



Kemp's Ridley Sea Turtle Project at Padre Island National Seashore and Texas Sea Turtle Nesting and Stranding

2002 Report



U.S. Department of the Interior
National Park Service
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By Donna J. Shaver, Ph.D.

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U.S. Department of the Interior

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ABSTRACT

National Park Service and U.S. Geological Survey employees and volunteers conducted patrols repeatedly each day to detect sea turtle nesting on North Padre Island [including Padre Island National Seashore (PAIS)] from 25 March through 13 July 2002. During 2002, 10,723 hours were spent patrolling the 125 km length of North Padre Island beachfront for a total of 155,964 km patrolled. From April through early August 2002, the U.S. Fish and Wildlife Service, Gladys Porter Zoo, and others conducted patrols repeatedly each day on the northernmost 47.5 km of South Padre Island and the 11.5 km length of Boca Chica Beach, the only other areas on the Texas coast systematically patrolled to detect nesting. Cumulatively, these patrollers spent roughly 1,099 hours patrolling 14,043 km on South Padre Island and Boca Chica Beach during 2002. Sea Turtle Stranding and Salvage Network (STSSN) participants patrolled year-round to detect sea turtles stranded on Texas Gulf beaches. Several entities conducted public education efforts to alert beach visitors to report nesting and stranded sea turtles on the Texas coast and responded to these reports.

Forty-one sea turtle nests were confirmed on the Texas coast during 2002. The 41 included 38 Kemp's ridley (*Lepidochelys kempii*), two green (*Chelonia mydas*), and one loggerhead (*Caretta caretta*) nests. Two of the Kemp's ridley nests were found on Galveston Island, one on Quintanna Beach, one on Matagorda Peninsula, one on Mustang Island, 26 on North Padre Island (including 23 at PAIS), five on South Padre Island, and two on Boca Chica Beach. The loggerhead nest was located on North Padre Island (at PAIS). The two green nests were located on North Padre Island (at PAIS). Only two other confirmed Kemp's ridley nests were located in the U.S. during 2002 and these nests were found in Florida.

Nesting females were examined at 15 of the 38 Kemp's ridley nests found on the Texas coast during 2002. Six of the 15 nests were from nesting turtles that were part of the head-starting project, including: one nesting female that had been hatched in 1987 (1987 year-class) and documented nesting on the Texas coast once in

1998 and 2000 and twice in 2002; one from the 1991 year-class (not previously documented); one from the 1988 year-class (not previously documented); one from the 1989 year-class (not previously documented); and, one from the 1992 year-class (not previously documented). This was the first year that head-started turtles taken directly from Mexico as hatchlings were documented nesting on the Texas coast. The other nine Kemp's ridleys examined were not conclusively linked to the experimental head-starting project, seven of these had not been seen before and one had been seen nesting on the Texas coast in 1998 and one in 2000. Two other females were examined during 2002, but they did not lay eggs. One female that attempted to nest, but did not lay eggs was from the 1990 year-class and had not been previously documented. Another female attempting to nest on the Texas coast, did not lay eggs and had not been documented in previous years.

At the other 23 Kemp's ridley nest sites, the nesting turtles re-entered the water before biologists arrived and hence were not examined for tags. Three of the 23 were detected by visitors at hatching.

Satellite transmitters were applied to four of the Kemp's ridley turtles that nested at Padre Island National Seashore in April 2002. By the end of June 2002, all had moved northward and then eastward within Gulf of Mexico waters. As of December 31, 2002, the four transmitters were still functioning and the turtles were located in the northern Gulf of Mexico.

Eggs from 31 of the 41 confirmed nests found on the Texas coast were packed into Styrofoam boxes and transported to the incubation facility at PAIS and the resulting hatchlings were released there. The hatching and emergence rates were 67.4% and 66.2% for the 2,773 Kemp's ridley eggs (28 nests) held in the incubation facility and 1,837 hatchlings were released, of which 1,833 successfully entered the surf and four were retained for prolonged care. The hatching and emergence rates were both 58.3% for the loggerhead 12 eggs (one nest) held in the incubation facility and seven hatchlings were released. The hatching and emergence rates were both 79.4% for the 239 green eggs (two nests)

held in the incubation facility and 189 hatchlings were released. The estimated hatching and emergence rates were 74.0% for the estimated 300 Kemp's ridley eggs (3 nests) that incubated *in-situ* and approximately 208 surviving hatchlings were released.

The seven sea turtle clutches laid on South Padre Island and Boca Chica Beach were transferred to one of two protective corrals located on either Boca Chica Beach or South Padre Island and the resulting hatchlings were released there. The hatching and emergence rates were 74.0% and 71.0% for the 696 Kemp's ridley eggs (7 nests) incubated in the corral and 495 hatchlings were released.

During 2002, 353 wild (non-head-started) sea turtles were located stranded along the Texas coast. Among the 353 were 90 Kemp's ridley, 130 loggerhead, 63 green (*Chelonia mydas*), 16

leatherback (*Dermochelys coriacea*), 47 hawksbill (*Eretmochelys imbricata*), and 7 turtles of unknown species. Of the 90 Kemp's ridleys, 22 were adults (> 60.0 cm straight-line carapace length). Forty-one hatchlings and post-hatchlings (< 10.0 cm straight-line carapace length) were found stranded along the Texas coast during 2002, between 20 May and 6 November. Among the 41 found statewide were 30 Kemp's ridleys, 1 green turtle and 10 hawksbills. Eleven Kemp's ridley and one green found likely originated from clutches laid, incubated, and released in south Texas and these were excluded from the Sea Turtle Stranding and Salvage Network (STSSN) totals. Two other Kemp's ridley hatchlings may have emerged from undetected Kemp's ridley nests, but this could not be ascertained with certainty and they were included in STSSN totals. Also included were 27 other stranded hatchlings that likely did not emerge from nests in Texas.

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BACKGROUND

Most Kemp's ridley turtles (*Lepidochelys kempii*) nest on the Gulf of Mexico coast near the village of Rancho Nuevo, Tamaulipas, Mexico (U.S. Fish and Wildlife Service and National Marine Fisheries Service, 1992; Burchfield *et al.*, 1999). During each summer from 1978 to 1988, approximately 2,000 Kemp's ridley turtle eggs were shipped to Padre Island National Seashore (PAIS) from Rancho Nuevo in an experimental attempt to establish a secondary breeding colony of this native species through imprinting. Of the 22,507 eggs received, 17,358 (77.1%) hatched and 15,875 hatchlings were shipped to the National Marine Fisheries Service Laboratory in Galveston, Texas for head-starting (Fontaine *et al.*, 1989; Shaver, 1989b; 1992a). Overall, 13,275 yearlings were released into the Gulf of Mexico (and elsewhere) after 9 to 11 months of head-starting (Caillouet *et al.*, 1995). Several others were released after longer periods of head-starting and captive rearing.

Transfer of Kemp's ridley eggs from Rancho Nuevo, Mexico to PAIS was terminated after the 1988 incubation season. Currently, the primary objective of this project is to determine whether Kemp's ridleys return to nest in Texas (Shaver, 1989a; 1992a; 1995a). In addition, the location, documentation, study, and protection of nesting sea turtles and sea turtle nests are significant objectives of this project. Beach patrols and public education efforts are critical components of the detection program and a variety of entities are cooperating to conduct these activities in Texas. During the last two decades, most Kemp's ridley nests located in the U.S. have been found in Texas, with more at PAIS than at any other single location in the U.S. (Shaver and Caillouet, 1998). Returnees from the experimental imprinting and head-starting project have been documented nesting on the south Texas coast since 1996 (Shaver, 1996a; 1996b; 1997a; 1997b; 1998a; 1999a; 1999b; 2000; 2001; 2002).

Since 1980, stranded sea turtles found on the Texas coast have been documented in conjunction with the national Sea Turtle Stranding and Salvage Network (STSSN). STSSN participants in Texas include employees and volunteers from a variety of federal and state

agencies, universities, and other entities. Stranded sea turtles are documented on standardized forms using standardized protocols (Shaver, 1998c; Shaver and Teas, 1999). As the Texas Coordinator of the STSSN, the author maintains records of stranded sea turtles and sea turtle nests documented in Texas.

This report summarizes sea turtle nests and stranded sea turtles that were documented in Texas during 2002. Also summarized are efforts conducted on North Padre Island (including PAIS) to patrol for nesting sea turtles, educate the public about sea turtles, incubate sea turtle eggs, and satellite-track nesting Kemp's ridley turtles during 2002. This effort on North Padre Island was conducted by the National Park Service (NPS) and U.S. Geological Survey (USGS) with support and assistance by Texas Parks and Wildlife Department (TPWD), National Marine Fisheries Service (NMFS), and others.

BEACH PATROLS FOR NESTING TURTLES

The Kemp's Ridley Sea Turtle Recovery Plan (U.S. Fish and Wildlife Service and National Marine Fisheries Service, 1992) recommends patrolling for nesting Kemp's ridley turtles on Padre Island "in view of the large number of turtles that were experimentally imprinted there" and states that "it would be a terrible waste if the imprinting experiment had worked but we did not know it because of a lack of observations". Beach patrols for nesting sea turtles, tracks, and nests began on North Padre Island in 1986, but were not very comprehensive until 1996 and thereafter. Systematic patrols began on Boca Chica Beach in 1999 and on South Padre Island in 2000 and continued through 2002.

From 25 March through 13 July 2002, NPS and USGS employees and volunteers conducted patrols along North Padre Island. The 125 km patrol area extended from the Nueces County/Kleberg County line (20 km north of PAIS) to the Mansfield Channel. The patrol area was divided into sections that were repeatedly patrolled during daylight hours each day.

Patrols began as early as 0600 hours (h) and terminated as late as 1830 h. Most employee patrol shifts lasted 10 hours. While some

volunteers also completed 10-hour patrol shifts, most worked in half-day shifts. Volunteers patrolled primarily in the northern part of the patrol area and employees primarily in the central and southern sections of the patrol area. Patrols originated from the northern end of PAIS (at Ranger Road) or the southern end of PAIS (at the base camp established at the PAIS 65 km marker). Four employees comprised each camping group and each of these employees patrolled for three consecutive days, including the day that they arrived at the camp, the day they remained stationed at the southern end of PAIS, and the day that they returned from camping and were replaced by a group of four new employees that would camp.

A total of 155,997 km of patrol distance was logged on North Padre Island during 2002, slightly more than the patrol distance recorded there in 2001 (Fig. 1). All-terrain four-wheel cycles (ATVs) are the preferred vehicle type for patrols (Shaver, 2001) and only patrols via ATV were included in 2002 totals. Four-wheel drive trucks and sport utility vehicles were used as support vehicles for the patrol program and by other employees conducting various activities on the beach, but their usage was not included in the 2002 patrol totals. During the 2002 nesting patrol season, 10,723 hours were spent patrolling on

North Padre Island, slightly more than during 2001 (Fig. 2). Patrol hours were split between employees (6,613 hours) and volunteers (4,110 hours) (Fig. 2).

Systematic patrols to detect nesting were also conducted on South Padre Island and Boca Chica Beach during 2002; these were the only other areas on the Texas coast systematically patrolled for nesting that year. The Gladys Porter Zoo (GPZ), U.S. Fish and Wildlife Service (USFWS), and other cooperators conducted these patrols and a USGS biological technician served as the Field Coordinator. Repeatedly each day from April through the end of July, these patrols were conducted along the northernmost 47.5 km of South Padre Island, north of the most heavily developed area, and along the entire 11.5 km length of Boca Chica Beach. Cumulatively, about 1,099 hours were spent patrolling approximately 14,043 km on South Padre Island and Boca Chica Beach.

The author provided training regarding detection, investigation, and documentation protocols to employees and volunteers conducting patrols in south Texas. This training ensured usage of standardized procedures throughout south Texas to gather comparable data for long-term studies regarding stranded sea turtles, nesting sea turtles, and sea turtle nests.

EDUCATION EFFORTS

Many entities participated in collaborative efforts to educate people that use the Texas beaches for work or recreation during 2002. Since beach users report numerous stranded sea turtles and a few nesting sea turtles each year, it is imperative that these individuals receive information to encourage and enable them to assist with detection of turtles.

