KEMP'S RIDLEY SEA TURTLE
(LEPIDOCHELYS KEMPII)

5-YEAR REVIEW:
SUMMARY AND EVALUATION

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

1.0 GENERAL INFORMATION 4
1.1 Reviewers 4
1.2 Background 4
1.2.1 FR notice citation announcing initiation of this review 4
1.2.2 Listing history 4
1.2.3 Associated rulemakings 5
1.2.4 Review history 5
1.2.5 Species' recovery priority number at start of review 5
1.2.6 Recovery plan 5
2.0 REVIEW ANALYSIS 5
2.1 Application of the 1996 Distinct Population Segment (DPS) policy 5
2.1.1 Is the species under review a vertebrate? 6
2.1.2 Is the species under review listed as a DPS? 6
2.1.3 Is there relevant new information for this species regarding the application of the DPS policy? 6
2.2 Recovery Criteria 6
2.2.1 Does the species have a final, approved recovery plan containing objective, measurable criteria? 6
2.3 Updated Information and Current Species Status 9
2.3.1 Biology and Habitat 9
Distribution 9
Migration 10
Demography 13
Taxonomy, Phylogeny and Genetics 16
Habitat Use or Ecosystem Conditions 16
Abundance and Population Trends 18
2.3.2 Five-Factor Analysis (threats, conservation measures, and regulatory mechanisms) 25
2.3.2.1 Present or threatened destruction, modification or curtailment of its habitat or range: 25
2.3.2.2 Overutilization for commercial, recreational, scientific, or educational purposes: 27
2.3.2.3 Disease or predation: 28
2.3.2.4 Inadequacy of existing regulatory mechanisms: 29
2.3.2.5 Other natural or manmade factors affecting its continued existence: 32
2.4 Synthesis 37
3.0 RESULTS 38
3.1 Recommended Classification: 38
3.2 New Recovery Priority Number: 38
4.0 RECOMMENDATIONS FOR FUTURE ACTIONS 39
5.0 REFERENCES 40

LIST OF FIGURES

Figure 1. Class intervals of annual numbers of nesting events documented for each beach in Mexico in 2014 10
Figure 2. The total number of nests recorded at Tamaulipas (Rancho Nuevo and adjacent beaches) and Veracruz , Mexico, from 1947-2014. 21
Figure 3. The total number of nests recorded at PAIS, Texas, from 1948-2014 222
Figure 4. Best fit model predicted to observed nests. 24

LIST OF TABLES

Table 1. Total number of recorded nests (includes corral and *in* situ) and hatchlings released from the three primary nesting beaches: Rancho Nuevo, Tepehuajes, and Playa Dos, Mexico. . 19
Table 2. Bounds placed on parameters fit by Excel Solver or manual entry to minimize negative log-likelihood in population model. 23
Table 3. Best fit parameter values used in the model updated from the Bi-National Recovery Plan for the Kemp's Ridley Sea Turtle. 24
Table 4. Numbers of stranded sea turtles along the coast of the State of Tamaulipas, Mexico.. 34

5-YEAR REVIEW
Kemp's Ridley Sea Turtle/*Lepidochelys kempii*

1.0 GENERAL INFORMATION

1.1 Reviewers

National Marine Fisheries Service:
Therese Conant – 301-427-8456
Allison Kepple, Intern, June – August, 2013

1.2 Methodology and background

A 5-year review is a periodic analysis of a species' status conducted to ensure that the listing classification of a species as threatened or endangered on the List of Endangered and Threatened Wildlife and Plants (List) (50 CFR 17.11 – 17.12) is accurate. The 5-year review is required by section 4(c)(2) of the Endangered Species Act of 1973, as amended (ESA). To achieve this, the National Marine Fisheries Service (NMFS) Office of Protected Resources led the 5-year review with input from the U.S. Fish and Wildlife Service (FWS). The draft document was distributed to NMFS regional offices and science centers and FWS regional and field offices for their review and edits, which were incorporated where appropriate. Concurrently, the 5-year review was reviewed by six peer reviewers (Charles Caillouet, Jr., Ph.D., Laura Sarti, Ph.D.; Jeffrey Schmid, Ph.D.; Donna Shaver, Ph.D.; Kimberly Reich, Ph.D.; Thane Wibbels, Ph.D.). Information sources include the final rule listing this species under the Endangered Species Act (ESA); the Bi-National recovery plan; peer reviewed publications; unpublished field observations by the Services, States, and other experienced biologists; unpublished survey reports; and notes and communications from other qualified biologists. The public notice for this review was published on October 10, 2012, with a 60-day comment period (77 FR 61573). Comments received were incorporated as appropriate into the 5-year review. The information on the Kemp's ridley biology and habitat, threats, and conservation efforts were summarized and analyzed in light of the recovery criteria and the ESA section 4(a)(1) factors (see Section 2.3.2.1) to determine whether a reclassification or delisting is warranted (see Section 3.0).

1.2.1 FR notice citation announcing initiation of this review

October 10, 2012 (77 FR 61573)

1.2.2 Listing history

Original Listing
FR notice: 35 FR 18320
Date listed: December 2, 1970
Entity listed: Species
Classification: Endangered

1.2.3 Associated rulemakings

There are no associated rulemakings with the original listing.

1.2.4 Review history

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.

FWS conducted 5-year reviews for the Kemp's ridley in 1985 (50 FR 29901) and in 1991 (56 FR 56882).

Conclusion: Retain the listing as an endangered species.

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.

NMFS and FWS. 2007. Kemp's Ridley Sea Turtle (*Lepidochelys kempii*) 5-Year Review: Summary and Evaluation. 50 pages.

Conclusion: Retain the listing as an endangered species.

1.2.5 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).

1.2.6 Recovery plan

Name of plan: Bi-National Recovery Plan for the Kemp's Ridley Sea Turtle (*Lepidochelys kempii*)
Date issued: September 22, 2011

Dates of previous plans:
Original Plan- September 19, 1984
Recovery Plan for the Kemp's Ridley Sea Turtle - August 21, 1992

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?

Yes. The "Bi-National Recovery Plan for the Kemp's Ridley Sea Turtle (*Lepidochelys kempii*)" was signed in 2011 (NMFS *et al.* 2011) as a revision to the 1992 "Recovery Plan for the Kemp's Ridley Sea Turtle (*Lepidochelys kempii*)". The 2011 "Bi-National Recovery Plan for the Kemp's Ridley Sea Turtle" adheres to all elements of the NMFS Interim Recovery Planning Guidance (NMFS 2010).

The recovery objectives from the 2011 Bi-National Recovery Plan for the Kemp's Ridley Sea Turtle are identified below:

Recovery Objectives as written in the Bi-National Recovery Plan for the Kemp's Ridley Sea Turtle

Downlisting Criteria
The Kemp's ridley sea turtle can be considered for downlisting from Endangered to Threatened if the following conditions are met:

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.

   Status: This criterion has not been met. In 2014, there were 7,272 nests in Rancho Nuevo, 1,381 in Tepehuajes, and 2,333 in Playa Dos, Mexico, for a total of 10,986 nests. This number represents approximately 4,395 nesting females for the season based on 2.5 clutches/female/season. The number of nests reported annually from 2010 to 2014 overall declined. Although there has been a substantial increase in the Kemp's ridley population within the last few decades, the number of nesting females is still below the number of

nesting females per season required for downlisting. See Section 2.3.1 Abundance and Population Trends for more detail.

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.

   Status: This criterion has been met. Since 2000, more than 300,000 hatchlings have been released each year. In 2014, 519,345 hatchlings were released from Rancho Nuevo, Tepehuajes, and Playo Dos.

Listing Factor Criteria

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 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.

   Status: This effort is ongoing. Rancho Nuevo was declared a Natural Reservation in 1977 and was declared a Sanctuary in 2002. 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 2013, Mexico implemented regulations to protect all sea turtle nesting beaches, including Ranch Nuevo, Tepehujues, and Playa Dos (NOM-162-SEMARNAT-2012).

2. Social and/or economic initiatives that are compatible with the 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.

   Status: This effort is ongoing. Projects are currently in progress in four communities adjacent to the main nesting beaches (Rancho Nuevo, Barra del Tordo, La Pesca, Tepehuajes); local community members are hired to work with the Kemp's ridley conservation program. The Ministry of Urban Development and Environment is requesting assistance from CONANP to continue the PROCODES Community Support Program at La Pesca and Tepehuajes in 2015 as well as assistance to implement a more permanent environmental education program in these communities.

3. Predation of nests is reduced through protective measures implemented to achieve 300,000 hatchlings per season at Rancho Nuevo, Tepehuajes and Playa Dos in Mexico through *in situ* incubation, incubation in corrals or a combination of both.

Status: This criterion has been met as evidenced by the number of hatchlings released each year (see criterion no. 2). The predation rate on nests left *in situ* at Rancho Nuevo is about 5-10% each nesting season (L. Sarti, National Commission of Natural Protected Areas (CONANP), personal communication 2015).

4. Turtle excluder device (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.

   Status: This criterion has not been met and effort is ongoing. Skimmer trawls are known to adversely impact Kemp's ridleys; however, TEDs are not required in this fishery pending further development and testing of effective TEDs. In the U.S., compliance with the TED regulations dropped substantially in the last several years. For example, in 2011 in the Gulf of Mexico, observed compliance ranged from a low of 53% in May and high of 85% in August. TED compliance in the South Atlantic shrimp fishery in 2011 was estimated to be 67% (see NMFS 2012 for further details). NMFS increased TED monitoring and, based on law enforcement and gear monitoring data, changed the 97% TED exclusion rate (which assumed 100% compliance with TEDs) to 88% turtle exclusion rate for TEDs. This new compliance standard is a target for law enforcement and monitoring purposes to ensure the TED regulations are effectively excluding sea turtles. By 2015, TED compliance had exceeded the 88% turtle exclusion rate (NMFS unpublished data 2015). In early 2010, Mexico was decertified under U.S. Public Law 101-162 to export wild harvested shrimp to the U.S. because their TED program was not comparable to the U.S. program (75 FR 16225 March 31, 2010). However in 2011, Mexico was recertified based on improvements in the TED program (76 FR 32010, June 2, 2011).

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.

   Status: This effort is ongoing. The Services will organize, in coordination with Mexico, a workshop of experts to determine the best approach (including what data should be collected) to in-water population monitoring and to identify, if appropriate, index monitoring sites for implementation by appropriate federal and state agencies and/or academia. Existing surveys in the Gulf of Mexico (e.g., SEAMAP, Sabine Pass, Calcasieu Pass) and Atlantic (e.g., SEAMAP, SCDNR turtle trawl survey) should be examined to determine whether those surveys, as currently conducted, are providing site-specific robust population trend and/or vital rate data. A non-governmental organization, TOMAME (Tortugas Marinas de Mexico), has also proposed to locate and monitor sea turtle foraging areas within and in coordination with the State of Tamaulipas. Available data indicate pelagic juveniles inhabit the oceanic waters of the Gulf of Mexico and northwest Atlantic Ocean, while neritic juveniles inhabit coastal waters of the northern Gulf and U.S. Atlantic coast north to New England. Coastal areas in the northwestern

and western Gulf of Mexico including tidal passes, bays, and coastal lakes, represent optimal developmental habitats due to favorable water temperature and abundant prey. Along the U.S. Atlantic coast, juveniles make seasonal north and south migrations. However, it is not well understood the degree to which migrants along the Atlantic coast contribute to the breeding population. Published records indicate fewer than 20 Kemp's ridleys tagged in the Atlantic Ocean have been documented to nests on Gulf of Mexico beaches. Studies have identified the nearshore areas in the U.S. Gulf of Mexico, especially off Louisiana as important foraging habitat for post-nesting females from PAIS, upper Texas coast, and Rancho Nuevo, Tamaulipas, Mexico. Nearshore areas off the Yucatan Peninsula have been identified as important foraging habitat for post-nesting females from Rancho Nuevo, Tamaulipas, Mexico. See Section 2.3.1 for more detail.

