

KEMP'S RIDLEY SEA TURTLE
(*LEPIDOCHELYS KEMPII*)

5-YEAR REVIEW:
SUMMARY AND EVALUATION

NATIONAL MARINE FISHERIES SERVICE
OFFICE OF PROTECTED RESOURCES
SILVER SPRING, MARYLAND
AND
U.S. FISH AND WILDLIFE SERVICE
SOUTHWEST REGION
ALBUQUERQUE, NEW MEXICO

AUGUST 2007



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



U.S. Department of the Interior
U.S. FISH AND WILDLIFE SERVICE

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5-YEAR REVIEW

Kemp's Ridley Sea Turtle/*Lepidochelys kempii*

1.0 GENERAL INFORMATION

1.1 Reviewers

National Marine Fisheries Service:

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1.2. Methodology used to complete the review

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include the final rule listing this species under the Act; the recovery plan; peer reviewed scientific publications; unpublished field observations by the Services, State, and other experienced biologists; unpublished survey reports; and notes and communications from other qualified biologists.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

1.3 Background

1.3.1 FR notice citation announcing initiation of this review

April 21, 2005 (70 FR 20734)

1.3.2 Listing history

Original Listing

FR notice: 35 FR 18320

Date listed: December 2, 1970

Entity listed: Species

Classification: Endangered

1.3.3 Associated rulemakings

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

1.3.4 Review history

Plotkin, P.T. (Editor). 1995. National Marine Fisheries Service and U.S. Fish and Wildlife Service Status Reviews for Sea Turtles Listed under the Endangered Species Act of 1973. National Marine Fisheries Service, Silver Spring, Maryland. 139 pages.

Conclusion: Retain the listing as an endangered species throughout its range.

Mager, A.M., Jr. 1985. Five-year status reviews of sea turtles listed under the Endangered Species Act of 1973. U.S. Department of Commerce, NOAA, National Marine Fisheries Service, St. Petersburg, Florida. 90 pages.

Conclusion: Retain the listing as an endangered species throughout its range.

FWS also conducted 5-year reviews for the Kemp's ridley in 1985 (50 FR 29901) and in 1991 (56 FR 56882). In these reviews, the status of many species was simultaneously evaluated without an in-depth assessment of the five listing factors or threats as they pertain to the individual species. The notices stated that FWS was seeking any new or additional information relative to a change in the status of the species under review. The notices indicated that if significant data were available warranting a change in a species' classification, the Service would propose a rule to modify the species' status. No change in the Kemp's ridley listing classification was recommended from these 5-year reviews.

1.3.5 Species' recovery priority number at start of review

National Marine Fisheries Service = 5 (this represents a moderate magnitude of threat, a high recovery potential, and the presence of conflict with economic activities).

U.S. Fish and Wildlife Service (48 FR 43098) = 2C (this represents a species with a high degree of threat, a high recovery potential, and the potential for conflict

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

1.3.6 Recovery plan

Name of plan: Recovery Plan for the Kemp's Ridley Sea Turtle (*Lepidochelys kempii*)

Date issued: August 21, 1992

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

2.0 REVIEW ANALYSIS

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

2.1.1 Is the species under review a vertebrate?

Yes.

2.1.2 Is the species under review listed as a DPS?

No.

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

No.

2.2 Recovery Criteria

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

No. The "Recovery Plan for the Kemp's Ridley Sea Turtle (*Lepidochelys kempii*)" was signed in 1992. However, a revision of the recovery plan is nearing completion. While not all of the recovery criteria in the current recovery plan strictly adhere to all elements of the 2004 NMFS Interim Recovery Planning Guidance, they are still a viable measure of the species status. See Section 4.0 for additional information.

The recovery criteria from the 1992 Recovery Plan are identified below, along with several key accomplishments:

Recovery Plan for the Kemp's Ridley Sea Turtle (Lepidochelys kempii):

The Kemp's ridley can be considered for downlisting to Threatened under the ESA if the following four criteria are met:

1. Continue complete and active protection of the known nesting habitat, and the waters adjacent to the nesting beach (concentrating on the Rancho Nuevo area) and continue the bi-national protection project.
 - Full protection of nesting females and their eggs is ongoing in Mexico under the auspices of the Mexico-United States bi-national protection project, which has been ongoing since 1978.
 - The primary nesting beach was protected by the Declaration of Rancho Nuevo as a Reservation Area in 1986 and as a sanctuary in 2002. This includes a prohibition of sailing and fishing within 4 miles of the beach.
 - Research on relocated versus nests left in place has been conducted to guide future conservation efforts.
2. Essentially eliminate mortality from incidental catch in commercial shrimping in the United States and Mexico through use of Turtle Excluder Devices (TEDs) and achieve full compliance with the regulations requiring TED use.
 - Regulations requiring year-round use of TEDs by most shrimp trawlers operating in southeastern U.S. waters were required after December 1992.
 - Continued TED outreach and training efforts are underway.
 - Gear research has been conducted to develop TEDs suitable for use in non-shrimp trawl fisheries such as the flynet, whelk, summer flounder, and scallop trawl fisheries.
3. Attain a population of at least 10,000 females nesting in a season.
 - An estimated 4,047 females nested in 2006, which is a substantial increase from the 247 nesting females estimated during the 1985 nesting season (P. Burchfield, Gladys Porter Zoo, personal communication, 2007).
 - In 2007, an estimated 5,500 females nested in the State of Tamaulipas from May 20-22 (P. Burchfield, Gladys Porter Zoo, personal communication, 2007).
 - 10,000 nesting females in a season = about 30,000 nests.
4. Successfully implement all priority-one recovery tasks.
 - Several important marine habitats in the U.S. and Mexico, as well as juvenile/subadult nearshore habitat use, have been identified through in-water surveys and the use of satellite telemetry.
 - Migration routes and foraging areas of adults have been identified through the use of satellite telemetry.

2.3 Updated Information and Current Species Status

2.3.1 Biology and Habitat

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

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

2.3.1.1.1 Age and growth

A variety of studies have addressed growth rates and age to various life stages in Kemp's ridleys. Based on mark-recapture data, skeletal chronological analysis, and growth rates in captivity, it has been estimated that Kemp's ridleys require approximately 1.5 to 2 years to grow from a hatchling to a size of approximately 20 cm straight carapace length (SCL), at which size they are capable of making a transition to a benthic immature stage (B. Higgins, NMFS, personal communication, 2007; Caillouet *et al.* 1995; Schmid and Witzell 1997; Zug *et al.* 1997; Schmid 1998; Snover *et al.* 2007). However, variability in growth rates suggests that the actual time necessary to achieve a 20 cm SCL could range from approximately 1 to 4 years or more (Turtle Expert Working Group (TEWG) 2000).

Based on the size of nesting females (Marquez-M. 1994), it is assumed that turtles must attain a size of approximately 60 cm SCL prior to maturing. Thus, turtles in the benthic immature stage must grow from their initial size of approximately 20 cm SCL to an adult size of approximately 60 cm SCL or greater. Growth models based on mark-recapture data suggest that a time period of 7 to 9 years would be required for this growth from benthic immature to mature size (Schmid and Witzell 1997, Snover *et al.* 2007).

A variety of studies have attempted to estimate the overall average age-to-maturity in Kemp's ridleys (Snover *et al.* 2007). These studies have included study of captive turtles, recaptured turtles of known age, mark-recapture data, and skeletochronology. Many of these studies utilized von Bertalanfy curves to estimate growth trajectories. Data from these studies suggest age to sexual maturity ranging from approximately 10 to 17 years for Kemp's ridleys. However, estimates of 10 to 13 years predominate in previous studies that include an appropriate range of values for the statistical models (Caillouet *et al.* 1995, Schmid and Witzell 1997, TEWG 2000), and the most recent analysis by Snover *et*

al. (2007) using skeletochronology suggests 9.9 to 16.7 years to maturity. These estimates are consistent with the age of headstart turtles that were recorded nesting at ages ranging from 10 to 15 years (Shaver and Wibbels 2007). Tag-recapture data suggest that growth of individual turtles can vary greatly and may correlate to the specific benthic environment occupied by a turtle (Fontaine *et al.* 1989, Schmid and Witzell 1997, Snover *et al.* 2007). For example, one study suggests slower growth rates for Kemp's ridleys in the Gulf of Mexico in comparison to those in the Atlantic (Schmid and Witzell 1997); however, those results were based on small sample sizes. Collectively, previous studies suggest a variable range to maturity (approximately 10 to 17 years), which may be dependent, in part, to the specific habitat occupied by individuals. Given these studies are somewhat inconclusive due to small sample sizes, it is unknown if Kemp's ridley growth rates in the Gulf of Mexico are similar to those in the Atlantic.

