nesting sites have been identified on Turkey's beaches (Margaritoulis *et al*. 2003). Nesting activity on Libya is spread throughout the entire coast, but may be less dense in western areas (Laurent *et al*. 1999). Nesting occurs along the western and southern coasts of Greece and on the island of Crete, yet the vast majority of nesting occurs on the island of Zakynthos (Margaritoulis 1987, 1998; Margaritoulis *et al*. 1995; Margaritoulis *et al*. 2003; Margaritoulis 2005).

Marine habitats have been suggested as: (1) Gulf of Gabés, and (2) northern Adriatic Sea, both of which constitute shallow benthic habitats for adults (including post-nesting females) and juveniles (Margaritoulis 1988, Argano *et al*. 1992, Laurent and Lescure 1994, Lazar *et al*. 2000).

Some other foraging areas include Amvrakikos Bay in western Greece and Lakonikos Bay in southern Greece. In addition, tagged juveniles have been recorded crossing the Mediterranean from the eastern to the western basin and vice versa (Argano *et al*. 1992).

Reproductive migrations have been confirmed by flipper tagging and satellite telemetry. Female loggerheads, after nesting in Greece, migrate mainly to the Gulf of Gabés and the northern Adriatic (Margaritoulis 1988, Margaritoulis *et al.* 2003, Zbinden *et al.* in review). Loggerheads nesting in Cyprus migrate to Egypt and Libya, exhibiting fidelity in following the same migration route during subsequent nesting seasons (Broderick *et al.* 2007). In addition, directed movements of juvenile loggerhead have been confirmed through flipper tagging (Argano *et al*. 1992) and satellite tracking (Rees and Margaritoulis in press).

Indian Ocean

In the southwestern Indian Ocean, loggerhead nesting includes the southeastern coast of Africa, spanning from the Paradise Islands in Mozambique southward to St. Lucia in South Africa, and on the south and southwestern coasts of Madagascar (Baldwin *et al*. 2003). Foraging habitats are only known of the Tongaland loggerheads, and appear to be non-specific, as these loggerheads are observed migrating eastward to Madagascar, northward to Mozambique, Tanzania, and Kenya, and southward to Cape Agulhas at the southernmost point of Africa and into the Atlantic Ocean (Baldwin *et al*. 2003).

In the northern Indian Ocean, Oman hosts the vast majority of loggerhead nests. Outside of Oman, loggerhead nesting is rare, although small nesting concentrations occur in Sri Lanka, southern India, and the Gulf of Mannar (Deraniyagala 1939; Kar and Bhaskar 1982; Dodd 1988; K. Shanker, Indian Institute of Science, personal communication, 2006). The majority of the nesting on Oman occurs on Masirah Island, on the Al Halaniyat Islands, and on mainland beaches south of Masirah Island all the way to the Oman-Yemen border (IUCN - The World Conservation Union 1989a, 1989b; Salm 1991; Salm and Salm 1991). In addition, nesting probably occurs on the mainland of Yemen on the Arabian Sea coast, and nesting has been confirmed on Socotra, an island off the coast of Yemen (Pilcher and Saad 2000). Limited information exists on the foraging whereabouts of northern Indian Ocean loggerheads; however, foraging individuals have been reported off the southern coastline of Oman (Salm *et al*. 1993). Satellite telemetry studies conducted in Oman have revealed new information on post-nesting migrations of loggerheads nesting on Masirah Island. Preliminary results reveal extensive use of the waters of the Arabian peninsula, with the majority of telemetered turtles traveling southwest following the shoreline of southern Oman and Yemen as far west as the Gulf of Aden and the Bab-el-Mandab. A minority traveled north as far as the western Arabian Gulf. These preliminary data suggest that post-nesting migrations and adult female foraging areas may be centered within the region (Environment Society of Oman and Ministry of Regional Municipalities, Water Resources and Environment, Oman, unpublished data).

The only verified nesting beaches for loggerheads on the Indian subcontinent are found in Sri Lanka. No credible nesting occurs on the mainland of India despite historical papers suggesting loggerhead sightings on mainland beaches (Tripathy 2005, Kapurusinghe 2006). This discrepancy may be attributed to inaccurate identification of nesting species, as loggerheads are sometimes confused with olive ridleys in the Indian Ocean (Tripathy 2005). In addition, the Gulf of Mannar provides foraging habitat for juveniles and post-nesting adults (Tripathy 2005, Kapurusinghe 2006). The only loggerhead nesting reported in south and southeastern Asia occurs in Myanmar (Thorbjarnarson *et al*. 2000).

In the eastern Indian Ocean, western Australia hosts all known loggerhead nesting (Dodd 1988). Nesting distributions in western Australia span from the Shark Bay World Heritage Area northward through the Ningaloo Marine Park coast to the North West Cape and to the nearby Muiron Islands (Baldwin *et al*. 2003). Nesting individuals from Dirk Hartog Island have been recorded foraging within Shark Bay and Exmouth Gulf, while other adults range much farther (Baldwin *et al*. 2003).

2.3.1.6 Habitat or ecosystem conditions:

Various human activities have resulted in increased predation altering the ecosystem dynamics of nesting beaches (Bjorndal 2003). For example, the intentional introduction of the red fox (*Vulpes vulpes*) in Australia resulted in intense predation of loggerhead nests (Limpus and Reimer 1994). The unintentional introduction of fire ants (*Solenopsis invicta*) in the United States has resulted in the killing of embryos and pre-emergent hatchlings (Bjorndal 2003). In Zakynthos, Greece, hatchling predation by sea gulls has been facilitated by a nearby landfill that attracts sea gulls (Margaritoulis *et al.* 2007). Changes in raccoon (*Procyon lotor*) distribution and abundance resulting from human activities (e.g., garbage, mosquito control impoundments) have resulted in this species being the most important predator of loggerhead eggs in the southeast U.S.

A shift in ecosystem dynamics may also result from increased consumption of marine organisms by humans, subsequently depleting the diversity and abundance of marine predators' prey (Pauly *et al*. 1998, Trites *et al*. 1997). Loggerheads may be vulnerable to this phenomenon (Bjorndal 1997), as some loggerhead prey items (e.g., saucer scallop and queen conch) may also be heavily fished human food items (Bjorndal 2003). Seney and Musick (2007) reported changes in loggerhead diet resulting from alterations of prey availability resulting from depletion of horseshoe and blue crabs in an important foraging habitat (Chesapeake Bay, Virginia, U.S.).

Additional information on habitat changes is included in the following Five-Factor Analysis.

2.3.2 Five-Factor Analysis (threats, conservation measures, and regulatory mechanisms)

The determination to list a species under the ESA is based on the best scientific and commercial data regarding five listing factors (see below). Subsequent 5-year reviews must also make determinations about the listing status based, in part, on these same factors.

2.3.2.1 Present or threatened destruction, modification or curtailment of its habitat or range:

Terrestrial Zone

Destruction and modification of loggerhead nesting habitats are occurring worldwide throughout the species range. The main anthropogenic (i.e., caused by humans) threats impacting loggerhead nesting habitat include coastal development/construction, placement of erosion control structures and other barriers to nesting, beachfront lighting, vehicular and pedestrian traffic, sand extraction, beach erosion, beach nourishment, beach pollution, removal of native vegetation, and planting of non-native vegetation (Baldwin 1992, NMFS and FWS 1998, Margaritoulis *et al*. 2003).

Worldwide, development near coastal areas continues and is a major problem as more and more people are moving to or visiting coastal areas. Coastal development may include, but is not limited to, the construction of roads, highways, public infrastructure, hotels, condominiums, houses, harbors, jetties, sea walls, and other forms of coastal armoring. All of these various forms of coastal construction alter nesting habitat to one degree or another, typically making it less suitable for nesting females, egg incubation, and hatchling emergence.

Erosion of nesting beaches can occur as a result of coastal development when native dune vegetation, which enhances beach stability and acts as an integral buffer zone between land and sea, is degraded or destroyed. This in turn often leaves insufficient nesting opportunities above the high tide line, and nests may be washed out. Preliminary studies on nesting beaches in New Caledonia include local oral histories that attribute the decrease in loggerhead nesting to the removal of vegetation for construction purposes and subsequent beach erosion (Limpus *et al*. 2006). In contrast, the planting or invasion of less stabilizing, non-native plants (e.g., Australian pines) can lead to increased erosion and degradation of suitable nesting habitat and can also increase shading, and therefore shift the population demographic to a male favored population (Schmelz and Mezich 1988). Planting of non-native plants can also have a detrimental effect in the form of roots invading eggs (e.g., tamarisk tree roots invading eggs in Zakynthos, Greece) (Margaritoulis *et al*. 2007). The noted decline of the nesting population at Rethymno, Island of Crete, Greece, is partly attributed to beach erosion caused by construction on the high beach and at sea (e.g., groins) (Margaritoulis *et al*. in press).

Sand extraction has been a serious problem on Mediterranean nesting beaches, especially in Turkey (Türkozan and Baran 1996), Cyprus (Godley *et al.* 1996), and Israel (Levy 2004).

Beach nourishment also affects the incubation environment and nest success. Although the placement of sand on beaches may provide a greater quantity of nesting habitat, the quality of that habitat may be less suitable than pre-existing natural beaches. Constructed beaches tend to differ from natural beaches in several important ways. They are typically wider, flatter, more compact, and the sediments are more moist than those on natural beaches (Nelson *et al*. 1987, Ackerman *et al*. 1991, Ernest and Martin 1999). On severely eroded sections of beach, where little or no suitable nesting habitat previously existed, sand placement can result in increased nesting (Ernest and Martin 1999). However, on most beaches, nesting success typically declines for the first year or two following construction, even though more nesting habitat is available for turtles (Trindell *et al*. 1998, Ernest and Martin 1999, Herren 1999). Reduced nesting success on constructed beaches has been attributed to increased sand compaction, escarpment formation, and changes in beach profile (Nelson *et al*. 1987, Crain *et al*. 1995, Lutcavage *et al*. 1997, Steinitz *et al.* 1998, Ernest and Martin 1999, Rumbold *et al*. 2001). Compaction can inhibit nest construction or increase the amount of time it takes for turtles to construct nests, while escarpments often cause female turtles to return to the ocean without nesting or to deposit their nests seaward of the escarpment where they are more susceptible to frequent and prolonged tidal inundation. In short, sub-optimal nesting habitat may cause decreased nesting success, place an increased energy burden on nesting females, result in abnormal nest construction (Carthy

1996), and reduce the survivorship of eggs and hatchlings. Crain *et al*. (1995) provides a review of the potential effects of beach nourishment on sea turtles. In addition, sand used in nourishing beaches may have a different composition than the original beach; thus introducing lighter or darker sand, consequently affecting the relative nest temperatures (Ackerman 1997, Milton *et al*. 1997).

The construction of beachfront armoring (e.g., rigid structures placed parallel to the shoreline on the upper beach to prevent both landward retreat of the shoreline and inundation or loss of upland property by flooding and wave action; includes bulkheads, seawalls, soil retaining walls, rock revetments, sandbags, and geotextile tubes) greatly impacts nesting opportunities and hatching success of loggerhead turtles. Mosier (1998) reported that fewer loggerheads made nesting attempts on beaches fronted by seawalls than on adjacent beaches where armoring structures were absent. Mosier (1998) and Mosier and Witherington (2002) found that when turtles did emerge in the presence of armoring structures, more returned to the water without nesting than those on non-armored beaches. Additionally, Mosier (1998) found that turtles on armored sections of beach tended to wander greater distances than those that emerged on adjacent natural beaches. Armoring structures can effectively eliminate a turtle's access to upper regions of the beach/dune system. Consequently, nests on armored beaches were generally found at lower elevations than those on non-walled beaches. Nests laid at lower elevations are subject to a greater risk of repeated tidal inundation and erosion, which can potentially alter thermal regimes, and thus sex ratios (Mrosovsky and Provancha 1989, Mrosovsky 1994, Ackerman 1997).

In the southeastern U.S., the proportion of coastline that was armored as of the early 2000s was approximately 18% (239 km) in Florida (Clark 1992, Schroeder and Mosier 2000), 9% (14 km) in Georgia (M. Dodd, GDNR, personal communication, 2000), 12% (29 km) in South Carolina (S. Murphy, SCDNR, personal communication, 2000), and 2% (9 km) in North Carolina (S. McGuire, North Carolina Division of Coastal Management, personal communication, 2000). In Japan, the entire potential nesting area on Hii-Horikiri beach on Yakushima is lined by a cement blockade forcing females to nest below the high tide line; thus, almost all nests left *in situ* are eventually washed away (Matsuzawa 2006). Likewise, on the primary nesting beach in New Caledonia, a rock wall was constructed to prevent coastal erosion, and nesting attempts have been unsuccessful. Local residents are seeking authorization to extend the wall further down the beach (Limpus *et al*. 2006).

Developments, such as roadways, high rise hotels, and condominiums, also contribute to habitat degradation by increasing noise and light pollution. Studies have shown that light pollution disorients hatchlings, causing them to move inland away from the ocean (Witherington 1997). Hatchlings unable to find the ocean, or delayed in reaching it, incur high mortality from dehydration, exhaustion, or predation (Ehrhart and Witherington 1987, Witherington and Martin 1996). Hatchlings lured into lighted parking lots or toward streetlights are often crushed by passing vehicles (Witherington and Martin 1996). In addition, light pollution deters nesting females from emerging onto the beach to nest (Witherington 1992). Reports of hatchling disorientation events in Florida describe several hundred nests each year and are likely to involve tens of thousands of hatchlings (Nelson *et al*. 2002). However, this number, calculated from disorientation reports, is likely a vast underestimate. Independent of these reports, Witherington *et al*. (1996) surveyed hatchling orientation at nests located at 23 representative beaches in six counties around Florida in 1993 and 1994 and found that, by county, approximately 10 to 30% of nests showed evidence of hatchlings disoriented by lighting. From this survey and from measures of hatchling production (FFWCC, unpublished data), the number of hatchlings disoriented by lighting in Florida is calculated in the range of hundreds of thousands per year. In the Mediterranean disorientation of hatchlings due to artificial lighting has been recorded mainly in Greece (Rees 2005, Margaritoulis *et al.* 2007, Margaritoulis *et al*. in press), and Turkey (e.g., Türkozan and Baran 1996).

