Bi-National Recovery Plan for the Kemp's Ridley Sea Turtle
(*Lepidochelys kempii*)

<u>SECOND REVISION</u>

Secretariat of Environment
& Natural Resources
MEXICO

National Commission
of Natural Protected Areas
MEXICO

Federal Attorney of
Environmental Protection
MEXICO

U.S. Department of Commerce
National Oceanic and Atmospheric Administration
NATIONAL MARINE FISHERIES SERVICE

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Bi-National Recovery Plan for the Kemp's Ridley Sea Turtle (*Lepidochelys kempii*)

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ADDITIONAL COPIES MAY BE OBTAINED FROM:

U.S. National Marine Fisheries Service's Office of Protected Resources website:
http://www.nmfs.noaa.gov/pr/recovery/plans.htm#turtles

U.S. Fish and Wildlife Service website:
http://www.fws.gov/kempsridley/

Mexico CONANP website:
http://www.conanp.gob.mx/procer/

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EXECUTIVE SUMMARY

CURRENT STATUS: The Kemp's ridley nesting population is exponentially increasing, which may indicate a similar increase in the population as a whole. Nesting aggregations at Rancho Nuevo in Tamaulipas, Mexico, were discovered in 1947. Dr. Henry Hildebrand used films taken by Andres Herrera in 1947 to arrive at an estimate in excess of 40,000 nesting females (Carr 1963, Hildebrand 1963). However, by the mid-1980s the population had drastically declined to fewer than 800 nests, representing approximately 300 females nesting that season (based on an estimated 2.5 nests per female each season). Since the mid-1980s, the number of nests increased. From 1988-2003, the number of nests observed at Rancho Nuevo and nearby beaches increased 15% per year (Heppell *et al.* 2005). In 2009, the total number of nests recorded at Rancho Nuevo and adjacent beaches exceeded 20,000, which represents about 8,000 females nesting during the nesting season. For Texas, from 2002-2010, a total of 911 Kemp's ridley nests have been documented on the Texas coast. This is over eleven times the 81 nests recorded over the previous 54 years from 1948-2001 (Shaver and Caillouet 1998, Shaver 2005a). An updated population model predicts the population will grow 19% per year from 2010-2020, assuming current survival rates within each life stage remain constant. The population could attain at least 10,000 nesting females (one criterion for downlisting) in a season by 2011. The rapid population growth rate predicted in the models is contingent on a high egg survival rate. In the short term, this rate can only be achieved through relocation of 14,500+ nests to corrals where the eggs are protected from predation. As the population increases, the proportion of protected nests will decrease. A reduction in egg survival with increasing nest density would drop the predicted rate of growth (Heppell *et al.* 2005). The nesting and hatchling recruitment data are encouraging and indicate past and current conservation measures have been and are highly effective. The Team is cautiously optimistic that the population is on its way to recovery, but continued protection of nesting females and nests is needed on the primary nesting beaches throughout the species historical nesting range. Protection of all life stages in adjacent waters in Mexico and developmental habitat throughout the Gulf of Mexico and U.S. Atlantic is necessary to ensure the recovery of the species.

RECOVERY GOALS: To conserve and protect the Kemp's ridley sea turtle so that protections under the Endangered Species Act are no longer necessary and the species can be removed from the List of Endangered and Threatened Wildlife.

RECOVERY STRATEGY: The highest priority needs for Kemp's ridley recovery are to maintain and strengthen the conservation efforts that have proven successful. On the nesting beaches, this includes reinforcing habitat protection efforts, protecting nesting females and nests, and maintaining or increasing hatchling production levels. In the water, successful conservation efforts include maintaining the use of turtle excluder devices (TEDs) in fisheries currently required to use them, expanding TED-use to all trawl fisheries of concern, and reducing mortality in gillnet fisheries. Adequate enforcement in both the terrestrial and marine environment also is essential to meeting recovery goals.

To achieve recovery for the Kemp's ridley, it is not sufficient simply to maintain current efforts. In Mexico, community social/economic programs must be developed for the fishing sector to reduce incidental capture of Kemp's ridleys in fisheries. In the US, several fisheries have implemented measures to reduce the impacts to the Kemp's ridley, however bycatch reduction should be expanded to all fisheries of concern. Additional research and monitoring are needed to identify important marine foraging, breeding, and internesting habitats; determine migratory pathways among foraging grounds and between foraging grounds and nesting beaches; and collect data on interactions between Kemp's ridleys and recreational and commercial fisheries, especially the Mexican shark fishery. Agencies must carefully monitor current and/or emerging issues affecting the population to ensure that the observed nesting population increases continue.

Finally to ensure long-term protection and sustained recovery of the Kemp's ridley well after it is delisted, sources of increased funding for conservation efforts must be identified and sustained and education programs and partnerships with local, state, Federal, private, and international entities must be strengthened and sustained.

RECOVERY CRITERIA:

Downlisting Criteria

Demographic Criteria

1. A population of at least 10,000 nesting females in a season (as measured by clutch frequency per female per season) distributed at the primary nesting beaches (Rancho Nuevo, Tepehuajes, and Playa Dos) in Mexico is attained. Methodology and capacity to implement and ensure accurate nesting female counts have been developed.

2. Recruitment of at least 300,000 hatchlings to the marine environment per season at the three primary nesting beaches (Rancho Nuevo, Tepehuajes, and Playa Dos) in Mexico is attained to ensure a minimum level of known production through *in situ* incubation, incubation in corrals, or a combination of both.

Listing Factor Criteria

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

1. Long-term habitat protection of two of the primary nesting beaches is maintained in Mexico (Rancho Nuevo, Tepehuajes) as federal, state, municipal, or private natural protected areas or under a similar legally protective designation or mechanism. Long-term habitat protection of the nesting beach at Playa Dos, through establishment as a natural protected area or similar legally protective designation or mechanism is initiated.

Factor B: Overutilization for commercial, recreational, scientific, or educational purposes

2. Social and/or economic initiatives that are compatible with Kemp's ridley conservation programs have been initiated and/or developed in conjunction with the Kemp's ridley conservation program at Rancho Nuevo and at least two other communities adjacent to Kemp's ridley sea turtle camps. The National Commission of Protected Natural Areas

(CONANP) will determine whether these initiatives are sufficient based on community need and potential benefits to conservation.

Factor C: Disease or predation

3. Predation of nests is reduced through protective measures implemented to achieve Demographic Criterion number 2.

Factor D: Inadequacy of existing regulatory mechanisms

4. TED regulations, or other equally protective measures, are maintained and enforced in U.S. and Mexican trawl fisheries (e.g., shrimp, summer flounder, whelk) that are known to have an adverse impact on Kemp's ridleys in the Gulf of Mexico and U.S. Atlantic.

Factor E: Other natural or manmade factors affecting its continued existence

5. A sub-group of the Team and other technical experts has been convened and made progress in identifying and reviewing the most current data on major foraging areas (especially for juveniles), inter-nesting habitats, mating areas, and adult migration routes in Mexico and U.S. waters to provide information to ensure recovery.

Delisting Criteria

Demographic Criteria

1. An average population of at least 40,000 nesting females per season (as measured by clutch frequency per female per season) over a 6-year period distributed among nesting beaches in Mexico and the U.S. is attained. Methodology and capacity to ensure accurate nesting female counts have been developed and implemented.

2. Ensure average annual recruitment of hatchlings over a 6-year period from *in situ* nests and beach corrals is sufficient to maintain a population of at least 40,000 nesting females per nesting season distributed among nesting beaches in Mexico and the U.S into the future. This criterion may rely on massive synchronous nesting events (i.e., arribadas) that will swamp predators as well as rely on supplemental protection in corrals and facilities.

Listing Factor Criteria

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

1. Long-term habitat protection of the nesting beaches of Tamaulipas (Rancho Nuevo, Tepehuajes, Playa Dos), Veracruz (Lechuguillas and Tecolutla), and Texas (federally-managed sections of North Padre (PAIS), South Padre, and Boca Chica Beach) is maintained via federal, state, municipal, or private natural protected areas or under a similar legally protective designation or mechanism.

Factor B: Overutilization for commercial, recreational, scientific, or educational purposes

2. Community socioeconomic programs initiated in conjunction with Kemp's ridley conservation programs at Rancho Nuevo, Tepehuajes, and La Pesca are maintained and expanded to other areas such as La Pesca-Costa Lora, San Vicente, Buena Vista, Barra del Tordo and Barra Moron—Playa DosRancho Nuevo where significant Kemp's ridley nesting occurs in Mexico. The CONANP will determine whether these initiatives are sufficient based on community need and potential benefits to conservation.

Factor C: Disease or predation

3. Predation of nests is reduced through protective measures implemented to achieve Demographic Criterion number 2.

Factor D: Inadequacy of existing regulatory mechanisms

4. Specific and comprehensive Federal, State, and local legislation or regulations are developed, promulgated, implemented, and enforced to ensure post-delisting protection of Kemp's ridleys and their terrestrial and marine habitats, as appropriate. These would address significant impacts to Kemp's ridleys in trawl, gillnet, hook and line, trap/pot activities, including the Mexican shark fishery. Mexico and U.S. continue collaborative efforts to ensure post-delisting protection of Kemp's ridleys and their terrestrial and marine habitats under the auspices of the Inter-American Convention for the Protection and Conservation of Sea Turtles.

Factor E: Other natural or manmade factors affecting its continued existence

5. A network of in-water sites in the Gulf of Mexico and U.S. Atlantic to monitor populations (e.g., demographics and abundance) is established, and surveys are implemented (as developed by the sub-group convened under downlisting criteria).

6. Monitoring programs have been initiated in commercial and recreational fisheries of concern in both Mexico and the U.S to monitor Kemp's ridley bycatch. Necessary measures to minimize mortality in all commercial and recreational fisheries have been implemented sufficiently to ensure recruitment to maintain population level in Demographic Criterion number 1 after delisting.

7. All other human significant sources of Kemp's ridley mortality have been addressed sufficiently through implementation measures to minimize mortality to ensure recruitment to maintain population level in Demographic Criterion number 1 after delisting.

8. Sea Turtle Stranding and Salvage Network research and data collection will be continued to monitor the effectiveness of protection and restoration activities for Kemp's ridley in the U.S. and Mexico.

ACTIONS NEEDED:

- Protect and manage nesting and marine habitats
- Protect and manage populations on the nesting beaches and in the marine environment
- Maintain a stranding network
- Manage captive stocks
- Educate the public
- Develop community partnerships
- Maintain and develop local, state, and national government partnerships
- Maintain, promote awareness of, and expand U.S. and Mexico laws
- Implement international agreements
- Enforce laws in the marine and terrestrial environment and in the marketplace

DATE OF RECOVERY:

We anticipate that the Kemp's ridley will attain its downlisting criterion of 10,000 nesting females in a season by 2011. Based on population growth rates of 19% per year, we anticipate that the Kemp's ridley could attain its delisting criterion of an average of 40,000 nesting females per season over a 6-year period by 2024.

LIST OF ACRONYMS AND ABBREVIATIONS

The following standard abbreviations for units of measurement and other scientific, technical, and institutional acronyms and terms are found throughout this document:

ACOE	U.S. Army Corps of Engineers
ARK	Animal Rehabilitation Keep
APEDS	Agency for Sustainable Development, Mexico
BOEMRE	Bureau of Ocean Energy Management, Regulation and Enforcement (note: formerly Mineral Management Service)
CBTA	Centro de Bachillerato Tecnologico Agropecuario (High School Center for Farming Technologies), Mexico
CITES	Convention on International Trade in Endangered Species of Wild Fauna and Flora
CRIP	Centro Regional de Investigaciones Pesqueras (Regional Center for Fisheries Research), Mexico
CCL	Curved carapace length
CONAFOR	National Forestry Commission, Mexico
CONANP	Comisión Nacional de Áreas Naturales Protegidas (National Commission of Protected Natural Areas), Mexico
CONAPESCA	National Commission of Aquaculture and Fisheries, Mexico
DDE	1,1-dichloro-2, 2-bis(p-chlorophenyl)ethylene
DOF	Diario Oficial de la Federación
ESA	U.S. Endangered Species Act of 1973
FWS	U.S. Fish and Wildlife Service, U.S. Department of the Interior
GPZ	Gladys Porter Zoo
HABs	Harmful algal blooms
HEART	Help Endangered Animals—Ridley Turtles
INP	Instituto Nacional de Pesca (National Institute of Fisheries), Mexico
KRWG	Kemp’s Ridley Working Group
MARPOL	Marine Pollution Control Act
MIH	Mullerian inhibiting hormone
MMS	Mineral Management Service (note: became BOEMRE in 2010)
NGO	Non-governmental organization
NMFS	National Marine Fisheries Service, U.S. Department of Commerce
NOM	Norma Oficial Mexicana or Official Mexican Norm
NPS	National Park Service, U.S. Department of the Interior
PAIS	Padre Island National Seashore, U.S. Department of the Interior
PCBs	Polychlorinated biphenyl
PIT	Passive integrated transponder
PROCODES	Program of Conservation for Sustainable Development, Mexico
PROFEPA	Federal Ministry for Environmental Protection, Mexico
RAMSAR	Convention on Wetlands of International Importance
RV	Reproductive value
RRV	Relative reproductive value

SAGARPA	National Fisheries Commission of the Secretariat of Agriculture, Cattle Raising, Rural Development, Fishing and Food, Mexico
SCL	Straight carapace length
SEMARNAT	Secretariat of Environment and Natural Resources, Mexico
SEDUE	Secretariat of Urban Development and Ecology, Mexico
SEPESCA	Secretariat of Fisheries, Mexico
STSSN	Sea Turtle Stranding and Salvage Network
TAMU	Texas A&M University at Galveston
TED	Turtle Excluder Device
TEWG	Turtle Expert Working Group
TPWD	Texas Parks and Wildlife Department
TTS	Texas Territorial Sea
UAB	University of Alabama at Birmingham
U.S.	United States of America
USCG	U.S. Coast Guard, Department of Homeland Security

PREFACE

This revision of the 1992 Recovery Plan for the Kemp's Ridley Sea Turtle adds new and refines existing recovery program activities. The Recovery Plan is composed of four major sections:

1. Background: This section acquaints the reader with the Kemp's ridley sea turtle, its status, past and ongoing conservation efforts, and the threats it faces. It also serves as a review of the biological literature for this species.

2. Recovery Strategy: This section describes the overall recovery strategy: the goal of the plan; the downlisting and delisting criteria based upon the five listing factors and population benchmarks to assist in evaluating the status of the species; and the actions needed to achieve recovery. The recovery actions are presented in a narrative outline, organized by four major objectives: (1) Protect and Manage Habitat; (2) Protect and Manage Population; (3) Sustain Conservation Programs; and (4) Legal Framework.

3. Implementation Schedule: This section presents the recovery actions from the narrative outline in table format; assigns priorities to the recovery actions; estimates the time necessary to complete the recovery actions; identifies parties with authority, responsibility, or expressed interest in implementation of the recovery actions; and estimates the cost of the recovery actions and recovery program.

4. Appendices: This section presents additional information used by the U.S. Fish and Wildlife Service (FWS), National Marine Fisheries Service (NMFS), Secretary of Environment and Natural Resources, Mexico (SEMARNAT), and the Team to draft this revision.

PART I: BACKGROUND

A. LISTING STATUS

In the United States of America, the Endangered Species Act of 1973, as amended (16 U.S.C. 1531 *et seq*.) (ESA), establishes policies and procedures for identifying, listing, and protecting species of wildlife that are endangered or threatened with extinction. The purposes of the ESA are "to provide a means whereby the ecosystems upon which endangered species and threatened species depend may be conserved, [and] to provide a program for the conservation of such endangered species and threatened species..." The ESA defines an "endangered species" as "any species which is in danger of extinction throughout all or a significant portion of its range." A "threatened species" is defined as "any species which is likely to become an endangered species within the foreseeable future throughout all or a significant portion of its range." The Kemp's ridley sea turtle (*Lepidochelys kempii*) was listed as endangered throughout its range on December 2, 1970 (FWS 1970), and has received Federal protection under the ESA since that time. The Kemp's ridley was listed on Appendix I by the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES) on July 1, 1975, which prohibited all commercial international trade. The International Union for the Conservation of Nature lists the Kemp's ridley as Critically Endangered.

The Secretaries of the Department of the Interior and the Department of Commerce are responsible for administering the ESA's provisions. Authority for endangered and threatened species under the Departments' jurisdictions has been delegated to the U.S. Fish and Wildlife Service (FWS) and the National Marine Fisheries Service (NMFS). FWS and NMFS share Federal jurisdiction for sea turtles, with FWS having lead responsibility on the nesting beaches and NMFS in the marine environment.

To help identify and guide species' recovery needs, Section 4(f) of the ESA directs the Secretary to develop and implement recovery plans for listed species or populations. Such plans are to include: (1) a description of such site-specific management actions as may be necessary to achieve the plan's goal for the conservation and survival of the species; (2) objective, measurable criteria which, when met, would result in a determination that the species be removed from the endangered and threatened species list in accordance with the provisions of Section 4; and (3) estimates of the time and funding required to achieve the plan's goals and intermediate steps. Section 4 of the ESA and regulations (50 CFR Part 424) promulgated to implement its listing provisions, also set forth the procedures for reclassifying and delisting species on the Federal lists. A species can be delisted if the Secretary of the Interior and/or the Secretary of Commerce determines that the species no longer meets the endangered or threatened status based upon the five factors listed in Section 4(a)(1) of the ESA:

(A) the present or threatened destruction, modification, or curtailment of its habitat or range;
(B) overutilization for commercial, recreational, scientific, or educational purposes;
(C) disease or predation;
(D) the inadequacy of existing regulatory mechanisms; and
(E) other natural or manmade factors affecting its continued existence.

A species may be delisted, according to 50 CFR Part 424.11(d), if the best scientific and commercial data available substantiate that the species or population is neither endangered nor threatened for one of the following reasons: (1) extinction, (2) recovery, or (3) original data for classification of the species were in error.

In the United Mexican States, the General Directorate for Wildlife of the Secretariat of Environment and Natural Resources (SEMARNAT) is entrusted with applying the policies in order to conserve and protect marine turtle species, in coordination with the National Commission of Natural Protected Areas (CONANP), the Federal Attorney for Environmental Protection (PROFEPA) and the National Fisheries Commission of the Secretariat of Agriculture, Cattle Raising, Rural Development, Fishing and Food (SAGARPA). The legal situation of the marine turtles is determined by the General Law of Ecological Balance and Protection to the Environment, the General Law of Wildlife and the Official Mexican Standard NOM-O59-SEMARNAT-2001 (published in the Mexican Federal Register, Diario Oficial de la Federacion [DOF 2002a]. The latter lists all marine turtle species as "in danger of extinction."

NMFS approved the initial recovery plan for the Kemp's ridley sea turtle on September 19, 1984. This initial plan was a multi-species plan for all six species of sea turtles occurring in the United States. On August 21, 1992, FWS and NMFS approved a separate recovery plan for the Kemp's ridley sea turtle (FWS and NMFS 1992). In 2002, FWS, NMFS, and SEMARNAT initiated the process to revise the plan for a second time but this time as a bi-national recovery plan truly reflective of the historical and essential partnership between our countries and institutions to fully recover this species.

Since approval of the first revised plan in 1992, significant research has been accomplished and important conservation and recovery activities have been undertaken. As a result, we have a greater knowledge of the species and its status. This second revision of the Bi-National Recovery Plan for the Kemp's Ridley Sea Turtle (hereinafter referred to as 'Plan') addresses current threats and needs, highlights conservation accomplishments that have been undertaken since the species was listed, refines recovery criteria for downlisting, identifies recovery criteria for delisting, and specifically addresses the planning requirements of the ESA.

B. TAXONOMY

The Kemp's ridley was first described by Samuel Garman (Garman 1880), as *Thalassochelys kempii* (or *Colpochelys kempii*). The sea turtle was named for Richard M. Kemp, a fisherman interested in natural history who submitted the type specimen from Key West, Florida. Baur (1890) allocated *kempii* to the genus, *Lepidochelys*, Fitzinger 1843, when it was realized that Kemp's ridley and the Indo-Pacific olive ridley, *Lepidochelys olivacea*, were congeneric, but this designation was not supported until Carr (1942) revised the genera of cheloniid turtles. During this interim, some authors gave *Colpochelys* full generic status and used the species name *kempi* rather than *kempii* (Hay 1908, Schmidt and Dunn 1917, Deraniyagala 1939). There also has been considerable debate on the correct spelling of species names ending in -i and -ii (see review by Pritchard 1996). Carr (1942, 1952) initially used the specific name *kempii*, though he switched to *kempi* in later publications (Carr 1957, 1963, Carr and Caldwell 1956, 1958, Carr and Goin 1959). At the 1990 meeting of the International Commission of Zoological Nomenclature (Commission), a proposal was accepted in which either spelling would be admissible regardless of the original spelling. However, the Commission later ruled that species names ending in -i and -ii are homonyms when the taxa they denote are included in the same genus and, when two or more names are homonyms, only the senior may be used as the valid name. Accordingly, the form *kempii* (Garman 1880) is the appropriate specific name for the

Kemp's ridley (J. Savage, University of Miami, personal communication, as referenced in Schmid and Barichivich 2006).

Although some have considered *L. kempii* to be a sub-species of *L. olivacea*, currently it is recognized as a full species clearly distinct from *L. olivacea* (Bowen *et al.* 1991). The latter species is distributed predominately in the Pacific and Indian Oceans and the southern Atlantic Ocean. Although individuals occasionally reach the Northwest Atlantic (Stokes and Epperly 2006), the olive ridley is not sympatric with *L. kempii*, a more northern species in the Atlantic. A taxonomic review of the genus including a detailed morphological description of the two species, established that they have enough morphological differentiation to justify designation as separate full species (Pritchard 1969, 1989). This status is widely accepted (Marquez 1970, 1990, Brongersma 1972, Marquez *et al*. 1976, 1982, Smith and Smith 1979, Frair 1982, Pritchard and Trebbau 1984, Marquez and Bauchot 1987, Bowen *et al.* 1991). Genetic studies examined mitochondrial (mt) DNA restriction sites and found that the Kemp's ridley is distinct from the olive ridley in matriarchal phylogeny, and that the two species are sister taxa with respect to other marine turtles (Bowen *et al*. 1991). During further comparisons of mtDNA control region sequences, Bowen *et al*. (1998) confirmed a fundamental partition between the two species.

A few turtles that phenotypically appeared to be hybrids between Kemp's ridley and loggerhead turtles, and Kemp's ridley and green turtles, have been observed nesting in Tamaulipas, Mexico (J. Pena, Gladys Porter Zoo (GPZ), personal communication 2006). A hybrid between a female Kemp's ridley and a male loggerhead turtle was discovered in Chesapeake Bay, Virginia, during 1992 and documented with molecular genetics techniques (Bowen and Karl 1997). A possible hybrid was identified phenotypically during a coldstunning event in Massachusetts in 2002 (Sea Turtle Stranding and Salvage Network unpublished data). Nuclear genotype data from three hatchlings taken from Rancho Nuevo in Tamaulipas, Mexico, in 1999 showed they were hybrid offspring between female Kemp's ridleys and male loggerheads (Barber *et al.* 2003).

Kichler (1996a, 1996b) and Kichler *et al*. (1999) found Kemp's ridleys nesting in Rancho Nuevo to be polyandrous, in many cases with up to four fathers in one clutch and three fathers in 14 of the clutches (n=211) examined. One male was always very dominant in numbers of offspring and the other males had far fewer offspring. Kichler (1996a) found allele heterozygosity at a few loci and concluded that there was not much difference in *L. olivacea* and *L. kempii* in this regard and that "The decline in the Kemp's ridley population does not appear to have been severe enough to affect their genetic health". However, Stephens (2003) concluded that results from three analytical approaches involving microsatellites (temporal change in allele frequency, an excess of heterozygotes in progeny, and a mean ratio of the number of alleles to the range of allele size) suggested that Kemp's ridley sustained a measurable loss of genetic variation due to the demographic bottleneck. Nevertheless, Kichler (1996a) showed that the genetic variability as measured by heterozygosis at microsatellite loci is high (H=0.60), which indicates that the demographic bottleneck has occurred too fast to be detected even with highly variable markers. If this conclusion holds, the rapid population increase in the Kemp's ridley over one or two generations will likely prevent any negative consequence in the genetic variability of the species.

Dutton *et al*. (2006) examined mtDNA control region sequences from 42 Kemp's ridley females that nested at Padre Island National Seashore (PAIS) between 2002 and 2004 and compared haplotype frequencies with those from the Rancho Nuevo population in order to test for a shift in haplotype frequencies that might indicate a possible founder event. They identified a total of six distinct haplotypes, with one found at high frequency both at PAIS and Rancho Nuevo. There was no significant difference in haplotype frequency indicating genetic homogeneity between both populations. Frey *et al.* (2008) described use of microsatellite markers for assigning nesting females to unknown nests on the Texas coast. The objective of this on-going study is to expand knowledge of the annual numbers of females nesting, inter-nesting intervals, re-migration intervals, site fidelity, and results of experimental imprinting and headstarting in Texas (see G.4.2 Imprinting and Headstarting).

C. SPECIES DESCRIPTION

The Kemp's ridley and its congener, the olive ridley, are the smallest of all extant sea turtles. Kemp's ridleys diverged from the olive ridley approximately 2.5-3.5 million years ago (Bowen *et al.* 1991). The weight of an adult is generally between 32-49 kg and the straight carapace length is around 60-65 cm (Heppell *et al.* 2005). Adult Kemp's ridley shells are almost as wide as they are long. The coloration changes significantly during development from the grey-black dorsum and plastron of hatchlings, a grey-black dorsum with a yellowish-white plastron as post pelagic juveniles and then to the lighter grey-olive carapace and cream-white or yellowish plastron of adults. There are two pairs of prefrontal scales on the head, five vertebral scutes, usually five pairs of costal scutes and generally 12 pairs of marginals on the carapace. In each bridge adjoining the plastron to the carapace, there are four scutes, each of which is perforated by a pore. This is the external opening of the Rathke's gland, which secretes a substance of unknown (possibly pheromonal) function. Males are not well described but resemble the females in size and coloration. Secondary sexual characteristics typical of male sea turtles are present: longer tail, more distal vent, recurved claws, and a softened mid-plastron during breeding. The eggs are between 34-45 mm in diameter and 24-40 g in weight. Hatchlings generally range from 42-48 mm in straight line carapace length, 32-44 mm in width and 15-20 g in weight (Chavez *et al.* 1967, Marquez 1972, 1990, Pritchard and Marquez 1973).

D. POPULATION DISTRIBUTION AND TRENDS

The Kemp's ridley has a restricted distribution. Nesting is essentially limited to the beaches of the western Gulf of Mexico, primarily in Tamaulipas, Mexico (Figure 1). Nesting also occurs in Veracruz and a few historical records exist for Campeche, Mexico (Marquez 1994). Nesting also occurs regularly in Texas and infrequently in a few other U.S. states. However, historic nesting records in the U.S. are limited to south Texas (Werler 1951, Carr 1961, Hildebrand 1963).

Most Kemp's ridley nests located in the U.S. have been found in south Texas, especially Padre Island (Shaver and Caillouet 1998, Shaver 2002b, 2005a). Nests have been recorded elsewhere in Texas (Shaver 2005a, 2006b, 2006c, 2007, 2008), and in Florida (Johnson *et al.* 1999, Foote and Mueller 2002, Hegna *et al.* 2006), Alabama (J. Phillips, FWS, personal communication, 2007, J. Isaacs, FWS, personal communication, 2008), Georgia (Williams *et al.* 2006), South Carolina (Anonymous 1992), and North Carolina (Marquez *et al.* 1996), but these events are less frequent (Figure 1). Kemp's ridleys inhabit the Gulf of Mexico Northwest Atlantic Ocean, as far north as the Grand Banks (Watson *et al.* 2004) and Nova Scotia (Bleakney 1955). They occur near the Azores and eastern north Atlantic (Deraniyagala 1938, Brongersma 1972, Fontaine *et al.* 1989a, Bolten and Martins 1990) and Mediterranean (Pritchard and Marquez 1973, Brongersma and Carr 1983, Tomas and Raga 2007, Insacco and Spadola 2010).

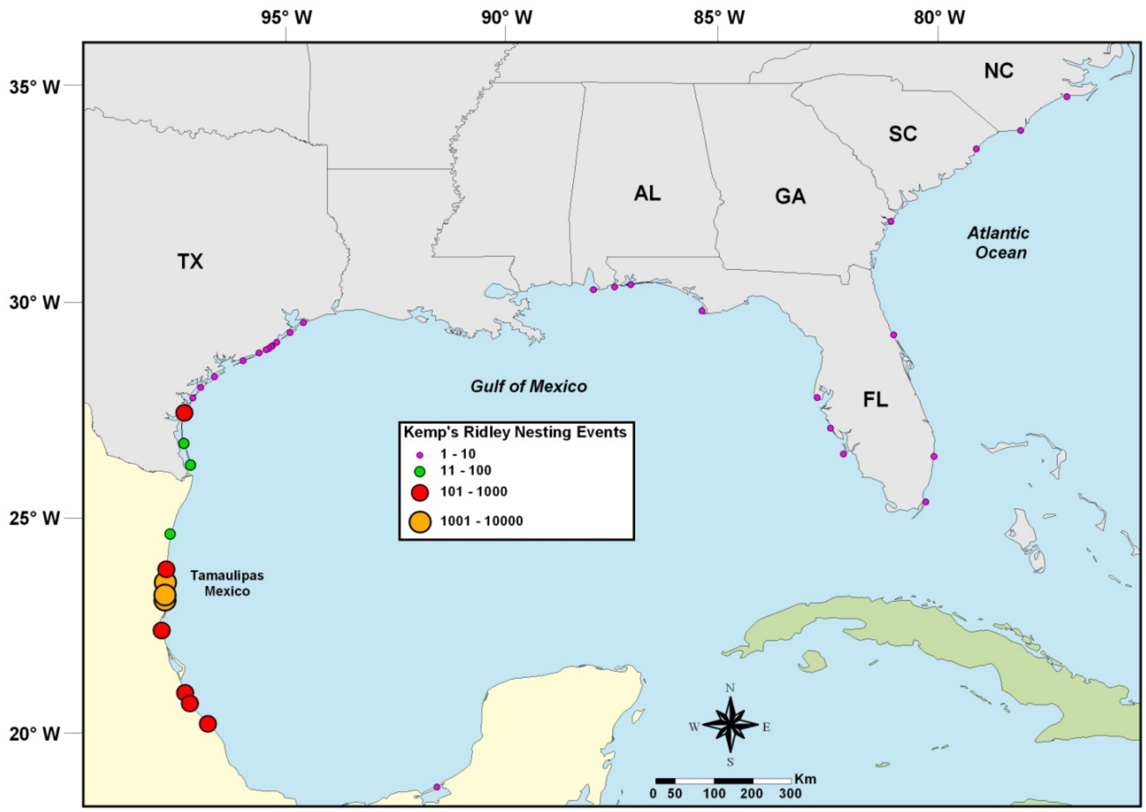
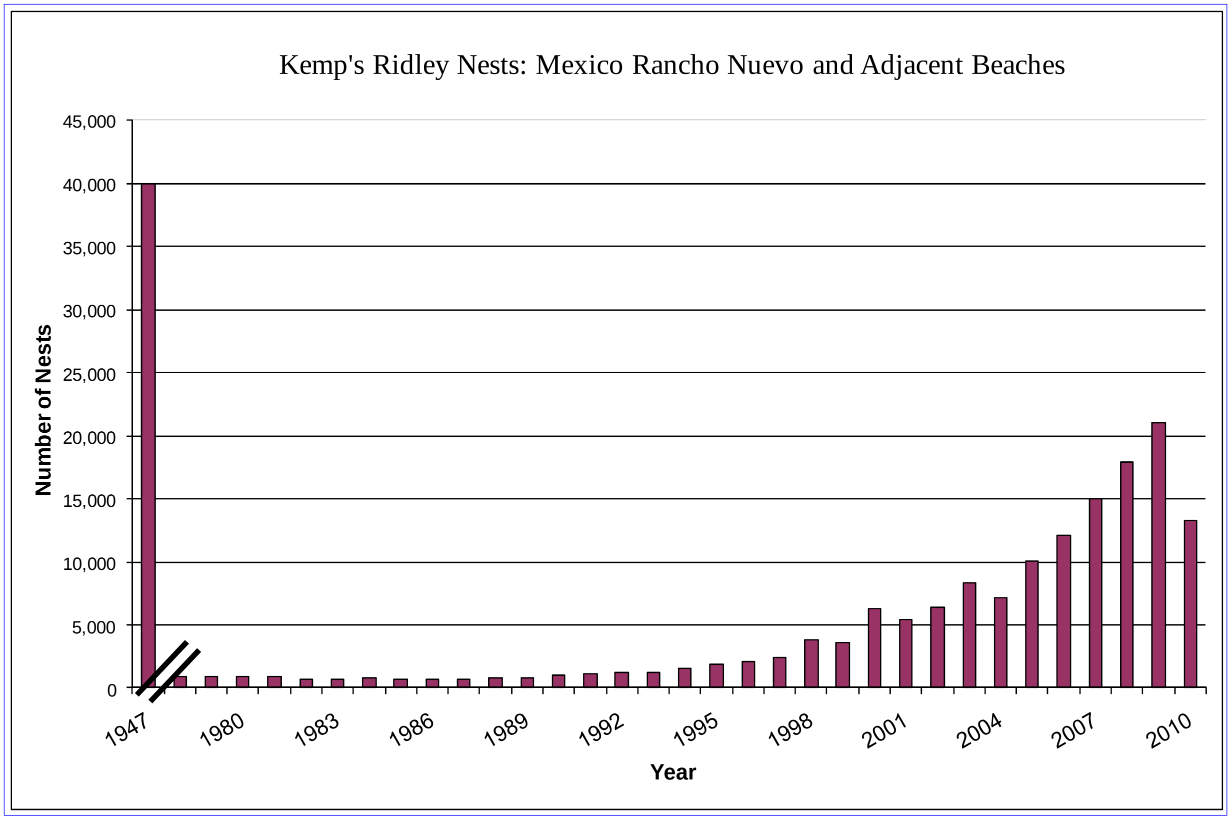


Figure 1. Major nesting beaches in the State of Tamaulipas, Mexico, and proportion of total nests documented for each beach in 2009 (*Source*: J. Pena, GPZ), and location of nests recorded in U.S. (*Source:* Padre Island National Seashore, FWS, Florida Marine Research Institute, Georgia Department of Natural Resources, South Carolina Department of Natural Resources, and North Carolina Wildlife Resources Commission).

Nesting aggregations at Rancho Nuevo were discovered in 1947, and the adult female population was estimated to be 40,000 or more individuals based on a film by Andres Herrera (Hildebrand 1963, Carr 1963).[1] Within approximately three decades, the population had declined to 924 nests and reached the lowest recorded nest count of 702 nests in 1985. Females lay approximately 2.5 nests each season they nest (see Section F. Demography), thus, 702 nests represents fewer than 300 females nesting in a season. Since the mid-1980s, the number of nests observed at Rancho Nuevo and nearby beaches has increased 15% per year (Heppell *et al.* 2005),

[1] Dickerson and Dickerson (2006) digitized the original Herrera 16-mm Kodachrome film and requested volunteers who were either naïve or knowledgeable with the film's history to count the number of turtles in the photo and guess the length of beach. Volunteers were given either a printed (N=41) or computerized (N=35) version of the digitized photograph. Those who had the computer version were encouraged to use image enhancing capabilities. The results were a mean of 503 (SD = 89.82, var. = 8,068) turtles and pooled mean value of 700 meters for the beach length. Using these values, they estimated 5,746 turtles were present in the Herrera film at the time the photograph was taken. This specific estimate is substantially lower than the Hildebrand (1963) and Carr (1963) estimates. However, these published estimates reflected total projected numbers for the complete arribada that occurred in 1947. The Dickerson and Dickerson (2006) estimate is based on pooled estimates from respondents of unknown levels of expertise and different methods may have been used to count the turtles. The Team believes the best available estimate is based on Hildebrand (1963) and Carr (1963), given the possible biases introduced in the Dickerson and Dickerson (2006) estimate.

allowing cautious optimism that the population is on its way to recovery. The total annual number of nests recorded at Rancho Nuevo and adjacent camps has exceeded 10,000 in recent years (Figure 2). Over 20,000 nests were recorded in 2009 at Rancho Nuevo and adjacent camps, but only 13,302 nests were recorded in 2010 (J. Pena, GPZ, personal communication 2010). For Texas, from 2002-2010, a total of 911 Kemp's ridley nests have been documented on the Texas coast (Figure 3). This is more than eleven times greater than the 81 nests recorded over the previous 54 years from 1948-2001 (Shaver and Caillouet 1998, Shaver 2005a), indicating an increasing nesting population in Texas. From 2005 through 2010, the number of nests from all monitored beaches indicate approximately 5,500 females are nesting each season



in the Gulf of Mexico.

Figure 2. Number of nests recorded during surveys of nesting beaches at Tamaulipas and Veracruz, Mexico (*Source:* National Institute of Fisheries, Mexico (INP), GPZ, and U.S. Fish and Wildlife Service). Notes: The 1947 number was derived from an amateur film by Andres Herrera and is a single reference point representing nesting females on a single day. The total nests over the entire 1947 nesting season is believed to be much higher. Systematic surveys of the Rancho Nuevo nesting beach began in 1966 and were extended to other beaches in 1990.

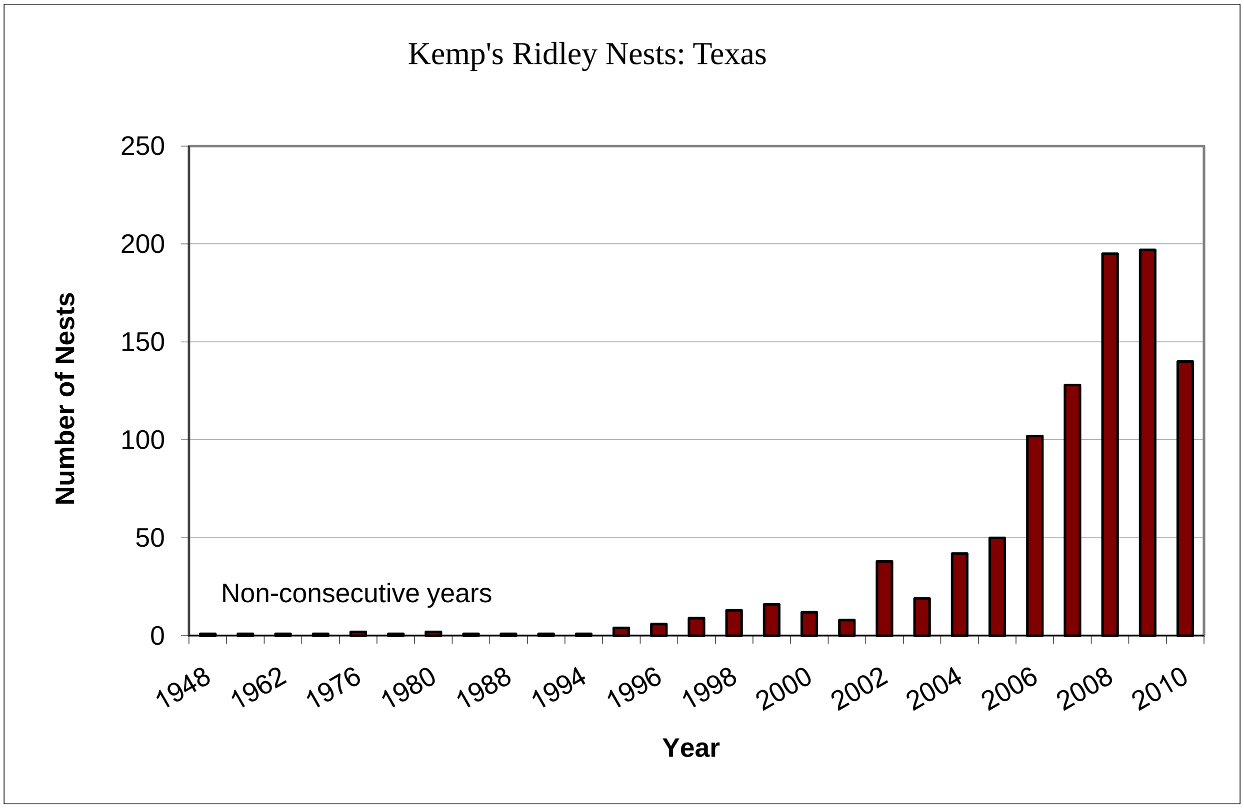


Figure 3. Number of nests recorded on nesting beaches in Texas, U.S. (*Source*: Shaver and Caillouet 1998, Shaver 2004, 2005a, 2005b, 2006b, 2006c, 2007, D. Shaver, PAIS, personal communications 2008, 2010). Notes: Nests were reported opportunistically by the public or through systematic surveys, and recorded after confirmation of the presence of eggs. Systematic surveys of the PAIS nesting beach did not begin until 1986, but were minimal for the first decade and surveys were extended to other beaches in Texas starting in 1999.

Population models predict the population will grow at least 12-16% per year, (19% based on updated model in this plan), for the near future, assuming current survival rates within each life stage remain constant (Heppell *et al.* 2005) (Figure 4). The population could attain at least 10,000 nesting females in a season on the major beaches in Mexico in this decade [by 2015 (Heppell *et al*. 2005); by 2011 (updated model in this Plan)]. This criterion is not dissimilar to the one in the 1992 Recovery Plan (FWS and NMFS 1992), which specified at least 10,000 nesting females in a season, but did not identify which beaches it applied to. The 1992 Recovery Plan noted that nearly the entire adult female population nests along 60 km of beach on the east coast of Mexico (i.e., Rancho Nuevo). Thus, the criterion would be achieved by what was documented at that locality. We retained that in this Plan and identified Rancho Nuevo, Tepehuajes, and Playa Dos as the primary nesting beaches. Of note, the population growth rate may decrease soon after this criterion is reached as a result of a decrease in the nest survival rate due to an increasing number of nests left *in situ* (Heppell *et al.* 2005). The rapid population growth rate predicted in the models is contingent on a high egg survival rate. In the short term, this rate can only be achieved through relocation of many nests to corrals where the eggs are protected from predation, harvest, and inundation. As the population increases, the proportion of protected nests will decrease. A reduction in egg survival with increasing nest density would decrease the predicted rate of growth (Heppell *et al.* 2005).