Delisting

An analysis of the delisting criteria is not required because the Kemp's ridley sea turtle has not met the downlisting criteria. The criteria required for the delisting of the Kemp's ridley are listed under the 2011 Bi-National Recovery Plan for the Kemp's Ridley Sea Turtle, which is available at: http://www.nmfs.noaa.gov/pr/pdfs/recovery/turtle_kempsridley_draft2.pdf

2.3 Updated Information and Current Species Status

This review is based on the best available information through February 2015. The review provides an overview of the information on Kemp's ridley biology, population distribution and trends, habitat, and threats that have emerged or have been mitigated since the last 5-year review (NMFS and FWS 2007) to assess whether a status review of the current listing classification for the Kemp's ridley sea turtle is appropriate. The age structured model used for population projection completed for the last recovery plan (NMFS *et al.* 2011) was updated for this 5-year review (Heppell. S., Oregon State University (OSU), unpublished data 2015; NMFS award NA110AR4320091) to determine whether we have met downlisting criterion number 1 given the recent downturn in annual nests numbers.

Since the last 5-year review (NMFS and FWS 2007), we continue to make strides in our knowledge of the biology of Kemp's ridleys, especially away from the nesting beach. Improvements in models to assess population status and trends have provided new insights into the species' response to threats and conservation efforts. Advances in tagging techniques, such as satellite, radio, and sonic telemetry have vastly improved our knowledge of the biology and ecology of Kemp's ridley sea turtles. We have a better understanding of foraging site selection and fidelity and migratory patterns for adults and oceanic and neritic juveniles in the Gulf of Mexico. Important contributions have been made toward hypothesizing the impact of climate and oceanographic processes on population viability. Increased evaluation of fisheries bycatch has provided important insights into the management needs for this species.

2.3.1 Biology and Habitat

Distribution

The Kemp's ridley sea turtle has a restricted distribution (Morreale *et al*. 2007). Kemp's ridleys inhabit the Gulf of Mexico and northwest Atlantic Ocean, as far north as the Grand Banks

(Márquez 2001; Watson *et al.* 2004) and Nova Scotia (Bleakney 1955). They sporadically occur near the Azores and northeast Atlantic Ocean (Bolten and Martins 1990; Brongersma 1972; Deraniyagala 1938; Fontaine *et al.* 1989; Witt *et al.* 2007) and Mediterranean Sea (Brongersma 1982; Brongersma and Carr 1983; Insacco and Spadola 2010; Pritchard and Márquez 1973; Tomás and Raga 2007, 2008). Sightings in the Mediterranean Sea have increased, which may be due to misidentified loggerhead sea turtles, increased hatchling production at the nesting beaches, or a migration expansion by the Kemp's ridley to exploit valuable foraging grounds in the region (Tomás and Raga 2008).

Kemp's ridley nesting is essentially limited to the beaches of the western Gulf of Mexico, primarily in Tamaulipas, Mexico. Nesting also occurs in Veracruz and a few historical records exist for Campeche, Mexico. In the United States, nesting occurs primarily in Texas (especially PAIS), and occasionally in Florida, Alabama, Georgia, South Carolina, and North Carolina (below **Figure 1**.).

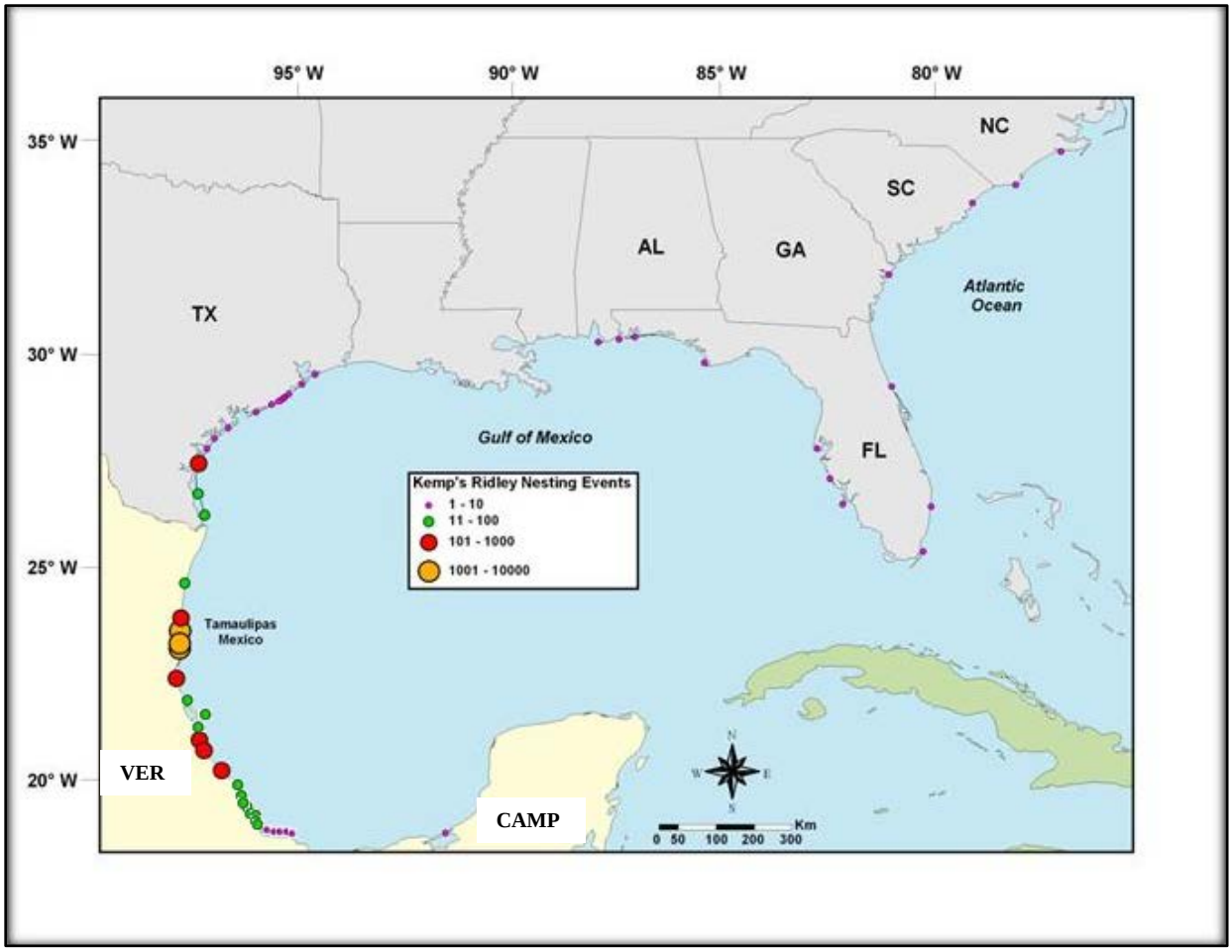

Figure 1. Class intervals of annual numbers of nesting events documented for each beach in Mexico in 2014 (*Source*: L. Sarti, CONANP, personal communication 2015), and in U.S. in 2009 (*Source:* NMFS *et al.* 2011: Padre Island National Seashore, FWS, Florida Marine Research Institute, Georgia Department of Natural Resources, South Carolina Department of Natural Resources, and North Carolina Wildlife Resources Commission).

Migration

Females

During the nesting season, adult females from Texas beaches establish residency in nearshore waters in Texas and Louisiana (Hughes and Landry 2013; Seney and Landry 2008, 2011; Shaver and Rubio 2008). Márquez (1994) reviewed recaptures of females tagged while nesting on Mexico beaches, but recent published data are lacking on the internesting movement of females from Mexico beaches.

Post-nesting migration of females from Rancho Nuevo and Texas beaches indicate that turtles move along coastal migratory corridors either to the north or south from the nesting beach (Byles 1989; Byles and Plotkin 1994; Hughes and Landry 2013; Renaud 1995; Renaud *et al*. 1996; Seney and Landry 2011; Shaver 1999, 2002; Shaver and Rubio 2008; Shaver *et al.* 2013). These migratory corridors appear to extend throughout the coastal areas of the Gulf of Mexico, and most adult females 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; however waters off the upper Texas coast through Mississippi, especially off Louisiana, appear to be a 'hotspot' as turtles returned to the area to forage over multiple years (Shaver *et al.* 2013). Females from Rancho Nuevo, Mexico, also headed south and east and traveled as far as the Yucatan Peninsula (Guzmán-Hernández *et al.* 2007; Morreale *et al*. 2007; Shaver *et al.* 2013). Those females 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 offshore various coastal locations in the Gulf of Mexico (Byles and Plotkin 1994; Morreale *et al*. 2007; Shaver *et al.* 2013).

The general migratory pattern that emerges is that females may begin migrating along relatively shallow migratory corridors toward the nesting beach in the late winter in order to arrive at the nesting beach by early spring. Based on captive animals, mating is believed to occur about 3 to 4 weeks prior to the first nesting of the season (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). The female is capable of storing the sperm in the upper oviduct after mating 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. The ovary of a reproductively active female will have follicles that begin to enlarge approximately 4 to 6 months prior to mating. A variety of steroid hormones and pituitary hormones are believed to coordinate ovulation and egg production (Rostal 2007).

Males

Males tracked in waters off Tamaulipas, Mexico, during different seasons either remained in foraging areas near the nesting beach (n = 10) or migrated to distant foraging grounds (n = 1; Shaver *et al*. 2005). This study focused on capturing males in the waters near Rancho Nuevo and may represent a bias since resident males may have been more available for capture than transient males. Shaver (2007) also followed the movements of one adult male Kemp's ridley that stranded alive 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.

Males and immature turtles had smaller core foraging areas (Shaver *et al.* 2005) compared to females (Seney and Landry 2011), which may indicate that adult females require larger foraging areas to meet their nutritional needs. However, further studies on male and immature Kemp's ridley foraging strategies are needed in order to compare movement patterns between life stages (Seney and Landry 2011).

Hatchlings and Juveniles

Hatchling dispersal is not well known, but is likely influenced by the oceanic currents in the western Gulf of Mexico (NMFS *et al.* 2011; Putman *et al.* 2013). Kemp's ridley hatchlings enter the Gulf of Mexico from beaches near Rancho Nuevo, Mexico, and are presumably carried by major oceanic currents (e.g., anticyclonic Mexican Current) into various areas of the Gulf of Mexico and North Atlantic. 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; Witherington *et al.* 2012a). This period is within four days of hatching, which is thought to be the 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 facilitate hatchling transport to the pelagic environment within 4 days and subsequent migration to foraging grounds within 2 years (Putman *et al*. 2010).

Pelagic juveniles spend approximately 2 years in the ocean prior to recruiting to nearshore waters (Epperly *et al.* 2013; Ogren 1989; Snover *et al.* 2007; Zug *et al.* 1997). During this oceanic stage, juveniles either remain in the current system of the northern and western Gulf of Mexico or are transported to the Gulf Stream of the northwest Atlantic Ocean (Collard and Ogren 1990; Putman *et al.* 2010, 2013). Some individuals are transported to the eastern Atlantic Ocean, including the Mediterranean Sea (Brongersma 1982). Between 1992 and 2011, Witherington *et al.* (2012a) conducted searches within and between patches of *Sargassum* to determine the importance of this macroalgae community to young sea turtles. The authors estimated the Kemp's ridleys associated with *Sargassum* were either 1 or 2 yr olds. In the northern and eastern Gulf of Mexico, many of the Kemp's ridleys were 25 cm straight carapace length (SCL), which represents the lower size observed within nearby coastal-neritic habitats. It was hypothesized that these turtles were on the verge of recruiting to coastal habitats, and the open waters of the northern and eastern Gulf of Mexico support unique transitional habitat (Witherington *et al.* 2012a). Kemp's ridley pelagic juveniles (n = 20; 14.1-29.9 cm SCL) captured offshore in the northern and eastern Gulf of Mexico were tracked by satellite telemetry, and their movement was analyzed in comparison to passive surface drifters and modelled virtual particles (Putman and Mansfield 2015). The Kemp's ridleys actively oriented and swam from their release sites and were transported in ocean currents in the Gulf of Mexico, which may promote their retention within the area.