Burgeoning numbers of visitors to beaches may cause sand compaction and nest trampling. For example, on Yakushima in Japan, egg mortality and hatchling emergence success is lower in areas where public access is not restricted and is mostly attributed to human foot traffic on nests (Kudo *et al*. 2003). In addition, the placement of recreational beach equipment (e.g., lounge chairs, cabanas, umbrellas, catamarans) degrades the suitability of beaches as nesting habitat by hampering or deterring nesting turtles from accessing the upper beach (Sobel 2002; Margaritoulis *et al*. 2007; FFWCC, unpublished data), thus limiting the potential area for nesting.

Operating public vehicles on nesting beaches for recreational purposes or beach access also degrades nesting habitat. The ruts left by vehicles in the sand prevent or impede hatchlings from reaching the ocean following emergence from the nest (Mann 1977, Hosier *et al*. 1981, Cox *et al*. 1994, Hughes and Caine 1994). Hatchlings impeded by vehicle ruts are at greater risk of death from predation, fatigue, desiccation, and being crushed by additional vehicle traffic. Light pollution from vehicle lights on the beach after dark may deter females from nesting and disorient hatchlings. Driving directly above incubating egg clutches can cause sand compaction, which may decrease hatching and emergence success and directly kill pre-emergent hatchlings (Mann 1977). Additionally, vehicle traffic on nesting beaches may contribute to erosion, especially during high tides or on narrow beaches where driving is concentrated on the high beach and foredune. In the U.S., driving is still allowed on some Florida, Georgia, North Carolina, and Texas beaches, including National Seashores. On Zakynthos Island in Greece, Venizelos *et al*. (2006) reported that vehicles drove along the beach and sand dunes throughout the tourist season on East Laganas and Kalamaki beaches, leaving deep ruts in the sand, disturbing sea turtles trying to nest, and impacting hatchlings trying to reach the sea. Baldwin (1992) identified regular beach driving as a serious threat to turtle nesting habitat in the Arabian region.

Neritic/Oceanic Zones

Habitat degradation and destruction in the neritic and oceanic zones occurs less conspicuously than it does in terrestrial zones. Direct impacts to bottom habitats occur from activities including bottom trawl fishing, channel dredging, and sand extraction. Indirect effects can result from both point and non-point source pollution (e.g., upland runoff, direct sewage discharge) associated with coastal development.

Perhaps the most destructive fishing methods in neritic ecosystems are bottom trawling and dredging. The ecological effects of trawling and dredging on the marine environment have been likened to the terrestrial ecological effects of clearcutting forests (Watling and Norse 1998).

Other fishing methods such as drift and set gillnets, longlines, and pots/traps affect both neritic and oceanic zones by not only incidentally capturing loggerheads but also depleting fish populations, and thus altering ecosystem dynamics. For example, depleted fish stocks in Zakynthos, Greece, likely contributed to predation of adult loggerheads by monk seals (Margaritoulis *et al.* 1996). In many cases loggerhead foraging areas coincide with fishing zones. For example, using satellite telemetry, juvenile foraging hotspots have recently been identified off the coast of Baja California, Mexico; these hotspots overlap with intense small-scale fisheries (Peckham and Nichols 2006). Selective and usually intense harvest of species in fisheries will result in changes in neritic and oceanic ecosystems (e.g., predator-prey interactions, trophic dynamics and food webs; see Bjorndal 2003). Seney and Musick (2007) reported changes in loggerhead diet resulting from alterations of prey availability in an important foraging habitat. Comprehensive data are lacking to fully understand and quantify these impacts.

Marine pollution can affect loggerhead habitats in both the neritic and oceanic zones. These impacts include contamination from herbicides, pesticides, oil spills, and other chemicals, as well as structural degradation from excessive boat anchoring and dredging (Francour *et al*. 1999, Lee Long *et al*. 2000, Waycott *et al*. 2005). In the Mediterranean Sea, underwater explosives have been identified as a key threat to loggerhead habitat in internesting areas (Margaritoulis *et al*. 2003).

2.3.2.2 Overutilization for commercial, recreational, scientific, or educational purposes:

Deliberate hunting of loggerheads for their meat, shells, and eggs is reduced from previous exploitation levels, but still exists. In Egypt, turtles are sold in fish markets despite prohibitive laws, 68% of these turtles were loggerheads (Laurent *et al*. 1996). Nada (2001) reported 135 turtles (of which 85% loggerheads) slaughtered at the fish market of Alexandria in six months (December 1998-May 1999). In the southwestern Indian Ocean, on the east coast of Africa, subsistence hunting by the local people constitutes a consistent threat to the loggerhead (Baldwin *et al*. 2003). In Sri Lanka, populations are declining mainly due to turtle egg exploitation and meat hunting (Frazier 1980, Hewavisenthi 1990). Preliminary studies suggest that local harvesting in New Caledonia constitutes about 5% of the nesting population (Limpus *et al*. 2006). Meanwhile, legislation in Australia outlaws the harvesting of loggerheads by indigenous peoples (Limpus *et al.* 2006), while in Japan, egg harvesting no longer represents a problem (Ohmuta 2006).

In the Caribbean, 14 of 28 (50%) countries/territories allow the harvest of loggerheads. The loggerhead harvest in the Caribbean is generally restricted to the non-nesting season with the exception of St. Kitts and Nevis and the Turks and Caicos Islands. Most countries/territories, with the exception of Haiti and Trinidad and Tobago, have size restrictions that favor the harvest of large juveniles and adults, the most reproductively valuable members of the population. All Central and South American countries in the northwest Atlantic legislate complete protection of loggerheads in their territorial waters with the exception of Guyana. Despite national laws, in many countries the poaching of eggs and hunting of adults and juveniles is still a problem, as seen in Baja California Sur, Mexico (Koch *et al*. 2006). As the population of black turtles has declined in Baja California Sur waters, poachers have switched to loggerheads (H. Peckham, Pro Peninsula, personal communication, 2006).

2.3.2.3 Disease or predation:

The population level effects of diseases in loggerheads are not known. At least two bacterial diseases have been described in wild loggerhead populations, including bacterial encephalitis and ulcerative stomatitis/obstructive rhinitis/pneumonia (George 1997). There are few reports of fungal infections in wild loggerhead populations. Homer *et al*. (2000) documented systemic fungal infections in stranded loggerheads in Florida. Both bacterial and fungal infections are common in captive sea turtles (Herbst and Jacobson 1995, George 1997).

Viral diseases have not been documented in free-ranging loggerheads, with the possible exception of sea turtle fibropapillomatosis, which may have a viral etiology (Herbst and Jacobson 1995, George 1997). Fibropapillomatosis is a disease that is characterized by the presence of internal and/or external tumors (fibropapillomas). External tumors can interfere with swimming, vision, and feeding. Although fibropapillomatosis reaches epidemic proportions in some wild green turtle populations, the prevalence of this disease in most loggerhead populations is thought to be small. An exception is Florida Bay in the southeastern U.S. where approximately 11-13% of the loggerhead population is afflicted with fibropapillomatosis (Schroeder *et al*. 1998; B. Schroeder, NMFS, personal communication, cited in Ehrhart *et al*. 2003). Also, in Moreton Bay, Australia, 4.4% of the 320 loggerheads captured exhibited the disease during 1990-1992 (Limpus *et al*. 1994). Mortality levels associated with the disease are still unknown.

A variety of endoparasites, including trematodes, tapeworms, and nematodes have been described in loggerheads (Herbst and Jacobson 1995). Heavy infestations of endoparasites may cause or contribute to debilitation or mortality in sea turtles. Trematode eggs and adult trematodes were recorded in a variety of tissues including the spinal cord and brain of debilitated loggerheads during an epizootic in South Florida during late 2000 and early 2001. These endoparasites were implicated as a possible cause of the epizootic (i.e., an epidemic outbreak of disease in an animal population) (Jacobson *et al*. 2006). Endoparasites in loggerheads have been also studied in the western Mediterranean (Aznar *et al.* 1998).

Depredation of sea turtle eggs and hatchlings by native and introduced species occurs on almost all nesting beaches in the southeastern U.S. For instance, Witherington *et al*. (2006) report that survivorship from egg to hatchling is highly variable on Florida nesting beaches and identify depredation, especially by raccoons, as one of the key factors affecting survivorship of this life stage. In 2001, 635 (20%) of 3,110 sample nests on Florida beaches were depredated by raccoons (*Procyon lotor*), ghost crabs (*Ocypode quadrata*), nine-banded armadillos (*Dasypus novemcinctus*), foxes (*Urocyon cinereoargenteus* and *Vulpes vulpes*), domestic dogs (*Canis domesticus*), feral pigs (*Sus scrofa*), spotted skunks (*Spilogale putorius*), and unidentified larval insect species (Witherington *et al*. 2006). On Ossabaw Island, Georgia, in 2005, feral pigs completely depredated 16% of loggerhead nests and partially depredated an additional 5% in spite of an active feral pig control program (Dodd and Mackinnon 2005). In addition to the destruction of eggs, predators may take considerable numbers of hatchlings prior to or upon emergence from the sand. Most major nesting beaches in the southeast U.S. employ some type of control (e.g., trapping and removal, nest screening) of mammalian predators to reduce nest loss.

In the Mediterranean Sea, loggerhead hatchlings and eggs are subject to depredation by wild canids (i.e., foxes, jackals), feral/domestic dogs, and ghost crabs (Margaritoulis *et al*. 2003). Predators have caused the loss of 48.4% of loggerhead clutches at Kyparissia Bay, Greece (Margaritoulis 1988), 70-80% at Dalyan Beach, Turkey (Erk'akan 1993), 36% (includes green turtle clutches) in Cyprus (Broderick and Godley 1996), and 44.8% in Libya (Laurent *et al*. 1995). Loggerhead eggs are also depredated by insect larvae in Cyprus (McGowan *et al*. 2001), Turkey (Özdemir *et al*. 2004), and Greece (Lazou and Rees 2006). Predation of adult loggerheads (nesting females) by golden jackals (*Canis aureus*) has been recorded in Turkey (Peters *et al.* 1994).

In the southwestern Indian Ocean, side striped jackals (*Canis adustus*) and honey badgers (*Mellivora capensis*) depredate nests (Baldwin *et al*. 2003). In the eastern Indian Ocean along the Ningaloo coast of western Australia, red fox have long preyed on loggerhead eggs on the North West Cape and mainland nesting beaches. Baldwin *et al*. (2003) suggest this long-term predation may be one of the reasons for the decrease in mainland loggerheads.

In the Pacific, a feral dog population poses a threat to loggerheads nesting in New Caledonia, and thus far no management has been implemented (Limpus *et al*. 2006). During the late 1970s and 1980s, introduced red foxes destroyed a large proportion of loggerhead eggs on eastern Australia mainland beaches (Limpus 1985). Fox-baiting around nesting areas in Australia commenced in the late 1980s, and currently egg loss due to fox depredation is limited to less than 5% annually (Limpus *et al*. 2006). However, researchers believe the earlier egg loss will greatly impact recruitment to this nesting population in the early 21st century (Limpus and Reimer 1994).

2.3.2.4 Inadequacy of existing regulatory mechanisms:

Loggerheads are highly migratory, which makes them a shared resource among many nations. Therefore, conservation efforts for loggerhead populations in one country may be jeopardized by activities in another. Many countries lack regulations or have inadequate regulations in place to address the impacts of a wide range of anthropogenic activities that directly injure and kill loggerheads, disrupt necessary behaviors, and alter terrestrial and marine habitat used by the species. In particular, improved regulations of fisheries that incidentally capture loggerheads are needed to reduce mortality. Improved fishery observer coverage is also needed to provide more basic information on loggerhead bycatch. Government regulation and community programs need to be initiated or strengthened to address the impacts of turtle hunting and egg poaching. Overall, increased efforts are needed to assist many foreign countries with the enactment and enforcement of national regulations to protect loggerheads.

The conservation and recovery of sea turtles is facilitated by a number of regulatory instruments at international, regional, national, and local levels. As a result of these designations and agreements, many of the intentional impacts directed at sea turtles have been lessened: harvest of eggs and adults has been slowed at several nesting areas through nesting beach conservation efforts and an increasing number of community-based initiatives are in place to slow the take of turtles in foraging areas. Moreover, there is now a more internationally concerted effort to reduce sea turtle interactions and mortality in artisanal and industrial fishing practices.

Despite these advances, human impacts continue throughout the world. The lack of comprehensive and effective monitoring and bycatch reduction efforts in many pelagic and near-shore fisheries operations still allows substantial direct and indirect mortality, and the uncontrolled development of coastal and marine habitats threatens to destroy the supporting ecosystems of long-lived sea turtles. Although several international agreements provide legal protection for sea turtles, additional multi-lateral efforts are needed to ensure they are sufficiently implemented and/or strengthened, and key non-signatory parties need to be encouraged to accede.

Considering the worldwide distribution of loggerhead turtles, the majority of legal instruments that target or impact sea turtles cover loggerhead turtles. A summary of the main regulatory instruments from throughout the world that relate to loggerhead turtle management is provided below. The pros and cons of many of these were recently evaluated by Hykle (2002), and a summary of his findings is given when appropriate.