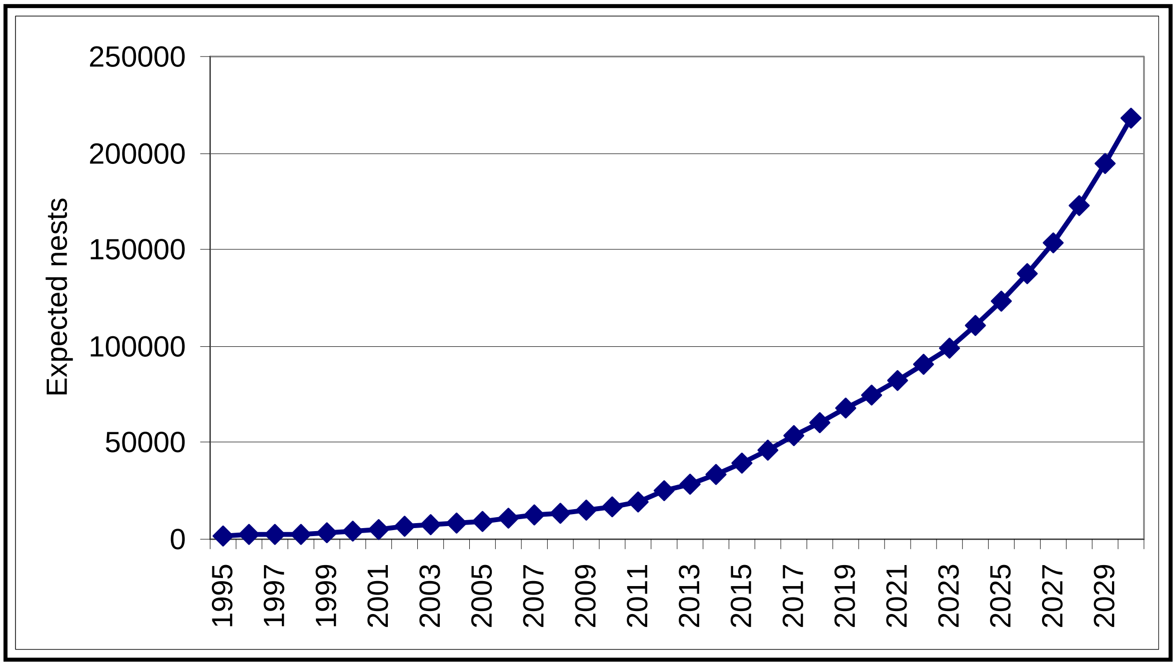


Figure 4. Expected number of nests predicted in the model for past and future years based on the assumption of continued high egg survival rates. The updated model runs were based on information presented in section F. Demography and nesting activity through 2009. We assumed that 14,500 would be placed in corrals for protection, which is about 50% of the nests at the time of downlising. As more nests are left *in situ*, overall egg survival will decrease and, with a lag equal to age-at-maturity, the population growth rate will be reflected in subsequent nesting activity.

Many factors affect population growth rates and, given the longevity of this species, long time lags and multiple co-occuring management actions prevent us from directly attributing an observed increase or decrease in abundance to a particular cause. The recent increase in Kemp's ridley nesting is likely due to a combination of management measures including elimination of direct harvest, nest protection, the use of TEDs, reduced trawling effort in Mexico and the U.S., and possibly other changes in vital rates (Turtle Expert Working Group (TEWG) 1998, 2000). Although egg protection efforts began in the 1960s, sustained annual increases in nesting were not recorded until the late 1980s/early 1990s.

E. LIFE HISTORY/ECOLOGY

Kemp's ridleys share a general life history pattern similar to other sea turtles such as the loggerhead (*Caretta caretta*) (Bolten 2003). Females lay their eggs on coastal beaches where the eggs incubate in sandy nests. After 45-58 days of embryonic development, the hatchlings emerge, *en masse*, and swim offshore into deeper, ocean water where they feed and grow until returning at a larger size to nearshore coastal habitats. This life history pattern is characterized by three basic ecosystem zones: (1) **Terrestrial zone** (supralittoral) - the nesting beach where both oviposition and embryonic development occur; (2) **Neritic zone** - the nearshore (including bays and sounds) marine environment (from the surface to the sea floor) where water depths do not exceed 200 meters, including the continental shelf; and (3) **Oceanic zone** - the vast open ocean environment (from the surface to the sea floor) where water depths are greater than 200 meters.

E.1. Terrestrial Zone: Nesting Female/Egg/Hatchling Stage

Kemp's ridleys nest on ocean beaches. The beach at Rancho Nuevo (where a majority of nests are laid and which is characteristic of nesting beaches in Mexico) is formed by low dunes, isolated on the land side by shallow coastal lagoons with several narrow cuts that open during the rainy season forming estuaries or temporary sand bars (Marquez 1994). The beach is typically formed by two berms, which vary in width from 15 m to 45 m. The sand contains a high portion of fine grains. The dunes vary in height and are stabilized by coastal plants such as sea oats (*Uniola sp.*) and cord grass (*Spartina sp.*). Rancho Nuevo is considered a high energy beach with sand flats running parallel and adjacent to the beach, forming reef-like barriers (Marquez 1994).

The beach on the Texas coast varies geographically, with some areas generally similar to Rancho Nuevo and other areas differing. Prior to initiation of the bi-national program to establish a secondary nesting colony at PAIS, beach profiles and sand characteristics of Rancho Nuevo and PAIS were compared and deemed relatively similar. However, it is unclear which area of PAIS was surveyed. The beach is not homogeneous at PAIS. In some areas of PAIS, where nearshore currents converge, the beach consists of more shell fragments and often forms steeper berms. There are some areas at PAIS where the dunes are very tall, but on the upper Texas coast there is virtually no dune line and the beach is highly erosional and maintained through sand replenishment.

Nesting occurs primarily from April into July. Nesting often occurs in synchronized emergences termed *arribadas* or *arribazones*, which may be triggered by high wind speeds, especially north winds, and changes in barometric pressure (Jimenez *et al*. 2005). Nesting is primarily during daylight hours, although some night nesting has been recorded in Mexico and Texas during recent years (P. Burchfield, GPZ, personal communication 2007, D. Shaver, PAIS, personal communication 2009).

The hatchlings emerge usually at night or early morning after 45-58 days, depending on incubation conditions, especially temperature. See Pritchard and Marquez (1973) for a complete description of the nesting process. See F.2. Reproduction in this document for additional discussion on the demographic aspects of nesting.

E.2. Neritic Zone: Early Transitional Neritic Stage for Hatchling/Post-Hatchling

The early transitional neritic stage for the Kemp's ridley is not well known (see Collard and Ogren 1990) but may be similar to the loggerhead model (Bolten 2003). Thus, the term 'early transitional neritic' refers to the period after a Kemp's ridley hatchling leaves the beach, swims offshore, and associates with boundary currents and prior to it being transported in pelagic currents within the open ocean.

Upon emerging from the nest, sea turtle hatchlings enter the surf and swim offshore for approximately 20-30 hours (Carr and Ogren 1960, Carr 1962, 1982, Wyneken and Salmon 1992, Witherington 1995). Hatchlings begin swimming as soon as they are lifted off the substrate by the surf. Their swimming pattern consists of alternating powerstroking below the surface and brief dogpaddling/breathing at the surface (Salmon and Wyneken 1987, Witherington 1995). As with green turtle hatchlings (Carr 1962), Kemp's ridley hatchlings likely dive as breaking waves approach so that they are swept seaward by wave motion near the bottom.

Lohmann *et al.* (1997) discuss orientation cues used by hatchlings as they crawl on the beach, swim through the surf, migrate offshore, and navigate the oceans. Hatchlings enter the surf and orient offshore by swimming into the oncoming waves. They are able to sense the surge motion and orbital movement of water associated with waves to guide themselves seaward (Wyneken *et al*. 1990, Lohmann *et al*. 1995, Wang *et al*. 1998). These cues likely evolved as a mechanism to ensure offshore movement because waves that reach the shallow waters move directly toward shore. The mechanism is hardwired in that hatchlings will orient into oncoming waves even if it places them closer to land (Lohmann and Lohmann 1992). Evidence suggests that orienting into oncoming waves is short-lived and that other cues dominate as hatchlings move farther from shore where wave direction is a less reliable indicator of offshore direction (Witherington 1995). Farther from shore, hatchlings appear to rely on a magnetic compass similar to birds (Lohmann 1991, Light *et al.* 1993, Lohmann and Lohmann 1994).

Because their main nesting area is in the Mexican state of Tamaulipas, Kemp's ridley hatchling transport is controlled by the oceanic currents in the western Gulf of Mexico. Hatchlings cross the narrow continental shelf off Tamaulipas and initially become entrained in the anticyclonic Mexican Current. The narrow shelf off Rancho Nuevo may enhance the probability of hatchlings reaching a western boundary current in a short period of time, possibly less than 24 hours (Collard and Ogren 1990). This period is within four days, which is thought to be extent of the hatchling's reserve energy stores from the nutrient rich yolk sac (Kraemer and Bennett 1981). Ocean circulation conditions offshore of Tamaulipas and Veracruz nesting beaches may also facilate hatchling transport to the pelagic environment within 4 days and subsequent migration to foraging grounds within 2 years (Putman *et al*. 2010).

E.3. Oceanic Zone: Juvenile Stage

Upon entering the boundary current, post-transitional hatchlings likely decrease their swimming activity and become passive migrants in oceanic currents. Their feeding habits may be similar to loggerhead hatchlings that have migrated away from land and are found near the Gulf Stream off Florida (Witherington 2002). Use of the *Sargassum* community has been suggested for oceanic juvenile loggerhead and green turtles in the Northwest Atlantic (Carr 1986). Shaver (1991) noted that two juvenile (< 20 cm straight carapace length (SCL)) Kemp's ridleys stranded in south Texas had ingested *Sargassum* and invertebrates associated with this brown macroalgae, providing support that this species may also use the *Sargassum* community as epipelagic developmental habitat. Most Kemp's ridley post-hatchlings likely remain within the Gulf of Mexico. Others are transported into the northern Gulf of Mexico and then eastward, with some continuing southward in the Loop Current, then eastward on the Florida Current into the Gulf Stream (Collard and Ogren 1990, Putman *et al.* 2010).

The oceanic juvenile stage can be divided into two distinct groups, one that remains in the current system of the northern and western Gulf of Mexico, and another that is transported to the Gulf Stream of the Northwest Atlantic. In any case, it is more likely that the predominant retention is in the Gulf of Mexico and not along the U.S. Atlantic coast (Collard and Ogren 1990, Putman *et al.* 2010). Some individuals are transported to the eastern Atlantic, including the Mediterranean Sea (Brongersma 1982). Juvenile Kemp's ridleys spend on average 2 years in the oceanic zone (NMFS SEFSC unpublished preliminary analysis, July 2004), presumably living and feeding among floating algal communities. They recruit to the neritic zone where they forage on benthic fauna at approximately 2 years of age (Ogren 1989), although the time spent in the oceanic zone may vary from 1 to 4 years or perhaps more (Baker and Higgins 2003, Dodge *et al.* 2003, TEWG 2000).

The ontogenetic shift from oceanic to neritic benthic habitat has been documented by skeletochronology (Snover 2002). During growth, bone formation ceases or slows followed by rapid growth. This pattern is repeated each year and is evidenced by a growth mark described as a settlement line or annulus. For Kemp's ridleys during their juvenile pelagic phase in the Northwest Atlantic, the first year growth mark is indistinct, which likely indicates rapid growth rates and a lack of total cessation of bone growth (Snover 2002). The growth mark becomes well-defined by the second year, and differential isotope ratios of carbon and nitrogen before and after the growth mark indicate feeding at higher trophic levels (Snover 2002). This is consistent with shifting from pelagic invertebrate prey to nearshore benthic species such as crabs. In addition, Kemp's ridleys ranging in age from 1 to 3 years (coded wire tagged as hatchlings) were found stranded during cold weather on Cape Cod, Massachusetts (Dodge *et al.* 2003, Snover *et al.* 2005). The average carapace length of the Cape Cod stranded turtles was 28 cm SCL, which fell within the average size for all Kemp's ridleys that stranded from 1999-2003, indicating nearshore recruitment within several years (Dodge *et al.* 2003). The movement of young Kemp's ridleys into coastal waters marks the beginning of a new life stage: the juvenile developmental neritic stage.

E.4. Neritic Zone: Juvenile Stage

After a pelagic existence, juvenile Kemp's ridleys settle into nearshore areas within the Gulf of Mexico and the Northwest Atlantic. Kemp's ridleys that remained in the Gulf of Mexico during their early oceanic stage apparently move into coastal waters, mainly along the northern and eastern shorelines of the Gulf (Landry and Seney 2008). Juveniles in the Northwest Atlantic transition into shallow coastal habitats along the eastern U.S. extending from Florida to New England (Morreale and Standora 1999, Morreale *et al.* 2007). Both the initial transition and the subsequent movements of juvenile Kemp's ridleys to and from these shallow coastal habitats appear to be seasonal.

The main characteristics that define the areas inhabited during the juvenile developmental stage are somewhat protected, temperate waters, shallower than 50 m. A large portion of the neritic juveniles resides in waters with temperatures that vary seasonally.

There are many descriptive accounts of the habitat characteristics associated with the important coastal foraging sites for juvenile neritic Kemp's ridleys. Carr (1942) first suggested the use of the mangrove coastline of southern Florida, particularly Florida Bay. A wide variety of benthic communities and substrates has since been proffered as foraging habitat, including seagrass beds (Carr and Caldwell 1956, Byles 1988, Danton and Prescott 1988, Schmid and Barichivich 2005, 2006), oyster reefs (Schmid 1998), sandy bottoms (Morreale and Standora 1992), mud bottoms (Ogren 1989, Schmid 1998), or a combination of communities and substrates (Ogren 1989, Rudloe *et al*. 1991). However, none of these studies have described the amount of time turtles spend using these habitats or characterized all the habitats available to turtles within the respective study areas. Estimates of resource use and availability are necessary to test for habitat preferences (Schmid 2000, Schmid *et al.* 2003) and to subsequently identify coastal foraging habitats essential to the recovery of the species (Thompson *et al*. 1990, FWS and NMFS 1992). Live bottom (sessile invertebrates attached to hard substrate) has been documented as a preferred habitat of neritic juveniles in the coastal waters of western Florida, which has not been identified in any previous descriptive accounts of benthic habitat use (Schmid 2000, Schmid *et al.* 2003, Schmid and Barichivich 2006). The preference for nearshore live bottom habitat has important implications for offshore winter habitat use by neritic juveniles and adults (Schmid and Witzell 2006).

The Kemp's ridley turtle is considered to be cancrivorous, feeding primarily on decapod crustaceans (Hildebrand 1982, Shaver 1991, Burke *et al*. 1993b, 1994, Marquez 1994, Seney and Musick 2005). Ogren (1989) suggested that areas inhabited by neritic juveniles overlapped with the distribution of portunid crabs, as this has been identified as an important component of their diet, yet the studies since that time indicate a much broader and more diverse dietary preference. Shaver (1991) suggested that the distribution of foraging Kemp's ridleys is related to the distribution and availability of all the major crab species that are consumed. Studies have also shown that their diets include various items such as mollusks, natural and synthetic debris, sea horses, and tunicates (Shaver 1991, Burke *et al.* 1993a, 1993b, 1994, Werner 1994, Witzell and Schmid 2005). However, nearly every Kemp's ridley stomach and fecal sample examined to date from U.S. Atlantic and Gulf of Mexico coastal habitats has included crabs. Therefore, crabs constitute the bulk of their diet (Lutcavage and Musick 1985, Bellmund *et al.* 1987, Shaver 1991, Burke *et al.* 1993a, 1994, Schmid 1998, Seney and Musick 2005).

E.4.1. Gulf of Mexico

Juvenile neritic Kemp's ridleys occupy shallow coastal waters in the northern Gulf of Mexico (Carr and Caldwell 1956, Ogren 1989, Rudloe *et al.* 1991, Schmid 1998, Schmid 2000, Witzell and Schmid 2004), but have not been reported in the southern Gulf of Mexico (Carr 1967). Known foraging areas frequented by neritic juveniles extend from south Texas to southwestern Florida. Key examples of coastal foraging areas include Sabine Pass, Texas; Caillou Bay and Calcasieu Pass, Louisiana (Landry *et al.* 1995, 2005); Big Gulley, Alabama, Charlotte Harbor, Apalachicola, Apalachee, Deadman, Waccassasa, and Gullivan Bays, Florida (Schmid and Barichivich 2005, 2006, Witzell 2007).

Kemp's ridleys were captured in the historic west Florida turtle fishery, which operated April through November (Carr and Caldwell 1956, Carr 1980). More recent tagging studies with neritic juveniles have confirmed this pattern of seasonal occurrence in shallow coastal waters and have determined that turtles occurred when water temperatures were above 20ºC (Schmid 1998, Schmid and Barichivich 2005, 2006). A similar seasonal occurrence has been described from tagging studies in Texas and Louisiana (Landry *et al.* 2005). Capture data from tagging studies in the northern Gulf of Mexico indicate that turtles leave coastal foraging areas in the fall presumably moving out to more suitable overwintering habitat in deeper or more southern waters and returning to coastal feeding areas the following spring (Ogren 1989, Schmid 1998). However, sightings and captures in Florida have also been reported in December and March during periods of unseasonably warm water temperatures (Schmid and Barichivich 2005, 2006). Turtles were captured or sighted in the coastal waters of southwest Florida during all months of the year, but abundance decreased in winter months (December–February) and turtles were not observed during some of the colder winters (Witzell and Schmid 2004). Turtles were observed in 17.3°C in December south of Gullivan Bay in southwest Florida (Witzell 2007). Recaptures of tagged turtles indicate some individuals return to the same foraging areas in subsequent years (Schmid 1998, Witzell and Schmid 2004).

Satellite telemetry has been used to document a southerly/southwesterly winter migration by Kemp's ridleys in the northwestern Gulf of Mexico, a west to east migration in the northern Gulf, and a southerly winter migration in the eastern Gulf (Renaud and Williams, 2005). The passage of cold fronts in the fall reduced water temperatures in coastal waters and turtles responded by moving to offshore waters. Recent efforts in west Florida confirmed that neritic juvenile Kemp's ridleys emigrated from coastal foraging grounds in Waccasassa Bay/Cedar Keys during November in response to rapidly decreasing water temperatures (Schmid and Witzell 2006). Turtles migrated southward through December, but some moved to deeper waters offshore of Anclote Keys (120 km from Cedar Keys) and others continued in shallower coastal waters as far south as Sanibel Island (296 km from Cedar Keys). Despite these differences in latitudinal and offshore distribution, Kemp's ridleys reached their southernmost migration by the end of January and began moving northward to shallower waters in February and March. All turtles eventually returned to the Waccasassa Bay/Cedar Keys area by late March. Five of the six turtles occupied relatively confined foraging areas (4–48 km^2) in Cedar Keys through August, and three of these returned to their initial capture location (Schmid and Witzell 2006). As proposed by Schmid *et al.* (2003), this latter observation provides evidence that Kemp's ridley turtles return to previously used foraging habitat, and the former suggests turtles may re-establish foraging range areas between seasons. Given the multi-annual recaptures in this area (Schmid 1998), neritic juveniles may continue this pattern of seasonal migrations and foraging site fidelity for a number of years until maturing and moving to adult foraging areas. Thus, not only are the nearshore foraging grounds in the Gulf important to neritic stage Kemp's ridleys, but offshore overwintering areas in the Gulf also are crucial to the conservation and recovery of Kemp's ridleys.

E.4.2. Atlantic

In the Northwest Atlantic, foraging areas for neritic juvenile Kemp's ridleys are in shallow coastal waters, mainly in the large estuarine systems along the eastern U.S., extending from Florida to New England. Key developmental habitats where the activity and foraging of young Kemp's ridleys have been studied are in the vicinities of Pamlico Sound, North Carolina, Chesapeake Bay, Virginia, and Long Island Sound, New York. Other foraging areas likely include Charleston Harbor, South Carolina, and Delaware Bay, New Jersey. Activity in foraging habitats is seasonal, spanning the warmer months (Bleakney 1965, Lutcavage and Musick 1985, Keinath *et al.* 1987, Shoop and Kenney 1992, Keinath *et al*. 1994, Burke *et al*. 1994, Musick *et al*. 1994, Epperly *et al*. 1995a, Morreale and Burke 1997, Morreale and Standora 1998, Mansfield and Musick 2005). It has been suggested the average size of Kemp's ridleys foraging along the U.S. Atlantic coast increases gradually from north to south (Carr 1980, Henwood and Ogren 1987). This clinal pattern is apparent when comparing the average size of turtles from the New England states to those of the mid-Atlantic states; however, an increasing gradient in mean size or size class composition is not apparent when comparing captures from Virginia, South Carolina/Georgia, and east-central Florida (Schmid 2000, Schmid and Barichivich 2006). These spatial comparisons are complicated by the fact that individuals move among these areas seasonally. The larger size of turtles in the south may be a result of different growth rates as habitat conditions change, or they simply may be older turtles (Snover 2002).

Kemp's ridleys along the eastern seaboard migrate out of coastal foraging areas to more favorable overwintering sites due to abrupt temperature declines each year. The timing of emigration varies by latitude, with earlier emigration in the more northern waters. The outcome is a pulse of turtles of mixed species departing simultaneously from Atlantic coastal developmental habitats each year in late fall (for overview see Morreale and Standora 2005). Along the way the northernmost turtles likely are joined by others migrating southward from coastal New Jersey and Delaware waters. By early November, turtles head southward past the Virginia border, where they presumably become part of an ongoing procession of migrants out of Chesapeake Bay (Lutcavage and Musick 1985, Byles 1988, Keinath 1993, Renaud 1995) and North Carolina inshore waters (Epperly *et al*. 1995b, c). This group of migrants from the north joining the stream of migrating mid-Atlantic coast turtles means that each December there probably is a rather large confluence of sea turtles in that region, and many continue their trek southward. Indeed, such large clusters of turtles have been reported in separate observation studies during winter months in North Carolina waters (Musick *et al.* 1994, Epperly *et al*. 1995a, b). It also is likely that a relatively large proportion of neritic juvenile Kemp's ridleys in the Atlantic are part of this aggregation each year.

After neritic juvenile Kemp's ridleys migrate south of Cape Hatteras, North Carolina, different patterns of behavior emerge. Some individuals continue swimming southward to as far as Cape Canaveral, Florida (Keinath 1993, Renaud 1995, Gitschlag 1996). The offshore waters south of Cape Canaveral have been identified as an important overwintering area for seasonal migrants along the U.S. Atlantic coast (Henwood and Ogren 1987, Schmid 1995). Telemetry data suggest turtles inhabited areas of hard bottom substrate and live bottom habitat on Florida's east coast south of Cape Canaveral (Gitschlag 1996, Schmid and Witzell 2006). Kemp's ridleys traveled southward from the coastal waters of Georgia and northern Florida in October and November, remained in coastal waters south of Cape Canaveral from December through February, moved northward in March and April, and resided off the South Carolina coast through July (Renaud 1995, Gitschlag 1996). However, one individual stopped its southward movement in Onslow Bay, North Carolina, where it remained in the vicinity until early January, when colder temperatures likely prompted a second movement offshore and into eddies of the nearby Gulf Stream (Renaud 1995). This overwintering behavior nearly exactly mirrored the early winter stopover location of two large loggerhead turtles tracked from Virginia in 1991 (Keinath 1993), and four juvenile loggerhead turtles migrating from New York in 1994 and 1995 (Morreale and Standora 1999). Thus, another potentially important overwintering area may be off central North Carolina (Morreale and Standora 1999). The section of coastline between Cape Hatteras and Frying Pan Shoals, including Onslow Bay and Raleigh Bay, North Carolina, is warmer because of the nearby Gulf Stream.

In the spring, Kemp's ridleys residing in east-central Florida waters migrate northward (Henwood and Ogren 1987, Schmid 1995). At the same time, young turtles are observed farther north, from Georgia to North Carolina (Musick *et al*. 1994, Epperly *et al*. 1995a, b). In May, as water temperatures continue to rise even farther northward, Kemp's ridleys and loggerheads begin to appear in Virginia (Lutcavage and Musick 1985, Keinath *et al*. 1987, Keinath *et al*. 1994), and by June, juveniles begin to arrive in New York (Burke *et al.* 1994, Morreale and Burke 1997) and New England (Bleakney 1965, Shoop and Kenney 1992). Neritic juveniles tagged along the U.S. Atlantic coast have been observed nesting at Rancho Nuevo (Schmid 1995, Chaloupka and Zug 1997, Schmid and Witzell 1997, Witzell 1998, Schmid and Woodhead, 2000), indicating their recruitment to the adult stage in the Gulf of Mexico. From 1994 to 2009, six Kemp's ridleys originally tagged in the Atlantic (size 26.3–54.8 cm SCL) were recaptured nesting at Rancho Nuevo and adjacent beaches (L. Belskis, NMFS SEFSC, personal communication 2009). One of these turtles originally tagged in Chesapeake Bay, Maryland, has been recaptured at Rancho Nuevo twice while nesting—3 years apart (L. Belskis, NMFS, personal communication 2009). However, neritic juveniles tagged in the Atlantic have not been recorded nesting in Texas (D. Shaver, PAIS, personal communication 2009).

E.5. Neritic Zone: Adult Stage

Adult Kemp's ridleys occur primarily in the Gulf of Mexico, but are occasionally found on the U.S. Atlantic coast (FWS and NMFS, 1992). Nearshore waters of 37 m or less provide the primary marine habitat, although it is not uncommon for adults to venture farther from shore where waters are deeper (Byles 1989, Mysing and Vanselous 1989, Renaud *et al*. 1996, Shaver *et al*. 2005b, Shaver and Wibbels 2007, Shaver and Rubio 2008). Adult Kemp's ridleys are largely cancrivorous (crab eating), with a preference for portunid crabs. From studies of stomach contents of dead stranded individuals, adults appear to be shallow water, benthic feeders, consuming primarily crabs and occasionally clams, shrimp, vegetation, fish, and marine debris (Marquez 1970, Pritchard and Marquez 1973, Hildebrand 1982, Shaver 1991).

Principal courtship and mating areas are not well known. Anecdotal information supplied by fishers revealed that mating presumably occurs at or before the nesting season in the vicinity of the nesting beach (Pritchard 1969, Marquez 1970, 1990). Shaver (1992) reported a mating pair of Kemp's ridleys in Mansfield Channel, Texas, at the southern boundary of PAIS. Mating may take place about 30 days before the first clutch of eggs for the season is laid (Rostal 1991, Rostal *et al*. 1998).

Recaptures of nesting females tagged at Rancho Nuevo indicate post-nesting migrations northward to areas offshore of Texas and Louisiana or southward to the Bay of Campeche in the Mexican states of Campeche and Tabasco (Chavez 1969, Márquez 1970, 1990, 1994, Pritchard and Márquez 1973). Satellite telemetry studies have shown that adult female Kemp's ridleys typically migrate between nesting and foraging areas and are primarily nearshore, shallow water inhabitants, capable of swimming rather long distances in a directed manner (Byles 1989, Mysing and Vanselous 1989, Renaud *et al*. 1996, Shaver 1998a, 1999b, 2000, 2001a, 2001b, 2002a, 2004, 2005b, 2006b, 2006c, 2007, Landry and Seney 2006, Morreale *et al.* 2007, Shaver and Rubio 2008). The waters off the western and northern Yucatan Peninsula and the northern Gulf of Mexico from southern Texas to western Florida are important foraging areas where adult female residency is established seasonally (Byles 1989, Márquez 1990, Shaver 1991, 1998b, 2001b, 2005a, Shaver and Rubio 2008). Knowledge of movements and habitat use by adult males is more limited. Satellite telemetry used to monitor movements of adult males captured near Rancho Nuevo and Texas (Shaver 2006a, 2007, Shaver *et al*. 2005b) found that most remained within nearshore waters (see G.4 Research Efforts).

F. DEMOGRAPHY

F.1. Age and Growth

Mark-recapture studies have provided evidence of geographic, ontogenetic, and seasonal variation in growth rates of Kemp's ridley turtles, but these estimates can be biased by small sample sizes and extrapolation from short-term recaptures. Schmid and Woodhead (2000) analyzed the NMFS Cooperative Marine Turtle Tagging Program database and determined that the mean growth rate for Kemp's ridleys tagged in the Gulf of Mexico (7.5 ± 6.2 cm/yr) was significantly greater than that of turtles tagged in the Atlantic (5.5 ± 6.2 cm/yr). Fontaine *et al.* (1989a) compared growth rates for head-started Kemp's ridleys and also found higher rates for turtles recaptured in the Gulf. Relatively high growth rates have also been calculated for Kemp's ridleys captured on the coast of Texas/Louisiana (7.3 cm/yr; Landry *et al.* 2005) and southwest Florida (6.5 ± 3.0 cm/yr; Witzell and Schmid 2004) compared to that of New York (4.0 ± 3.8 cm/yr; Morreale and Standora 1998). However, Schmid and Barichivich (2006) compared tagging studies in Florida and did not detect a significant difference when comparing Kemp's ridley growth rates from the Gulf coast (Deadman Bay - 4.1 ± 2.3 cm/yr, Waccassasa Bay/Cedar Keys - 5.4 ± 3.3 cm/yr) with that of the U.S. Atlantic coast (Cape Canaveral - 7.6 ± 9.2 cm/yr). The latter locality had a few exceptionally high growth rates that resulted in a higher estimate of growth and the associated variability with the estimate.

Seasonal and ontogenetic variability in growth rates are likely to confound geographic comparisons of growth. The mean growth rate for Kemp's ridleys recaptured in Waccassasa Bay/Cedar Keys within season (7.7 ± 3.6 cm/yr) was significantly greater than that of turtles recaptured between seasons (3.3 ± 1.1 cm/yr) (Schmid 1998). The annual growth rates calculated based on within season recaptures could be overestimates due to extrapolation from short time periods (<180 days) of high growth to a longer period of time (annual). Growth apparently slows during the migration to and from more favorable thermal regimes. Chaloupka and Zug (1997) proposed a polyphasic growth model for Kemp's ridley turtles and growth rates from tagging studies correspond to the growth cycles in the polyphasic model. The first growth phase coincides with the oceanic juvenile stage and growth slows after shifting to coastal-benthic habitats of the neritic juvenile stage. Growth rates for Kemp's ridleys in New York waters increase from 2.2 ± 1.6 cm/yr for turtles in the 20–30 cm size class to 4.5 ± 4.2 cm/yr for the 30–40 cm size class (Morreale and Standora 1998). Similarly, slower growth has been observed for the 20-30 cm size class of turtles inhabiting west Florida (Schmid and Barichivich 2006). During the second growth phase, Chaloupka and Zug (1997) attributed a growth spurt at 46 cm SCL to a possible shift in developmental habitat prior to sexual maturation. The size for this proposed shift corresponds to a decreasing frequency of turtles > 40 cm SCL at Deadman Bay, which was characterized as seagrass habitat, and their increasing frequency at Waccassasa Bay/Cedar Keys, where a preference for live bottom habitat has been documented (Schmid and Barichivich 2005, 2006). In addition to an ontogenetic habitat shift, it was suggested that the peak of the second growth phase may coincide with the onset of puberty in the 40 – 50 cm size class (Gregory and Schmid 2001). However, Witzell and Schmid (2004) also suggested a preference for live bottom habitat for Kemp's ridleys in Gullivan Bay/Ten Thousand Islands and the mean growth rate for turtles < 40 cm (8.0 ± 3.0 cm/y) was significantly greater than turtles > 40 cm (5.6 ± 2.6 cm/y). There was no seasonal difference in growth rates for this latter study and the higher growth rates may be attributable to a longer growth season in southwest Florida and little, if any, winter migration.

A variety of studies, including those of captive turtles, recaptured turtles of known age, mark-recapture data, and skeletochronology, have estimated the overall average age to maturity in Kemp's ridleys. Maturation estimates for wild Kemp's ridleys have ranged between 10 and 16 years (Chaloupka and Zug 1997, Schmid and Witzell 1997, Zug *et al.*1997, Schmid and Woodhead, 2000). Marquez (1972) calculated the age to maturity based on captive growth, mark-recapture data, and minimum nesting size as 5-7 years. Snover *et al.* (2007) estimated sexual maturity between 9.9 to 16.7 years based on skeletochronology. These estimates are consistent with the age of headstart turtles that were recorded nesting at sizes 58.1-65.8 cm SCL when first detected nesting at 10-20 years of age (Shaver 2005a, D. Shaver, PAIS, personal communication 2008, Shaver and Wibbels 2007). It is unlikely that most adults grow very much after maturity. After discussing the available information, the Team determined that the best available point estimate of age to maturity is 12 years, based primarily on skeletochronology.

F.2. Reproduction

Females lay an average of 2.5 clutches (range 1.8 – 3.075; see TEWG 2000) within a season (TEWG 1998) and inter-nesting interval generally ranges from 14-28 days (Miller 1997, Donna Shaver, PAIS, personal communication 2007). The Team chose 2.5 clutches per female per season as representative of multiple estimates. The mean remigration interval for adult females is 2 years, although intervals of 1 and 3 years are not uncommon (Marquez *et al*. 1982, TEWG 1998, 2000). Males may not be reproductively active on an annual basis (Wibbels *et al*. 1991). The annual average number of eggs per nest for 1966-1992 was 100 (Márquez 1994) and 97 eggs per nest during 1993-2003 (Maria del Carmen Jimenez unpublished data based on National Institute of Fisheries, Mexico, annual reports 1966-1998 and GPZ annual reports 1992-2005).

Sex is determined by temperature during egg incubation (Mrosovsky 1994, Wibbels 2003). Sex ratios for Kemp's ridley eggs relocated to corrals from 1998 through 2000 were predicted to have a strong female-bias, possibly 80-90% or greater (Geis *et al*. 2005). An analysis of corral nests from 1998-2006 provides an estimate of 76% females (T. Wibbels, University of Alabama at Birmingham (UAB), unpublished data cited in NMFS and FWS 2007). In 2002, nests left *in situ* also were predicted to have approximately an 80% female-bias (Wibbels and Geis 2003). Data from 2001-2006 indicate a sex ratio of hatchlings from *in situ* nests of 64% female (T. Wibbels, UAB, unpublished data cited in NMFS and FWS 2007). Although juveniles exhibit the same female-bias, the bias is distinctly less than the sex ratios found in hatchlings (Gregory and Schmid 2001, Witzell *et al*. 2005, Coyne and Landry 2007). See Wibbels (2003, 2007) for a review of sex determination in sea turtle populations.

F.3. Survival Rates

With the exception of the survival of eggs to hatchlings, survival rates for various life stages have been generated as fitted values in demographic models rather than by direct estimate. Catch-curve analyses are often used for these models. To prepare a catch curve, it is necessary to estimate the ages of individuals, and growth curves such as von Bertalanffy curves are used to estimate age from size. This may introduce error as the true relationship of size and age in sea turtles is not known and there is likely to be a great deal of variability in age and size.

Recent survival of eggs and emergence of hatchlings at Rancho Nuevo 1992-2003 is estimated to be 0.678 (C. Jimenez unpublished data based on INP annual reports 1966-1998 and GPZ annual reports 1992-2005). Because all animals from the corrals are released directly to the water, survival to the water is 100%. In contrast, survival of emerged hatchlings from *in situ* nests is less. An arribada during the 2007 nesting season resulted in a large number of nests left *in situ*. Over 3,000 *in situ* nests were monitored for emergence success, which was calculated at 80.1% (J. Pena, GPZ, personal communication 2007). Of the monitored *in situ* nests, hatchlings from 163 nests were monitored and it was determined that 66.4% of the emerged hatchlings made it to the water (T. Wibbels, UAB, unpublished data, personal communication 2007).

Survival rates for all life stages except eggs to hatchlings are difficult to estimate due to the wide range and migration habits of the species. Previous demographic models for Kemp's ridleys have used a variety of survival rate estimates based on life history theory (larger individuals of a species should experience higher natural survival rates than smaller ones), rates from loggerhead turtles of similar size, catch curve analysis of predicted age distributions from strandings data, and model fitting techniques (TEWG 2000, Heppell *et al.* 2006, Heppell *et al.* 2007).

Catch curve analysis was used to estimate survival for age 2-5 and is explained in detail in TEWG 2000 and Heppell *et al.* (2005). For small, immature Kemp's ridleys in the neritic environment (2-5 years = small benthic immatures of Heppell *et al.* 2005), an instantaneous mortality rate (Z) was estimated using a catch-curve analysis of stranded turtles as the slope of a line drawn through the log transformed estimate of turtle abundance in each age class. Several catch curve slopes converged on about Z = 0.5, which translates into an annual Survival Rate (S) of 0.61. With larger turtles, the ability to estimate the slope of the mortality function deteriorated, possibly because larger turtles experience more variable growth rates or different capture probability.

Heppell *et al.* (2005) derived annual survival rates for the remaining life stages (pelagic immature, large neritic juveniles and adults) based on an age-based model fit to the observed nest numbers from 1978–2003 at Rancho Nuevo, Tepehuajes, and Playa Dos, Mexico. The model included a parameter that affected survival rates of neritic turtles (juveniles and adults) post-1990 to enable a fit that matched the increase in nests. Instantaneous mortality rates were estimated by fitting the model for least squares calculations of expected nests versus observed nests. The best-fit parameter estimates for annual survival were 0.31 for pelagic immatures and 0.91 for large benthic immatures and adults (Heppell *et al.* 2005). These estimates were based on the observed increase in nests, assuming age at maturity (i.e., age at first nesting) at 10 years, and using the small benthic instantaneous mortality rate (Z) of 0.5 and the calculated post-1990 mortality multiplier.

F.4. Population Model Parameterization, Analysis, and Projection

The Heppell *et al*. (2005) deterministic, age-structured model was updated with new information from the Kemp's Ridley Five-Year Status Review (NMFS and FWS 2007) and this Plan. The updated input parameters, fitted survival rates and and the best fit multipliers for mortality reduction following TED implementation are given in Table 1. Females are assumed to mature at age 12, but only ½ of the females breed each year (2 year remigration interval); following the original model (TEWG 2000), this frequency of reproduction is applied to the 12 year olds as well as older females, thereby slightly increasing the average age of maturity. Note that the only input survival rate, for ages 2-5, was the original value calculated from the catch curve described above. The model was fit using least squares of nest numbers for 1978-2009, using the known number of hatchlings released at Rancho Nuevo, Tepehuajes (North Camp) and Barra del Tordo (South Camp) from 1966-2009. The initial age distribution assumed a population of adults only and 6000 nests in 1966 (Heppell et al. 2005).

When a single post-1990 multiplier was applied to the deterministic mortality rates for neritic turtles, the model fit to nest numbers since 1978 was generally poor, with a clear pattern of biased residuals, regardless of what year the multiplier was applied (1985-2000). Close examination of the nest numbers over time, and the residuals of the model fit, strongly suggest an acceleration of the nest number rate of increase in the mid-1990s. This acceleration could not be accounted for with this model by the increase in hatchling production alone. So, a second multiplier was fit for the mid-1990s. The best fit model, based on residuals and sum of squared errors for 1978-2009, had two different multipliers that decreased the instantaneous mortality rates in 1988 and 1997. Adding a second, larger decrease in mortality rates in this fashion improved the model sum-of squares by 60% and reduced the bias in residuals (Figure 5).

To project the model forward in time, additional parameters were required to relate expected females and nests to expected hatchling production. The maximum corral capacity was set at 14,500 nests, and *in situ* survival of nests was set conservatively at 50% (note that this is lower than recent hatchling production for *in situ* nests to account for nests that are not detected or screened before they are depredated or otherwise lost). Sex ratios of corral and *in situ* produced hatchlings follow those recorded in recent years by Wibbels and Geis (2003).

To estimate reproductive values and adult equivalents for the current, rapidly increasing population, we produced a matrix model using the survival rates predicted by the model fit and a corral:*in situ* nest ratio of 1:2 (in an increasing population, the fixed number of nests in corrals becomes a smaller and smaller proportion of total nests over time; 50% in corrals is a conservative estimate for a population reaching the required levels for downlisting, but that percent would go down if the population continued to increase rapidly). The resulting reproductive values were used in the threats analysis (see Appendix 1, which also covers assumptions of and caveats about the updated model).

The updated population model also was used by the Team to estimate the number of hatchlings needed to support the adult population sizes identified in the downlisting criterion (see Part II). The estimates are based on hatchling production required for a stable population, if the population continues to experience the high survival rates predicted by the model fit and is at stable age distribution. Density dependence is assumed to affect fertility only, so this value is the estimated hatchling production (0 year-olds) for a stable population assuming no changes in age at maturity, survivorship from hatchling to adulthood, or annual adult survival.

Table 1. Input parameters for the updated age-based model of Heppell *et al*. (2005) fit to observed increase in nests.