2.3.1.1.2 Reproductive biology and behavior

Nesting biology and behavior

Various aspects of the reproductive biology of the Kemp's ridley have been characterized in past and recent studies. The majority of these studies have focused on the female, although some information is gradually accumulating on males. Approximately 60% of Kemp's ridley nesting occurs along an approximate 40-km stretch of beach near Rancho Nuevo, Tamaulipas, Mexico (FWS 2006). There is a limited amount of scattered nesting to the north and south of the primary nesting beach. For example, several hundred nests were laid during 2006 to the south near Tampico (Altamira and Ciudad Madero), and approximately 100 nests were laid in Texas during 2006 (FWS 2006; D. Shaver, National Park Service, personal communication to T. Wibbels, University of Alabama at Birmingham (UAB), 2006).

The Kemp's ridley, like the olive ridley, tends to nest in large aggregations or arribadas (Bernardo and Plotkin 2007). It has been speculated that the arribada phenomenon may be advantageous for a variety of reasons, including mate finding and enhancing the survival of eggs and hatchlings due to predator swamping (Bernardo and Plotkin 2007). The period between Kemp's ridley arribadas averages approximately 25 days (Rostal *et al.* 1997), but the precise timing of the arribadas is highly variable and unpredictable (Bernardo and Plotkin 2007). The biological or physical factors that initiate an arribada are not clear, but a variety of potential cues have been suggested, including strong onshore wind, lunar and tidal cycles, social facilitation, and olfactory signals (Bernardo and Plotkin 2007). Some Kemp's ridleys will nest between arribadas as solitary nesters and can thus exhibit a

shorter internesting interval (e.g., 14 days) than the arribada nesters (Rostal *et al.* 1997, Rostal 2007).

Like all sea turtles, the Kemp's ridley nests multiple times in a single nesting season. Earlier estimates suggested that Kemp's ridleys may only nest 1.3 to 1.5 times per season (Marquez M. 1990), but that estimate was later revised to 2.3 times per nesting season (Pritchard 1990). The most recent analysis suggests approximately 3.075 nests per nesting season per female; that analysis included an evaluation of the previous studies as well as a variety of physiological data including hormone levels and ultrasonography (Rostal 2007).

The annual average number of eggs per nest (clutch size) for 1966-1992 was 100 (Márquez-M., 1994). The mean clutch size for Kemp's ridleys in 2001-2006 was approximately 94-95 eggs (FWS 2000-2006) and eggs typically take 45 to 58 days to hatch, depending on temperatures (Marquez-M. 1994, Rostal 2007).

Several studies have addressed the interannual nesting interval in the Kemp's ridley. Data suggest that approximately 20% nest every year, 60% nest every 2 years, 15% nest every 3 years, and 5% nest every 4 years (Marquez Millan *et al.* 1989, TEWG 2000). These data suggest an interannual remigration rate for female Kemp's ridleys of approximately 1.8 (Rostal 2007) to 2.0 years (Marquez Millan *et al.* 1989, TEWG 2000).

Reproductive migrations and mating

Adult Females

The reproductive cycle of the female includes migrations between foraging grounds and the nesting beach. The majority of satellite telemetry data are from females that were tagged on the nesting beach, thus documenting their movements back to the foraging grounds (Morreale *et al.* 2007). Tracking of post-nesting females from Rancho Nuevo and Texas beaches indicates that turtles move along coastal migratory corridors either to the north or south from the nesting beach (Byles 1989b; Byles and Plotkin 1994; Renaud 1995; Renaud *et al.* 1996; Shaver 1999, 2002). These migratory corridors appear to extend throughout the coastal areas of the Gulf of Mexico, and most appear to travel in waters less than 50 meters in depth. Turtles that headed north and east traveled as far as the waters off southwest Florida, USA, whereas those that headed south and east traveled as far as the Yucatan Peninsula, Mexico (Morreale *et al.* 2007). However, those represented the extreme migrations, and some were tracked to nearby locations. In general, the data suggest that the turtles head north or south from the

nesting beach and then settle into resident feeding areas for several months or more in various coastal locations in the Gulf of Mexico (Byles and Plotkin 1994, Morreale *et al.* 2007). Females were tracked to foraging areas from the Yucatan Peninsula to southwest Florida (Morreale *et al.* 2007).

One study placed a satellite transmitter on a female that was captured in a foraging area in Louisiana, USA (Renaud *et al.* 1996). It was tagged in August and remained on the upper Texas coast until approximately December. From December through early March, it gradually moved southward along the coast to the waters off Rancho Nuevo. It nested on April 23, 2004, and again on May 19, 2004.

The general migratory pattern that emerges is that females may begin migrating along relatively shallow migratory corridors toward the nesting beach in the winter in order to arrive at the nesting beach by early spring. Mating is believed to occur about 3 to 4 weeks prior to the first nesting (Rostal 2007), which means it occurs during late March through early to mid April. It is presumed that most mating takes place near the nesting beach (Morreale *et al.* 2007, Rostal 2007). After successfully mating prior to the nesting season, the female is capable of storing the sperm in the upper oviduct, and will then use that sperm to fertilize eggs after each ovulation during the nesting season (Rostal 2007). The female will initially ovulate within a few days after successful mating and lay her first clutch approximately 2 to 4 weeks later; if a turtle nests more than once a season, subsequent ovulations occur within approximately 48 hours after each nesting (Rostal 2007). The ovary of a reproductively active female will have follicles that begin to enlarge approximately 4 to 6 months prior to mating (Rostal 2007). A variety of steroid hormones and pituitary hormones are believed to coordinate ovulation and egg production (Rostal 2007).

Adult Males

As stated above for adult females, it is currently presumed, but not well documented, that mating takes place approximately 3 to 4 weeks prior to the first nesting and near the nesting areas (Morreale *et al.* 2007, Rostal 2007). Thus, it is possible that males could behave in a fashion similar to the adult females and migrate to the mating areas during the winter and early spring. In contrast to adult females, much less is known about the actual movements and biology of adult males. In a recent study, 11 males were captured near Rancho Nuevo and tagged with satellite transmitters during various times of the year (Shaver *et al.* 2005). The majority of these males remained in the waters off Tamaulipas, Mexico, after the nesting season, suggesting they were residents of local feeding grounds. However, one of the 11 males traveled north along a shallow

migratory corridor and was last located off Galveston, Texas. These data suggest that some males take up residency in foraging areas near the nesting beach, whereas others migrate to distant foraging grounds. Because the Shaver *et al.* (2005) study focused on capturing males in the waters near Rancho Nuevo, it may represent a bias in that resident males may have been more available for capture than transient males.

2.3.1.1.3 Sex determination and sex ratios

Temperature-dependent sex determination

Like all sea turtles, the Kemp's ridley has been shown to have temperature-dependent sex determination in which the incubation temperature of the egg during the middle third of incubation determines the sex (Wibbels 2007). Sex determination in the Kemp's ridley has been addressed in several studies (Aguilar 1987, Shaver *et al.* 1988). Based on data from eggs incubated in styrofoam boxes (Shaver *et al.* 1988), a pivotal (i.e., threshold temperature at which the sex ratio is 1:1) temperature of 30.2°C was estimated. Temperatures above 30.8°C produced all females. Between 29.0 and 30.0°C, the sex ratios varied from all males to mostly females, and temperatures between 28.0 and 29.0°C produced mostly males (Shaver *et al.* 1988). Aguilar (1987) examined natural incubation conditions and found that temperatures of approximately 30.8°C or above were conducive to the production of females and temperatures of 28.4°C or below were conducive to the production of males. Collectively, these data indicate that, for Kemp's ridley, cooler temperatures produce males and warmer temperatures produce females, and the pivotal temperature is near 30.2°C. Temperatures of approximately 31.0°C or above produce all females, and temperatures of approximately 28.0°C or below produce all males (Aguilar 1987).