United States Magnuson-Stevens Fishery Conservation and Management Act

The recently-amended U.S. Magnuson-Stevens Fishery Conservation and Management Act (MSA), implemented by NMFS, mandates environmentally responsible fishing practices within U.S. fisheries. Section 301 of the MSA establishes National Standards to be addressed in management plans. Any regulations promulgated to implement such plans, including conservation and management measures, shall, to the extent practicable, (A) minimize bycatch and (B) to the extent bycatch cannot be avoided, minimize the mortality of such bycatch. Section 301 by itself does not require specific measures. However, mandatory bycatch reduction measures can be incorporated into management plans for specific fisheries, as has happened with the U.S. pelagic longline fisheries in the Atlantic and Pacific oceans. Section 316 requires the establishment of a bycatch reduction engineering program to develop "technological devices and other conservation engineering changes designed to minimize bycatch, seabird interactions, bycatch mortality, and post-release mortality in Federally managed fisheries."

FAO Technical Consultation on Sea Turtle-Fishery Interactions

While not a true international instrument for conservation, the Food and Agriculture Organization of the United Nations' (FAO) technical consultation on sea turtle-fishery interactions was groundbreaking in that it solidified the commitment of this international body to reduce sea turtle bycatch in marine fisheries operations. Recommendations from the technical consultation were endorsed by the FAO Committee on Fisheries (COFI) and called for the immediate implementation by member nations and Regional Fishery Management Organizations (RFMOs) of guidelines to reduce sea turtle mortality in fishing operations, developed as part of the technical consultation. Compliance with these guidelines is voluntary.

Indian Ocean – South-East Asian Marine Turtle Memorandum of Understanding (IOSEA)

This MOU puts in place a framework through which States of the Indian Ocean and South-East Asian region, as well as other concerned States, can work together to conserve and replenish depleted marine turtle populations for which they share responsibility. This collaboration is achieved through the collective implementation of an associated Conservation and Management Plan. Currently, there are 26 signatory states. The United States became a signatory in 2001. Numerous accomplishments have been made under the auspices of this MOU (for detailed information, visit the IOSEA website at http://www.ioseaturtles.org).

Memorandum of Understanding on ASEAN Sea Turtle Conservation and Protection

The objectives of this MOU, initiated by the Association of South East Asian Nations (ASEAN), are to promote the protection, conservation, replenishing, and recovery of sea turtles and their habitats based on the best available scientific evidence, taking into account the environmental, socio-economic and cultural characteristics of the Parties. It currently has nine signatory states in the South East Asian Region. Additional information is available at http://www.aseansec.org/6185.htm.

Memorandum of Understanding Concerning Conservation Measures for Marine Turtles of the Atlantic Coast of Africa.

This MOU was concluded under the auspices of the Convention on the Conservation of Migratory Species of Wild Animals (CMS) and became effective in 1999. It aims at safeguarding six marine turtle species - including the loggerhead turtle - that are estimated to have rapidly declined in numbers during recent years due to excessive exploitation (both direct and incidental) and the degradation of essential habitats. However, despite this agreement, killing of adult turtles and harvesting of eggs remains rampant in many areas along the Atlantic African coast. Additional information is available at http://www.cms.int/species/africa_turtle/AFRICAturtle_bkgd.htm.

Inter-American Convention for the Protection and Conservation of Sea Turtles (IAC)

This Convention is one of only a handful of international treaties dedicated exclusively to sea turtles, setting standards for the conservation of these endangered animals and their habitats with a large emphasis on bycatch reduction. It is the only binding multi-national agreement for sea turtles and is open to all countries in North, Central, and South America, and the Caribbean. It currently has 12 signatory countries, with the United States being a signatory in 1999. Additional information is available at http://www.iacseaturtle.org.

Convention on the Conservation of Migratory Species of Wild Animals

This Convention, also known as the Bonn Convention or CMS, is an international treaty that focuses on the conservation of migratory species and their habitats. As of January 2007, the Convention had 101 member states, including parties from Africa, Central and South America, Asia, Europe, and Oceania. While the Convention has successfully brought together about half the countries of the world with a direct interest in sea turtles, it has yet to realize its full potential (Hykle 2002). Its membership does not include a number of key countries, including Brazil, Canada, China, Indonesia, Japan, Mexico, Oman, and the United States. Additional information is available at http://www.cms.int.

Convention on Biological Diversity (CBD)

The primary objectives of this international treaty are 1) the conservation of biological diversity, 2) the sustainable use of its components, and 3) the fair and equitable sharing of the benefits arising out of the utilization of genetic resources. This Convention has been in force since 1993 and currently has 190 Parties. While the Convention provides a framework within which broad conservation objectives may be pursued, it does not specifically address sea turtle conservation (Hykle 2002). Additional information is available at http://www.cbd.int.

Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES)

Known as CITES, this Convention was designed to regulate international trade in a wide range of wild animals and plants. CITES was implemented in 1975 and currently includes 169 Parties. Although CITES has been effective at minimizing the international trade of sea turtle products, it does not limit legal and illegal harvest within countries, nor does it regulate intra-country commerce of sea turtle products (Hykle 2002). Additional information is available at http://www.cites.org.

Protocol Concerning Specially Protected Areas and Biological Diversity in the Mediterranean

This Protocol is under the auspices of the Barcelona Convention for the Protection of the Mediterranean Sea against Pollution. It has been in force since 1999 and includes general provisions to protect sea turtles and their habitats within the Mediterranean Sea. The Protocol requires Parties to protect, preserve, and manage threatened or endangered species, establish protected areas, and coordinate bilateral or multilateral conservation efforts (Hykle 2002). In the framework of this Convention, to which all Mediterranean countries are parties, the Action Plan for the Conservation of Mediterranean Marine Turtles has been in effect since 1989. Additional information is available at http://www.rac-spa.org.

Convention on the Conservation of European Wildlife and Natural Habitats

Also known as the Bern Convention, the goals of this instrument are to conserve wild flora and fauna and their natural habitats, especially those species and habitats whose conservation requires the cooperation of several States, and to promote such co-operation. The Convention was enacted in 1982 and currently includes 45 European and African States and the European Union. According to Hykle (2002), while the Convention's "innovative approach to holding States to account for their implementation of the Convention is laudable, and has certainly drawn attention to issues of species and habitat protection, its efficacy in relation to particular marine turtle cases that have been deliberated for many years is debatable." Additional information is available at http://www.coe.int/t/e/cultural_co-operation/ environment/nature_and_biological_diversity/Nature_protection.

Convention for the Protection and Development of the Marine Environment of the Wider Caribbean Region

Also called the Cartagena Convention, this instrument has been in place since 1986 and currently has 21 signatory states. Under this Convention, the component that may relate to loggerhead turtles is the Protocol Concerning Specially Protected Areas and Wildlife (SPAW) that has been in place since 2000. The goals of this protocol are to encourage Parties "to take all appropriate measures to protect and preserve rare or fragile ecosystems, as well as the habitat of depleted, threatened or endangered species, in the Convention area." All six sea turtle species in the Wider Caribbean are listed in Annex II of the protocol, which prohibits (a) the taking, possession or killing (including, to the extent possible, the incidental taking, possession or killing) or commercial trade in such species, their eggs, parts or products, and (b) to the extent possible, the disturbance of such species, particularly during breeding, incubation, estivation, migration, and other periods of biological stress. Hykle (2002) believes that in view of the limited participation of Caribbean States in the aforementioned Convention on the Conservation of Migratory Species of Wild Animals, the provisions of the SPAW Protocol provide the legal support for domestic conservation measures that might otherwise not have been afforded. Additional information is available at http://www.cep.unep.org/law/cartnut.html.

Convention for the Protection of the Natural Resources and Environment of the South Pacific Region

This Convention has been in force since 1990 and currently includes 12 Parties. The purpose of the Convention is to protect the marine environment and coastal zones of the South-East Pacific within the 200-

mile area of maritime sovereignty and jurisdiction of the Parties, and beyond that area, the high seas up to a distance within which pollution of the high seas may affect that area. Additional information is available at http://ekh.unep.org/?q=node/684.

2.3.2.5 Other natural or manmade factors affecting its continued existence:

The most significant manmade factor affecting the conservation and recovery of the loggerhead is incidental capture in commercial and artisanal fisheries. Incidental capture (bycatch) of loggerheads occurs in various fisheries throughout the range of the species. Longline gear, drift and set gillnet, bottom trawling, fishing dredges, and pot and trap gear are the primary gear types affecting loggerheads. While significant progress has been made to reduce bycatch in some fisheries in certain parts of the loggerhead range, serious bycatch problems remain unaddressed.

In the Mediterranean, longline fisheries may be the primary source of loggerhead bycatch. The most severe bycatch in the Mediterranean occurs around Balearic Islands where 1,950-35,000 juveniles are caught annually in the longline fishery (Aguilar *et al*. 1995; Camiñas 1988, 1997; Mayol and Castello Mas 1983). Gerosa and Casale (1999) estimated that incidental bycatch, marine pollution, debris ingestion, and boat collisions, affect more than 35,000 turtles annually in the Mediterranean.

In the northern Indian Ocean bycatch is a significant threat to loggerheads (Kapurusinghe and Cooray 2002). A bycatch survey recently administered off the coast of Sri Lanka reported 5,241 total turtle entanglements between Kalpitiya and Kirinda during November-June 2000, of which 1,310 were loggerheads (Kapurusinghe and Saman 2001).

In the U.S. Atlantic, a variety of fishing gears that incidentally capture loggerhead turtles are employed including gillnets, trawls, hook and line, longlines, seines, dredges, and various types of pots/traps. Among these, gillnets, longlines, and trawl gear collectively result in tens of thousands of loggerhead deaths annually in the Atlantic Ocean and Gulf of Mexico. Considerable effort has been expended since the 1980s to document and address some of these serious mortality factors. Observer programs have been implemented in most federally managed fisheries to collect turtle bycatch data and efforts to reduce bycatch and mortality of loggerheads in certain fishing operations have been undertaken. These efforts include developing gear solutions to prevent or reduce captures or to allow turtles to escape without harm (e.g., TEDs, circle hooks and bait combinations), implementing time and area closures to prevent interactions from occurring (e.g., prohibitions on gillnet fishing along the mid-Atlantic coast during the critical time of northward migration of loggerheads), and/or modifying gear (e.g., requirements to reduce mesh size in the leaders of pound nets to prevent entanglement).

In the eastern Pacific, significant bycatch has been reported in gillnet and longline fisheries operating out of Peru (Shigueto *et al*. 2006). Extensive ongoing studies regarding loggerhead mortality and bycatch have been administered off the coast of Baja California Sur, Mexico. The location and timing of loggerhead strandings indicate bycatch in the halibut fishery which employs gillnets and longlines (Peckham and Nichols 2002). Based on fisheries observations and surveys conducted in 2005, 900 loggerheads were estimated killed by just 2 of the 10 or more small-scale fishing fleets that fish the loggerhead juvenile foraging areas off the coast of Baja California Sur, Mexico (Peckham *et al*. 2006). These results suggest that incidental capture at Baja California Sur is one of the most significant sources of mortality identified for the north Pacific loggerhead population and underscores the importance of reducing bycatch in small-scale fisheries.

In the western Pacific, bottom trawling gear has been a contributing factor to the decline in the eastern Australian loggerhead population (Limpus and Reimer 1994). Robins (1995) estimated that 4,064-6,526 sea turtles captured annually in the Queensland east coast otter trawl fishery, the predominant species captured was the loggerhead. Mortality rates were estimated at 340 turtles/year. Longline fisheries operating out of Australia also capture and kill loggerheads. Robins *et al*. (2002) estimate that approximately 400 turtles are killed annually in Australian pelagic longline fishery operations. Efforts have been taken by Australia to reduce fishery bycatch, including mandatory TED use in key trawl fisheries. In the U.S. Pacific, longline fisheries targeting swordfish and tuna and drift gillnet fisheries targeting swordfish have been identified as the primary fisheries of concern for loggerheads. Bycatch of loggerhead turtles in these fisheries has been significantly reduced as a result of time-area closures, required gear modifications, and hard caps imposed on turtle bycatch, with 100% observer coverage in certain areas.

In addition to fisheries bycatch, climate change is another factor that has the potential to greatly impact loggerhead turtles. Impacts from climate change, especially due to global warming, are likely to become more apparent in future years (Intergovernmental Panel on Climate Change (IPCC) 2007a). The global mean temperature has risen 0.76ºC over the last 150 years, and the linear trend over the last 50 years is nearly twice that for the last 100 years (IPCC 2007a). There is a high confidence, based on substantial new evidence, that observed changes in marine systems are associated with rising water temperatures, as well as related changes in ice cover, salinity, oxygen levels, and circulation. These changes include shifts in ranges and changes in algal, plankton, and fish abundance (IPCC 2007b), which could affect loggerhead prey distribution and abundance.

One of the most certain consequences of climate change is rising sea levels (Titus and Narayanan 1995), which will result in increased erosion rates along nesting beaches. This could particularly impact areas with low-lying beaches where sand depth is a limiting factor, as the sea will inundate nesting sites and decrease available nesting habitat (Daniels *et al*. 1993, Fish *et al*. 2005, Baker *et al*. 2006). The loss of habitat as a result of climate change could be accelerated due to a combination of other environmental and oceanographic changes such as an increase in the frequency of storms and/or changes in prevailing currents, both of which could lead to increased beach loss via erosion (Antonelis *et al*. 2006, Baker *et al*. 2006). On some undeveloped beaches, shoreline migration will have limited effects on the suitability of nesting habitat. Bruun (1962) hypothesized that during a sea level rise a typical beach profile will maintain its configuration but will be translated landward and upward. However, along developed coastlines, and especially in areas where erosion control structures have been constructed to limit shoreline movement, rising sea levels will cause severe effects on nesting females and their eggs. Erosion control structures can result in the permanent loss of dry nesting beach or deter nesting females from reaching suitable nesting sites (National Research Council 1990). Nesting females may deposit eggs seaward of the erosion control structures potentially subjecting them to repeated tidal inundation. Climate change may also affect loggerhead sex ratios. Loggerhead turtles exhibit temperature-dependent sex determination. Rapidly increasing global temperatures may result in warmer incubation temperatures and highly female-biased sex ratios (e.g., Glen and Mrosovsky 2004).