Updated Input Parameters for Model Fitting	**Values**		
Age at maturity	12.00		
Average remigration interval	2.00		
Average number of nests per female per nesting season	2.50		
Average number of eggs per nest	97.00		
Egg to hatchling survival in corral	0.678		
Sex ratio of hatchlings released (proportion female)	0.760		
The survival rates below were obtained by minimizing the sum of squares error for nest numbers for 1978-2009 and multiplying the instantaneous mortality rates of small and large juveniles and adults by 0.676 for years 1988-1996 and 0.410 for 1997-2009.			
	Pre-1988	**1988-1996**	**Post-1996**
Survival rate of hatchlings and pelagic stage	0.318	0.318	0.318
Survival rate of small juveniles age 2-5 (note: this was an input parameter and was estimated by the original catch curve)	0.607	0.713	0.815
Survival rate of large juveniles age 6-11	0.850	0.896	0.935
Survival rate of adults age 12+	0.850	0.896	0.935
Additional Parameters for Model Projections			
Sex ratio of hatchlings from *in situ* nests (proportion female)	0.64		
Egg to hatchling survival in *in situ* nests (assumed to be zero prior to 2004) – projected for 2010 onwards	0.5		
Maximum number of nests in corrals	14,500		

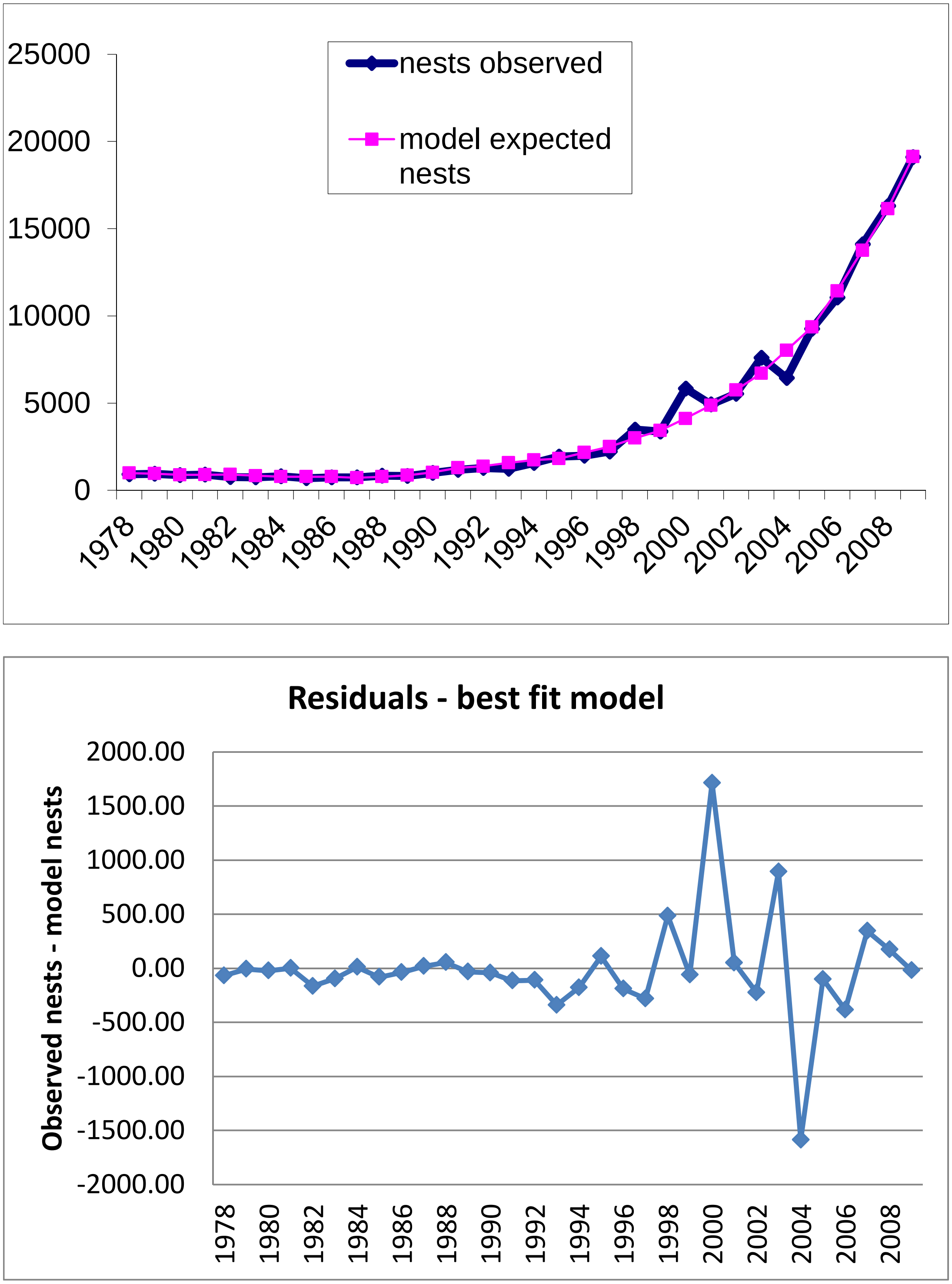


Figure 5. Model fit to observed nests and residuals for the updated age structured model used for population projection. The model has deterministic survival rates but utilizes the known number of hatchlings released at Rancho Nuevo, Tepehuajes, and Barra del Tordo. Nest counts are also beased on these three sites only, following TEWG (2000). A) model and observed nests, 1978-2009. B) residuals.

G. CONSERVATION ACCOMPLISHMENTS

G.1. Existing Regulatory Mechanisms

G.1.1. Mexico

Efforts to protect nesting Kemp's ridleys and nesting beaches in Mexico have been ongoing since the 1960s (Marquez 1994). Legal ordinances were enacted that prohibited harvest of certain marine turtle species seasonally from May to August in the Gulf of Mexico in 1973 (DOF 1973); and all marine turtle species that occur along the Pacific and Gulf of Mexico year-round in 1978 (Márquez *et al*. 1989). In 1990, take of all marine turtle species was prohibited by presidential decree (DOF 1990). Also in 1990, the Secretariat of Urban Development and Ecology (SEDUE) and Secretariat of Fisheries (SEPESCA) published the "Programa Nacional de Protection y Conservation de Tortugas Marinas (Propuesta)." This document was the origin of the National Program for Protection, Conservation, Research and Management of Marine Turtles, which was implemented in 2000 and proposed strategies and actions for the protection, conservation, and recovery of marine turtle populations that nest in Mexico. Rancho Nuevo was declared a Natural Reservation in 1977 (DOF 1977) and further protection measures were added in 1986 (DOF 1986, Marquez *et al*. 1989). Rancho Nuevo was declared a Sanctuary in 2002 (DOF 2002b). In 2004, it was included in the listing of Wetlands of International Importance under the Convention on Wetlands (RAMSAR), signed in Ramsar, Iran, in 1971.

In 1993, Mexico mandated the use of TEDs in the Gulf of Mexico and the Caribbean through the publication of the Official Mexican Norm NOM-002-PESC-1993 (DOF 1993). In 1997, the NOM was modified to require the use of hard TEDs along the Pacific, Gulf of Mexico, and Caribbean coasts (DOF 1997). Hard TEDs are similar to those used in the U.S., consisting of a metal grid installed in front of the codend and an escape opening either at the top or bottom of the net. A number of factors are responsible for the post-1990 increase in survival rates (e.g., nest protection, TEDs, decreased shrimping effort), which have contributed to the increase in reproduction documented on the nesting beaches (TEWG 1998, Heppell *et al*. 2005).

G.1.2. United States

The Kemp's ridley has been protected under U.S. law since its listing as an endangered species on December 2, 1970. The ESA prohibits 'take' of species listed under its authority. Take is defined as "harass, harm [to the species or its habitat], pursue, hunt, shoot, wound, kill, trap, capture, or collect, or to attempt to engage in any such conduct." Exceptions to the take prohibitions may be provided under the ESA for research, experimental populations, and take incidental to otherwise legal activities as long as the take does not jeopardize the continued existence of the species or adversely modify the species' critical habitat. The ESA also calls for recovery plans, such as this one, to help guide the recovery of the species. Protection from international trade has been afforded by CITES under which the Kemp's ridley is listed on Appendix I.

G.2. Beach Protection

G.2.1. Mexico

In 1966, Mexico sent a team of biologists that included Humberto Chavez, Martin Contreras, and, in 1967, Rene Marquez, to Rancho Nuevo, Tamaulipas, to survey the Kemp's ridley sea turtle population at Rancho Nuevo, Tamaulipas, and to establish a conservation effort for this diminishing population (Chavez *et al*. 1967). The objective of the effort in Mexico was to protect the remaining females, their eggs and hatchlings from human and animal predators thus eliminating the land-based mortality from the life cycle.

From 1966 to 1987, the conservation program focused on the area of Rancho Nuevo with the camp located first at Barra Calabazas and then at Barra Coma where it presently exists. In 1977, the FWS, National Park Service (NPS), NMFS, and Texas Parks and Wildlife Department (TPWD) joined in the conservation efforts with the INP at Rancho Nuevo (Manzella *et al*. 1988, Woody 1989). In 1988, the program (now a bi-national one), expanded to the south to Barra del Tordo with a camp at Playa Dos. In 1989, a third camp was established to the north at Barra Ostionales on Rancho Los Pericos. The north camp's location was changed 10 km to the north of its original location, to near the town of Tepehuajes in 1996 for logistical reasons. Also in 1996, in coordination with SEMARNAP and the Tamaulipas' State Government, a camp was established in La Pesca. Under SEMARNAP's supervision, GPZ, API Altamira and Universidad del Noreste expanded the project to include the beaches of Tampico and Altamira. In Veracruz, El Raudal camp was installed in 1994, but was later transferred to Lechuguillas, municipality of Vega de Alatorre. In 1997, this camp was incorporated into the bi-national program.

In the 2002 season, two auxiliary corrals were constructed on the Rancho Nuevo beach. One was located to the north at Barra Carrizo and the other was constructed to the south. The corrals were constructed to protect nests from predation, decrease the distance eggs were transported, and provide additional space to the main corral at Rancho Nuevo.

General monitoring and protection activities consist of daily beach patrols made by one team to search for nesting females and protect observed nests. When several females are counted in one trip, the monitoring team alerts the camps of a possible arribada event. During the arribadas, several teams patrol the beach on all-terrain vehicles, collecting biological data from females and relocating clutches to the protected corrals. The clutches are collected and transported to the corrals as soon as possible, with the necessary precautions to avoid the early embryo mortality caused by handling. Each clutch is reburied in a cavity of similar size and depth as the *in situ* nest and marked for monitoring throughout the incubation period. After hatchlings emerge from their nests, they are counted, collected, and released in large groups in different spots on the beach. The content of the nest is excavated after the hatchlings are released to determine hatching success.

G.2.2. United States

During the last 50 years, more confirmed Kemp's ridley nests have been located at PAIS in south Texas than at any other location in the U.S. (Shaver and Caillouet 1998, Shaver 2005a). The first documented record of Kemp's ridley nesting on the Texas coast was made in 1948 (Carr 1967) at what was later designated as PAIS. PAIS is considered a secondary nesting colony

(Shaver 1998a, Shaver 1999a). Nests have been found elsewhere in the southeastern U.S. in conjunction with reports from the public and during monitoring conducted for loggerhead nesting activity (Anonymous 1992, Marquez *et al*. 1996, Johnson *et al*. 1999, Foote and Mueller 2002, Williams *et al*. 2006).

Since 1986, NPS staff and volunteers have conducted patrols on North Padre Island to detect and protect nesting Kemp's ridley turtles and their eggs, determine results of the imprinting and headstarting experiment (see G.4.2. Imprinting and Headstarting), and gather biological data (Shaver 1990, 2005a). Patrols were conducted along the entire 128 km Gulf of Mexico shoreline of North Padre Island, including 104 km of PAIS and 24 km north of the PAIS north boundary and patrol effort increased over time (Shaver 2004, 2005a). From 1986-1994, the entire North Padre Island target patrol area was covered from 2-5 days each week. From 1995-1997, the entire area was covered 7 days each week. Starting in 1998, the entire area was repeatedly traversed each day to increase the likelihood of observing nesting females and locating their eggs.

From 1986-1998, North Padre Island was the only area on the Texas coast specifically patrolled to detect nesting sea turtles. Systematic patrol programs were developed by various entities elsewhere in Texas starting in 1999. NPS staff at PAIS aided with development of many of these other nesting patrol projects by providing training, technical assistance, and some equipment. FWS, Sea Turtle, Inc., and GPZ (some years) led a program of repeated daily patrols by staff, volunteers, and interns on the 11 km of Boca Chica Beach beginning in 1999 and on the northernmost 51 km of South Padre Island beginning in 2000. Additional walking patrols were conducted on the southern developed portion of South Padre Island starting in 2006. FWS staff and Texas Master Naturalists volunteers began patrols on 45 km of Matagorda Island in 2003 and later expanded this program to include more days per week, repeated daily patrols, and the entire Kemp's ridley nesting season. Staff and volunteers with the Animal Rehabilitation Keep (ARK) and University of Texas Marine Science Institute at Port Aransas conducted a few nesting patrols on 30 km of Mustang Island during the 2004 nesting season. The program was reinstituted and expanded to encompass at least one patrol per day during most days of the nesting season in 2006 and all days of the nesting season starting in 2007. San Jose Island has been patrolled once every eigth day since the mid-1990s. In 2005, volunteers with Help Endangered Animals-Ridley Turtles (HEART) and the Sea Turtle Restoration Project conducted patrols intermittently during the nesting season along various segments of the 230 km shoreline between Sabine Pass and the Matagorda Peninsula. This effort continued, but starting in 2006 FWS led the intermittent patrols by staff and volunteers on the northern end of Matagorda Peninsula. Texas A&M University at Galveston (TAMU) conducted patrols on Galveston Island starting in 2007 and on Bolivar Peninsula starting in 2008.

Educational programs alerting beach users to report nesting Kemp's ridley turtles were implemented at PAIS in the mid-1980s and later expanded coast-wide by various groups (Shaver 1990, 2004, 2005a, 2006b, 2006c, Shaver and Miller 1999). Beach user reports have been investigated, resulting in documentation of up to half of the Kemp's ridley nests found in Texas each year through the mid-2000s. However, from 2006-2010, beach users only found 14-21% of the annual number nests documented in Texas, likely due to the more comprehensive patrol programs conducted state-wide during those years.

From 1978-1999, eggs from the nests found by patrollers and beach users along the entire Texas coast were transported to the incubation facility at PAIS for protected care. After 2000, eggs from most nests located on North Padre Island and northward on the Texas coast were transferred to the facility. The first two incubation facilities at PAIS were screen-enclosed structures attached to buildings. The first was operated from 1978-1982, the second was operated from 1983-2005, and both were used to hold over 22,000 incubating eggs received from Mexico during the experimental imprinting and headstarting project from 1978-1988 (see G.4.2. Imprinting and Headstarting). A larger solid-walled building was used starting in 2006. Further information on the incubation facilities and egg care procedures can be found in Shaver (1989, 1990, 1994, 1997a,1997b, 1998a, 1999b, 2000, 2001a, 2002a, 2004, 2005a, 2005b, 2006b, 2006c) and Shaver *et al*. (1988). Nearly all of the turtles hatched in the incubation facility were released during the early evening, night, or morning at the northern end of PAIS, in the vicinity of the incubation facility, although a few were released elsewhere on the beach. Healthy hatchlings from all but one of the nests found in Texas were allowed to go free after release. However, hatchlings from one Texas nest were transferred to the NMFS Galveston Laboratory for headstarting, as were the majority of hatchlings that emerged from eggs that were part of the 1978-1988 experimental imprinting effort (see G.4.2. Imprinting and Headstarting).

Starting in 2008, some nests found at the southern end of PAIS were incubated in a corral located at the turtle patrol base camp, near the PAIS 64-km marker. The hatchlings from these nests were released at the southern end of PAIS (D. Shaver, PAIS, personal communication, 2009).

In 2000 and 2001, eggs found on Boca Chica Beach and South Padre Island were transferred to a corral on Boca Chica Beach. In 2002, eggs found on Boca Chica Beach were transferred to a corral there and on South Padre Island were transferred to a corral there. Starting in 2003, eggs from both South Padre Island and Boca Chica Beach nests were incubated in a corral on South Padre Island. The hatchlings were released at the corral locations that they emerged from on Boca Chica Beach or South Padre Island.

G.3. Marine Protection

G.3.1. Mexico

Mexico has implemented several protection measures for turtles in the marine environment. Sailing and fishing within 6.44 km of the the beach at Rancho Nuevo was prohibited through the 1986 amendment to the declaration of Rancho Nuevo as a National Reservation and the 2002 declaration as a Sanctuary. TEDs have been required in the shrimp fishery operating in the Gulf of Mexico and Caribbean since 1993.

Mexican Official Standard NOM-029 (DOF 2006) prohibits the longline shark fishery from fishing in a 5 km buffer zone off the six beaches of Tamaulipas from March through June and the five beaches of Veracruz from March through August, which overlap with the nesting period of the Kemp's ridley. The NOM also mandated removal of fish hooks from turtles captured incidentally and required longlines to be used in the marine zone, away from a coastal band of 18.53 km starting from the baseline from which the Territorial Sea is measured (DOF 2007).

G.3.2. United States

Development of TEDs began in the late 1970s to reduce incidental capture of sea turtles in the shrimp fishery (Henwood *et al*. 1992). TEDs consist of a device that prevents the turtle from entering the codend of the net and an escape opening that allows the turtle to escape. TEDs were first required by Florida state law in 1987 to be used by large shrimp vessels operating along the east coast of Florida between 28° and 29° N. latitudes. From 1987 through 1990, their seasonal use in the shrimp fishery expanded to include all ocean waters south of the North Carolina/Virginia border through Texas. Beginning in 1992, TEDs were required in the summer flounder fishery operating in waters off North Carolina through southern Virginia; at the same time, the shrimp fishery rules were expanded to require TED use in both inshore and ocean waters during all times of the year. The National Research Council (Magnuson *et al*. 1990) reviewed numerous studies and data and determined that there was strong evidence that shrimp trawling was the primary cause of sea turtle mortality in the southeast United States. They estimated that shrimp trawling caused 86% of the human caused mortalities of juvenile and adult sea turtles. The consistent and correct use of TEDs has reduced mortality due to shrimp fishing and contributed to the Kemp's ridley population increase. It is also likely that the decline in the shrimp fishing effort in the northern Gulf of Mexico since the early 1990s has reduced sea turtle mortalities from shrimp trawling (Caillouet *et al.* 2008, Nance *et al. in press*, NMFS 2007a). Since 1990, corresponding with the more widespread use of TEDs in U.S. waters, the instantaneous mortality rate of neritic sea turtles (all species observed to interact with the shrimp fishery) has been reduced by 44%-50% (TEWG 2000). The range in annual mortality reduction represents the post-1990 mortality multiplier necessary to be included in the model to obtain the observed rate of the Kemp's ridley population increase. Age-based models indicate an increase in large benthic and adult survival post-1990s (Heppell *et al*. 2005).

In addition to the use of TEDs, time and area closures have been established to enhance shrimp catch. The Texas Legislature established the Texas Closure through the Shrimp Conservation Act of 1959. The Texas Closure was implemented to delay harvest of brown shrimp in the Texas Territorial Sea (TTS) until the shrimp reach a larger, more valuable size and to minimize waste caused by discarding smaller shrimp during Gulf harvest (Fuls 2001). The timing of the closure can be altered by Texas, but generally occurs mid-May through mid-July, which coincides with the peak Kemp's ridley nesting period. In addition, the Gulf of Mexico Fishery Management Council Shrimp Fishery Management Plan implements a closure of the U.S. waters off Texas to complement the traditional Texas Closure. Several rules were adopted in the early 2000s by the Texas Parks and Wildlife Commission to reduce fishing effort on shrimp stocks and provide additional protection to sea turtles, particularly in the nearshore Gulf (Osburn *et al*. 2003). The most significant rule conserving Kemp's ridleys in Texas was a seasonal shrimping closure from Corpus Christi Fish Pass to the Texas-Mexico border (177 linear km) including all of PAIS from the beach out to 5 nautical miles from December 1 to the Summer Gulf opening or July 15. Historically, 68% of the turtle strandings and less than 3% of the total Texas shrimp weight of landings occur in this area during this timeframe. However, despite TED regulations and reductions in fishing effort, significant correlations between sea turtle stranding rates and shrimp trawling intensities in the northwestern Gulf of Mexico continued to exist through at least 1993 (Caillouet *et al.* 1996).

Other gear regulations may also protect Kemp's ridleys. Several states, including Virginia, Maryland, Delaware, New Hampshire and Florida, maintain offshore areas permanently closed to trawling. The State of Georgia requires the use of NMFS-approved TEDs in all trawl fisheries operating in state waters. South Carolina uses a water-temperature trigger to ensure whelk trawling occurs only when sea turtles are less abundant. Many states (South Carolina, Georgia, Florida, Louisiana, and Texas) have prohibited gillnets, but there remain active fisheries in other states and in Federal waters. Several regulations have been implemented to protect sea turtles, including Kemp's ridleys. Since 2001, gillnet restrictions have been implemented in Pamlico

Sound, North Carolina, and in offshore waters of the Economic Exclusive Zone to reduce sea turtle interactions. In 2002, NMFS prohibited, in certain areas and at certain times in the Chesapeake Bay, Virginia, pound nets with leaders having mesh greater than or equal to 30.5 cm and leaders with stringers.

The Marine Pollution Act was enacted under the International Convention for the Prevention of Pollution from Ships and subsequent regulations by the United States Coast Guard (USCG) to restrict the discharge of plastics and set the standards for other solid waste dumping into the marine environment (Shaver and Plotkin 1998). A large portion of the debris found washed ashore at the nesting beach, and presumably floating in neonatal/juvenile pelagic habitat, is garbage dumped from ships and oil platforms. Over 90% of the trash is composed of inorganic material, mainly plastic (Sarti *et al*. 1996). The regulations prohibit the disposal by all vessels and offshore platforms of all plastics, paper, rags, glass, metal, bottles, crockery, and similar refuse.

Oil and gas exploration activities require mitigation and measures to minimize the impacts to the Kemp's ridley nesting beaches and marine environment. Various Federal, state, and local entities have developed spill contingency plans that are updated annually. These entities formed emergency response teams to reduce potential impacts from these spills. Oil and gas exploration and development occur at PAIS. The NPS strictly regulates these activities through the use of NPS regulations, in-depth environmental assessments under the National Environmental Policy Act, consultation with resource agencies, and close coordination with the mineral owners and developers. The NPS and FWS work to make sure that the conditions under which approval of this drilling is granted protect the park's resources, especially the Kemp's ridley turtle. Measures have been developed to protect Kemp's ridleys, and the plans allowing for the drilling of new wells incorporate these strict measures. Patrols are conducted at PAIS to locate and move eggs for protected incubation, thereby limiting threats from oil and gas activities and natural threats to the eggs and hatchlings. Beach patrols also involve location and protection of nesting and live-stranded turtles, although beach visitors sometimes find them before patrollers arrive. Oil and gas development and exploration in other areas on the Texas coast where Kemp's ridleys have been documented nesting are regulated by various local, state, and Federal regulations.

G.4. Research Efforts

G.4.1. Movement and Habitat Use

Detailed information on sea turtle migrations, diving patterns, and habitat use has been collected with the use of satellite telemetry, radio and sonic telemetry, passive integrated transponder (PIT) tags, flipper tags, and in-water capture studies. Nesting females tagged at Rancho Nuevo displayed a northward and southward post-nesting migration to the offshore waters of coastal states in the U.S. and Mexico (Chavez 1969, Pritchard and Marquez 1973, Marquez 1990, 1994). Satellite telemetry studies have indicated that adult Kemp's ridley females inhabit the nearshore, shallow waters and are able to swim long distances during migrations (Byles 1989, Mysing and Vanselous 1989, Byles and Plotkin 1994, Renaud *et al*. 1996, Shaver 2001b, Shaver and Rubio 2008). Adult male Kemp's ridleys may take up residency near nesting beaches (Shaver *et al.* 2005b, 2007). Juveniles exhibit seasonal migrations to important foraging areas in the Gulf of Mexico and U.S. Atlantic coast north to New England (Keinath *et al.* 1987, 1994, Byles 1988, Gitschlag 1996, Morreale and Standora 1998, Mansfield and Musick 2005, Schmid and Witzell 2006 see section E.4.2 Atlantic). Kemp's ridleys exhibit patterns consistent with seasonal coastal migration with movement up to 202 km (Gitschlag 1996), and their movement is significantly correlated to the direction of the tidal flow (Schmid *et al*. 2002).

Shaver *et al.* (2005b) used satellite telemetry to monitor movements of 11 adult male Kemp's ridley turtles near Rancho Nuevo and postulated that they may be permanent residents in the offshore waters of the nesting beach. In a subsequent study, movements of 14 adult male Kemp's ridley turtles captured by local fishers near Rancho Nuevo during the non-nesting season were monitored using satellite telemetry between 2003 and 2005 (Shaver 2006a). Thirteen of the 14 adult males remained within waters off Tamaulipas. The other turtle traveled southward, offshore from Veracruz, Mexico during the tracking period, but returned to waters off Tamaulipas. During both studies, most movements were within nearshore waters of 50 m water depth or less. Based on these findings, a significant proportion of the adult male Kemp's ridley population may reside in the vicinity of the Tamaulipas nesting beach year-round. The majority of adult males in these studies, however, were not tagged during nesting season, and reproducing males may migrate. Nevertheless, a resident population of adult males underscores the need for protection of the marine habitat adjacent to the Tamaulipas coast year-round. Shaver (2007) also followed the movements of one adult male Kemp's ridley that was located stranded on North Padre Island in April 2006. This turtle soon traveled to waters off the upper Texas coast and western coast of Louisiana and remained there through the remainder of the 13-month tracking period.

Byles (1989) and Mysing and Vanselous (1989) studied the movements of adult females after nesting in Rancho Nuevo and found them to be primarily migratory. Mysing and Vanselous (1989) attached satellite transmitters to two nesting females and monitored their movements. The transmitter for one of the turtles was found on the beach approximately 40 km south of Tampico, Mexico, 14 days after deployment. The second turtle tagged was released on June 10, 1985, and caught by shrimp fishers off Freeport, Texas, on July 19, 1985. Byles (1989) outfitted 18 post-nesting females with transmitters during May 1987, and April and June 1988. Fourteen tracks of turtles were obtained, lasting up to 127 days. These turtles inhabited water depths of 50 m or less, made nearshore movements, and traveled various distances. Data transmissions ceased for three of these turtles before they moved away from Rancho Nuevo. Four turtles swam northward from the nesting beach. Two of the northward-bound turtles were tracked as far as Corpus Christi, Texas, and one of those showed indications of being taken aboard a boat. The remaining seven turtles migrated southward to Veracruz, Campeche, and Yucatan, Mexico. The two longest migrations to the northern tip of the Yucatan Peninsula, Mexico, covered more than 1,500 km.

Satellite telemetry has also been used to gather data on the habitat preferences and movement patterns of Kemp's ridley females after nesting on the south Texas coast. These data have also been used to help locate Kemp's ridleys during successive nesting, thereby improving the documentation of reproduction, the study and protection of the nesting turtles and their eggs, and the evaluation of experimental imprinting and headstarting (see below G.4.2. Imprinting and Headstarting). Between 1997 and 2007, 40 transmitters were deployed to monitor the movements of headstarted and wild adult female Kemp's ridley turtles after they nested on North Padre and Mustang Islands, Texas (Shaver 1998a, 1999b, 2000, 2001a, 2001b, 2002a, 2004, 2005b, 2006b, 2006c, 2007, Shaver and Wibbels 2007, D. Shaver, PAIS, personal communication 2008, Shaver and Rubio 2008), n = 9-841 days. Eleven headstarted and 21 wild individuals were monitored. The 11 headstarted individuals were 12-19 years of age when tracked; 10 had been released at nearly 1 year of age and one at nearly 3 years of age (which was categorized as a super headstart due to her prolonged time in captivity). Most of the turtles tracked left south Texas and traveled northward, parallel to the coastline, after they completed nesting for the season, with their last identified locations in the northern or eastern Gulf of Mexico. However, four briefly traveled southward to waters off the coast of Mexico and then moved northward. Three turtles remained in south Texas waters through the entire tracking period, but the tracking periods for these three were among the shortest recorded. Most identified positions were in 35.6 m water depth or less. Movements of wild and headstarted turtles and movements of individuals during and after different nesting seasons were generally similar**.** Despite extended time in captivity, the headstarted turtle had nested normally, but unfortunately her track only lasted 18 days, preventing detailed comparison to other headstarted and wild turtles.

For turtles tracked from 1999-2001, approximately 40% of their accepted locations in Gulf waters off the south Texas coast were in 18.3 m depth or less, within about 7.4 km from shore, and approximately 80% of their accepted locations in Gulf waters off the south Texas coast were in 35.6 m depth or less, within about 27.4 km from shore (Shaver 2002b). Movements of 10 turtles that nested or emerged on the upper Texas coast in 2005, 2006, and 2007 were monitored using satellite telemetry (Landry and Seney 2006). Seven were headstarted and three were wild. The headstarted turtles were 12-18 years of age when tracked. During 2005, 2006, and 2007, tracking extended for 1-24 months and at the end of the tracking period the turtles were either in waters off the upper Texas coast, Louisiana coast, or panhandle of Florida. As with turtles tracked after nesting in south Texas, most accepted locations were in 35.6 m water depth or less, and movements of wild and headstarted turtles were generally similar (Landry and Seney 2006, A. Landry and E. Seney, TAMU, personal communication 2009).

Sonic and radio tags, and satellite telemetry have been used to study the behavioral habits of submergence. During summer and fall months, juvenile Kemp's ridleys (n=27) in New York waters spent most of the daylight hours submerged (Morreale and Standora 1998). In shallow waters, these turtles spent most of their time feeding on the bottom. However, as they moved into deeper open water, dive depth tailed off to less than 15 m regardless of bottom depth, suggesting they were transiting and not foraging (Morreale and Standora 1998). Data collected on 106 Kemp's ridley's between 1988 and 1996 showed a mean submergence time of greater than 30 minutes during the winter and less than 15 minutes during other seasons. Percent submergence time ranged from 69-96% with an average of 92% (Renaud and Williams 2005) with significantly longer submerged durations at night (Renaud 1995, Gritschlag 1996). In Florida, nine Kemp's ridleys monitored with radio and sonic telemetry had a rate of movement of 0.44 ± 0.33 km/h, a mean surface duration of 18 seconds (S.D. ± 15s) and mean submergence duration of 8.4 minutes (S.D. ± 6.4 minutes) (Schmid *et al*. 2002). The rate of movement was negatively correlated with surface and submergence durations and positively correlated with the number of surfacings. Additionally, rates of movement were higher and surface and submergence durations were shorter during the day (Schmid *et al*. 2002). Mansfield and Musick (2005) tracked five Kemp's ridleys in the Chesapeake Bay, Virginia, and found the mean time at the surface during the day was between 30-32.9% during the spring and early summer. Satellite tracking studies should be continued since these studies contribute considerably to our understanding of Kemp's ridley habitat use and requirements and thus to our ability to protect foraging and migratory habitats.

In-water studies have provided information on habitat use, factors that influence abundance and distribution, and growth rates (Ogren 1989, Landry *et al.* 1995, Morreale and Standora 1998, Schmid 1998, Schmid 2000, Witzell and Schmid 2004, Witzell 2007). See Section E—Life History/Ecology for additional information.

G.4.2. Imprinting and Headstarting

"Headstart" is the term used to describe the process whereby sea turtles are maintained in captivity for a period following hatching, so that the presumably high neonatal mortality may be circumvented (Caillouet 2000). The animals are released when they are believed to have outgrown threats from many predatory species. The turtles used in the Kemp's ridley headstart experiment were hatched at either PAIS or Rancho Nuevo (Shaver and Wibbels 2007). A total of 22,507 eggs were sent to PAIS from 1978-1988 in an attempt to form a secondary nesting colony there, as a safeguard against extinction of the species (Shaver 2005a). The eggs were collected in plastic bags as they were laid, to prevent them from touching the Rancho Nuevo sand, and placed into polystyrene foam boxes containing sand from PAIS prior to shipping to PAIS (Manzella *et al*. 1988). The overall hatching rate for those 11 years was 77.1% resulting in 17,358 hatchlings. These hatchlings were allowed to crawl down the beach and swim 5-10 m for the "imprinting" process and then were captured with aquarium nets. From 1978 to 1988, 15,875 ridley hatchlings were "imprinted" and taken to the NMFS laboratory in Galveston for one year of headstarting. Survival during that procedure was 90% or greater, whereas first-year survival in the wild was believed to be less than 1% (Fontaine *et al*. 1989a, Heppell *et al.* 2005). A total of 13,275 yearlings were released into the Gulf of Mexico. Most of these headstarted turtles that were experimentally imprinted to PAIS were released in the Gulf of Mexico offshore of Mustang Island and North Padre Island, Texas with the objective of reinforcing any "imprinting" to Padre Island. Some of the headstarted turtles were released off the Galveston, Texas shoreline, selected bay systems in the lower Texas coast, and Key West and Homasassa, Florida. Data collected after their release (movements, growth, diet, and nesting) indicated that the turtles adapted well to the Gulf of Mexico environment (Shaver and Wibbels 2007).

Additionally, 10,198 headstarted turtles, obtained as hatchlings from Rancho Nuevo (after hatching in the corral, crawling down the beach, entering the surf, and being retrieved there) in 1978, 1979, 1980, 1983, and 1989-2000, were released after 9-33 months of headstarting (Caillouet 1995, Caillouet *et al*. 1995b, Fontaine and Shaver 2005, Shaver 2005a, B. Higgins, NMFS, personal communication 2006). Typical headstarted Kemp's ridleys were 7-15 months of age at release. Those released after longer periods of captive rearing were considered overly conditioned to captive rearing, and therefore atypical. These were called "super headstarts" for lack of a better term (Caillouet *et al.* 1995b). Survival of these turtles that had been obtained directly from Mexico was also over 90% during headstarting.

Sea turtles headstarted in Galveston were tagged in one or more of the following ways: (1) inconel metal flipper tag on the right foreflipper; (2) binary-coded magnetic-wire tag embedded in the left foreflipper; (3) living tag formed by grafting a light colored piece of plastron tissue into the darker carapace; and (4) passive integrated transponder tag inserted in the latero-ventral muscle of the left axial area (Fontaine *et al*. 1989b, Fontaine *et al*. 1993).

Since 1996, the Kemp's ridleys documented nesting in Texas has been a mixture of headstarted turtles and turtles from the wild stock. Padre Island imprinted head-starts have been recorded nesting in south Texas and Mexico imprinted head-starts state-wide (D. Shaver, PAIS, personal communication 2010). However since 2002, nesting by turtles from the wild stock has predominated (Shaver 2005a, 2006b, 2006c, 2007, 2008, D. Shaver, PAIS, personal communication 2010). Kemp's ridley nests were not documented on the Texas coast north of Mustang Island until beginning in 2002. Based on the nesting turtles examined from 1986-2010, the origins of these turtles have varied geographically within Texas (D. Shaver, PAIS, personal communication 2010). On the upper Texas coast, most nests were from Mexico imprinted headstarts. In contrast, in south Texas, the documented historic nesting range for the species in the U.S., most nests were from wild stock turtles. Most nests recorded in the U.S. were located in the southern part of Texas, with nearly 55% of the nests documented from 1989-2010 being located at PAIS (D. Shaver, PAIS, personal communication 2010).

Documented nesting by some headstarted Kemp's ridley turtles contributed to the increased numbers of nests detected in Texas since 1996 and is an encouraging sign that the experimental imprinting and headstarting efforts have achieved some success. However, due to the difficulty of finding nesting Kemp's ridleys on the Texas coast, additional years of data collection are needed to link additional nesting turtles to the project (Shaver 2002b). Assessment of the long-term success of this restoration effort requires continued detection and examination of nesting Kemp's ridleys as well as collection of various types of biological data. This project provides the unique opportunity to evaluate the success of experimental imprinting and headstarting and the utility of these techniques to restoration efforts. However, given the success of more proven conservation practices such as nest protection practices on the main nesting beaches and TED requirements for trawl fisheries in the U.S. and Mexico, it is important to focus efforts on proven practices.

NMFS established a Blue Ribbon Panel in 1989 to assess the headstarting program, including whether to continue it (Wibbels *et al*. 1989) and a subsequent expert panel in 1992 to examine the experimental design of the headstarting program (Eckert *et al.* 1994). The Blue Ribbon panel recommended that the headstart program be limited to 2,000 hatchlings/year and recommended criteria for assessing success of headstarting. They also recommended that headstarting not be expanded unless it could be demonstrated to be an effective conservation tool. Finally, the panel recommended that headstarted turtles should not be reared for longer than one year before release and emphasis should be on protection of Kemp's ridleys in their natural habitat. The expert working group established in 1992 to review the experimental design of the headstarting program recommended that NMFS focus on a large-scale mark and recapture program designed to gather life history parameters (e.g., survival rate of hatchlings, growth rates) on headstarted and wild turtles.

G.4.3. Sex Ratio and Hatching Success

Prior to initiation of the bi-national program to form a secondary nesting colony at PAIS, beach temperatures of Rancho Nuevo and PAIS were compared and deemed relatively similar. In the U.S., a beach temperature profile study was undertaken during the summer of 1986 to more thoroughly examine temperatures at which Kemp's ridley sea turtle eggs would incubate at PAIS, by examining temperatures at three beach locations on PAIS (Shaver *et al*. 1988). Temperatures were compared with simultaneously measured temperatures in Rancho Nuevo and the estimated pivotal temperature for the Kemp's ridley (30.2°C, Shaver *et al*. 1988) to predict seasonal trends in sex ratios. Based on these findings, clutches that undergo their middle third of development early in the nesting and incubation season should produce primarily males, later portions of the season primarily females, and middle of the season a mixture (Shaver *et al*. 1988, 1989, 2005a). Beach temperatures varied slightly with latitude and were warmest at the site farthest south, Rancho Nuevo, Mexico, and coolest at the site farthest north, Closed Beach, PAIS.

Since the mid-1980s, PAIS staff increased incubation temperatures in the PAIS facility to produce primarily females. They recorded incubation temperatures for clutches held in the facility using automated systems and collected gonads from dead embryos and hatchlings from Texas nests for histological sex determination. From 2000-2007, UAB and NPS provided dataloggers to monitor temperatures of clutches held in the incubation facility and in south Texas corrals. Females predominated in all year classes of Texas nests incubated in the facility since the mid-1980s and in corrals since 2000 (Shaver 2001a, 2002a, 2004, 2005a, 2005b, 2006b, 2006c, T. Wibbels, UAB, personal communication 2007). From 2002-2006, six clutches not found at egg-laying were documented at hatching after incubating *in situ* on the south Texas coast. Gonads were obtained from dead individuals in six of the clutches as sacrifice of live hatchlings for sex determination was not justifiable given the status of the species. Based on this limited and biased sampling, however, clutch sex ratios ranged from 0-100% female, although overall females predominated.

To determine the effects of the imprinting project on sex ratios (see G.4.2. Imprinting and Headstarting), incubation temperatures were measured twice daily at Rancho Nuevo and once an hour at PAIS (Shaver *et al*. 1988), and a variety of techniques were used to determine the sex of dead embryos and hatchlings and older reared turtles. Sex was identified for dead late-staged embryos and hatchlings using gonadal histology, for larger dead turtles using necropsy, and for larger live turtles using laparoscopy, serum testosterone assays, and tail length evaluations (adults only). Males predominated in most of the earlier year-classes (Shaver *et al*. 1988, Shaver 2005a). As discussed above, since the mid-1980s incubation facilities and practices at Rancho Nuevo and PAIS were modified to increase the proportion of females produced. Temperatures for incubating eggs of the 1985-1987 year classes were intentionally raised for this purpose (Shaver *et al*. 1988). These modifications were successful and 77.5% of the turtles examined from the 1985-1988 year-classes were identified as females (Shaver *et al*. 1988, Shaver 2005a). Considering the 1978-1988 year-classes collectively, 59.6% of the project turtles were females, for an overall sex ratio of 1.5F:1M (Shaver 2005a). Using data from the 1982-1987 year-classes, all clutches with mean temperatures exceeding 30.8^{o}C during the middle third of the incubation period produced 100% females and the pivotal temperature was estimated to be 30.2^{o}C with 95% confidence intervals from 29.9-30.5^{o}C (Shaver *et al*. 1988). Equations derived from this work can be used to estimate percent females for Kemp's ridley clutches with known incubation periods or mean middle third of incubation period temperatures (Shaver *et al*. 1988, Shaver 1989, 2005a).

The NMFS Laboratory at Galveston also headstarted and super headstarted turtles obtained directly from Mexico as hatchlings. Overall, 10,198 turtles that had been obtained as hatchlings in 1978, 1979, 1980, 1983, and 1989-2000 were released after 9-33 months in captivity (see above G.4.2. Imprinting and Headstarting). These individuals were also predominately females (C. Caillouet, retired NMFS, personal communication 2009).

Annual hatching success of eggs from Mexico hatched within the PAIS incubation facility between 1978 and 1988 in conjunction with experimental imprinting (see above G.4.2. Imprinting and Headstarting) ranged from 12-92% (mean = 77%) (Shaver 2005a). From 1979-2008, annual hatching success for eggs from Texas nests held in the PAIS incubation facility ranged from 55-97% (mean = 81%) (Shaver 2005a, 2006b, 2006c, 2007, 2008, D. Shaver, PAIS, unpublished data). From 2000-2008, annual hatching success for eggs from Texas nests held in corrals ranged from 62-88% (mean = 79%). Virtually 100% of the hatchlings from Texas nests released from the incubation facility and corrals survived on the beach and made it into the water as these releases were closely monitored by biologists. Between 1978 and 2008, 26 *in situ* nests were documented on the Texas coast. It was impossible to accurately estimate hatching success for these because many were depredated before or after hatching and no emergence was fully observed by biologists. Estimated overall hatching success for these 26 nests was a maximum of 62%. Survival of emerged hatchlings from *in situ* nests was assumed to be less than hatchlings from the protected incubation facility and corral nests. Some losses of hatchlings were documented for the *in situ* nests due to predation and beach driving, and additional losses due to these and other factors were possible (Shaver 2005a, 2006b, 2006c, 2007, 2008, D. Shaver, PAIS, unpublished data).

Sex ratio and emergence success data for Kemp's ridley nests documented in other U.S. states outside of Texas between 1989 and 2008 are incomplete since most of these nests incubated *in situ* without temperature monitoring and most of the releases of hatchlings from these nests were not witnessed by biologists.

At Rancho Nuevo, Mexico, comprehensive studies of sex ratios from the corrals have been conducted in recent years using temperature dataloggers that can be inserted directly into nests or into the sand at nest depth. From 1998 through 2007, temperature dataloggers have been used to monitor sand temperature in the hatcheries at mid-nest depth throughout the nesting season (Wibbels *et al*. 2000a, 2000b, Geis 2004, Wibbels 2007). Blood samples were obtained from random subsets of hatchlings from many of the nests in which incubation temperature had been monitored. These blood samples were used to sex hatchling Kemp's ridleys based on the amount of mullerian inhibiting hormone (MIH) in the blood. MIH is a hormone produced by male vertebrates that causes the oviducts to degenerate.

In general, sand temperatures at Rancho Nuevo gradually increase during the start of the nesting season (late March and April) and are at or above pivotal temperature by mid- to late May. Considering that the heaviest nesting occurs in May, the majority of eggs experience female-producing temperatures by the time they enter their thermosensitive period of sex determination (i.e., the middle third of the incubation period). During June and July, sand temperatures remain relatively high (normally above pivotal temperature) for the remainder of the nesting season, but can decrease episodically due to rain, possibly producing male-biased clutches. However, the overall expectation, in normal weather patterns, is that more females than males will be produced.

In addition to recording sand temperatures, dataloggers have been used to directly record nest temperature in the corrals at Rancho Nuevo from 1998 through 2007 (Wibbels *et al*. 2000a, 2000b, Geis 2004, Wibbels 2007). During each season, a subset of nests was sampled, including nests from each of the arribadas. Average nest temperatures during the middle third of the incubation period were used to predict sex ratios (Yntema and Mrosovsky 1982, Georges *et al*. 1994, Hanson *et al*. 1998) based on the pivotal temperature and transitional range of temperatures predicted for the Kemp's ridley (Aguilar 1987, Shaver *et al*. 1988). The results are consistent with the sand temperature data and suggest that the corrals consistently produced overall female-biased sex ratios (Wibbels *et al*. 2000a, 2000b, Geis 2004, Wibbels 2007). Although the data indicate that females predominate, males were predicted to be produced early in the nesting season when sand and nest temperatures were relatively cool. The length of time that this occurs will vary, depending on temperature conditions in a particular year. Thus, the results suggest that both males and females are produced in the corrals during a typical nesting season, but females predominate. The overall sex ratio predicted for the Rancho Nuevo corral for a 9-year period (1998-2006) was approximately 76% female (T. Wibbels, UAB, unpublished data). However, the 9-year period included one nesting season (2004) in which a male bias was predicted due to a series of weather systems with rain that tended to produce cooler incubation temperatures (T. Wibbels, UAB, unpublished data). Regardless, the data indicated that the overall hatchling sex ratio produced from the Rancho Nuevo corral is significantly female biased.