In the case of the Kemp's ridley, the majority of nesting for the entire species occurs on the primary nesting beach at Rancho Nuevo (Marquez-M. 1994). Nesting beach sand temperatures and incubation temperatures in natural nests have been examined at Rancho Nuevo, and those temperatures are relatively high (Wibbels *et al.* 2000a, 2000b; Geis 2004; Wibbels 2007). The estimated pivotal temperature for the Kemp's ridley (30.2°C) is also relatively high compared to most pivotal temperature estimates in sea turtles (Wibbels 2007). In general, sand temperatures 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, and remain above pivotal temperature through June and July (Wibbels 2007). It is plausible that the Kemp's ridley has evolved a relatively high pivotal temperature to match the warm beach temperatures.

Sex ratios

The sex ratios produced by temperature-dependent sex determination in the Kemp's ridley are of interest for a number of reasons, including from an ecological viewpoint, since they affect the reproductive output of the population (Wibbels 2003, Coyne and Landry 2007). Sex ratios are also of conservation interest, since sex ratios affect the reproductive output in the population, they can also affect the recovery of the species (Wibbels 2003).

Hatchling sex ratios from hatcheries

Hatchling sex ratios in the Kemp's ridley have also received attention. Until recently, almost all nests laid were moved to protective hatcheries to protect incubating eggs from predation, beach erosion, and potential disturbance from other nesting females (Marquez-M. 1994). The main hatchery is located on the primary nesting beach near Rancho Nuevo, Mexico, and the great majority of nests have been moved to that hatchery over the past several decades. Starting about 15 years ago, additional hatcheries were established at various distances north and south of Rancho Nuevo to decrease the transport distance for egg clutches. The majority of eggs are moved to the main hatchery at Rancho Nuevo.

Comprehensive studies of sex ratios from the hatcheries have been conducted in recent years using temperature data loggers that can be inserted directly into nests or into the sand at nest depth. From 1998 to the current nesting season (2007), temperature data loggers 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). In general, sand temperatures 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.

In addition to recording sand temperatures, data loggers have been used to directly record nest temperature in the hatcheries from 1998 through the present nesting season (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 hatcheries 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. Thus, the results suggest that both males and females are produced in the hatcheries during a typical nesting season, but females predominate. The overall sex ratio predicted for the Rancho Nuevo hatchery 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 hatchery is significantly female biased.

While these recent studies examined 9 years of temperature data, it is of interest that the main hatchery has typically been placed in the same general position on the nesting beach for several decades. Therefore, it is plausible that the main hatchery 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.

Hatchling sex ratios from natural nests

Recent 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 the present nesting season (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 data loggers). 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 hatcheries. 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 hatcheries. 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).

Sex ratio of immature and adult turtles

A variety of studies have investigated sex ratios of immature (i.e., juvenile and/or subadult) and adult Kemp's ridleys residing in the Gulf of Mexico and Atlantic Ocean (reviewed by Wibbels 2007). Adult sex ratios are difficult to interpret due to the possibility of biased sampling since adult sea turtles are known for sex-specific migration patterns (Henwood and Ogren 1987, Wibbels *et al.* 2000b). Therefore, although adult sex ratios will be noted, there will be an emphasis on the immature portion of the population.

A number of studies have examined sex ratios of immature and adult Kemp's ridleys (reviewed by Wibbels 2007, Coyne and Landry 2007). These studies represent numerous sampling locations and sampling periods, ranging from 1977 to 1997. The sex ratios reported often vary between studies, but some trends predominate. A sex ratio of 1.4:1.0 (female:male) was reported for stranded juveniles in Cape Cod Bay from 1977 through 1987 (Danton and Prescott 1988); however, more recent data from this region are lacking. A 2.0:1.0 (female:male) sex ratio was reported for 21 cold-stunned Kemp's ridleys from Long Island Sound, New York, during 1987, whereas nine turtles that stranded during 1985 in that same area were all females (Morreale *et al.* 1992).

Stabenau *et al.* (1996) reported an overall female biased sex ratio of 3.2:1.0 for Kemp's ridleys that stranded on the upper Texas coast from 1986-1992. However, those data included adult turtles that showed a strong female bias (13.0:1.0). If the adults are excluded, the immature sex ratio from that study is still female biased but it drops to approximately 2.9:1.0 or 2.8:1.0 (female:male) depending on the size class of turtle (i.e., less than 40 cm SCL or 40 to 60 cm SCL, respectively). The similarity in the two sex ratios from the different size classes of immature turtles is notable. Cannon (1998) reported an overall 1:1 sex ratio for Kemp's ridleys stranded on the upper Texas and Louisiana coasts during 1994, with the smaller immature turtles showing a slight male bias and the larger immature turtles showing a slight female bias. Testosterone levels were used to predict a 1.5:1.0 (female:male) sex ratio of juvenile Kemp's ridleys captured on the upper Texas and Louisiana coasts from 1992 through 1997 (Coyne 2000); however, excluding headstarted turtles from that study results in a 1.3:1.0 (female:male) sex ratio. The headstarted turtles captured in that

study showed a strong female bias (9.0:1.0). Testosterone levels were also used to predict an overall sex ratio of 1.8:1.0 (female:male) for juvenile Kemp's ridleys captured off Homasassa, Florida (Gregory and Schmid 2001). The sex ratios in that study varied from 3.0:1.0 (female:male) for the smaller immature turtles to 1.4:1.0 (female:male) for the larger immature turtles. Finally, there are two recent studies that have used the testosterone sexing technique to estimate sex ratios of immature Kemp's ridleys captured in the Gulf of Mexico in Ten Thousand Islands, Florida, during 2000 and 2001 (Witzell *et al.* 2005), and captured near Steinhatchee, Florida, during 1998 through 2000 (Wibbels 2007). The results from both of those studies suggested a female-biased sex ratio for the immature portion of the Kemp's ridley population.

Thus, a variety of sex ratios have been reported for juvenile Kemp's ridleys ranging from slightly male biased to strongly female-biased. The reasons for the variation are unknown, but could relate to many factors (reviewed by Wibbels 2007).

Although a clear understanding of sex ratios and sex ratio dynamics in the immature portion of the Kemp's ridley population has not yet emerged, a few trends are suggested. In general, sex ratios reported for immature Kemp's ridleys range from slightly male-biased to strongly female biased. However, reports of female biases predominate. Data from the late 1990s (Coyne 2000) suggest the possibility of a distinct female bias during more recent years. The possible occurrence of a female bias in the juvenile portion of the population is consistent with recent studies indicating the production of female biased hatchling sex ratios at Rancho Nuevo, Mexico. The data from the nesting beach studies are too recent to be reflected in the juvenile data reviewed above. However, recent hatchling sex ratio data could be indicative of data from previous years at Rancho Nuevo.

Conservation implications of a female-biased sex ratio

The production of biased hatchling sex ratios at Rancho Nuevo could significantly affect the recovery of the Kemp's ridley. The production of a female bias will potentially increase egg production as those turtles reach sexual maturity (assuming that males do not become a limiting factor) (Coyne and Landry 2007). In particular, the biased sex ratio has the potential of increasing the rate of recovery. However, one should be cautious when considering such hypotheses without support from empirical data. For example, 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). However, low fertility has not been reported to be a problem in the Kemp's ridley population. 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). Data suggest that a female bias may be present in the Kemp's ridley population and may 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.