Natural factors that have the potential to affect recovery of loggerhead turtles include the effects of aperiodic hurricanes and catastrophic environmental events such as tsunamis. In general, these events are episodic and, although they may affect loggerhead hatchling production, the results are generally localized and they rarely result in whole-scale losses over multiple nesting seasons. The negative effects of hurricanes on low-lying and/or developed shorelines may be longer-lasting and a greater threat overall.

Propeller and collision injuries from boats and ships are becoming more common in sea turtles. In the Mediterranean, 28.1% of loggerheads recovered in the Gulf of Naples from 1993-1996 had injuries attributed to boat strikes (Bentivegna and Paglialonga 1998). Along the Greece coastline from 1997-1999, boat strikes were reported as a seasonal phenomenon (Kopsida *et al*. 2002), but numbers were not presented. In the U.S. Atlantic, from 1997 to 2005, 14.9% of all stranded loggerheads were documented as having sustained some type of propeller or collision injuries although it is not known what proportion of these injuries were post or ante-mortem. The incidence of propeller wounds has risen from approximately 10% in the late 1980s to a record high of 20.5% in 2004 (NMFS, unpublished data). Propeller wounds are greatest in southeast Florida (Palm Beach through Miami-Dade County); during some years, as many as 60% of the loggerhead strandings found in these areas had propeller wounds (FFWCC, unpublished data).

Direct or indirect disposal of anthropogenic waste introduces potentially lethal materials into loggerhead foraging habitats. Loggerheads will ingest plastic pieces, styrofoam pieces, and other marine debris. Ingestion occurs when debris is mistaken for or associated with prey items. In the Mediterranean, over 20% of loggerhead turtles examined in Malta were found contaminated with plastic or metal litter and hydrocarbons (Gramentz 1988). In addition, loggerheads can become entangled in discarded fishing gear or other entangling materials.

Harmful algal blooms, such as a red tide, also impact loggerheads. In Florida, the species that causes most red tides is *Karenia brevis*, a type of microalgae known as a dinoflagellate that produces a toxin (Florida Marine Research Institute 2003). During four red tide events along the west coast of Florida, sea turtle stranding trends indicated that these events were acting as a mortality factor (Redlow *et al*. 2003). Sea turtles that washed ashore alive during these red tide events displayed symptoms that were consistent with acute brevitoxicosis (e.g., uncoordinated and lethargic but otherwise robust and healthy in appearance) and completely recovered within days of being removed from the area of the red tide. Other types of microorganisms cause different kinds of harmful algal blooms in other parts of the world as well (Florida Marine Research Institute 2003).

2.4 Synthesis

In the Pacific, the eastern Australian population has declined 86% in the last 23 years, while new studies in New Caledonia verify the same genetic population as eastern Australia with a concurrent decline in nesting populations (based on oral histories). In Japan, a gradual increase in nesting populations is exhibited over the past 7 years, however, longer-term census data indicate a substantial decline (50-90%) in the size of the annual loggerhead nesting population in Japan in recent decades. Hatchling mortalities in recent years are unusually high on Japanese beaches apparently due to erosion from typhoons and heavy beach traffic. In addition, foraging juvenile and subadult turtles in the eastern Pacific at Baja California, Mexico, and Peru are subjected to significant fisheries bycatch and intentional hunting.

In the Atlantic, previously unknown or unquantified nesting assemblages have been documented on the Cape Verde Islands, on the Cay Sal Bank in the eastern Bahamas, and in Cuba. Trends of these populations are currently unknown. Loggerhead nesting no longer occurs in Jamaica, Haiti, the Dominican Republic, and Puerto Rico.

Five different nesting subpopulations have been identified in the northwest Atlantic, and low gene flow and strong nesting site fidelity may make these subpopulations vulnerable to extirpation. For the Northern Nesting Subpopulation, standardized ground surveys of 11 North Carolina, South Carolina, and Georgia nesting beaches showed a significant (P=0.01) declining trend of 1.9% annually in loggerhead nesting from 1983-2005. In addition, standardized aerial nesting surveys in South Carolina have shown a significant annual decrease of 3.1% from 1980-2002. The South Florida Nesting Subpopulation showed an increase in nests of 3.6% annually for the period 1989-1998. However, the most recent analyses of the Florida Index Nesting Beach Survey data show a 22.3% decline in nests over the 17-year period from 1989-2005, and a 39.5% decline since 1998. The Florida Panhandle Nesting Subpopulation shows a significant declining trend (P=0.04) of 6.8% annually from 1995 and 2005. A longer time series is needed to assess trends in the Dry Tortugas Nesting Subpopulation.

The Yucatan Nesting Subpopulation showed a statistically significant increase in the number of nests laid on seven beaches from 1987-2001, however, nesting since 2001 has declined and the previously reported increasing trend appears to have not been sustained.

In the Mediterranean, additional nesting beach surveys, especially in Libya, are needed to better understand the structure of this distinct stock, and to determine long-term trends. No trend is detectable in Greece, due to high interannual fluctuations in nest numbers at Zakynthos and Kyparissia Bay. These nesting aggregations account for over 37% of the total nesting in the Mediterranean. Significant downward trends have been documented in the loggerhead populations nesting in Rethymno (Island of Crete, Greece) and Fethiye Beach (Turkey), these two beaches account for approximately 10% of the total documented loggerhead nesting in the Mediterranean.

In the Indian Ocean, there are few reliable assessments of population status and trends. The South African nesting assemblage exhibited an increasing trend over a 40 year period. Insufficient data preclude the determination of trends in Mozambique, Madagascar, Oman, Sri Lanka, western Australia, and Myanmar.

3.0 RESULTS

3.1 Recommended Classification:

Based on the best available information, we do not believe the loggerhead turtle should be delisted or reclassified. However, we have information that indicates an analysis and review of the species should be conducted in the future to determine the application of the DPS policy to the loggerhead turtle. See Section 4.0 for additional information.

3.2 New Recovery Priority Number: No change.

4.0 RECOMMENDATIONS FOR FUTURE ACTIONS

We have preliminary information that indicates an analysis and review of the species should be conducted in the future to determine the application of the DPS policy to the loggerhead turtle. Since the species' listing, a substantial amount of information has become available on population structure, nesting and foraging distribution, movements, and demography. These data appear to indicate a possible separation of populations by ocean basins, however a more in depth analysis, beyond the scope of this five-year review, is needed. To determine the application of the DPS policy to the loggerhead turtle, the Services intend to fully assemble and analyze all relevant information in accordance with the DPS policy.

The current Recovery Plan for U.S. Pacific Populations of the Loggerhead was completed in 1998. The recovery criteria contained in the Plan, while not strictly adhering to all elements of the 2004 NMFS Interim Recovery Planning Guidance, are a viable measure of the species status. The species biology and population status information can be updated; however, the recovery actions identified in the Plan are appropriate and properly prioritized. While some additional recovery actions can no doubt be identified, the Services believe that the current Plan remains a valid conservation planning tool. The Recovery Plan should be re-examined over the next 5-10 year horizon, incorporating new information and in conformance with the NMFS Interim Recovery Planning Guidance, particularly if the DPS analysis results in restructuring of the current listing. In the near-term, additional information and data are particularly needed on genetic relationships among nesting populations, impacts of fisheries (particularly trawl and longline fisheries) on population status, foraging areas and identification of threats at foraging areas and along migration routes, and long-term population trends. The Recovery Plan for U.S. Population of Loggerhead Turtles in the Atlantic is currently in revision.

5.0 REFERENCES

Ackerman, R.A. 1997. The nest environment and the embryonic development of sea turtles. Pages 83-106 *in* Lutz, P.L. and J.A. Musick (editors). The Biology of Sea Turtles. CRC Press, Boca Raton, Florida.

Ackerman, R.A., T. Rimkus, and R. Horton. 1991. The hydric structure and climate of natural and renourished sea turtle nesting beaches along the Atlantic coast of Florida. Unpublished report to Florida Department of Natural Resources. 61 pages.

Addison, D.S. 1997. Sea turtle nesting on Cay Sal, Bahamas, recorded June 2-4, 1996. Bahamas Journal of Science 5:34-35.

Addison, D.S. and B. Morford. 1996. Sea turtle nesting activity on the Cay Sal Bank, Bahamas. Bahamas Journal of Science 3:31-36.

Aguilar, R., J. Mas, and X. Pastor. 1995. Impact of Spanish swordfish longline fisheries on the loggerhead sea turtle *Caretta caretta* population in the western Mediterranean. Pages 1-6 *in* Richardson, J.I. and T.H. Richardson (compilers). Proceedings of the Twelfth Annual Workshop on Sea Turtle Biology and Conservation. NOAA Technical Memorandum NMFS-SEFSC-361.

Antonelis, G.A., J.D. Baker, T.C. Johanos, R.C. Braun, and A.L. Harting. 2006. Hawaiian monk seal (*Monachus schauinslandi*): status and conservation issues. Atoll Research Bulletin 543:75-101.

Argano, R., R. Basso, M. Cocco, and G. Gerosa. 1992. Nuovi dati sugli spostamenti di tartaruga marine commune (*Caretta caretta*) in Mediterraneo. [New data on loggerhead (*Caretta caretta*) movements within the Mediterranean.] Bollettino del Museo dell' Instituto di Biologia dell' Università di Genova 56-57:137-163.

Aznar, F.J., F.J. Badillo, and J.A.Raga. 1998. Gastrointestinal helminths of loggerhead turtles (*Caretta caretta*) from the western Mediterranean: constraints on community structure. Journal of Parasitology 84(3):474-479.

Baker, J.D., C.L. Littnan, and D.W. Johnston. 2006. Potential effects of sea level rise on the terrestrial habitats of endangered and endemic megafauna in the Northwestern Hawaiian Islands. Endangered Species Research 2:21-30.

Balazs, G. 2006. Pelagic research of Pacific loggerhead sea turtles in partnership with Japan and Taiwan. Pages 31-33 *in* Kinan, I. (compiler). Proceedings of the Second Western Pacific Sea Turtle Cooperative Research & Management Workshop. Volume II: North Pacific Loggerhead Sea Turtles. Western Pacific Regional Fishery Management Council, Honolulu, Hawaii.

Baldwin, R.M. 1992. Nesting turtles on Masirah Island: Management issues, options, and research requirements. Report, Ministry of Regional Municipalities and Environment, Oman.

Baldwin, R., G.R. Hughes, and R.I.T. Prince. 2003. Loggerhead turtles in the Indian Ocean. Pages 218-232 *in* Bolten, A.B. and B.E. Witherington (editors). Loggerhead Sea Turtles. Smithsonian Institution Press, Washington, D.C.

Basso, R. and M. Cocco. 1986. Il progetto nazionale tartarughe marine. Thalassia Salentina 16:65-72.

Bentivegna, F. and A. Paglialonga. 1998. Status of the sea turtles in the Gulf of Naples and preliminary study of migration. Pages 152-155 *in* Epperly, S.P. and J. Braun (compilers). Proceedings of the Seventeenth Annual Sea Turtle Symposium. NOAA Technical Memorandum NMFS-SEFSC-415.

Bentivegna, F., G. Treglia, and S. Hochscheid. 2005. The first report of a loggerhead turtle *Caretta caretta* nest on the central Tyrrhenian coast (western Mediterranean). Journal of the Marine Biological Association of the United Kingdom - Biodiversity Records 85(6):1555.

Bjorndal, K.A. 1997. Foraging ecology and nutrition of sea turtles. Pages 199-231 i*n* Lutz, P.L. and J.A. Musick (editors). The Biology of Sea Turtles. CRC Press. Boca Raton, Florida.

Bjorndal, K.A. 2003. Roles of loggerhead sea turtles in marine ecosystems. Pages 235-254 *in* Bolten, A.B. and B.E. Witherington (editors). Loggerhead Sea Turtles. Smithsonian Books, Washington, D.C.

Bolten, A.B. 2003. Active swimmers - passive drifters: the oceanic juvenile stage of loggerheads in the Atlantic system. Pages 63-78 *in* Bolten, A.B. and B.E. Witherington (editors). Loggerhead Sea Turtles. Smithsonian Books, Washington D.C.

Bolten, A.B., H.R. Martins, K.A. Bjorndal, M. Cocco, and G. Gerosa. 1992. *Caretta caretta* (loggerhead), pelagic movement and growth. Herpetological Review 23(4):116.

Bowen, B.W. 1994. Letter dated November 17, 1994, to Sandy MacPherson, National Sea Turtle Coordinator, U.S. Fish and Wildlife Service, Jacksonville, Florida. University of Florida. Gainesville, Florida.

Bowen, B.W. 1995. Letter dated October 26, 1995, to Sandy MacPherson, National Sea Turtle Coordinator, U.S. Fish and Wildlife Service, Jacksonville, Florida. University of Florida. Gainesville, Florida.

Bowen, B., J.C. Avise, J.I. Richardson, A.B. Meylan, D. Margaritoulis, and S.R. Hopkins-Murphy. 1993. Population structure of loggerhead turtles (*Caretta caretta*) in the northwestern Atlantic Ocean and Mediterranean Sea. Conservation Biology 7(4):834-844.

Bowen, B.W., F.A. Abreu-Grobois, G.H. Balazs, N. Kamezaki, C.J. Limpus, and R.J. Ferl. 1995. Trans-Pacific migrations of the loggerhead turtles (*Caretta caretta*) demonstrated with mitochondrial DNA markers. Proceedings of the National Academy of Sciences of the United States of America 92:3731-3734.

Broderick, A.C. and B.J. Godley. 1996. Population and nesting ecology of the green turtle, *Chelonia mydas*, and the loggerhead turtle, *Caretta caretta*, in northern Cyprus. Zoology in the Middle East 13:27-46.

Broderick, A.C., M.S. Coyne, W.J. Fuller, F. Glen, and B.J. Godley. 2007. Fidelity and over-wintering of sea turtles. Proceedings of the Royal Society B 274:1533-1538.