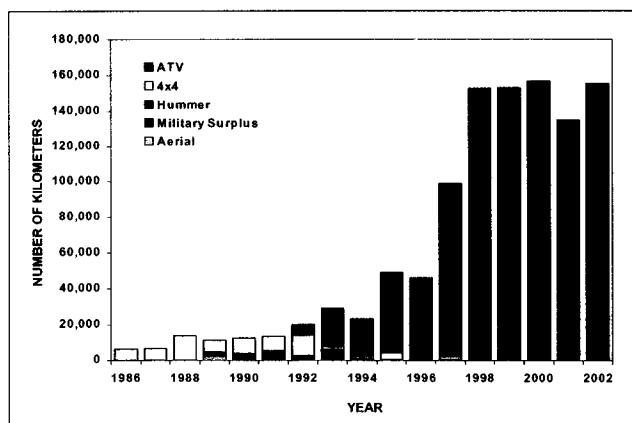


Figure 1. Number of kilometers patrolled on North Padre Island, Texas from 1986-2002.

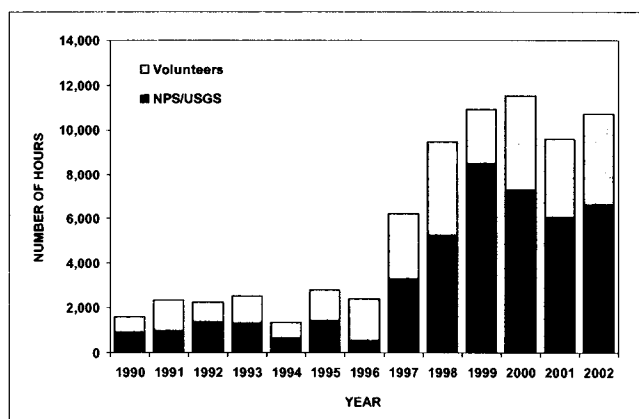


Figure 2. Number of hours various groups spent conducting patrols on North Padre Island, Texas from 1990-2002.

On North Padre Island, training sessions were given to many PAIS commercial fishing guides and other beach workers. Posters, detailing the need to report nesting sea turtles and tracks, were displayed at PAIS and other local parks and establishments. Beach signs, alerting visitors to immediately report observations of live sea turtle were posted at PAIS. A display and video tape

about the Kemp's ridley project were available at the PAIS Visitor Center. Patrollers made educational contacts with numerous beach visitors, informed them about the need to report sightings immediately, and provided them with brochures listing procedures that they should follow if they observe nesting. These brochures were also given to all visitors that stopped at the PAIS Entrance Station during the nesting season. Numerous media interviews were conducted during the patrol and hatchling release seasons and the author wrote a bi-weekly column for two local newspapers detailing the sea turtle work.

The public was invited to attend ten of the hatchling releases held at PAIS during 2002 and, cumulatively, over 1,000 visitors attended. The Hatchling Hotline, a recorded message that was regularly updated, was established to provide the public with current information about anticipated releases. This telephone number and anticipated release dates were published in the author's bi-weekly newspaper column, on various web-sites, and in various brochures. Educational programs about sea turtles were given at the hatchling releases attended by the public. Additionally, throughout the year, numerous educational programs were given to school children, community organizations, and PAIS visitors. An Adopt-A-Turtle program was also used to help educate the public about the turtle project.

INVESTIGATION OF NESTING TURTLES, TRACKS, AND NESTS

When possible, Kemp's ridley turtles found nesting (or suspected of nesting) on the Texas coast were examined by biologists for tags (metal, magnetic, PIT, living) and tag scars and measured for straight-line carapace length (SLCL), straight-line carapace width (SLCW), curved carapace length (CCL), and curved carapace width (CCW). Length measurements were from the center of the nuchal notch to the posterior tip of the post-central scute. Each was tagged with one PIT tag and two metal tags when those tags were not present. When possible, a blood sample was obtained and sent to The University of Charleston to determine their serum testosterone level, as an indicator of the number of remaining clutches that would be laid during that

season by that individual. Four of the turtles were outfitted with satellite transmitters.

Each emergence site was investigated to locate eggs. Confirmed nests were sea turtle emergences at which eggs were found. Confirmed non-nesting emergences were those emergences during which the nesting female failed to lay eggs (sometimes called false crawls). These were investigated and documented to such a degree that biologists were certain that no eggs were laid at the site.

Eggs were removed from all confirmed nests located at or soon after egg laying on the Texas coast during 2002. Eggs found on North Padre Island, Mustang Island, Matagorda Peninsula, Quintana Beach, and Galveston Island were shaded, counted, packed into Styrofoam incubation boxes containing sand from the nest sites, and transported to the incubation facility at PAIS in shaded conditions using a truck or sport utility vehicle. Large Kemp's ridley clutches and all clutches laid by other species were split into two incubation boxes designated A and B. Eggs found on South Padre Island were transferred to a corral located on South Padre Island while eggs found on Boca Chica Beach were transferred to a corral on Boca Chica Beach.

CONFIRMED NESTS AND NON-NESTING EMERGENCES

Confirmed nests

Forty-one sea turtle nests were detected on the Texas coast during 2002, from 24 April through 29 July (Table 1). Among the 41 were 38 Kemp's ridley nests located between 24 April and 15 July, two green nests located on 15 June and 26 July, and one loggerhead nest located on 29 July. The 41 nests included four Kemp's ridleys located on the upper Texas coast (Galveston Island, Quintana Beach, and Matagorda Peninsula), one Kemp's ridley located on Mustang Island, 26 Kemp's ridley, two green, and one loggerhead on North Padre Island (including 23 Kemp's ridley, two green, and one loggerhead at PAIS), five Kemp's ridley on South Padre Island, and two Kemp's ridley on Boca Chica Beach.

Thirty-five of the 38 Kemp's ridley nests found on the Texas coast during 2002 were detected at or within a few hours of egg laying,

whereas the other three were not found until hatching. Of the 35 found at or soon after egg laying, 24 were found by beach patrollers and 11 by the public. Beach visitors found and reported three of the 38 at hatching, including one on Mustang Island, one on North Padre Island north of PAIS, and one at PAIS. PAIS staff rushed to these sites as soon as they received these reports. Unfortunately, a total of 14 hatchlings were crushed and killed by passing vehicles at the two sites outside the National Seashore. Additionally, a beach visitor excavated the nest on Mustang Island immediately after the hatchlings emerged, discarding or taking dead hatchlings, dead embryos, and eggshells from the nest.

Data are available on beach position for 37 of the 38 Kemp's ridley nests found. Nests were recorded at a variety of beach positions, from the tide line to the dunes. However, the three nests that went undetected until hatching were in the dunes. It would be expected that the beach position of the undetected and detected nests should be similar, but this was not the case. Perhaps other nests went undetected at lower beach positions, but did not survive to hatching because of beach driving, human disturbance, or high tides occurring lower on the beach.

Several unusual circumstances surrounded the discovery and protection of the nest found on Matagorda Peninsula. A passing vehicle struck the nesting turtle after she laid eggs. Visitors put the injured turtle back into the water. A dead adult Kemp's ridley washed ashore about 8.25 km away, two weeks later. Relatively few adult Kemp's ridleys are found stranded in this region so it is possible that this stranded turtle was the individual that had been struck. Well-intentioned visitors excavated the eggs from this nest because they were concerned the eggs would be crushed since they were laid in the roadway. They packed the eggs in a cardboard box and transported them to their residence. A National Marine Fisheries Service employee retrieved the eggs from the visitors' residence and packed them into a Styrofoam incubation box which was transported to PAIS for incubation.

The record 38 confirmed Kemp's ridley nests documented during 2002 surpasses the eight during 2001, 12 during 2000, 16 during 1999

(previous record), 13 during 1998, and nine during 1997. An increase in the number of nests detected in 2002 may reflect the increased nesting, improved detection efforts, increased awareness and reporting by the public, or a combination of all these factors (Shaver and Caillouet, 1998; Shaver, 2000; 2001; 2002). However, the increase of nesting on the Texas coast could reflect a positive trend in the number of Kemp's ridley nests standardized for patrol effort found in Texas from 1995-2002 (Fig.3).

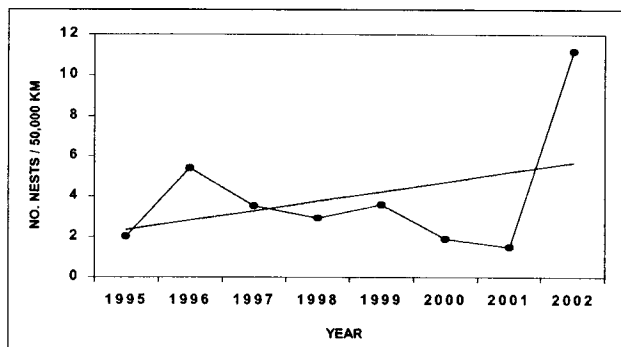


Figure 3. Number of Kemp's ridley nests per 50,000 km patrolled on the Texas coast from 1995-2002(•----) and the calculated regression line (----).

Two Kemp's ridley nests were located in Florida during 2002, including one on 18 May and one on 7 June (G. Harmon, pers. comm.). These were the only other Kemp's ridley nests documented in the U.S. that year.

One confirmed loggerhead turtle nest was found on the Texas coast during 2002 compared to three in 2001, five in 2000, two in 1999, two in 1998, four in 1997, and five in 1996. Twenty-seven confirmed loggerhead nests were located on the Texas coast from 1979-2001.

The nesting Kemp's ridley turtles were examined for tags at 15 of the 38 confirmed Kemp's ridley nests found during 2002 (Tables 2, 3). SLCL for the nine nesting individuals measured for this parameter ranged from 58.1 to 64.8 cm. Nine of the nesting Kemp's ridleys that were examined were not conclusively linked to the experimental imprinting and head-starting project; one had been tagged while nesting on the Texas coast in 1998 and another had been tagged while nesting on the Texas coast in 2000. The other seven turtles examined had no tags, although

one individual did have a tag scar. The other five nesting turtles examined were part of the head-starting project, including a 15 year old nesting female that was found nesting twice that had been hatched in 1987 (1987 year-class) and previously documented nesting on the Texas coast in 1998 and 2000. The other four nesting females included 1) a 14 year old from the 1988 year-class found nesting previously on the Texas coast two times in 1999; 2) a 13 year old turtle from the 1989 year-class found nesting once; 3) an 11 year old turtle from the 1991 year-class found nesting once; and, 4) a 10 year old turtle from the 1992 year-class found nesting once. To date, 13 turtles from the project have been documented laying a total of 22 clutches of eggs on the Texas coast (Shaver, 1996a; 1996b; 1997a; 1997b; 1998a; 1999a; 2000; 2001; 2002).

Confirmed non-nesting emergences

Seven non-nesting emergences were documented on the Texas coast during 2002 (Table 4). The turtles were not observed at five of the sites. At one site on the Bolivar Peninsula, a biologist saw an adult Kemp's ridley from the 1990 year-class that had been hatched at Rancho Nuevo, Mexico in 1990, allowed to enter the surf there, recaptured, and shipped to the National Marine Fisheries Service for head-starting. This turtle re-entered the water without nesting and had not been documented on a nesting beach previously (Tables 2, 3). At another site on North Padre Island (PAIS), a patroller saw an adult Kemp's ridley that was immediately examined by a biologist, tagged, and released; this turtle re-entered the water without nesting and had not been documented on a nesting beach previously (Tables 2, 3).

Number of individuals that nested during 2002

During 2002, one of the 14 nesting Kemp's ridleys examined was documented nesting more than once (Clutch 2 and 11) and the two Kemp's ridleys examined during a non-nesting emergence were never found nesting. Blood samples were obtained from 10 of these 16 turtles and the serum testosterone levels. Serum testosterone is a useful predictor of the number of clutches that remain to be laid by a nesting

Kemp's ridley that year, with a very low level indicating that the turtle probably would not nest again (Rostal *et al.*, 1997). These samples were shipped to the University of Charleston for analysis; results are not yet available.

Since the nesting turtles were not present or examined at 23 of the 38 Kemp's ridley nests, the two green turtle nests, and the one loggerhead nest documented during 2002, it was impossible to calculate the exact number of turtles that nested that year. The minimum and maximum numbers of individual females of each species that laid the confirmed clutches found on the Texas coast during 2002 were estimated based on tag observations, lay dates, typical inter-nesting intervals, and nest locations. The typical inter-nesting interval for *L. kempii* is 18-22 days and inter-nesting intervals less than 10-15 days are not possible for this species (Dr. David Owens, pers. comm.). The number of individual Kemp's ridley turtles that might have laid the 38 confirmed Kemp's ridley clutches on the Texas coast during 2002 ranges from a minimum of 14 to a maximum of 37. Since the two green turtle clutches located on the Texas coast in 2002 could have been laid by the same individual, as few as one green turtle nested in Texas in 2002. Only one loggerhead turtle clutch was laid on the Texas coast during 2002.