Neritic juveniles have been found in coastal habitats of the northern Gulf of Mexico and the U.S. Atlantic coast (Lyn *et al.* 2012; Morreale *et al*. 2007; Seney and Landry 2011; Turtle Expert Working Group (TEWG) 2000). In the Gulf of Mexico, juveniles make seasonal east, west, and

south migrations and move further offshore during the winter as water temperatures drop (Lyn *et al.* 2012; Renaud and Williams 2005; Schmid and Witzell 2006). Coastal areas in the northern Gulf of Mexico including tidal passes, bays, and coastal lakes, represent optimal developmental habitats due to favorable water temperature and abundant prey (Lyn *et al.* 2012; Seney and Landry 2011). Neritic juveniles exhibit site fidelity to shallow coastal foraging areas (Lyn *et al.* 2012; Schmid 1998; Schmid *et al.* 2003; Seney and Landry 2011). However, 2 of 3 immature turtles tracked off Texas in 2006 also ventured into deeper water where they remained for extended periods of time suggesting habitat preference may differ among years (Seney and Landry 2011). Along the U.S. Atlantic coast, neritic juveniles make seasonal north and south migrations (NMFS *et al.* 2011). 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). However, it is not well understood the degree to which migrants along the Atlantic coast contribute to the breeding population. Published records indicate fewer than 20 Kemp's ridleys tagged in the Atlantic Ocean have been documented to nests on Gulf of Mexico beaches (reviewed by Caillouet *et al. in press*).

Demography

Age and Growth

Growth rates vary by geography and ontogeny (Márquez 2001). Generally, growth rates in the Gulf of Mexico are greater (~7.0 cm/yr; Fontaine *et al.* 1989; Landry *et al.* 2005; Schmid and Woodhead 2000) than in the Atlantic Ocean (< ~ 6.0 cm/yr; Morreale and Standora 1998; Schmid and Woodhead 2000). However, specific sites in the Gulf of Mexico (e.g., Waccassasa Bay/Cedar Keys - 5.4 ± 3.3 cm/yr) and Atlantic Ocean (e.g., Cape Canaveral - 7.6 ± 9.2 cm/yr) do not fit this generality (Schmid and Barichivich 2006). Growth rates change over life stages (Chaloupka and Zug 1997). Post-hatchlings undergo rapid growth for the first year, but most experience a decline in growth around ages 2-3 (Snover *et al.* 2007). Growth rates seem to be stable and somewhat linear by ages 3-5. Growth was 16.9 cm in the first year, reaching an average carapace size of 21 cm/yr by age 1 (Snover *et al.* 2007). 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). A second growth spurt occurs at 46 cm SCL, possibly due to a shift in developmental habitat prior to sexual maturation (Chaloupka and Zug 1997). 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, and these maturing turtles were referred to as "subadults" (Coyne and Landry 2000; Gregory and Schmid 2001; Owens 1997). Based on known size-at-age head-started Kemp's ridleys, Snover *et al*. (2008) estimated that neritic juveniles transition to a pubertal subadult stage at about 4.3 years of age and at 52.2 cm SCL. Several studies, including those of captive turtles, recaptured turtles of known age, mark-recapture data, and skeletochronology, have estimated the average age to maturity in Kemp's ridleys ranges between 5 to 7 years (Márquez 1972), 10 years (headstarted, Caillouet *et al.* 1995), 5 to 12 years (captive only, Bjorndal *et al.* 2014), 10 to 16 years (Chaloupka and Zug 1997; Schmid and Witzell 1997; Zug *et al.*1997; Schmid and Woodhead, 2000), 9.9 to 16.7 years (Snover *et al.* 2007), and 10 and 18 years (Shaver and Wibbels 2007). While most of these studies estimated age to sexual maturity, estimates of age at first nesting may be used in age-based and life stage-based demographic modeling (see review by Caillouet *et al.* 2011).

Reproductive Capacity

It has been estimated that females lay an average of 2.5 clutches (estimates range 1.8 – 3.075 clutches/yr) within a season (TEWG 1998, 2000), which is the value used in the Bi-National Kemp's Ridley Recovery Plan (NMFS *et al.* 2011). However, using this average to extrapolate the number of females per nesting season may be resulting in underestimates of this vital criterion. Frey *et al.* (2014) used genotyping to assign nesting females to nests in Texas for nesting seasons 2003-2006. The average number of nests laid per female per nesting season ranged from 1.27 (2003) to 1.78 (2006) well below the previous estimated average and range for Rancho Nuevo, Mexico. The difference in values may reflect different nesting patterns or monitoring efforts between the two nesting beaches or known females may have nested outside of the monitored area. In addition, Frey *et al.* (2014) were unable to assign 19 of 141 nests, which suggest the existence of undetected nesting females. Further studies are needed to sample nesters and nests across years to improve the genotyping methodology and enable quantification of population parameters such as number of nests per female and inter-nesting interval.

The average number of eggs per clutch range from 95 to112 with 42-62 days of incubation prior to hatching (Burchfield 2009; Guzmán-Hernández *et al.* 2007). The average number of hatchlings per clutch peaked in 1989, reflecting an increase in the average number of eggs per clutch, and has declined roughly linearly ever since (Caillouet 2014). This may reflect a trend of overall decline in fecundity of nesters, the consequence of increasing proportions of neophyte nesters being added each year through 2009, which is a result of exponentially increasing annual hatchling releases in Tamaulipas through the same period (Caillouet 2014). Other factors such as insufficient energy reserves to meet the demands for egg production could reduce average number of eggs per nest, and therefore number of hatchlings per nest (e.g., Witzell *et al.* 2005).

Approximately 20% of females will nest every year, 60% every 2 years, 15% every 3 years, and 5% every 4 years (Márquez *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 (Márquez *et al*. 1989; TEWG 2000).

Kemp's ridleys tend to nest in large aggregations or arribadas (Bernardo and Plotkin 2007). Nesting in large aggregations may be advantageous for a variety of reasons, including mate finding, maintaining genetic diversity through multiple paternity, and enhancing the survival of eggs and hatchlings due to predator swamping (Bernardo and Plotkin 2007). The period between arribadas averages approximately 25 days (Rostal 2007; Rostal *et al*. 1997), but the precise timing of the arribada is highly variable and unpredictable (Bernardo and Plotkin 2007). The biological or physical factors that initiate an arribada are not known, 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; Shaver and Rubio 2008). Some Kemp's ridleys will nest between arribadas as solitary nesters and thus exhibit a shorter internesting interval (e.g., 14 days) than the arribada nesters (Rostal *et al*. 1997; Rostal 2007).

Sex Ratios

Sex determination in marine turtles is temperature dependent and occurs during approximately the middle third of incubation, which is known as the thermosensitive period (reviewed by

Wibbels 2003, 2007). During this thermosensitive period, the pivotal temperature at which an equal number of females and males are produced occurs at 30.0ºC (LeBlanc *et al.* 2012) to 30.2ºC (Shaver *et al.* 1988; reviewed by Wibbels 2007). This pivotal temperature generally is higher in Kemp's ridleys compared to other sea turtles (reviewed by Wibbels 2007). Temperatures of 32.5ºC or higher produced 100% female hatchlings, and although a minimum temperature could not be determined, temperatures less than 29º C produced predominately male hatchlings (LeBlanc *et al.* 2012).

At Rancho Nuevo, Mexico, sand temperatures gradually increase during the start of the Kemp's ridley 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 (Bevan *et al.* 2013; reviewed by Wibbels 2007). 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. 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, which can lower incubation temperatures to near or below the pivotal temperature. Although females are primarily produced at Rancho Nuevo, nests laid early in the season and those exposed to heavy rains during their thermosensitive period may produce more males (Bevan *et al.* 2013; reviewed by Wibbels 2007).

Sex ratios in adult and neritic juvenile Kemp's ridleys have been reported ranging from slightly male-biased to strongly female-biased. The reasons for the variation are unknown, but could relate to many factors including biased sampling (e.g., sampled in a migration corridor used more frequently by one sex or sampled from stranded turtles, which may represent differential mortality) (reviewed by Wibbels 2007).

The production of biased hatchling sex ratios at Rancho Nuevo could significantly affect the recovery of the Kemp's ridley (Bevan *et al.* 2013; reviewed by Wibbels 2003). The production of a female bias will potentially increase egg production as those turtles reach sexual maturity (Coyne and Landry 2007). In particular, the female-biased sex ratio has the potential of increasing the rate of recovery assuming that the number of males does not become a limiting factor. Empirical data are lacking to support this hypothesis, and the opposite may be true. For example, although one male may be able to inseminate multiple females (Frankel 2011; Frankel and Williams 2012; Kichler Holder and Holder 2007; Kichler *et al*. 1999), 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 fertility, however, has not been reported in the population. Low numbers of males could also result in the loss of genetic diversity within a population, but there is no evidence that this is a problem for the Kemp's ridley (Kichler Holder and Holder 2007; Kichler *et al*. 1999).

Taxonomy, Phylogeny and Genetics

The Kemp's ridley taxonomic classification (below) is unchanged since the last 5-year review (NMFS and FWS 2007).

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 was originally described by Samuel Garman in 1880 (Carr 1952), based on specimens submitted by Richard Kemp of Key West, Florida. The Kemp's ridley is closely related to the olive ridley (*Lepidochelys olivacea*) (Kichler Holder and Holder 2007), but it is a genetically distinct species (Bowen *et al*. 1991, 1998). Based on analysis of mitochondrial deoxyribonucleic acid, 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*. 1998). The ancestral split between the Kemp's ridley and olive ridley has been estimated to occur approximately 2.5 to 3.5 million (Bowen *et al*. 1998) or 4.5 to 5 million (Duchene *et al.* 2012) years ago.

Genetic data suggest a high level of multiple paternities in Kemp's ridleys, and the formation of nesting aggregations may facilitate multiple paternity (Bowen and Karl 2007; Frankel 2011; Frankel and Williams 2012; Kichler Holder and Holder 2007; Kichler *et al*. 1999; Rostal 2007). Multiple paternities are thought to increase the likelihood of fertilization, genetic variation, chance of receiving good genes, and overall fitness due to sperm competition (reviewed by Bowen and Karl 2007). The decline of this species to critically low numbers potentially caused a bottleneck resulting in a measurable loss of genetic variation (Stephens 2003). However, Kichler (1996) showed that the genetic variability as measured by heterozygosis at microsatellite loci is high (H = 0.60), which indicates that the demographic bottleneck 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 several decades will likely prevent any negative consequence in the genetic variability of the species.

Habitat Use or Ecosystem Conditions

Marine

Coastal developmental habitats for neritic juveniles occur throughout the entire northern Gulf of Mexico and U.S. Atlantic coast northward to New England (reviewed by Meylan *et al.* 2011; Morreale *et al*. 2007; Schmid 1998; Wibbels *et al*. 2005). The main characteristics that define developmental habitats are coastal areas sheltered from high winds and waves such as embayments, estuaries, and nearshore temperate waters. Suitability of these habitats depends on resource availability (TEWG 2000), and optimal environments appear to provide rich food sources of crabs and other invertebrates (Metz 2004; Ogren 1989; Schmid 1998). 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. Studies have shown that their diets include various items such as mollusks, natural and synthetic debris, sea horses, cownose rays, jellyfish, and tunicates (Burke *et al.* 1993a, 1993b, 1994; Frick *et al.* 1999; Shaver 1991; Werner 1994; Witzell and Schmid 2005). Based on necropsies of Kemp's ridleys in the northern Gulf of Mexico, fish appear to be a primary diet of juveniles (NMFS unpublished data).