Bruun, P. 1962. Sea-level rise as a cause of shore erosion. Journal of the Waterways and Harbors Division 88(WW1):117-130.

Camiñas, J.A. 1988. Incidental captures of *Caretta caretta* (L.) with surface long-lines in the western Mediterranean. Rapports et Procès-verbaux des reunions de la Commission Internationle pour l'Exploration Scientifique de la Mer Méditerranée 31: 285.

Camiñas, J.A. 1997. Capturas accidental es de tortuga boba (*Caretta caretta*, L. 1758) en el Mediterráneo occidental en la pesquería de palangre de superficie de pez espada (*Xiphias gladius* L.). ICCAT Collective Volume of Scientific Papers 46(4):446-455.

Canbolat, A.F. 2004. A review of sea turtle nesting activity along the Mediterranean coast of Turkey. Biological Conservation 116:81-91.

Carr, A.F. 1986. RIPS, FADS, and little loggerheads. Bioscience 36(2):92-100.

Carreras, C., M. Pascual, L. Cardona, A. Aguilar, D. Margaritoulis, A. Rees, O. Türkozan, Y. Levy, A. Gasith, M. Aureggi, and M. Khalil. 2007. The genetic structure of the loggerhead sea turtle (*Caretta caretta*) in the Mediterranean as revealed by nuclear and mitochondrial DNA and its conservation implications. Conservation Genetics 8(4):761-775.

Carthy, R.R. 1996. The role of the eggshell and nest chamber in loggerhead turtle (*Caretta caretta*) egg incubation. Ph.D. Dissertation, University of Florida, Gainesville. 123 pages.

Clark, R.R. 1992. Beach conditions in Florida: a statewide inventory and identification of beach erosion problem areas in Florida. Beaches and Shores Technical and Design Memorandum 89-1, 4th Edition. Florida Department of Natural Resources, Division of Beaches and Shores, Tallahassee, Florida. 208 pages.

Cox, J.H., H.F. Percival, and S.V. Colwell. 1994. Impact of vehicular traffic on beach habitat and wildlife at Cape San Blas, Florida. Cooperative Fish and Wildlife Research Unit Technical Report Number 50. 44 pages.

Crain, D.A., A.B. Bolten, and K.A. Bjorndal. 1995. Effects of beach nourishment on sea turtles: review and research initiatives. Restoration Ecology 3(2):95-104.

Daniels, R.C., T.W. White, and K.K. Chapman. 1993. Sea-level rise: destruction of threatened and endangered species habitat in South Carolina. Environmental Management 17(3):373-385.

Delaugerre, M. and C. Cesarini. 2004. Confirmed nesting of the loggerhead turtle in Corsica. Marine Turtle Newsletter 104:12.

Dellinger, T. and C. Freitas. 2000. Movements and diving behaviour of pelagic stage loggerhead sea turtles in the North Atlantic: preliminary results obtained through satellite telemetry. Pages 155-157 *in* Kalb, H.J. and T. Wibbels (compilers). Proceedings of the Nineteenth Annual Symposium on Sea Turtle Biology and Conservation. NOAA Technical Memorandum NMFS-SEFSC-443.

Demetropoulos, A. and M. Hadjichristophorou. 1989. Sea turtle conservation in Cyprus. Marine Turtle Newsletter 44:4-6.

Deraniyagala, P.E.P. 1939. The tetrapod reptiles of Ceylon. Volume 1. Testudinates and crocodilians. Colombo Museum Natural History Series, Colombo, Ceylon. 412 pages.

Dodd, C.K., Jr. 1988. Synopsis of the biological data on the loggerhead sea turtle *Caretta caretta* (Linnaeus 1758). U.S. Fish and Wildlife Service Biological Report 88(14). 110 pages.

Dodd, M.G. and A.H. Mackinnon. 2005. Loggerhead turtle nesting in Georgia, 2005. Georgia Department of Natural Resources annual report submitted to U.S. Fish and Wildlife Service for grant E-5-5 "Coastal Endangered Species Management." 47 pages.

Ehrhart, L.M. and B.E. Witherington. 1987. Human and natural causes of marine turtle nest and hatchling mortality and their relationship to hatchling production on an important Florida nesting beach. Final Report, Project Number GFC-84-018. Florida Game and Fresh Water Fish Commission, Nongame Wildlife Program, Technical Report No. 1. Tallahassee, Florida. 141 pages.

Ehrhart, LM.., D.A. Bagley, and W.E. Redfoot. 2003. Loggerhead turtles in the Atlantic Ocean: geographic distribution, abundance, and population status. Pages 157-174 *in* Bolten, A.B. and B.E. Witherington (editors). Loggerhead Sea Turtles. Smithsonian Institution Press, Washington, D.C.

Encalada, S.E., K.A. Bjorndal, A.B. Bolten, J.C. Zurita, B. Schroeder, E. Possardt, C.J. Sears, and B.W. Bowen. 1998. Population structure of loggerhead turtle (*Caretta caretta*) nesting colonies in the Atlantic and Mediterranean as inferred from mitochondrial DNA control region sequences. Marine Biology 130:567-575.

Erk'akan, F. 1993. Nesting biology of loggerhead turtles *Caretta caretta* L. on Dalyan Beach, Mugla-Turkey. Biological Conservation 66:1-4.

Ernest, R.G. and R.E. Martin. 1999. Martin County beach nourishment project; sea turtle monitoring and studies; 1997 annual report and final assessment. Ecological Associates, Jensen Beach, Florida. 96 pages + tables and figures.

Fish, M.R., I.M. Cote, J.A. Gill, A.P. Jones, S. Renshoff, and A.R. Watkinson. 2005. Predicting the impact of sea-level rise on Caribbean sea turtle nesting habitat. Conservation Biology 19:482-491.

Florida Marine Research Institute. 2003. What is red tide? Florida Marine Research Institute web page.

Foley, A., B. Schroeder, and S. MacPherson. In press. Post-nesting migrations and resident areas of Florida loggerheads. *In* Proceedings of the Twenty-fifth Annual Symposium on Sea Turtle Biology and Conservation. NOAA Technical Memorandum.

Francour, P., A. Ganteaume, and M. Poulain. 1999. Effects of boat anchoring in *Posidonia oceanica* seagrass beds in the Port-Cros National Park (north-western Mediterranean Sea). Aquatic Conservation: Marine and Freshwater Ecosystems 9:391-400.

Frazier, J. 1980. Exploitation of marine turtles in the Indian Ocean. Human Ecology 8(4):329-370.

Fretey, J. 2001. Biogeography and conservation of marine turtles of the Atlantic coast of Africa. CMS Technical Series Publication, No. 6, UNEP/CMS Secretariat, Bonn, Germany. 429 pages.

George, R.H. 1997. Health problems and diseases of sea turtles. Pages 363-385 *in* Lutz, P.L. and J.A. Musick (editors). The Biology of Sea Turtles. CRC Press, Boca Raton, Florida.

Gerosa, G. and P. Casale. 1999. Interaction of marine turtles with fisheries in the Mediterranean. Mediterranean Action Plan - UNEP, Regional Activity Center for Specially Protected Areas, Tunis Cedex.

Glen, F. and N. Mrosovsky. 2004. Antigua revisited: the impact of climate change on sand nd nest temperatures at a hawksbill turtle (*Eretmochelys imbricata*) nesting beach. Global Change Biology 10:2036-2045.

Godley, B.J., A.C. Broderick, S.E. Solomon, R. Tippett, and R. Malsom. 1996. Threats to marine turtles in northern Cyprus, eastern Mediterranean. Pages 100-104 *in* Keinath, J.A., D.E. Barnard, J.A. Musick, and B.A. Bell (compilers). Proceedings of the Fifteenth Annual Symposium on the Biology and Conservation of Sea Turtles. NOAA Technical Memorandum NMFS-SEFSC-387.

Gómez de Segura, A., J. Tomás, S.N.Pedraza, E.A. Crespo, and J.A. Raga. 2006. Abundance and distribution of the endangered loggerhead turtle in Spanish Mediterranean waters and the conservation implications. Animal Conservation 9:199-206.

Gramentz, D. 1988. Involvement of loggerhead turtle with the plastic, metal, and hydrocarbon pollution in the central Mediterranean. Marine Pollution Bulletin 19(1):11-13.

Hamza, A.A., H. Elghmati, E.M. Buras, M.A. Algumezi, M.S. Sola, W. Hamed, D.A. Hadoud, M.A. Alshwaihedi, M.E. Alsharif, U.M. Shalouf, and A. Ouerghi. 2006. Marine turtle conservation at three nesting sites in Sirte, Libya. Page 137 *in* Frick M., A. Panagopoulou, A.F. Rees, and K. Williams (compilers). Book of Abstracts of the Twenty-sixth Annual Symposium on Sea Turtle Biology and Conservation. International Sea Turtle Society, Athens, Greece.

Hatase, H., M. Kinoshita, T. Bando, N. Kamezaki, K. Sato, Y. Matsuzawa, K. Goto, K. Omita, Y. Nakashima, H. Takeshita, and W. Sakamoto. 2002. Population structure of loggerhead turtles, *Caretta caretta*, nesting in Japan: bottlenecks on the Pacific population. Marine Biology 141: 299-305.

Herbst, L.H. and E.R. Jacobson. 1995. Diseases of marine turtles. Pages 593-596 *in* Bjorndal, K.A. (editor). Biology and Conservation of Sea Turtles, Revised Edition. Smithsonian Institution Press. Washington, D.C.

Herren, R.M. 1999. The effect of beach nourishment on loggerhead (*Caretta caretta*) nesting and reproductive success at Sebastian Inlet, Florida. Unpublished Master of Science thesis. University of Central Florida, Orlando, Florida. 138 pages.

Hewavisenthi, S. 1990. Exploitation of marine turtles in Sri Lanka: historic background and the present status. Marine Turtle Newsletter 48:14-19.

Homer, B.L., A. Foley, K.J. Fick, M.C. Lores, A.E. Redlow, and E.R. Jacobson. 2000. Legions, pathogens and toxins identified in 13 stranded marine turtles in Florida. Pages 117-118 i*n* Abreu-Grobois, F.A., R. Briseno-Duenas, R. Marquez, and L. Sarti (compilers). Proceedings of the Eighteenth International Sea Turtle Symposium. NOAA Technical Memorandum NMFS-SEFSC-436.

Hosier, P.E., M. Kochhar, and V. Thayer. 1981. Off-road vehicle and pedestrian track effects on the sea-approach of hatchling loggerhead turtles. Environmental Conservation 8:158-161.

Hughes, A.L. and E.A. Caine. 1994. The effect of beach features on hatchling loggerhead sea turtles. Page 237 *in* Proceedings of the Fourteenth Annual Symposium on Sea Turtle Biology and Conservation, March 1-5, 1994, Hilton Head, South Carolina. National Oceanic and Atmospheric Administration, Technical Memorandum NMFS-SEFSC-351.

Hughes, G.R. 1999. The Tongaland sea turtle project-1998/1999. KZN Nature Conservation Service Internal Report, Pietermaritzburg, South Africa.

Hykle, D. 2002. The Convention on Migratory Species and other international instruments relevant to marine turtle conservation: pros and cons. Journal of International Wildlife Law and Policy 5:105-119.

Ilgaz, Ç., O. Türkozan, A. Özdemir, Y. Kaska, and M. Stachowitsch. 2007. Population decline of loggerhead turtles: two potential scenarios for Fethiye beach, Turkey. Biodiversity and Conservation 16:1027-1037.

Intergovernmental Panel on Climate Change. 2007a. Summary for Policymakers. *In* Solomon, S., D. Quin, M. Manning, Z. Chen, M. Marquis, K.B. Averyt, M. Tignor and H.L. Miller (editors). Climate Change 2007: The Physical Science Basis. Contribution of Working Group I to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change. Cambridge University Press, Cambridge, United Kingdom, and New York, New York, USA.

Intergovernmental Panel on Climate Change. 2007b. Summary for Policymakers. *In* Solomon, S., D. Quin, M. Manning, Z. Chen, M. Marquis, K.B. Averyt, M. Tignor and H.L. Miller (editors). Climate Change 2007: Climate Change Impacts, Adaptation, and Vulnerability. Contribution of Working Group II to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change. Cambridge University Press, Cambridge, United Kingdom, and New York, New York, USA.

IUCN - The World Conservation Union. 1989a. Oman coastal zone management plan: Dhofar. Volume 1. Action plan. IUCN, Gland, Switzerland.

IUCN - The World Conservation Union. 1989b. Oman coastal zone management plan: Dhofar. Volume 2. Resource atlas. IUCN, Gland, Switzerland.

Jacobson, E.R., B.L. Homer, B.A. Stacy, E.C. Greiner, N.J. Szabo, C.L. Chrisman, F. Origgi, S. Coberley, A.M. Foley, J.H. Landsberg, L. Flewelling, R.Y. Ewing, R. Moretti, S. Schaf, C. Rose, D.R. Mader, G.R. Harman, C.A. Manire, N.S. Mettee, A.P. Mizisin, and G.D. Shelton. 2006. Neurological disease in wild loggerhead sea turtles *Caretta caretta*. Diseases of Aquatic Organisms 70:139-154.

Kamezaki, N., Y. Matsuzawa, O. Abe, H. Asakawa, T. Fujii, K. Goto, S. Hagino, M. Hayami, M. Ishii, T. Iwamoto, T. Kamata, H. Kato, J. Kodama, Y. Kondo, I. Miyawaki, K. Mizobuchi, Y. Nakamura, Y. Nakashima, H. Naruse, K. Omuta, M. Samejima, H. Suganuma, H. Takeshita, T. Tanaka, T. Toji, M. Uematsu, A. Yamamoto, T. Yamato, and I. Wakabayashi. 2003. Loggerhead turtles nesting in Japan. Pages 210-217 *in* Bolten, A.B. and B.E. Witherington (editors). Loggerhead Sea Turtles. Smithsonian Books, Washington D.C.