IN-WATER MOVEMENTS OF POST-NESTING KEMP'S RIDLEY TURTLES

Platform Transmitter Terminals (PTTs) were used to investigate the inter-nesting and post-nesting movements of four Kemp's ridley turtles that nested in south Texas in 2002. Previously tracked during this study were two turtles that nested in south Texas in 1997, four in 1998, six in 1999, three in 2000, and three in 2001. The turtles selected for this study were the first individuals encountered during the nesting season that were deemed suitable for tracking. Transmitters were not attached to turtles with obvious injuries or unsuitable carapace characteristics.

The four turtles selected for tracking during 2002 were placed on cushions in the back of a sport utility vehicle and transported at moderate temperatures to the Turtle Laboratory

(located at the northern end of PAIS) for attachment of satellite transmitters. A Telonics, ST-6, backpack style, satellite transmitter was attached to the anterior of each turtle's carapace using fiberglass cloth and resin. All four transmitters (25220, 25217, 25218, 25219) were attached with the antenna positioned to the anterior. After transmitter attachment, all four of the turtles were released on Closed Beach at PAIS, approximately 2 km east of the Turtle Laboratory. One of the turtles (25218) was released on the same day that it nested and three (25220, 25217, 25219) were released the next day.

Turtle movements were monitored via satellite until transmissions ceased due to transmitter detachment or failure. PTTs were programmed with a transmission (duty) cycle of 6 h on/6 h off to extend the battery life. All data were screened extensively using location rejection criteria described by Plotkin (1998) to eliminate land locations, duplicate points, points where the rate of movement of a turtle between two consecutive locations exceeded 6 km/h, and locations that were obviously inaccurate. After data screening, the remaining locations from Argos class codes 3, 2, 1, 0, A, and B were mapped for each transmitter (Figs. 4, 5, 6, 7). Argos has estimated that accuracy in latitude and longitude for LC 3 is less than 150 m, for LC 2 is from 150-350 m, for LC 1 is from 350-1000 m, and for LC 0 is more than 1000 m (Argos, 1996). Argos provides no estimation of location accuracy for LC A and LC B, but this does not mean that locations are necessarily less accurate than LC 3, 2, 1, or 0.

Data continued to be received for all four transmitters through December 2002. Based on the accepted locations, all four eventually moved northward and eastward in the Gulf of Mexico and generally traveled parallel to the coastline, primarily in 20 fathoms depth or less (Figs. 4, 5, 6, 7). The last locations identified for transmitters on December 31, 2002 were:

- 25220 — off Fort Myers, Florida.
- 25217 — off Apalachicola, Florida.
- 25218 — off Pensacola, Florida
- 25219 — off Panama City, Florida.



Figure 4. Movements of a Kemp's ridley sea turtle after deployment of transmitter 25220, 25 April - 31 December 2002.



Figure 5. Movements of a Kemp's ridley sea turtle after deployment of transmitter 25217, 27 April - 31 December 2002.

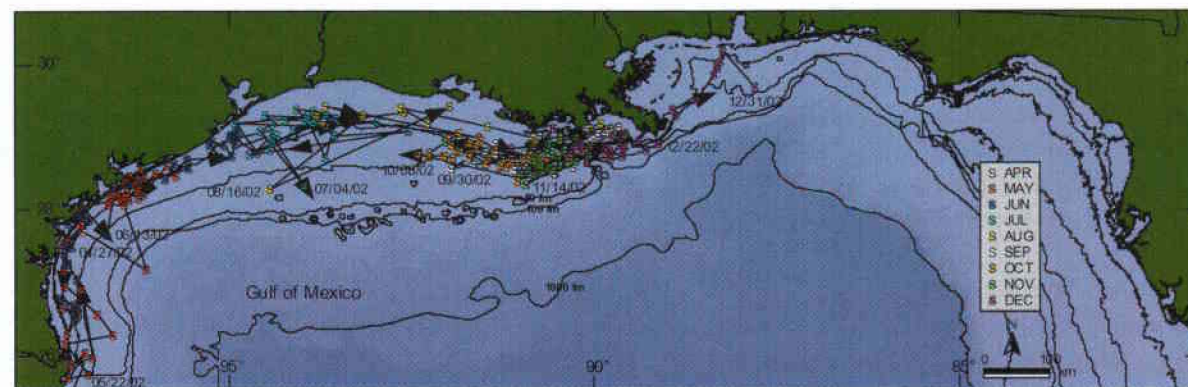


Figure 6. Movements of a Kemp's ridley sea turtle after deployment of transmitter 25218, 27 April - 31 December 2002.



Figure 7. Movements of a Kemp's ridley sea turtle after deployment of transmitter 25219, 30 April - 31 December 2002.

SEA TURTLE EGG INCUBATION TECHNIQUES

USGS biological technician Toni Torres found the seven sea turtle nests on South Padre Island and Boca Chica Beach while on patrol, excavated the nests, placed the eggs into the Boca Chica Corral or the South Padre Island Corral, monitored the eggs, and released the hatchlings on the beach. Incubation temperatures and hatchling measurements were not recorded for these clutches and techniques used in the corral will not be further detailed in this report.

Eggs from 31 of the 34 sea turtle clutches found from North Padre Island northward on the Texas coast were excavated and packed into new Styrofoam boxes with sand from the nest site and transported to the incubation facility located at the Turtle Laboratory as soon as possible after detection. At the incubation facility, each of the smaller Styrofoam boxes containing the eggs was placed into a larger Styrofoam box. Smaller Styrofoam boxes were placed into larger Styrofoam boxes to help ensure that egg temperatures were in accordance with ranges and thermal cycles that would be experienced by eggs incubated *in-situ* (Shaver *et al.*, 1988a; 1988b).

One notable exception to this Styrofoam box arrangement was the clutch from Matagorda Peninsula. Well meaning individuals removed these eggs from the nest site, packed them into a cardboard box, and transported them to their residence. A biologist from the NMFS Galveston Laboratory transferred the eggs to a large Styrofoam box and then transported them to PAIS for incubation. This large box was not inserted into another box at PAIS. In addition, 16 dataloggers were placed into clutches of 14 different Kemp's ridley nests incubated at PAIS. The eggs remained in this facility through the entire incubation period and the author oversaw incubation using procedures described by Shaver *et al.* (1986; 1988a) and Shaver (1990; 1992b; 1996c; 1997b; 1998b; 1999b; 2000; 2001; 2002). Eggs were held at the incubation facility from 24 April through 26 September 2002. Three control boxes were also in the incubation facility during this time. These control boxes were identical to the incubation boxes except that they contained only sand, rather than sand and eggs. Air

temperatures and control box temperatures were monitored at the three shelf heights in the incubation facility throughout this time. Air, control box, and incubation box temperatures were recorded at hourly intervals using a computerized Data Acquisition System.

Incubation temperature influences sex determination in Kemp's ridley and other sea turtles, with warmer temperatures producing primarily females (Shaver *et al.* 1988b). Incubation temperatures were elevated during the middle third of the incubation period to avoid the potentially masculinizing effects of incubating sea turtle eggs in Styrofoam boxes (Dutton *et al.*, 1985). Procedures were employed to produce mean middle third of incubation period temperatures that slightly exceeded pivotal temperatures, in hopes of producing primarily females.

Attempts were made to prevent incubation temperatures from becoming too hot, too cold, or too unstable, all of which could stress the developing embryos and reduce their viability (Shaver *et al.*, 1987; 1988b; Shaver, 1989b; Shaver and Chaney, 1989). Plastic sheeting, plastic shades, and black cotton bed sheets were placed over the shed walls to reduce temperature fluctuations, light, and noise within the facility. A heater was installed on an automatic thermostat to ameliorate cold temperatures.

During the last third of the incubation period, incubation temperatures could exceed lethal limits due to metabolic heat generated by the developing embryos and high ambient temperatures (Shaver *et al.*, 1987; Shaver, 1989b; Shaver and Chaney, 1989). Several means were utilized to reduce incubation temperatures of the clutches during the latter portion of the incubation period. An exhaust fan activated by an automatic thermostat was used to reduce high ambient temperatures in the incubation facility. Air cooled by an air conditioner was blown into the incubation facility during periods of exceptionally hot diurnal temperatures. Clutches were moved to cooler, lower shelves immediately after the middle third of the incubation period. Incubation box lids were removed to reduce incubation temperatures after they exceeded 33.0 C (for *L. kempii*) and 31.0 C (for other species). Generally, lids were

removed between 2200 and 0800 h and replaced by 1000 h. For incubation boxes that produced large amounts of metabolic heat, lids were removed and kept off for a few days at the end of the incubation period (Shaver, 2000).

Incubation boxes were opened approximately once a week throughout incubation to check for insects and sand moisture. Moisture content of the sand above the eggs was monitored by the "pie-crust" pinch technique. When decreased sand moisture was detected in the clutches (typically during the last several days of incubation) small amounts of distilled water were added to the top sand layers.

Incubation boxes were checked for hatching twice daily beginning on the 44th day of incubation. Hatching was typically detected prior to the hatchlings fully emerging from the eggshells and reaching the sand surface. The progress of hatching and activity levels of the hatchlings were monitored 24 hours a day after hatching was detected, to determine the appropriate release time for the hatchlings. Emerged hatchlings that had entered their frenzy or were ready for release were transferred to small Styrofoam boxes containing moist sand from PAIS. A cover constructed of black cotton bed sheets was placed over each box to eliminate extraneous light from entering the boxes. All hatchlings were measured for SLCL and weighed prior to release.

Hatchlings from the 31 clutches hatched at the incubation facility during 2002 were released on Closed Beach at PAIS, a section of beach closed to public vehicular access. Most hatchlings were released during the early morning hours, but some were released at night. During release, hatchlings were examined for final verification of species, assessment of health, and presence of deformities. Hatchlings were guarded from beach predators during release.

Such conditions were not afforded to most of the hatchlings from the three nests that visitors found at hatching. Biologists were only able to examine a few from the nest located on North Padre Island north of the National Seashore. Only a portion of the hatchlings from the two North Padre Island nests were guarded from beach predators and vehicles during release.

Unfortunately, a total of 14 hatchlings were killed at the two sites outside the National Seashore. The number of hatchlings that entered the surf from these three nests was estimated based on egg shell counts (when available) or from reports from the public. The full compliment of nest contents was only available for the nest on North Padre Island north of the National Seashore. The nest cavity was not located for the National Seashore nest. Beach visitors removed most of the eggshells and dead embryos from the Mustang Island nest, although, they later gave a portion of them to biologists participating in this work.

The author examined unhatched eggs from the incubation facility, corral, and nests hatched on the beach as soon as these eggs were not deemed viable (Shaver *et al.*, 1988a; Shaver and Chaney, 1989). Eggs were not preserved prior to examination, but those from the Boca Chica Beach and South Padre Island corral were chilled for the roughly 24 hours between removal from the corral and examination. Kemp's ridley embryos were staged according to criteria developed by Cratz (1982) and modified by Shaver and Chaney (1989) and loggerhead and green turtle embryos were staged according to criteria developed by Miller (1985).

Incubation facility temperatures

Comparisons were made among air temperatures recorded from the three shelf heights in the incubation facility during the time when eggs were incubating there (Table 6). Since temperatures were not normally distributed, non-parametric procedures were used to make comparisons. Median air temperatures on top (31.2 C), middle (30.8 C), and bottom (30.0 C) shelves in 2002 were significantly different (Kruskal-Wallis One Way Analysis of Variance on Ranks, $H=1184.687$, $df=2$, $P<0.001$). The median air temperatures on the top, middle, and bottom shelves were all significantly different from one another (Student-Newman-Keuls All Pairwise Multiple Comparison Procedures, $P<0.05$).

Comparisons were made among control box temperatures recorded from the three shelf heights in the incubation facility during the time when eggs were incubating there (Table 6). Since

temperatures were not normally distributed, non-parametric procedures were used to make comparisons. Median temperatures of control boxes located on top (30.4 C), middle (29.8 C), and bottom (29.1 C) shelves in 2002 were significantly different (Kruskal-Wallis One Way Analysis of Variance on Ranks, $H=3563.443$, $df=2$, $P<0.001$). The median temperatures of the control boxes on the top, middle, and bottom shelves were all significantly different from one another (Student-Newman-Keuls All Pairwise Multiple Comparison Procedures, $P<0.05$).