While these recent studies examined 9 years of temperature data, it is of interest that the main corral has typically been placed in the same general position on the nesting beach for several decades. Therefore, it is plausible that the main corral may have experienced similar temperatures in previous years, assuming similar weather patterns. If this was the case, then female-biased hatchling sex ratios may have been produced for many years at Rancho Nuevo.

Studies at Rancho Nuevo have also investigated hatchling sex ratios on the natural nesting beach (Geis 2004, Wibbels 2007, A.A. Geis and T. Wibbels, UAB, unpublished data). From 2001 through 2007, temperature transects were conducted to record sand temperature at mid-nest depth for an approximately 7-km stretch of beach at Rancho Nuevo. Additionally, a subset of nests was left in their natural locations to incubate (i.e., approximately 20 to 70 *in situ* nests per season with dataloggers). Protective covers consisting of wide mesh fence material and screen were placed just under the surface of the sand above the nest to prevent depredation. The preliminary findings indicate that the nesting beach temperatures show similar trends as the hatcheries but, on average, the nesting beach is slightly cooler than the corrals. However, temperatures were still warm enough on the nesting beach to produce an overall female bias, but not as strong a bias as in the corrals. Data from 6 years at Rancho Nuevo (2001-2006) indicate an overall hatchling sex ratio of approximately 64% female from the natural nests (T. Wibbels, UAB, unpublished data). Thus, the nesting beach at Rancho Nuevo may produce a "natural" hatchling sex ratio that is female-biased (Geis 2004, Wibbels 2007, A.A. Geis and T. Wibbels, UAB, unpublished data).

Hatching success for nests relocated to corrals from 1999-2004 ranged from 62 to 79% (Wibbels 2005). Documenting hatching success for *in situ* nests began in 2002; however, the majority of nests left in their original location were covered to protect against predation. Between 2002-2005, hatching success for protected *in situ* nests ranged from 74 to 86% for those nests that hatched. Over 90% of the nests left *in situ* without protective covers were depredated (Wibbels and Geis 2003, 2004; Wibbels and Park 2005, Wibbels and LeBlanc 2006). Because all animals from the corrals are released directly to the water, survival to the water is 100%. In contrast, survival of emerged hatchlings from *in situ* nests is less. An arribada during the 2007 nesting season resulted in a large number of nests left *in situ*. Hatchlings were monitored from 163 nests and it was determined that 66.4% of emerged hatchlings made it to the water (T. Wibbels, UAB unpublished data, personal communication 2007).

G.5 Sea Turtle Stranding and Salvage Network

G.5.1. Mexico

Starting in 2001, personnel from GPZ, working with SEMARNAT, the State of Tamaulipas, and PROFEPA, began a year round survey to document stranding events along the coastline of Tamaulipas. Prior to this coordinated effort, the stranding data in Mexico had been anecdotal and were recorded only during the months of nesting activity at the main nesting beaches. This survey period may not have represented average annual strandings because Mexico implements a shrimp closure during the Kemp's ridley nesting season, and strandings are likely lower during this period. Stranding data are a source of important information relative to various life history parameters and improved information on natural and anthropogenic causes of mortality. The number of dead turtles documented stranded on the Tamaulipas coast follows (Table 2).

Table 2. Number of dead turtles documented stranded on the Tamaulipas coast. The number of Kemp's ridley strandings is a subset of the total strandings (*source:* GPZ)

SURVEY DATE	KEMP'S STRANDINGS	TOTAL STRANDINGS
March-July 2000	46	68
March-August 15, 2001	51	95
March-August 15, 2002	31	78
Sept. 2002-August 2003	25	77
Sept. 2003-August 2004	57	112
Sept. 2004-August 2005	59	114
Sept. 2005-August 2006	44	83
Sept. 2006-August 2007	109	174
Sept. 2007-August 2008	94	159
Sept. 2008-August 2009	91	179

G.5.2. United States

The U.S. Sea Turtle Stranding and Salvage Network (STSSN) was established in 1980 to document strandings of sea turtles on U.S. beaches along the Gulf of Mexico, Atlantic Ocean, and the Caribbean Sea (Schroeder 1989). The STSSN attempts to quantify the seasonality, species composition, stock structure, life history stage, sex ratio, and distribution of turtles that wash ashore dead or alive. Stranded turtles are located during systematic surveys conducted in many U.S. coastal areas and by opportunistic reports from state and Federal personnel as well as the public. Participants in the STSSN have recovered many tagged animals from other programs contributing significantly to our understanding of migratory patterns and habitat use as well as providing biological samples for other scientific studies. Live stranded turtles have been taken to rehabilitation facilities and a large percent have later been released, thus directly contributing to conservation. Those not fit for release have provided opportunities for public viewing, research, development of medical and surgical procedures, and training in care and maintenance of Kemp's ridleys in captivity. The STSSN attempts to identify both anthropogenic and natural causal factors of mortality to develop and implement sound management and conservation measures. Important factors attributed to strandings include boat strikes, entanglement, ingestion of debris, and incidental capture during recreational and commercial fishing. Natural factors cause strandings and include disease, storms, and cold-stunning. From 1998-2005, approximately 4,000 Kemp's ridleys were documented to strand on U.S. beaches (NMFS STSSN database, unpublished). Summarized STSSN data are available at: http://www.sefsc.noaa.gov/seaturtlesprogram.jsp.

G.6. Educational Efforts

G.6.1. Mexico

Public education has been a priority in Mexico for many years and many entities have conducted these efforts. Educational programs have been given to children in the communities surrounding the conservation camps. In the 1980s, Help Endangered Animals Ridley Turtles (HEART) educated school children in the U.S. and obtained donations from them to purchase educational materials for school children in the Rancho Nuveo area. These donations were also used to construct a bunk house at the Rancho Nuevo conservation camp and a vehicle for use there. Over the years, public education efforts by HEART and many others resulted in continous public support for the federal and state agencies working in the U.S. and Mexico to conserve Kemp's ridley.

Kemp's ridley nesting and human activities around La Pesca have increased significantly in recent years. In order to diminish the negative impacts of human interactions with this endangered species, a proactive public education and conservation awareness program has been undertaken at the La Pesca Visitor Center. Visitors are provided with state-of-the-art exhibits, graphics, and interactive elements depicting Gulf of Mexico ecology and the life cycles of the Kemp's ridley and other species of marine turtles indigenous to the Gulf of Mexico and which nest in the La Pesca area. The importance of the lower density nesting beaches at the La Pesca, Altamira, and Miramar camps is that they allow the general public to observe program activities without the disturbance to the turtles that would occur at higher density nesting beaches or during large arribadas. Raising public awareness and participation in the field will lead to public support for the conservation program. Direct, supervised contact allows the participants to realize the species' vulnerability. Fostering the values of responsibility and respect is essential in enhancing environmental awareness.

Since the initiation of the bi-national program, many training sessions, workshops, and information sharing meetings have been conducted at the Rancho Nuevo sea turtle camp. Leading professionals in various disciplines have shared their knowledge on topics ranging from the biology of the Kemp's ridley to patterns and possible causes of stranding events.
In 2001, the Tepehuajes artisan project at Soto La Marina was established by local, state, Federal and international organizations. The project produces sea turtle pottery for export to the U.S., thus generating an economy for the local community. This is a model enterprise that generated funds for conservation efforts and raised community awareness about the importance of conservation. Through PRODERS, seven alternative projects have been established in Rancho Nuevo, Buena Vista, and La Pesca. These projects increase technical capabilities, strengthen social organization, and develop negotiation skills for the local citizens. Two organized groups of women (Rancho Nuevo and La Pesca) have adopted the image of the Kemp's ridley as a symbol and will develop a line of commercial products. Since 2006, an agreement with the Centro de Bachillerato Tecnológico Agropecuario High School Center for Farming Technologies in Aldama has provided opportunities for local students to participate in conservation activities

on the nesting beaches. Since 2008, volunteers from the Technological Institute of Biology in Altamira have also participated.

G.6.2. United States

Strong public interest and support for sea turtle conservation exists in the U.S. and encompasses Federal, state, private, and local sectors. Long-term, comprehensive education programs about Kemp’s ridleys have been developed and instituted (particularly in Texas) by the NPS, HEART/Sea Turtle Restoration Project (STRP), TPWD, GPZ, FWS, NMFS, Sea Turtle Inc., University of Texas Marine Science Institute, TAMU, University of Houston, Texas General Land Office, Sierra Club, Humane Society of America, Texas State Aquarium, Animal Rehabilitation Keep and others (Caillouet 2000, Shaver 2005a). The main goal of these programs has been to inform the public and generate and/or increase popular and official support for, and assistance with, the conservation of the Kemp's ridley. These programs have highlighted conservation needs for the species and what people should do if they see a nesting or stranded Kemp’s ridley turtle.

HEART/STRP has aided with public educatation in the U.S. and Mexico and raised funds that have benefitted public education, conservation, and research efforts there. They raised funds to feed Kemp’s ridley turtles held for headstarting at the NMFS Laboratory in Galveston, Texas and construct a new building to house them there. They also initiated educational campaigns that urged the public to write letters supporting various causes such as mandatory use of TEDs.

Other partners in educational programs and outreach in Texas have included the Alvin and Lucy Owsley Foundation, Coastal Bend Bays and Estuaries Program, Corpus Christi Visitors and Convention Bureau, Department of the Interior U.S.-Mexico Border Program, Environmental Defense, Forever Resorts, Friends of Aransas and Matagorda Island National Wildlife Refuges, Friends of Laguna Atascosa National Wildlife Refuge, Friends of Padre, Inc., Janet F. Harte Library, H-E-B, Houston Zoo, Meadows Foundation, National Fish and Wildlife Foundation, National Park Foundation, Norcross Wildlife Foundation, Padre Island Business Association, Schlumberger, Seashore Learning Center, SeaSpace, Shell Oil Company Foundation, Southwest Parks and Monuments Association, Texas Master Naturalists, Unilever HPC-U.S., USCG, U.S. Geological Survey, UAB, University of Charleston, several city and county governmental agencies, and many others. Some of the same agencies and many others have participated in outreach activities in other U.S. states outside of Texas. Of particular importance have been those that aided with detection and care of cold stunned Kemp’s ridley turtles along the U.S. Atlantic coast and those involved in protecting this species in the marine environment. The work has also involved partnerships and collaborations with various agencies and universities in Mexico.

Beginning in south Texas in the 1970s, and expanding to the middle and upper Texas coast in the early 2000s, collaborative efforts have been undertaken to educate people that use the beach for work or recreation and encourage and enable them to assist with detection of turtles. Training sessions have been given to many employees of government agencies, universities, and other entities that work on the beach. Posters detailing the need to report nesting sea turtles and tracks have been displayed at beach parks and establishments in the nearby areas. Beach signs alerting visitors to report turtles on the beach immediately have been posted at PAIS and other beaches in Texas. HEART/STRP funded a public information “hot line” number (1-866-TURTLE5) to report nesting and stranded sea turtles in Texas. They also funded signs and a billboard on the upper Texas coast advertizing this number. Using other funding sources, signs and posters displaying this telephone number are now displayed state-wide. This hotline has resulted in many reports of nesting turtles, nests, and stranded turtles that have been documented and protected. HEART/STRP funded educational bookmarks advertising this reporting number and more than 100,000 of these bookmarks have been distributed. They also developed a public service announcement sent to numerous television stations in Texas. HEART/STRP expanded the use of its public call-in number as a result of the Deepwater Horizon Oil Spill by giving residents in Louisiana, Mississippi, Alabama, and Florida a number (1-877-STRP-GLF) to access sea turtle responders and marine law enforcement in their states.

A display and videotape about the Kemp's ridley project have been made available at the PAIS Visitor Center. Displays about Kemp’s ridley nesting in Texas have also been placed at Sea Turtle, Inc., NMFS Galveston Laboratory, and other offices. Employees and volunteers conducting turtle patrols have made educational contacts with numerous beach visitors, informed them about the need to report sightings immediately, and provided them with brochures listing procedures they should follow if they observe nesting. These brochures have also been given to all visitors that stopped at the PAIS Entrance Station during the nesting season.

Kemp’s ridley restoration efforts have received widespread media coverage, which has helped to educate the public. Numerous media interviews have been conducted detailing the sea turtle work. In 1979, a PBS station at the University of Houston produced a documentary entitled “The Heartbreak Turtle,” which focused on exploitation of the turtles and nests in Mexico and bi-national conservation efforts which were beginning for the species. HEART/STRP funded a sequal to The Heartbreak Turtle called “The Heartbreak Turtle Today,” which debuted in 2010. In 1989, Pamela Phillips published a book called “The Great Ridley Rescue” that chronicled the biology of the Kemp’s ridley, its population decline, and conservation efforts for it (Phillips, 1989).

The public has been invited to attend many of the hatchling releases held at PAIS since the 1970s and up to 5,000 visitors have attended each year. The public has also been invited to attend some of the hatchling releases held on South Padre Island and Boca Chica Beach. Educational programs have been given at the hatchling releases attended by the public. Additionally, throughout the year, numerous educational programs have been given to school children, community organizations, and visitors to various establishments on the Texas coast involved in sea turtle work. Other educational methods used include web sites, social internet sites, bumper stickers, displays, special events, facility tours, public workshops, brochures, and Adopt-A-Turtle programs.

Along the U.S. Atlantic coast, especially in the Northeast, outreach efforts for responding to stranding events have been ongoing for decades. Almost every winter, Kemp’s ridleys strand along the coast of Massachusetts due to cold stunning. These turtles are rehabilitated and released. Releases are announced by press release and the public is invited to learn about the Kemp’s ridley and the physiological aspects of cold stunning.

H. THREATS

Recent assessments of recovery plans have indicated that the analysis of threats has received insufficient attention (Clark *et al*. 2002). A lack of knowledge regarding the nature of threats facing a species is likely to contribute to the failure of recovery plans (Lawler *et al*. 2002). In response to these assessments, the Team conducted a detailed analysis of threats to prioritize recovery actions. Appendix 1 describes the process the Team used to identify, categorize, quantify, and prioritize the threats described below. The reader should review carefully Appendix 1 to understand how the threats relatively contribute to the recovery of the Kemp's ridley.

H.1. Terrestrial Zone (Nesting Beach)

H.1.1. Resource Use

Illegal Harvest
Poaching of eggs and nesting females on the nesting beaches is uncommon in the U.S. and Mexico. Though poaching of eggs still occurs occasionally in Mexico, it has decreased dramatically since the project began at Rancho Nuevo, Mexico, in 1967. The decrease is due, in part, to the increased presence of armed military personnel and field biologists, as well as educational programs that have raised awareness among the local populace. Attempted poaching of nesting turtles and eggs has occurred in south Texas. Presence of field biologists and law enforcement personnel, and public education are also important to help prevent poaching in south Texas. To ensure this threat remains low, several recovery actions have been identified (see Stepdown Outline and Narrative).

Beach Cleaning
Beach cleaning refers to the removal of both abiotic and biotic debris from developed beaches. Several methods are employed including mechanical raking or scraping with large machinery, hand raking, and picking up debris by hand. Beaches are cleaned using these methods in some of the areas where Kemp's ridley nests have been documented in the U.S. and Mexico. Beach cleaning activities have the potential to cause direct lethal impacts by crushing nesting turtles, eggs, hatchlings, and live stranded turtles. Beach cleaning may destroy entire nests, harm pre-emergent hatchlings by removing the upper layer of sand above a nest, and decrease hatching success by exposing the uppermost eggs so that they are more vulnerable to overheating and crushing by both vehicles and pedestrians. Mann (1977) suggested that mortality within a nest might increase when the nest is subjected to externally applied pressure from beach cleaning. This mortality could arise from egg breakage or compaction of sand above the nest that makes it difficult or impossible for the hatchlings to escape. Disposal of debris and sand near the dune line or in piles on the beach could also cover incubating egg clutches and subsequently hinder and entrap emergent hatchlings and may alter natural nest temperatures. Beach cleaning can also cause ruts and ridges in the sand, which may hinder or trap nesting turtles or emerging hatchlings. During 2002, 12 Kemp's ridley hatchlings found by beach visitors became trapped by a ridge of sand created by heavy equipment used to clean the beach on North Padre Island, north of PAIS, and were subsequently crushed and killed by passing vehicles (Shaver 2004). Beach cleaning could obliterate tracks left in the sand by nesting turtles, making it difficult or impossible to locate, document, and protect the nests.

Human Presence
Human presence can negatively affect turtles, eggs, and hatchlings in numerous ways. Foot traffic could inadvertently crush eggs, disturb nesting turtles, disturb or crush emerging hatchlings, and crush small, live stranded turtles. Sea turtles emerging on beaches to lay eggs can be deterred from nesting by pedestrians approaching them. Human footprints on the beach can interfere with the ability of hatchlings to reach the ocean (Hosier *et al*. 1981). Heavy pedestrian traffic also may compact sand over unmarked nests (Mann 1977), although the effect of this compaction has not been determined and may be negligible (Arianoutsou 1988). Depending on the nesting substrate, pedestrian traffic over nests near the time of emergence can cause the nests to collapse and result in hatchling mortality (Mann 1977, Dutton *et al*. 1994). Eggs closest to the sand surface would be more vulnerable to crushing, but egg contents spilled into the nest cavity could attract pathogens or predators that could subsequently destroy other eggs. Also, pedestrians could potentially crush emerging hatchlings or small stranded individuals, especially if they were present in vegetation or debris and difficult to see.

Coastal development increases human presence. Human presence may result in increased populations of raccoons and other species known to prey on sea turtle eggs and hatchlings. Unsustainable animal predation on eggs/hatchlings is primarily due to human activities (e.g., food subsidy, removal of top predators, introduction of non-native predators, etc.).

Recreational Beach Equipment
The use of recreational beach equipment such as umbrellas, cabanas, lounge chairs, small water craft, volleyball nets, and barbeque grills, could injure or kill nesting females, eggs, hatchlings, and stranded turtles through crushing, entanglement, and impediment. The placement of recreational beach equipment directly above Kemp's ridley nests may destroy eggs through direct invasion and may hamper hatchlings during emergence. The placement of these obstacles on nesting beaches could also hamper or deter nesting attempts, causing false crawls or entrapment of nesting females, and interfere with incubating eggs and the sea approach of hatchlings.

Beach Vehicular Driving
The operation of motor vehicles is permitted at most beaches in Texas and some other beaches in the U.S. and Mexico, and can injure or kill nesting turtles, eggs, emergent hatchlings, and live-stranded turtles. Nesting turtles can be difficult to see and they cannot move quickly to avoid an approaching vehicle. As vehicle speed increases, stopping distance increases, and the chances of driving over nesting turtles and their tracks increases. In 2002, a nesting Kemp's ridley was struck by a passing vehicle on Matagorda Peninsula, Texas (Shaver 2004). Visitors placed the bleeding turtle into the surf and she swam away. A dead adult Kemp's ridley was found in the vicinity a few days later. Although it cannot be proven that this was the same turtle, it is possible because strandings of adult Kemp's ridleys were rare in that area at that time. During 2008, two Kemp's ridleys that emerged to nest on South Padre Island were struck by passing vehicles and died as a result of their injuries (J. Mays, FWS, personal communication 2008). The vehicle operator was apprehended at the second site and admitted that he was "driving fast in soft sand" and that by the time that he saw the turtle "it was too late to stop". It is estimated he was driving 25-30 mph. These were the first confirmed fatalities on the beach of Kemp's ridley turtles that emerged to nest on the Texas coast. In 2009, a fast moving truck drove over and killed a nesting turtle in La Pesca, Mexico.

Passing vehicles crushed and killed at least 29 hatchlings from six Kemp's ridley nests that were found at hatching by beach visitors, including one nest located on North Padre Island (north of PAIS) in 2002, two on Mustang Island in 2002 and 2004, one on Boca Chica Beach in 2006, and two on Bolivar Peninsula in 2008 (D. Shaver, PAIS, personal communication 2008). This includes at least six hatchlings emerging from two nests on Bolivar Peninsula killed by vehicular traffic along the upper Texas coast beach during 2008 (A. Landry, TAMU, personal communication 2008).

Driving on beaches can disrupt the nesting process and result in abandoned nesting attempts. Beach driving can obliterate tracks left in the sand by nesting turtles, making it more difficult or impossible to locate, document, and protect the nests. Nests left undetected and unprotected on Texas beaches suffer higher mortality than those nests protected in the incubation facility or corrals. Beach driving can remove sand from the top of the nest so that the uppermost eggs are very close to the surface and hence more vulnerable to overheating and crushing by vehicles or pedestrians. Driving directly above incubating sea turtle egg clutches can cause sand compaction, which may decrease nest success and kill pre-emergent hatchlings (Mann 1977). Beach driving can create ruts and ridges in the sand that pose obstacles to nesting turtles and emerging hatchlings attempting to reach the ocean, resulting in an extended period of travel or entrapment. Vehicle headlights can disorient (loss of bearings) and misorient (incorrect orientation) emergent hatchlings. Sea turtles that become trapped in ruts or disoriented by headlights would be more vulnerable to injury or death from predation, dehydration, and crushing by vehicles (Hosier *et al*. 1981).

Beach driving can also impact nesting habitat. Sand compaction by vehicles has been found to hinder nest construction in other species. Additionally, vehicle traffic on nesting beaches contributes to erosion, especially during high tides or on narrow beaches where driving is concentrated on the high beach and fore-dune. Erosion and destruction of fore-dunes can make nests more subject to tidal inundation.

H.1.2. Construction

Coastal construction has the potential to degrade Kemp's ridley nesting beach habitat. Construction activities that take place on the beach could injure or kill nesting turtles, eggs, hatchlings, and live-stranded turtles through crushing. The construction of buildings within or just behind the dunes can degrade nesting habitat by destroying the dune system that is important for successful egg laying and incubation. Lighting of these buildings at night could disorient females that attempt to nest or hatchings that emerge during darkness. Other nesting environment threats such as armoring, nourishment, beach cleaning (see above), beach vehicular driving (see above), and increased human disturbance often accompany construction of buildings.

Beach Nourishment

Beach nourishment is the periodic replenishment of sand to ameliorate loss from erosion to maintain a desired beach width for protection of coastal structures or to encourage tourism and satisfy beach recreation requirements. Beach nourishment often involves the excavation of large quantities of sand from one site and placing it on an existing, but eroding, section of coastline. Sand is most typically dredged from inlets or offshore "borrow" areas, although inland sand sources may also be used. Beach nourishment activities are known to impact sea turtle reproduction by burying nests and reducing hatching and emergence success (Crain *et al.* 1995).

Currently, beach nourishment has little effect on the Kemp's ridley population. Rancho Nuevo is remote and has Sanctuary status. Beach nourishment is expensive and unlikely to occur there. The majority of U.S. nesting occurs in PAIS, which also limits beach nourishment activities. The potential exists for future nourishment activities to impact Kemp's ridleys, given an expanding nesting range.

Other Shoreline Stabilizations

Drift fences, also commonly called sand fences, are constructed of narrowly spaced wooden or plastic slats or plastic fabric. They are erected to build and stabilize dunes by trapping sand moving along the beach and preventing excessive sand loss or to protect dune systems by deterring public access. Improperly placed, broken, or abandoned drift fences can impede nesting attempts and/or trap emergent hatchlings and nesting females. Groins and jetties are designed to trap sand during transport in long-shore currents or to keep sand from flowing into channels. Sand is accreted on one side of the structure and is eroded on the other (Pilkey *et al*. 1984), thereby degrading suitable nesting habitat. These structures alter water flow and current patterns and could cause emergent hatchlings to be swept into them (causing injury or death to the turtles) or to be improperly transported into the bay systems with the incoming tides. Large tubes consisting of polyester or polypropylene geotextiles are filled with dredge material and used in groin construction or to stabilize shorelines. These tubes disintegrate (5 to 10 years) when exposed to ultraviolet light and may result in Kemp's ridleys becoming entrapped in the material or ingesting it.

Energy Exploration, Development, and Removal

Oil and gas exploration and production have occurred in the Gulf of Mexico for over 100 years. Activities associated with exploration and development include, but are not limited to, construction of support facilities including refineries and waste management, increased traffic and construction in ports, installation of pipelines and oil platforms, and use of explosives and sonar. Oil and gas exploration will likely increase as existing sources are depleted.

Oil and gas exploration and development pose a potential threat to nesting turtles, eggs, hatchlings, and live-stranded turtles. Oil discharged on the beach or washed ashore due to oil spills, pipeline leaks, etc. could smother nests or adhere to nesting turtles, live-stranded turtles, and hatchlings crawling on an affected beach.

In Mexico, primary oil exploration and production primarily occurs south of Tamaulipas and Veracruz. Occassionally, Kemp's ridleys have been documented to strand on the nesting beaches partially or completely covered in crude oil from tank ship spills. Mortality attributed to the presence of petroleum has been documented, but the impact is not quantified. Some studies conducted on sea turtles exposed to the oil spill from Ixtoc I showed chronic exposure to hydrocarbons; the examined tissues and the comparison with similar studies in birds indicated that there was a minimum consumption of oil at 50,000 ppm in the daily diet (Marquez 1994).

Oil and gas exploration and development occurs on or near some U.S. beaches where Kemp's ridley nests have been documented. Beach driving (see above), lighting, and noise associated with these activities pose potential impacts to nesting turtles, eggs, hatchlings, and stranded turtles. Oil and gas exploration and development occur at PAIS, where more than half the Kemp's ridley nests recorded in the U.S. have been found. The NPS does not own the mineral rights at PAIS and must provide access to these subsurface rights. The FWS and NPS have developed mitigation measures, including a beach speed limit of 15 mph, to help protect nesting turtles and their nests from these activities.

Alternatives to traditional energy sources have been explored for decades and are becoming increasingly popular. Wind farms constructed offshore (>10 km from shore) or nearshore (<10 km from shore) are capable of converting the wind's kinetic energy into mechanical energy, which is converted into electricity. Wind farms consist of multiple wind turbines that rotate around a horizontal axis. The power generated by these offshore turbines is generally transmitted through undersea cables as either alternating or high voltage direct current. Large wind farms have been proposed offshore from North Padre, South Padre, and Galveston Islands, where nesting occurs. Wind farms have also been proposed in Kemp's ridley marine habitat off Massachusetts and Florida. Impacts to turtles in the marine environment and to eggs, hatchlings, and nesting females from construction, lighting, changes in ambient noise from vibration, ecosystem alterations, maintenance and repair, and alterations of magnetic fields are unknown but could potentially be significant. Searches for and reliance on alternative energy sources will likely increase.

H.1.3. Ecosystem Alterations

Beach Erosion and Vegetation Alteration in Coastal Habitats
Erosion events may influence the quality of nesting habitat. Erosion, frequent or prolonged tidal inundation, and accretion can negatively affect incubating egg clutches. Short-term erosion events (e.g., atmospheric fronts, northeasters, tropical storms, and hurricanes) are common phenomena and may vary considerably from year to year. Nesting females may deposit eggs at the base of an escarpment formed during an erosion event resulting in the clutch being more susceptible to repeated tidal inundation. Sea turtles have evolved a strategy to offset the effects of natural erosion on nesting beaches by laying large numbers of eggs and by distributing their nests both spatially and temporally. For example in 1989, Hurricane Gilbert deposited debris and eroded the beach exposing coral rock along the central part of Rancho Nuevo and displacing about 20% of the nesting activity to the north that season (Marquez 1990).

Rarely is the total annual hatchling production affected by storm-generated beach erosion and inundation. However, human activities along coastlines can accelerate erosion rates, interrupt natural shoreline migration, and reduce both the quantity and quality of available nesting habitat. It is unclear to what extent these human-induced effects might lower Kemp's ridley hatchling productivity. Deforestation for farming and overgrazing by goats and cattle has altered the composition of the vegetation on nesting beaches and adjacent areas of Tamaulipas. Large-scale alterations in vegetation have been postulated to alter rain patterns and create runoff, which increases beach erosion (Marquez 1994).

Beach erosion of some Kemp's ridley nesting beaches in Texas are considerable, particularly the upper coast beaches of Galveston Island, Bolivar Peninsula, and Surfside (TAMU, unpublished data http://coastal.tamug.edu/links.html).

Based on available studies on the geology of PAIS and consultations with coastal geologists Bob Morton (USGS) and Jim Gibeau (Texas A&M University Corpus Christi), it appears that most of the beach within PAIS boundaries is accreting over the long term (Jim Lindsay, PAIS, personal communication 2009). Defining whether areas are accreting or eroding depends on cycles of accretion and erosion over many decades or centuries. The impacts from hurricanes in recent years have narrowed the beach and impacted the dunes, which has happened many times. Vehicles driven on the fore-dunes kill vegetation and slow dune migration toward the Gulf and may slow accretionary processes. Although most of PAIS appears to be accreting, the southern third of PAIS is in a prolonged erosional state that is exacerbated by the Mansfield Channel jetties (constructed in 1957) that restrict sediment flow north of the Mansfield Channel. The beach north of the jetties is intermittently replenished with sand when the Army Corps of Engineers dredges the channel, but sediment transport from this area does not appear to be slowing erosion a few miles north of the channel.

H.1.4. Pollution

Oil, Fuel, Tar, and Chemical

Data on the impacts of oil on nesting female Kemp's ridleys are lacking. Nesting females could crawl through oil on beaches, thereby coating skin and shell or they may avoid oiled beaches (Milton *et al*. 2003). Females could potentially be prevented from accessing nesting beaches by containment booms or other barriers used in spill response activities.

The Gulf of Mexico is an area of high-density offshore oil exploration and extraction with chronic, low-level spills and occasional massive spills such as the explosion and destruction of a loaded supertanker, the Mega Borg, near Galveston in 1990, and the Ixtoc I oil well blowout and fire in the Bay of Campeche in 1979. Over several months, 10,000-15,000 barrels of oil were released daily from the Ixtoc I spill. The nesting beach at Rancho Nuevo was affected by the Ixtoc I oil spill. However, the spill reached the nesting beach after the nesting season, and adults were not present.

In the spring of 2010, the Deepwater Horizon (DWH) offshore deepwater oil rig sank in the Gulf of Mexico as a result of an explosion. There was an uncontrolled release of oil from the well at the beginning of sea turtle nesting season. While scientists are just beginning to understand the long term effects of this disaster, the short term effects were minimized by the coordinated response of Federal, state and local entities. The oil did not reach the nesting beaches in Texas and Mexico, but did affect nesting beaches in Alabama and the panhandle of Florida. Where the oil reached the nesting beaches, the nests were relocated to unaffected beaches and the hatchlings released to adjacent waters.

Eggs could be oiled if spills wash far enough up onto the beach to reach the zone where nests are laid. In 1980, lab experiments with five clutches of loggerhead eggs from Merritt Island, Florida, and *in situ* Kemp's ridley nests at Rancho Nuevo one year after the Ixtoc spill, were used to determine the effects of oil on embryo development. Researchers concluded that oil washing up on a nesting beach prior to nesting, even only a few weeks before nesting, will likely be weathered to a non-toxic state prior to the females' arrival. If oil washes up while eggs are incubating, significant mortality could result if the oil is carried high enough up on the beach to reach the level of the nests (Fritts and McGehee 1981). Oil poured on top of a clutch of eggs had a greater negative impact on hatching success than egg exposure to oil mixed into the sand. The portion of the egg covered by oil can affect hatching success (Phillott and Parmenter 2001). Oil can potentially adversely impact a nesting beach by interfering with gas exchange within the nest, altering the hydric environment of the nest, and/or modifying nest temperatures by changing the color and thereby the thermal conductivity of the sand (see Milton *et al*. 2003). Eggs can also be disturbed by oil spill cleanup activities.

Hatchlings that contact oil while crawling to the water can experience a range of effects from acutre toxicity to impaired movements and normal bodily functions (Milton *et al.* 2003); however, systematic data are not available regarding effects of oil on Kemp's ridley hatchlings in the terrestrial zone.

Light Pollution
Extensive research has demonstrated that the principal component of the sea-finding behavior of emergent hatchling sea turtles is a visual response to light (Daniel and Smith 1947, Hendrickson 1958, Carr and Ogren 1960, Ehrenfeld and Carr 1967, Dickerson and Nelson 1989, Witherington and Bjorndal 1991). Artificial beachfront lighting from buildings, streetlights, dune crossovers, vehicles, other types of beachfront lights, and artificial light experiments have documented the disorientation and misorientation of loggerhead, green, leatherback, and hawksbill hatchlings (McFarlane 1963, Philibosian 1976, Mann 1977, Ehrhart 1983, Dickerson and Nelson 1989). In Texas, Kemp's ridley hatchlings have been disoriented by vehicle headlights and building lights during some releases and emergences that occurred at night (D. Shaver, PAIS, personal communication 2008). None were documented killed on the beach as a result of disorientation or misorientation, but some may have been lost in vegetation at an *in situ* nest site on Bolivar Peninsula in 2008 (C. Hughes, TAMU, personal communication 2008). As hatchlings head toward lights or meander along the beach their exposure to terrestrial predators and the likelihood of desiccation is greatly increased. Disoriented hatchlings can become entrapped in vegetation or debris, or mistakenly enter nearby roadways and then be struck by vehicles. Hatchlings that successfully find the water could be disoriented after entering the surf zone or while in nearshore waters. Intense artificial lighting could even draw hatchlings back out of the surf (Daniel and Smith 1947, Carr and Ogren 1960).

In Mexico, light pollution is not a problem at the main nesting beaches in Tamaulipas.

Toxins
The effects of these contaminants on sea turtle eggs and hatchlings are unknown. Natural and anthropogenic toxins can induce sickness or biochemical changes in exposed organisms. Toxins can alter metabolic activities, development, and reproductive capacity. Studies of freshwater turtle species have shown that high concentrations of chlorobiphenyls (CBs) and organochlorine pesticides (OCPs) in the eggs are correlated to decreased hatching success (Bishop *et al*. 1991). Concentrations of organic contaminants have been found in the blood of Kemp's ridleys and green sea turtles (Swarthout *et al.* 2010). Contaminants have also been found in loggerhead and green turtle hatchlings and eggs, suggesting that females offload contaminants to their eggs (McKenzie *et al*. 1999).

H.1.5. Species Interactions

Predation
In Mexico, the major natural predators of Kemp's ridley nests are mammals, including raccoons, dogs, pigs, skunks, and badgers. Various species of ants are also known to prey on nests. Emergent hatchlings are preyed upon by ghost crabs, raccoons, coyotes, skunks, and badgers. During the 2003-2004 nesting seasons at Rancho Nuevo, a total of 88 *in situ* nests were left without protective covers, which prevent predation. Of these, 73 were depredated and 8 were poached, suggesting that the predator load on the beach is capable of taking a high proportion of unprotected nests. However, as arribada sizes increase, predator satiation could potentially limit depredation (Wibbels and Geis 2004, Wibbels and Park 2005). As with the poaching, nest

predation has decreased considerably due to the increased human presence and use of nest corrals.

Mites of the genus *Macrocheles* were collected from Kemp's ridley hatchlings from relocated nests at Rancho Nuevo (Mast and Carr 1985). The presence of mites is thought to be incidental to fly infestation, which is known to reduce hatching success in other sea turtle species (Broderick and Hancock 1997).

Predation from domestic animals has been minimal since 90% of the nests in Mexico are relocated to corrals. As more nests are left *in situ*, predation likely will increase, especially near towns such as Barra del Tordo and Ostionales. At Rancho Nuevo and Playa Dos-Barra del Tordo, technicians observed the loss of about 5% of the nests to dogs, pigs, and cats associated with human settlements along the coast. Predation increases during arribada events because the increased number of nests on the beach prevents technicians from relocating all of the nests (M. Arciniega, SEMARNAT, personal communication 2007).

The exotic South American fire ant (*Solenopsis invicta*) is a predator of Kemp's ridley eggs and emerging hatchlings. During 1980, only two hatchlings emerged from a Kemp's ridley nest incubated *in situ* at Padre Island National Seashore; investigation of the nest at hatching revealed that fire ant predation was the likely cause of failure of this nest (Donna Shaver, PAIS, personal communication 2006). In 1997, fire ants infested a Kemp's ridley nest on Mustang Island immediately after the eggs were laid in a dune that had been created by heavy equipment that pushed a mound of *Sargassum* seaweed and sand toward the dune-line (Shaver 1998a). Ants were brushed off each egg before it was placed into the incubation box and egg viability was not impacted. However, hatching success would likely have been lowered significantly had the nest not been located and removed from the site. Fire ants attempted to enter the first two incubation facilities at PAIS and the corral on South Padre Island, but programs were instituted to prevent them from harming eggs or hatchlings. These prevention efforts included diligent removal of dead organisms and sand that had come in contact with hatched eggs so that these materials did not attract ants. Also, hatching nests were monitored closely so that if ants were detected in the vicinity, the ants could be crushed by hand or the eggs and hatchlings could be moved before damage occurred. Laughing gulls, coyotes, raccoons, badgers, and ghost crabs have also killed eggs or hatchlings on the Texas coast.

Pathogens and Disease
Bacterial and fungal pathogens in nests typically increase dramatically in high density nesting situations such as in arribadas. This is well documented in the large arribadas of the olive ridley at Nancite in Costa Rica (Mo 1988). In some years and on some sections of the beach the hatching success can be as low as 5% (Cornelius 1986, Mo 1988). As the Kemp's ridley nest density at Rancho Nuevo and adjacent beaches continue to increase, appropriate monitoring of emergence success will be necessary to determine if there are any density dependent effects on emergence success.

Habitat Modification by Invasive Species
Non-native vegetation has invaded many coastal areas and often out-competes native species such as sea oats (*Uniola paniculata*), railroad vine (*Ipomoea pes-caprae*), sea grape (*Coccoloba uvifera*), bitter panicgrass (*Panicum amarum*), and seaside pennywort (*Hydrocotyle bonariensis*). The invasion of less stabilizing vegetation can lead to increased erosion and degradation of

suitable nesting habitat. Exotic vegetation may also form impenetrable root mats that can prevent proper nest cavity excavation, invade and desiccate eggs, or trap hatchlings.

The Australian pine (*Casuarina equisetifolia*) is common in Tamaulipas, where it is planted as a wind fence. Whether or not the plant would grow successfully along the lower beach face where most of the nesting occurs is unknown. The Australian pine currently is not a problem on the nesting beaches, but may present a future threat. The Australian pine has been documented to be harmful to other sea turtle species. Dense stands have taken over many coastal areas throughout central and south Florida. Australian pines cause excessive shading of the beach that would not otherwise occur. Studies in Florida suggest that nests laid in shaded areas are subjected to lower incubation temperatures, which may alter the natural hatchling sex ratio (Marcus and Maley 1987, Schmelz and Mezich 1988, Hanson *et al*. 1998). However, Schmid *et al.* (2008) analyzed the removal of Australian pine from a loggerhead nesting beach and found that shading from the pines did not affect incubation temperatures of nests any differently than native dune vegetation. The shallow root network of these pines can interfere with nest construction (Schmelz and Mezich 1988). Where dense stands of Australian pine have taken over native dune vegetation, nesting activity declined (Davis and Whiting 1977).

H.1.6. Other Factors

Climate Change

Climate change at normal rates (thousands of years) was not historically a problem for sea turtle species since they have persisted for millions of years. The Kemp's ridley has existed for approximately 3-4 million years as a species (Bowen and Karl 1997). There is a 90% probability that warming of the earth's atmosphere since 1750 is due to human activities resulting in atmospheric increases in carbon dioxide, methane, and nitrous oxide (Intergovernmental Panel on Climate Change [IPCC] 2007). All reptiles including sea turtles have a tremendous dependence on their thermal environment for regulating physiological processes and for driving behavioral adaptations (Spotila *et al*. 1997). In the case of sea turtles, where many other habitat modifications are documented (e.g., beach development, loss of foraging habitat), the prospects for accentuated synergistic impacts on survival of the species may be even more important in the long-term. Such potential problems have been discussed for some time (Myers 1992). In these species, where temperature determines the sex of the developing embryo, even a few degrees change in beach temperatures over the next decade will cause a strong shift toward more female hatchlings being produced. A female bias is presumed to increase egg production (assuming that the availability of males does not become a limiting factor) (Coyne and Landry 2007) and increase the rate of recovery. Although one male may be able to inseminate multiple females, it is unknown at what point the percentage of males may become insufficient to facilitate maximum fertilization rates in a population. If males become a limiting factor in the reproductive ecology of the Kemp's ridley, then reproductive output in the population could decrease (Coyne 2000). Low numbers of males could also result in the loss of genetic diversity within a population; however, there is currently no evidence that this is a problem in the Kemp's ridley population (Kichler *et al*. 1999, Kichler Holder and Holder 2007, but see Stephens 2003). Data suggest that a female bias may be present in the Kemp's ridley population and would be advantageous to the short-term recovery of this endangered sea turtle, but manipulation of natural sex ratios may have long-term, unknown positive or negative consequences.

Natural Catastrophe

Hurricanes and severe storms are common phenomena. Sea turtles have evolved a strategy to offset the effects of these phenomena by laying large numbers of eggs and by distributing their nests both spatially and temporally. Nevertheless, hurricanes and severe storm events have destroyed nesting beach habitat and nests in the past and have the potential to do so in the future. Hurricanes and storms are more frequent along the east Mexico coast and Gulf of Mexico during August and September when hatchlings and eggs are vulnerable. Hurricanes and severe storms can remove embryonic and primary dunes, or create wash-over channels, thereby reducing suitable habitat for egg deposition and incubation. Wash-over channels can also cut off access to areas for nest detection and protection. Such habitat alteration has occurred both in Mexico and the U.S. (P. Burchfield, GPZ, personal communication 2006, D. Shaver, PAIS, personal communication 2006). Incubating eggs and emerging hatchlings can be killed due to prolonged exposure to seawater over the top of the nest, by accretion of sand above the nest, or by the eggs being unearthed and washed out to sea. Nests were harmed or destroyed in Mexico during the 1980s due to hurricanes and severe storms, but mortality was later decreased when the egg incubation corrals were moved higher on the beach (P. Burchfield, GPZ, personal communication 2006). Conversely, lack of rain can change sand compaction, moisture content, temperature and can adversely affect egg development.

Conservation and Research Activities

Some conservation and research activities conducted in the U.S. and Mexico could potentially harm or kill Kemp's ridley turtles or their eggs. Monitors searching for nesting turtles could disturb nesting turtles and cause them to abandon their nesting attempts or could run over nests and turtles. Nesting turtles and turtles transported to rehabilitation facilities or laboratories could be inadvertently harmed or killed in the course of transport, treatment, documentation, or study. A majority of Kemp's ridley nests are placed in corrals or incubation facilities to protect them from various threats such as predation, poaching, or tidal inundation. Management practices that move or concentrate the nests have the potential to decrease hatching success or alter sex ratios. Unless done carefully, eggs moved more than 12 hours after initial deposition may have poorer hatching success than if they had been left *in situ*. Eggs moved higher on the beach for *in situ* or corral incubation would tend to be warmer than if they were left lower on the beach and hence would be predicted to produce a larger proportion of females. Eggs moved to an incubation facility could incubate under cooler conditions and hence produce a preponderance of males, but practices were successfully implemented at the PAIS incubation facility beginning in the mid-1980s to intentionally elevate temperatures and produce primarily females.