Kapurusinghe, T. 2006. Status and conservation of marine turtles in Sri Lanka. Pages 173-187 *in* Shanker, K. and B.C. Choudhury (editors). Marine Turtles of the Indian Subcontinent. Universities Press, Hyderabad, India.

Kapurusinghe, T. and M.M. Saman. 2001. Turtle bycatch in Sri Lanka. Pages 45-47 *in* Proceedings of the Twenty-first Annual Symposium on Sea Turtle Biology and Conservation. NOAA Technical Memorandum NMFS-SEFSC-528.

Kapurusinghe, T. and R. Cooray. 2002. Marine turtle by-catch in Sri Lanka: survey report September 1999-November 2000. Turtle Conservation Project (TCP) report, Sri Lanka.

Kar, C.S. and S. Bhaskar. 1982. Status of sea turtles in the eastern Indian Ocean. Pages 365-372 *in* Bjorndal, K.A. (editor). Biology and Conservation of Sea Turtles. Smithsonian Institution Press, Washington, D.C.

Koch, V., W.J. Nichols, H. Peckham, and V. de la Toba. 2006. Estimates of sea turtle mortality from poaching and bycatch in Bahía Magdalena, Baja California Sur, Mexico. Biological Conservation 128:327-334.

Kopsida, H., D. Margaritoulis, and D. Dimopoulos. 2002. What marine turtle strandings can tell us. Pages 207-209 *in* Mosier, A., A. Foley, and B. Brost (compilers). Proceedings of the Twentieth Annual Symposium on Sea Turtle Biology and Conservation. NOAA Technical Memorandum NMFS-SEFC-477.

Koutsodendris, A., C. Dean, and D. Margaritoulis. 2006. Short report on sea turtle conservation on Zakynthos Island, Greece, during 2006. Submitted to The European Commission, and the Standing Committee of the Bern Covention (Council of Europe). 14 pages.

Kudo, H., A. Murakami, and S. Watanabe. 2003. Effects of sand hardness and human beach use on emergence success of loggerhead sea turtles on Yakushima Island, Japan. Chelonian Conservation and Biology 4(3):695-696.

Laurent, L., J. Lescure, L. Excoffier, B. Bowen, M. Domingo, M. Hadjichristophorou, L. Kornaraki, and G. Trabuchet. 1993. Genetic studies of relationships between Mediterranean and Atlantic populations of loggerhead turtle *Caretta caretta* with a mitochondrial marker. Comptes Rendus de l'Academie des Sciences (Paris), Sciences de la Vie/Life Sciences 316:1233-1239.

Laurent, L. and J. Lescure. 1994. L’hivernage des tortues caouannes *Caretta caretta* dans le sud Tunisien. Revue d’ Ecologie (Terre et Vie) 49:63-85.

Laurent, L., M.N. Bradai, D.A. Hadoud, and H.M. El Gomati. 1995. Marine turtle nesting activity assessment on Libyan coasts. Phase I. Survey of the coasts between the Egyptian border and Sirte. RAC/SPA (UNEP), Tunis.

Laurent, L., E.M. Abd El-Mawla, M.N. Bradai, F. Demirayak, and A. Oruç. 1996. Reducing sea turtle mortality induced by Mediterranean fisheries: Trawling activity in Egypt, Tunisia, and Turkey. WWF International Mediterranean Programme Report on WWF Project 9E0103, Rome, Italy.

Laurent, L., P. Casale, M.N. Bradai, B.J. Godley, G. Gerosa, A.C. Broderick, W. Schroth, B. Schierwater, A.M. Levy, D. Freggi, E.M. Abd El-Mawla, D.A. Hadoud, H.E. Gomati, M. Domingo, M. Hadjichristophorou, L. Kornaraky, F. Demirayak, and Ch.

Gautier. 1998. Molecular resolution of marine turtle stock composition in fishery by-catch: a case study in the Mediterranean. Molecular Ecology 7:1529-1542.

Laurent, L., M.N. Bradai, D.H. Hadoud, H.M. El Gomati, and A.A. Hamza. 1999. Marine turtle nesting activity assessment on Libyan coasts. Phase 3. Survey of the coast to the west of Misratah. RAC/SPA (UNEP), Tunis

Lazar, B., D. Margaritoulis, and N. Tvrtkovic. 2000. Migrations of the loggerhead sea turtle (*Caretta caretta*) into the Adriatic Sea. Pages 101-102 *in* Abreu-Grobois, F.A., R. Briseño Dueñas, R. Márquez-Millán, and L. Sarti-Martínez (compilers). Proceedings of the Eighteenth International Sea Turtle Symposium. NOAA Technical Memorandum NMFS-SEFSC-436.

Lazou, A.P. and A.F. Rees. 2006. Factors influencing insect infestation of loggerhead (*Caretta caretta*) sea turtle nests on Zakynthos, Greece. Page 195 *in* Frick M., A. Panagopoulou, A.F. Rees, and K. Williams (compilers). Book of Abstracts of the Twenty-sixth Annual Symposium on Sea Turtle Biology and Conservation. International Sea Turtle Society, Athens, Greece.

Lee Long, W.J., R.G. Coles, and L.J. McKenzie. 2000. Issues for seagrass conservation management in Queensland. Pacific Conservation Biology 5:321-328.

LeRoux, R.A., V.L. Pease, E.L. LaCasella, A. Frey, and P.H. Dutton. 2007 Longer mtDNA sequences uncover additional genetic variation among North Pacific loggerheads. Page 156 *in* Frick, M., A. Panagopoulou, A.F. Rees, and K. Williams (compilers). Book of Abstracts. Twenty-seventh Annual Symposium on Sea Turtle Biology and Conservation. International Sea Turtle Society, Myrtle Beach, South Carolina, USA.

Levy, Y. 2003. Status of marine turtles and conservation efforts along the Israeli coastline. Page 149 *in* Seminoff, J.A. (compiler). Proceedings of the Twenty-second Annual Symposium on Sea Turtle Biology and Conservation. NOAA Technical Memorandum NMFS-SEFSC-503.

Lewison, R.L., S.A. Freeman, and L.B. Crowder. 2004. Quantifying the effects of fisheries on threatened species: the impact of pelagic longlines on loggerhead and leatherback sea turtles. Ecology Letters 7:221-231.

Limpus, C.J. 1985. A study of the loggerhead turtle, *Caretta caretta*, in eastern Australia. Ph.D. Thesis, University of Queensland, Brisbane, Australia.

Limpus, C.J. and D.J. Limpus. 2003. Loggerhead turtles in the equatorial and southern Pacific Ocean: a species in decline. Pages 199-209 *in* Bolten, A.B. and B.E. Witherington (editors). Loggerhead Sea Turtles. Smithsonian Books, Washington D.C.

Limpus, C. and D. Reimer. 1994. The loggerhead turtle, *Caretta caretta*, in Queensland: A population in decline. Pages 39-59 *in* James, R. (compiler). Proceedings of the Australian Marine Turtle Conservation Workshop. QDEH and ANCA, Canberra.

Limpus, C.J., P.J. Couper, and M.A. Read. 1994. The loggerhead turtle, *Caretta caretta*, in Queensland: Population structure in a warm temperate feeding area. Memoirs of the Queensland Museum 37(1):195-204.

Limpus, C.J., M. Boyle, and T. Sunderland. 2006. New Caledonian loggerhead turtle population assessment: 2005 pilot study. Pages 77-92 in Kinan, I. (compiler). Proceedings of the Second Western Pacific Sea Turtle Cooperative Research & Management Workshop. Volume II: North Pacific Loggerhead Sea Turtles. Western Pacific Regional Fishery Management Council, Honolulu, Hawaii.

Lutcavage, M.E., P. Plotkin, B. Witherington, and P.L. Lutz. 1997. Human impacts on sea turtle survival. Pages 387-409 *in* Lutz, P.L. and J.A. Musick (editors). The Biology of Sea Turtles. CRC Press. Boca Raton, Florida.

Mann, T.M. 1977. Impact of developed coastline on nesting and hatchling sea turtles in southeastern Florida. Unpublished Master of Science thesis. Florida Atlantic University, Boca Raton, Florida. 100 pages.

Manzella, S.A., C.T. Fontaine, and B.A. Schroeder. 1988. Loggerhead sea turtle travels from Padre Island, Texas to the mouth of the Adriatic Sea. Marine Turtle Newsletter 42:7.

Marcovaldi, M.A. and M. Chaloupka. 2007. Conservation status of the loggerehead sea turtle in Brazil: an encouraging outlook. Endangered Species Research (3)133-143.

Margaritoulis, D. 1987. Nesting activity and factors affecting breeding of the loggerhead sea turtle *Caretta caretta* (L.) in Greece. Final report to the EEC on project ENV-790-GR. Ministry of the Environment, Athens, Greece.

Margaritoulis, D. 1988. Post-nesting movements of loggerhead sea turtles tagged in Greece. Rapports et Procès-verbaux des reunions de la Commission Internationale pour l'Exploration Scientifique de la Mer Méditerranée 31(2):284.

Margaritoulis, D. 1998. On the island of Crete: A new nesting area of the loggerhead turtle in the Mediterranean. Pages 98-100 *in* Byles, R. and Y. Fernandez (compilers). Proceedings of the Sixteenth Annual Symposium on Sea Turtle Biology and Conservation. NOAA Technical Memorandum NMFS-SEFSC-412.

Margaritoulis, D. 2005. Nesting activity and reproductive output of loggerhead sea turtles, *Caretta caretta*, over 19 seasons (1984-2002) at Laganas Bay, Zakynthos, Greece: the largest rookery in the Mediterranean. Chelonian Conservation and Biology 4(4):916-929.

Margaritoulis, D. and A. Rees. 2001. The loggerhead turtle, *Caretta caretta*, population nesting in Kyparissia Bay, Peloponnesus, Greece: results of beach surveys over seventeen seasons and determination of the core nesting habitat. Zoology in the Middle East 24:75-90.

Margaritoulis, D., M. Dretakis, and A. Kotitsas. 1995. Discovering new nesting areas of *Caretta caretta* in Greece. Pages 214-217 *in* Richardson, J.I. and T.H. Richardson (compilers). Proceedings of the Twelfth Annual Workshop on Sea Turtle Biology and Conservation. NOAA Technical Memorandum NMFS-SEFSC-361.

Margaritoulis, D., D. Karavellas, and C. Irvine. 1996. Predation of adult loggerheads by Mediterranean monk seals. Pages 193-196 *in* Keinath, J.A., D.E. Barnard, J.A. Musick, and B.A. Bell (compilers). Proceedings of the Fifteenth Annual Symposium on the Biology and Conservation of Sea Turtles. NOAA Technical Memorandum NMFS-SEFSC-387.

Margaritoulis, D., R. Argano, I. Baran, F. Bentivegna, M.N. Bradai, J.A. Camiñas, P. Casale, G. De Metrio, A. Demetropoulos, G. Gerosa, B.J. Godley, D.A. Haddoud, J. Houghton, L. Laurent, and B. Lazar. 2003. Loggerhead turtles in the Mediterranean Sea: present knowledge and conservation perspectives. Pages 175-198 *in* Bolten, A.B. and B.E. Witherington (editors). Loggerhead Sea Turtles. Smithsonian Books, Washington D.C.

Margaritoulis, D., C. Dean, and A. Koutsodendris. 2007. Monitoring and public awareness work at the sea turtle nesting habitat of Laganas Bay, Zakynthos Island, Greece, during 2006. Unpublished report of ARCHELON, the Sea Turtle Protection Society of Greece. 52 pages.

Margaritoulis D., A. Panagopoulou, and A.F. Rees. In press. Loggerhead nesting in Rethymno, Island of Crete, Greece: fifteen-year nesting data (1990-2004) indicate a declining population. *In* Demetropoulos, A. and O. Türkozan (editors). Proceedings of the Second Mediterranean Conference on Marine Turtles. Kemer, Turkey, 4-7 May 2005.

Matsuzawa, Y. 2006. Nesting beach management of eggs and pre-emergent hatchlings of north Pacific loggerhead sea turtles in Japan. Pages 13-22 *in* Kinan, I. (compiler). Proceedings of the Second Western Pacific Sea Turtle Cooperative Research & Management Workshop. Volume II: North Pacific Loggerhead Sea Turtles. Western Pacific Regional Fishery Management Council, Honolulu, Hawaii.

Mayol, J. and M. Castelló Mas. 1983. Contribución al conocimiento de la tortuga boba en las Baleares. Ministerio de Agricultura, Pesca y Alimentación. Palma de Mallorca, ICONA.

McGowan, A., L.V. Rowe, A.C. Broderick, and B.J. Godley. 2001. Nest factors predisposing loggerhead sea turtle (*Caretta caretta*) clutches to infestation by dipteran larvae on northern Cyprus. Copeia 2001(3):808-812.

McRae, G. 2006. Letter dated October 18, 2006, to Dr. Alan Bolten, Loggerhead Recovery Team Leader, Archie Carr Center for Sea Turtle Research, University of Florida. Gainesville. Fish and Wildlife Research Institute, Florida Fish and Wildlife Conservation Commission. St. Petersburg, Florida.

Milton, S.L., A.A. Schulman, and P.L. Lutz. 1997. The effect of beach nourishment with aragonite versus silicate sand on beach temperature and loggerhead sea turtle nesting success. Journal of Coastal Research 13(3):904-915.

Mingozzi, T., G. Masciari, G. Paolillo, B. Pisani, M. Russo, and A. Massolo. 2006. Discovery of a regular nesting area of loggerhead turtle *Caretta caretta* in southern Italy: a new perspective for national conservation. Biodiversity and Conservation DOI 10.1007/s10531-006-9098-6.