Incubation temperatures and hatching results

Temperature manipulations of incubation boxes were successful in achieving mean middle third of incubation period temperatures above the pivotal temperature for all Kemp's ridley (30.2 C) (Shaver *et al.*, 1988b), loggerhead, and green turtle clutches (Table 6).

The incubation period for the Kemp's ridley clutches ranged from 43-53 days and for the green clutches ranged from 48-49 days. The loggerhead clutch was incubated for 59 days (Table 5). For eggs held in the incubation facility, incubation period is the number of days from eggs laying until hatching was detected. Generally, hatching was detected at pipping but occasionally it was not detected until complete hatching emergence and hatchling frenzy. For eggs held in the corral, incubation period was measured as the number of days from egg laying until hatchling release. Incubation period could not be determine for those three clutches found at hatching.

Overall, an estimated 67.8% of the roughly 3,771 Kemp's ridley eggs that were incubated on the Texas coast hatched (Table 5) from which about 2,536 hatchlings successfully entered the Gulf of Mexico (Table 5). The hatching rate was 67.4% and emergence rate was 66.2% for the 2,773 Kemp's ridley eggs held in the incubation facility. Thirty-three hatchlings died after emergence on the sand surface, but prior to release; four hatchlings that were too weak to enter the surf when placed on the beach were transferred to the University of Texas Marine Science Institute (UTMSI) for prolonged care, but succumbed; and 1,833 hatchlings were released and successfully entered the water. The hatching

and emergence rates were 74.0% and 71.0% for the 696 Kemp's ridley eggs incubated at one of the corrals located at Boca Chica Beach or South Padre Island and 495 hatchlings were released there.

Based on counts of eggshells, and unhatched eggs, visitor reports, and average clutch size, emergence success was estimated to be 74.0% of the three nests that incubated *in-situ*. From these three nests, 14 hatchlings were killed by passing vehicles and about 208 surviving hatchlings successfully entered the water.

The two Kemp's ridley clutches found and incubated *in-situ* in Florida contained 221 eggs. The hatching and emergence rates were 74.2 % and 73.8% for the two nests and 163 hatchlings were released.

Overall, the forty Kemp's ridley nests found in the U.S. during 2002 contained approximately 3,992 eggs. The estimated emergence rate was 68.1% and an estimated 2,699 hatchlings were released on the beach and entered the Gulf of Mexico.

Hatching and emergence success rates have been usually larger for Kemp's ridley eggs hatched in the incubation facility than in corrals. During 2002, the emergence success for the twenty-eight Kemp's ridley clutches held at the incubation facility (66.2%) was lower than for the seven clutches incubated in the corral on Boca Chica Beach (71.0%), the three natural hatching clutches incubated *in-situ* in Texas (74.0%), and the two clutches incubated *in-situ* in Florida (73.8%). The yearly mean hatching success of Kemp's ridley eggs retrieved from south Texas beaches held at the incubation facility from 1978-2001 was 77.9%. In comparison, the yearly mean hatching success for the Kemp's ridley eggs incubated in corrals in Mexico from 1978-1999 was 63% (Burchfield *et al.*, 1999).

All loggerhead and all green eggs were incubated at the incubation facility. Overall, 58.3% of the 12 loggerhead eggs incubated hatched and all 7 hatchlings were released on the beach and entered the Gulf of Mexico (Table 5). The hatching and emergence rates were 79.1% for the 239 green turtle eggs incubated at the incubation facility and 189 hatchlings were released.

SLCLs and weights of live hatchlings from the twenty-eight Kemp's ridley, two green turtle, and one loggerhead clutches held at the incubation facility were recorded and summarized (Table 7). SLCLs and weights of the four hatchlings that were sent to UTMSI were included in the descriptive statistics for their clutch of origin, but the measurements for the fifty-four that died prior to release were not.

The unhatched eggs from the clutches found on the Texas coast were examined after full-term clutch incubation and were determined to have ceased development at various times during the incubation period (Tables 8, 9). The unhatched eggs contained two deformed green turtle embryos and eighteen deformed Kemp's ridley embryos (Table 10).

Gonads were removed from dead hatchlings and late-staged embryos for histological sex determination (Tables 8, 9). The tissues were shipped to the University of Alabama at Birmingham, where histology will be used to determine gender of the embryos and dead hatchlings. Some gonad samples were obtained from thirty Kemp's ridley clutches found on the Texas coast (includes box incubation, corral, and *in-situ* nests). The mean percent females for the 30 Kemp's ridley clutches analyzed was 87.9% (Table 11). The samples collected from the one green and three loggerhead clutches were too decomposed to be analyzed. Since few samples were available to derive these estimates based on histology, Kemp's ridley clutch sex ratios were also estimated for those hatched in the incubation facility based upon the mean middle third of incubation period temperature and incubation period. Using the equation correlating percent female with the mean middle third of incubation period temperature [$Y = -1297.8747 + 44.7152X$ (Shaver *et al.*, 1988b)], the mean percent females estimated for the clutches was 86.9% (Table 11). Using the equation correlating percent female with the incubation period [$Y = 772.343 - 14.634X$ (Shaver, 1989a)], the mean percent females estimated for the 28 clutches was 84.8% (Table 11).

Genetic analysis focusing on Kemp's ridley reproduction in Texas

A genetics research project was initiated in 2002 in collaboration with Dr. Peter Dutton, leader of the NMFS National Sea Turtle Molecular Genetics Program. Blood samples were taken from some nesting Kemp's ridley turtles and tissue samples were taken from dead embryos/hatchlings and from dead stranded adults.

The goals of this project are to further investigate the number of nesting females, number of nests laid per season, nest site fidelity, remigration intervals, inter-nesting intervals, impacts of local adult mortality on the nesting population, and results of the experimental imprinting and head-starting procedures. Also, the number of males that fathered nests and multiple paternity within individual nests are being investigated. It is also hoped that a passive tagging system for future identification can be developed as a result of this work.

SEA TURTLE STRANDINGS

General

Stranded sea turtles are those individuals located washed ashore or floating, either alive or dead. Sea turtles captured incidentally (such as in active fishing or fisheries operations, on power plant intake grids, etc.) are not included in stranding totals. Stranded sea turtles found on the Texas coast are documented in conjunction with the STSSN. Stranded sea turtles are located during systematic surveys and in response to information provided by the public and individuals working on the beach. Systematic surveys for stranded turtles are conducted along Texas Gulf beaches at least once per week throughout the year. However, systematic surveys for nesting and strandings are conducted repeatedly each day during the nesting patrol season on North Padre Island, South Padre Island, and Boca Chica Beach.

Each turtle found stranded in Texas is documented on a standardized form and photographed. Locations are classified as either offshore (Gulf of Mexico and associated beaches) or inshore (bays, inlets, and channels and associated beaches). Locations are also

categorized according to statistical zones designated by NMFS. Zones 17-21 are positioned from north to south along the Texas coast, with the majority of zone 17 located along the Louisiana coast. PAIS is located in the southern half of zone 20 and northern half of zone 21.

Three hundred fifty-three wild (non-head-started) sea turtles were located stranded along the Texas coast in 2002 (Table 12). Among the 353 turtles that were located stranded were 90 Kemp's ridley, 130 loggerhead, 63 green, 16 leatherback, 47 hawksbill, and 7 turtles of unknown species (Table 12). The total number of wild turtles found in Texas during 2002 (353) was the 9th highest since the STSSN was established. None of these species tallies for 2002 reached record annual levels.

This was the second year for the Texas Parks and Wildlife Department regulation prohibiting shrimp trawling in the Gulf of Mexico waters out to 8 km from shore, off the southern 2/3 of zone 20 and all of zone 21, from 1 December through 15 May.

off the Texas coast were closed to shrimp trawling during the Texas Closure (15 May through 15 July 2002) (Fig. 8), as typically occurs (Shaver, 1994b; 1995b; 1996d; 1998c).

Figure 8. Number of stranded sea turtles located on offshore Texas beaches for each week from January through December 2002.

During 2002, 13 of the 315 turtles found stranded offshore were linked to likely stranding causes (five hatchlings and post-hatchlings that drifted onto shore with currents; one wedged in jetty rocks; one with a rope tied around it; one entangled in non-fishing gear medium; four with a hook in the mouth or other body part; and one entangled in a net. Twelve of the 38 turtles found stranded inshore were linked to likely stranding causes (six hypothermic stunned; and six with a hook in the mouth or other body part). Additionally, seven turtles that stranded inshore were found with likely boat propeller injuries and/or likely boat collision injuries, but these wounds could have been inflicted either pre- or

post-mortem. Some stranded turtles found during 2002 had signs of interactions with sharks and other animals, but these injuries could have been the result of post-mortem scavenging.

Strandings of adult Kemp's ridley turtles

Twenty-one wild (non-head-started) adult Kemp's ridleys (≥ 60.0 cm SLCL) were located stranded on the Texas coast during 2002. This is slightly less than the 25 found during 2001 and the record 37 found during the entire year in 1998. These 21 stranded adults found during 2002 were documented between 28 January and 20 December. All 21 located were dead.

The 21 included 10 females, eight males, and three of undetermined sex. One of the 21 had PIT tag 4039473C43 and metal tag FB452 linking it to nesting in Rancho Nuevo, Mexico on 17 May 2000 (J. Pena, pers. comm.); one had PIT tag 410147433C linking it to nesting in Rancho Nuevo on 5 April 2000 (J. Pena, pers. comm.); and one male had evidence of tag scars. None of the remaining 18 had evidence of living, magnetic, PIT, or metal tags, but many of these turtles were missing flippers and/or scutes and thus could not be examined to determine if they were from the experimental project or had been tagged previously.

Unfortunately, more adult Kemp's ridleys are typically found stranded in Texas than in any other U.S. state, even though adult Kemp's ridleys forage in, and migrate through, near shore waters of several other U.S. states. Twenty-seven adult Kemp's ridleys were found stranded in the U.S. during 2002 including 21 found in Texas, three in Florida, one in Louisiana, one in South Carolina, and one in Virginia (W. Teas, pers. comm.). Fourteen of the 27 were found stranded in zone 21, more than in any other U.S. zone that year.

At least half of the adult Kemp's ridleys found stranded on the Texas coast during recent years were females and the loss of each female represents a loss of up to three clutches/nesting season, potentially for many years of nesting. The success of efforts to determine results of the experimental project and to increase nesting in south Texas could be threatened by continued mortality of adults in waters offshore from south Texas nesting beaches (Shaver, 1999a).

Strandings of hatchlings

Hatchlings and post-hatchlings (hereafter referred to as hatchlings) measure less than 10 cm SLCL. Forty-one hatchlings were found washed ashore along the Texas coast during 2002, between 20 May and 6 November (Table 14). Among the 41 hatchlings were 30 Kemp's ridleys, 10 hawksbills and one green. As during 1990-2001, pedestrians located most of the hatchlings (Shaver, 1990; 1991; 1992b; 1993; 1994a; 1996c; 1997b; 1998b; 1999b; 2000; 2001; 2002).

Most of the hatchlings were measured for SLCL, SLCW, CCL, CCW, and weight (Table 14). To assess the possibility that these hatchlings emerged from eggs laid in Texas, most were examined for the presence of an umbilical scar, egg tooth, internal yolk (if dead), gut contents (if dead), wounds, and epizoots (Table 14). Gonads were removed from many of the dead hatchlings and shipped to the Texas A&M University, Veterinary Diagnostic Laboratory, where histology was used to determine their gender (Table 14).

Eleven Kemp's ridley and one green hatchling likely originated from clutches that were laid in south Texas, incubated under protected conditions, and released by biologists; all were excluded from stranding totals due to their likely origin. Seven Kemp's ridley hatchlings were found washed ashore on 1 July, likely from clutches 10, 11, or 12 that were released on 30 June - 3 July. These hatchlings were the size of newly hatched turtles and possessed an umbilical scar and/or egg tooth (Table 12) and probably stranded due to intense wave action during release. The two Kemp's ridley hatchlings found washed ashore on 4 July were likely from clutch S2 that was released the same day. The Kemp's ridley hatchling found washed ashore on 14 August and the Kemp's ridley hatchling found on 15 August were likely from clutch 27 that was released on 14 August. Additionally, one green hatchling was found washed ashore on 18 September and was almost certainly from clutch 33 released on 14-17 September.