2.3.1.2 Abundance, trends, and demographic features:

During the mid 20th century, the Kemp's ridley was abundant in the Gulf of Mexico. Historic information indicates that tens of thousands of ridleys nested near Rancho Nuevo, Mexico, during the late 1940s (Hildebrand 1963). The famous "Herrera" film from 1947 was estimated to include as many as 40,000 turtles in a single arribada (Carr 1963, Hildebrand 1963)¹. The Kemp's ridley population experienced a devastating decline between the late 1940s and the mid 1980s. The largest arribadas recorded from 1966 to 1968 ranged from approximately 1,500 to 5,000 turtles (Chavez *et al.* 1969, Pritchard 1969). From 1978 through the 1980s, arribadas were 200 turtles or less, and by 1985, the total number of nests at Rancho Nuevo had dropped to approximately 740 nests for the entire nesting season (FWS and NMFS 1992, TEWG 2000). Recent data suggest that females nest approximately three times per nesting season (Rostal 2007); therefore, the total number of nesting females during the 1985 nesting season was approximately 234 turtles. The total annual number of nests at Rancho Nuevo remained below 1,000 throughout the 1980s, but gradually began to increase in the 1990s. By 2002, the number of nests at Rancho Nuevo had risen to over 4,000 per year. Beginning in the 1990s, an increasing number of beaches in Mexico were being monitored for nesting, and the total number of nests on all beaches in Tamaulipas and Veracruz in 2002 was over 6,000 (FWS 2002). This upward trend has continued to present.

In 2006, approximately 7,866 nests were laid at Rancho Nuevo, and the total number of nests for all the beaches in Mexico was estimated to be 12,143 (FWS 2006). In addition, approximately 100 nests were

¹ A more recent estimate is 5,746 turtles were present in the Herrera film (Dickerson and Dickerson 2006). However, the recent estimate is based on pooled estimates from volunteers of unknown level of expertise, and different methods may have been used to count the turtles. Of particular concern is the degree to which respondents were able to estimate the beach length given curvature and other variations in the landscape. Volunteers who were either naive or knowledgeable with the film's history were asked 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.

recorded during 2006 in the U.S., primarily in Texas (D. Shaver, National Park Service, personal communication to T. Wibbels, UAB, 2006). Assuming females lay approximately three nests per season (Rostal *et al.* 1997, Rostal 2007), 12,143 nests would represent approximately 4,047 nesting females. Most recently, the 2007 nesting season included an arribada of over 4,000 turtles over a 3-day period at Rancho Nuevo during May (P. Burchfield, Gladys Porter Zoo, personal communication to T. Wibbels, UAB, 2007).

Data suggest that in adult female Kemp's ridleys, approximately 20% nest every year, approximately 60% nest every 2 years, 15% nest every 3 years, and 5% nest every 4 years (Marquez Millan *et al.* 1989, TEWG 2000). These data indicate a remigration rate of female Kemp's ridleys from 1.8 (Rostal 2007) to 2.0 years (Marquez Millan *et al.* 1989, TEWG 2000), suggesting that the total number of adult females in the Kemp's ridley population during 2006 was approximately 7,000 to 8,000 turtles.

The number of adult males in the population is currently unknown, but hatchling and immature sex ratio data suggest that a female-bias predominates (see sex ratio information above). Considering that strong female biases have been predicted for many year classes of hatchlings at Rancho Nuevo, it is conceivable that the number of adult males in the population is considerably less than the number of adult females.

2.3.1.3 Genetics and genetic variation:

Genetic analyses indicate that all of the Kemp's ridley haplotypes group together and are related to those of the olive ridley. The genetic divergence between the Kemp's ridley and the olive ridley is more than twice as large as the divergence within the olive ridley (Bowen *et al.* 1993, 1998). These data suggest that the split between the Kemp's ridley and olive ridley occurred approximately 2.5 to 3.5 million years ago (Bowen *et al.* 1998). Genetic studies have also provided insight on the reproductive biology of the Kemp's ridley. Genetic data suggest a high level of multiple paternity in the Kemp's ridley (Kichler *et al.* 1999). It has been suggested that the aggregation of ridleys associated with arribada nesting could facilitate the multiple paternity (Kichler Holder and Holder 2007). Finally, it has been suggested that the decline of this species to critically low numbers potentially caused a bottleneck resulting in a measurable loss of genetic variation within this species (Stephens 2003). Nevertheless, Kichler (1996) showed that the genetic variability as measured by heterozygosity 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.

2.3.1.4 Taxonomic classification:

Kingdom: Animalia

Phylum: Chordata

Class: Reptilia

Order: Testudines

Family: Cheloniidae

Genus: *Lepidochelys*

Species: *kempii*

Common name: Kemp's ridley sea turtle

The Kemp's ridley (*Lepidochelys kempii*) was originally described by Samuel Garman in 1880 (Carr 1952), based on a specimen submitted by Richard Kemp of Key West, Florida. Genetic analysis indicates that the Kemp's ridley is closely related to the olive ridley (*Lepidochelys olivacea*) (Kichler Holder and Holder 2007), but that it is a genetically distinct species (Bowen *et al.* 1991, 1993, 1998).

2.3.1.5 Spatial distribution:

2.3.1.5.1 General distribution

The Kemp's ridley, along with the flatback sea turtle (*Natator depressus*), has the most geographically restricted distribution of any sea turtle species (Morreale *et al.* 2007). The Kemp's ridley occurs in the Gulf of Mexico and along the Atlantic coast of the U.S. (TEWG 2000). A handful of records exist of immature ridleys making transatlantic movements (FWS and NMFS 1992). It was originally speculated that Kemp's ridleys found outside the Gulf of Mexico might be lost to the breeding population (Hendrickson 1980), but data indicate that these turtles are capable of moving back into the Gulf of Mexico (Henwood and Ogren 1987) and this prior speculation is no longer supported. There are documented cases of Kemp's ridleys captured in the Atlantic that migrated back to the nesting beach at Rancho Nuevo (Schmid and Witzell 1997, Schmid 1998, Witzell 1998). It is not known what proportion of the Kemp's ridley population migrates to U.S. Atlantic coastal waters.

2.3.1.5.2 Distribution of post-hatchling and immature turtles

Kemp's ridley hatchlings enter the Gulf of Mexico from beaches near Rancho Nuevo, Mexico, and are presumably carried by major oceanic currents into various areas of the Gulf of Mexico and North Atlantic

(Collard and Ogren 1990). Stranding data suggest that post-hatchling Kemp's ridleys are distributed in both the Gulf of Mexico and the Atlantic where they are recruited into neritic habitats (TEWG 2000). Once Kemp's ridleys reach approximately 20 cm SCL, they are believed to make a transition from a post-hatchling pelagic habitat to benthic coastal habitats (Ogren 1989), which occurs approximately 2 years after hatching (Zug *et al.* 1997), but can range from 1 to 4 years or more (TEWG 2000). Stranding data indicate that immature turtles in this benthic stage are found in coastal habitats of the entire Gulf of Mexico and U.S. Atlantic coast (TEWG 2000, Morreale *et al.* 2007). These data indicate that developmental habitats for this life stage can occur in many coastal areas throughout their range, and that these habitats may shift depending on resource availability (TEWG 2000). Tagging studies indicate that certain coastal areas throughout the Gulf of Mexico may represent optimal developmental habitats since they can accommodate relatively large numbers of immature Kemp's ridleys (Gregory 1996, Schmid 1998, Coyne 2000, Gregory and Schmid 2001, Geis *et al.* 2005, Witzell *et al.* 2005).

2.3.1.5.3 Distribution, movements, and migrations of adults

Data collected from nesting Kemp's ridleys suggest that adult females typically have SCLs greater than 60 cm (Marquez-M. 1994). Stranding data indicate that adult Kemp's ridleys occupy the coastal regions of the Gulf of Mexico and Atlantic coast of the southeastern U.S., but they are generally rare off the Atlantic coast of the northeastern U.S. (TEWG 2000). Historically, it has been suggested that adult Kemp's ridleys are seasonally abundant in prey-rich waters such as the mouth of the Mississippi River and the Campeche Banks, and then migrate toward Rancho Nuevo during the nesting season (Carr 1963, Pritchard 1969, Pritchard and Marquez-M. 1973, Hildebrand 1982). Recent satellite telemetry studies have shed light on the post-nesting migrations of nesting females and adult males captured near the nesting beach (Morreale *et al.* 2007). Tracking of post-nesting females from Rancho Nuevo and Texas beaches indicates that turtles moved along coastal migratory corridors (generally shallower than 50 meters in depth) either to the north or south from the nesting beach (Byles 1989b; Byles and Plotkin 1994; Renaud 1995; Renaud *et al.* 1996; Shaver 1999, 2002). These migratory corridors appeared to extend throughout the coastal areas of the Gulf of Mexico. Turtles that headed north and east traveled as far as the waters off southwest Florida, whereas those that headed south and east traveled as far as the Yucatan Peninsula, Mexico (Morreale *et al.* 2007). However, those represented the extreme migrations, and some were tracked to locations near the nesting beach. In general, the data suggest that turtles head north or south from the nesting beach and then settle into resident feeding areas for several

months or more in various coastal locations in the Gulf of Mexico (Byles and Plotkin 1994, Morreale *et al.* 2007).