A variety of substrates have been proffered as good foraging habitats, including seagrass beds (Byles 1988; Carr and Caldwell 1956), 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 that are essential to the recovery of the species (NMFS *et al.* 2011). Accordingly, 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 and this benthic community has not been identified in any previous descriptive accounts of habitat use (Schmid 2000, Schmid *et al.* 2003, Schmid and Braichivich 2006). Furthermore, the preference for nearshore live bottom habitat has important implications for offshore winter habitat use by neritic juveniles and adults (Schmid and Witzell 2006).

Key foraging areas studied in the Gulf of Mexico include Sabine Pass, Texas; Caillou Bay and Calcasieu Pass, Louisiana; Big Gulley, Alabama (Metz 2004; Ogren 1989; Seney and Landry 2011); Cedar Keys, Florida (Carr and Caldwell 1956; Ogren 1989; Schmid 1998; Schmid *et al*. 2002); St Joseph Bay, Florida (Stephens *et al.* 2013), Pine Island Sound, Florida (Schmid and Tucker 2012; Schmid *et al.* 2013), and Ten Thousand Islands, Florida (Witzell and Schmid 2004, 2005). Foraging areas studied along the Atlantic coast include Pamlico Sound, Chesapeake Bay, Long Island Sound, Charleston Harbor, and Delaware Bay (Burke *et al*. 1994; Epperly *et al*. 1995; Keinath *et al.* 1987, 1994; Lutcavage and Musick 1985; Morreale and Burke 1997; Morreale and Standora 1998; Musick *et al*. 1994; Seney and Musick 2005; Seney *et al.* 2014; Shoop and Kenney 1992).

Waters of the northern Gulf of Mexico, particularly off Louisiana, were found to be important foraging habitat (< 68 meters deep; mean 33.2 km $\pm$25.3 km from shore) for post-nesting females from PAIS, United States, and Rancho Nuevo, Mexico (Shaver *et al.* 2013). Females from Rancho Nuevo also use shelf waters off the Yucatan Peninsula. Distance to the nesting beach, distance to mainland coast, annual mean sea surface temperature, bathymetry and net primary production were significant predictors for where a post-nesting female chose to forage (Shaver *et al.* 2013). Post-nesting females from beaches along the upper Texas coast foraged primarily in nearshore waters between Louisiana and southwest Florida, with the heaviest concentration of females using the Mississippi River Delta (Hughes and Landry 2013). Knowledge of habitat-use by adult males is more limited, but satellite telemetry used to monitor movements of adult males captured near Rancho Nuevo, Tamaulipas, Mexico (Shaver 2006), indicate that males inhabit nearshore waters similar in depth and bottom composition to females.

Terrestrial
The beach at Rancho Nuevo, 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 (Márquez 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 and cord grass. Rancho Nuevo is considered a high energy beach with sand flats running parallel and adjacent to the beach, forming reef-like barriers (Márquez 1994).

The beach on the Texas coast varies geographically, with some areas generally similar to Rancho Nuevo and other areas differing. However, 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 beach renourishment activities.

Abundance and Population Trends
Information suggests the Kemp's ridley was historically abundant (see discussion below). Recent population abundance, based on nests and hatchling recruitment, was estimated by Gallaway *et al.* (2013, in press). They estimated the female population size for age 2 and older in 2012 to be 188,713 (SD = $\pm$32,529). Assuming females comprise 76% (sex ratio = 0.76; TEWG 1998, 2000) of the population, they estimated the total population of age 2 years and over at 248,307. Based on the number of hatchlings released in 2011 and 2012 (1+ million) and recognizing mortality over the first two years is high, Gallaway *et al.* (2013, in press) thought the total population, including hatchlings younger than 2 years, may exceed 1 million turtles. It is important to note that 2012 was the highest year for recorded nests since monitoring began, and in 2014, the number of nests (all beaches) was almost half of the 2012 number; thus, the population estimate would be much lower.

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). See Wibbels and Bevan (2015) for more information on the history of the film and the 'discovery' of the Kemp's ridley. The Kemp's ridley population experienced a rapid and significant 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). The total number of nests at Rancho Nuevo was at a record low of 702 in 1985, estimated to be fewer than 250 nesting females. This dramatic decline resulted from intensive egg collection, killing of nesting females, and bycatch and drowning in the shrimp fleets of the U.S. and Mexico (NMFS *et al.* 2011). Due to intensive conservation actions, the Kemp's ridley began to slowly rebound during the 1990s. The number of nests at Rancho Nuevo increased to 1,430 in 1995, 6,947 in 2005, and 15,459 in 2009 (CONANP 2009a.,b.; J. Pena, Gladys Porter Zoo (GPZ), personal communication 2012). However, in 2010 the number of nests dropped to 9,840, a 36% reduction from 2009 (CONANP 2010a.,b.). In 2011 and 2012, the number of nests at Rancho Nuevo

exceeded 16,000 nests each year (CONANP 2011a.,b., 2012a.,b.; J. Pena, GPZ, personal communication 2013). Preliminary data through May 30, 2015, show at total of 11,955 for the Rancho Nuevo, Tepehuajes, and Playa Dos (J. Pena, GPZ, personal communication 2015). The number of hatchlings released from Rancho Nuevo, Tepehuajes, and Playa Dos, Mexico, beaches has exceeded 300,000 each year since 2002, and was over 1 million in 2009, but dropped to about 520,000 in 2014 (CONANP 2009a.,b., 2010a.,b., 2011a.,b., 2012a.,b., 2013a.,b., 2014a.,b.) due to fewer nests. Total nests and hatchlings released from Rancho Nuevo, Tepehuajes, and Playa Dos, Mexico, from 1966-2014 are provided below (**Table 1**).

Table 1. Total number of recorded nests (includes corral and *in* situ) and hatchlings released from the three primary nesting beaches: Rancho Nuevo, Tepehuajes, and Playa Dos, Mexico (*source:* L. Sarti, CONANP, preliminary data, 2014).

YEAR	TOTAL NESTS	HATCHLINGS RELEASED	YEAR	TOTAL NESTS	HATCHLINGS RELEASED
1966	5,991	30,555	1991	1,178	79,749
1967	5,519	25,305	1992	1,275	92,116
1968	5,117	15,750	1993	1,241	84,605
1969	4,018	29,820	1994	1,562	107,687
1970	3,017	32,970	1995	1,930	120,038
1971	2,012	13,755	1996	1,981	114,842
1972	1,824	15,330	1997	2,221	141,770
1973	1,643	24,675	1998	3,482	167,168
1974	1,466	24,675	1999	3,369	211,355
1975	1,266	11,100	2000	5,834	365,479
1976	1,110	36,100	2001	4,927	291,268
1977	1,036	30,100	2002	5,525	357,313
1978	924	48,009	2003	7,604	433,719
1979	954	63,996	2004	6,309	421,684
1980	868	37,378	2005	9,236	569,963

YEAR	TOTAL NESTS	HATCHLINGS RELEASED	YEAR	TOTAL NESTS	HATCHLINGS RELEASED
1981	897	53,282	2006	11,322	715,002
1982	750	48,007	2007	13,849	902,290
1983	746	32,921	2008	17,131	806,079
1984	798	58,124	2009	19,163	1,025,027
1985	702	51,033	2010	12,377	663,614
1986	744	48,818	2011	18,215	630,182
1987	737	44,634	2012	18,184	927,002
1988	842	62,218	2013	13,035	688,792
1989	828	66,802	2014	10,987	519,273
1990	992	74,339			

Total number of nests for all Mexico was 20,913 in 2009, 13,832 in 2010, 21,126 in 2011, 22,458 in 2012, 16,944 in 2013, and 12,060 in 2014 (**Figure 2**). Based on an average of 2.5 nests per female per nesting season (NMFS *et al.* 2011), the total number of nests on Mexico beaches represents about 8,984 nesting females in 2012, 6,778 in 2013, and 4,824 in 2014 (CONANP 2009a.,b., 2010a.,b., 2011a.,b., 2012a.,b., 2013a.,b., 2014a.,b.).

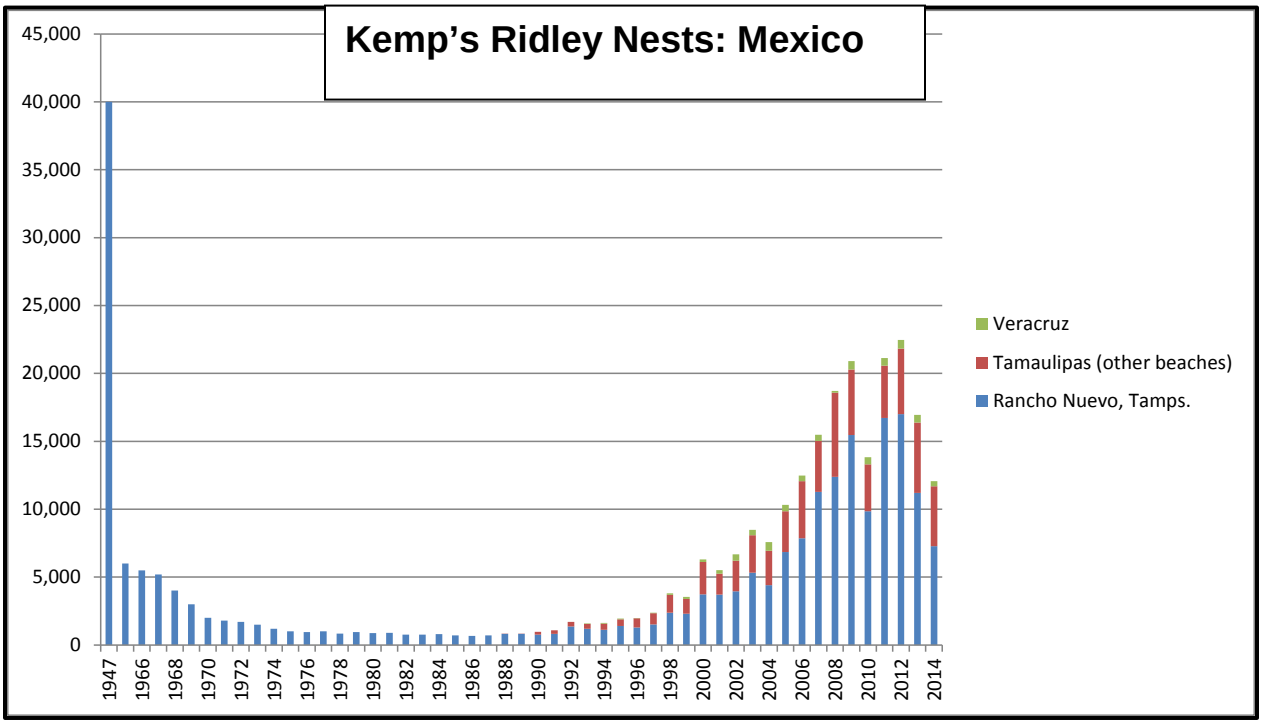

Figure 2. The total number of nests recorded at Tamaulipas (Rancho Nuevo and adjacent beaches) and Veracruz , Mexico, from 1947-2014 (*Source*: CONANP 2009a.,b., 2010a.,b., 2011a.,b., 2012a.,b., 2013a.,b., 2014a.,b.). Prior to 1988 only Rancho Nuevo was surveyed. Playa Dos was added in 1988 and Tepehuajes in 1996.

Similar to Mexico, Texas also experienced an increase in the number of nests through 2009, but saw a noticeable drop in 2010 (D. Shaver, PAIS, personal communication 2013). In Texas, the number of observed nests was 1 in 1985, 4 in 1995, 50 in 2005, and 197 in 2009. However, in 2010 only 141 nests were recorded followed by 199 in 2011, 209 in 2012, 153 in 2013, and 119 in 2014 (**Figure 3**; D. Shaver, PAIS, personal communication 2015).