In 2007, NMFS authorized 1,365 live and 26 dead Kemp's ridleys to be taken as a result of 22 research experiments (NMFS unpublished data research permit tracking 2007). Mexico authorized over 20,000 Kemp's ridleys to be taken live for conservation and research activities (e.g., tagging, egg relocation) and at Rancho Nuevo (SEMARNAT unpublished data research permit tracking 2007). The vast majority of Kemp's ridleys taken during research are released alive and uninjured.

Military Activities

Military activities are currently not an issue for Kemp's ridley nesting females, nests, eggs, and hatchlings. PAIS was suggested as an alternative site to conduct military exercises after the 2003 closure of the bombing range in Vieques, Puerto Rico, but this plan was abandoned. The Team believes that national security issues are likely to increase military exercises in the future.

Military exercises on the beach could harm or kill nesting turtles, eggs, hatchlings, and stranded turtles through crushing. Nesting turtles could abandon nesting attempts due to disturbance or hatchlings could become misoriented or disoriented due to lighting associated with the exercises.

Tracks left in the sand by nesting females could be obscured, making it difficult or impossible to locate, document, and protect the nests. Activities associated with military exercises could excavate and destroy incubating eggs or remove the upper layer of sand above a nest thereby exposing pre-emergent hatchlings near the surface of the nest or decreasing the burial depth of the uppermost eggs so that they are more vulnerable to overheating and crushing by vehicles or pedestrians. Mortality could arise from egg breakage or compaction of sand above the nest that makes it difficult or impossible for the hatchlings to escape. Nesting beach habitat could be harmed or destroyed.

Funding
Lack of funding is generally not specified as a threat in recovery plans. However, the Team felt strongly that the lack of funds should be highlighted as a potential factor that could reverse the population growth of the Kemp's ridley. Funding for support to monitor, protect, and conduct educational efforts is essential to Kemp's ridley recovery. These efforts require staffing, vehicles, infrastructure, and associated equipment and materials. Monitoring and education not only enable location, documentation, and protection of the nesting turtles, eggs, hatchlings, and stranded turtles, but also provide an excellent deterrent to possible negative human interactions with these animals. Many of the existing programs are funded primarily through grants and donations. These short-duration funding sources vary greatly each year, and more stable sources of funding are necessary for the long-term continuity of these programs.

H.2. Marine: Neritic and Oceanic Zone

H.2.1. Resource Use: Fisheries Bycatch

Sea turtles caught in commercial and recreational fisheries are often injured or killed. Entanglement in fishing gear can lead to abrasions, restrictions, tissue necrosis, and drowning. Sea turtles that are forcibly submerged undergo respiratory and metabolic stress that can lead to severe disturbance of their biochemistry. Stress from forced submergence can trigger anaerobic glycolysis, sometimes leading to death (Lutcavage and Lutz 1997, Hoopes *et al.* 2000, Stabenau and Vietti 2003, Snoddy *et al.* 2009). Thus, reducing the risk of interactions in fishing gear is important to recovering the Kemp's ridley.

Trawls, Bottom Fishing
Of all commercial and recreational fisheries in the U.S., shrimp trawling has had the greatest effect on the status of sea turtle populations. The National Academy of Sciences estimated that between 500 and 5,000 Kemp's ridleys were killed annually by the offshore shrimping fleet in the southeastern U.S. Atlantic and Gulf of Mexico (Magnuson *et al*. 1990). Mortality associated with shrimp trawls was estimated to be 10 times that of all other human-related factors combined. However, those estimates were based on an overcapitalized fishery that was not using TEDs. In recent years, the shrimp fishery has decreased due to several factors including increased fuel costs, reduced shrimp prices, competition with aquaculture and imported shrimp, and the 2005 hurricane season (NMFS 2007a, Caillouet *et al.* 2008). Thus, the relative impact of

the shrimp fishery on sea turtles probably is less than was estimated in the past based on fishing effort alone.

In 1978, NMFS began testing a device that would separate the target catch from bycatch. The design was based on a device already used by many shrimpers to exclude jellyfish. After experimentation they learned that turtle catch could be eliminated almost completely and named the device a TED (Oravetz and Grant 1986). However, the original design was heavy and unwieldy. Thus, NMFS, in cooperation with commercial fishers, developed several new lighter TED designs. Because of the increasing number of new TED designs developed by fishers, NMFS adopted standardized guidelines that required all approved TEDs to be 97% effective in excluding turtles (NMFS 1987, see also G.3.2. United States). TEDs were first fully implemented seasonally in 1990 and by 1994 were required in all areas where the southeast U.S. shrimp fishery operated and at all times of the year (Epperly 2003).

Under current TED requirements, the estimated annual mortality of Kemp's ridleys in the U.S. southeast and Gulf of Mexico shrimp fishery was estimated to be up to 4,208 individuals (NMFS 2002a). However, these estimates are based on shrimp effort as of 2001. By 2009, shrimp effort had declined by 61% in the Gulf of Mexico and by 38% in the U.S. Atlantic (SEFSC 2011). Assuming bycatch rates are unchanged from the NMFS (2002a) estimate and using 2009 effort, lethal take of Kemp's ridleys in 2009 was estimated to be 1,717. However, an increase in neritic juveniles with a growing population will likely expose more turtles to shrimp trawling, thus the 2009 bycatch estimate may be biased low.

Since 1992, TEDs have also been required in the summer flounder fishery operating off Virginia and North Carolina. As a result of exceptionally high strandings of sea turtles along the shores of southern Virginia and northern North Carolina in the fall of 1991, NMFS implemented an at-sea monitoring program of the summer flounder fishery. An estimated 1,063 turtles (95% C.I. = 529-1,764) of all species were taken by the fleet (Epperly *et al.* 1995c). Kemp's ridleys represented 36% of the total estimated take (live and lethal) and 0-56 Kemp's ridleys were estimated to be killed. From 1996-2007, three Kemp's ridleys were documented in the summer flounder fishery operating off Virginia and North Carolina (Murray 2006, NMFS unpublished data 2007).

In Mexico, the shrimp fishery does not operate year-round and its timing and periodicity depends on the migration of shrimp from the lagoons to the sea, which occurs between May and June (Fernandez-M. *et al*. 2001, DOF 2007). All shrimp vessels must receive certificates from the Federal Ministry for Environmental Protection (PROFEPA) stating that their TEDs are installed correctly in order to fish. There are approximately 270 shrimp boats operating out of Tamaulipas, and 100 boats fishing in waters adjacent to Tamaulipas. In recent years, shrimp effort has dropped, in part, due to high fuel cost. During 2003, PROFEPA inspected 329 vessels and found only eight out of compliance.

There were several fish trawlers in the Gulf of Mexico but their fishing grounds were over the continental shelf off Yucatan. During 89 fishing trips (March 1997-December 2000) 693 turtles were reported captured. Most of them were loggerheads (72.9 %) followed by hawksbills (25.3%) and Kemp's ridleys (0.7%). This fleet stopped operating in 2004 (Quiroga-Brahms, 2004).

In the U.S., TEDs are not required in many trawl fisheries that may interact with Kemp's ridley turtles (Epperly *et al*. 2002). Skimmer trawls are used to catch shrimp and are fished in inshore waters throughout the southeast U.S. in all states except Texas. They have become increasingly popular, in part, because they are exempt from TED requirements, but they still are required to restrict tow times to reduce the probability of mortality. Skimmer trawls are mounted on frames attached to the sides of the boat, and part of the net extends above the water surface. There is no estimate of the total catch of turtles in skimmer trawls. Kemp's ridleys have been observed captured in skimmer trawls (NMFS SEFSC, unpublished data).

Turtles also are captured in trynets used in larger otter trawls in the shrimp fishery. Like skimmer trawls, they are subject to tow time restrictions. In 2009, 4 Kemp's were observed in trynets, all in the Gulf of Mexico (SEFSC 2011). All were released alive.

Beam trawls are used by approximately 15 vessels harvesting bait and table shrimp in inshore waters adjacent to Corpus Christi, Texas. Beam trawls are described as a shrimp trawl net, which is attached at the mouth to a rigid pole, beam, or frame to maintain speed (Epperly *et al.* 2002). Beam trawls could potentially capture sea turtles. Pusher head trawls are banned from Louisiana but may operate off Mississippi. The gear consists of a rigid or flexible frame and net that is attached to a pair of long poles mounted to the bow. The net is 'pushed' out in front of the boat. Fishers using beam or pusher head trawls must limit their tow-times to decrease the probability that a sea turtle will drown in the net (Epperly *et al.* 2002).

Less than a dozen shrimpers operating in the northern Gulf of Mexico will use their shrimp trawls without TEDs to target sheepshead (*Archosargus probatocephalus*) and black drum (*Pogonias cromis*) to supplement income if the weather is bad, or when shrimping is slow (G. Rousse and J. Boulet, NMFS, personal communications 2005). The probability of these vessels encountering a Kemp's ridley is the same as for the shrimp fishery in the area.

Whelk trawls are currently used in South Carolina and Georgia in late winter and early spring. As of December 2000, TEDs are required in Georgia waters when trawling for whelk. No such restrictions occur in South Carolina, but the fishery is regulated and closes once water temperatures reach 17.8 °C (Epperly 2003).

Channel nets are similar to shrimp trawls but are fished as static gear. Channel nets are funnel-shaped, stationary nets that fishers stake and anchor in high flow channels, canals, and rivers to catch emigrating shrimp (Epperly *et al.* 2002). Channel nets are only used in North Carolina and South Carolina and are prohitied from use in Florida and Louisiana (Epperly *et al.* 2002). In South Carolina, TEDs are required in channel nets fishing in roughly three meters or greater depths.

Bottom and mid-water trawl fisheries are a major component of Mid-Atlantic and Northeast fisheries (Orphanides and Magnusson 2007). Bottom trawl trips target squid and finfish over 80% of time and the effort occurs throughout the Gulf of Maine, Georges Bank, and southern New England. Sea scallops, whelks, and crabs also are captured in trawls. Kemp's ridleys have been documented to interact with bottom trawl fisheries in the Northeast, but estimated annual bycatch was not derived because only 2 takes were observed from 1996 through 2004 (Murray 2008). There is uncertainty of what impacts the total non-TED bottom trawl fisheries may have on Kemp's ridleys (e.g., NMFS 1999).

Flynets are high opening bottom trawls that are typically used to target squid and finfish species that school higher in the water column than typical groundfish (NCDMF 2007). Target species include *Loligo* and *Ilex* squid, Atlantic croaker, weakfish, scup, sea bass, striped bass, and bluefish. Flynets are fished in both nearshore and offshore waters. The nearshore fisheries take place in depths less than 91.4 m and operate year round in the mid-Atlantic depending on the target species. The offshore fisheries take place outside of 91.4 m and operate from Cape Cod, Massachusetts to Cape Hatteras, North Carolina, from September through May depending on target species (NCDMF 2007). Murray (2006) reported loggerhead interactions in flynets during 1994-1998. However, beginning in 2000, observers stopped recording the type of trawl net used during a haul, so the number of sea turtle captures in flynet gear is unknown after 2000. A minimum of 23 interactions occurred in flynets on 27 trips observed (Murray 2006). One trip caught 12 turtles and a second trip caught 8 turtles. None were Kemp's ridleys. However, Kemp's ridleys are taken in other trawl gear in the area (Murray 2006) and an interaction is possible.

Regulations, including but not limited to TEDs, regarding trawl fisheries under state jurisdiction are highly variable. Some states, including Virginia, Maryland, and Florida, maintain offshore areas permanently closed to trawling. The State of Georgia requires the use of NMFS-approved TEDs in all trawl fisheries operating in state waters. South Carolina uses a water-temperature trigger to ensure whelk trawling occurs when sea turtles are less abundant. Texas has closed state waters to shrimping generally from mid-May through mid-July each year since 1981. Additionally, Texas has designated an area that is closed to shrimp trawling offshore of Corpus Christi Fish Pass to the U.S/Mexico border out to 5 nm from December 1 through mid-May. With the exception of the shrimp and summer flounder fisheries, TEDs are not required in most state trawl fisheries.

In Mexico, the shrimp fishery out of Campeche has diminished due to the decline in shrimp abundance (C. Jimenez, INP, personal communication 2006). The decline in shrimp abundance was due to overfishing of juveniles by the artisanal fleet (Gracia 1995) and environmental changes that affected recruitment (Arreguin-Sanchez *et al.* 2004, Ramirez-Rodriguez *et al*. 2006). The fishing fleet has operated in waters adjacent to Tamaulipas and Veracruz. Observers were placed on approximately 5% of the shrimp fishing trips in 2005 and 2006. Although bycatch estimates are not available, no Kemp's ridleys interactions were reported in 2005 and 5 were reported in 2006 (J. Molina, INP, unpublished data). Since 2004, bottom trawl fisheries for fish have not operated in Mexican waters of the Gulf of Mexico (C. Quiroga-Brahms, INP, personal communication, 2009).

Trawls, Top and Midwater

Unlike bottom trawls, top and midwater trawls are designed to fish off the bottom. There are several types including otter trawls and butterfly nets.

Butterfly nets are similar to skimmer trawls, except they are fished off the bottom. Butterfly nets are used in deeper parts of channels, rivers, and canals in Florida and Louisiana. There is minimal use in North Carolina. Butterfly nets are capable of capturing sea turtles, including Kemp's ridleys, as their use overlaps with sea turtle distribution (Epperly *et al.* 2002).

The potential for a U.S. commercial jellyfish fishery exists due to increasing consumer demand in Asia (Hsieh *et al.* 2001). Trawls used to harvest jellyfish are rigged to fish high in the water column, and tow times are likely short due to the abundance of jellyfish (D. Whitaker, South

Carolina Marine Resources Division, personal communication 2003). A trawl sargassum fishery existed in North Carolina; however there is only one vessel permitted and it has not operated since 2001. These fisheries may pose a future threat because the gear would be deployed in areas where Kemp's ridleys are present.

Dredges

The NMFS Northeast Fisheries Observer Program lists three types of dredges for fisheries: hydraulic clam, sea scallops, and other. Within those gear types, scallop, quahog, surf clam, or unknown clams species trips have been observed. Sea turtle interactions have only been recorded on trips targeting sea scallops (H. Haas, NMFS, personal communication, 2009). Dredges are used to harvest blue crab and whelk, but these fisheries occur mostly in state waters and information on sea turtle interactions is lacking.

The Atlantic sea scallop dredge fishery, which operates off the mid-Atlantic coast of the U.S, has been documented to take Kemp's ridleys. Scallop dredges are composed of a heavy steel frame and a bag, made of metal rings and mesh twine, attached to the frame. The gear is fished along the bottom and a dredge with a width of 14.6 m weighs approximately 2,043 kg (4,500 lbs) when rigged. Although turtle interactions have not been observed on the bottom during fishing, the condition of turtles that are brought onboard indicate they are struck and injured or killed by the dredge frame and/or captured in the bag where they may drown or be injured or killed when the catch and heavy gear are dumped on the vessel deck. The first recorded take of a Kemp's ridley in the scallop dredge fishery occurred in 2005. From 1996-2005, loggerheads were the most common species captured in the scallop dredge fishery. In addition to 50 loggerheads, the observer program reported one Kemp's ridley, one green (*Chelonia mydas*), and 22 sea turtles not identified to species. Kemp's ridleys occur in the area where the scallop dredge fishery operates, and two were documented to be taken in sea scallop dredge gear on George's Bank (Murray 2007).

Longline, Pelagic and Demersal

Longlines, both pelagic and bottom, are known to take sea turtles. In the Atlantic, the U.S. pelagic longline fishery primarily targets swordfish, yellowfin tuna, or bigeye tuna in various areas and seasons including the Gulf of Mexico yellowfin tuna fishery, the south Atlantic-Florida east coast to Cape Hatteras swordfish fishery, the mid-Atlantic and New England swordfish and bigeye tuna fishery, the U.S. distant water swordfish fishery, and the Caribbean Islands tuna and swordfish fishery.

Pelagic longline gear is composed of several parts, including a mainline attached to buoys, and gangion lines with attached hooks spaced at certain intervals. Swordfish sets are fished relatively shallow and have few hooks between floats. This same type of gear arrangement is used for mixed target sets. Tuna sets may use a different type of float placed farther apart. Compared with swordfish sets, there may be more hooks between the floats and the hooks are set much deeper in the water column (> 109 meters) during tuna sets.

Kemp's ridleys have been reported captured in the U.S. pelagic longline fishery for tuna and swordfish between 1994 and 2010. The identification of the two earliest reports (1994 and 1997) cannot be confirmed (Johnson *et al.* 1999). A third turtle whose identification was confirmed, was caught in 2006; it was entangled but not hooked, and it was released alive. (Fairfield-Walsh and Garrison 2007). In 2003, during controlled longline gear experiments on the Grand Banks, one area where the traditional pelagic longline fleet operates, one small Kemp's ridley was dipnetted (Watson *et al.* 2004). Another Kemp's ridley was captured by NMFS using surface longlines during a resource assessment cruise by NMFS in the Gulf of Mexico; the hook was removed and the turtle was released alive (NMFS SEFSC unpublished data). During 2008 - 2010, 2 Kemp's ridleys were taken on bottom longline gear during NMFS resource assessment cruises in the Gulf of Mexico; all gear was removed and both were released alive (NMFS SEFSC unpublished data).

In Mexico, the INP monitors the pelagic longline fishery, which targets tuna in the Gulf of Mexico. Between 1994 and 2006, 100% of trips (totaling 4,096) were observed and a total of 11 Kemp's ridleys were incidentally captured, with 9 of them recorded in 2001 (Ramirez and Ania 2000, J. Molina, INP, personal communication 2007). The fleet dedicated to the tuna fishing in the Gulf of Mexico annually makes an average of 375 trips. There are 36 tuna fishing vessels in the Gulf of Mexico according to CONAPESCA (http://www.conapesca.sagarpa.gob.mx), and 100% are observed (J. Molina, INP, personal communication 2007).

The U.S. shark bottom longline fishery is active in the Atlantic and Gulf of Mexico from North Carolina through Texas. Gear varies regionally, but generally is 8-24 km of long monofilament mainline and 500 to 1,500 hooks. Gear is set at sunset and allowed to soak overnight (Hale and Carlson 2007). Observations of the shark-directed bottom longline fishery in the Atlantic Ocean and Gulf of Mexico have been conducted since 1994. From 1994 through 2001, observer coverage was voluntary but beginning with the 2002 fishing season, observer coverage became mandatory under authority of 50 CFR 635.7. For the demersal longline fishery targeting shark, no Kemp's ridleys were recorded from 1994-2002, however 8 unidentified turtles were recorded during the period (Hale and Carlson 2007). From July 2005 through 2010, 413 trips were observed on 112 vessels with a total of 1598 hauls, and no Kemp's ridleys were observed as bycatch.

Currently 213 U.S. fishers are permitted to target sharks (excluding dogfish) in the Atlantic Ocean and Gulf of Mexico, and an additional 260 fishers are permitted to land sharks incidentally. Recent amendments to the Consolidated Atlantic Highly Migratory Species Fishery Management Plan based on updated stock assessments have eliminated the major directed shark fishery in the U.S. Atlantic (NMFS 2007a). The amendments implement a shark research fishery, which allows NMFS to select a limited number of commercial shark vessels on an annual basis to collect life history data and catch data for future stock assessments. Furthermore, the revised measures drastically reduce quotas and retention limits, and modify the authorized species in commercial shark fisheries. The intent of these measures is to reduce effort in this fishery, which may result in a beneficial effect for Kemp's ridleys. Observer coverage is 4-6% in the directed shark fishery and 100% in the research fishery. No Kemp's ridleys have been observed. In the shark directed fishery, loggerheads have been observed taken as follows: 4 in 2007, 1 in 2008, 2 in 2009, and 4 in 2010 (NMFS SEFSC unpublished data).

Due to closures of the large coastal shark fishery, directed shark permit holders have shifted effort to grouper/snapper and tilefish targeted longline sets. NMFS began placing observers on vessels targeting snapper-grouper in 2005. In 2005-2006, observers recorded information from 34 hauls on four (4) trips observed targeting grouper/snapper or grouper/shark in the Gulf of Mexico. Although interactions with loggerhead sea turtles were observed for bottom longline vessels targeting grouper/snapper or grouper/shark mix, no Kemp's ridley sea turtle have been observed caught. However, 18 reported captures were unidentified hardshell turtles (note: hardshell includes all species of marine turtle except *Dermochelys coriacea*). From 2007 through 2010 there were 779 hauls on 40 trips targeting grouper/snapper, grouper/tilefish, and other shallow-water reef fish in the Gulf of Mexico with no observed Kemp's ridley encounters (NMFS SEFSC unpublished data).

Bottom longlines are used in the Gulf of Mexico reef fish fishery, which primarily targets groupers and snappers. The primary gears used by this fishery include longline, electric reel, and handlines. A limited observer program conducted from 1993 through 1995 did not record any sea turtle interactions. NMFS required observer coverage in 2006 for the commercial reef fish fishery operating in the Gulf of Mexico. Since the observer program began, 21 hardshell turtles were observed in 2006 through 2008, including 18 loggerheads. NMFS estimated that 861.1 (95% CI 383.5-1,934.3) hardshell sea turtles (mostly loggerheads) were taken each year in the bottom longline reef fish fishery in the Gulf of Mexico (NMFS 2009a). In 2009-2010, 13 loggerheads were observed, but no Kemp's ridleys (NMFS SEFSC unpublished data).

Bottom longlines are also the primary gear used to target tilefish. The fishery operates almost exclusively at greater than 5.6 km from shore along deepwater canyons. Tilefish are fished along the Atlantic coast from the Gulf of Maine and the Gulf of Mexico. The depths fished are largely determined by water temperature and currents, which indicate tilefish habitat and suitable fishing conditions. Depths range from 128 to 823 m. The mainline can consist of tarred line (rope), cable, or monofilament. Observer coverage of vessels targeting tilefish and deepwater groupers in the Gulf of Mexico indicate no interactions with Kemp's ridley sea turtle to date (Hale and Carlson 2007; Hale *et al.* 2009). Anecdotal information suggests that loggerhead and leatherback sea turtles have been taken by hook in the tilefish bottom longline fishery (C. Bergmann, NMFS, personal communication 2007). Since Kemp's ridleys tend to use mid-Atlantic inshore waters for summer foraging, they are not expected to be foraging in the deep water areas where the tilefish fishery operates, but could be in areas where the fishery operates during migrations. Thus, the possible risk of an interaction is believed to be low.

In Mexico, shark fishing is conducted with small outboard motor (48-75 horse power) boats, approximately 7-7.6 m in length. This fleet operates in waters from 3.6 to 252 m. Larger vessels range in size from 14.3-21.9 m and operate along the Tamaulipas and Veracruz continental shelf and slope at depths ranging from 54 to 252 m. The fishing trips are 8 to 30 days long. DOF (2007) authorized artisanal fishers to use longlines with 500 hooks, 5 m gangions with swivel and snap devices of 20 cm, straight 'J' hooks (64 mm length and 22 mm gap) or circle hooks ($\geq$ 25 mm length and 18 mm gap). The fleet of vessels larger than 14 m and with stationary motors can use a bottom longline with a maximum of 1,000 hooks (one per gangion). Each gangion must be a maximum 5 m in length and with a swivel and snap device no greater than 20 cm. Circle hooks (64 mm length and 22 mm gap) are required for gangions near the surface or when the length of the gangion plus the buoy line is less than 40 m deep. In deep-set gangions, fishers can use any kind of hook as long as it is not larger than the specifications for the circle hooks. Bait varies depending on availability and includes, but is not limited to, the King snake eel (*Ophichthus rex*), little tunny (*Euthynnus alletteratus*), cownose ray (*Rhinoptera bonasus*), and Atlantic Cuttlassfish (*Trichiurus lepturus*). In Veracruz, longlines are fished for up to 12 hours, but are checked every 40 minutes during some months depending on the target species.

Gillnets, Demersal, Sink, and Drift
In the U.S., a detailed summary of gillnet fisheries operating off the Atlantic and Gulf Coasts was presented in NMFS (2001a). However, the dearth of sea turtle mortality data for these fisheries precluded a quantitative analysis of their impact on Kemp's ridley survival. Four

hundred fifty-nine drift gillnet sets in U.S. Federal waters have been observed systematically from 2000-2008. Nearly all sets were located along the Atlantic coast of Florida to North Carolina. During that period, no Kemp's ridleys were observed taken (Garrison 2007, Baremore *et al.* 2007, Passerotti *et al.* 2009). From 2000-2006, 563 vessels reported using gillnets, but it is unknown how many sets or what type of gillnet was employed. The gillnet observer program has continued and expanded into the Gulf of Mexico. One Kemp's ridley was documented captured in the GOM in 2009; it was released alive and uninjured (Passerotti et al. 2010). In 2010, a total of 295 sets comprising various gillnet fisheries was observed with no sea turtle interactions (NMFS SEFSC unpublished data).

Many states (South Carolina, Georgia, Florida, Louisiana, and Texas) have banned gillnets, but there remain active fisheries in other states and in Federal waters. North Carolina monitors the shallow water gillnet fishery targeting southern flounder in Pamlico Sound for sea turtle interactions from September through December each year. Observer coverage varies but does not drop below 2%. From 2000 through 2004, 37 live and 46 dead Kemp's ridleys were estimated to be taken in the fishery (Price 2004), from 2005-2007, 4 Kemp's ridley takes with no mortalities were estimated (Price 2008). The impact of some of these state gillnet fisheries, particularly those using large mesh nets, which can lead to entanglement and drowning, could be significant. In the spring of 2000, approximately 280 sea turtles stranded dead over a 2-week period when the monkfish fishery was operating nearshore. Several of the dead turtles were entangled in large mesh gillnets. NMFS determined that the likely cause of the mortalities was due to the monkfish fishery, and enacted seasonally-adjusted closures for large-mesh gillnets in Federal waters off the coasts of North Carolina and Virginia to reduce the likelihood of sea turtle interactions with those fisheries (67 Federal Register 71895, December 3, 2002). North Carolina and Virginia both enacted their own restrictions on large-mesh gillnets in state waters beginning in 2005 and 2006 to further address the issue.

In July 1995, one Kemp's ridley was observed dead in a drift gillnet deployed for swordfish off Massachusetts. From 1996 through 2005, NMFS observed 6,705 gillnet trips in the mid-Atlantic, south of Cape Cod. Eight Kemp's ridleys ranging from ~28-44 cm SCL were observed captured, mostly in the vicinity of Cape Hatteras; most turtles observed in this fishery were dead (Murray 2009). Because the catch rates were so low and were zero for many years, Kemp's ridley bycatch was not estimated for the fishery.

In Mexico, coastal fisheries in Tamaulipas and Veracruz use surface gillnets fixed or drifting with different mesh sizes, the most common are 3-6 inches (DOF 2005). During the spring migrations of the Atlantic Spanish mackerel (*Scomberomorus maculates*), the fisheries intensify in depths less than 73 m in Tamaulipas (April) and Veracruz (March). This fishery uses 3.5 and 4 inch (9 and 10 cm) mesh, 400-1,000 m length and 10-12 m height. The artisanal shark fisheries use gillnets of different mesh sizes and lengths, as well as longlines. DOF (2007) allows vessels to fish one gillnet with a maximum length of 750 m, 50 mesh height, and a minimum mesh size of 6 inches (152.4 mm). Shark fishing consists of small boats that operate near the coast in depths less than 20 fathoms during the "corridas" (e.g., autumn-winter migrations or runs). CONAPESCA (http://www.conapesca.sagarpa.gob.mx) recorded 485 boats of which the majority of the fleet (60%) was located in the municipalities of Matamoros and San Fernando, both north of the nesting beach of Rancho Nuevo, with less of the fleet operating out of Soto la Marina, Aldama, and Tampico. The artisanal fleet of Veracruz has 439 boats (CONAPESCA http://www.conapesca.sagarpa.gob.mx) and comprises more than 90% of the fishing effort.

Gillnet fisheries in Mexico are not systematically monitored for sea turtle bycatch. However, 17 subadult and 14 adult Kemp's ridleys were reported to be caught in gillnet gear from 1966-1991 (INP unpublished data). In 2005, the shark drift gillnet fishery operated adjacent to Rancho Nuevo during the nesting season, and adult turtles were recorded stranded on the beach. Enforcement stepped up efforts to warn fishers to move out of the area, and strandings declined (J.Pena, GPZ, personal communication, 2005).

Pound nets

Pound nets are fixed gear composed of a series of poles driven into the bottom on which netting is suspended. Pound nets basically operate like a trap and are constructed with three distinct segments: the pound, which is the enclosed end with a netting floor where the fish entrapment takes place; the heart, which is a net in the shape of a heart that aids in funneling the fish into the pound; and the leader, which is a long straight net that leads the fish offshore toward the pound (see Epperly *et al*. 2007 for a diagram).

Sea turtles trapped in the pound are able to surface and breathe and are usually safe from injury. They often feed on the fishes trapped with them. Entrapped turtles may be released easily when the fishers pull the nets (Mansfield *et al*. 2002). However, sea turtles are documented to entangle in or impinge on the leader and pound, resulting in injury or death by drowning. Large mesh (greater than 12-inch [30.5-cm] stretch) leaders may act as a gillnet, entangling sea turtles by the head or fore flippers (Bellmund *et al*. 1987). Chesapeake Bay appears to be the primary location where pound nets with large mesh leaders are used (NMFS 2004), and the problem is exacerbated by high currents in the area. In the early 1980s, 3-33% of all sea turtle mortalities in Virginia were attributed to large mesh leaders in the Chesapeake Bay (Bellmund *et al*. 1987). At that time, 173 such nets were being fished. However, the fishery has declined since then and in 2000 only 20 pound nets with large mesh leaders remained in the Virginia Chesapeake Bay (Mansfield *et al*. 2002). From 2002-2005, NMFS monitored the top visible portion of the pound net leaders in Chesapeake Bay (with varying levels of observer effort), and documented a total of 14 Kemp's ridley entanglements (12 dead, 2 alive) and 2 impingements (both alive) (NMFS unpublished data). A long-term, index abundance survey has yielded 1-42 Kemp's ridleys each year collected from pound nets in Pamlico and Core Sounds, North Carolina (Epperly *et al*. 2007, NMFS SEFSC unpublished data). Catch rates appear to be increasing: 14 Kemp's ridleys were observed captured in this study during 1995-1997, 54 were observed during 2001-2003, and with less observer effort, 82 were observed during 2007-2009 (Epperly *et al*. 2007, NMFS SEFSC unpublished data). One mortality was observed in the pound section (Epperly *et al*. 2007). Kemp's ridleys also are found in the pound section of the pound net gear set in Long Island Sound, New York (Morreale and Standora 1998). Turtles have not exhibited any signs of injury or trauma from pound net captures in New York (S. Morreale, Cornell University, personal communication 2009).

Weirs have also been documented to take sea turtles. Weirs are similar to poundnets. They consist of a fence of long stakes driven into the ground with nets arranged in a circle or heart shape. The bottom stake rises just above low tide level and is fastened to a top stake that rises several feet above high water. In 2007, a dead Kemp's ridley was observed taken in a weir operating in Massachusetts (NMFS unpublished data).

In Mexico, pound nets are not fished in the Gulf of Mexico (C. Jimenez, INP, personal communication 2009).

Pot and Traps

Pots and traps are commonly used in the capture of crabs, lobster, whelk, eels, and fish. These traps vary in size and configuration and are generally attached to a surface float by means of a line leading to the trap. Turtles can become entangled in trap lines below the surface of the water and subsequently drown. In other instances, stranded turtles have been recovered entangled in trap lines with the trap in tow. Kemp's ridleys may be vulnerable to entanglement in trap lines because of their attraction to, or attempts to feed on, species caught in the traps and epibionts (living organisms) growing on traps, trap lines, and floats. Twelve Kemp's ridleys were found entangled in spiny lobster or crab trap/pot gear, notably all in Florida with most occurring in the Florida Keys and Gulf Coast (NMFS unpublished data). No Kemp's ridleys have been documented entangled in pot/trap gear in the Northeast lobster, crab, whelk or other pot fisheries (NMFS unpublished data). There are no directed observer programs for pot/trap fisheries in the U.S., and documented entanglements are opportunistic or via stranded turtles. No fishery-wide estimates exist for bycatch in these fisheries.

Haul Seines

Kemp's ridleys have been documented taken in long haul seines in North Carolina (NMFS 2001a, N.C. Marine Fisheries Commission Sea Turtle Advisory Committee 2006). Seine lengths can be up to 2 km in length and deployment requires two boats to herd and then encircle the fish; a haul may last much of the day. Fishers pull the seine net ends together and take fish out of the diminishing circle of net. Although a haul seine can be very long and pulled for many hours, much of the time the animals are herded in front of the net and a turtle could surface to breathe. Thus, it is not likely that mortality would result. However, a turtle could possibly be captured in the tailbag part of the net and drown, but a lethal take of a Kemp's ridley has not been observed.

Channel Net

Channel nets are used only in North Carolina (15-20 fishers) and South Carolina (< 60 licenses). Channel nets have been documented to catch turtles, including Kemp's ridleys (Epperly *et al*. 2002). Channel nets set in South Carolina are required to be equipped with TEDs as a result of the documentation of turtle takes there. Channel nets are fished and checked frequently, thus, mortality is likely to be low.

Purse Seine

A purse seine is a floated and weighted encircling net (mesh size from 7.6-10.9 cm) that is closed by means of a purse line (a drawstring) threaded through rings attached to the leaded bottom of the net. At the end of the set, a heavy weight is deployed that pulls the purse line tight, closing the bottom of the net. The net can be between 869 to 1,646 m long. Purse seine gear is used to target pelagic species such as menhaden, mackerel, and tuna. Similar to midwater trawl gear, purse seine gear has a negligible catch of demersal species, as the gear is designed to fish in the upper layers of the water column for fish schooling at or near the surface of the ocean. In addition, as opposed to trawl gear, purse seine gear is not towed through the water column, giving demersal species the opportunity to escape. If they are caught, air breathers, such as the Kemp's ridley, should be able to reach the surface. No Kemp's ridleys have been documented in this gear type and the potential for take is considered low.

Hook & Line (Commercial)

Kemp's ridleys are known to bite a baited hook, frequently ingesting the hook. Hooked turtles have been reported from commercial fishers fishing for reef fish and sharks with both single rigs and bottom longlines (TEWG 2000). The vertical line component of the GOM reef fish fishery was observed July 2006-December 2008 (197 trips) and no Kemp's ridleys were documented (NMFS 2009b). State managed fisheries have documented Kemp's ridley takes in several hook and line fisheries in the Atlantic and Gulf of Mexico (NMFS 2001a).

Fisheries may include a commercial hook and line component (e.g., Atlantic Highly Migratory Species Fisheries, Northeast Multispecies fishery). Adequate at-sea sampling is necessary to derive bycatch estimates for the hook and line component. The hook and line component of the Northeast Multispecies fishery (NMFS 2001c) has been observed and no Kemp's ridley takes have been documented. However, this may be a function of lack of seasonal overlap between fishing effort and Kemp's distribution. The multispecies fishery occurs mostly in northeastern U.S. waters, with concentrations and occurrence of species (and therefore fishing effort) dwindling south of Georges Bank and Hudson Canyon. Sea turtles are present in the more northern waters in the summer through early fall, when water temperatures are well within their thermal tolerance. The highest fishery effort occurs in April, followed by May and June. This overlap reduces the fishery interactions with sea turtles during the warmer months (approximately June to November).

Hook & Line (Recreational)
Hooked turtles have been reported by the public fishing from boats, piers, and the beach (Cannon *et al.* 1994, TEWG 2000). From 1980 through 1992, 118 Kemp's ridleys were documented associated with hook and line gear along the Texas coast (Cannon *et al.* 1994). Most of these interactions resulted in minor injuries; however some required veterinary care or were dead (Cannon *et al.* 1994). In Texas, many Kemp's ridleys are documented caught in hook and line gear from piers during the early spring when temperatures in nearshore waters are warmer (D. Shaver, PAIS, personal communication 2009). Empirical data indicate Kemp's ridleys are caught by recreational hook and line fisheries, but there are no estimates of total take. Some of these animals have stranded dead, possibly due to the interaction (TEWG 2000). From 1980 to 2006, 354 Kemp's ridleys stranded along the U.S. Atlantic and Gulf of Mexico coast with evidence of interactions with recreational or commercial hook and line fisheries, based on the internal and/or external presence of hook and line gear (NMFS STSSN unpublished data). In 2006, the Marine Recreational Fishery Statistics Survey included 3 questions related to sea turtles in their intercept interviews of anglers fishing in the Gulf of Mexico, excluding Texas. An analysis of those responses indicates an estimated 27,291 (± 28,128) hardshell turtles were captured and released alive (NMFS unpublished data: e-mail from D. Van Voorhees, NMFS, to J. Lee, NMFS, May 19, 2009). Evidence of interactions specifically with Kemp's ridleys has been reported along the U.S. Atlantic coast and off Texas (NMFS unpublished data). From 2004-2006, eight juvenile Kemp's ridleys were recorded caught in hook and line gear along the upper Texas coast (TAMU unpublished data 2008).

In Mexico, there are no records of stranded turtles associated with hook and line, but interactions are likely.

H.2.2. Resource Use: Non Fisheries

Illegal Harvest
Illegal harvest of Kemp's ridleys in the marine environment is uncommon in the U.S. and Mexico. Though it occurs, poaching of adults and juveniles for food has decreased dramatically since the project began at Rancho Nuevo, Mexico. This is due, in part, to the educational

programs that have raised awareness among the local populace as well as the presence of researchers, military personnel, and enforcement officers during the nesting season.

Industrial Plant Intake and Entrainment
Kemp's ridleys have been documented to be taken during power plant operations generally as a result of entrainment in or impingement on the intake structures that transport water to cool plant condensers and auxiliary systems. Intake structures include bar racks, traveling screens, and seawater pump components. Water is drawn from the intake canal through the bar racks, through the traveling screens, into the pumps. Intake bar racks prevent trash and large debris carried by the seawater from entering the intake structure. Entrapment in the intake canal can result in direct negative impacts on turtles in a number of ways: drowning in the intake pipes, injury sustained in the pipes and the canal, debilitation of condition due to long entrapment, exposure to predators in the intake canal, injury and stress sustained during capture, and impingement and drowning on barrier nets and on the intake racks.

Under Section 7 of the ESA, NMFS has consulted with the Nuclear Regulatory Commission on the activities of five power plants in the Atlantic and the possible impacts to sea turtles. St. Lucie Power Plant on Hutchinson Island, Florida, has documented over 6,000 sea turtles entrapped at their intake canal between 1976 through 1999 (NMFS 2001b). Less than 40 of these were Kemp's ridleys. The majority of turtles entering the canal are in good condition and few die (3.0%) as a result of extensive efforts to capture and safely release entrained turtles on a daily basis. Operations at the Brunswick, North Carolina, power plant resulted in 101 live and 22 lethal sea turtle takes from 1986 through 1996. Of these takes, 5 live and 1 lethal take were Kemp's ridley (NMFS 2000). In 1998, the Crystal River Energy Complex, located adjacent to the Cedar Keys, Florida, foraging grounds, documented a total of 40 sea turtles entrapped, of which 37 were Kemp's ridleys (NMFS 2002b). In New Jersey, Oyster Creek Nuclear Generating Station has documented 28 (8 lethal) Kemp's ridley takes since 2000 (NMFS 2005b).

Boat Strikes
Propeller and collision injuries from boats and ships are common in sea turtles. From 1997 to 2001, 12.7% of all stranded turtles were documented as having sustained injuries consistent with propeller wounds or collision, although it is not known what proportion of these injuries were post or ante-mortem (NMFS STSSN, unpublished data). Boat-related injuries are recorded at higher frequencies in areas of high boating traffic. Witzell and Schmid (2004) reported 3 out of 178 Kemp's ridley captures in Gullivan Bay/Ten Thousand Islands exhibited obvious propeller scarring. One turtle with deep lacerations in the posterior carapace was later recaptured with the wounds healing and a healthy appearance.

From 1996 through 2000, the number of adult nesting females recorded with apparent propeller wounds was 99 for Rancho Nuevo, 25 for Tepehuajes, and 4 for Playa Dos (GPZ unpublished data). During 2009, a nesting Kemp's ridley was found on South Padre Island with apparent earlier boat strike injuries that were so severe that the turtle had to be euthanized (J. George, Sea Turtle, Inc. personal communication 2009).

H.2.3. Construction

Beach Nourishment
Beach nourishment activities may affect Kemp's ridleys in the marine environment. Inlet maintenance involves removing sand for navigational purposes and often involves dredging and

disposal of the material onto a nearby beach. Inlet sand bypass systems are engineered to allow sand that has been restricted from its normal movement pattern by a man-made structure (jetty or artificially deepened channel) to be placed on the downdrift beach. These systems usually consist of a large depression constructed near the end of a jetty or groin on the updrift side of an inlet. As sand migrates past the structure, it collects in the sink. When the sink is full, sand is pumped to the downdrift beach with a hydraulic dredge. Impacts in the marine environment from beach nourishment are generally related to the associated vessel traffic and dredge activities that can injure or kill sea turtles.

Dredging

The construction and maintenance of Federal navigation channels has been identified as a potentially significant source of sea turtle mortality. Pipeline, clamshell, and hopper dredges are all used to dredge and maintain navigation channels and pose varying levels of risk for sea turtles. Of particular concern are hopper dredges, which are frequently used in ocean channels and sometimes in harbor channels and offshore borrow areas. Hopper dredges move relatively rapidly and can entrain and kill sea turtles, presumably as the drag arm of the moving dredge overtakes the slower moving or sedentary turtle. Dredging also can destroy or degrade habitat. Dredging would likely cause indirect effects on sea turtles by reducing prey species through the alteration of the existing biotic assemblages such as crabs and mollusks, both important prey species for the Kemp's ridley. Another indirect effect of dredging is the increased watercraft traffic associated with deepened channels.

The Army Corps of Engineers (ACOE) maintains navigable harbors throughout the northeastern and southeastern U.S. Projects include dredging existing channels and providing new and safe access to waters. Kemp's ridleys are taken during dredging and maintenance of channels (http://el.erdc.usace.army.mil/seaturtles/index.cfm). Activities include blasting, disposal of dredged material, increased vessel traffic, and relocation of turtles by means of trawl nets. NMFS has consulted under Section 7 of the ESA on numerous projects, which are anticipated to take Kemp's ridleys, throughout the Gulf of Mexico and along the U.S. Atlantic coast (for example see NMFS 2005a).

The proposed deepening of navigation channels could also affect the degree of exposure of Kemp's ridleys to contaminants. A well documented effect of dredging activities is the resuspension of sediments, thus the potential for exposure to contaminated sediments would increase with dredging. In 1995, a study was performed to evaluate the degree of resuspension of sediment particles into the water column from dredging activities (ACOE 1999). This study took place in the Arthur Kill at the Howland Hook Marine Terminal, New Jersey, an area with contaminated clay sediments and high current velocities (i.e., potential for suspended sediments to be transported great distances). The study concluded that the range of transported suspended solids in the water column after dredging operations was less than 152.4 m from the dredge. The areas most likely to experience an increase in biological exposure to contaminants due to dredging activities are within 152.4 m of the navigation channels in Newark Bay, New Jersey—Arthur Kill, Kill van Kull, and Bay Ridge Channel (ACOE 1999). These regions are the most contaminated within the Harbor Complex and also contain the highest proportions of fine grain material in the sediment.