Recent studies have also begun to look at the movements of adult males. Shaver *et al.* (2005) captured and satellite tagged 11 males near Rancho Nuevo during various times of the year. The majority of these males remained in relatively shallow waters off Tamaulipas, Mexico, even during the non-nesting season, suggesting they were locally resident. One of the 11 males tracked in that study traveled north along a shallow migratory corridor and was last located off Galveston, Texas. These data suggest that some males take up residency in foraging areas near the nesting beach, whereas others migrate to more distant foraging areas. Because the Shaver *et al.* (2005) study focused on capturing males in the waters near Rancho Nuevo, it may represent a bias in that resident males may have been more available for capture than transient males.

2.3.1.6 Habitat or ecosystem conditions:

Coastal developmental habitats for juveniles occur throughout the entire Gulf of Mexico and U.S. Atlantic coast northward to New England (Schmid 1998, Wibbels *et al.* 2005, Morreale *et al.* 2007). Key foraging areas studied in the Gulf of Mexico include Sabine Pass, Texas; Caillou Bay and Calcasieu Pass, Louisiana; Big Gulley, Alabama (Ogren 1989, Coyne *et al.* 1995); Cedar Keys, Florida (Carr and Caldwell 1956, Ogren 1989, Schmid 1998, Schmid *et al.* 2002); and Ten Thousand Islands, Florida (Witzell *et al.* 2005). Foraging areas studied along the Atlantic coast include Pamlico Sound, Chesapeake Bay, Long Island Sound, Charleston Harbor, and Delaware Bay.

The main characteristics that define developmental habitats are coastal areas sheltered from high winds and waves such as embayments, estuaries, and nearshore temperate waters that are shallower than 50 meters. Suitability of these habitats depends on resource availability (TEWG 2000), and optimal environments appear to provide rich food sources of crabs and other invertebrates (Ogren 1989, Schmid 1998). A variety of substrates have been proffered as good foraging habitats, including seagrass beds (Carr and Caldwell 1956, Byles 1988), oyster reefs (Schmid 1998), sandy bottoms (Morreale and Standora 1992), mud bottoms (Ogren 1989, Schmid 1998), and rock outcroppings (Schmid 2000). Attempts to associate juvenile Kemp's ridleys with a specific substrate type have mostly failed because the turtles apparently are flexible or indifferent to subtle habitat distinctions, both within and among habitats.

Near-shore waters of 37 meters (20 fathoms) or less provide the primary marine habitat for adults, although it is not uncommon for adults to

venture further from shore where waters are deeper (Byles 1989a, Mysing and Vanselous 1989, Renaud *et al.* 1996, Shaver *et al.* 2005, Shaver and Wibbels 2007). Nearshore waters inhabited by adults are generally rich in crabs and typically have a sandy or muddy bottom. The waters off the western and northern Yucatan Peninsula, southern Texas coast, and northern Gulf of Mexico are important foraging areas where adult female residency is established seasonally (Byles 1989a; Márquez 1990; Shaver 1998, 2005). Knowledge of habitats used by adult males is more limited, but satellite telemetry used to monitor movements of adult males captured near Rancho Nuevo, Tamaulipas, Mexico (Shaver 2006a), indicate that males inhabit nearshore waters similar in depth and bottom composition to females.

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

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

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

The Kemp's ridley's primary nesting area near Rancho Nuevo is relatively undeveloped and consequently human impact is limited. However, as the population of Kemp's ridleys has increased over the past decade, an increasing number of turtles are nesting in areas north and south of Rancho Nuevo (FWS 2006). Nesting areas in Mexico that are close to larger cities, such as Altamira and Ciudad Madero (near Tampico) and La Pesca (north of Rancho Nuevo), are more commercialized and there is a greater potential for human impact from coastal development on the nesting habitat. The number of Kemp's ridleys nesting in the U.S. along the Texas coast is increasing and exceeded 100 nests per year in 2006 and 2007 (Shaver 2006b; D. Shaver, National Park Service, personal communication, 2007). Most nesting occurs on protected public lands in south Texas with occasional nesting occurring in developed areas of the upper Texas coast. Currently, Texas A&M University-Galveston monitors nesting and protects nests at Bolivar Island and Galveston Island, Brazoria National Wildlife Refuge (NWR) from Surfside to Matagorda Peninsula, Aransas NWR on Matagorda Island, University of Texas Science Center on San Jose and Mustang Islands, Padre Island National Seashore along North Padre Island, Laguna Atascosa NWR along South Padre Island, and Lower Rio Grande Valley NWR at Boca Chica.

Because the Kemp's ridley has one primary nesting beach, this species is particularly susceptible to habitat destruction by natural and human caused events. Of particular importance are the aperiodic effects of tropical storms and hurricanes, which can result in degradation of nesting habitat. Human caused threats include the potential for oil spills. The Gulf of Mexico is an area of high-density offshore oil exploration and extraction. The nesting beach at Rancho Nuevo is susceptible and was historically affected by the Ixtoc I oil spill of 1979 (Yender and Mearns 2003).

Habitat destruction is also occurring as a result of activities that directly impact bottom habitats, such as bottom trawling and dredge fishing. Shoreline development can result in benthic habitat degradation from direct impacts from construction activities to indirect effects such as that from runoff. Perhaps the most destructive fishing methods in neritic ecosystems are bottom trawling and dredging. These methods entail the dragging of heavy fishing gear along the bottom of shallow waters, essentially destroying or disturbing everything in the way. The ecological effects of trawling and dredging on the marine environment have been likened to the terrestrial ecological effects of clearcutting forests (Watling and Norse 1998).

Periodic dredging of sediments from navigational channels is conducted to provide for the passage of large commercial and military vessels. The negative impacts of dredging include destruction or degradation of habitat. Channelization of inshore and nearshore habitat and the subsequent disposal of dredged material in the marine environment can degrade foraging habitats through spoil dumping, degraded water quality/clarity, and altered current flow (FWS and NMFS 1992).

Modifications of the Mississippi River's outflow by levees and channel construction have dramatically altered the historical patterns of distribution of flow from its mouth, thereby altering beach replenishment and erosion in the Western Gulf. These changes in flow distribution of the Mississippi River outflow have had profound effects on Western Gulf coastal habitats with sediments now being deposited in deep waters offshore in the Gulf, for the most part. In addition to the sediment load from the Mississippi, its waters contain materials causing eutrophication, which could negatively impact Kemp's ridley prey (Milton and Lutz 2003).

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

Overutilization of eggs in Mexico was a historical factor in the decline of the Kemp's ridley sea turtle nesting population. Extensive protection

measures along all of the main nesting beaches in Mexico have eliminated this threat although if these protection measures were removed it is likely at this point in time that exploitation of eggs would resume without development of a more extensive community based conservation program.

2.3.2.3 Disease or predation:

Fibropapillomatosis-like growths have been reported in a few Kemp's ridleys (Barragan and Sarti 1994, Guillen and Peña-Villalobos 2000). Fibropapillomatosis is a disease characterized by the presence of internal and/or external tumors (fibropapillomas) that may grow large enough to hamper swimming, vision, and feeding (Herbst 1994). Fibropapillomas have been reported in all sea turtle species. Fortunately, the frequency of fibropapillomatosis in Kemp's ridleys is low and is not presently a major source of concern for this species.

Depredation of eggs and hatchlings on the beach is limited because the great majority of the nests are transferred to protected hatcheries (Wibbels 2007). If the recovery trajectory of this population continues, an increasing number of nests will be left in their natural locations on the beach. Preliminary studies indicate that predators, such as coyotes, skunks, raccoons, ghost crabs, and certain birds, are prevalent on the nesting beach near Rancho Nuevo, but the arribada phenomenon helps to enhance hatchling survival through predator swamping.