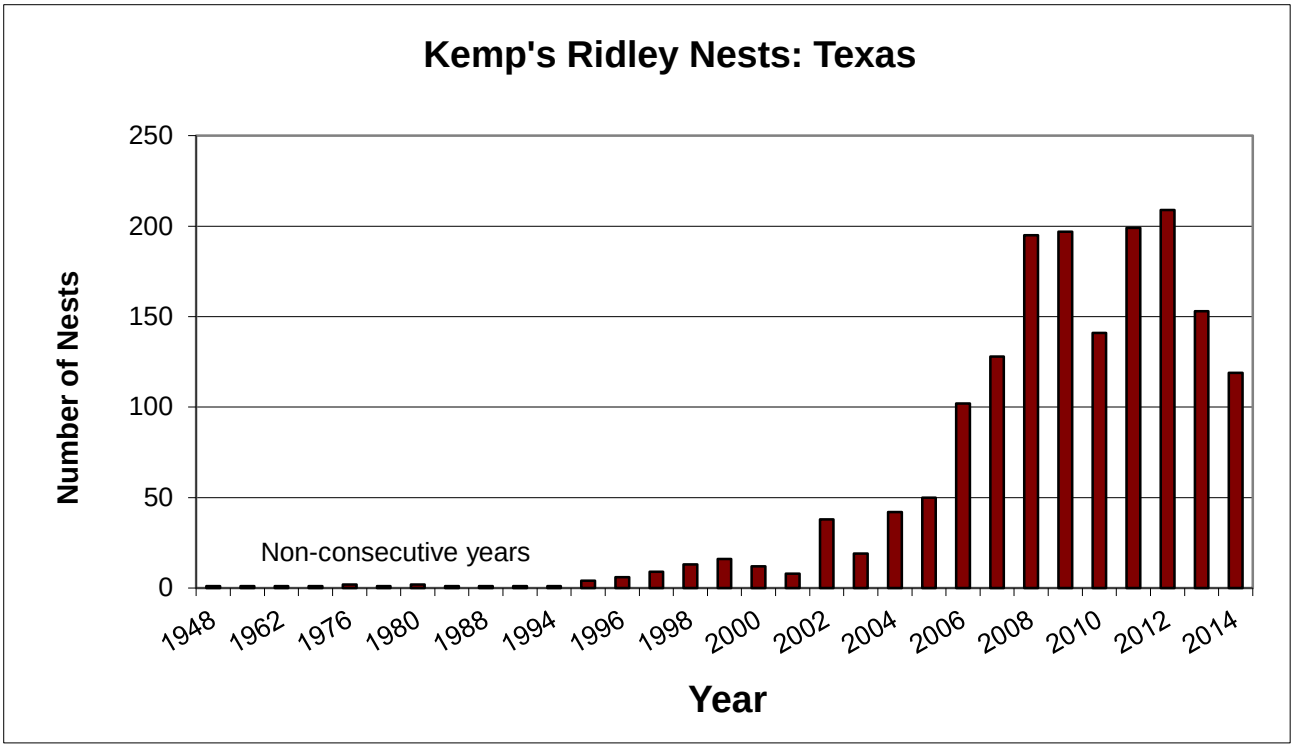

Figure 3. The total number of nests recorded at PAIS, Texas, from 1948-2014 (D. Shaver, PAIS, personal communication 2015).

The Bi-National Recovery Plan for the Kemp's Ridley (NMFS *et al.* 2011) contained an updated deterministic (i.e., no annual variability in vital rates) age-based model from Heppell *et al*. (2005) to better understand population growth and recovery. Assuming current survival rates within each life stage remained constant, the population was predicted to grow 19% per year from 2010-2020, and at least 10,000 nesting females (one criterion for downlisting) in a season was predicted to occur by 2011 and 40,000 nesting females per season over a 6-year period (one criterion for delisting) was predicted to occur by 2024. Given the recent decline in nest numbers, the population is not projected to grow at former rates (e.g., 15% per year from 1988-2003; Heppell *et al.* 2005). Dr. Heppell (OSU, unpublished data 2015) updated the population model used in the Kemp's ridley recovery plan with the nest numbers from the three index areas (Rancho Nuevo, Tepehuajes, and Playa Dos). Observed nests and hatchling production at these three beaches, which comprise over 85% of nesting activity by the species, were updated with data provided by Laura Sarti, CONANP, in December 2014. The updated model included a variable age at first nesting to represent a more gradual maturation rate rather than the 12-year fixed age used in the recovery plan. The updated model also separated neophyte from remigrant female nesters rather than grouping all adult females together in their first year of maturity. Finally, the updated model included a separate mortality multiplier for adult turtles to account for life stage-specific changes in mortality rates at different intervals**.** Reproductive rates remained the same as those used in NMFS *et al.* (2011), due to a lack of new information on nests per female or remigration interval. Baseline (pre 1990s) survival rates and multipliers for survival rates were fit based on a negative log-likelihood estimation with an additional fitted coefficient of variation parameter based on observed nests each year and predicted nests for each year,

starting in 1978 when nest counts were standardized. Bounds were placed on most of the fitted parameters (**Table 2**). Although the updated model is also deterministic, it uses the number of female hatchlings produced each year from the three core nesting beaches. Female hatchling numbers are based on estimates of sex ratios of 0.76 in the corrals and 0.64 for *in situ* nests (NMFS *et al.* 2011).

Table 2. Bounds placed on parameters fit by Excel Solver or manual entry to minimize negative log-likelihood. Not all of the parameters listed were used in every model. Mortality rates are total instantaneous mortality (Z), where e^Z = annual survival (proportion surviving each year). Age classes of the Large Immature and Adult stages overlap according to the maturation (*source:* Heppel, OSU, unpublished data 2015).

Parameter	**Solver fit?**	**Constant all years?**	**Bounds (low, high)**
Age at 50% mature	No	Yes	9, 14
Pelagic immature mortality (hatchlings and age 1)	Yes	Yes	0.5, 2
Small immature mortality (age 2-5)	Yes	No (changed by mortality multiplier)	0.2, 0.7
Large immature mortality (age 6+)	Yes, equal to Adult	No (changed by mortality multiplier)	0.05, 0.4
Adult (mature) mortality	Yes	No (changed by mortality multiplier)	0.05, 0.4
Mortality multipliers	Yes, small and large immatures equal	No (1, 2 or 3 shifts)	0, unbounded
Year of mortality shift(s)	No	--	1986,1992 1994,2000 2008,2011
Proportion of remigrant adults nesting in 2010	Sometimes	--	0, 0.5
CV for likelihood	Yes	Yes	unbounded

The updated model could only attain a best fit to the observed nests since 2009 by applying a substantial decrease in annual survival rates of immature and adult turtles, resulting in a decline in nests of over 40% per year (**Table 3; Figure 4)**. Also, short-term removals of immature or mature turtles from the model gave poor model fits, suggesting that there is a persistent reduction in survival and/or recruitment to the nesting population. The results indicate the population is not recovering and cannot meet recovery goals unless survival rates improve (Heppell, S., OSU, unpublished data 2015). However, caution is warranted on interpreting the results, given the model is fitted to nest counts only and does not account for impacts to the youngest age classes and variability or changes in demographic parameters, such as proportion of adults nesting (Heppell, S., OSU, unpublished data 2015).

Table 3. Best fit parameter values used in the model updated from NMFS *et al.* 2011 Bi-National Recovery Plan for the Kemp's Ridley Sea Turtle (*source:* Heppell, OSU, unpublished data 2015).

Initial Instantaneous mortality (Z)		survival (S)		Reproduction	
hatchling and age 1	0.827	0.437		nests/female	2.5
age 2-5	0.700	0.497		probability of breeding if mature	0.5
age 6-9	0.173	0.841		sex ratio corral	0.76
age 10+ and adults	0.173	0.841		sex ratio in situ	0.64
Z multipliers	1989	1998	2009	Maturation	
age 2-5	0.620	0.429	2.885	q (age at 50% mature)	12
age 6-9	0.620	0.429	2.885	alpha (slope)	1.25
age 10+ and adults	0.618	1.000	4.631		
Annual survival	1989	1998	2009		
age 2-5	0.648	0.741	0.133	Likelihood	5.864169898
age 6-9	0.898	0.929	0.608	CV	0.05878646
age 10+ and adults	0.899	0.841	0.449	NLL	207.6917421

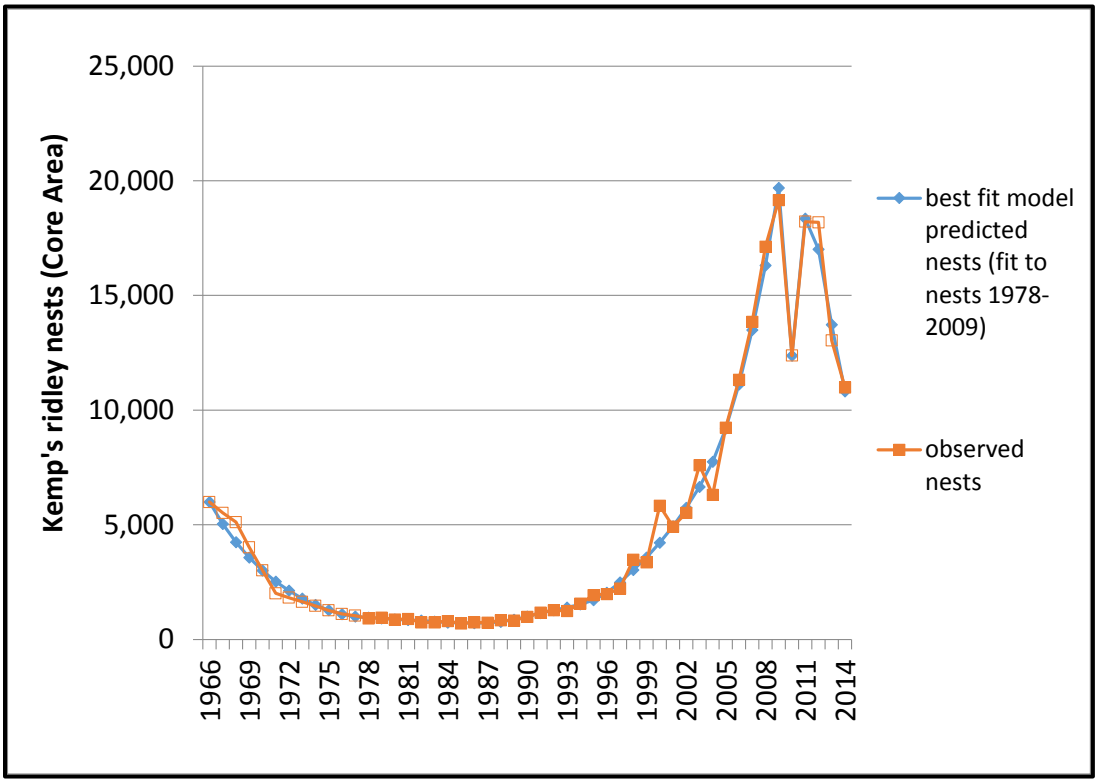

Figure 4. Best fit model predicted to observed nests (*source:* Heppell, OSU, unpublished data 2015).

Caillouet (2014) suggested that it was unprecedented mortality in subadult and adult females post-2009 nesting season. A fundamental, detrimental alteration of the 2009 age structure and momentum of the population likely occurred sometime between the ends of the 2009 and 2010 nesting seasons, which had a carryover impact on annual nest numbers in 2011-2014 (Caillouet 2014).

To better understand the recent downturn in nest numbers, additional data are needed on reproductive rates such as clutch frequency and remigration intervals, as these demographic factors have a large impact on the relationship between the number of nests and the number of adults in the population. Likewise, changes in somatic growth rates and age at maturation could affect expected recruitment to the adult nesting population. Nest counts and hatchling production are key indicators of population status for this species but are insufficient to diagnose the cause of changes in nest numbers and the apparent population trajectory. See Section 2.3.2 for further discussion on possible causes of the overall decline in observed nests since 2009.