Because turtles forage on benthic invertebrates and vegetation, in which contaminants accumulate primarily from the sediment rather than from the water column, suspension of contaminants in the water column during dredging activities is not expected to increase the turtles' exposure significantly (ACOE 1999). However, suspension of contaminated sediments will subject sea turtles to direct physical contact with these toxics. Loggerheads have consistently higher levels of PCBs (Polychlorinated biphenyl) and DDE (1,1-dichloro-2, 2-bis(p-chlorophenyl)ethylene) than green sea turtles, and it has been hypothesized that the variation is due to dietary differences (George 1997). Little is known about the effect of chemical pollutants on sea turtles, but based on knowledge of the effects in other organisms it is possible that pollutants can cause immunosuppression, which could lead to disease later in life.

Oil, Gas, and Liquid Natural Gas Exploration, Development, and Removal
The Gulf of Mexico experiences a high density of offshore oil and gas platforms with chronic low-level spills and infrequent large spills. There are almost 4,000 active platforms in U.S. jurisdictional waters (MMS 2000). Kemp's ridleys could be impacted by the degradation of water quality resulting from operational discharges, including oil spills and oil-spill response activities.

In the spring of 2010, the DWH offshore deepwater oil rig sank in the Gulf of Mexico as a result of an explosion. There was an uncontrolled release of oil from the well at the beginning of sea turtle nesting season. The most highly impacted coastal areas included eastern Louisiana, Mississippi, Alabama, and northwestern Florida. The oil was tracked in the water column in several directions and to several areas, but by August of 2010, the oil was diluted. While scientists are just beginning to understand the long term effects of this disaster, the short term effects were minimized by the coordinated response of Federal, state and local entities. The U.S. Federal natural resource trust agencies, working with the States counterpart agencies implemented Area Contingency Plans and initated a Natural Resource Damage Assessment and Restoration (NRDAR) process to assess natural resource injuries caused by the spill, and to identifiy appropriate restoration actions. The assessment phase may continue for several years, as will the restoration phase.

The primary feeding grounds for adult Kemp's ridley turtles in the northern and southern Gulf of Mexico are near major areas of nearshore and offshore oil production. Their risk of being exposed to oil slicks in nearshore waters is reasonably high since adults reside in coastal regions of the Gulf of Mexico and congregate seasonally in certain areas like the mouth of the Mississippi River, the Campeche Banks, and off the beaches of Tamaulipas, Mexico, and Texas (Carr 1963, Prichard 1969, Pritchard and Marquez 1973, Shaver *et al.* 2005b, Shaver 2006a, Shaver and Rubio 2008).

Sea turtles are vulnerable to the effects of oil at all life stages—eggs, post-hatchlings, juveniles, and adults in nearshore waters. Several aspects of sea turtle biology and behavior place them at particular risk, including a lack of avoidance behavior, indiscriminate feeding in convergence zones, and large pre-dive inhalations. Oil effects on turtles include increased egg mortality and developmental defects, direct mortality due to oiling in hatchlings, juveniles, and adults; and negative impacts to the skin, blood, digestive and immune systems, and salt glands (Shigenaka *et al*. 2003). Swimming sea turtles can directly contact oil if they emerge to breathe in a slick, and may further prolong their contact with the oil if they passively drift with spills. Other sea turtles are known to ingest tar balls and oil. The sea turtles apparently do not recognize or avoid oil slicks nor are they able to distinguish tar balls from regular food items (Witham 1983, Van Vleet and Pauly 1987, Witherington 1994).

Oil platforms are removed by explosives when they are no longer operable. Sea turtles have been observed in proximity to oil and gas platforms and there is evidence that they may be temporary or permanent residents (Gitschlag and Renaud 1989). Preliminary tests by O'Keefe and Young (1984) showed that shock waves from explosives injure lungs and other organs of turtles.

In the U.S., explosives to remove oil and gas platforms during 1986 caused at least 51 sea turtle strandings (including several Kemp's ridleys). Over a 1-month period in 1986, 22 explosions occurred associated with offshore drilling. During this period and the following 2 weeks, 51 turtles, the majority Kemp's ridleys, stranded on beaches within a 54 km radius (Klima *et al*. 1988). Of eight sea turtles deliberately exposed to underwater explosions at distances varying between 229 m and 915 m from the detonation site, five (including 2 Kemp's ridleys) were rendered unconscious (Klima *et al*. 1988). An intensive observer program was initiated in 1987 to prevent subsequent occurrences (Gitschlag and Renaud 1989, Richardson 1989, Gitschlag 1992, Shaver 1998b). From 1987 through April 2003, dead or injured turtles were recovered on beaches adjacent to rig removal sites suggesting a positive relationship between strandings and offshore explosions, although no Kemp's ridleys were identified (G. Gitschlag, NMFS, personal communication 2003).

Seismic surveys conducted during oil and gas exploration in the marine environment may also impact sea turtles. The potential impacts of the seismic surveys would be primarily a result of the operation of airguns, although multi-beam sonar and sub-bottom profilers are also operated. Impacts may include increased marine noise and resultant avoidance behavior by sea turtles. Protection measures designed to mitigate the potential environmental impacts should include marine species observers to alert surveyors to the presence of protected species and the use of "ramp-up" (i.e., slowly increasing sonar output) procedures when protected species are observed during operations (NSF 2007).

H.2.4. Ecosystem Alterations

Trophic Changes from Fishing

Anthropogenic disruptions of marine communities have not been well studied and even fewer studies have been focused on the effects of these disruptions on sea turtles. Seney (2003) analyzed the diet of Kemp's ridleys in Virginia from 1987 to 2002, and found that blue crabs and spider crabs were key components of their diet. Seney (2003) noted the appearance of hermit crabs, purse crabs, and fish in gut contents of Kemp's ridleys sampled in Virginia during 2000-2002 and concluded that this could be due to the small sample sizes in earlier years, or it may suggest that Chesapeake Bay blue crab declines (Lipcius and Stockhausen 2002) are beginning to affect the Kemp's ridley diet. Blue crab spawning stock, larval abundance, and postlarval recruitment were significantly lower during 1992-1999 than during 1985-1991 in the lower Chesapeake Bay. Fishing pressure and natural mortality are thought to be the major cause of the diminished blue crab stock. Seney (2003) hypothesized the decrease in crab abundance and availability may affect the Kemp's ridley diet.

Trophic Changes from Benthic Habitat Alteration

Benthic habitat alteration by mobile fishing gear, especially trawls and dredges, constitutes a globally significant physical disturbance to the marine environment and has significant effects on marine biodiversity (Watling and Norse 1998). The National Research Council (1994) found that habitat alteration by fishing activities is perhaps the least understood of the important environmental effects of fishing. They reviewed the known research on effects of bottom trawl and dredge fishing on the benthic habitat (National Research Council 2002). Studies indicate that trawling and dredging reduce habitat complexity, change the species structure composition in benthic communities, and reduce the productivity of benthic habitats. Indirect effects include changing the nutrient exchange rate between sediment and water column, disrupting water purification, substrate stabilization, and structure formation by directly removing those organisms responsible for such functions in the benthic habitat, and increasing organisms' susceptibility to other stressors such as predation and hypoxia by removing physical structures.

The effects of benthic habitat alteration on Kemp's ridley prey abundance and distribution, and the effects of these potential changes on Kemp's ridley populations have not been determined, but are of concern.

Dams and Water Diversion

Dams and water diversion change natural hydrologic features. Freshwater inflows to estuaries are required for various life stages of Kemp's ridley prey species, which are primarily crustaceans. The Mississippi River outflow region is probably the most productive Kemp's ridley habitat within its range. Reduced flow and the alteration of flow characteristics as a result of engineered changes to the Mississippi River system have significantly altered the nature of the northern Gulf of Mexico estuaries and nearshore outflow waters.

TPWD reports that blue crabs favor different salt water regimes, depending upon life stage and sex. Mating occurs in low salinity waters, while spawning occurs in high salinity waters. During non-reproductive stages, large male crabs prefer low salinity water, and females prefer high salinity water. Generally, blue crab production has been highest in the bays that receive the most fresh water and lowest in those that receive the least (Longley 1994). In Texas, the blue crab population has improved with improved regulations for commercial crabbing, license limitations and buybacks, and the mandatory use of Bycatch Reduction Devices (BRDs) by the shrimp trawling fleet. However, this trend is highly variable (J. Tolan, TPWD, personal communication 2005).

As human populations increase in Texas and other coastal states, the demand for freshwater will also increase. Reduction in the amount of freshwater that an estuary receives may disrupt part of the life cycle of prey species of the Kemp's ridley. In addition, the increased pollution of estuarine waters from agricultural, industrial, and domestic discharges may indirectly affect the Kemp's ridley sea turtle. These discharges may have either direct effects upon the prey species by reducing their health, fitness, or mortality rates, or indirect impacts upon these prey species' habitat through degradation of sea grass pastures (Plotkin 1995).

In Florida, freshwater flow is altered by canals constructed to drain wetlands for development. These canal systems may result in too much freshwater flowing into some estuaries while at the same time resulting in too little freshwater flowing into other estuarine areas. Browder *et al.*, (1986) found significant decreases in abundance of macroinvertebrates, including blue crabs, in Florida bays affected by canal discharge.

Runoff, Harmful Algal Blooms, and Hypoxia

Eutrophication is a condition in aquatic ecosystems where high nutrient concentrations can stimulate harmful algal blooms (HABs). Human activities can greatly accelerate eutrophication by increasing the rate at which nutrients and organic substances enter aquatic ecosystems from their surrounding watersheds. Agricultural runoff, urban runoff, leaking septic systems, sewage discharges, and similar sources can increase the flow of nutrients and organic substances into aquatic systems. In the Mexican portion of the Gulf, practically all the coastal populations discharge their domestic waste into the rivers, estuaries, coastal lagoons and the sea without any treatment. Eutrophication caused by excessive nutrient pollution in coastal waters can affect sea turtles both directly and indirectly (Milton and Lutz 2003).

Red tides and HABs cloud the water and block sunlight, causing underwater seagrasses to die. Secondly, when the algae die and decompose, oxygen is used up. This is a concern because dissolved oxygen in the water is essential to most organisms living in the water, including crabs, which are prey items for Kemp's ridleys. Gulf of Mexico red tides as well as the increasing number and area of anoxic coastal dead zones due to agricultural run off in the Mississippi River outflow are killing benthic invertebrates at an alarming rate. The dead zones in estuaries, during the summer heat, once known as 'Jubilees,' are clearly increasing in number, area, and duration (D. Owens, College of Charleston, personal communication 2009). The presence of HABs also can result in increased levels of ammonia and toxins, including tumor promoters and immunosuppressants (Osborne *et al*. 2001). The effects of large-scale eutrophication on resident sea turtle populations currently are unknown because of the lack of long-term in-water population studies in affected areas (Milton and Lutz 2003).

Red tide and HAB events have occurred with increasing frequency throughout the range of the Kemp's ridley. Heavy blooms not only kill important prey species, but may also cause mortalities in Kemp's ridleys as well, although these events are sporadic. Although mortalities related to red tide have not been documented in waters adjacent to nesting beaches in Texas and Mexico, red tides and HABs could affect Kemp's ridleys in foraging areas. Red tide and HAB events should continue to be monitored.

A hypoxic zone develops in bottom waters off Louisiana each summer (Renaud 1985), sometimes extending up to 20,000 km^2 (Craig *et al.* 2001). The hypoxic zone does not extend into Texas each year, but can reach the upper Texas coast in some years (M. Ray, TPWD, personal communication 2009). Hypoxic waters generally occur in shallow water (5-30 m) from 5-30 km from shore, but have been recorded in deeper water further offshore. This hypoxic zone is caused by nitrogen pollution from agriculture, municipal waste treatment, and other human activities. Hypoxia conditions result in fewer benthic fauna such as shrimp and other crustaceans that are a prey source for the Kemp's ridley. Aerial surveys indicate an absence of sea turtles in areas where hypoxia is intense (Craig *et al.* 2001). Kemp's ridleys are unlikely to forage and inhabit the hypoxic area for any length of time, due to the reduced abundance of food (McDaniel *et al.* 2000).

Sand Mining
Historically, sea turtle takes associated with sand mining activities for beach restoration and constrution, conducted using hopper dredges, have been few compared to channel dredging. Along the U.S. Atlantic coast, 11 loggerheads were taken from 1997-1999 at sand mining sites off Myrtle Beach, South Carolina. In North Carolina, two Kemp's ridleys were taken in a single day at the Bogue Banks Restoration Project borrow site on December 21, 2001, apparently attracted to remains of an artificial, tire reef, and another Kemp's ridley was taken on April 11, 2002. There are no instances of takes yet recorded for sand mining activities in the Gulf of Mexico; these activities have been limited, sometimes have not been reported to NMFS, and it is not known if observers have been present. However, NMFS expects that future takes will occur

in association with hopper dredge sand mining activities in the Gulf of Mexico. NMFS anticipates 20 Kemp's ridleys injured or killed per year (includes the hopper dredge activity).

In Mexico, sand mining does not occur on the Tamaulipas and Veracruz coast, but may be a future concern.

H.2.5. Pollution

Marine Debris Ingestion and Entanglement
Marine debris in the Gulf of Mexico and Atlantic Ocean constitutes an increasingly serious threat to sea turtles of all ages and species. Ingestion of plastic, rubber, fishing line and hooks, tar, string, Styrofoam, epoxy, and aluminum has been documented in Kemp's ridley turtles (Shaver 1991, D. Shaver, PAIS, personal communication 2004, Werner 1994). However, debris ingestion in Kemp's ridleys is thought to be less severe than other sea turtle species because they consume more active prey and are less likely to ingest debris (Bjorndal *et al.* 1994) or they forage in areas where winds and currents do not concentrate marine debris (Witzell and Schmid 2005). Digestive tract impaction or toxic absorption are the two major risks to sea turtles from marine debris (Balazs 1985, P. Lutz, Florida Atlantic University, personal communication 2004). Carr (1987) noted that areas of concentration for pelagic phase young sea turtles are convergence zones, which increase the likelihood of ingestion of persistent debris that also concentrates in these areas.

Kemp's ridley turtles have been documented stranded in Texas and elsewhere in the U.S. entangled in plastics, monofilament, discarded netting, and many other waste items (Plotkin and Amos 1988, D. Shaver, PAIS, personal communication 2005). Entanglement can lead to death, injury, mutilation, starvation, and increased susceptibility to predation.

Oil, Fuel, Tar, and Chemical
The Gulf is an area of high-density offshore oil extraction with chronic, low-level spills and occasional massive spills (such as the Ixtoc I oil well blowout and fire in the Bay of Campeche in 1979, the explosion and destruction of a loaded supertanker, the Mega Borg, near Galveston in 1990, and the DWH rig explosion and massive oil spill in 2010).

The two primary feeding grounds for adults in the northern and southern Gulf of Mexico are both near major areas of nearshore and offshore oil exploration and production. The nesting beach at Rancho Nuevo is also vulnerable and was affected by the Ixtoc I oil spill in 1979. The spill reached the nesting beach after the nesting season when adults had returned or were returning to their feeding grounds. It is unknown how the adult turtles using the Bay of Campeche fared. It is possible that high post-hatchling mortality occurred that year in the open Gulf of Mexico as a result of the floating oil. Laboratory studies on the effects of oil on sea turtles revealed skin changes, decreased blood glucose, and increased white blood cell counts (Vargo *et al*. 1986, Lutz and Lutcavage 1989).

Stranded Kemp's ridley turtles have been documented in Texas with ingested tar or tar on their bodies (Shaver 1991, D. Shaver, PAIS, personal communication 2004). No oiled sea turtles in Texas were recorded as a result of the DWH event in 2010 (NMFS unpublished data). In 1983, approximately 90 heavily-oiled yearling Kemp's ridleys were found stranded on beaches of Texas (Fontaine *et al.* 1989b). Juvenile greens have been found with their oral cavities occluded by tar (Witham 1978). After the 1979 Ixtoc spill in the Gulf of Mexico, 5 dead, heavily-oiled, juvenile green sea turtles washed up on Padre and Mustang Islands, as well as 2 oiled green sea turtle carcasses and 1 oiled young Kemp's ridley carcass that were found in the Laguna Madre (Rabalais and Rabalais 1980). Necropsies on the 3 turtles from the Laguna Madre did not positively identify the cause of death. However oil was found in the mouth and esophagus, and all three had evidence of petroleum hydrocarbons in lung, esophageal, intestinal, liver and kidney tissues, and were in poor body condition. Tissue chemical analysis revealed chronic oil exposure and it may have been this prolonged exposure that led to poor body condition, thus contributing to their death (Hall *et al*. 1983). Oiled juvenile green sea turtles have demonstrated signs of eye irritation (Petrae 1995).

Oil-covered hatchlings of other species have been found stranded on beaches (Diaz-Piferrer 1962, Rutzler and Sterrer, 1970, Witham 1978). Most reports of oiled hatchlings come from convergence zones where oil/tar aggregates along with smaller sea turtles (Milton *et al*. 2003). Hatchlings and post-hatchlings ingest tar in Sargassum. Sixty-five of 103 post-hatchling loggerheads in convergence zones off Florida's east coast were found with tar in the mouth, esophagus or stomach (Loehefener *et al* 1989). Thirty-four percent of post-hatchlings captured in Sargassum off the Florida coast had tar in the mouth or esophagus and more than 50% had tar caked in their jaws (Witherington 1994).

Low Frequency Noise Pollution

In some parts of the world, underwater noise levels have increased dramatically in recent decades due to anthropogenic sources, such as commercial, industrial, and recreational maritime activities. Notably, a predominant component of sounds from these sources is from low frequencies, which travel the farthest and persist longer in the marine environment. Currently, this type of noise may be a concern for sea turtles because their hearing is confined to low frequencies (Ridgway *et al*. 1969, Bartol *et al*. 1999). Furthermore, sea turtles aggregate in coastal areas where human activity, and therefore anthropogenic disturbance and underwater noise, is greatly heightened. It is possible that continued increases in anthropogenic noise could have adverse effects on sea turtle biology, short-term behavior, and longer-term health.

Many studies have linked anthropogenic noise to adverse effects on the natural ecology of marine organisms. Among the higher vertebrates, it has been shown that bowhead whales exhibit strong avoidance reactions to oil drilling sound (Malme *et al*. 1983) and to seismic exploration noises (Richardson *et al*. 1986). In addition, whales decrease their call rates (Lesage *et al*. 1999) or stopped vocalizing (Bowles *et al*. 1994) in response merely to boats moving closer, which indicates the response is highly dependent on the context of the acoustic exposure. Among fish, several species have been shown to react to noise stimuli by increasing swimming speed (Olsen *et al*. 1983), by swimming downward (Suzuki *et al*. 1980) and avoiding sound sources (Blaxter and Hoss 1981, Schwarz and Greer 1984, Vabo *et al*. 2002). Sound can have physical effects too, causing measurable damage to sensory cells of the ears of fishes (Hastings *et al*. 1996). Invertebrates, such as brown shrimp, have been shown to be adversely affected by underwater noise (Lagardère 1982). When exposed to higher levels of noise, brown shrimp exhibited increased aggression and higher mortality rates, and decreased food uptake, as well as showing significant reductions in their growth and reproduction rates (Lagardère 1982). Different responses may be expected even within a taxon, depending on sex, age, time of season, and many factors other than exposure level or duration.

For sea turtles, much of the acoustic research has focused on studying turtle ear anatomy and auditory sensory capabilities. These studies clearly demonstrated that sea turtles are able to detect and respond to sounds, and that their hearing is limited to low frequencies (less than 1000 Hz), with maximum sensitivity between 200-700 Hz, and a peak about 400 Hz (Ridgway *et al*. 1969, Bartol *et al*. 1999). Related studies showed that after presentation of acoustic stimuli, sea turtles responded with abrupt bodily movements, such as eye flickering, head retraction, and flipper movement, all of which were interpreted as startle responses (Lenhardt *et al*. 1983, Lenhardt 1994, Lenhardt *et al*. 1996). In addition, higher level responses, such as changes in swimming patterns and orientation were noted when turtles in a confined canal were subjected to high-pressure level air gun pulses of frequencies ranging from 25 to 1000 Hz (O'Hara and Wilcox 1990).

Samuel (*et al*. 2005) measured underwater noise levels in nearshore habitats in New York, where there is great overlap between the activity of juvenile foraging Kemp's ridleys and humans during summer months. The study concluded that within the range of sea turtle hearing, noise intensity was very high during periods of high human activity, and diminished proportionally with decreasing human presence. Significant differences in intensity were accompanied by an increase in complexity of noises across all frequencies that are detected by the turtles. Further analyses of the behavior of the juvenile Kemp's ridleys and other sea turtles indicated that these anthropogenic noises have a negative effect on sea turtle behavior, especially on their submergence patterns.

The combined results of the studies on sea turtle hearing, behavior, and environmental noise indicate that the pervasive noise levels in important nearshore foraging habitats could adversely affect Kemp's ridley behavior and ecology. In addition, the existing noise levels and additional increases from anthropogenic sources could have more far-reaching effects on sea turtle orientation and health that will be harder to quantify. With increasing human activity, it may be important to acknowledge potential impacts of underwater noise in future management strategies and recovery plans for the Kemp's ridley and other sea turtles.

Toxins

The presence of toxins is well documented along the east coast of the U.S. and Gulf of Mexico as a result of the large numbers of oil and gas production facilities, petrochemical and petroleum processing plants, runoff from agricultural activities, coal fired power plants and some of North America's highest density human population (Colburn *et al*. 1996). While only a few specific examples of serious impacts have been well documented in various vertebrates (DDT for example), there is a general sense that there are many "chemical time bombs" still to be uncovered (Meffe and Carroll 1997). The estuaries, neritic zones, and various fish species are well known to contain toxins such as heavy metals, persistent organochlorines and various agricultural byproducts. Kemp's ridleys live in areas where much of this material is deposited and sequestered. Preliminary studies have documented mercury and other heavy metals in Kemp's ridley blood (Orvik 1997, Wang 2005), which likely acts as a medium to transfer the metals to the scutes and tissues (Presti 1999) of the Kemp's ridley. Persistent organochlorines have been documented in Kemp's ridley tissues (Rybitski *et al*. 1995, Keller *et al*. 2004). Unfortunately, there are few specific studies that provide quantitative information on the direct or indirect effects of toxins on sea turtles (Pugh and Becker 2001, Day *et al.* 2007).

The Kemp's ridley feeds on other consumers such as mollusks and crustaceans. Since the Kemp's ridley may live for at least 20 years, their dietary preference may result in the bioaccumulation of environmental toxins in their body tissues, especially fat, or keratin. Pugh and Becker (2001) reviewed the literature on environmental contaminants in sea turtles and found only seven papers with reference to Kemp's ridleys. Studies have examined contaminants in fat tissue, liver, kidney, brain, and blood of dead stranded Kemp's ridleys (Keller 2003, Lake 1994, Innis *et al.* 2008). Organochlorine contaminants (OCs) such as PCBs and DDT and its related metabolites have generally been found to be higher in loggerhead and Kemp's ridley tissues than in the tissues of other sea turtles (Lake 1994, Keller 2003). However, Kemp's ridleys tend to have lower contaminant levels compared to loggerheads based on the amount of PCBs and pesticides found in fat samples from stranded turtles (Lake 1994, Keller 2003). Interestingly, PCBs seem to have decreased in Kemp's ridleys over the decade between these studies. We must be careful however in interpreting the differences between loggerheads and Kemp's ridleys due to the fact that the Kemp's ridleys examined in these studies are actually very young animals (1-3 years) compared to the loggerheads, which although still juveniles, are probably 15-30 years old. While the PCB levels seen in Kemp's ridleys are not as high as reported in marine mammals, there is reason for concern since stranded dead loggerheads were found to have higher levels of mercury in blood and keratin than wild captured individuals (Day 2003, Day *et al.* 2005), suggesting a relationship with their mortality. Day *et al.* (2007) also documented clear correlations of blood and keratin mercury with indicators of reduced immune function in loggerheads.

Orvik (1997) measured mercury, copper and zinc in the blood (not a traditional tissue for this type of study) of Kemp's ridleys, and found a positive correlation with observed metal levels and the size of the turtle. This strongly suggests bioaccumulation as the animal grows.

Balazs and Pooley (1991) list environmental contamination as one of the possible factors contributing to the viral infection in sea turtles known as fibropapillomatosis. Although not histologically confirmed as fibropapilloma, skin lesions were reported for Kemp's ridleys at Rancho Nuevo (P. Burchfield, GPZ, unpublished data) and in Texas (D. Shaver, PAIS, personal communication 2009) but did not exhibit the severe and debilitating symptoms seen in the green turtles of Florida and Hawaii. Contaminants are known to influence the immune systems of vertebrates, and additional immunological studies on sea turtles are needed.

A serious deficiency in the studies of toxicology in Kemp's ridleys is that adult animals have never been examined in detail for any of these contaminants. Since their early life history is pelagic and they only begin feeding neritically as juveniles through adulthood, we clearly do not have a complete picture of potential contaminant levels in this species.

H.2.6. Species Interactions

Predation

Among the many predatory fishes occurring off the nesting beaches, jackfish (*Caranx hippos*) and redfish (*Sciaenops ocellatus*) are known to feed on hatchling Kemp's ridleys (Hildebrand 1963). Natural predators also include sharks. A shark identified as a great hammerhead (*Sphyrna mokarran*) was observed attacking a post-pelagic (21 cm SCL) Kemp's ridley in the shallow waters of Deadman Bay in northwest Florida (Barichivich, U.S. Geological Survey, personal observation, Schmid and Barichivich, 2006). The turtle was recovered immediately after the shark released its prey, and subsequent inspection revealed abrasions on the carapace and plastron as a result of the attack. Another slightly larger turtle (33 cm SCL) was later captured in the same area and exhibited similar wounds. Many of the neritic juveniles captured in western Florida were missing the distal ends of the flippers, particularly the rear flippers (J. Schmid, Conservancy of Southwest Florida, personal communication 2008), which may indicate frequent, non-lethal encounters with sharks or other large predatory fish during their developmental stages.

From 1980 through 2006, 159 Kemp's ridleys collected as strandings were documented as having sustained wounds suggesting shark bites/attack. It is unknown how many of these wounds were sustained before or after death. Size breakdown with frequency of occurrence in parentheses is as follows: 20.0-29.9 cm SCL (n=15), 30.0-39.9 cm SCL (n=30), 40.0-49.9 cm SCL (n=30), 50.0-59.9 cm SCL (n=42), 60.0 cm + SCL (n=27) and 15 of unknown size (STSSN unpublished data). There are also 3 records in the database for "hatchling found in stomach of predator;" all three were <6 cm in length and were found in the stomachs of dolphinfish (*Coryphacena hippurus*) (STSSN unpublished data). Records of stranded turtles represent only a fraction of at-sea mortality, thus it is unknown what level of natural predation or scavenging actually occurs in the Kemp's ridley population.

Pathogens

A variety of bacterial, fungal, and viral diseases have been found in wild and captive turtles (Herbst and Jacobson 1995, George 1997, Roberston and Cannon 1997). Systemic mycoses caused by fungal infestation have been found in cold-stunned Kemp's ridleys (Manire *et al.* 2002) and can result in high mortality in captive-reared Kemp's ridleys (Leong *et al.* 1989). Heavy infestations of endoparasites including trematodes, tapeworms, and nematodes may cause or contribute to debilitation or mortality in sea turtles. Ectoparasites, including leeches and barnacles, may have debilitating effects on Kemp's ridleys. Leech infestations may result in anemia and act as vectors for other disease-producing organisms (George 1997). Barnacles are generally considered innocuous although some burrowing species may penetrate the body cavity resulting in mortality (Herbst and Jacobson 1995, http://galveston.ssp.nmfs.gov/puplications/pdf/145.pdf).

Fibropapillomatosis is an epizootic disease characterized by the presence of cutaneous lesions (George 1997). The disease has been found in several chelonid species, primarily in green turtles. Barragan and Sarti (1994) reported the first possible case of fibropapilloma in Kemp's ridleys but they were unable to collect a tissue sample from the nesting turtle so the cause of the tumor could not be determined. There are a number of records of abnormal growths similar to fibropapillomas that were observed at Rancho Nuevo, Mexico from 1985 to 1998 (Guillen and Pena Villalobos 2000). In-water surveys in Texas and Florida resulted in the capture of over a thousand juvenile Kemp's ridleys and fibropapillomatosis was not observed (W. Witzell, NMFS, J. Schmid, NMFS, A. Landry, TAMU, personal communications 2005, B. Schroeder, NMFS, personal communication 2006). Although 31 nesting females at Rancho Nuevo were documented with skin lesions from 1985-2002 (J. Pena, GPZ, unpublished data 2006) and a few nesting females have been documented with skin lesions in Texas (D. Shaver, PAIS, personal communication 2009), these lesions were not histologically examined and it is likely these lesions were not fibropapilloma as has been documented in green turtles (D. Owens, College of Charleston, personal communication 2007).

Toxic Species

There are several toxic jellyfish (e.g., *Aurelia aurita*, *Cyanea capillata*, *Physalia physalis, Chrysaora quinquecirrha, Carukia barnesi and Phyllorhiza punctata*; the latter three are introduced species) that are found within the range of the Kemp's ridley. Red tides occur in the coastal waters inhabited by Kemp's ridleys, and Kemp's ridleys have stranded, both live and dead during red tide events (NMFS unpublished data). The STSSN documented 59 Kemp's ridley strandings "found in apparent association with red tide occurrence" from 1991-2001: all but 4 of these turtles were dead. The vast majority (57 of 59) of these strandings were documented along the Florida Gulf coast. An increase in marine turtle deaths along the west central coast of Florida was recorded during 1995-1996, and necropsy results from 26 Kemp's ridleys showed evidence of possible red tide involvement (Foote *et al*. 1998). In 2005, 42 Kemp's ridleys stranded during a red tide event along the Florida Gulf coast (A. Foley, Florida Fish and Wildlife Marine Research Institute, personal communication 2006*)*.

H.2.7 Other Factors

Climate Change

Climate change at normal rates (thousands of years) was not historically a problem for sea turtles species since they have shown unusual persistence over a scale of millions of years. However, there is a 90% probability that warming of the earth's atmosphere since 1750 is due to human activities resulting in atmospheric increases in carbon dioxide, methane, and nitrous oxide (IPCC 2007). All reptiles including sea turtles have a tremendous dependence on their thermal environment for regulating physiological processes and for driving behavioral adaptations (Spotila *et al*. 1997). In the case of sea turtles, where many other habitat modifications are documented (beach development, loss of foraging habitat, etc.), the prospects for accentuated synergistic impacts on survival of the species may be even more important in the long-term. Atmospheric warming creates habitat alteration which may change food resources such as crabs and other invertebrates. It may increase hurricane activity leading to an increase in debris in nearshore and offshore waters, resulting in increase in entanglement, ingestion, or drowning. Atmospheric warming may change convergence zones, currents and other oceanographic features that are relevant to Kemp's ridleys, including changes to rain regimes and nearshore runoff.

Conservation and Research Activities

Some conservation and research activities conducted in U.S. and Mexico waters could potentially harm or kill Kemp's ridley turtles. In-water studies may use entanglement nets or trawl gear to collect Kemp's ridleys. Although these collection methods are closely monitored, the possibility of a lethal take exists. Experiments designed to test fishing gear modifications to reduce sea turtle bycatch often require turtles to be caught in the control treatment. Sometimes these takes are lethal. NMFS currently authorizes 1,365 live and 26 dead Kemp's ridleys to be taken as a result of 22 research experiments in U.S. waters (NMFS unpublished research permit tracking 2007). The vast majority of Kemp's ridleys authorized to be taken in research are released alive and unharmed.

Military Activities

The use of underwater explosives for military activities can injure or kill turtles and may destroy or degrade habitat. No data are available on the impacts of military explosives on Kemp's ridley turtles. However, underwater explosives have been associated with mortality of Kemp's ridley and other sea turtles (see H.2.3. Construction: Oil, Gas, and Liquid Natural Gas Exploration, Development, and Removal). The Team feels it is likely that underwater explosive activities associated with Military operations would have similar effects, depending on explosive size, depth, and location of activity. The U.S. Navy has developed a program to monitor, mitigate, and minimize the potential impacts to sea turtles from explosives related to training activities. Measures include, but are not limited to, buffer zones around target areas and suspending artillery when sea turtles are documented in the area.

Cold Stunning

Kemp's ridleys are susceptible to cold stunning, a natural phenomenon, in which turtles become incapacitated as a result of rapidly dropping water temperatures (Morreale *et al*. 1992). As temperatures fall below 8-10^{o}C, turtles may lose their ability to swim and dive, often floating to the surface. Cold stunning events occur throughout the Kemp's ridley's range, but are common each year along the shores of Long Island Sound and Cape Cod Bay when water temperatures drop (Morreale *et al*. 1992, NMFS STSSN unpublished data). From 1994 through 2006, 1,084 immature Kemp's ridleys (CCL <50 cm) were cold stunned in the northeast U.S., and over half (n = 593) initially stranded alive. Of these live animals, at least one quarter were rehabilitated and released (NMFS STSSN unpublished data).

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PART II: RECOVERY PROGRAM

The following sections present a strategy to recover the Kemp's ridley sea turtle, including objective and measurable recovery criteria to achieve downlisting and delisting, and site-specific management actions to monitor and reduce or remove threats, as required under Section 4 of the ESA. The Plan also addresses the five statutory listing factors (Section 4(a)(1) of the ESA) to demonstrate how the recovery criteria and actions will lead to removal of the Kemp's ridley sea turtle from the lists of Endangered and Threatened Wildlife.

A. RECOVERY STRATEGY

The Kemp's ridley nesting population is increasing at a steady rate and recovering from its historic low point in the mid-1980s. Conservation efforts on the primary nesting beaches in Mexico and required TED-use in the U.S. and Mexico are the likely reasons for the population's increase. Accordingly, the highest priority needs for Kemp's ridley recovery are to maintain and strengthen the conservation efforts that have proven successful. On the nesting beaches, this includes reinforcing habitat protection efforts, protecting nesting females, and maintaining or increasing hatchling production levels. In the water, successful conservation efforts include maintaining the use of TEDs in fisheries currently required to use them, expanding TED-use to all trawl fisheries of concern, and reducing mortality in gillnet fisheries. Adequate enforcement in both the terrestrial and marine environment also is essential to meeting recovery goals.

To achieve recovery for the Kemp's ridley, it is not sufficient simply to maintain current efforts. In Mexico, community social/economic programs must be developed for the fishing sector to reduce incidental capture of Kemp's ridleys in fisheries. In the US, several fisheries have implemented measures to reduce the impacts to the Kemp's ridley, however bycatch reduction should be expanded to all fisheries of concern. Additional research and monitoring are needed to identify important marine foraging, breeding, and internesting habitats; determine migratory pathways among foraging grounds and between foraging grounds and nesting beaches; and collect data on interactions between Kemp's ridleys and recreational and commercial fisheries, especially the Mexican shark fishery. Agencies must carefully monitor current and/or emerging issues affecting the population to ensure that the observed nesting population increases continue.

Finally to ensure long-term protection and sustained recovery of the Kemp's ridley well after it is delisted, sources of increased funding for conservation efforts must be identified and sustained and education programs and partnerships with local, state, Federal, private, and international entities must be strengthened and sustained.

B. RECOVERY GOAL

The recovery goal is to conserve and protect the Kemp's ridley sea turtle so that protections under the ESA are no longer necessary and the species can be removed from the List of Endangered and Threatened Wildlife. Biological recovery criteria form the basis from which to gauge whether the species should be reclassified to threatened (i.e., downlisted) or delisted, whereas listing factor criteria ensure that the threats affecting the species are controlled or eliminated.

C. OBJECTIVE AND MEASURABLE RECOVERY CRITERIA

C.1. Downlisting Criteria

C.1.1. Demographic Criteria

1. A population of at least 10,000 nesting females in a season (as estimated by clutch frequency per female per season) distributed at the primary nesting beaches (Rancho Nuevo, Tepehuajes, and Playa Dos) in Mexico is attained. Methodology and capacity to implement and ensure accurate nesting female counts have been developed.

2. Recruitment of at least 300,000[2] hatchlings to the marine environment per season at the three primary nesting beaches (Rancho Nuevo, Tepehuajes, and Playa Dos) in Mexico is attained to ensure a minimum level of known production through *in situ* incubation, incubation in corrals, or a combination of both.

C.1.2. Listing Factor Criteria

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

1. Long-term habitat protection of two of the primary nesting beaches is maintained in Mexico (Rancho Nuevo, Tepehuajes) as federal, state, municipal, or private natural protected areas or under a similar legally protective designation or mechanism. Long-term habitat protection of the nesting beach at Playa Dos, through establishment as a natural protected area or similar legally protective designation or mechanism is initiated.

Factor B: Overutilization for commercial, recreational, scientific, or educational purposes

2. Social and/or economic initiatives that are compatible with Kemp's ridley conservation programs have been initiated and/or developed in conjunction with the Kemp's ridley conservation program at Rancho Nuevo and at least two other communities adjacent to Kemp's ridley sea turtle camps. The CONANP will determine whether these initiatives are sufficient based on community need and potential benefits to conservation.

Factor C: Disease or predation

3. Predation of nests is reduced through protective measures implemented to achieve Demographic Criterion number 2.

Factor D: Inadequacy of existing regulatory mechanisms

[2] See Section F.3 Survival Rates Table 1 for explanation of how the criterion was derived.

4. TED regulations, or other equally protective measures are maintained and enforced in all U.S. and Mexican trawl fisheries (e.g., shrimp, summer flounder, whelk) that are known to have an adverse impact on Kemp's ridleys in the Gulf of Mexico and Northwest Atlantic.

Factor E: Other natural or manmade factors affecting its continued existence

5. A sub-group of the Team and other technical experts has been convened and made progress in identifying and reviewing the most current data on major foraging areas (especially for juveniles), inter-nesting habitats, mating areas, and adult migration routes in Mexico and U.S. waters to provide information to ensure recovery.

C.2. Delisting Criteria

The Team decided on a 6-year average population of 40,000 nesting females per season because the mean remigration interval for adult females is 2 years (Marquez *et al*. 1982, TEWG 1998). A 6-year period would encompass three nesting cycles, which the Team believes represents an adequate time period to account for natural annual variability in the number of nesting females and hatchlings produced. Changes in reproduction during that period are more likely to represent a trend in the population rather than natural variation.

C.2.1. Demographic Criteria

1. An average population of at least 40,000 (Hildebrand 1963) nesting females per season (as measured by clutch frequency per female per season and annual nest counts) over a 6-year period distributed among nesting beaches in Mexico and the U.S. is attained. Methodology and capacity to ensure accurate nesting female counts have been developed and implemented.

2. Ensure average annual recruitment of hatchlings over a 6-year period from *in situ* nests and beach corrals is sufficient to maintain a population of at least 40,000 nesting females per nesting season distributed among nesting beaches in Mexico and the U.S into the future. This criterion may rely on massive synchronous nesting events (i.e., arribadas) that will swamp predators as well as rely on supplemental protection in corrals and facilities.

C.2.2. Listing Factor Criteria

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

1. Long-term habitat protection of the nesting beaches of Tamaulipas (Rancho Nuevo, Tepehuajes, Playa Dos), Veracruz (Lechuguillas and Tecolutla), and Texas (federally-managed sections of North Padre (PAIS), South Padre, and Boca Chica Beach) is maintained via federal, state, municipal, or private natural protected areas or under a similar legally protective designation or mechanism.

Factor B: Overutilization for commercial, recreational, scientific, or educational purposes

2. Community socioeconomic programs initiated in conjunction with Kemp's ridley conservation programs at Rancho Nuevo, Tepehuajes, and La Pesca are maintained and expanded to other areas such as La Pesca-Costa Lora, San Vicente, Buena Vista, Barra del Tordo and Barra Moron—Playa Dos, Rancho Nuevo where significant Kemp's ridley nesting occurs in Mexico. The CONANP will determine whether these initiatives are sufficient based on community need and potential benefits to conservation.

Factor C: Disease or predation

3. Predation of nests is reduced through protective measures implemented to achieve Demographic Criterion number 2.

Factor D: Inadequacy of existing regulatory mechanisms

4. Specific and comprehensive Federal, State, and local legislation or regulations are developed, promulgated, implemented, and enforced to ensure post-delisting protection of Kemp's ridleys and their terrestrial and marine habitats, as appropriate. These would address significant impacts to Kemp's ridleys in trawl, gillnet, hook and line, trap/pot activities, including the Mexican shark fishery. Mexico and U.S. continue collaborative efforts to ensure post-delisting protection of Kemp's ridleys and their terrestrial and marine habitats under the auspices of the Inter-American Convention for the Protection and Conservation of Sea Turtles.

Factor E: Other natural or manmade factors affecting its continued existence

5. A network of in-water sites in the Gulf of Mexico and Northwest Atlantic to monitor populations (e.g., demographics and abundance) is established and surveys are implemented (as developed by the sub-group convened under downlisting criteria).

6. Monitoring programs have been initiated in commercial and recreational fisheries of concern in both Mexico and the U.S to monitor Kemp's ridley bycatch. Necessary measures to minimize mortality in all commercial and recreational fisheries have been implemented sufficiently to ensure recruitment to maintain population level in Demographic Criterion number 1 after delisting.

7. All other human significant sources of Kemp's ridley mortality have been addressed sufficiently through implementation measures to minimize mortality to an extent that ensures recruitment to maintain population level in Demographic Criterion number 1 after delisting.

8. STSSN research and data collection will be continued to monitor the effectiveness of protection and restoration activities for Kemp's ridley in the U.S. and Mexico.

D. STEPDOWN OUTLINE AND NARRATIVE

1. Protect and Manage Habitat

11. Protect and manage nesting habitats

111. Ensure long-term protection of important nesting beaches in Mexico

1111. Maintain and reinforce habitat protection efforts on nesting beaches (Listing Factors A and D)

The participation of the three levels of government in Mexico and the cooperation of the United States, as well as the work done by non government organizations (NGOs), the shrimping industry and the Universities, has set the Kemp's ridley sea turtle on the road to recovery. These partnerships must be maintained and reinforced. Since the Kemp's ridley is endemic to the Gulf of Mexico and the majority of nesting occurs on the beaches of Tamaulipas, the protection and conservation of the Kemp's ridley terrestrial habitat is essential.