Once in the water, it is presumed that Kemp's ridley experience depredation similar to other sea turtles, with hatchlings being preyed upon by a variety of predatory fish, while larger immature and adult turtles are susceptible to shark attacks.

2.3.2.4 Inadequacy of existing regulatory mechanisms:

Kemp's ridleys are migratory and occur among several nations, although they are most commonly found in Mexico and the United States. Therefore, conservation efforts for Kemp's ridleys in one country may be jeopardized by activities in another. The conservation and recovery of sea turtles is facilitated by a number of regulatory instruments at international, regional, national, and local levels. As a result of these designations and agreements, many of the intentional impacts directed at sea turtles have been lessened. Harvest of eggs and adults has been virtually eliminated at nesting areas through nesting beach conservation efforts, and an increasing number of community-based initiatives are in place to reduce the take of turtles in foraging areas. Moreover, there is now a more internationally concerted effort to reduce sea turtle interactions and mortality in artisanal (i.e., generally smaller scale local,

non-commercial) and industrial fishing practices (e.g., mandatory TED requirements for shrimp trawls).

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

A summary of the main regulatory instruments that relate to Kemp's ridley conservation is provided below. The pros and cons of many of these were recently evaluated by Hykle (2002) and Tiwari (2002), and a summary of these findings is given when appropriate.

United States Magnuson-Stevens Fishery Conservation and Management Act

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

FAO Technical Consultation on Sea Turtle-Fishery Interactions

While not a true international instrument for conservation, the Food and Agriculture Organization of the United Nations' (FAO) technical consultation on sea turtle-fishery interactions was groundbreaking in that it solidified the commitment of this international body to reduce sea turtle bycatch in marine fisheries operations. Recommendations from

the technical consultation were endorsed by the FAO Committee on Fisheries (COFI) and called for the immediate implementation by member nations and Regional Fishery Management Organizations (RFMOs) of guidelines to reduce sea turtle mortality in fishing operations, developed as part of the technical consultation. Compliance with these guidelines is voluntary.

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

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

Convention on the Conservation of Migratory Species of Wild Animals

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

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

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

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

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

2.3.2.5 Other natural or manmade factors affecting its continued existence:

A principal cause of the decline of the Kemp's ridley nesting population was the taking of eggs from the nesting beaches. For the past several decades, the vast majority of Kemp's ridley nests are relocated into protective hatcheries to prevent poaching and reduce predation. The extensive hatchery operations to protect nests in response to the historically significant take of eggs by local communities is considered here because of possible adverse impacts to hatching success, sex ratios, and fitness due to manmade intervention. While relocation of nests into hatcheries is currently a necessary management measure, this relocation and concentration of eggs into limited areas is of concern since it makes the eggs more susceptible to reduced viability due to movement-induced mortality (Limpus *et al.* 1979, Parmenter 1980); adverse impacts on incubation temperature, gas exchange, and hydric environment; catastrophic events like hurricanes; and predation from both land and marine predators (Glenn 1998, Wyneken *et al.* 1998). Emergence rates have averaged 66.3% from 1978 through 2005 for nests relocated to hatcheries at Rancho Nuevo and other camps (FWS 2006). Relocating nests into sands deficient in oxygen or moisture can result in mortality, morbidity, and reduced behavioral competence of hatchlings (Ackerman 1980, Packard *et al.* 1981, Packard *et al.* 1984, Packard *et al.* 1985,

Packard and Packard 1986, Miller *et al.* 1987, Packard *et al.* 1988, McGehee 1990). Hatchery protocols include delayed release of hatched eggs. Delaying hatchlings from crawling down the beach significantly lowers their crawling and swimming speeds (Hewavisenthi 1994, Pilcher and Enderby 2001) and may increase the risk of predation. In spite of these many concerns, hatchery operations within Mexico have clearly provided the necessary hatchling recruitment to support a steady population increase in conjunction with the use of TEDs in Gulf of Mexico and Atlantic shrimp trawls.

There are several other manmade factors that affect Kemp's ridleys in foraging areas and on nesting beaches. Impacts from climate change, especially due to global warming, are likely to become more apparent in future years (IPCC 2007a). The global mean temperature has risen 0.76°C over the last 150 years, and the linear trend over the last 50 years is nearly twice that for the last 100 years (IPCC 2007a). There is a high confidence, based on substantial new evidence, that observed changes in marine systems are associated with rising water temperatures, as well as related changes in ice cover, salinity, oxygen levels, and circulation. These changes include shifts in ranges and changes in algal, plankton, and fish abundance (IPCC 2007b), which could affect Kemp's ridley prey distribution and abundance. 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 a restricted nesting area, global warming could potentially impact population sex ratios and thus the reproductive ecology of this species.

Sea-level is expected to rise due to ocean warming, glacier and snow cover melt, and loss of the ice sheets of Greenland and Antarctica (IPCC 2007a). The pending sea level rise from global warming is a potential problem, particularly for areas with low-lying beaches where sand depth is a limiting factor, as the sea will inundate nesting sites and decrease available nesting habitat (Daniels *et al.* 1993, Fish *et al.* 2005, Baker *et al.* 2006). The loss of habitat as a result of climate change could be accelerated due to a combination of other environmental and oceanographic changes such as increase in the frequency of storms (IPCC 2007b) and/or changes in prevailing currents, both of which could lead to increased beach loss via erosion (Antonelis *et al.* 2006, Baker *et al.* 2006).

Historically, certain commercial fisheries have been a major threat to the Kemp's ridley (Frazier *et al.* 2007). Prior to the implementation of TEDs, it was estimated that 500 to 5,000 Kemp's ridleys were killed annually by shrimp trawls (National Research Council 1990). Full

implementation of TEDs in the shrimp fishery occurred in December 1992 in the coastal waters of the U.S. The improved prognosis for the Kemp's ridley nesting population at Rancho Nuevo can be attributed to a combination of factors including protection of females and eggs on the nesting beach and the restriction of the U.S. shrimping fleet in Mexican waters, and a decline in size of the Mexican shrimping fleet (TEWG 2000). Additionally, since 1978, the waters adjacent to approximately 14 km of beach near Rancho Nuevo have been closed to fishing during the nesting season, but this has not been strictly enforced (TEWG 2000). In August 2000, the Texas Parks and Wildlife Commission adopted new shrimping rules that provided significantly more protection to sea turtles by establishing a South Texas seasonal closure from the beach out to 5 nautical miles from December 1 through July 15, which is the time when adult ridleys mate, nest, forage, and migrate to and from the Tamaulipas nesting grounds (Osburn *et al.* 2003).

The mid-Atlantic trawl fishery for summer flounder has also been identified as a source of Kemp's ridley mortality (Epperly *et al.* 1995, 1996). As a result, this industry is now required to use TEDs south of Cape Charles, Virginia (TEWG 2000).

Gill net fisheries operating along the mid and southeast U.S. Atlantic coastlines are known to incidentally capture Kemp's ridleys (Trent *et al.* 1997, TEWG 2000). Several of these gill net fisheries have been temporarily closed in recent years in response to increased strandings of sea turtles (TEWG 2000).

There are commercial fishing camps near Rancho Nuevo, and gill netting for sharks occurs along the coast of Tamaulipas (FWS and NMFS 1992). Although this is restricted in the waters directly off Rancho Nuevo during the nesting season, it is of concern because some adult males remain resident in that area year round (Shaver *et al.* 2005). Recent stranding data reported 59 stranded Kemp's ridleys along the coast of Tamaulipas during a 53-week period (FWS 2006). An estimated 100 adult Kemp's ridley sea turtles were found stranded along the Tamaulipas coast during the month of March 2007 and suspected to be from the shark fishery (P. Burchfield, Gladys Porter Zoo, personal communication, 2007).

Although there are records of Kemp's ridley captures by longline fisheries (TEWG 2000, Fairfield-Walsh and Garrison 2007), the impact appears minimal. From 1992-1997, observers on the U.S. longline fleet documented the capture of 4,808 loggerheads, but no Kemp's ridleys (Witzell 1999). Kemp's ridleys are also known to be captured occasionally by other fishing gear including hook and line, beach seine, purse seine, and pound nets (Caillouet *et al.* 1996, Frazier *et al.* 2007).