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, Mexico, is relatively undeveloped and consequently human impact is limited. However, an increasing number of turtles are nesting in areas north and south of Rancho Nuevo (Burchfield 2009). 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. In the United States, 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 and Turtle Island Restoration Network monitor nesting and protect nests at Bolivar Peninsula Galveston Island, and Surfside; Brazoria National Wildlife Refuge from Quintana Beach to Matagorda Peninsula; Aransas National Wildlife Refuge on Matagorda Island; University of Texas Science Institute on San Jose and Mustang Islands; PAIS along North Padre Island; and Sea Turtle, Inc. along South Padre Island and Boca Chica Beach.

Because the Kemp's ridley has one primary nesting beach, this species is particularly susceptible to habitat destruction by natural (e.g., hurricanes) and human caused events. Human caused threats include the potential for oil spills, especially in the Gulf of Mexico since it is an area of high-density offshore oil exploration and extraction. British Petroleum's Deepwater Horizon (DWH) oil spill occurred in 2010, and the short and long-term impacts to sea turtles as a result of habitat impacts, prey loss, and subsurface oil components broken down through physical, chemical, and biological processes are unknown (Crowder and Heppell 2011; NMFS 2012). However, observations of oil and other pollutants have been found within major foraging

grounds for Kemp's ridleys (Witherington *et al.* 2012a). From May through September 2010, searches were conducted in offshore foraging habitat to rescue sea turtles affected by the oil spill (Witherington *et al.* 2012b). During this rescue effort, approximately 1,000 sea turtles were observed of which half were captured. Of the captured turtles, 76% showed visible signs of external oil. Pelagic/oceanic juvenile Kemp's ridleys were the most common species captured (Witherington *et al.* 2012b). During the entire response phase to the DWH oil spill (April 26 – October 20, 2010), a total of approximately 1,200 sea turtles were recovered, either as strandings (dead or debilitated, generally onshore or nearshore) or were captured offshore during sea turtle search and rescue operations (NMFS 2014). Kemp's ridley sea turtles accounted for approximately 70% of all recovered turtles (alive and dead), and and approximately 80% of all turtles recovered dead (NMFS 2014). Declines in the number of nests reported in 2010 at Tamaulipas, Mexico, have been attributed to the DWH oil spill, however this is still under evaluation. The timing of the spill does not support this claim. Female Kemp's ridleys migrate to nesting beaches in late winter with mating occurring in late-March through mid-April. The DWH event began on April 20, 2010, in the northeastern Gulf of Mexico, so for the oil spill to have reduced nesting in 2010, it would have had to kill large numbers of nesters directly or indirectly, provide barriers or interfere with navigation to the nesting beaches in Mexico (Caillouet 2011). More plausible explanations for the decline in 2010 nesting include environmental variants, or alternate-year nesting oscillation (Caillouet 2011), increases in mortality of all life stages and both sexes, but particularly subadult and adult females affecting age structure and population momentum (Caillouet 2014), or density-dependent factors (e.g., habitat carrying capacity) limiting population growth (Gallaway *et al.* 2013). Nonetheless, the oil spill may have lasting effects depending on different life-stage exposure to the distribution of the oil and dispersants used in responding to the oil spill (Caillouet 2011). Further analysis of juvenile growth rates, remigration intervals, and nests per female are needed to detect changes in vital rates that could be linked to density-dependence or changes in foraging resources (Heppell, S. OSU, unpublished data 2015). Monitoring the number of nesting females and recorded nests during each nesting year will be vital in determining potential effects on the population trajectory (Bjorndal *et al.* 2011).

Habitat destruction is also occurring as a result of activities that directly impact bottom habitats, primarily bottom trawling, dredge fishing, dredging of channels, and dredging associated with beach nourishment activities. Bottom trawling and dredging 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). Shoreline development can result in benthic habitat degradation from direct impacts from construction activities to indirect effects such as runoff.

Periodic dredging of sediments from navigational channels is conducted to allow 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 (NMFS *et al.* 2011).

Global warming is, in part, an anthropogenic factor that will affect Kemp's ridley habitat and biology. Impacts from climate change, especially due to global warming, are likely to become more apparent in future years (Intergovernmental Panel on Climate Change (IPCC) 2007, 2013). The global average for combined land and ocean surface temperatures show a warming of 0.85 °C (0.65 to 1.06 °C) over the period 1880 to 2012 (IPCC 2013). Levels of atmospheric carbon dioxide have almost reached 400 parts per million (see Earth System Research Laboratory), a level not recorded since the Pliocene Epoch. Based on substantial new evidence, 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 2007), which could affect Kemp's ridley prey distribution and abundance. Turtles may also alter their migratory behaviors in response to increasing water temperatures. Global warming is expected to increase the frequency and intensity of tropical storms and hurricanes, which can result in degradation of nesting habitat (e.g., Pike 2013). See Section 2.3.2.5 for further discussion on impacts due to climate change.

Given their limited nesting distribution and coastal foraging habitat, the threats from anthropogenic activities including oil spills, fishing, and climate change are expected to adversely impact the Kemp's ridley habitat. For these reasons, the Services conclude the Kemp's ridley sea turtle remains in danger of extinction because of ongoing and threatened destruction, modification, and curtailment of their habitat.

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 that exploitation of eggs would resume without development of a more extensive community based conservation program. See Caillouet *et al.* (*in* press) for review of Mexico and U.S. conservation efforts and the head-start and reintroduction program at PAIS.

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 require turtles to be caught during testing. Sometimes these takes are lethal, but the vast majority of Kemp's ridleys authorized to be taken in research are released alive and unharmed (NMFS *et al.* 2011).

For the reasons described above, the Services conclude that currently the Kemp's ridley is not in danger of extinction due to overutilization for commercial, recreational, scientific, or educational purposes.

2.3.2.3 Disease or predation:

Depredation of eggs and hatchlings on the beach is limited because the majority of nests are transferred to protected hatcheries (Wibbels 2007). Low predation also occurs for nests that are not transferred to protected hatcheries. Bevan *et al.* (2014) found low predation (less than 15%) and high hatchling survival (approximately 71%) of nests left *in situ* that had not been lost due to inundation during the 2009-2012 nesting seasons at Rancho Nuevo, Mexico. Almost 90% of the emergent hatchlings from *in situ* nests made it successfully to the sea. Although predators have been historically prevalent at Rancho Nuevo, these results indicate predator abundance may be low (Bevan *et al.* 2014). If the number of nests begins to increase again, a greater number of nests will be left in their natural locations on the beach. Predator abundance may increase to take advantage of this available food source, but the arribada phenomenon helps to enhance hatchling survival through predator swamping. Additionally, bacterial and fungal pathogens in nests may also increase with increased nest density, and appropriate monitoring of emergence success will be necessary to determine if there are any density dependent effects (NMFS *et al.* 2011).

Once in the water, it is presumed that Kemp's ridleys experience predation similar to other sea turtles, with hatchlings being preyed upon by a variety of predatory fish. There is no published information on the specific predators of pelagic or neritic juveniles and adults, although sharks have been implicated as the primary predator (Márquez 1994). The tiger shark (*Galeocerdo cuvier*) preys extensively on large cheloniid turtles (Stancyk 1982; Witzell 1987) and its foraging habitat overlaps that of Kemp's ridley, but there are no records of predator-prey interactions between these two species. A great hammerhead (*Sphyrna mokarran*) was observed attacking a post-pelagic juvenile in the shallow waters of west Florida (Schmid and Barichivich 2006). The turtle was recovered after being released by the shark, and it had sustained abrasions to the carapace and plastron as a result of the attack. Adult turtles have been observed with wounds similar to that of a shark attack, but it is often difficult to distinguish shark bite trauma from that of boat collisions and propeller damage (Witzell 2007).

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. The frequency of fibropapillomatosis in Kemp's ridleys is low and is not a source of concern for this species.

Blooms of the harmful algae *Karenia brevis* referred to as 'red tide,' impact numerous marine species, including sea turtles (Fauquier *et al.* 2013; Perrault *et al.* 2014). Brevetoxins, a potent neurotoxin, are produced with the mass accumulation of *Karenia brevis* and can lead to major neurological damage and mortality. Immature Kemp's ridleys were collected after red tide blooms in western Florida and tested positive for brevetoxin (Fauquier *et al.* 2013). Brevetoxin concentrations were significantly higher (by 59%, $P = 0.04$) for Kemp's ridleys exposed to red tide events compared to turtles sampled between events; however, no clinical signs of brevetoxicosis were observed (Perrault *et al.* 2014). Although red tide blooms occur naturally, their frequency and persistence may be increasing due to nutrient and chemical run off associated with human activities (Heisler *et al.* 2008).

Due to the conservation and monitoring programs on the beach and the low incident of diseases, the Services conclude the Kemp's ridley is not in danger of extinction due to disease or predation.

2.3.2.4 Inadequacy of existing regulatory mechanisms:

The conservation and recovery of sea turtles is enhanced by a number of regulatory instruments at international, regional, national, and local levels. Although the primary range for the Kemp's ridley is in the Gulf of Mexico, the species occurs in the North Atlantic Ocean and Mediterranean Sea, legal instruments that target or impact sea turtles in these areas likely affect Kemp's ridleys. A summary of the main regulatory instruments that relate to the conservation and recovery of Kemp's ridley sea turtles is provided below.

United States Magnuson-Stevens Conservation and Management Act
The United States Magnuson-Stevens Fishery Conservation and Management Act (MSA), implemented by NMFS, mandates environmentally responsible fishing practices within federally managed 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 and sea scallop fisheries operating in the Atlantic Ocean. 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."

Mexico Regulations
Efforts to protect nesting Kemp's ridleys and nesting beaches in Mexico have been ongoing since the 1960s. Legal ordinances were enacted that prohibited harvest of certain marine turtle species seasonally from May to August in the Gulf of Mexico in 1973 (Diario Oficial de la Federación (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, Márquez *et al*. 1989). Rancho Nuevo was declared a Sanctuary in 2002 (DOF 2002). 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 2013, Mexico implemented regulations to protect all sea turtle nesting sites

(NOM-162-SEMARNAT-2012), including restrictions on lighting, removal of native vegetation and introduction of exotic species on nesting beaches.

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 United States, consisting of a metal grid installed in front of the codend and an escape opening either at the top or bottom of the net.

FAO Technical Consultation on Sea Turtle-Fishery Interactions

The 2004 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 the lead United Nations agency for fisheries 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.

Currently, all five of the tuna RFMOs call on their members and cooperating non-members to adhere to the 2009 FAO "Guidelines to Reduce Sea Turtle Mortality in Fishing Operations," which describes all the gears sea turtles could interact with and the latest mitigation options. Longline fishermen must carry line cutters and use dehookers to release sea turtles caught on a line. Longliners must either use large circle hooks, whole finfish bait, or mitigation measures approved by the Scientific Committee and the Technical and Compliance Committee. The International Commission for the Conservation of Atlantic Tunas (http://www.iccat.int) has a recommendation on sea turtles, which calls for implementing the FAO Guidelines for sea turtles. The Commission does not have any specific gear requirements in longline fisheries. The International Commission for the Conservation of Atlantic Tunas is currently undertaking an ecological risk assessment to better understand the impact of its fisheries on sea turtle populations. Although there are records of Kemp's ridley captures by longline fisheries (TEWG 2000, Fairfield-Walsh and Garrison 2007), the impact appears minimal.

Other international fisheries organizations that may influence Kemp's ridley recovery include the Southeast Atlantic Fisheries Organization (http://www.seafo.org) and the North Atlantic Fisheries Organization (http://nafo.int). These organizations regulate trawl fisheries in their respective Convention areas. Given that sea turtles can be incidentally captured in these fisheries, both organizations have sea turtle resolutions calling on their Parties to implement the FAO Guidelines on sea turtles as well as to report data on sea turtle interactions.