The remaining 29 hatchlings were categorized as true strandings since they could not be linked to any known releases. Based on size and various attributes (egg tooth, umbilical scar,

internal yolk, and no gut contents), two stranded Kemp's ridley hatchlings (LK-02-27 and LK-02-28) may have emerged from an undetected south Texas nest. However, it is unlikely that any other of the 27 hatchlings originated from south Texas nests.

RECOMMENDATIONS

The detection, study, and protection of nesting sea turtles, sea turtle nests, and stranded sea turtles must continue annually on the Texas coast. The numbers of Kemp's ridley turtles nesting on the Texas coast are still extremely low and more dead adults are found washed ashore in south Texas than at any other location in the U.S. To ensure the future of Kemp's ridley nesting in south Texas, it is essential that survival of both wild and head-started adults be secured and that recruitment of hatchlings be maximized. Eggs laid should be located, handled by the most experienced personnel, and incubated using the most appropriate technology to produce the largest number of hatchlings that are vigorous and have a female-biased sex ratio. Individual differences in egg handling protocols have profound impacts on hatching success (Shaver, 2001). These impacts not only reduce hatchling production, but also greatly confound the ability to compare fecundity of wild and head-started turtles, an important criterion required to assess the results of the experimental imprinting and head-starting procedures used in this project (U.S. Fish and Wildlife and National Marine Fisheries Service, 1992).

Systematic nesting turtle patrols are needed in order to critically evaluate the imprinting and head-starting experiment. Patrols are essential to continued unique research efforts to evaluate the experiment as a potential conservation tool for sea turtles worldwide, as well as research to understand the mechanisms that play a role in guiding adult turtles back to natal beaches. Continued collection of long-term research data is also essential to investigate trends and evaluate results of regulations.

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Table 1. Locations and dates of the 41 confirmed sea turtle nests detected along the Texas coast during 2002.

Clutch (Species ¹)	Nest Site ²	Incubation Type ³	How Located	Detection Stage ⁴	Lay Date	Time Tracks or Turtle Detected (h)
1(LK)	NPI, PAIS	B	Turtle-public	E	24 April	1745
2(LK)	NPI, PAIS	B	Turtle-public	E	26 April	1745
3 (LK)	NPI, PAIS	B	Turtle-patroller	E	27 April	0927
4(LK)	NPI, PAIS	B	Turtle-patroller	E	29 April	1445
5(LK)	NPI, PAIS	B	Turtle-patroller	E	1 May	1015
6(LK)	NPI, North of PAIS	B	Turtle-patroller	E	1 May	1430
7(LK)	NPI, PAIS	B	Turtle-patroller	E	6 May	1630
8(LK)	NPI, PAIS	B	Tracks-patroller	E	8 May	0745
9(LK)	NPI, PAIS	B	Tracks-patroller	E	8 May	0845
10(LK)	NPI, PAIS	B	Turtle-patroller	E	13 May	1055
11(LK)	NPI, PAIS	B	Turtle-patroller	E	16 May	1435
12(LK)	NPI, PAIS	B	Tracks-patroller	E	16 May	1145
13(LK)	NPI, PAIS	B	Turtle-patroller	E	18 May	0830
14(LK)	NPI, North of PAIS	B	Turtle-public	E	18 May	0930
15(LK)	NPI, PAIS	B	Tracks-patroller	E	22 May	0950
16(LK)	NPI, PAIS	B	Turtle-patroller	E	23 May	0645
17(LK)	Quintana Beach	B	Turtle-public	E	23 May	0800
18(LK)	NPI, PAIS	B	Tracks-patroller	E	31 May	1315
19(LK)	NPI, PAIS	B	Tracks-patroller	E	31 May	1530
20(LK)	NPI, PAIS	B	Tracks-patroller	E	31 May	1550
21(LK)	NPI, PAIS	B	Tracks-patroller	E	31 May	1715
22(LK)	NPI, PAIS	B	Turtle-public	E	4 June	0930
23(LK)	GAL, West end	B	Turtle-public	E	9 June	1630
24(LK)	GAL, West end	B	Turtle-public	E	10 June	0930
25(LK)	Matagorda Peninsula	B	Turtle-public	E	9 June	n/a
26(CM)	NPI, PAIS	B	Tracks-patroller	E	15 June	0715
27(LK)	NPI, PAIS	B	Tracks-patroller	E	26 June	0930
28(LK)	NPI, PAIS	B	Tracks-patroller	E	26 June	1530
29(LK)	MI	I	Hatchling Nest-Public	H	?	2020
30(LK)	NPI, PAIS	I	Hatchling Nest-Public	H	?	0815
31(LK)	NPI, North of PAIS	I	Hatchling Nest-Public	H	?	0945
32(LK)	NPI, PAIS	B	Tracks-patroller	E	15 July	0800
33(CM)	NPI, PAIS	B	Turtle-public	E	26 July	1437
34(CC)	NPI, PAIS	B	Tracks-patroller	E	29 July	1000
S1(LK)	SPI	C	Turtle-public	E	13 May	1400
S2(LK)	SPI	C	Turtle-patroller	E	18 May	1150
S3(LK)	SPI	C	Tracks-patroller	E	18 May	1130
S4(LK)	BCB	C	Turtle-public	E	18 May	1752
S5(LK)	BCB	C	Turtle-public	E	22 May	1035
S6(LK)	SPI	C	Tracks-patroller	E	24 May	1320
S7(LK)	SPI	C	Tracks-patroller	E	9 June	1733

¹ LK = Kemp's ridley, CC = loggerhead, CM = green turtle.

² NPI = North Padre Island, PAIS = Padre Island National Seashore, GAL = Galveston Island, MI = Mustang Island, SPI = South Padre Island, BCB = Boca Chica Beach, BSP = Brazos Santiago Pass.

³ B = incubation boxes, C = corral, I = *in situ*.

⁴ E = eggs found within 24 hours of being laid, H = eggs found at hatching.

Table 2. Measurements and tags^{1,2} for emergent sea turtles documented on the Texas coast during 2002.

Clutch (Sp.) ³	SLCL (cm)	SLCW (cm)	CCL (cm)	CCW (cm)	Tags present					Tags applied	
					PIT	Mag- netic	Liv- ing	Metal	Tag Scar	Metal	PIT
1(LK)	61.2	59.6	64.9	67.8	-	-	-	-	-	LF:SSQ840 LR:SSQ871	LF:41302E3B7A RF:41307E5B0D
2(LK) ⁴	60.9	60.2	64.5	69.2	LF:4130764833	LF	RC2	-	-	LF:SSQ838 RR:SSQ839	-
3(LK)	64.7	64.6	67.5	70.4	-	-	-	-	-	LF:SSQ116 LR:SSQ117	LF:4130426F4A RF:4130732E7F
4(LK)	61.5	59.8	65.0	67.7	LF:4077164833	-	-	LF:SSQ101	-	RF:SSQ118 RR:SSQ119	-
5(LK)	62.1	61.8	65.2	68.2	-	-	-	-	-	LF:SSQ836 LR:SSQ837	LF:41305C1D2A RF:41303E6FF0B
6(LK)	62.5	59.1	66.0	68.0	LF:4130442013	-	-	-	LF	RF:SSQ834 LR:SSQ835	-
7(LK)	64.8	59.1	69.0	68.2	-	-	-	-	-	LF:SSQ832 LR:SSQ833	LF:412B65467B
- (LK) ⁵	-	-	64.7	60.4	LF:7F7D260715	-	RC2	-	RF	-	-
10(LK)	-	-	66.5	66.8	-	-	-	-	-	LF:SSQ828 LR:SSQ829	LF:412B561B0B
13(LK)	58.1	56.7	61.5	65.3	-	LF	LC2	-	RF	LF:SSQ830 LR:SSQ831	LF:412B4E4F2D
14(LK) ⁶	-	-	-	-	-	-	LC1	-	RF	-	-
16(LK)	58.2	59.2	60.7	64.5	LF:7F7D3A0E2A	LF	RC4	-	RF	LF:XXR774 LR:XXR775	-
- (LK) ⁵	64.1	63.0	68.0	69.6	-	-	-	-	-	LF:XXR772 LR:XXR773	LF:4130211539
23(LK)	-	-	-	-	-	-	RC3	-	RF	-	-
24(LK)	-	-	-	-	-	-	-	-	RF	-	-
S1(LK)	-	-	69.5	69.0	-	-	-	-	-	RF:XXR776	LF:4077156960

¹ PIT, magnetic, and metal tags and metal tag scars that were present or applied to the left front flipper (LF), right front flipper (RF), left rear flipper (LR), or right rear flipper (RR).

² Living tag that was present on the right costal 2 (RC2), right costal 3 (RC3), right costal 4 (RC4), left costal 1 (LC1), or left costal 2 (LC2).

³ LK = Kemp's ridley.

⁴ Clutch 2 is same individual that nested again on 16 May, 2002 (see clutch 11).

⁵ This turtle did not nest during this emergence.

⁶ Photos obtained from public confirm living tag and tag scar.

Table 3. Comments regarding emergent sea turtles documented on the Texas coast during 2002.

Clutch (Species) ¹	Year-class	Serum Testosterone (pg/ml)	Satellite Transmitter (if applied)	Comments
1(LK)	-	pending	25220	antenna forward, three indentions (nicks) on rear carapace
2(LK)	1987	pending	25217	antenna forward, previously documented nesting on NPI in 2000, previously documented nesting at PAIS in 1998, post notch on left rear side of carapace, nested again on 16 May 2002 (see clutch 11)
3(LK)	-	pending	25218	antenna forward, large projection on left rear side of carapace. carapace large and flat with spine on top
4(LK)	-	pending	25219	antenna forward, missing big notch on 2 marginals on rear tip of carapace; previously documented nesting in 2000.
5(LK)	-	pending	-	-
6(LK)	-	pending	-	previously documented nesting at PAIS ² in 1998
7(LK)	-	pending	-	missing tip of left front flipper
- (LK)	1990	-	-	did not nest during this emergence
10(LK)	-	pending	-	slight indentation on left front flipper
13(LK)	1991	pending	-	short front flippers
14(LK) ³	1988	-	-	previously documented nesting twice in 1999 on MI ²
16(LK)	1989	pending	-	short front flippers
- (LK)		pending	-	-
23(LK)	1992	-	-	-
24(LK)	-	-	-	notch on rear left of carapace
S1(LK)	-	-	-	-

¹ LK = Kemp's ridley.

² NPI = North Padre Island, PAIS = Padre Island National Seashore, MI = Mustang Island.

³ Photos obtained from public confirm individual.

Table 4. Locations and dates of confirmed non-nesting emergences (no eggs located) documented on the Texas coast during 2002.

Suspected Species ¹	Location ²	How Located	Date	Time (h)	Comments
LK	Bolivar Peninsula	Turtle-public	7 May	1120	observed crawling ³
LK	NPI, PAIS	Turtle-patroller	14 May	0650	U-shaped
LK	NPI, PAIS	Tracks-patroller	24 May	1120	end at base of dunes
LK	NPI, PAIS	Turtle-patroller	26 May	1430	observed crawling ³
CC	NPI, PAIS	Tracks-patroller	4 July	0740	ended at disturbed area
CC	NPI, North of PAIS	Tracks-patroller	6 July	1010	ended at vehicular road
CC	GAL, Sergeant Beach	Tracks-public	14 July	0630	ended at disturbed area

¹ LK = Kemp's ridley, CC = loggerhead.

² GAL = Galveston Island, NPI = North Padre Island, PAIS = Padre Island National Seashore.

³ Turtle was observed crawling on the beach, but did not lay eggs during this emergence (included in Tables 2, 3).

Table 5. Incubation and hatching information for the 41 confirmed sea turtle nests documented on the Texas coast during 2002.