Monzón-Argüello, C., C. Rico, E. Naro-Maciel, N. Varo Cruz, P. López, A. Marco, and L.F. López-Jurado. 2007. Population genetic analysis of loggerhead turtles in the Cape Verde Islands. Page 266 *in* Frick, M., A. Panagopoulou, A.F. Rees, and K. Williams (compilers). Book of Abstracts. Twenty-seventh Annual Symposium on Sea Turtle Biology and Conservation. International Sea Turtle Society, Myrtle Beach, South Carolina, USA.

Mosier, A. 1998. The impact of coastal armoring structures on sea turtle nesting behavior at three beaches on the East Coast of Florida. Unpublished Master of Science thesis. University of South Florida, Tampa, Florida. 112 pages.

Mosier, A.E. and B.E. Witherington. 2002. Documented effects of coastal armoring structures on sea turtle nesting behavior. Pages 304-306 *in* Mosier, A., A. Foley, and B. Brost (compilers). Proceedings of the Twentieth Annual Symposium on Sea Turtle Biology and Conservation. NOAA Technical Memorandum NMFS-SEFSC-477.

Mrosovsky, N. 1994. Sex ratios of sea turtles. Journal of Experimental Zoology 270(1):16-27.

Mrosovsky, N. and J. Provancha. 1989. Sex ratio of hatchling loggerhead sea turtles: data and estimates from a five year study. Canadian Journal of Zoology 70:530-538.

Nada, M.A. 2001. Observations on the trade in sea turtles at the fish market of Alexandria, Egypt. Zoology in the Middle East 24:109-118.

National Marine Fisheries Service and U.S. Fish and Wildlife Service. 1998. Recovery plan for U.S. Pacific populations of the loggerhead turtle (*Caretta caretta*). National Marine Fisheries Service, Silver Spring, MD. 59 pages.

National Research Council. 1990. Decline of the sea turtles: causes and prevention. National Academy Press, Washington, D.C. 259 pages.

Natural Heritage Trust. 2005. Draft issues paper: for six species of marine turtles found in Australian waters that are listed as threatened under the Environment Protection and Biodiversity Conservation Act 1999. Australian Government, Department of the Environment and Heritage unpublished report. 39 pages.

Nelson, D.A., K. Mauck, and J. Fletemeyer. 1987. Physical effects of beach nourishment on sea turtle nesting, Delray Beach, Florida. Technical Report EL-87-15, U.S. Army Corps of Engineers Waterways Experiment Station, Vicksburg, Mississippi. 56 pages + appendix.

Nelson, K.A., R. Trindell, B. Morford, B. Witherington, D. Arnold, and K. Moody. 2002. An analysis of reported disorientation events in the State of Florida. Pages 323-324 *in* Mosier, A., A. Foley, and B. Brost (compilers). Proceedings of the Twentieth Annual Symposium on Sea Turtle Biology and Conservation. NOAA Technical Memorandum NMFS-SEFSC-477.

Newbury, N., M. Khalil, and L. Venizelos. 2002. Population status and conservation of marine turtles at El-Mansouri, Lebanon. Zoology in the Middle East 27:47-60.

Nishemura, W. and S. Nakahigashi. 1990. Incidental capture of sea turtles by Japanese research and training vessels: results of a questionnaire. Marine Turtle Newsletter 51:1-4.

Ohmuta, K. 2006. The sea turtle situation of Yakushima Island. Pages 23-26 *in* Kinan, I. (compiler). Proceedings of the Second Western Pacific Sea Turtle Cooperative Research & Management Workshop. Volume II: North Pacific Loggerhead Sea Turtles. Western Pacific Regional Fishery Management Council, Honolulu, Hawaii.

Ottenwalder, J.A. 1996. The current status of sea turtles in Haiti. Contributions to Herpetology 12:381-393.

Özdemir, A., O. Türkozan, Ç. Ilgaz, and R. Martin. 2004. Nest site factors and invertebrate infestation of loggerhead turtle nests. Israel Journal of Zoology 50:333-340.

Pauly, D., V. Christensen, J. Dalsgaard, R. Froese, and F. Torres, Jr. 1998. Fishing down marine food webs. Science 279:860-863.

Pearce, A.F. 2001. Contrasting population structure of the loggerhead turtle (*Caretta caretta*) using mitochondrial and nuclear DNA markers. Unpublished Master of Science thesis. University of Florida, Gainesville, Florida. 71 pages.

Peckham, H. and W.J. Nichols. 2002. Why did the turtle cross the ocean? Pelagic red crabs and loggerhead turtles along the Baja California coast. Pages 47-48 *in* Seminoff, J.A. (compiler). Proceedings of the Twenty-second Annual Symposium on Sea Turtle Biology and Conservation. NOAA Technical Memorandum NMFS-SEFSC-503.

Peckham, H. and W.J. Nichols. 2006. An integrated approach to reducing mortality of north Pacific loggerhead turtles in Baja California, SUR, Mexico. Pages 49-57 *in* Kinan, I. (compiler). Proceedings of the Second Western Pacific Sea Turtle Cooperative Research & Management Workshop. Volume II: North Pacific Loggerhead Sea Turtles. Western Pacific Regional Fishery Management Council, Honolulu, Hawaii.

Peckham, H., W.J. Nichols, D. Maldonado, V. de la Toba, A. Walli, N. Rossi, and E. Caballero-Aspe. 2006. Population level impacts of small-scale fisheries bycatch on highly-migratory megavertebates: a case study of loggerhead turtle mortality at Baja California Sur, Mexico. Page 315 *in* Frick M., A. Panagopoulou, A.F. Rees, and K. Williams (compilers). Book of Abstracts of the Twenty-sixth Annual Symposium on Sea Turtle Biology and Conservation. International Sea Turtle Society, Athens, Greece.

Peters, A., K.J.F. Verhoeven, D.C.G. van Piggelen, and H. Strijbosch. 1994. *Caretta caretta* (Loggerhead sea turtle). Predation. Herpetological Review 25(3):120.

Pilcher, N.J. and M.A. Saad. 2000. Sea turtles of Socotra. Report to the Senckenberg Research Institute, Frankfurt, Germany. 15 pages.

Pitman, K.L. 1990. Pelagic distribution and biology of sea turtles in the eastern tropical Pacific. Pages 143-148 in E.H. Richardson, J.A. Richardson, and M. Donnell (compilers), Proc. Tenth Annual Workshop on Sea Turtles Biology and Conservation. U.S. Dep. Commerce, NOAA Technical Memo. NMFS-SEC-278.

Poiner, I.R. and A.N.M. Harris. 1996. Incidental capture, direct mortality and delayed mortality of sea turtles in Australia's northern prawn fishery. Marine Biology 125:813-825.

Poiner, I.R., R.C. Buckworth, and A.N.M. Harris. 1990. Incidental capture and mortality of sea turtles in Australia's northern prawn fishery. Australian Journal of Marine and Freshwater Research 41:97-110.

Polovina, J., I. Uchida, G. Balazs, E. Howell, D. Parker, and P. Dutton. 2006. The Kuroshio Extension Current Bifurcation Region: a pelagic hotspot for juvenile loggerhead sea turtles. Pages 35-38 *in* Kinan, I. (compiler). Proceedings of the Second Western Pacific Sea Turtle Cooperative Research & Management Workshop. Volume II: North Pacific Loggerhead Sea Turtles. Western Pacific Regional Fishery Management Council, Honolulu, Hawaii.

Rakotonirina, B. 2001. Sea turtles in Madagascar. Pages 38-39 *in* Ciccione, S., D. Roos, and J.-Y. Le Gall (editors). Knowledge and Conservation of Sea Turtles in the South-west Indian Ocean. Proceedings of a workshop held at Saint-Leu Ile de la Reunion, November-December 1999. Etudes et Colloques du CEDTM. IFREMER, La Reunion.

Redlow, T., A. Foley, and K. Singel. 2003. Sea turtle mortality associated with red tide events in Florida. Page 272 *in* Seminoff, J.A. (compiler). Proceedings of the Twenty-second Annual Symposium on Sea Turtle Biology and Conservation. NOAA Technical Memorandum NMFS-SEFSC-503.

Rees A.F. 2005. A preliminary study on emergence patterns of loggerhead hatchlings in Kyparissia Bay, Greece. Pages 290-291 *in* Proceedings of the Twenty-first Annual Symposium on Sea Turtle Biology and Conservation. NOAA Technical Memorandum NMFS-SEFSC-528.

Rees, A.F. and D. Margaritoulis. In press. International migration of non-nesting loggerhead turtles from Greece to Turkey and Libya tracked by satellite. *In* Demetropoulos, A. and O. Türkozan (editors). Proceedings of the Second Mediterranean Conference on Marine Turtles. Kemer, Turkey, 4-7 May 2005.

Robins, J.B. 1995. Estimated catch and mortality of sea turtles from the east coast otter trawl fishery of Queensland, Australia. Biological Conservation 74:157-167.

Robins, C.M., S.J. Bache, and S.R. Kalish. 2002. Bycatch of sea turtles in pelagic longline fisheries - Australia. Bureau of Rural Sciences Final Report to the Fisheries Resources Research Fund, Agriculture, Fisheries and Forestry, Australia, Canberra. 132 pages.

Ross, J.P. 1979. Sea turtles in the Sultanate of Oman. Manuscript report of IUCN/WWF Project 1320.

Ross, J.P. 1998. Estimations of the nesting population size of loggerhead sea turtles, *Caretta caretta*, Masirah Island, Sultanate of Oman. Pages 84-87 *in* Epperly, S.P. and J. Braun (compilers). Proceedings of the Seventeenth Annual Sea Turtle Symposium. NOAA Technical Memorandum NMFS-SEFSC-415.

Ross, J.P. and M.A. Barwani. 1982. Review of sea turtles in the Arabian area. Pages 373-383 *in* Bjorndal, K.A. (editor). Biology and Conservation of Sea Turtles. Smithsonian Institution Press, Washington, D.C.

Royer, E. 1984. The national report for the country of Jamaica. Pages 225-295 *in* Bacon, P., F. Berry, K. Bjorndal, H. Hirth, L. Ogren, and M. Weber (compilers). Proceedings of the Western Atlantic Turtle Symposium, San Jose, Costa Rica, July 1983. University of Miami Press, Miami, Florida.

Rumbold, D.G., P.W. Davis, and C. Perretta. 2001. Estimating the effect of beach nourishment on *Caretta caretta* (loggerhead sea turtle) nesting. Restoration Ecology 9(3):304-310.

Salm, R.V. 1991. Turtles in Oman: Status, threats, and management options. Report of the Scientific Results of the IUCN Coastal Zone Management Project CZMP4:F11.

Salm, R. and S. Salm. 1991. Sea turtles in the Sultanate of Oman. The Historical Association of Oman.

Salm, R.V., R.A.C. Jensen, and V.A. Papastavrou. 1993. Marine fauna of Oman: Cetaceans, turtles, seabirds and shallow water corals. IUCN, Gland, Switzerland.

Schmelz, G.W. and R.R. Mezich. 1988. A preliminary investigation of the potential impact of Australian pines on the nesting activities of the loggerhead turtle. Pages 63-66 *in* Schroeder, B.A. (compiler). Proceedings of the Eighth Annual Workshop on Sea Turtle Conservation and Biology. NOAA Technical Memorandum NMFS-SEFC-214.

Schroeder, B.A. and A.E. Mosier. 2000. Between a rock and a hard place: coastal armoring and marine turtle nesting habitat in Florida. Pages 290-292 *in* Abreu-Grobois, F.A., R. Briseño-Dueñas, R. Márquez, and L. Sarti (compilers). Proceedings of the Eighteenth Symposium on Sea Turtle Biology and Conservation. NOAA Technical Memorandum NMFS-SEFSC-436.

Schroeder, B.A., A.M. Foley, B.E. Witherington, and A.E. Mosier. 1998. Ecology of marine turtles in Florida Bay: population structure, distribution, and occurrence of fibropapilloma. Pages 265-267 *in* Epperly, S.P. and J. Braun (compilers). Proceedings of the Seventeenth Annual Symposium on Sea Turtle Biology and Conservation. NOAA Technical Memorandum NMFS-SEFSC-415.

Seney, E.E. and J.A. Musick. 2007. Historical diet analysis of loggerhead sea turtles (*Caretta caretta*) in Virginia. Copeia 2007(2):478-489.

Shanker, K. 2004. Marine turtle status and conservation in the Indian Ocean. Pages 85-134 *in* FAO Fisheries Report No. 738 supplement. Rome, Italy. 238 pages.

Shigueto, J.A., J. Mangel, and P. Dutton. 2006. Loggerhead turtle bycatch in Peru. Pages 43-44 *in* Kinan, I. (compiler). Proceedings of the Second Western Pacific Sea Turtle Cooperative Research & Management Workshop. Volume II: North Pacific Loggerhead Sea Turtles. Western Pacific Regional Fishery Management Council, Honolulu, Hawaii.

Sobel, D. 2002. A photographic documentation of aborted nesting attempts due to lounge chairs. Page 311 *in* Mosier, A., A. Foley, and B. Brost (compilers). Proceedings of the Twentieth Annual Symposium on Sea Turtle Biology and Conservation. NOAA Technical Memorandum NMFS-SEFSC-477.

Steinitz, M.J., M. Salmon, and J. Wyneken. 1998. Beach renourishment and loggerhead turtle reproduction: a seven year study at Jupiter Island, Florida. Journal of Coastal Research 14(3):1000-1013.

SWOT. 2006. State of the World's Sea Turtles: Volume II. Conservation International, Crystal City, Virginia. 52 pages.

Thorbjarnarson, J.B., S.G. Platt, and S.T. Khaing. 2000. Sea turtles in Myanmar: past and present. Marine Turtle Newsletter 88:10-11.

Titus, J.G. and V.K. Narayanan. 1995. The probability of sea level rise. U.S. Environmental Protection Agency EPA 230-R-95-008. 184 pages.