1112. Develop and implement a management plan specific to Kemp's ridleys for the Rancho Nuevo Sanctuary (Listing Factors A and D)

The development of a conservation and management program is done based on the terms of references dictated by Comisión Nacional de Áreas Naturales Protegidas (CONANP - National Commission for the Natural Protected Areas). According to Art. 145 frac. VI. of the internal regulations of SEMARNAT, the Regional Operation General Direction (Dirección General de Operación Regional) is responsible for executing the process for approval and publication of the management programs for the natural protected areas of Federal competence, with the participation of the other administrative units in the Commission. Rancho Nuevo is a Sanctuary of Federal administration, therefore CONANP is currently developing the management program. The program will identify threats, develop strategies and define the operation regulations within the Sanctuary. The program will adopt the recommendations of this Plan.

1113. Expand boundaries of Rancho Nuevo Sanctuary north to Laguna Madre-Rio Bravo Protected Area (Listing Factors A and D)

Rancho Nuevo Sanctuary (17.6 km in length) is located between 23°18'10" N 97°45'40" W and 23°10'00" N 97°45'30"W. Its northern limit is only 3 km from the southern limit of Laguna Madre-Rio Bravo Delta Protected Area. These 3 km are currently covered by the daily patrols for the conservation activities. To ensure long-term coverage of this area, which is outside of the Rancho Nuevo Sanctuary, protection of the area through formal government authority is needed.

1114. Develop and implement a management plan specific to Kemp's ridleys for natural protected areas other than sanctuaries (Listing Factors A and D)

Protected areas, which benefit the Kemp's ridley, may be established under Mexico authority through several mechanisms. For example, Laguna Madre-Rio Bravo Deleta Protected Area for Protection of Flora and Fauna is an area managed by CONANP. Development of a management plan is underway. The plan will focus on stabilizing the beach and coastal dunes to protect Kemp's ridley nesting habitat.

1115. Develop and implement a coastal zone management plan throughout Kemp's ridley distribution in Tamaulipas and Veracruz (Listing Factors A and D)

A coastal zone management plan for Tamaulipas and Veracruz, Mexico, within Kemp's ridley nesting habitat, needs to be developed and implemented. Economic activities have modified the nesting beach habitat, and these changes represent a potential threat to the viability of the species. The development and implementation of the coastal zone management plan will allow, among other things, establishment of appropriate construction set backs from the mean high water line and guidelines which must be considered for the development of economic activities in coastal zones.

1116. Initiate reforestation program for Rancho Nuevo (Listing Factor A)

As part of the restoration actions inside the Natural Protected Area established by the Conservation and Management Program, in coordination with the National Forestry Commission (Comisión Nacional Forestal – CONAFOR), a restoration plan for the recovery of mangrove areas close to the beach of Rancho Nuevo, will be developed and implemented. PROCODES (Programa de Conservación para el Desarrollo Sustentable – Program of Conservation for Sustainable Development) is restoring and protecting the soils in Ejido Buena Vista, and doing training for the management of livestock systems, using eco-friendly techniques.

1117. Undertake topographic surveys of three major nesting beaches (Listing Factor D)

In order to reinforce nesting beach protection and conservation activities, the geographic extent of the Rancho Nuevo Sanctuary, as well as the main nesting areas in Rancho Nuevo and Barra del Tordo in the municipality of Aldama, and in Tepehuajes in the municipality of Soto la Marina need to be identified. Once the geographic boundaries are established, a request can be made under Mexico authority to designate these areas for protection (see tasks 1113 and 1114).

112. Ensure long-term protection of important nesting beaches in Texas (Listing Factors A and D)

Nesting habitat must be protected on Federal, state, and other public lands in Texas, including PAIS, Lower Rio Grande National Wildlife Refuge, and Laguna Atascosa National Wildlife Refuge. Protection measures should include increased monitoring and protection of nesting activities, implementing and strengthening coastal zone management plans, and acquiring additional lands where Kemp's ridley nesting occurs. Kemp's ridley nesting is increasing in Texas and over 70% of the nests found in the state are located on North Padre Island, South Padre Island, and Boca Chica Beach on federally protected lands. The protection of these major nesting beaches in Texas is critical in attaining the goal of the long-term, bi-national effort to re-establish nesting to form a secondary nesting colony of Kemp's ridleys at PAIS where about 55% of the nests are located. Long-term protection of nesting habitat on these public lands will be even more critical in the future, as other areas in Texas are increasingly developed.

113. Assess long-term impacts of global climate change on terrestrial habitats (Listing Factors A, D, and E)

Federal, state, and local resource agencies must assess the impacts of climate change and adopt mitigation measures to minimize impacts to the Kemp's ridley. Thousands of studies have confirmed that our planet is in an accelerated phase of global warming, primarily due to increased anthropogenic greenhouse gas emissions (IPCC 2007). The impact of this warming trend on hatchling sex ratios is unknown. Changes during geological history were on a much slower time scale and shifts in preferred nesting beaches occurred due to natural selection and natal beach imprinting. A serious concern and possibly the most important long-term conservation threat to sea turtles is the potential for feminization of populations due to increased temperature regimes. Models (Davenport 1997, Hawkes *et al*. 2007, Hulin and Guillon 2007) predict very long-term reductions in fertility in sea turtles due to climate change, but due to the relatively long life cycle of sea turtles, reductions may not be seen until 30 to 50 years in the future. Another serious impact from global climate change is sea level rise. In areas of development, nesting beaches have no possibility for natural barrier island migration landward as sea levels rise. In the case of the Kemp's ridley where most of the critical nesting beaches are undeveloped, beaches may shift landward and still be available for nesting. The PAIS shoreline is accreting, unlike much of the Texas coast, and with nesting increasing and the sand temperatures slightly cooler than at Rancho Nuevo, PAIS could become an increasingly important source of males for the population.

114. Develop an oil spill contingency plan that includes responses at nesting beaches (Listing Factors A, D, and E)

A contingency plan for a rapid response to protect nesting beaches from any oil spill should be developed. The contingency plan should include response activities for spills on nesting beaches. Multi-agency, coordinated oil spill contingency plans for terrestrial and marine response exist in the U.S., and the U.S. participates in bi-national response drills with Mexico on an annual basis. However, these plans are not focused on primary Kemp's ridley nesting beaches. A similar response plan for spills on these nesting beaches is needed. The contingency plan should be developed in coordination with the entities above, and should include response training for all people working in the nesting sites, protocols for responding to oiled nests, and methods for protecting and relocating nests, nesting females, and hatchlings. Alternate release sites should be identified, transportation protocols be developed, permit issues resolved, and temporary rehabilitation facilities identified for emergency use.

12. Protect and manage marine habitats

Little is known about foraging habitats of neonate, juvenile, and adult ridleys. The neonate habitat is pelagic, surficial, largely planktonic, and presumably within the Gulf of Mexico and Northwest Atlantic. Juveniles and adults are cancrivorous (crab-eating), foraging mostly in the shallow-water coastal zone. Juveniles occupy littoral habitat in the Gulf and along the eastern seaboard of the United States while adults are largely restricted to nearshore areas of the Gulf of Mexico. Habitat degradation has resulted from coastal development, industrialization, river and estuarine pollution, increased vessel traffic, channel construction and maintenance, oil and gas development, and recreational and commercial fishing. Identification and protection of essential habitat must be vigorously undertaken.

121. Identify important marine foraging, breeding, and inter-nesting habitats (Listing Factor A)

Little is known about the neonatal "lost years" habitat of the Kemp's ridley, and investigations to delineate habitat use during this phase should be initiated. Marking of hatchlings with wire tags indicates that this phase lasts about 2 years (B. Higgins, NMFS, personal communication 2006). Developmental habitat for juveniles has been identified in Texas, Louisiana, both coasts of Florida, Georgia, the Carolinas, Chesapeake Bay, Long Island Sound, and Cape Cod. There are no developmental areas reported from Mexico, although seemingly acceptable habitat with abundant crustaceans exists. Efforts are needed to further identify habitat essential to juvenile/subadult Kemp's ridleys along the Gulf of Mexico and east coast of the United States. Adult foraging habitat in the Gulf of Mexico also needs to be characterized and identified more precisely.

122. Identify and evaluate the value of designating marine protected areas to facilitate increased protection of important foraging, breeding, and inter-nesting habitats; implement where appropriate (Listing Factors A and D)

A "marine protected area" (MPA) encompasses a wide variety of approaches to time and place-based conservation and management zones. The National Oceanic and Atmospheric Adminisration Marine Protected Areas office developed a process to assess seasonal recreational and commercial use and management alternatives to protect and conserve natural resources (NMPAC 2006). This process should be evaluated and used where appropriate for protecting Kemp's ridley habitat.

123. Ensure oil and gas exploration and development activities do not negatively affect foraging, breeding, or inter-nesting habitat (Listing Factors A and D)

Direct and indirect impacts to Kemp's ridleys may occur as a result of petroleum platform operation and removal. All current technologies and measures should be taken to reduce impacts on turtles and their habitat. The lessons learned from the DWH spill show that industry and government regulatory agencies must work together to prevent accidents. The Bureau of Ocean Energy Management, Regulation and Enforcement (BOEMRE, formerly Mineral Management Service) is mandated to provide safety oversight of oil and gas operations to reduce the risk of oil spills.

In addition, these agencies have worked with the drilling field leaseholders to develop platform removal methodologies that avoid and minimize impacts to all protected marine species (Continental Shelf Associates, Inc. 2004). Use of NOAA observers and implementation of new removal methodologies has led to far fewer interactions with protected species. Mitigation measures include mandatory use of a 500-m exclusion zone, ramp-up, and shut-down procedures, monitoring, collection of debris created by oil exploration and extraction activities, oil contingency plans, and strategic placement of spill cleanup equipment by trained personnel (NMFS 2007b). Deaths caused by platform removal operations are not expected because of existing mitigation measures (MMS 2000).

2. Protect and Manage Population

21. Protect and manage populations on the nesting beaches

211. Protect nesting females (Listing Factors B and D)

In order for the population to retain its breeding potential, nesting females, their nests, and hatchlings need to continue to be protected in both Mexico and the U.S.

212. Maintain hatchling production at levels to achieve recovery goals (Listing Factor E)

One of the key elements in the current population increase has been the restoration of hatchling production through adequate management of nesting beaches in Mexico and the United States. Target levels of hatchling production have been identified in the downlisting criterion.

213. Monitor and assess nesting female trends

2131. Continue monitoring and collecting basic biological information on primary nesting beaches in Mexico and the U.S. (Listing Factor E)

The collection of basic biological information on the population dynamics of a species using standardized survey methodology is critical for science-based management decisions. For sea turtle populations, critical insight on status is obtained through long-term monitoring of annual number of nesting females. Because clutch frequency and remigration interval vary among females, it is critical that nesting trends be based on the correct identification of the number of females and not only on number of nests. Furthermore, because clutch frequency and remigration intervals may vary, and Kemp's ridley age-to-maturity likely is more than 10 years, long-term monitoring programs are needed. As nesting densities increase, monitoring the annual number of nesting females may become exceedingly difficult and other survey methods may need to be developed to ensure the accuracy of the estimates.

2132. Assess nesting south of Matamoros and north of Carbonera (Listing Factors A and D)

Recovery of this species is expected to include the expansion of the recent geographic range of its nesting activities. In order to monitor this phenomenon, it will be necessary to identify new nesting sites outside of its current concentrations in Tamaulipas, evaluate nesting abundance and trends over time, and provide adequate protection.

214. Develop nesting beach management plans, which address future needs/threats (Listing Factors A and D)

Effective management plans, which account for future needs, for nesting beaches are essential to the recovery of this species and should be completed for Rancho Nuevo, Tepehuajes, and Playa Dos. Management plans should include details of how local threats to the nesting environment, nesting females, nests, and emergent hatchlings are identified and addressed. Among other items, future planning should also address issues associated with nest protection as the population grows. Nesting abundance will reach levels that outstrip the capacity to translocate all nests to hatcheries. Alternative strategies such as *in situ* incubations of nests must be evaluated. Guidelines will need to be developed on the critical proportion or number of nests to be moved to hatcheries and those permitted to stay *in situ* such that the hatchling production levels remain within the limits guaranteeing recovery goals. These management plans/guidelines should be written in conjunction with the various activities under 111.

215. Assess sex ratios

2151. Continue monitoring and assessing long-term impacts on hatchling sex ratios (Listing Factor E)

Research on the effects of hatchling sex ratios should continue. Average nest temperatures in corrals at Rancho Nuevo indicate a strong female sex bias. Data suggest that a female bias may be present in the Kemp's ridley population and would be advantageous to the short-term recovery of this endangered sea turtle, but manipulation of natural sex ratios may have long-term, unknown positive or negative consequences.

2152. Model climate change effects on sex ratio (Listing Factor E)

Climate change effects on Kemp's ridley sex ratio should be assessed. Impacts from climate change, especially due to global warming, are likely to become more apparent in future years (IPCC 2007). As global temperatures continue to increase, so will sand temperatures, which in turn will alter the thermal regime of incubating nests and alter natural sex ratios within hatchling cohorts (e.g., Glen and Mrosovsky 2004). Considering that the Kemp's ridley has temperature-dependent sex determination (Wibbels 2003) and the vast majority of the nesting range is restricted to the State of Tamaulipas, Mexico, global warming could potentially impact population sex ratios and thus the reproductive ecology of this species.

216. Determine and monitor nesting female survival rates (Listing Factor E)

Accurate population models are necessary not only to predict growth trends into the future, but also to allow testing possible outcomes from alternative management actions through simulations. Accuracy of these models depends on good knowledge of key population parameters. Survival rates of adult females are a key parameter needed for population models. Available data are not sufficient to determine adult female survivorship. Future tagging efforts should be designed to ensure this analysis could be done.

217. Monitor neophyte nesters (Listing Factor E)

Measuring recruitment of females into the breeding population is critical to the understanding and accurate tracking of population processes, including the response by populations to management actions. Recruitment can be approximated by following changes in the number and proportion of neophyte nesters over time. First time nesters can be identified through a combination of factors, including body and clutch size, hatching success, and tag returns. Care should be exercised in designing a methodology that is robust in identifying true first-time breeders, and to avoid confusion with non-first time breeders that have not yet been tagged or have lost previous tags.

22. Protect and manage populations in the marine environment

221. Establish monitoring sites in foraging areas (Listing Factor A)

Foraging areas, representative of each of the range of habitats used by the species need to be identified and sites established for the monitoring of abundance, sex ratios, size- and sex-specific growth, survival rates, and health as well as changes in the quality and integrity of the habitat. Monitoring sites should be established where Kemp's ridleys spend the largest portion of their lives, over a range of life history stages, and include both sexes. Because of the spatial and temporal complexities of sea turtle life histories, monitoring of changes to population parameters and quality of the animal's habitat needs to be accomplished at representative sites over their entire distribution. The full range of the species needs to be determined, with special attention to ascertaining whether there are foraging grounds to the south of the nesting beaches.

222. Determine migratory pathways among foraging grounds and between foraging grounds and nesting beaches (Listing Factor A)

Because sea turtles undertake seasonal migrations for foraging through subtropical and temperate waters, or for breeding, they may be vulnerable to a number of threats. The migratory corridors need to be determined and threats identified.

223. Monitor fisheries and reduce interactions

2231. Implement monitoring programs in recreational and commercial fisheries of concern in both Mexico and the U.S. (Listing Factor D)

Few fisheries are monitored for take of protected species. The U.S. and Mexico need to design and implement statistically valid monitoring programs in all Federal and state fisheries that have potential to interact with Kemp's ridleys, and quantify the impact of those activities on the species. Data collected from monitoring programs are necessary to quantify the impact of fishing on the population, and to focus management measures to reduce the impact.

2232. Implement monitoring in the shark fishery in Mexico (Listing Factor D)

An at-sea observer program is necessary to evaluate incidental capture of Kemp's ridleys in the shark fishery. The shark fishery in the Gulf of Mexico is seasonal, occurring mostly at the end of spring and summer. The fishery is performed mainly in artisanal boats with drift nets, longline, and hand lines at depths that vary from 10 to 50 fathoms. Incidental capture of Kemp's ridleys in this fishery is likely. During the fishing seasons, Kemp's ridley carcasses have been documented stranded on beaches adjacent to the fishing grounds.

2233. Monitor emerging fisheries (Listing Factor D)

Emerging fisheries may pose a threat to the recovery of Kemp's ridleys. Both U.S. and Mexico should be alert to emerging fisheries and, based on the potential for interactions with Kemp's ridleys, act accordingly (e.g., increased monitoring, implementing gear modifications, seasonal closures).

2234. Reduce mortality in all fisheries of concern (Listing Factor D)

Significant takes of Kemp's ridleys occur in commercial and recreational fisheries. Collective mortality due to fisheries bycatch may impede recovery if mortality is not reduced. Capture of ridleys has been documented in trawl fisheries, pound nets, gillnets, dredge, and hook and line fisheries. Efforts are needed that would both reduce the number of interactions with both recreational and commercial fisheries and reduce the mortality associated with the interactions.

22341. Maintain regulations in fisheries currently required to use TEDs (Listing Factor D)

Currently, TEDs are required in shrimp trawls and in bottom trawls used in the trawl fishery for summer flounder off Virginia and North Carolina. In addition selected fisheries in the state waters of Georgia and South Carolina are required to use TEDs: channel nets, whelk trawls, and jellyfish trawls. These regulations need to be maintained.

TED regulations in the shrimp and summer flounder fisheries have been enforced at varying levels since the early 1990s. However, if TEDs are not installed or used properly, their effectiveness is significantly diminished and expected conservation gains will not be realized. At the turn of the century, other gear types, such as large mesh gillnets and pound nets, were restricted, in some areas, to reduce sea turtle bycatch.

22342. Require TEDs, or other equally effective bycatch reduction measures as appropriate, in all trawl fisheries of concern (Listing Factor D)

Bottom trawl fisheries throughout the Gulf of Mexico and along the Atlantic coast take significant numbers of Kemp's ridleys. A major component, the shrimp bottom trawl fishery, is required to use TEDs, but trawl fisheries other than the shrimp fishery catch and drown Kemp's ridleys. Other fisheries may need to use TEDs, depending on the impacts these fisheries have on Kemp's ridleys. The U.S. is developing a plan to require bycatch reduction measures in bottom trawl fisheries and to develop bycatch reduction measures in fisheries where effective TEDs have not yet been developed (NMFS 2009c). This work needs to proceed and similar activities should be initiated in Mexico.

22343. Reduce mortality in gillnet fisheries (Listing Factor D)

Management strategies to reduce bycatch and mortality in gillnets have included limiting soak time, limiting mesh size, limiting net length, requiring nets to be tended, prohibiting tie downs, and closing areas with high densities of turtles. Efforts are needed to further develop, test, and implement gillnet bycatch reduction measures.

22344. Reduce mortality in hook and line fisheries (Listing Factor D)

Hook and line fisheries take Kemp's ridleys. These include longline fisheries, bandit reels, and rod and reel, both commercial and recreational. Research has shown that the use of circle hooks, as compared to "J" hooks, result in fewer animals being hooked in the esophagus and gut, presumably resulting in reduced turtle mortality (Watson *et al*. 2005). Reduced mortality of the target species and other bycatch has also been documented when "J" hooks are used (Prince *et al*. 2002, Skomal *et al*. 2002). Large circle hooks (18/0 and greater) reduced the takes of sea turtles. These and other promising technologies need to be researched and implemented as appropriate in all the hook and line fisheries operating in areas at times when Kemp's ridleys might be present.

22345. Reduce mortality in trap/pot fisheries (Listing Factor D)

Bycatch of Kemp's ridleys has been documented in a number of trap/pot fisheries in the Gulf of Mexico and likely occurs in other pot/trap fisheries. For example, loggerhead, leatherback and green sea turtles have been taken in lobster and whelk pots in the northeast and mid-Atlantic. Given Kemp's ridley presence may overlap with these fishery operations, an interaction is possible. The problem appears to involve entanglement in the float lines or the bridles of the trap/pot. Research is ongoing to reduce the amount of exposed line on traps and includes using a ground line to tie pots together rather than each having its own float. This and other promising technologies need to be pursued and implemented as appropriate.

224. Ensure enforcement of all fisheries regulations (Listing Factor D)

A number of federal and state regulations have been enacted over the past 20 years to reduce bycatch of sea turtles in various fishing gears, such as trawls, gillnets, and pound nets. Enforcement is critical to maintaining effectiveness of these bycatch reduction measures. State enforcement agencies have developed joint enforcement agreements with NMFS and USCG to enforce fisheries regulations. Year-round vigorous enforcement efforts both dockside and at-sea must be implemented and/or enhanced and maintained.

225. Monitor and reduce impacts from hopper dredging activities (Listing Factor D)

The ACOE is congressionally mandated to maintain United States navigational channels. To ensure that authorized channel depths are sustained, periodic dredging is required. Some types of dredges, particularly the hopper dredge, have been shown to take sea turtles. On a cumulative basis, this take is believed to be significant. The ACOE implemented sea turtle deflector devices, relocation trawling, and dredging windows for hopper dredges in 1992, and is currently working, and should continue to work, on new technologies to reduce interactions.

Turtle mortality can be documented by screening the inflows/outflows on a hopper dredge, observing aboard a clamshell dredge, or observing the discharge of a pipeline dredge. Presently, NMFS believes that few, if any, turtles are affected by clamshell or pipeline dredges. However, hopper dredges have been documented to take turtles. Therefore, seasonal restrictions on its use, adequate observer coverage, and appropriate screening on all hopper dredge operations should be required to reduce and document take and associated mortality.

226. Monitor and reduce impacts from oil/gas activities (Listing Factor D)

The highest concentration of petroleum industry infrastructure is found in the northern and western portions of the Gulf of Mexico. Exploration for new petroleum reserves, construction of new platforms and liquid natural gas terminals, removal of platforms, and conversion of rigs into artificial reefs will continue in the Gulf of Mexico and may occur to a greater extent along the U.S. Atlantic coast. Kemp's ridleys are known to associate with oil and gas production platforms, particularly those in the shallow waters of the continental shelf where they feed and migrate. Studies to better document the presence of Kemp's ridleys near oil and gas production facilities and liquid natural gas terminals, particularly in nearshore waters, are needed to better assess potential impacts and to inform efforts to reduce identified impacts. Research to determine the impact of anti-biofouling agents used in liquid natural gas operations on Kemp's ridleys and their prey is also needed. The lessons learned from the DWH spill show that industry and government agencies must work together to prevent accidents. The BOEMRE is mandated to provide safety oversight of oil and gas operations to redue the risk of oil spills.

227. Monitor and reduce impacts from terrestrial and marine military activities (Listing Factors A and E)

National security is a major public concern and has resulted in the need for increased military training and monitoring operations. Operations with potential impact on Kemp's ridleys include, but are not limited to, construction and logistical support, increased traffic (air, ground, and water), marine debris, ordnance release, and sonar operations. The Department of Defense continues to consult with FWS and NMFS on the potential impact their activities have on Kemp's ridleys. Existing monitoring and mitigation measures must be maintained. Additional measures to reduce the impacts should be developed and implemented as new technologies and practices are employed.

228. Reduce marine pollution

2281. Reduce entanglement in and ingestion of marine debris (Listing Factor A)

Discarded ropes, fishing line, crab pots, mesh bags, and other materials can entangle Kemp's ridley turtles, causing injury or death. Kemp's ridleys may also ingest debris, such as Styrofoam and plastic, causing injury or death. Programs should be continued to educate boaters, fishers, and others not to discard items that could cause entanglement and/or be ingested. The Marine Pollution Control Act (MARPOL) treaty should be actively enforced. Marine and beach debris clean-ups should be continued.

2282. Assess and reduce effects of contaminants on Kemp's ridleys (Listing Factor A)

Few contaminant studies exist on the Kemp's ridley, and a high volume of hydrocarbon and other chemical production systems exist in the Gulf of Mexico. Additional studies as well as periodic re-evaluation of contaminant data are needed as new and more sensitive measurement technologies are developed. Since end point effects (e.g., reproductive or immunological impacts) of contaminants have not been determined in the Kemp's ridley, these types of studies are priorities. Research to determine the impact of anti-biofouling agents used in liquid natural gas operations on Kemp's ridleys and their prey is also needed.

2283. Conduct baseline health assessments for the Kemp's ridley population (Listing Factor C)

Although several baseline health reviews are available (e.g., Caillouet 1997, Rostal 2007), more basic and more detailed studies of baseline health patterns in Kemp's ridleys are needed to improve our ability to diagnose toxicological, reproductive, and other sub-lethal stressors of individuals and populations. These studies should cover all ages and developmental stages of the species. A better understanding of the medical condition as well as improved medical approaches is needed to rehabilitate stranded turtles in order to reduce the long times (and high costs) now required for rehabilitation. Full blood diagnostics, including basic chemistries, enzymes, immunological, toxicological, and endocrinological components are needed for the Kemp's ridley and, with very few exceptions, have not been well documented. NMFS Galveston laboratory developed a useful database for captive headstarted turtles. An on-line database that could be accessed by medical intervention teams would markedly improve how rehabilitation facilities treat their turtles.

2284. Continue monitoring red tide and HABs (Listing Factors C and E)

Red tide and HAB events have occurred throughout the range of the Kemp's ridley. Heavy blooms can kill important prey species, and Florida researchers have confirmed red tide caused mortalities in Kemp's ridleys, although these events are sporadic. Mortalities associated with red tide events have not been documented in Texas or Mexico. Red tide and HAB events should continue to be monitored, and researchers should develop remedial actions for minimizing impacts of red tide and HABs.

229. Genetics

2291. Monitor status of hybrids (Listing Factor E)

Hybridization between sea turtle species has been documented for most species pairs. Although very rare, the phenomenon appears to be more common if there is a temporal and spatial overlap in mating areas, and when one of the species pairs is abundant and the other relatively rare (Karl *et al.* 1995; Seminoff *et al.* 2003). Also, while both sexes have been implicated as parents of hybrids in many species, the relative smaller size of Kemp's ridleys with respect to other species with overlapping distributions may result in only females being involved in inter-specific crosses (Karl *et al.* 1995). The only hybrid confirmed by genetics involved a female Kemp's ridley and a male loggerhead (Karl *et al.* 1995). However, possible hybrids involving loggerhead and green turtle crosses based on phenotype have been reported in nesting Kemp's ridleys (J. Pena, GPZ, personal communication 2006). Although the events are rare, they could be underreported. The Kemp's ridley population has experienced reduced abundance over decades, increasing the probability of hybridization with loggerheads and greens which overlap to some extent with the nesting season of the Kemp's ridley. Periodic monitoring of hybrids by morphological and genetic means is recommended to quantify the extent of extraneous genes being introduced into the normal population.

2292. Genetic composition on foraging grounds (Listing Factor E)

In parallel with the genetic characterization (using multiple loci) of established and emerging rookeries, the molecular composition of the population at key foraging grounds needs to be established. If inter-rookery genetic differentiation is detected, molecular markers should be used to evaluate the stock composition at foraging grounds. Levels and changes in the contribution by source populations will be useful to monitor the recruitment and status of individual rookeries in the marine habitat.

23. Maintain a stranding network (Listing Factor D)

The STSSN in the U.S. and the stranding network in Mexico should be continued to help protect and manage Kemp's ridley populations in the marine environment. These networks can document hot spots of nearshore negative human/sea turtle interactions and provide data that can be used to focus monitoring, research, and management actions to recover Kemp's ridleys. The stranding networks collect information on the biology of the species, which is also important for protection and management in the marine environment. Additionally, live stranded turtles are transported to rehabilitation facilities and a large percent are later released, thus directly contributing to conservation. Stranding network data collection and associated activities should be continued to help ensure the effectiveness of protection and restoration activities for Kemp's ridley.

24. Manage captive stocks (Listing Factor E)

Because of the outstanding long-term efforts of the NMFS Galveston laboratory and Cayman Turtle Farm, Ltd. on Grand Cayman Island, the requirements for rearing and captive breeding of the Kemp's ridley are well understood and unusually well documented. With the species undergoing recovery, there is no need to continue to captively rear Kemp's ridleys. An important spin off of this captive work, which was in the 1980s considered essential for the full recovery of the species, has been the development of a considerable body of physiological, health, and nutritional knowledge of this species.

It would be inappropriate to encourage the development of further captive populations of this species at this time. Also, release to the wild is not recommended for captive rearing and release of current captive turtles with symptoms of disease. Large collections of Kemp’s ridleys are located at the Cayman Turtle Farm and at Xcaret Marine Park in Quintana Roo, Mexico. The Team supports educational use and limited captive research and study of these populations, but we are concerned that release of these animals back to the wild may expose the natural stock to diseases. Some unknown medical problem might have developed in the captive stocks and might be transferable to the recovering wild stocks from the captive individuals. Most of the members of the Team believe this is unlikely to occur, but we recommend no further headstarting or maintenance for purposes of captive breeding or release of current captive turtles exhibiting disease symptoms to the wild. A careful study of the medical and health status of current captive stocks is recommended.

3. Sustain Education and Partnership Programs

31. Educate the public

311. Continue programs currently in place (Listing Factors A and B)

Public education programs implemented in Mexico and the U.S. (by CONANP, State of Tamaulipas, GPZ, FWS, NPS, HEART, NMFS, Sea Turtle Inc., and others) should be continued. The main goal of these educational programs is to generate, maintain, or increase support for, and assistance with, the conservation of the Kemp's ridley. Such programs will facilitate the sustained adoption of attitudes and conduct that will benefit environmental conservation and the recovery of the species through the understanding of how individual and group actions can influence the relationship between the environment’s condition and the quality of human life. Education programs must be continued to help minimize threats to the turtles and their eggs, as human and Kemp’s ridley populations continue to increase.

312. Develop and implement a communication campaign in various media (Listing Factors A and B)

The development and implementation of a communication campaign in various media (e.g., radio, television, computer, print) will inform citizens on the efforts carried out by both governments to protect, conserve, and recover populations of Kemp’s ridley, not only in nesting sites but also in feeding and resting zones. The campaign will advise the public on the relevance of protecting and conserving wild populations. Also, it would help to promote the participation of all stakeholders in such actions, thereby reducing the number of illegal activities that adversely affect the Kemp’s ridley.

313. Continue to focus Kemp's ridley education programs at peripheral camps (Listing Factors A and B)

At the peripheral camps (La Pesca, Altamira, and Miramar), the general public is allowed to observe the conservation activities. Public interaction with conservation programs has been shown as effective at securing public interests in such programs and will lead to awareness through the participation of the local communities in the sea turtle conservation activities. Direct involvement in conservation activities that benefit Kemp's ridleys allows the participant to realize the species' vulnerability. Fostering the values of responsibility and respect is essential to create an environmental conscience.

314. Develop additional public education plans (Listing Factors A and B)

Tamaulipas and Veracruz state-wide education plans should be developed as part of the Kemp's Ridley Bi-national Program activities. These plans should be coordinated with Mexico and U.S. government agencies, as well as NGOs. The recently formed Tamaulipas Sea Turtle Protection and Conservation Coordinating Committee can be an integral part in the development of this plan and representatives of Veracruz government agencies and NGOs (such as the Veracruz Aquarium) should be encouraged to participate. The plan should include a public awareness aspect and be carried out by volunteers or students under the supervision of experienced biologists and/or educators. Technology transfers may also be part of this plan where sea turtle biologists from both countries participate in workshops and other specialized training.

While major emphasis should take place at the beaches where there is a large urban component nearby (i.e., La Pesca and Playa Miramar) ecological and conservation education programs are imporatant in all the communities surrounding the field stations.

Historically, in subsistence level coastal communities where conservation laws prohibit the harvest of resources (e.g., sea turtles and eggs), attitudes toward the protected resources may most effectively be changed through education. Creating socioeconomic alternatives to replace the economy based on the protected resource is critical in combination with educational programs.

315. Place educational signs on nesting beaches (Listing Factors A and B)

Educational signs should be placed on Mexico's nesting beaches (Rancho Nuevo, Tepehuajes, Playa Dos, Lechuguillas, and Tecolutla) and the U.S. (North and South Padre, and Boca Chica Beach) to raise public awareness and ensure conservation programs are sustained. These signs should inform the public about the biology, status, and laws protecting the Kemp's ridley, list procedures to follow, and provide contact information with appropriate authorities if nesting or stranded turtles are found. Beach signs should also grab the attention of the public, transmit a clear and concise message, and be of the same structure and composition to create a consistent and recognizable image.

As human and Kemp's ridley populations continue to increase, there will be more incidents of the public arriving at nesting events prior to the official beach monitors/patrollers. The public needs to be informed about what they should do to ensure the safety of the nesting turtle and nest (e.g., watch from a safe distance, report the observation immediately, etc.), particularly in Texas, where approximately half of the nests located each year are found by the public.

32. Develop community partnerships

321. Implement community social/economic development programs in Mexico (Listing Factors A and B)

One of the main causes for mortality of sea turtles is the incidental capture in various fisheries that occur on migration routes, feeding grounds, breeding grounds, and concentration areas in front of the nesting beaches. Community social/economic development programs for fisheries within the communities are needed in conjunction with the Kemp's ridley conservation programs. Efforts will initially focus on Rancho Nuevo, but will be expanded to other communities.

With the objective of lowering the impacts caused by the fishing operations in these zones, fishers should have economic alternatives to fishing. Pilot projects should continue to be developed by Federal, state, and local government to design, promote, and implement viable, socially accepted economic alternatives. Projects should be geared toward the fishing sectors taking into consideration the cultural and socio-economic situation of each type of fishery.

322. Continue to build partnerships with businesses/corporations (Listing Factor A)

Economic development presents one of the great challenges to sustaining an ecological balance. The governments of Mexico and the U.S. must build and maintain partnerships with states, businesses, and local communities to ensure that future development does not adversely impact Kemp's ridley habitat. Alternatives to projects that may have an adverse impact on Kemp's ridleys need to be developed and financed. Sustainable, long-term protection of the Kemp's ridley may be achieved largely through the collaboration, partnering, and participation at all levels of society.

323. Develop effective consumer awareness program to promote potential green measure options for economic activities related to recovery (Listing Factors B and E)

Alternatives to traditional management measures that promote the protection and conservation of Kemp's ridleys are essential to their long-term recovery.

Consumer awareness can be enhanced through ecotourism and incentives to support products and services that are 'turtle-safe.' Market-driven strategies will provide economic opportunities while protecting sea turtles.

33. Maintain and develop local, state, and national government partnerships

331. Develop memorandum of understanding/agreements/commitments between the U.S. and Mexico (Listing Factor D)

The U.S. and Mexico governments have successfully collaborated for over 30 years on the conservation of the Kemp's ridley. The States of Tamaulipas and Texas have also become major partners in conservation efforts during the last decade. A formal Memorandum of Understanding or Agreement would be beneficial to clarify and affirm the continued commitments of these entities to long-term conservation and contribute to the smooth operation of on-the-ground activities in Mexico.

332. Form a state working group/committee for the Kemp's ridley in Mexico (Listing Factor D)

A State committee for the protection and conservation of the Kemp's ridley should be formed to ensure integrated management planning and action. This committee should include participants from proper authorities, local communities, government agencies, NGOs, fishers, and tourist industries. Participation of local communities is essential in decisions about site specific management. This might be accomplished via a memorandum of understanding or other form of agreement.

333. Identify and obtain sustainable sources of funding (Listing Factor D)

The current successful recovery of the Kemp's ridley population on the nesting beaches is only sustainable through long-term, intensive presence and management on the nesting beaches as well as continued compliance with the TED requirements in both countries. This will require commitments to at least the current levels of funding (adjusted for inflation) and effort for the foreseeable future. Disruption in full funding at the national and state levels will particularly undermine the support and commitment of conservation at the local community level where long-term security of the nesting population ultimately rests.

4. Legal Framework

41. Maintain, promote awareness of, and expand U.S. and Mexican laws

411. Promote awareness of laws (Listing Factor D)

The lack of knowledge of laws makes it difficult to protect and conserve sea turtles. Mechanisms are needed to achieve public awareness of the laws and regulations concerning sea turtle conservation and protection as well as the social awareness that will lead to the compliance with the laws. Workshops, such as those mentioned below, should be continued and other methods employed.

PROFEPA has convened regional protection and conservation workshops specifically designed for fishers. These workshops cover subjects such as environmental laws, policies, conservation management, and responsible fishing practices. These workshops include both Federal agencies and conservation organizations. SEMARNAT, PROFEPA, and the state should present promotional materials (e.g., pamphlets, signs) about the laws and other conservation subjects in future workshops.

The results of conservation efforts by both Mexico and the U.S. must also be made known so that society as a whole is aware of how important active participation is when it comes to upholding the laws concerning the protection and conservation of sea turtles.

412. Identify gaps in law; consider need for revisions (Listing Factor D)

In Tamaulipas, Mexico, the highest number (216) of dead stranded Kemp's ridleys was recorded in 2007, which coincided with the publication of the new regulations for shark and ray fisheries (DOF 2007). An analysis is needed of whether the 5 km-wide area of protected ocean in front of the nesting beaches is enough to prevent Kemp's ridleys from drowning in fishing gear.

42. Implement international agreements

421. Ensure the proper implementation of international conventions (Listing Factor D)

The U.S. and Mexico are both signatories to the Inter-American Convention for the Protection and Conservation of Sea Turtles as well as CITES. Both conventions require parties to carry out specific activities to ensure the conservation of marine turtles through measures such as nesting beach programs and the use of TEDS in shrimp fisheries. These instruments provide a mechanism to ensure the long-term conservation of the Kemp's ridley through regional cooperation.

43. Enforce laws

431. Ensure adequate law enforcement in the marine environment (Listing Factors B and D)

Adequate regulatory authority exists under the ESA to protect Kemp's ridleys; however, resources for both Federal and state enforcement are lacking. This situation has been exacerbated, in part, by reassignment of priorities in the USCG to homeland security. Enforcement surveillance should be increased and an increase in penalties for not using TEDs in shrimp trawlers should also be considered. Joint Enforcement Agreements should be established with all relevant coastal states.

Illegal directed fishing for sea turtles in U.S. and Mexican waters is not believed to be a major problem. However, incidental take and subsequent consumption of turtles may be a larger problem than suspected among certain groups of fishers. Law enforcement efforts should be increased to find and prosecute fishers possessing sea turtles illegally and to ensure that rules and regulations are followed.

The Comisión Nacional de Pesca y Acuacultura should establish an enforcement and inspection program specifically designed to verify that the fishing vessels operating in a particular area have the proper permits and are conducting authorized fishing practices.

432. Ensure adequate law enforcement in the terrestrial environment (Listing Factors B and D)

Illegal poaching of sea turtle eggs for human consumption and the alteration of nesting beach habitat due to illegal activities negatively affects Kemp's ridleys in Mexico. To protect nesting sea turtles and stop egg poaching, monitoring and surveillance on the nesting beaches should be strengthened through permanent operations in coordination with agencies such as Secretaría de Marina and in collaboration with local communities.

433. Ensure adequate law enforcement in the marketplace (Listing Factors B and D)

Illegal commerce of eggs, meat, and products derived from Kemp's ridleys and other sea turtles is a problem in Mexico. Inspection programs should be strengthened and coordinated for states and municipalities that are near the nesting beaches where egg consumption is traditional.

PART III: IMPLEMENTATION SCHEDULE

IMPLEMENTATION SCHEDULE TABLE

IMPLEMENTATION SCHEDULE
Recovery Plan for the Kemp's Ridley Sea Turtle

Priority[3]	Action Category	Action Number	Action Description	Action Duration (Years)	Responsible Party		Total Cost ($1,000s)	Cost Estimate by FY (by $1,000s)					Comments
					Lead	Others		FY11	FY12	FY13	FY14	FY15	
1	**11 Protect and manage nesting habitats**	1111	Maintain and reinforce habitat protection efforts on nesting beaches	Continuous	CONANP	PROFEPA	routine						regulatory—ongoing; routine costs includes agency staff & infrastructure
2		1112	Develop & implement a management plan for Kemp's ridley for Rancho Nuevo Sanctuary	2 years	CONANP		routine						routine costs includes agency staff & infrastructure
2		1113	Expand boundaries of Rancho Nuevo Sanctuary from 23° N	5 years	CONANP		routine						regulatory; routine costs includes agency staff & infrastructure
2		1114	Develop & implement a management plan for Kemp's ridley for Natural Areas and other sanctuaries	5 years	CONANP		routine						routine costs includes agency staff & infrastructure

[3] See Appendix I: Kemp's Ridley Threats Analysis steps (11) and (12) describing how the Team prioritized recovery actions.