Clutch (Species) ¹	Number of Eggs Incubated ²	Hatch Date ³	Incubation Period (Days)	Hatching Success ⁴	Number Hatchlings Died Prior to Release	Emergence Success	Number Hatchlings Released ⁵	Hatchling Release Dates
1(LK)	91	6 June	44	81.3	0	81.3	74	12-13 June
2(LK)	95	9 June	44	77.9	3	74.7	71	13-18 June
3(LK)	99	10 June	45	92.9	1	91.9	91	13 June
4(LK)	116	11 June	44 & 44	95.7	1	94.8	110	17-18 June
5(LK)	90	14 June	45	76.7	0	76.7	69	19-20 June
6(LK)	87	16 June	47	28.7	2	26.4	23	19-21 June
7(LK)	109	22 June	48 & 48	92.7	0	92.7	101	25 June
8(LK)	113	24 June	48 & 48	40.7	1	39.8	45	25-26 June
9(LK)	102	21 June	45	98.0	0	98.0	100	23 June
10(LK)	88	27 June	46	87.5	2	85.2	75	30 June
11(LK)	105	27 June	43	59.0	5	54.3	57	1-2 July
12(LK)	102	27 June	43	79.4	1	78.4	80	1-3 July
13(LK)	82	3 June	47	51.2	0	51.2	42	5 July
14(LK) ⁶	103	-	-	0.0	0	0.0	0	-
15(LK)	96	4 July	44	95.8	0	95.8	92	8-13 July
16(LK) ⁶	70	-	-	0.0	0	0.0	0	-
17(LK) ⁷	113	7 July	46	94.7	0	94.7	107	11-13 July
18(LK)	105	12 July	43	83.8	0	83.8	88	16 July
19(LK) ⁷	88	13 July	44	89.8	1	88.6	78	16 July
20(LK)	110	13 July	44	76.4	5	71.8	79	15-18 July
21(LK)	105	12 July	43	56.2	2	54.3	57	15 July
22(LK)	100	17 July	44	80.0	4	76.0	76	19-20 July
23(LK)	95	23 July	45	87.4	0	87.4	83	28 July
24(LK)	78	27 July	48	42.3	0	42.3	33	29-31 July
25(LK) ⁷	122	22 July	44	63.9	3	61.5	75	25 July
26(CM)	96	2 August	49 & 49	90.6	0	90.6	87	3-4 August
27(LK)	116	11 August	47 & 47	50.0	2	48.3	56	14 August
28(LK)	83	10 August	46	86.7	0	86.7	72	13 August
29(LK) ⁸	?	2 July	-	?	?	?	~68	2 July
30(LK) ⁸	?	7 July	-	?	?	?	~54	7 July
31(LK) ⁸	102	7 July	-	97.1	1	96.1	~86	7 July
32(LK)	112	6 Sept.	53 & 53	2.7	0	2.7	3	7 Sept.
33(CM)	143	12 Sept.	48 & 49 & 49	71.3	0	71.3	102	14-17 Sept.
34(CC)	12	26 Sept.	59	58.3	0	58.3	7	26 Sept.
S1(LK)	111	1 July	49	89.2	0	89.2	99	1-2 July
S2(LK)	77	4 July	47	59.7	2	57.1	44	4-5 July
S3(LK)	107	5 July	48	62.6	12	51.4	55	5 July
S4(LK)	105	5 July	48	79.0	0	79.0	83	5 July
S5(LK)	110	9 July	48	96.4	0	96.4	106	9 July
S6(LK)	65	5 July	42	69.2	1	67.7	44	5-6 July
S7(LK)	121	25 July	47	57.0	5	52.9	64	25-26 July

Table 5. (Continued)

¹ LK = Kemp's ridley, CM = green turtle, CC = loggerhead.

² Total number of eggs incubated: 3,771 LK (estimated), 12 CC, and 239 CM = 4,022 eggs all species (estimated).

³ Hatch date is the date that hatching was detected for eggs incubated in boxes, the date that emergence from the nest was detected for eggs incubated in a corral, and the date that emergence from the nest was for *in-situ* nests detected at hatching.

⁴ Calculated based on the number of eggs incubated divided by the number of live hatchlings.

⁵ Hatchlings that successfully entered the surf. Total number of hatchlings released: 2,536 LK (estimated), 7 CC, 189 CM.

⁶ In two clutches all eggs were infertile and incubation boxes were dismantled.

⁷ Four hatchlings were measured, but too weak to enter the surf and were transferred to rehabilitation for prolonged care and later died there.

⁸ *In-situ* nests: information on hatching and hatchling production is approximate based on egg shell count and number of hatchlings witnessed entering the water. Two hatchlings from clutch 29 and 12 hatchlings from clutch 31 were killed on beach by passing vehicles.

Table 6. Temperatures (Celsius) recorded in the incubation facility at Padre Island National Seashore for egg incubation boxes, air temperature probes, and control boxes during 2002¹.

Temperature Measured	Entire Incubation Period				Middle Third of Incubation Period			
	N	Range	Mean (S.E.)	Median	N	Range	Mean (S.E.)	Median
Clutch 1	987	27.0–33.9	31.3(0.0)	31.1	336	30.1–32.6	31.2(0.0)	31.1
Clutch 2	1021	26.9–34.8	31.6(0.0)	31.3	360	29.9–32.6	31.2(0.0)	31.1
Clutch 3	1015	26.3–35.8	31.7(0.1)	31.3	360	30.0–32.4	31.2(0.0)	31.2
Clutch 4A	999	27.8–34.9	31.6(0.0)	31.1	336	29.4–32.3	31.1(0.0)	31.0
Clutch 4B	1000	28.0–34.6	31.3(0.0)	30.8	336	29.1–32.2	30.8(0.0)	30.7
Clutch 5	1041	26.8–34.6	31.6(0.0)	31.2	360	29.4–32.7	31.2(0.0)	31.2
Clutch 6	1095	27.7–33.3	31.1(0.0)	31.0	360	29.1–32.5	31.1(0.0)	31.1
Clutch 7A	1112	26.1–34.0	31.3(0.0)	31.3	384	30.0–33.0	31.4(0.0)	31.3
Clutch 7B	1112	26.3–34.2	31.8(0.0)	31.7	384	30.5–33.7	31.9(0.0)	31.7
Clutch 8A	1129	27.3–33.4	31.6(0.0)	31.6	384	30.9–33.4	31.9(0.0)	31.9
Clutch 8B	1129	27.5–33.1	31.4(0.0)	31.6	384	30.7–33.1	31.7(0.0)	31.6
Clutch 9	1051	26.9–36.0	32.5(0.1)	31.4	360	31.1–33.7	32.2(0.0)	32.3
Clutch 10	1071	25.6–35.3	31.8(0.1)	32.3	360	30.9–33.9	32.0(0.0)	31.8
Clutch 11	971	28.8–34.7	32.0(0.0)	31.7	336	31.0–33.4	32.0(0.0)	31.8
Clutch 12	970	27.5–34.5	32.0(0.1)	31.8	336	31.2–33.9	32.2(0.0)	32.1
Clutch 13	1096	24.7–33.5	31.1(0.0)	32.1	360	30.8–32.4	31.3(0.0)	31.3
Clutch 14	1213	23.6–31.8	30.5(0.0)	30.7	0	Undefined	Undefined	Undefined
Clutch 15	1024	25.1–35.9	32.1(0.1)	32.0	336	30.3–33.8	32.1(0.0)	32.0
Clutch 16	1193	24.6–33.0	30.4(0.0)	30.4	0	Undefined	Undefined	Undefined
Clutch 17	1068	23.8–33.0	30.5(0.0)	30.6	360	29.9–32.4	31.1(0.0)	31.0
Clutch 18	993	26.3–35.4	32.1(0.0)	31.7	336	30.6–33.6	31.9(0.0)	31.8
Clutch 19	1016	26.1–34.7	31.8(0.0)	31.6	336	30.4–33.5	31.6(0.0)	31.5
Clutch 20	1016	26.4–35.3	32.2(0.1)	31.9	336	30.6–33.7	31.9(0.0)	31.8
Clutch 21	992	26.5–34.5	32.0(0.0)	31.8	336	30.5–33.8	32.0(0.0)	31.9
Clutch 22	1027	28.3–35.5	32.4(0.0)	32.1	336	31.0–33.4	32.1(0.0)	32.1
Clutch 23	1023	25.8–34.1	31.0(0.0)	30.6	336	29.7–31.6	30.5(0.0)	30.5
Clutch 24	1119	28.6–31.8	30.4(0.0)	30.4	384	28.9–31.5	30.5(0.0)	30.7
Clutch 25	975	26.6–34.0	31.7(0.0)	31.4	336	30.3–32.6	31.4(0.0)	31.4
Clutch 26A	1142	29.5–33.6	30.8(0.0)	30.5	384	29.7–31.9	30.6(0.0)	30.5
Clutch 26B	1142	29.5–33.4	30.9(0.0)	30.5	384	29.8–31.6	30.6(0.0)	30.5
Clutch 27A	1092	29.8–32.4	31.0(0.0)	30.9	360	29.9–31.7	30.9(0.0)	30.9
Clutch 27B	1092	29.8–32.2	30.9(0.0)	30.9	360	29.8–31.4	30.8(0.0)	30.8
Clutch 28	1069	29.8–33.7	31.3(0.0)	30.9	360	30.3–31.8	31.0(0.0)	30.9
Clutch 32A	1269	28.2–31.0	29.7(0.0)	29.6	432	28.5–31.0	30.1(0.0)	30.2
Clutch 32b	1269	28.1–31.0	29.6(0.0)	29.6	432	28.4–31.0	30.0(0.0)	30.2
Clutch 33A	1160	27.1–33.3	30.5(0.0)	30.6	384	29.3–32.0	30.8(0.0)	31.0
Clutch 33B	1183	27.7–33.1	30.4(0.0)	30.4	384	28.7–31.7	30.6(0.0)	30.8
Clutch 33C	1184	26.5–33.0	30.2(0.0)	30.3	384	29.0–31.7	30.6(0.0)	30.7
Clutch 34A	835	27.8–31.0	29.4(0.0)	29.6	0	Undefined	Undefined	Undefined
Clutch 34B	1408	27.7–30.7	29.3(0.0)	29.3	480	27.7–30.6	29.4(0.0)	29.5
Air 1	3676	26.5–34.1	31.1(0.0)	31.2				
Air 2	3676	26.2–33.6	30.7(0.0)	30.8				
Air 3	3676	25.9–32.6	30.1(0.0)	30.0				

Table 6. (Continued)

Control 1	3676	27.5–32.0	30.3(0.0)	30.4
Control 2	3676	26.7–31.6	29.8(0.0)	29.8
Control 3	3676	25.9–30.5	29.0(0.0)	29.1

¹ Air 1 = air probe on top shelf of incubation facility.

Air 2 = air probe on middle shelf of incubation facility.

Air 3 = air probe on bottom shelf of incubation facility.

Control 1 = control box on top shelf of incubation facility.

Control 2 = control box on middle shelf of incubation facility.

Control 3 = control box on bottom shelf of incubation facility.

Table 6a. Temperatures recorded by dataloggers placed in egg incubation boxes at Padre Island National Seashore during 2002.

Temperature Measured	Middle Third of Incubation Period		
	Datalogger#	Range	Mean (S.E.)
Clutch 2	UAB# 208	29.5–31.93	30.72(.028)
Clutch 4A ¹	UAB# 213	--	--
Clutch 4B	UAB# 212	28.7–31.52	30.11(.04)
Clutch 5	UAB# 216	29.1–31.93	30.51(.04)
Clutch 6	UAB# 214	28.7–31.93	30.32(.04)
Clutch 7A	UAB# 186	29.5–32.34	30.92(.04)
Clutch 7B	UAB# 189	29.9–32.76	31.33(.04)
Clutch 8A	UAB# 188	30.31–32.34	31.33(.03)
Clutch 10	UAB# 185	30.31–33.17	31.74(.04)
Clutch 11	UAB# 251	30.71–33.17	31.94(.04)
Clutch 13	UAB# 187	29.9–31.93	30.92(.02)
Clutch 14 ²	UAB# 254	--	--
Clutch 15	UAB# 252	29.9–33.17	31.56(.04)
Clutch 16 ²	UAB# 253	--	--
Clutch 22	UAB# 275	29.9–32.4	31.12(.04)
Clutch 28	UAB# 276	29.9–31.12	30.51(.02)

¹ No temperature data available.

² Nest did not hatch. No temperature data available

Table 7. Lengths and weights of live hatchlings from clutches documented on the Texas coast and hatched in the incubation facility at Padre Island National Seashore during 2002.