Tomas, J., F.J. Aznar, and J.A. Raga. 2001. Feeding ecology of the loggerhead turtle *Caretta caretta* in the western Mediterranean. Journal of Zoology 255:525-532.

Tomas, J., J.L. Mons, J.J. Martin, J.J. Bellido, and J.J. Castillo. 2002. Study of the first reported nest of loggerhead sea turtle, Caretta caretta, in the Spanish Mediterrean coast. J. Marine Biol. Assoc. 82:1005-1007.

Trindell, R., D. Arnold, K. Moody, and B. Morford. 1998. Post-construction marine turtle nesting monitoring results on nourished beaches. Pages 77-92 *in* Tait, L.S. (compiler). Proceedings of the 1998 Annual National Conference on Beach Preservation Technology. Florida Shore & Beach Preservation Association, Tallahassee, Florida.

Tripathy, B. 2005. Status of the loggerhead turtle in India. Current Science 88(4):535-536.

Trites, A.W., V. Christensen, and D. Pauly. 1997. Competition between fisheries and marine mammals for prey and primary production in the Pacific Ocean. Journal of Northwest Atlantic Fishery Science 22:173-187.

Türkozan, O. and I. Baran. 1996. Research on the loggerhead turtle, *Caretta caretta*, of Fethiye beach. Turkish Journal of Zoology 20:183-188.

Turtle Expert Working Group. 2000. Assessment update for the Kemp's ridley and loggerhead sea turtle populations in the western North Atlantic. NOAA Technical Memorandum NMFS-SEFSC-444. 115 pages.

Venizelos, L., V. Kouroutos, and P. Robinson. 2006. Update report on marine turtle conservation in Zakynthos (Laganas Bay), Greece 2006. MEDASSET unpublished report. 54 pages.

Watling, L. and E.A. Norse. 1998. Disturbance of the seabed by mobile fishing gear: a comparison to forest clearcutting. Conservation Biology 12(6):1180-1197.

Waycott, M., B.J. Longstaff, and J. Mellors. 2005. Seagrass population dynamics and water quality in the Great Barrier Reef region: a review and future research directions. Marine Pollution Bulletin 51:343-350.

Witherington, B.E. 1992. Behavioral responses of nesting sea turtles to artificial lighting. Herpetologica 48(1):31-39.

Witherington, B.E. 1997. The problem of photopollution for sea turtles and other nocturnal animals. Pages 303-328 *in* Clemmons, J.R. and R. Buchholz (editors). Behavioral Approaches to Conservation in the Wild. Cambridge University Press, Cambridge, United Kingdom.

Witherington, B.E. and C.M. Koeppel. 2000. Sea turtle nesting in Florida, USA, during the decade 1989-1998: an analysis of trends. Pages 94-96 *in* Kalb, H. and T. Wibbels (compilers). Proceedings of the Nineteenth Annual Symposium on Sea Turtle Conservation and Biology. NOAA Technical Memorandum NMFS-SEFSC-443.

Witherington, B.E. and R.E. Martin. 1996. Understanding, assessing, and resolving light-pollution problems on sea turtle nesting beaches. Florida Marine Research Institute Technical Report TR-2. 73 pages.

Witherington, B., C. Crady, and L. Bolen. 1996. A "hatchling orientation index" for assessing orientation disruption from artificial lighting. Pages 344-347 *in* Keinath, J.A., D.E. Barnard, J.A. Musick, and B.A. Bell (compilers). Proceedings of the Fifteenth Annual Symposium on the Biology and Conservation of Sea Turtles. NOAA Technical Memorandum NMFS-SEFSC-387.

Witherington, B., R. Herren, and M. Bresette. 2006. *Caretta caretta* - loggerhead sea turtle. Chelonian Research Monographs 3:74-89.

Zbinden J.A., A. Aebischer, D. Margaritoulis, and R. Arlettaz. In review. Important areas at sea for adult loggerhead sea turtles in the Mediterranean Sea: satellite tracking corroborates findings from potentially biased sources. Marine Biology.

Zurita, J.C., R. Herrera, A. Arenas, M.E. Torres, C. Calderón, L. Gómez, J.C. Alvarado, and R. Villavicencio. 2003. Nesting loggerhead and green sea turtles in Quintana Roo, Mexico. Pages 125-127 *in* Seminoff, J.A. (compiler). Proceedings of the Twenty-second Annual Symposium on Sea Turtle Biology and Conservation. NOAA Technical Memorandum NMFS-SEFSC-503.

U.S. FISH AND WILDLIFE SERVICE
5-YEAR REVIEW of *Loggerhead Sea Turtle*

Current Classification: Threatened

Recommendation resulting from the 5-Year Review: No change

Review Conducted By:

Therese Conant, Barbara Schroeder (National Marine Fisheries Service)
Sandy MacPherson, Earl Possardt, Kelly Bibb (U.S. Fish and Wildlife Service)

FIELD OFFICE APPROVAL:

Lead Field Supervisor, Fish and Wildlife Service

Approve ______________________ Date 8/27/07
David L. Hankla

REGIONAL OFFICE APPROVAL:

for **Lead Regional Director, Fish and Wildlife Service**

Approve ______________________ Date 8/27/07

Cooperating Regional Director, Fish and Wildlife Service

✓ Concur _____ Do Not Concur

Signature ______________________ Acting Date 8·27·07

NATIONAL MARINE FISHERIES SERVICE
5-YEAR REVIEW of *Loggerhead Sea Turtle*

Current Classification: Threatened

Recommendation resulting from the 5-Year Review: No change

Review Conducted By:

Barbara Schroeder, Therese Conant (National Marine Fisheries Service)
Sandy MacPherson, Earl Possardt, Kelly Bibb (U.S. Fish and Wildlife Service)

REGIONAL OFFICE APPROVAL: The draft document was reviewed by the appropriate Regional Offices and Science Centers.

HEADQUARTERS APPROVAL:
Director, Office of Protected Resources, NOAA Fisheries

Approve: James H. Lecky Date: AUG 27 2007
James H. Lecky

Assistant Administrator, NOAA Fisheries

✓ Concur _____ Do Not Concur

Signature William T Hogarth Date 8-27-07

William T. Hogarth, Ph.D.
Assistant Administrator
for Fisheries

APPENDIX

Summary of peer review for the 5-year review of
***Loggerhead Sea Turtle* (*Caretta caretta*)**

A. Peer Review Method: See B. below.

B. Peer Review Charge: On June 20, 2007, the following letter and Guidance for Peer Reviewers of Five-Year Status Reviews were sent via e-mail to potential reviewers requesting comments on the 5-year review. Requests were sent to Dr. Alan Bolten (University of Florida), Dr. Robert Baldwin (Environmental Society of Oman), Mark Dodd (Georgia Department of Natural Resources), Dr. Llewellyn Ehrhart (University of Central Florida), Dr. George Hughes (Kwazulu Natal Nature Conservation Service), Dr. Naoki Kamezaki (Sea Turtle Association of Japan), Dr. Colin Limpus (Queensland Parks and Wildlife Service), Dr. Dimitris Margaritoulis (Sea Turtle Protection Society of Greece), and Dr. Blair Witherington (Florida Fish and Wildlife Conservation Commission).

We request your assistance in serving as a peer reviewer of the U.S. Fish and Wildlife Service and National Marine Fisheries Service's (Services) 5-year status review of the loggerhead turtle (Caretta caretta). The 5-year review is required by section 4(c)(2) of the United States Endangered Species Act of 1973, as amended (Act). A 5-year review is a periodic process conducted to ensure the listing classification of a species as threatened or endangered on the Federal List of Endangered and Threatened Wildlife and Plants is accurate. The initiation of the 5-year review for the loggerhead turtle was announced in the Federal Register on April 21, 2005, and the public comment period closed on July 20, 2005. Public comments have been incorporated into the status review.

The enclosed draft of the status review has been prepared by the Services pursuant to the Act. In keeping with directives for maintaining a high level of scientific integrity in the official documents our agencies produce, we are seeking your assistance as a peer reviewer for this draft. Guidance for peer reviewers is enclosed with this letter. If you are able to assist us, we request your comments be received on or before July 20, 2007. Please send your comments to Sandy MacPherson at the address on this letter. You may fax your comments to Sandy MacPherson at 904-232-2404 or send comments by e-mail to Sandy_MacPherson@fws.gov.

We appreciate your assistance in helping to ensure our decisions continue to be based on the best available science. If you have any questions or need additional information, please contact Sandy MacPherson at 904-232-2580, extension 110. Thank you for your assistance.

Sincerely yours,

David L. Hankla
Field Supervisor
Jacksonville Ecological Services Field Office

Enclosures

Guidance for Peer Reviewers of Five-Year Status Reviews

U.S. Fish and Wildlife Service, North Florida Ecological Services Office

February 7, 2007

As a peer reviewer, you are asked to adhere to the following guidance to ensure your review complies with Service policy.

Peer reviewers should:

1. Review all materials provided by the Service.

2. Identify, review, and provide other relevant data that appears not to have been used by the Service.

3. Not provide recommendations on the Endangered Species Act classification (e.g., Endangered, Threatened) of the species.

4. Provide written comments on:

- *Validity of any models, data, or analyses used or relied on in the review.*
- *Adequacy of the data (e.g., are the data sufficient to support the biological conclusions reached). If data are inadequate, identify additional data or studies that are needed to adequately justify biological conclusions.*
- *Oversights, omissions, and inconsistencies.*
- *Reasonableness of judgments made from the scientific evidence.*
- *Scientific uncertainties by ensuring that they are clearly identified and characterized, and that potential implications of uncertainties for the technical conclusions drawn are clear.*
- *Strengths and limitation of the overall product.*

5. Keep in mind the requirement that we must use the best available scientific data in determining the species' status. This does not mean we must have statistically significant data on population trends or data from all known populations.

All peer reviews and comments will be public documents, and portions may be incorporated verbatim into our final decision document with appropriate credit given to the author of the review.

Questions regarding this guidance, the peer review process, or other aspects of the Service's recovery planning process should be referred to Sandy MacPherson, National Sea Turtle Coordinator, U.S. Fish and Wildlife Service, at 904-232-2580, extension 110, email: Sandy_MacPherson@fws.gov.

C. Summary of Peer Review Comments/Report:

A summary of peer review comments from the four respondents is provided below. The complete set of comments is available at the Jacksonville Ecological Services Field Office, U.S. Fish and Wildlife Service, 6620 Southpoint Drive South, Suite 310, Jacksonville, Florida, 32216.

Mr. Robert Baldwin, Environmental Society of Oman, Oman: Mr. Baldwin provided edits and suggestions for strengthening the document, but stated that all models, data, and analyses appear to be valid and reliable. He also provided some information on the post-nesting migrations of loggerheads outfitted with satellite transmitters on Masirah Island, Oman, in 2006, which suggest that post-nesting migrations and foraging grounds may be centered within the region.

Dr. Alan Bolten, University of Florida, Gainesville, FL, USA: Dr. Bolten expressed concern about the overall lack of detail in the document and felt this was particularly apparent for the Atlantic Ocean sections. He suggested that the Atlantic Ocean sections throughout the document be divided into North Atlantic Ocean and South Atlantic Ocean similar to what was done for the Pacific Ocean. He also indicated that the review of the biology was very limited and did not include recent information about population genetics and demography (e.g., survival estimates, somatic growth rates). He identified numerous publications that should be referenced in the document. Dr. Bolten stated that although there are significant gaps in the detail of the 5-year review, he does not think these omissions should affect the ability of the Services to make a recommendation for an ESA classification when one considers the significant and precipitous decline of the peninsular Florida nesting population - one of the two largest nesting colonies in the world.

Dr. Dimitris Margaritoulis, Sea Turtle Protection Society of Greece, Athens, Greece: Dr. Margaritoulis provided numerous edits and suggested rewrites, particularly in the portions of the text relating to the Mediterranean. He also requested clarification of some issues throughout the document. Dr. Margaritoulis provided several research papers that he felt should be referenced in the document.

Dr. Blair Witherington, Florida Fish and Wildlife Conservation Commission, Melbourne Beach, FL, USA: Dr. Witherington stated that although the review was well researched and clearly written, he felt that it would be helpful to include a synthesis of abundance, trends, and threats. Specifically, he recommended that the document be rewritten to quantify threats, discuss the life stages affected (and their reproductive value), and indicate which threats are most important based on numbers of turtles and their collective value to the population. He felt that the inclusion of a table describing populations in terms of common units (e.g., nesting females per year) in the abundance and trends section also would be helpful. Dr. Witherington also provided recommendations on additional information to include in the document.

D. Response to Peer Review:

Mr. Robert Baldwin, Environmental Society of Oman, Oman: All of Mr. Baldwin's edits were incorporated. Additional text was added describing the post-nesting migrations of loggerheads outfitted with satellite transmitters on Masirah Island, Oman, in 2006.

Dr. Alan Bolten, University of Florida, Gainesville, FL, USA: The Services have referenced all of research papers that Dr. Bolten suggested be included in the document. The Services agree that the document might be enhanced by the dividing the Atlantic Ocean sections into North Atlantic Ocean and South Atlantic Ocean subheadings; however, the Services are under a time constraint to complete the sea turtle 5-year reviews by the end of August 2007 so we are unable to address this recommendation.

Dr. Dimitris Margaritoulis, Sea Turtle Protection Society of Greece, Athens, Greece: All of Dr. Margaritoulis' edits and suggested rewrites were incorporated. Several issues were also clarified based on Dr. Margaritoulis' recommendations. The research papers he provided were added to the document.

Dr. Blair Witherington, Florida Fish and Wildlife Conservation Commission, Melbourne Beach, FL, USA: Additional information was included in the document in response to Dr. Witherington's recommendations. The Services agree that the document would be enhanced by the inclusion of a table showing nesting populations and trends by regions, as well as an assessment of threats by life stage; however, the Services are under a time constraint to complete the sea turtle 5-year reviews by the end of August 2007 so we are unable to address these recommendations.