Incidental take of Kemp's ridleys has also been documented in channel dredging operations (FWS and NMFS 1992). Capture and mortality of sea turtles by hopper dredges was identified as a problem in the late 1970s. To minimize mortality associated with hopper dredging, the U.S. Army Corps of Engineers funded research to develop a plow-like deflector designed to push or move turtles away from the suction of the draghead (Nelson and Shafer 1996). In addition, shrimp trawlers have been employed to capture and relocate sea turtles prior to or during dredging operations. Observations during dredging projects in Texas and Florida suggest that sea turtles also may be captured and killed during pipeline or cutterhead dredging operations (NMFS, unpublished data). However, interactions between slow moving cutterhead dredges and sea turtles are thought to be rare.

Exposure to heavy metals and other contaminants in the marine environment is also of concern. In addition to other sources of contaminants, coastal runoff has the potential to pollute the shallow coastal habitats of the Kemp's ridley, and sea turtles, including the Kemp's ridley, are known to bioaccumulate a variety of toxins including organochlorine compounds and heavy metals (Lake *et al.* 1994; Rybitski *et al.* 1995; Pugh and Becker 2001; Kenyon *et al.* 2001; Wang *et al.* 2003; Keller *et al.* 2004, 2005; Gardner *et al.* 2006). Although their explicit effects on sea turtles have yet to be determined, such exposure may lead to immunosuppression or other hormonal imbalances (J. Keller, National Institute of Standards and Technology, personal communication to J. Seminoff, NMFS, 2006). The interaction from oil spills is an episodic problem that can also impact turtles worldwide (Yender and Mearns 2003), and this may lead to immunosuppression and other chronic health issues (Sindermann *et al.* 1982).

Additional human caused factors affecting Kemp's ridleys include the impacts of boat traffic on turtles and coastal habitats, ingestion and entanglement in marine debris, and intake of turtles into cooling systems of coastal power plants. Boat strikes have been shown to be a mortality source in the Southeast U.S. (Singel *et al.* 2003). Marine debris in the Gulf of Mexico is becoming an increasing threat to the Kemp's ridley (FWS and NMFS 1992, Frazier *et al.* 2007). The ingestion of and entanglement in marine debris can reduce food intake and digestive capacity and absorption of toxic materials (Balazs 1985, Bjorndal *et al.* 1994, Sako and Horikoshi 2002), and entanglement has been shown to cause mortality of sea turtles (Bugoni *et al.* 2001). Along the Atlantic coast of the U.S. and in the Gulf of Mexico, power plants are known to entrain small numbers of Kemp's ridleys in the intake channels of their cooling systems (TEWG 2000, Florida Power and Light and Quantum Resources Inc. 2005).

Aperiodic tropical storms and hurricanes may greatly impact the Kemp's ridley. In general, these events are episodic and may occur during the hatching season; however, given the limited nesting range of the Kemp's ridley, hurricanes have the potential to significantly impact the survival of nests in a given year.

2.4 Synthesis

The Kemp's ridley population, as measured by the number of nesting females, declined precipitously from the late 1940s through the mid 1980s. This decline, from an estimated 40,000 nesting females in a single arribada in 1947, to fewer than 250 nesting females in an entire nesting season in the mid 1980s resulted from intensive egg collection, killing of nesting females, and incidental capture and drowning in the shrimp fleets of the U.S. and Mexico. Due to intensive conservation actions, the Kemp's ridley began to slowly rebound during the 1990s and this recovery trajectory has continued through the present day. These conservation actions included the protection of females, nests, and hatchlings on the nesting beach since the late 1960s and enhancement of survival in the marine habitats through the implementation of TEDs in the early 1990s and a decrease in the amount of shrimping off the coast of Tamaulipas and in the Gulf of Mexico in general. Approximately 4,000 females are currently documented nesting annually, which is less than half the downlisting criterion of at least 10,000 females nesting annually and only 10% of the number of females estimated to nest in a single arribada in the late 1940s. The species is believed to be in the early stages of recovery, but this should be viewed in the context of a much larger population in the mid-20th century, only 60 years ago.

While the increases documented at nesting beaches are extremely encouraging and a testament to the commitments of the two nations (Mexico and the U.S.) primarily entrusted with conservation of the species, Kemp's ridleys, like other sea turtles, continue to face numerous threats. These threats include incidental capture in shrimp trawl and other coastal fisheries, coastal development and expanding human populations adjacent to important nesting beaches, degradation of coastal foraging habitats, and the potential effects of global warming on sex ratios.

3.0 RESULTS

3.1 Recommended Classification: Based on the best available information, we do not believe the Kemp's ridley should be reclassified.

3.2 New Recovery Priority Number: No change.

4.0 RECOMMENDATIONS FOR FUTURE ACTIONS

The current "Recovery Plan for the Kemp's Ridley Sea Turtle (*Lepidochelys kempii*)" was signed in 1992. Significant new information on the biology and population status of Kemp's ridley has become available since 1992. Consequently, a full revision of the recovery plan has been undertaken by the Services and is nearing completion. The revised plan will provide updated species biology and population status information, objective and measurable recovery criteria, and updated and prioritized recovery actions. In the near-term, nesting female and nest protection efforts must continue at the primary and secondary nesting beaches and TED use must be strictly and actively monitored and enforced in the U.S. and in Mexico. Annual surveys of the nesting population should continue as the primary means of monitoring the status of the species. To augment these population status data, additional long-term in-water studies are needed to monitor the status of juveniles in the marine environment at key foraging areas. Existing monitoring programs at juvenile foraging areas should be continued. Efforts to evaluate the conservation implications of leaving nests to incubate on the beach should continue, as well as studies on the effects of incubation temperature on hatchling sex ratios. Incidental capture of Kemp's ridleys in non-shrimp trawl fishing gear should be fully evaluated and measures to reduce this bycatch should be implemented. The effects of human caused habitat modification on Kemp's ridleys need to be evaluated and addressed, if warranted.

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**U.S. FISH AND WILDLIFE SERVICE
5-YEAR REVIEW of Kemp's Ridley Sea Turtle**

Current Classification: Endangered

Recommendation resulting from the 5-Year Review: No change


Review Conducted By:

Therese Conant, Barbara Schroeder (National Marine Fisheries Service)
Sandy MacPherson, Earl Possardt, Kelly Bibb (U.S. Fish and Wildlife Service, Southeast Region)
Tom Shearer, Wendy Brown (U.S. Fish and Wildlife Service, Southwest Region)

FIELD OFFICE APPROVAL:

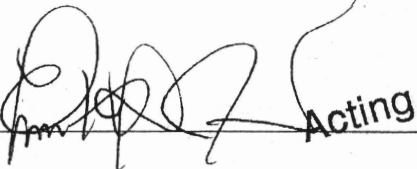
Lead Field Supervisor, Fish and Wildlife Service

ACTING

Approve  Date 08-23-07

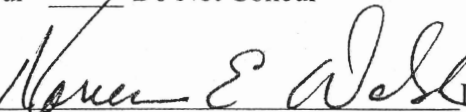
REGIONAL OFFICE APPROVAL:

Lead Regional Director, Fish and Wildlife Service

Approve  **Acting** Date 8/22/07

Cooperating Regional Director, Fish and Wildlife Service

Concur Do Not Concur

Signature  Date 8/24/07

**NATIONAL MARINE FISHERIES SERVICE
5-YEAR REVIEW of *Kemp's Ridley Sea Turtle***

Current Classification: Endangered

Recommendation resulting from the 5-Year Review: No change

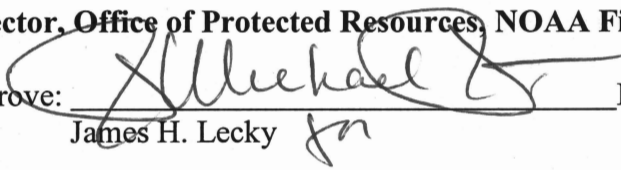
Review Conducted By:

Therese Conant, Barbara Schroeder (National Marine Fisheries Service)
Sandy MacPherson, Earl Possardt, Kelly Bibb (U.S. Fish and Wildlife Service, Southeast Region)
Tom Shearer, Wendy Brown (U.S. Fish and Wildlife Service, Southwest Region)

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


HEADQUARTERS APPROVAL:

Director, Office of Protected Resources, NOAA Fisheries

Approve:  Date: 8/14/07
James H. Lecky *fn*

Assistant Administrator, NOAA Fisheries

Concur Do Not Concur

Signature  Date 8/16/07
Samuel D. Rauch, III
Deputy Assistant Administrator
for Regulatory Programs

APPENDIX

Summary of peer review for the 5-year review of *Kemp's Ridley Sea Turtle (Lepidochelys kempii)*

A. Peer Review Method: See B. below.

B. Peer Review Charge: On July 2, 2007, the following letter and Guidance for Peer Reviewers of Five-Year Status Reviews were sent via e-mail to potential reviewers requesting comments on the 5-year review. Requests were sent to Dr. Alberto Abreu Grobois (Unidad Academica Mazatlán), Dr. Patrick Burchfield (Gladys Porter Zoo), Dr. Charles W. Caillouet, Jr. (NMFS Retired), Dr. David Owens (College of Charleston), Dr. Oscar Ramirez Flores (SEMARNAT), Michael Ray (Texas Parks and Wildlife), and Dr. Donna J. Shaver (National Park Service).

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

The enclosed draft of the status review has been prepared by the Services pursuant to the Act. In keeping with directives for maintaining a high level of scientific integrity in the official documents our agencies produce, we are seeking your assistance as a peer reviewer for this draft. Guidance for peer reviewers is enclosed with this letter. If you are able to assist us, we request your comments be received on or before July 30, 2007. Please send your comments to Sandy MacPherson at the address on this letter. You may fax your comments to Sandy MacPherson at 904-232-2404 or send comments by e-mail to Sandy_MacPherson@fws.gov.

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

Sincerely yours,

*David L. Hankla
Field Supervisor
Jacksonville Ecological Services Field Office*

Enclosures

Guidance for Peer Reviewers of Five-Year Status Reviews
U.S. Fish and Wildlife Service, North Florida Ecological Services Office

February 7, 2007

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

Peer reviewers should:

- 1. Review all materials provided by the Service.*
- 2. Identify, review, and provide other relevant data that appears not to have been used by the Service.*
- 3. Not provide recommendations on the Endangered Species Act classification (e.g., Endangered, Threatened) of the species.*
- 4. Provide written comments on:*
 - Validity of any models, data, or analyses used or relied on in the review.*
 - Adequacy of the data (e.g., are the data sufficient to support the biological conclusions reached). If data are inadequate, identify additional data or studies that are needed to adequately justify biological conclusions.*
 - Oversights, omissions, and inconsistencies.*
 - Reasonableness of judgments made from the scientific evidence.*
 - Scientific uncertainties by ensuring that they are clearly identified and characterized, and that potential implications of uncertainties for the technical conclusions drawn are clear.*
 - Strengths and limitation of the overall product.*
- 5. Keep in mind the requirement that we must use the best available scientific data in determining the species' status. This does not mean we must have statistically significant data on population trends or data from all known populations.*

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

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

C. Summary of Peer Review Comments/Report:

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

Dr. Patrick Burchfield, Gladys Porter Zoo, Brownsville, TX: Dr. Burchfield provided corrections, updates, and clarifications on average clutch size and numbers of nesting and stranded Kemp's ridley sea turtles in the State of Tamaulipas, Mexico.

Dr. Charles W. Caillouet, Jr., NMFS Retired, Montgomery, TX: Dr. Caillouet provided extensive substantive and editorial comments and provided an extensive bibliography of Kemp's ridley publications that he believed should be included as information sources. Dr. Caillouet also believed the draft revised recovery plan, which is currently being prepared by the Bi-National Kemp's Ridley Recovery Team, should be mentioned, examined, and cited in this review, and to assure consistency between this 5-year review and the new recovery plan. He emphasized that age-based models used to explain and project nesting population trajectories, and to rank threats and recovery priorities, should be updated and re-run, using improved inputs for parameters such as duration of the pelagic stage, and sex ratio (which is female-biased). He also pointed to the recent imagery analysis (Dickerson and Dickerson 2006) of the 1947 film of a Kemp's ridley arribada that he believed should be discussed and compared to the original estimate of 40,000 females in the arribada, which is often quoted as an historical reference to the population size as well as a nesting population threshold upon which recovery criteria have been based. Dr. Caillouet also felt Section 2.3.2.2 was not balanced in terms of the concerns expressed about negative effects of nesting beach corral hatchery operations on hatching and hatchlings versus their clear benefits (i.e., there would be no Kemp' ridley nesting population now if there had not been extensive beach hatchery operations over the last four decades). Regarding 2.3.2.5, Dr. Caillouet suggested that manmade factors should be reordered from highest to lowest severity in relation to their threat to the continued existence of the Kemp's ridley.

Dr. Oscar Ramirez Flores, SEMARNAT, Mexico: Dr. Ramirez provided several edits. Dr. Ramirez agreed the hatchery program at Rancho Nuevo may have some adverse effects but felt the management program was not suited for mention under Section 2.3.2.2.

Michael Ray, Texas Parks and Wildlife, Austin, TX: Mr. Ray felt the document provided an excellent overview of the relevant scientific findings since the last review and accurately portrayed the status of the species. He commented on the significant reduction in shrimp trawling effort in the Gulf of Mexico in the past 5 to 6 years and pointed to a NOAA reference on the subject supporting this statement, which he felt was important to note in the review since this has undoubtedly positively affected the survivorship of adults and immature Kemp's ridleys. Mr. Ray also pointed to the establishment of an annual South Texas seasonal shrimp trawling closure and referenced a publication detailing the closure, which he believed important to mention in Section 2.3.2.5.

Dr. Donna J. Shaver, National Park Service, Corpus Christi, TX: Dr. Shaver pointed out that there was no mention in Section 2.3.2.2 about the illegal historic and current poaching on Mexico nesting beaches, which was a major factor in the decline of the population. Dr. Shaver also felt this section dwelled on the potential negative impacts from hatcheries and failed to point out that the dramatic increases in nesting demonstrate that the hatcheries in practice have in fact benefited the species. Dr. Shaver pointed to the mandatory use of TEDs in shrimp trawls and a decline in the shrimping industry as being important manmade factors contributing to the

increase in the Kemp's ridley population. She also said that references to movements of adult females away from the nesting beaches should be broadened to include Texas.

D. Response to Peer Review:

Dr. Patrick Burchfield, Gladys Porter Zoo, Brownsville, TX: All comments and corrections were incorporated in the review.

Dr. Charles W. Caillouet, Jr., NMFS Retired, Montgomery, TX: The majority of editorial comments and most substantive comments that called for corrections or additions in the review have been incorporated. The comment recommending the draft revised Kemp's ridley recovery plan be discussed and cited in the review cannot be done as the draft revised plan is a pre-decisional document under discussion and development by the Services. The comment regarding the recent imagery analysis of the 1947 Rancho Nuevo arribada was added, but the Services feel a comparison of the recent and historical estimate is premature given limitations of the recent analysis. We agree with Dr. Caillouet's comment and recommendation about the value of updating and re-running age-based models used to explain and project nesting population trajectories; however, this is not the purpose or within the purview of this 5-year review, which is to synthesize and assess any new information that is available. We recognize that the format and presentation of Section 2.3.2.5 could be revised as recommended by Dr. Caillouet; however, the Services are under time constraints to complete the sea turtle 5-year reviews by the end of August 2007 so we are unable to address some of the format and presentation recommendations.

Dr. Oscar Ramirez Flores, SEMARNAT, Mexico: All comments were incorporated in the review.

Michael Ray, Texas Parks and Wildlife, Austin, TX: All comments were incorporated in the review.

Dr. Donna J. Shaver, National Park Service, Corpus Christi, TX: Text was edited to reflect Dr. Shaver's comments on Section 2.3.2.2. The text was also revised to include Texas when discussing movements of adult females away from the nesting beaches.