Clutch (Species) ¹	N ²	Straight-line Carapace length (mm)			Weight (g)		
		Range	Mean (S.E.)	Median	Range	Mean (S.E.)	Median
1(LK)	74	38.12–43.58	41.14(0.14)	41.24	13.68–18.04	15.98(0.10)	16.10
2(LK)	71	37.50–44.25	41.58(0.16)	41.68	12.73–17.50	15.81(0.14)	16.10
3(LK)	91	39.26–45.89	43.08(0.14)	43.88	14.06–19.22	17.30(0.11)	17.55
4(LK)	110	41.30–46.36	44.29(0.09)	44.42	14.45–18.85	17.26(0.08)	17.37
5(LK)	69	30.10–46.23	43.62(0.26)	43.93	13.87–19.02	17.13(0.14)	17.27
6(LK)	23	39.35–44.29	42.36(0.32)	42.77	13.52–17.33	15.81(0.21)	15.99
7(LK)	101	42.82–46.07	44.65(0.67)	44.72	13.97–17.75	16.64(0.05)	16.66
8(LK)	45	39.38–44.79	42.05(0.21)	42.21	11.90–15.84	13.98(0.16)	13.85
9(LK)	100	39.62–45.92	43.09(0.15)	43.18	13.34–19.23	17.64(0.10)	17.84
10(LK)	75	41.26–46.47	44.06(0.12)	44.04	13.59–16.93	15.61(0.08)	15.63
11(LK)	57	38.94–43.98	41.58(0.16)	41.62	13.22–17.28	15.42(0.13)	15.49
12(LK)	80	37.09–44.32	41.57(0.18)	41.73	10.19–18.11	15.80(0.14)	16.06
13(LK)	42	39.75–45.83	43.15(0.22)	43.47	15.31–20.78	17.41(0.19)	17.26
14(LK) ³	0	Undefined	Undefined	Undefined	Undefined	Undefined	Undefined
15(LK)	92	38.06–44.11	42.06(0.10)	42.15	13.08–16.79	15.25(0.08)	15.23
16(LK) ³	0	Undefined	Undefined	Undefined	Undefined	Undefined	Undefined
17(LK)	107	40.39–44.76	42.84(0.09)	42.95	13.73–17.03	15.57(0.07)	15.71
18(LK)	88	40.96–48.48	43.70(0.13)	43.71	14.64–19.90	16.40(0.09)	16.28
19(LK)	78	37.95–45.10	42.84(0.17)	43.08	12.75–19.99	16.68(0.13)	16.83
20(LK)	79	40.25–45.57	43.74(0.12)	43.92	14.91–19.09	17.40(0.09)	17.51
21(LK)	57	39.03–45.33	42.02(0.21)	42.11	11.98–16.80	14.49(0.16)	14.72
22(LK)	76	40.51–47.11	44.06(0.15)	44.16	14.42–19.85	17.83(0.12)	18.04
23(LK)	83	41.56–45.48	43.70(0.10)	43.77	13.66–18.30	16.10(0.09)	16.14
24(LK)	33	38.22–45.35	42.75(0.28)	42.91	13.63–17.50	15.25(0.16)	15.23
25(LK)	75	36.39–44.12	40.92(0.18)	41.28	11.17–20.01	15.00(0.19)	14.97
26(CM)	87	51.20–56.86	54.11(0.13)	54.21	26.48–31.92	29.97(0.09)	29.98
27(LK)	56	36.39–42.88	40.25(0.21)	40.22	11.17–16.03	14.02(0.14)	13.89
28(LK)	72	38.76–45.18	42.73(0.15)	42.77	13.01–17.99	15.31(0.13)	15.19
29(LK) ⁴	0	Undefined	Undefined	Undefined	Undefined	Undefined	Undefined
30(LK) ⁴	0	Undefined	Undefined	Undefined	Undefined	Undefined	Undefined
31(LK) ⁴	0	Undefined	Undefined	Undefined	Undefined	Undefined	Undefined
32(LK)	3	44.73–47.35	46.24(0.78)	46.64	19.81–21.62	20.68(0.52)	20.61
33(CM)	102	48.22–55.75	53.24(0.12)	53.11	24.73–32.68	29.66(0.12)	29.57
34(CC)	7	44.98–49.96	47.34(0.77)	46.84	21.79–23.66	22.89(0.28)	23.14

¹ LK = Kemp's ridley, CM = green, CC = loggerhead.

² N = number measured.

³ Clutches 14 and 16 were 100% infertile.

⁴ Clutches 29–31 not incubated at PAIS.

Table 8a. Results of analyses of unhatched Kemp's ridley eggs^{1,2} and histological sex determination for Kemp's ridley clutches documented on the Texas coast during 2002.

Parameter	Clutch														
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
<u>Analyses of unhatched eggs</u>															
no. unhatched	17	21	7	5	21	62	8	67	2	11	43	21	40	102	4
no. infertile	2	1	0	0	1	0	2	1	0	1	0	0	31	102	0
no. fertile w/o embryos	6	1	6	1	7	21	5	4	1	8	1	14	6	0	1
no. decomposed embryos	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
no. stage 8 embryos	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0
no. stage 9 embryos	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0
no. stage 10 embryos	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
no. stage 11 embryos	0	0	0	0	1	0	0	0	0	0	0	1	2	0	0
no. stage 12 embryos	0	0	0	0	0	6	0	0	0	0	0	0	0	0	0
no. stage 13 embryos	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0
no. stage 14 embryos	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
no. stage 15 embryos	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0
no. stage 16 embryos	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
no. stage 17 embryos	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0
no. stage 18 embryos	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
no. stage 19 embryos	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
no. stage 20 embryos	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0
no. stage 21 embryos	0	0	0	0	0	0	0	0	0	0	1	0	0	0	1
no. stage 22 embryos	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
no. stage 25 embryos	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0
no. stage 26 embryos	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
no. stage 27 embryos	1	1	0	0	0	10	0	6	0	0	5	0	0	0	0
no. stage 28 embryos	0	0	0	1	0	7	0	4	0	0	2	0	0	0	0
no. stage 28-29 embryos	1	5	0	0	2	6	0	11	0	1	12	0	0	0	0
no. stage 29 embryos	3	4	0	0	2	3	0	11	0	0	9	2	0	0	0
no. stage 29-30 embryos	2	3	0	1	1	2	0	7	0	0	5	0	1	0	0
no. stage 30 embryos	3	6	0	2	5	3	1	22	1	1	7	4	0	0	1
no. stage 30-31 embryos	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
<u>Number of dead hatchlings</u>	0	3	1	1	0	2	0	1	0	2	5	1	0	0	0
<u>Histological sex determination for late-staged embryos and dead hatchlings</u>															
no. specimens collected	9	21	1	5	10	22	1	53	1	4	39	7	1	0	1
no. analyzed ³	9	19	1	4	8	9	1	19	1	3	9	7	0	0	1
no. males	0	3	0	0	1	0	0	1	0	0	0	0	0	0	0
no. females	7	14	0	3	6	8	0	18	1	3	8	6	0	0	0
no. unknown	3	2	1	1	1	1	1	0	0	0	1	1	0	0	0

¹ Cratz (1982) was used to categorize embryological stage of development at death.

² Twins (stage 27 and stage 30) were found in one egg from clutch 1.

Table 8a. (Continued)

³ Specimens collected but not analyzed were either too decomposed to analyze or more samples than needed to verify the clutch sex ratio.

Table 8b. Results of analyses of unhatched Kemp's ridley eggs^{1,2} and histological sex determination for Kemp's ridley clutches documented on the Texas coast during 2002.

Parameter	Clutch													
	16	17	18	19	20	21	22	23	24	25	27	28	31	32
<u>Analyses of unhatched eggs</u>														
no. unhatched	70	6	17	9	26	46	20	12	45	46	58	11	2	109
no. infertile	70	0	0	0	0	0	1	1	0	0	4	4	0	106
no. fertile w/o embryos	0	4	9	2	12	4	1	8	24	8	16	4	1	3
no. decomposed embryos	0	0	0	0	0	0	0	1	0	1	0	2	1	0
no. stage 8 embryos	0	0	2	0	0	0	0	0	0	0	1	0	0	0
no. stage 9 embryos	0	0	0	1	0	0	0	0	0	0	0	0	0	0
no. stage 10 embryos	0	0	0	0	0	0	0	1	0	0	0	0	0	0
no. stage 11 embryos	0	1	1	0	0	1	0	0	1	0	0	0	0	0
no. stage 12 embryos	0	0	1	0	0	0	0	0	0	0	0	0	0	0
no. stage 13 embryos	0	0	0	0	0	0	0	0	0	0	0	0	0	0
no. stage 14 embryos	0	0	1	0	0	0	0	1	0	0	0	0	0	0
no. stage 15 embryos	0	0	0	0	0	0	0	0	0	0	0	0	0	0
no. stage 16 embryos	0	0	0	0	0	0	0	0	1	0	0	0	0	0
no. stage 17 embryos	0	0	0	0	0	0	0	0	1	0	0	0	0	0
no. stage 18 embryos	0	0	1	0	0	0	0	0	3	0	0	0	0	0
no. stage 19 embryos	0	0	0	0	0	0	0	0	2	0	0	0	0	0
no. stage 20 embryos	0	0	0	0	0	0	0	0	0	0	1	0	0	0
no. stage 21 embryos	0	0	1	0	0	0	0	0	0	0	1	0	0	0
no. stage 22 embryos	0	0	0	0	0	0	0	0	1	0	1	0	0	0
no. stage 25 embryos	0	0	0	0	0	1	0	0	0	0	0	0	0	0
no. stage 26 embryos	0	0	0	0	0	0	0	0	0	0	0	0	0	0
no. stage 27 embryos	0	0	0	0	1	4	1	0	0	2	1	0	0	0
no. stage 28 embryos	0	0	0	0	2	2	0	0	0	1	1	0	0	0
no. stage 28-29 embryos	0	1	1	0	3	10	3	0	5	6	4	1	0	0
no. stage 29 embryos	0	0	0	1	3	7	4	0	0	4	5	0	0	0
no. stage 29-30 embryos	0	0	0	0	1	3	0	0	5	2	4	0	0	0
no. stage 30 embryos	0	0	0	5	3	13	10	0	2	21	17	0	0	0
no. stage 30-31 embryos	0	0	0	0	1	1	1	0	0	1	3	0	0	0
<u>Number of dead hatchlings</u>	0	1	0	2	5	2	4	0	0	5	2	0	13	0
<u>Histological sex determination for late-staged embryos and dead hatchlings</u>														
no. specimens collected	0	2	1	8	18	38	22	0	10	37	37	1	3	0
no. analyzed ³	0	2	1	8	13	12	19	0	10	19	39	1	3	0
no. males	0	1	0	2	0	0	0	0	2	1	1	0	0	0
no. females	0	1	1	5	13	12	17	1	7	18	5	1	3	0
no. unknown	0	0	0	1	0	0	2	0	1	0	6	0	0	0

¹ Cratz (1982) was used to categorize embryological stage of development at death.

Table 8b. (Continued)

² Twins (stage 30–31 and dead hatchling) were found in one egg from clutch 22. Twins (stage 20 and 22) were found in one egg from clutch 27.

³ Specimens collected but not analyzed were either too decomposed to analyze or more samples than needed to verify the clutch sex ratio.

Table 8c. Results of analyses of unhatched Kemp's ridley eggs¹ and histological sex determination for Kemp's ridley clutches documented on the Texas coast during 2002.

Parameter	Clutch						
	S1	S2	S3	S4	S5	S6	S7
<u>Analyses of unhatched eggs</u>							
no. unhatched	12	31	42	22	4	20	52
no. decomposed	0	9	1	1	0	0	0
no. infertile	0	3	0	2	1	1	4
no. fertile w/o embryos	6	6	4	12	0	7	15
no. stage 9 embryos	0	0	0	0	0	0	1
no. stage 11 embryos	0	0	0	0	0	0	5
no. stage 12 embryos	0	0	0	0	0	1	2
no. stage 13 embryos	0	0	0	0	0	0	1
no. stage 14 embryos	0	0	0	0	0	1	2
no. stage 15 embryos	0	0	0	0	0	0	2
no. stage 17 embryos	0	0	1	0	1	0	0
no. stage 18 embryos	0	1	0	0	0	0	1
no. stage 21 embryos	0	0	0	0	1	0	0
no. stage 22 embryos	0	0	0	1	0	0	0
no. stage 25 embryos	0	0	0	0	0	0	1
no. stage 26 embryos	0	0	0	1	0	0	0
no. stage 27 embryos	0	0	0	0	0	1	1
no. stage 28 embryos	0	0	0	1	0	0	0
no. stage 28-29 embryos	0	5	0	1	0	0	6
no. stage 29 embryos	0	5	1	0	0	6	6
no. stage 29-30 embryos	0	1	8	1	0	1	0
no. stage 30 embryos	0	1	27	2	1	2	5
<u>Number of dead hatchlings</u>	0	2	12	0	0	1	5
<u>Histological sex determination for late-staged embryos and dead hatchlings</u>							
no. specimens collected	0	11	35	5	1	11	21
no. analyzed ³	0	6	12	3	1	9	9
no. males	0	0	0	0	0	0	0
no. females	0	6	12	3	1	7	9
no. unknown	0	0	0	0	0	2	0

¹ Cratz (1982) was used to categorize embryological stage of development at death.