Implementation Schedule
Recovery Plan for the Kemp's Ridley Sea Turtle

Priority[3]	Action Category	Action Number	Action Description	Action Duration (Years)	Responsible Party		Total Cost ($1,000s)	Cost Estimate by FY (by $1,000s)					Comments
					Lead	Others		FY11	FY12	FY13	FY14	FY15	
2		1115	Develop and implement a coastal zone management plan throughout Kemp's nesting distribution in Mexico	5 years	CONANP		routine						regulatory; routine costs includes agency staff & infrastructure
3	**11 Protect and manage nesting habitats**	1116	Initiate reforestation program for Rancho Nuevo	10 years	CONANP	Community of Rancho Nuevo	1,000		100	100	100	100	
2		1117	Undertake topographic survey of three main nesting beaches in MX	3 years	CONANP		150		50	50	50		
2		112	Ensure nesting habitat is protected on Texas nesting beaches	Continuous	PAIS	State of Texas FWS	routine						regulatory—ongoing; routine costs includes agency staff & infrastructure
2		113	Assess long-term impacts of global climate change on nesting beaches	Continuous	CONANP	FWS PAIS	100	50	25	25			
2		114	Develop oil spill contingency plan that includes responses at nesting beaches	Continuous	SEMARNAT FWS USCG	PAIS BOEMRE	routine						regulatory—ongoing; routine costs includes agency staff & infrastructure

Implementation Schedule Recovery Plan for the Kemp's Ridley Sea Turtle													
Priority[3]	**Action Category**	**Action Number**	**Action Description**	**Action Duration (Years)**	**Responsible Party**		**Total Cost ($1,000s)**	**Cost Estimate by FY (by $1,000s)**					**Comments**
					Lead	**Others**		**FY11**	**FY12**	**FY13**	**FY14**	**FY15**	
1	**12 Protect and manage marine habitats**	121	Identify important marine foraging, breeding and inter-nesting habitats	10 years	NMFS CONANP		1,000	100	100	100	100	100	
1		122	Identify & designate marine protected areas to facilitate increased protection of important foraging, breeding, and inter-nesting habitats	20 years	NMFS CONANP	Coastal states	routine						regulatory—ongoing; routine costs includes agency staff & infrastructure
2		123	Ensure oil and gas exploration and development activities do not negatively affect foraging, breeding or inter-nesting habitat.	Continuous	NMFS CONANP USCG	BOEMRE PAIS	routine						routine costs includes agency staff & infrastructure
1	**21 Protect and manage population on nesting beaches**	211	Protect nesting females	Continuous	CONANP FWS PAIS	GPZ	* 750/yr	750	750	750	750	750	*includes costs for tasks 212 & 2131
1		212	Maintain hatchling production at levels to achieve recovery goals	Continuous	CONANP PAIS	FWS GPZ	*	*	*	*	*	*	
1		2131	Continue monitoring and collecting basic biological information on primary nesting beaches in MX and U.S.	Continuous	CONANP PAIS	FWS GPZ	*	*	*	*	*	*	
3		2132	Assess nesting south of Matamoros and north of Carbonera	Continuous	CONANP	FWS GPZ	25/yr	25	25	25	25	25	
2		214	Develop nesting beach management plans	3 years	CONANP PAIS	GPZ FWS	routine						routine costs includes agency staff & infrastructure
2		2151	Continue monitoring and assessing hatchling sex ratios	Continuous	CONANP PAIS	UAB	25/yr	25	25	25	25	25	
2		2152	Model climate change	1 year	CONANP	UAB	25		25				

IMPLEMENTATION SCHEDULE
Recovery Plan for the Kemp's Ridley Sea Turtle

Priority[3]	Action Category	Action Number	Action Description	Action Duration (Years)	Responsible Party: Lead	Responsible Party: Others	Total Cost ($1,000s)	Cost Estimate by FY (by $1,000s): FY11	FY12	FY13	FY14	FY15	Comments
			effects on hatchling sex ratios		FWS								
2		216	Determine and monitor nesting female survival rates	Continuous	CONANP PAIS	FWS GPZ	50/yr	50	50	50	50	50	
2		217	Monitor neophyte nesters	Continuous	CONANP PAIS	FWS GPZ	**	**	**	**	**	**	**Incl in 216 costs
1	**22 Protect and manage populations in marine environment**	221	Establish monitoring sites in foraging areas	10 yrs	CONANP NMFS	Coastal state marine resource agencies	5,000	500	500	500	500	500	
1		222	Determine migratory pathways among foraging grounds and between foraging grounds and nesting beaches	10 yrs	CONANP NMFS	Universities PAIS	5,000	500	500	500	500	500	
1	**22 Protect and manage populations in marine environment**	2231	Implement monitoring programs in recreational and commercial fisheries in U.S. & Mexico	Continuous	NMFS CONAPESCA	Coastal state marine resource agencies CONANP	1,000/yr	1,000	1,000	1,000	1,000	1,000	
1		2232	Implement monitoring in the shark fishery in Mexico	Continuous	CONAPESCA	CONANP	50/yr	50	50	50	50	50	
2		2233	Monitor emerging fisheries	Continuous	CONAPESCA NMFS	CONANP Coastal state marine resource agencies	50/yr	50	50	50	50	50	
1		22341	Maintain regulations in fisheries currently required to use TEDs	Continuous	NMFS CONAPESCA	Coastal state marine resource agencies	750/yr	750	750	750	750	750	regulatory—ongoing; includes 224

IMPLEMENTATION SCHEDULE
Recovery Plan for the Kemp's Ridley Sea Turtle

Priority[3]	Action Category	Action Number	Action Description	Action Duration (Years)	Responsible Party		Total Cost ($1,000s)	Cost Estimate by FY (by $1,000s)					Comments
					Lead	Others		FY11	FY12	FY13	FY14	FY15	
1		22342	Require TEDs in all trawl fisheries of concern	5 years	NMFS CONAPESCA	Coastal state marine resource agencies	routine						regulatory—ongoing; routine costs includes agency staff & infrastructure
1		22343	Reduce mortality in gillnet fisheries	5 years	NMFS CONAPESCA	Coastal state marine resource agencies	1,000	200	200	200	200	200	research and regulatory
1		22344	Reduce mortality in hook and line fisheries	10 years	NMFS CONAPESCA	Coastal state marine resource agencies	1,000	200	200	200	200	200	research and regulatory
2		22345	Reduce mortality in trap/pot fisheries	4 years	NMFS CONAPESCA	Coastal state marine resource agencies	100	30	30	30	10		research and regulatory
1		224	Ensure enforcement of all fisheries regulations	Continuous	NMFS CONAPESCA USCG	Coastal state marine resource agencies	*						* see 22341
3	**22 Protect and manage populations in marine environment**	225	Monitor and reduce impacts from dredging activities	Continuous	COE NMFS	Coastal state marine resource agencies	routine						routine costs includes agency staff & infrastructure
2		226	Monitor & reduce impacts from oil & gas activities	Continuous	NMFS USCG BOEMRE CONANP PROFEPA	Coastal state marine resource agencies	routine						routine costs includes agency staff & infrastructure
2		227	Monitor and reduce impacts from military activities	Continuous	NMFS USNavy USCG	FWS NPS	routine						routine costs includes agency staff & infrastructure
3		2281	Reduce entanglement and ingestion of marine debris	Continuous	NMFS USCG SEMARNAT	FWS Coastal state marine resource agencies	routine						routine costs includes agency staff & infrastructure

IMPLEMENTATION SCHEDULE
Recovery Plan for the Kemp's Ridley Sea Turtle

Priority[3]	Action Category	Action Number	Action Description	Action Duration (Years)	Responsible Party		Total Cost ($1,000s)	Cost Estimate by FY (by $1,000s)					Comments
					Lead	Others		FY11	FY12	FY13	FY14	FY15	
2		2282	Assess and reduce effects of contaminants on Kemp's ridleys	3 years	NMFS FWS SEMARNAT	Universities	150		50	50	50		research
2		2283	Determine baseline health assessment for Kemp's ridley population	3 years	NMFS FWS CONANP	Universities	150		50	50	50		
3		2284	Continue monitoring red tide and HABs	Continuous	NMFS SEMARNAT	Universities Coastal state marine resource agencies	routine						routine costs includes agency staff & infrastructure
3		2291	Monitor status of hybrids	Continuous	CONANP NMFS	Universities	75/yr	75	75	75	75	75	
3		2292	Determine genetic composition on foraging grounds	10 yrs	NMFS SEMARNAT	Universities, Coastal state marine resource agencies	750	75	75	75	75	75	
2	**23 Maintain stranding network**	23	Ensure stranding network continues	Continuous	NMFS CONANP	Coastal state marine resource agencies, Universities, FWS, NPS, and NGOs	250/yr	250	250	250	250	250	
2	**24 Manage captive stocks**	24	Ensure captive turtles are not released to the wild	Continuous	SEMARNAT NMFS FWS	Permitted holding facilities	routine						routine costs includes agency staff & infrastructure
2	**31 Public education**	311	Continue education programs currently in place	Continuous	CONANP PAIS	FWS Sea Turtle Inc.	routine						routine costs includes agency staff & infrastructure
2		312	Develop and implement communication	3 years	SEMARNAT	FWS NMFS	45	15	15	15			

IMPLEMENTATION SCHEDULE
Recovery Plan for the Kemp's Ridley Sea Turtle

Priority[3]	Action Category	Action Number	Action Description	Action Duration (Years)	Responsible Party		Total Cost ($1,000s)	Cost Estimate by FY (by $1,000s)					Comments
					Lead	Others		FY11	FY12	FY13	FY14	FY15	
			campaign in different media			Sea Turtle Inc., other ngos							
2		313	Continue to focus Kemp's ridley education programs at La Pesca	Continuous	APEDS		routine						routine costs includes agency staff & infrastructure
2		314	Develop additional public education plans	5 yrs	CONANP		35	10	10	5	5	5	
3		315	Place educational signs on nesting beaches	5 yrs	CONANP APEDS PAIS FWS		50	10	10	10	10	10	
1	**32 Community involvement**	321	Implement community social/economic development program	Continuous	CONANP APEDS	FWS	150/yr	150	150	150	150	150	
2		322	Continue to build partnerships with business/corporations	Continuous	SEMARNAT CONANP FWS NMFS	PAIS	routine						routine costs includes agency staff & infrastructure
3		323	Develop effective consumer awareness program	5 years	SEMARNAT CONANP APEDS	FWS NMFS	50	10	10	10	10	10	
3	**33 Local, state, and national government responsibility and coordination**	331	Develop memorandum of understanding for bi-national commitments between U.S. and Mexico	1 year	SEMARNAT CONANP FWS NMFS CONAPESCA		routine						routine costs includes agency staff & infrastructure
3		332	Form state working group/committee in Mexico	2 years	CONANP		routine						routine costs includes agency staff & infrastructure
1		333	Identify and ensure sustainable sources of funding	Continuous	CONANP	FWS NMFS NPS, Coastal state marine resource agencies	routine						routine costs includes agency staff & infrastructure

IMPLEMENTATION SCHEDULE Recovery Plan for the Kemp's Ridley Sea Turtle													
Priority[3]	Action Category	Action Number	Action Description	Action Duration (Years)	Responsible Party		Total Cost ($1,000s)	Cost Estimate by FY (by $1,000s)					Comments
					Lead	Others		FY11	FY12	FY13	FY14	FY15	
3	**41 U.S. and Mexican laws**	411	Promote awareness of laws	Continuous	PROFEPA SEMARNAT NMFS FWS USCG		routine						routine costs includes agency staff & infrastructure
2		412	Indentify gaps in law, consider need for revisions	Continuous	PROFEPA SEMARNAT		routine						routine costs includes agency staff & infrastructure
3	**42 International agreements**	421	Ensure the proper implementation of international conventions	Continuous	SEMARNAT FWS NMFS		routine						routine costs includes agency staff & infrastructure
1	**43 Law enforcement**	431	Ensure adequate law enforcement in marine environment	Continuous	PROFEPA NMFS USCG		routine						routine costs includes agency staff & infrastructure
1		432	Ensure adequate law enforcement in terrestrial environment	Continuous	PROFEPA FWS	PAIS, state agencies	routine						routine costs includes agency staff & infrastructure
3		433	Ensure adequate law enforcement in marketplace – Mx	Continuous	PROFEPA		routine						routine costs includes agency staff & infrastructure

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APPRENDIX: KEMP'S RIDLEY THREATS ANALYSIS

Recent assessments of recovery plans have indicated that the analysis of threats has received insufficient attention (Clark *et al*. 2002) and that this lack of knowledge regarding the nature of threats facing a species is likely to contribute to the failure of recovery plans (Lawler *et al*. 2002). Based on these assessments, the Kemp's Ridley Recovery Team adopted, with minor changes, a detailed analysis of threats used by the Loggerhead Recovery Team to prioritize recovery actions (see: Bolten et al. 2010). The following steps describe the process used to identify, categorize, rank, and prioritize threats. The annotated threats tables are posted on the FWS Kemp's Ridley Recovery Plan website [http://www.fws.gov/kempsridley/index.html] and NMFS Office of Protected Resources Recovery Plan website [http://www.nmfs.noaa.gov/pr/recovery/plans.htm].

(1) Threats affecting Kemp's ridleys are often specific to life stages and the habitats where they occur. The Team identified and evaluated three ecosystems used by the Kemp's ridley (terrestrial, neritic, and oceanic) and associated each with the life stages occurring in those ecosystems (see below) as the first step in developing the threats analysis matrix. The eight life stage/ecosystem combinations used in the threats analysis are presented in the table below. The Team acknowledged that adult Kemp's ridleys are not generally considered to be oceanic, however for purposes of possible threats in the pelagic environment, the Team identified this life stage and ecosystem.

Lifestage	Ecosystem
Nesting female	Terrestrial Zone
Egg	Terrestrial Zone
Hatchling stage	Terrestrial Zone
Hatchling swim frenzy, transitional stage	Neritic Zone
Juvenile stage	Oceanic Zone
Adult stage	Oceanic Zone
Juvenile stage	Neritic Zone
Adult stage	Neritic Zone

(2) All identified threats were grouped into 7 categories (see Table A1-1): Resource Use-Fisheries Bycatch, Resource Use-Non-Fisheries, Construction, Ecosystem Alterations, Pollution, Species Interactions, and Other Factors.

(3) To facilitate ranking and presenting the threats affecting the Kemp's ridley, the three elements (life stage, ecosystem, and specific categories of threats) were combined into a matrix using Microsoft Excel (Table A1-2). A separate worksheet was developed for each of the 7 threat categories (see Table A1-1; see separate worksheets at A1-7—A1-13) with each specific threat within the threat categories identified as a separate column.

(4) Annual mortality for each life stage/ecosystem for each specific threat was estimated as a "category" of mortality using a color-coded geometric ($\log_{10}$) scale (Table A1-3). The annual mortality category for each threat was based on current risk or risk in the foreseeable future. The geometric midpoint for that color-coded category was used for calculations of the annual mortality based on the relative reproductive value each life stage contributed to overall population reproductive viability (Table A1-4; see (6) below).

When quantitative data were not available, the Team assigned a category of mortality based on best available information and their expert opinion. The estimated annual mortality is expressed as 0 (no evidence of mortality) or as a geometrically-scaled class interval (Table A1-3). However, the Team was not able to estimate a category of mortality for a number of threats because there were insufficient data on the effect of those threats on annual mortality. For those threats, the cells are represented by three color codes: (1) stippled-sublethal effects only; (2) stippled & gray-sublethal and mortality; and (3) gray-mortality only (Table A1-3).

The <**COMMENT**> feature of Microsoft Excel was used to document the data source, calculations, and justification for each estimate of mortality presented in each cell of the matrix. The annotated threats tables with <**COMMENT**> fields are posted on the FWS Kemp's Ridley Recovery Plan website [http://www.fws.gov/kempsridley/index.html] and NMFS Office of Protected Resources Recovery Plan website [http://www.nmfs.noaa.gov/pr/recovery/plans.htm]. The individual threats tables follow (A1-7 –A1-13).

(5) Sub-lethal effects have been identified for certain threats and life stages. Sub-lethal effects are likely to affect individual fitness (e.g., somatic growth, egg production, hatchling production, nesting range, foraging range), but do not result in mortality. Sub-lethal effects were not included in the annual mortality estimate. The Team recognized that sub-lethal effects are likely inherent in any threat where mortality occurs. The Team also acknowledged that data are insufficient for all sub-lethal effects. The Team felt a cell category that expresses insufficient data for both sub-lethal effects and mortality was needed (Table A1-3). This cell category helped the Team prioritize threat categories where information was lacking for both sub-lethal effects and mortality.

(6) For each threat category, the total annual mortality for each life stage/ecosystem for all specific threats within that threat category was summed. To compare annual mortality among life stages, the annual mortality for each life stage was adjusted by the reproductive value of each life stage. This adjustment was done to evaluate the lost reproductive potential of those animals killed by the threat. An individual's potential for contributing offspring to future generations is its reproductive value (RV, Table A1-4). The reproductive values were developed using an updated stage-based demographic model for the Kemp's ridley (S. Heppell, Oregon State University, unpublished data, see Demographics section (F) for detail on the model inputs). The reproductive values were converted to "relative reproductive values" (RRV) based on the reproductive value of a nesting female, which is 1 (Table A1-4). The estimated annual mortality category (A1-3)

geometric midpoint value was summed for each life stage/ecosystem and multiplied by the RRV to derive the 'Total Estimated Adjusted Annual Mortality" (i.e., adult female equivalent) for all specific threats within a threat category (A1-7—A1-13). This approach is for illustrative purposes to highlight threats relevant to each other and is not meant to devalue the importance of conserving young animals.

Several assumptions were made in calculating the relative reproductive values and need to be recognized when interpreting the results of this threats analysis. Most importantly, one must assume that there is a stable age distribution – a constant proportion of individuals in each life stage of the growing population. While that may be nearly true now, it may not be in future if density dependence occurs. Also, Table A1-4 suggests that there is a knife-edge ontogenetic change from the oceanic juvenile stage to the neritic juvenile stage and from the juvenile neritic stage to reproductive adults. In reality, this first ontogenetic change occurs over time (the average is 1.5-2 years) and over a range of sizes and age-to-maturity. In addition, the neritic juvenile stage spans 10 years (oceanic stage duration = 2 yr and age at maturity of 12 yr), which results in an overestimate of adjusted mortality for threats exclusively affecting small juveniles and an underestimate of adjusted mortality for threats exclusively affecting large juveniles.

Reproductive values are approximate and based on our current estimates of survival and reproductive rates, which are fit to observed nest numbers that have been increasing since the mid-1990s. The growth rate observed on the nesting beach and the egg survival in corrals has been relatively constant for more than one Kemp's ridley generation, suggesting that the current population could be in a state that is close to a stable age distribution; however, natural populations do not remain at constant proportions due to variability in the vital rates and productivity from year to year. As the population growth rate slows, the reproductive value of juveniles will change as the population shifts to a new average age distribution. If population growth rate slows due to a decrease in the reproductive rate, the value of juveniles will increase relative to the value of adults. Because of the potential changing reproductive value as a scalar, the threat tables presented here should be viewed qualitatively rather than quantitatively, and be updated with new monitoring data on a regular basis.

(7) The uncertainty in the data is noted as a level of data sufficiency for each threat category and was calculated as the total of sublethal effects (stipple); sublethal and mortality with insufficient data (stipple and gray); and mortality with insufficient data (gray) (see Table A1-3). The number of cells for these color codes was expressed as a percent of the total cells for each of the 7 threat categories (Tables A1-7—A1-13).

(8) The threats tables, including the estimated annual mortality values, for each of the threats categories are presented on the FWS Kemp's Ridley Recovery Plan website [http://www.fws.gov/kempsridley/index.html] and NMFS Office of Protected Resources Recovery Plan website [http://www.nmfs.noaa.gov/pr/recovery/plans.htm] and are provided in Tables A1-7—A1-13.

(9) Two types of summary tables were developed. First, a summary table was developed by combining the row totals for the specific threats within a threat category adjusted for relative reproductive values (step 6), for each of the 7 threat categories (Table A1-5). Values are not presented in this summary table, only categories of annual estimates of mortality based on the color-coded scale. Summary Table A1-5 presents the relative importance of each threat category by life stage/ecosystem.

(10) A second summary table was developed to present the annual mortality for each specific threat within a threat category summed for all life stages/ecosystems and adjusted for relative reproductive values for each life stage/ecosystem (Table A1-6).

(11) The summary tables allowed the Team to evaluate the relative importance of each threat category by life stage/ecosystem and by specific threat. The Team used these summary tables to identify and prioritize recovery actions (see Recovery Narrative and Implementation Schedule).

(12) In addition to prioritizing recovery actions, the summary tables identify gaps in our knowledge (stippled and gray-shaded cells) where further research is needed. Although these stippled and gray-shaded cells could not be quantified, they may represent significant threats to the recovery of the Kemp's ridley sea turtle.

Table A1-1. Threat categories and description.

Table A1-1. Threat categories and description		
Category	**Threat**	**Description**
Resource Use-Fisheries Bycatch	Bottom trawl with TEDs	Includes bottom trawl fisheries for shrimp, flounder in NC/southern VA, and Georgia whelk
	Bottom trawl without TEDs	Includes bottom trawl fisheries for other flounder fisheries, shrimp skimmer, blue crab, general finfish, scallop, whelk
	Top/midwater trawl	Includes trawls for *Sargassum,* cannonball jellyfish, and the North Carolina flynet fishery for weakfish
	Dredge	Includes dredge fisheries for Atlantic sea scallops and whelks
	Pelagic longline	Includes longline fisheries for shark, swordfish, tuna, wahoo, and mahi mahi
	Demersal longline	Includes longline fisheries for shark, snapper, grouper, and tilefish
	Demersal, gillnet	Includes gillnet fisheries for black drum, dogfish, monkfish, shark, southern flounder, and general finfish
	Drift and sink gillnet	Includes drift and sink gillnet fisheries for shark, swordfish, tuna, summer flounder, sciaenids, and general finfish
	Pound nets/trap	Includes pound nets for general finfish
	Pot/trap	Includes pot fisheries for crab, lobster, finfish, and whelk
	Haul seine	Includes haul seines for general finfish
	Channel net	Includes channel nets for general finfish
	Purse seine	Includes purse seines for menhaden, shrimp, and tuna
	Commercial hook and line	Includes commercial hook and line fisheries for snapper/grouper, Gulf reef fish, king and Spanish mackerel, and sharks
	Recreational hook and line	Includes recreational hook and line for general finfish
Resource Use Non-Fisheries	Legal harvest	Includes legal harvest of all life stages
	Illegal harvest	Includes illegal harvest of all life stages
	Industrial plant intake/entrainment	Includes entrainment in all aspects of plant operations
	Boat strikes/propeller	Includes strikes by vessels
	Beach cleaning	Includes methods to remove debris

Table A1-1. Threat categories and description		
Category	**Threat**	**Description**
	Human presence	Includes foot traffic and other disturbances
	*Recreational beach equipment	Includes recreational equipment such as volley ball nets, barbeque grills
	Beach vehicular driving	Includes motorized vehicles
Construction (Although light pollution is associated with construction and development, that threat is captured under the “Pollution” category.)	Beach nourishment	Includes beach nourishment, beach restoration, and inlet sand bypassing
	Beach armoring	Includes bulkheads, seawalls, soil retaining walls, rock revetments, sandbags, and geotextile tubes
	Other shoreline stabilization	Includes groins, jetties, mesh groins (nets), and offshore breakwaters
	Dredging	Includes construction and maintenance for navigable waters
	Oil, gas, and liquid natural gas exploration, development and removal	Includes construction, operation, and maintenance associated with oil, gas, and liquid natural gas use
Ecosystem alterations	Trophic changes from fishing	Refers to trophic changes from harvest of target species in fisheries (e.g., sargassum harvest)
	Trophic changes from benthic habitat alteration	Refers to trophic changes from human related activities (e.g., boat anchoring, bottom trawling)
	Beach erosion (washouts)	Refers to natural and anthropogenic causes for beach erosion
	Dams, water diversion	Refers to trophic changes due to hydrology changes
	Runoff and hypoxia	Refers to industrial, stormwater, and other effluents
	Vegetation alteration in coastal habitats	Refers to alterations in plant species composition, density, and distribution
	Sand mining	Refers to trophic changes associated with offshore sand mining for beach restoration
Pollution	Marine debris ingestion	Refers to ingestion of debris from anthropogenic sources (e.g., oil spills)
	Marine debris entanglement	Refers to entanglement from anthropogenic sources (e.g., discarded fishing gear)
	Beach debris obstruction	Refers to natural and anthropogenic sources of obstruction to nesting females and emergent hatchlings

Table A1-1. Threat categories and description		
Category	**Threat**	**Description**
	Oil/fuel/tar/chemical	Refers to anthropogenic sources of pollutants (e.g., oil spills)
	Light pollution	Refers to anthropogenic sources of pollutants (e.g., coastal development)
	Low frequency <1K Hz noise pollution	Refers to anthropogenic sources (e.g., oil exploration, military exercises)
	Toxins	Refers to natural and anthropogenic sources of toxins that bioaccumulate
Species Interactions	Predation	Refers to natural predation
	Pathogens and Disease	Refers to natural and anthropogenic sources of pathogens and disease
	Domestic animals	Refers to anthropogenic sources of predation
	Predation by exotic species	Refers to anthropogenic sources of predation from introduced species
	Habitat modification by invasive species	Refers to natural and anthropogenic sources of habitat modification by invasive species
	Toxic species	Refers to natural and anthropogenic sources of toxic species
Other Factors	Climate change	Refers to anthropogenic sources of climate change
	Natural catastrophe	Refers to natural environmental catastrophic events
	Conservation/research activities	Refers to anthropogenic activities
	Military activities	Refers to activities associated with military training and readiness
	Cold stunning	Refers to natural causes of cold stunning

Table A1-2. Threats matrix.

LIFE STAGE	ECOSYSTEM	THREATS			
Nesting female	Terrestrial Zone				
Egg	Terrestrial Zone				
Hatchling stage	Terrestrial Zone				
Hatchling swim frenzy, post-hatchling transitional stage	Neritic Zone				
Juvenile stage	Oceanic Zone				
Adult stage	Oceanic Zone				
Juvenile stage	Neritic Zone				
Adult stage	Neritic Zone				

Table A1-3. Key used to assign estimated annual mortality to each threat category.

KEY		
Estimated Annual Mortality	**Color code**	**Value**
No evidence of mortality, based on best available information		**0**
Stippled-Sublethal Sub-lethal effects occur at this stage and may result in reduced fitness, e.g., through reduced somatic growth rates, hatchling production, quality of nesting and/or foraging habitats	(stippled)	**unknown**
Stippled & Gray-Sublethal and Mortality Sub-lethal effects occur and mortality has been documented or is likely to occur; however, data are insufficient and an order of magnitude was not assigned	(stippled gray)	**unknown**
Gray-Mortality Mortality has been documented or is likely to occur; however, data are insufficient and an order of magnitude was not assigned	(gray)	**unknown**
1-10	(light orange)	**3**
11-100	(yellow)	**30**
101-1000	(orange)	**300**
1001-10,000	(red)	**3,000**
10,001-100,000	(black)	**30,000**

Table A1-4. Life stage/ecosystem reproductive values adjusted to the relative reproductive value of adult female.

LIFE STAGE	ECOSYSTEM	REPRODUCTIVE VALUES	RELATIVE REPRODUCTIVE VALUES (RRV)
Nesting female	**Terrestrial Zone**	**1.000**	**1.000**
Egg	**Terrestrial Zone**	**193.000**	**0.005**
Hatchling stage	**Terrestrial Zone**	**193.000**	**0.005**
Hatchling swim frenzy stage, post-hatchling transitional stage	**Neritic Zone**	**193.000**	**0.005**
Juvenile stage	**Oceanic Zone**	**101.000**	**0.010**
Adult stage	**Oceanic Zone**	**1.000**	**1.000**
Juvenile stage	**Neritic Zone**	**3.270**	**0.306**
Adult stage	**Neritic Zone**	**1.000**	**1.000**

Table A1-5. Annual mortality for each lifestage/ecosystem for each threat category adjusted by relative reproductive equivalents (sub-lethal effects are included in the table, but not calculated in the relative reproductive equivalents). Numeric values are not presented in this summary table, only categories of annual estimates of mortality based on the color-coded log scale (Table A1-3).

Annual mortality for each lifestage/ecosystem for each threat category adjusted by relative reproductive equivalents								
Life Stage	Ecosystem	Resource Use-Fisheries Bycatch	Resource Use - non-fisheries	Construction	Ecosystem alterations	Pollution	Species Interacations	Other factors
Nesting female	Terrestrial Zone							
Egg	Terrestrial Zone							
Hatchling stage	Terrestrial Zone							
Hatchling swim frenzy stage, post-hatchling transitional stage	Neritic Zone							
Juvenile stage	Oceanic Zone							
Adult stage	Oceanic Zone							
Juvenile stage	Neritic Zone							
Adult stage	Neritic Zone							
Data Sufficiency		Mortality data were available for 120 out of 120 cells.	Mortality data were available for 63 out of 64 cells.	Mortality data were available for 30 out of 40 cells.	Mortality data were available for 52 out of 56 cells.	Mortality data were available for 45 out of 56 cells.	Mortality data were available for 40 out of 48 cells.	Mortality data were available for 45 out of 48 cells.

Table A1-6. Annual mortality for each threat within a threat category summed for all lifestages/ecosystems and adjusted for relative reproductive values for each lifestage/ecosystem (sub-lethal effects are included in the table, but not calculated in the relative reproductive values). Data sufficiency refers to the quality of data available upon which to assign a category of annual mortality. Data on fisheries interactions were more sufficient than the other threat categories, with information on pollution being the least sufficient. Numeric values are not presented in this summary table, only categories of annual estimates of mortality based on the color-coded log scale (Table A1-3).

Annual mortality for each threat within a threat category summed for all lifestages/ecosystems and adjusted for RRV for each lifestage/ecosystem																
DATA SUFFIC-IENCY	THREAT CATEGORY	SPECIFIC THREAT WITHIN A THREAT CATEGORY														
HIGH	Resource Use - Fisheries Bycatch	TRAWL TEDs (BOTTOM)	TRAWL NO TEDs (BOTTOM)	TRAWL (TOP/ MID-WATER)	DREDGE	LONGLINE (PELAGIC)	LONGLINE (DEM-ERSAL)	GILLNET (DEM-ERSAL)	GILLNET (SINK & DRIFT)	POUND NET/TRAP	POT/ TRAP	HAUL SEINE	CHANNEL NET	PURSE SEINE	HOOK & LINE (COMM-ERCIAL)	HOOK & LINE (RECREA-TIONAL)
↓	Resource Use	LEGAL HARVEST	ILLEGAL HARVEST	INDUSTRIAL PLANT INTAKE/ ENTRAIN- MENT	BOAT STRIKES	BEACH CLEANING	HUMAN PRESENCE	RECREA-TIONAL BEACH EQUIP-MENT	BEACH VEHIC-ULAR DRIVING							
	Other Factors	CLIMATE CHANGE	NATURAL CATAS-TROPHE	CONSERV-ATION/ RESEARCH ACTIVITIES	MILITARY ACTIVITIES	COLD STUNNING										
	Ecosystem Alterations	TROPHIC CHANGES FROM FISHING	TROPHIC CHANGES FROM BENTHIC HABITAT ALTER-ATION	BEACH EROSION (WASH OUTS)	DAMS, WATER DIVERSION	RUNOFF & HYPOXIA	VEGE-TATION ALTER-ATION IN COASTAL HABITATS	SAND MINING								
	Species Interactions	PRED-ATION	PATH-OGENS & DISEASE	DOMESTIC ANIMALS	PREDATION BY EXOTIC SPECIES	HABITAT MODIFI-CATION BY EXOTIC SPECIES	TOXIC SPECIES									
	Construc-tion	BEACH NOURISH-MENT	BEACH ARMOR-MING	OTHER SHORE-LINE STABILIZ-ATIONS	DREDGING	OIL, GAS, AND LNG EXPLOR-ATION, DEVELOPMENT AND REMOVAL										
LOW	Pollution	MARINE DEBRIS INGESTION	MARINE DEBRIS ENTANGLE-MENT	BEACH DEBRIS OBSTRUC-TION	OIL/FUEL/ TAR/ CHEMICAL	LIGHT POLLUTION	LOW FRE-QUENCY <1K Hz NOISE POLLUTION	TOXINS								

Table A1-7. Annual mortality for RESOURCE USE: FISHERIES BYCATCH summed for all lifestages/ecosystems and adjusted for relative reproductive values for each lifestage/ecosystem (sub-lethal effects are included in the table, but not calculated in the relative reproductive values). The annotated threats tables with <**COMMENT**> fields are posted on the FWS Kemp's Ridley Recovery Plan website [http://www.fws.gov/kempsridley/index.html].

LIFE STAGE	ECOSYSTEM	TRAWL TEDs (BOTTOM)	TRAWL NO TEDs (BOTTOM)	TRAWL (TOP/ MIDWATER)	DREDGE	LONGLINE (PELAGIC)	LONGLINE (DEMERSAL)	GILLNET (DEMERSAL)	GILLNET (SINK & DRIFT)	PUOND NET/TRAP	POT/TRAP	HAUL SEINE	CHANNEL NET	PURSE SEINE	HOOK & LINE (COMM-ERCIAL)	HOOK & LINE (RECREA-TIONAL)	SUM	RRV	TOTAL ESTIMATED ADJUSTED ANNUAL MORTALITY (# OF ADULT FEMALES)
Nesting female	Terrestrial Zone	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1.000	0
Egg	Terrestrial Zone	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.005	0
Hatchling stage	Terrestrial Zone	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.005	0
Hatchling swim frenzy stage, post-hatchling transitional stage	Neritic Zone	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.005	0
Juvenile stage	Oceanic Zone	0	0	3	0	30	0	0	0	0	0	0	0	0	0	0	33	0.010	0
Adult stage	Oceanic Zone	0	0	0	0	30	0	0	0	0	0	0	0	0	0	0	30	1.000	30
Juvenile stage	Neritic Zone	3000	3000	300	3	30	3	300	30	30	30	3	3	3	300	300	7335	0.306	2245
Adult stage	Neritic Zone	300	300	30	0	30	3	30	3	0	3	0	0	0	30	30	759	1.000	759
TOTAL ESTIMATED ADJUSTED ANNUAL MORTALITY (# OF ADULT FEMALES)		1218	1218	122	1	69	4	122	12	9	12	1	1	1	122	122			
DATA SUFFICIENCY *		100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%			

* The percentage of cells in each threat category for which sufficient data were available to assign a category of mortality based on a Delphi approach

Table A1-8. Annual mortality for RESOURCE USE summed for all lifestages/ecosystems and adjusted for relative reproductive values for each lifestage/ecosystem (sub-lethal effects are included in the table, but not calculated in the relative reproductive values). The annotated threats tables with <COMMENT> fields are posted on the FWS Kemp's Ridley Recovery Plan website [http://www.fws.gov/kempsridley/index.html].

LIFE STAGE	ECOSYSTEM	LEGAL HARVEST	ILLEGAL HARVEST	INDUSTRIAL PLANT INTAKE/ ENTRAIN-MENT	BOAT STRIKES (PROPELLER)	BEACH CLEANING	HUMAN PRESENCE	RECREA- TIONAL BEACH EQUIPMENT	BEACH VEHICULAR DRIVING	SUM	RRV	TOTAL ESTIMATED ADJUSTED ANNUAL MORTALITY (# OF ADULT FEMALES)
Nesting female	Terrestrial Zone	0	30	0	0	0		0	3	33	1.000	33
Egg	Terrestrial Zone	0	3000	0	0	300	0	300		3600	0.005	18
Hatchling stage	Terrestrial Zone	0	0	0	0	300	3	0	300	603	0.005	3
Hatchling swim frenzy stage, post-hatchling transitional stage	Neritic Zone	0	0	0	0	0	0	0	0	0	0.005	0
Juvenile stage	Oceanic Zone	0	0	0	0	0	0	0	0	0	0.010	0
Adult stage	Oceanic Zone	0	0	0	0	0	0	0	0	0	1.000	0
Juvenile stage	Neritic Zone	0	3	30	300	0	0	0	0	333	0.306	102
Adult stage	Neritic Zone	0	3	3	30	0	0	0	0	36	1.000	36
TOTAL ESTIMATED ADJUSTED ANNUAL MORTALITY (# OF ADULT FEMALES)		0	49	12	122	3	0	2	5			
DATA SUFFICIENCY *		100%	100%	100%	100%	100%	88%	100%	88%			

* The percentage of cells in each threat category for which sufficient data were available to assign a category of mortality based on a Delphi approach

Table A1-9. Annual mortality for CONSTRUCTION summed for all lifestages/ecosystems and adjusted for relative reproductive values for each lifestage/ecosystem (sub-lethal effects are included in the table, but not calculated in the relative reproductive values).

The annotated threats tables with <COMMENT> fields are posted on the FWS Kemp's Ridley Recovery Plan website [http://www.fws.gov/kempsridley/index.html].

LIFE STAGE	ECOSYSTEM	BEACH NOURISHMENT	BEACH ARMORMING	OTHER SHORELINE STABILIZATIONS	DREDGING	OIL, GAS, AND LIQUID NATURAL GAS EXPLORATION, DEVELOPMENT AND REMOVAL	SUM	RRV	TOTAL ESTIMATED ADJUSTED ANNUAL MORTALITY (# OF ADULT FEMALES)
Nesting female	Terrestrial Zone		0		0		0	1.000	0
Egg	Terrestrial Zone		0		0		0	0.005	0
Hatchling stage	Terrestrial Zone	0	0	0	0		0	0.005	0
Hatchling swim frenzy stage, post-hatchling transitional stage	Neritic Zone	0	0		0	0	0	0.005	0
Juvenile stage	Oceanic Zone	0	0	0	0		0	0.010	0
Adult stage	Oceanic Zone	0	0	0	0	0	0	1.000	0
Juvenile stage	Neritic Zone		0	0	30		30	0.306	9
Adult stage	Neritic Zone		0	0	3		3	1.000	3
TOTAL ESTIMATED ADJUSTED ANNUAL MORTALITY (# OF ADULT FEMALES)			0		12				
DATA SUFFICIENCY *		50%	0%	63%	100%	25%			

* The percentage of cells in each threat category for which sufficient data were available to assign a category of mortality based on a Delphi approach

Table A1-10. Annual mortality for ECOSYSTEMS ALTERATIONS summed for all lifestages/ecosystems and adjusted for relative reproductive values for each lifestage/ecosystem (sub-lethal effects are included in the table, but not calculated in the relative reproductive values). The annotated threats tables with <COMMENT> fields are posted on the FWS Kemp's Ridley Recovery Plan website [http://www.fws.gov/kempsridley/index.html].

LIFE STAGE	ECOSYSTEM	TROPHIC CHANGES FROM FISHING	TROPHIC CHANGES FROM BENTHIC HABITAT ALTERATION	BEACH EROSION (WASH OUTS)	DAMS, WATER DIVERSION	RUNOFF & HYPOXIA	VEGETATION ALTERATION IN COASTAL HABITATS	SAND MINING	SUM	RRV	TOTAL ESTIMATED ADJUSTED ANNUAL MORTALITY (# OF ADULT FEMALES)
Nesting female	Terrestrial Zone	0	0		0	0	0	0	0	1.000	0
Egg	Terrestrial Zone	0	0		0	0		0	0	0.005	0
Hatchling stage	Terrestrial Zone	0	0	0	0	0	0	0	0	0.005	0
Hatchling swim frenzy stage, post-hatchling transitional stage	Neritic Zone	0	0	0	0	0	0	0	0	0.005	0
Juvenile stage	Oceanic Zone			0	0	0	0	0	0	0.010	0
Adult stage	Oceanic Zone	0	0	0	0	0	0	0	0	1.000	0
Juvenile stage	Neritic Zone			0					0	0.306	0
Adult stage	Neritic Zone			0					0	1.000	0
TOTAL ESTIMATED ADJUSTED ANNUAL MORTALITY (# OF ADULT FEMALES)		0	0		0	0					
DATA SUFFICIENCY *		63%	63%	75%	75%	75%	63%	75%			

* The percentage of cells in each threat category for which sufficient data were available to assign a category of mortality based on a Delphi approach

Table A1-11. Annual mortality for POLLUTION summed for all lifestages/ecosystems and adjusted for relative reproductive values for each lifestage/ecosystem (sub-lethal effects are included in the table, but not calculated in the relative reproductive values). The annotated threats tables with <**COMMENT**> fields are posted on the FWS Kemp's Ridley Recovery Plan website [http://www.fws.gov/kempsridley/index.html].

LIFE STAGE	ECOSYSTEM	MARINE DEBRIS INGESTION	MARINE DEBRIS ENTANGLE-MENT	BEACH DEBRIS OBSTRUC-TION	OIL/FUEL/ TAR/ CHEMICAL	LIGHT POLLUTION	LOW FREQUENCY <1K Hz NOISE POLLUTION	TOXINS	SUM	RRV	TOTAL ESTIMATED ADJUSTED ANNUAL MORTALITY (# OF ADULT FEMALES)
Nesting female	Terrestrial Zone	0	0	0		0	0	0	0	1.000	0
Egg	Terrestrial Zone	0	0	0		0	0		0	0.005	0
Hatchling stage	Terrestrial Zone	0	0	0			0		0	0.005	0
Hatchling swim frenzy stage, post-hatchling transitional stage	Neritic Zone			0		0	0		0	0.005	0
Juvenile stage	Oceanic Zone			0		0			0	0.010	0
Adult stage	Oceanic Zone	0	0	0	0	0	0	0	0	1.000	0
Juvenile stage	Neritic Zone	30		0		0			30	0.306	9
Adult stage	Neritic Zone	3		0		0			3	1.000	3
TOTAL ESTIMATED ADJUSTED ANNUAL MORTALITY (# OF ADULT FEMALES)		12		0			0	0			
DATA SUFFICIENCY *		75%	50%	100%	13%	88%	63%	25%			

* The percentage of cells in each threat category for which sufficient data were available to assign a category of mortality based on a Delphi approach

Table A1-12. Annual mortality for SPECIES INTERACTIONS summed for all lifestages/ecosystems and adjusted for relative reproductive values for each lifestage/ecosystem (sub-lethal effects are included in the table, but not calculated in the relative reproductive values). The annotated threats tables with <COMMENT> fields are posted on the FWS Kemp's Ridley Recovery Plan website [http://www.fws.gov/kempsridley/index.html].

LIFE STAGE	ECOSYSTEM	PREDATION	PATHOGENS & DISEASE	DOMESTIC ANIMALS	PREDATION BY EXOTIC SPECIES	HABITAT MODIFI-CATION BY EXOTIC SPECIES	TOXIC SPECIES	SUM	RRV	TOTAL ESTIMATED ADJUSTED ANNUAL MORTALITY (# OF ADULT FEMALES)
Nesting female	Terrestrial Zone	0	0	0	0		0	0	1.000	0
Egg	Terrestrial Zone	300,000		300	300		0	300,600	0.005	1503
Hatchling stage	Terrestrial Zone	300,000	0		300	0	0	300,300	0.005	1502
Hatchling swim frenzy stage, post-hatchling transitional stage	Neritic Zone		0	0	0	0	0	0	0.005	0
Juvenile stage	Oceanic Zone		0	0	0	0	0	0	0.010	0
Adult stage	Oceanic Zone	0	0	0	0	0	0	0	1.000	0
Juvenile stage	Neritic Zone			0	0	0		0	0.306	0
Adult stage	Neritic Zone			0	0	0		0	1.000	0
TOTAL ESTIMATED ADJUSTED ANNUAL MORTALITY (# OF ADULT FEMALES)		3000		2	3	0				
DATA SUFFICIENCY *		38%	63%	88%	100%	75%	75%			

* The percentage of cells in each threat category for which sufficient data were available to assign a category of mortality based on a Delphi approach

Table A1-13. Annual mortality for OTHER FACTORS summed for all lifestages/ecosystems and adjusted for relative reproductive values for each lifestage/ecosystem (sub-lethal effects are included in the table, but not calculated in the relative reproductive values). The annotated threats tables with <COMMENT> fields are posted on the FWS Kemp's Ridley Recovery Plan website [http://www.fws.gov/kempsridley/index.html].

LIFE STAGE	ECOSYSTEM	CLIMATE CHANGE	NATURAL CATAS-TROPHE	CONSERV-ATION/ RESEARCH ACTIVITIES	MILITARY ACTIVITIES	COLD STUNNING	SUM	RRV	TOTAL ESTIMATED ADJUSTED ANNUAL MORTALITY (# OF ADULT FEMALES)
Nesting female	Terrestrial Zone			3	0	0	3	1.000	3
Egg	Terrestrial Zone			300	300	0	600	0.005	3
Hatchling stage	Terrestrial Zone	0		300	3	0	303	0.005	2
Hatchling swim frenzy stage, post-hatchling transitional stage	Neritic Zone			0	0	0	0	0.005	0
Juvenile stage	Oceanic Zone		0	0	0	3	3	0.010	0
Adult stage	Oceanic Zone	0	0	0	0	0	0	1.000	0
Juvenile stage	Neritic Zone		0	3	30	300	333	0.306	102
Adult stage	Neritic Zone		0	3	3	0	6	1.000	6
TOTAL ESTIMATED ADJUSTED ANNUAL MORTALITY (# OF ADULT FEMALES)		0		10	14	92			
DATA SUFFICIENCY *		25%	50%	100%	100%	100%			

* The percentage of cells in each threat category for which sufficient data were available to assign a category of mortality based on a Delphi approach