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

This Convention is the only binding international treaty dedicated exclusively to sea turtles and sets standards for the conservation of these endangered animals and their habitats with an emphasis on bycatch reduction. The Convention area is the Pacific and the Atlantic waters of the Americas. Currently, there are 15 Parties. The United States became a Party in 1999. The IAC has worked to adopt fisheries bycatch resolutions, carried out workshops on sea turtle

conservation, and established collaboration with other agreements such as the Convention for the Protection and Development of the Marine Environment of the Wider Caribbean Region and the International Commission for the Conservation of Atlantic Tunas. 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 June 2015, the Convention had 119 Parties, including Parties from northwest Africa and the Mediterranean countries. The Kemp's ridley is listed under Appendix I, which among several measures, calls upon Parties to conserve and, where feasible and appropriate, restore those habitats of the species which are of importance in removing the species from danger of extinction. However, Mexico and the United States are not Parties to the Convention. 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 had 181 Parties as of June 2015. The Kemp's ridley is listed under Appendix I, which prohibits international trade except when the purpose of the import is not commercial (e.g., scientific research). However, CITES 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 has 25 Signatory States as of June 2015, including the United States and Mexico. Under this Convention, the component that may relate to Kemp's ridleys is the Protocol Concerning Specially Protected Areas and Wildlife (SPAW) that has been in place since 2000. The goals 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, including the Kemp's ridley, 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. The SPAW protocol has partnered with WIDECAST to develop a program of work on sea turtle conservation, which has helped many of the Caribbean nations to identify and prioritize their conservation actions through Sea Turtle Recovery Action Plans. 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/about-cep/spaw.

Summary
U.S. and Mexico domestic laws and regulations have been effective at addressing some threats (e.g., regulations to protect turtles on the beach, TED requirements in some fisheries), but other threats remain (e.g.,laws and regulations do not address adequately all fisheries bycatch) to the Kemp's ridley. The effectiveness of some of the international instruments varies (Frazier 2008; Hykle 2002; Tiwari 2002). The problems with existing international treaties are often that they have not realized their full potential, do not include some key countries, do not specifically address sea turtle conservation, are handicapped by the lack of a sovereign authority to enforce environmental regulations, and are not generally legally-binding. The ineffectiveness of international treaties and national legislation is often times due to the lack of funding, motivation or obligation by countries to implement and enforce them. A thorough discussion of this topic is available in a special 2002 issue of the Journal of International Wildlife Law and Policy: International Instruments and Marine Turtle Conservation (Hykle 2002).

Notwithstanding the growing number of domestic and intergovernmental authorities, the Services remain concerned that existing regulatory mechanisms, without the protection of the ESA, are overall inadequate, and the Kemp's ridley sea turtle remains in danger of extinction.

2.3.2.5 Other natural or manmade factors affecting its continued existence:

Strandings
The number of Kemp's ridley strandings in the northern Gulf of Mexico has been elevated since 2010, particularly in the Mississippi Sound and adjacent waters (Sea Turtle Stranding and Salvage Network data, http://www.sefsc.noaa.gov/species/turtles/strandings.htm). In the first three weeks of June 2010, over 120 strandings were reported from Mississippi and Alabama waters, none of which exhibited any signs of external oiling to indicate effects associated with the DWH oil spill event (NMFS 2014). For the entire year, a total of 644 sea turtle strandings were reported from Louisiana, Mississippi, and Alabama waters, of which 561 (87%) were Kemp's ridleys. In 2011, a total of 525 sea turtle strandings were reported from Louisiana, Mississippi, and Alabama waters, of which 390 (86%) were Kemp's ridleys. In 2012, a total of 428 sea turtles were reported from Louisiana, Mississippi, and Alabama waters, of which 301 (70%) were Kemp's ridleys (though the 2012 data are incomplete, NMFS 2014). These stranding numbers are substantially greater than reported in past years; Louisiana, Mississippi, and Alabama waters reported 42 and 73 sea turtle strandings for 2008 and 2009, respectively; however, it should be noted that stranding coverage has increased considerably due to the DWH oil spill event (NMFS 2014). While a definitive cause for these strandings has not been identified, necropsy results indicate a substantial number of stranded turtles from these events likely perished due to forced submergence, which is commonly associated with fishery interactions (NMFS 2014). Yet, available information indicates fishery effort was extremely limited during the stranding events. In response to these strandings, and due to speculation that fishery interactions may be the cause, fishery observer effort was shifted to evaluate the inshore skimmer trawl fishery during the summer of 2012. During May-July, observers reported 24 sea turtle interactions in the skimmer trawl fishery, all but one of which were identified as Kemp's ridleys (NMFS 2014). Thus, Kemp's ridleys were the most common species being taken in the skimmer trawl fishery, and it is reasonable to anticipate other nearshore fisheries would interact with them as well (see *Fisheries Interactions* discussion below).

Fisheries Interactions

Historically, commercial fisheries have been a major threat to the Kemp's ridley (Frazier *et al*. 2007; National Research Council 1990). Bycatch occurs throughout the Gulf of Mexico and northwest Atlantic Ocean (reviewed by Wallace *et al.* 2013). Kemp's ridleys have the highest rate of interaction with fisheries operating in the Gulf of Mexico and Atlantic Ocean than any other species of turtle (Finkbeiner *et al.* 2011). Compliance with the TED regulations is an important factor in accounting for the level of Kemp's ridleys that stranded dead on the coast in the western Gulf of Mexico (Lewison *et al.* 2003). Although TED compliance had dropped (NMFS 2014), recent information indicates that compliance with TED requirements has increased and the turtle exclusion rate is 88% or higher (NMFS unpublished data 2015). Despite an apparent decrease in Kemp's ridley injury and mortality in the shrimp fishery operating in the southeastern United States as evidenced by the use of properly installed TEDs, Kemp's ridleys continue to be captured and killed at high rates (Finkbeiner *et al*. 2011; NMFS 2014). The shrimp fishery has declined over the last couple of decades due to many factors including rising fuel and insurance costs (Caillouet *et al.* 2008; Nance *et al.* 2010). Nonetheless, the fishery is estimated each year to interact with 430,787 Kemp's ridleys of which 76,954 are captured and almost 60% (44,247) of these are killed (all gear combined: otter trawl, skimmer trawl, try nets) (NMFS 2014, Table 39). However, these estimates are highly uncertain given the assumption that catch per unit effort (CPUE) and Kemp's ridley population growth rate are linearly related which may not be the case. The population growth rate is indicated by increases in the number of nests, and it is assumed that the change in nest numbers reflects a proportional change in the population size and CPUE. Interaction estimates for 2009 ranged from 193,410 to 657,125. Similarly, capture estimates ranged from 5,802 to 120,834 depending on the level of compliance assumed and presuming there are no multiple recaptures. Mortalities were estimated to range from 5,122 to 102,079 assuming no multiple recaptures (NMFS 2014, Table 40). Preliminary analyses indicate that the shrimp fishery operating in the Gulf of Mexico contributes between 4-20% of the total anthropogenic mortality; however, Gallaway *et al.* (2013, in press) state that mortality related to shrimp fishing alone cannot account for the abrupt change in population growth post 2009. In addition, the Kemp's ridley population could not have been increasing exponentially for more than three decades had losses to the population from all anthropogenic and natural sources not been overwhelmed by additions to the population (Heppell *et al*. 2007).

Bycatch of Kemp's ridleys in bottom otter trawls also occurs in the mid-Atlantic, generally off Virginia and southward (Epperly *et al*. 1995, 1996; Haas 2010; Warden 2011). Gill net fisheries operating along the mid and southeast U.S. Atlantic coastlines are known to incidentally capture Kemp's ridleys (Byrd *et al.* 2011; Finkbeiner *et al*. 2011; McClellan *et al.* 2009, 2011; Murray 2009, 2013; Snoddy and Williard 2010; Snoddy *et al.* 2009; TEWG 2000; Trent *et al*. 1997). Kemp's ridleys also are caught in pound nets. Conservation actions include modified leaders in Chesapeake Bay, VA (71 FR 36024 June 23, 2006; 80 FR 6925 February 9. 2015), which appear to reduce interactions with Kemp's ridleys (Silva *et al.* 2011). Although there are records of Kemp's ridley captures by longline fisheries (TEWG 2000, Fairfield-Walsh and Garrison 2007), the impact appears minimal. The south Atlantic Snapper-Grouper Fishery hook and line component is anticipated to take approximately 19 Kemp's ridleys over a 3-year period (NMFS 2014). From 1992-1997, observers on the U.S. longline fleet targeting Atlantic tunas, swordfish, and sharks documented the capture of 4,808 loggerheads, but no Kemp's ridleys (Witzell 1999).

Recreational fisheries are also a concern as hooked turtles have been reported by the public fishing from boats, piers, and the beach (Cannon *et al.* 1994; Coleman *et al.* 2013; 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). In 2012, almost 200 turtles, the majority were immature Kemp's ridleys, were caught alive by recreational fishermen at coastal fishing piers in Mississippi (Coleman *et al.* 2013). Some individuals exhibit an affinity for fishing piers in Florida as indicated by repeated hookings over prolonged periods (Rudloe and Rudloe 2005).

In Mexico, coastal fisheries in Tamaulipas and Veracruz use fixed or drifting surface gillnets with different mesh sizes, the most common are 3-6 inches (NMFS *et al.* 2011). The artisanal shark fisheries use gillnets of different mesh sizes and lengths, as well as longlines. Shark fishing consists of small boats that operate near the coast in depths less than 20 fathoms (120 feet). The artisanal fleet of Veracruz comprises more than 90% of the overall fishing effort. For Tamaulipas, the majority of effort occurs north of Rancho Nuevo and is restricted in the waters directly off Rancho Nuevo during the nesting season (NMFS *et al.* 2011). Gillnet fisheries in Mexico are not systematically monitored for sea turtle bycatch. An estimated 100 adult Kemp's ridley sea turtles were found stranded along the Tamaulipas coast during the month of March 2007, and the cause was suspected to be the shark fishery (P. Burchfield, Gladys Porter Zoo, personal communication, 2007). Similar stranding levels occurred in April 2015, which were suspected to be caused by the shark fishery (Wibbels, University Alabama at Birmingham, personal communication, 2015). Also, these artisanal boats sometimes illegally enter and fish in Gulf of Mexico waters off the south Texas coast (Shaver, NPS, personal communication, 2015). The number of observed stranded Kemp's ridley sea turtles along the coast of Tamaulipas has decreased over the last 8 years (**Table 4.)**

Table 4. Numbers of stranded sea turtles along the coast of the State of Tamaulipas, Mexico. Numbers are totals from September of the previous year through August of the year shown in the table *(source:* J. Pena, GPZ, unpublished data 2015).

September - August	***Lepidochelys kempii***	***Chelonia mydas***	***Caretta caretta***	***Eretmochelys imbricata***	***Dermochelys coriacea***
2007	102	44	17	4	0
2008	94	41	13	7	4
2009	91	54	19	14	1
2010	88	87	24	11	0
2011	60	395	12	13	1
2012	75	58	9	9	0
2013	82	73	14	9	1
2014	31	139	11	1	0

Climate Change

There are natural and manmade factors that affect Kemp's ridleys in foraging areas and on nesting beaches. As discussed earlier (Section 2.3.2.1 Present or threatened destruction, modification or curtailment of its habitat or range), impacts from climate change, especially due to global warming, are likely to become more apparent in future years (IPCC 2007, 2013). The global average for combined land and ocean surface temperatures show a warming of 0.85 °C (0.65 to 1.06 °C) over the period 1880 to 2012 (IPCC 2013). Present trends in greenhouse-gas emissions are now forcing warming temperatures in the Northern Hemisphere that are irreversible (Smith *et al.* 2015). Based on an analysis of 40-year periods dating back 1,000 years, the rate of global-mean temperature will increase to 0.25 °C (± 0.05 °C) per decade by 2011-2020, an average greater than peak rates of change during the previous one to two millennia (Smith *et al.* 2015). Based on substantial new evidence, 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 2007). Climate change will impact sea turtles through increased temperatures, sea-level rise, ocean acidification, changes in precipitation and circulation patterns, and increased cyclonic activity (reviewed by Hamann *et al.* 2013; Poloczanska *et al.* 2009). At sea, hatchling dispersal, adult migration, and prey availability may be affected by changes in surface current and thermohaline circulation patterns (reviewed by Hamann *et al.* 2013; Hawkes *et al.* 2007, 2009; Pike 2013). 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 (Glen and Mrosovsky 2004; Hawkes *et al.* 2007, 2009; Mrosovsky and Godfrey 2010). Preliminary data suggest that long-term changes in temperature are impacting the reproductive physiology of the Kemp's ridley, including nesting phenology and hatchling sex ratios (Bevan and Wibbels, unpublished data). Considering that the Kemp's ridley has temperature-dependent sex determination and a restricted nesting area, global warming could potentially impact population sex ratios and thus the reproductive ecology of this species. Other species have changed their reproduction timing with increased temperatures. An earlier onset of the nesting season may help mitigate effects on sex ratios, but further research is needed to understand seasonality in sea turtle nesting (Mrosovsky and Godfrey 2010). Beaches that tend to produce more males should be identified to cushion against the effects of increased beach temperatures. For Kemp's ridleys, beaches north of Tamaulipas should be examined to determine whether they naturally produce male-dominated hatchling sex ratios (Caillouet 2012a).

Additionally, 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 2007). 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 (Baker *et al*. 2006; Daniels *et al*. 1993; Fish *et al*. 2005; reviewed by Hamann *et al.* 2013; Poloczanska *et al.* 2009).

Other

Incidental take of Kemp's ridleys has also been documented in channel dredging operations (NMFS *et al.* 2011). Capture and mortality of sea turtles by hopper dredges was first 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.

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 shallow coastal habitats used by Kemp's ridleys. Kemp's ridleys are known to bioaccumulate a variety of toxins including organochlorine compounds and heavy metals (Gardner *et al*. 2006; Innis *et al.* 2008; Keller *et al* 2004, 2005; Kenyon *et al*. 2001; Lake *et al*. 1994; Pugh and Becker 2001; Rybitski *et al*. 1995; Wang *et al*. 2003). Although effects on sea turtles have yet to be determined, such exposure may lead to immunosuppression or other hormonal imbalances. Organic contaminants have recently been found in the blood of both green sea turtles and Kemp's ridleys (NMFS *et al.* 2011; Swarthout *et al.* 2010). Keller *et al*. (2012) investigated levels of perfluoroalkyl compounds (PFCs) in several different species of turtles. PFCs are found in things such as stain-resistant coatings and fire-fighting foam. Juvenile Kemp's ridleys contained the highest levels of perfluorooctane sulfonate, which is the most common PFC (Keller *et al.* 2012). High levels of perfluorooctane sulfonate could potentially lead to enlarged livers, thyroid disruption and shifts in neuro-behavior (Keller *et al.* 2012).

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 Gulf of Mexico and Atlantic Ocean (Foley *et al.* 2009; Singel *et al*. 2003; STSSN/NMFS: http://www.sefsc.noaa.gov/species/turtles/strandings.htm). Terrestrial hazards such as beach vehicles have caused a number of fatalities by running over nesting turtles, nests and hatchlings (NMFS *et al.* 2011).

Marine debris in the Gulf of Mexico is becoming an increasing threat to the Kemp's ridley (Frazier *et al*. 2007; Mallos and Schutes 2013; NMFS *et al.* 2011; Schuyler *et al*. 2013). The ingestion of and entanglement in marine debris can increase absorption of toxic materials and reduce food intake and digestive capacity (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; Snoddy and Williard 2010; Snoddy *et al.* 2009; Stabenau and Vietti 2003). Synthetic buoyant pollutants such as plastic and oil have been known to aggregate together forming clusters that look similar to *Sargassum*-drifting communities, which have been observed as key habitats for young turtles, including the Kemp's ridley. The third most common item found in the gut of sea turtles associated with *Sargassum* was synthetic material, especially plastic, which can block the gut and be fatal (Witherington *et al.* 2012a).

Along the U.S. Atlantic coast and in the Gulf of Mexico, power plants are known to entrain Kemp's ridleys in the intake channels of their cooling systems (Finn 2013; Florida Power and Light and Quantum Resources Inc. 2005; NMFS and FWS 2014; TEWG 2000).

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). Cold-

stunned sea turtles have been documented throughout the Atlantic Region from Massachusetts to Virginia; however, the peak is in Massachusetts. The largest Massachusetts cold-stunned stranding season on record was in 2014/2015. Preliminary data through May 28, 2015, indicate 1,242 turtles stranded due to cold-stunning, almost three times the next largest year's total. Kemp's ridleys (1,180) were the predominant species involved in the event, but greens (37), loggerheads (20), and turtles of unknown species (5, including 4 potential hybrids) were also involved at much lower levels. It is unknown why the 2014/2015 cold-stunning event was so much larger than other years (E. Keane, NMFS Greater Atlantic Region Office, personal communication 2015). In January 2010, unusual cold winter conditions in Florida resulted in approximately 5,000 sea turtles (73 Kemp's ridleys) stranding from cold-stunning (Avens *et al.* 2012; Belskis *et al.* 2012; Bowan *et al.* 2012; Foley *et al.* 2012). Although the majority of these turtles stranded alive, approximately 20% did not survive (Avens *et al.* 2012). Of 302 cold-stunned Kemp's ridleys admitted to the New England Aquarium from November 2006 to December 2011, 70% survived, and most deaths occurred within the first week of admission with deaths afterwards largely associated with *Enterococcus* spp. infections (Innis *et al.* 2014). Aspiration of seawater into the lungs may also increase the chance of delayed mortality in forced submergence and cold-stunned turtles (Caillouet 2012b).

Based on the information described above, the Services conclude that Kemp's ridley sea turtles remain in danger of extinction because of other natural or manmade factors affecting their continued existence.

2.4 Synthesis

Since the last 5-year review, we have a better understanding of foraging site selection and fidelity and migratory patterns for adult females and neritic juveniles in the Gulf of Mexico. The offshore waters of the Gulf of Mexico, particularly the eastern and north central coast areas, support unique habitat where surface-pelagic 1 to 2 year old Kemp's ridleys grow and then recruit to nearshore waters. Neritic juveniles exhibit site fidelity to nearshore developmental habitats that are shallower than 50 meters. Juveniles make seasonal east, west, and south migrations and move further offshore during the winter as water temperatures drop. Coastal areas in the northern Gulf of Mexico including tidal passes, bays, and coastal lakes, represent optimal developmental habitats due to favorable water temperature and abundant prey. The northern Gulf of Mexico, particularly off Louisiana, is important foraging habitat for post-nesting females from Texas, United States, and Rancho Nuevo, Mexico. Females from Rancho Nuevo also use benthic habitats off the Yucatan Peninsula (see Section 2.3.1).

Since the last 5-year review, the population growth rate (as measured by numbers of nests) stopped abruptly after 2009. Given the recent lower nest numbers, the population is not projected to grow at former rates. In 2014, approximately 4,395 females nested at the three primary nesting beaches (Rancho Nuevo, Tepehuajes, and Playa Dos). We have not met the downlisting criterion of 10,000 nesting females in a season (predicted to occur by 2011) and are unlikely to attain 40,000 nesting females per season over a 6-year period (one criterion for delisting) by 2024. The updated model from the recovery plan used in this 5-year review could only attain a best fit to the observed nests since 2009 by applying a substantial decrease in annual survival rates of immature and adult turtles, resulting in a population decline of over 40% in

nests per year. An unprecedented mortality in subadult and adult females post-2009 nesting season may have altered the 2009 age structure and momentum of the population, which had a carryover impact on annual nest numbers in 2011-2014. The results indicate the population is not recovering and cannot meet recovery goals unless survival rates improve (see Section 2.3.1).

The DWH oil spill that occurred at the onset of the 2010 nesting season and exposed Kemp's ridleys to oil in nearshore and offshore habitats may have been a factor in fewer females nesting in subsequent years, however this is still under evaluation. The long-term impacts from the DWH oil spill and response to the spill (e.g., dispersants) to sea turtles are not yet known. Given the Gulf of Mexico is an area of high-density offshore oil exploration and extraction, future oil spills are highly probable and Kemp's ridleys and their habitat may be exposed and injured. Commercial and recreational fisheries continue to pose a substantial threat to the Kemp's ridley despite measures to reduce bycatch. Kemp's ridleys have the highest rate of interaction with fisheries operating in the Gulf of Mexico and Atlantic Ocean than any other species of turtle. Climate change will impact sea turtles through increased temperatures, sea-level rise, ocean acidification, changes in precipitation and circulation patterns, and increased cyclonic activity (see Sections 2.3.2.1 and 2.3.2.5).

Several international agreements provide legal protection for sea turtles; however, additional multi-lateral efforts are needed to ensure they are sufficiently implemented and/or strengthened, and key non-signatory parties need to be encouraged to accede. The effectiveness of some of these international instruments varies due to many factors such as participation, funding, and compliance (see Section 2.3.2.4).

3.0 RESULTS

3.1 Recommended Classification:

Based on the best available information, the Services do recommend the Kemp's ridley remain classified as Endangered.

3.2 New Recovery Priority Number:

Based on the best available information, NMFS recommends that the Recovery Priority Number be changed from '5' to a '1.' A recovery priority 1 is defined as a species whose extinction is almost certain in the immediate future because of a rapid population decline or habitat destruction, whose limiting factors and threats are well understood and the needed management actions are known and have a high probability of success, and is a species that is in conflict with construction or other developmental projects or other forms of economic activity. We recommend the change because of the overall decrease in number of nests since 2009, the species has/is experiencing major threats from oil spills, fisheries interactions, and climate change. Further, the recovery potential is high since the main threats occur primarily within U.S. and Mexico jurisdictions. There are numerous well-understood national and bi-national instruments (e.g., IAC, Mexico-U.S. Bi-National conservation program, Marine Turtle Conservation Act) that, with increased resources, can be taken to change the recovery outlook for this species. FWS recommends retaining its 2C classification because the Kemp's ridley is

considered the highest recovery priority for a non-monotypic genus species, which is in conflict with development or other economic activity.

4.0 RECOMMENDATIONS FOR FUTURE ACTIONS

The current "Bi-National Recovery Plan for the Kemp's Ridley Sea Turtle (*Lepidochelys kempii*)" was signed in 2011. This revised plan provides updated species biology and population status information, objective and measurable recovery criteria, and updated and prioritized recovery actions since the previous recovery plan that was signed in 1992. The Services recommend that efforts continue towards achieving the major recovery actions in the plan. However, the Services recommend the following actions be given a priority to address the downturn in the annual number of nests:

(a) continue funding by FWS, NMFS, CONANP at a level of support needed to run the successful turtle camps in the State of Tamaulipas, Mexico, in order to continue the high level of hatchling production and nesting female protection;
(b) increase TED compliance in U.S. and Mexico shrimp fisheries;
(c) require TEDs in U.S. skimmer trawl fisheries and other trawl fisheries (or where TEDs are not effective, other measures to reduce bycatch) in coastal waters where fishing overlaps with the distribution of Kemp's ridleys;
(d) assess bycatch in gillnets in the Northern Gulf of Mexico and States of Tamaulipas and Veracruz, Mexico, to determine whether modifications to gear or fishing practices are needed.
(e) collect data on vital rates starting in the 2015 season, and for the next 5 years, including clutch frequency, remigration intervals, growth and mortality rates, recruitment into the breeding population, age distribution at first nesting, and oceanic temperature influences on fecundity. These data are needed to better assess nesting trends in the future and to better inform recovery actions.
(f) collect and continue to evaluate data on climate change and how it effects Kemp's ridley sea turtles and their habitat. Develop management plans to minimize any effects from climate change.

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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, Allison Kepple, Intern (National Marine Fisheries Service)
Tom Shearer (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: Donna S. Wieting Date: 6/16/15
Donna S. Wieting

Assistant Administrator, NOAA Fisheries

_____Concur _____ Do Not Concur

Signature _____ Date 6/18/15

U.S. FISH AND WILDLIFE SERVICE
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FIELD OFFICE APPROVAL:

Lead Field Supervisor, Fish and Wildlife Service

Approve _____ Date 7-8-15

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