² Included in analyses of unhatched eggs were 6 eggs from clutch S1 that were not examined due to predation by ghost crabs in corral incubation.

³ Specimens collected but not analyzed were either too decomposed to analyze or more samples than needed to verify the clutch sex ratio.

Table 9. Results of analyses of unhatched loggerhead and green turtle eggs¹ and histological sex determination for loggerhead and green turtle clutches documented on the Texas coast during 2002.

Parameter	Clutch		
	26	33	34
<u>Analyses of unhatched eggs</u>			
No. unhatched	9	41	5
No. decomposed w/ no white spot	0	0	3
No. infertile	1	2	0
No. fertile w/o embryos	8	5	0
No. stage 19 embryos	0	1	0
No. stage 23 embryos	0	1	0
No. stage 28 embryos	0	1	0
No. stage 29 embryos	0	31	2
<u>Number of dead hatchlings</u>	0	0	0
<u>Histological sex determination for late-staged embryos and dead hatchlings</u>			
No. specimens collected	0	26	2
No. analyzed ²	--	--	--
No. males	--	--	--
No. females	--	--	--
No. unknown	--	--	--

¹ Miller (1985) was used to categorize embryological stage of development at death.

² Specimens collected but not analyzed were either too decomposed to analyze or more samples than needed to verify the clutch sex ratio.

Table 10. Deformed embryos from sea turtle clutches documented on the Texas coast during 2002.

Clutch (Species) ¹	Stage	Deformities Observed and Comments
1(LK)	27 & 30	Dead embryo – twins with yolk shared
6(LK)	20	Dead embryo – top jaw short, eyes poorly developed
13(LK)	29–30	Dead embryo – missing egg tooth, upper jaw short, no eyes
20(LK)	28–29	Dead embryo – jaws crossed
	29	Dead embryo – jaws crossed
22(LK)	31 & 30–31	Dead embryo and dead hatchling – twins, stage 31 is dead hatchling
24(LK)	29–30	Dead embryo – rear flipper on top of head, inverted backwards
	29–30	Dead embryo – carapace shortened
	29–30	Dead embryo – internal organs, including liver outside of abdomen
	17	Dead embryo – cleft in upper jaw
	18	Dead embryo – missing right portion of carapace, bones protruding
27(LK)	28–29	Dead embryo – soft section on plastron
	29	Dead embryo – partial albino, entirely white except tips of flippers, no eyes, crossed jaws, no egg tooth
	28–29	Dead embryo – partial albino, half white and half black, white on underside
	28	Dead embryo – no lower jaw, protrusion of soft skin through top of skull, left front flipper bifurcated, partial albino, half black and half white, white on underside
	28–29	Dead embryo – bump on head, no eyes, no lower jaw
	20 & 22	Dead embryo – twins
33(CM)	29	Dead embryo – posterior of carapace missing, plastron curled backwards to partially for a carapace, white at rear, rear flippers close together and folded on top of each other, left front flipper with indentation posterior to claw, liver and several organs protruding through abdomen into the yolk sac
	29	Dead embryo – fatty liver outside of abdomen and protruding through
S5(LK)	30	Dead embryo – spot on top of head where skin missing, uncovering most of top of head
S7(LK)	28–29	Dead embryo – partial albino, pigment on tips of flippers, body is inverted, rear flippers on head, left front flipper is short, no eyes, no egg tooth, upper jaw is short
	18	Dead embryo – no eyes

¹ LK = Kemp's ridley, CC = loggerhead, CM = green.

Table 11. Estimated sex ratios for sea turtle clutches documented on the Texas coast during 2002.

Clutch (Species) ¹	Estimated % Female Based on Temperature ²	Estimated % Female Based on Incubation Period ³	Identified % Female Based on Histology ⁴
1(LK)	97.2	100	70
2(LK)	97.2	100	73.7
3(LK)	97.2	100	--
4(LK)	92.8 & 79.4	100 & 100	75.0
5(LK)	97.2	100	75.0
6(LK)	92.6	84.5	88.9
7(LK)	100 & 100	69.9 & 69.9	--
8(LK)	100 & 100	69.9 & 69.9	94.7
9(LK)	100	100	100
10(LK)	100	99.1	100
11(LK)	100	100	88.8
12(LK)	100	100	85.7
13(LK)	100	84.5	--
14(LK)	--	--	--
15(LK)	100	100	--
16(LK)	--	--	--
17(LK)	92.8	99.1	50
18(LK)	100	100	100
19(LK)	100	100	62.5
20(LK)	100	100	100
21(LK)	100	100	100
22(LK)	100	100	89.5
23(LK)	65.9	100	100
24(LK)	65.9	69.9	70.0
25(LK)	100	100	94.7
26(CM)	--	--	--
27(LK)	83.8 & 79.4	84.5 & 84.5	66.7
28(LK)	88.3	99.1	100
29(LK)	--	--	--
30(LK)	--	--	--
31(LK)	--	--	100
32(LK)	48.1 & 43.6	0.0 & 0.0	--
33(CM)	--	--	--
34(CC)	--	--	--
S1(LK) ⁶	--	--	--
S2(LK) ⁶	--	--	100
S3(LK) ⁶	--	--	100
S4(LK) ⁶	--	--	100
S5(LK) ⁶	--	--	100
S6(LK) ⁶	--	--	77.8
S7(LK) ⁶	--	--	100
Overall			
<i>L. kempii</i>	86.9	84.8	87.9
<i>C. caretta</i>	--	--	--
<i>C. mydas</i>	--	--	--

Table 11. (Continued)

¹ LK = Kemp's ridley, CC = loggerhead, CM = green.

² Calculated using equation relating % female and mean middle third of incubation period temperature for Kemp's ridley ($Y = -1297.8747 + 44.7152X$) (Shaver et al., 1988b).

³ Calculated using equation relating % female and incubation period for Kemp's ridley ($Y = 772.343 - 14.634X$) (Shaver, 1989a).

⁴ Calculated based on results of histological analyses of gonads from dead hatchlings and late-staged embryos (see Tables 8 and 9 for sample sizes analyzed).

⁵ Mean for the 31 Kemp's ridley, one loggerhead, and two green clutches from which samples were analyzed.

⁶ Nests incubated in a corral on South Padre Island and Boca Chica Beach. No temperature data was available.

Table 12. Sea turtles found stranded along the Texas coast during 2002¹.

Species ²	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sep.	Oct.	Nov.	Dec.	Total
CC	7	5	7	20	11	4	23	25	2	15	6	5	130
LK	2	2	4	23	11	3	20	13	1	4	4	3	90
CM	11	3	0	6	5	6	8	4	1	2	9	8	63
DC	0	0	1	5	9	0	1	0	0	0	0	0	16
EI	2	0	1	2	13	11	8	8	0	0	1	1	47
UN	0	0	0	1	0	0	3	2	0	0	1	0	7
Total	22	10	13	57	49	24	63	52	4	21	21	17	353

¹ Hatchlings and post-hatchlings are included, but head-started individuals are excluded.

² CC = loggerhead, LK = Kemp's ridley, CM = green, DC = leatherback, EI = hawksbill, UN = unknown.

Table 13. Head-started Kemp's ridley sea turtles found stranded along the Texas coast during 2002.

Species ¹	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sep.	Oct.	Nov.	Dec.	Total
LK	0	0	0	0	0	0	0	0	0	0	0	0	0

¹ LK = Kemp's ridley.

Table 14. Sea turtle hatchlings and post-hatchlings (<10.0cm SLCL) found stranded on the Texas coast during 2002.

I.D.	Sp. ¹	SLCL (cm)	SLCW (cm)	CCL (cm)	CCW (cm)	Weight (g)	Location ²	Date	Sex ³	Comments ⁴
EI-02-03	EI	8.8	7.0	9.6	8.7	81.6	MI,	20 May	U	ep, g
EI	EI	7.1	6.0	7.8	6.7	-	NPI, PAIS	2 June	U	wu
LK-02-22 ⁵	LK	4.4	3.8	4.6	4.8	16.2	MI	1 July	U	et, us
LK-02-23 ⁵	LK	4.1	3.8	4.5	4.7	14.9	MI	1 July	F	et, us, wf
LK-02-25 ⁵	LK	4.4	3.8	4.7	4.8	17.8	MI	1 July	U	et, us
LK-02-26 ⁵	LK	4.2	3.8	4.4	4.5	16.2	MI	1 July	M	et, us, y
LK ⁵	LK	3.9	3.1	4.3	4.3	13.4	NPI, North of PAIS	1 July	U	et, y
LK-02-24 ⁵	LK	3.8	3.2	-	-	11.9	NPI, North of PAIS	1 July	U	et, us, y
LK-02-21 ⁵	LK	4.1	3.3	-	-	13.2	NPI, North of PAIS	1 July	U	et, us, wf
LK-02-27 ⁶	LK	3.8	2.8	-	-	11.6	NPI, North of PAIS	2 July	U	y
LK-02-28 ⁶	LK	3.8	3.1	4.4	4.0	12.2	MI	2 July	U	et, us, y
LK-02-43	LK	4.3	3.6	4.5	4.4	14.0	MI	3 July	F	et, us
LK-02-42	LK	4.1	3.6	4.3	4.4	14.8	MI	3 July	F	et, us
LK-02-44	LK	4.3	3.6	4.7	4.5	15.6	MI	3 July	F	et, us, wf
LK ⁷	LK	4.4	3.5	-	-	30.0	SPI	4 July	U	-
LK ⁷	LK	4.4	3.5	-	-	30.0	SPI	4 July	U	-
LK	LK	4.2	3.8	4.3	4.5	15.6	NPI, North of PAIS	7 July	U	wf
LK-02-46	LK	5.1	4.5	5.7	5.7	26.9	MI	8 July	F	wf, g
LK-02-41	LK	4.4	3.7	4.7	4.4	14.9	NPI, North of PAIS	10 July	F	et, us, wf
LK	LK	4.7	4.0	4.9	4.7	18.9	MI	24 July	U	wf
LK-02-45	LK	3.8	3.0	4.3	4.1	12.0	MI	26 July	F	et, us, y
LK	LK	4.8	4.4	5.1	4.9	19.1	MI	28 July	U	ep, wf
LK	LK	8.9	5.7	-	-	-	NPI, PAIS	31 July	U	wu
EI-02-07	EI	5.9	4.6	6.1	5.6	27.2	NPI, PAIS	6 Aug.	U	-
EI-02-09	EI	5.2	4.7	5.7	5.5	23.9	NPI, North of PAIS	12 Aug.	U	ep, wf, g
EI	EI	5.1	4.6	-	-	-	GI	13 Aug.	U	wf
LK ⁸	LK	3.9	3.5	4.0	4.2	13.1	NPI, North of PAIS	14 Aug.	U	wu
LK-02-67 ⁸	LK	4.3	3.9	4.5	4.4	13.6	MI	15 Aug.	U	wf
EI	EI	6.7	5.0	7.0	5.5	45.0	SPI	16 Aug.	U	-
EI	EI	5.6	4.5	6.0	5.5	29.0	MI	17 Aug.	U	ep
EI	EI	6.1	5.0	6.8	6.3	34.8	NPI, North of PAIS	17 Aug.	U	ep, wf
LK-02-66	LK	4.3	4.1	-	-	14.9	NPI, PAIS	17 Aug.	U	ep, et, wf
EI-02-08	EI	5.1	4.1	6.0	5.5	26.5	MI	18 Aug.	U	ep
LK	LK	4.7	4.0	-	-	14.3	NPI, PAIS	18 Aug.	U	ep
LK-02-65	LK	4.8	4.6	5.1	5.1	14.5	MI	22 Aug.	U	g
LK	LK	5.0	4.7	5.2	5.4	19.0	MI	22 Aug.	U	wf
EI	EI	5.8	4.8	6.2	5.9	30.2	MI	24 Aug.	U	wh
LK	LK	4.9	4.6	5.5	5.4	20.9	MI	24 Aug.	U	wh
2002-33-35 ⁹	CM	5.2	3.8	5.6	4.6	22.1	MI	18 Sep.	U	y
LK	LK	6.4	5.8	6.8	6.7	41.7	MI	4 Oct.	U	wh,
LK	LK	8.0	7.0	8.0	7.5	100.0	SPI	6 Nov.	U	wh

¹ EI = hawksbill, LK = Kemp's ridley, CC = loggerhead, CM = green.

² MI = Mustang Island, NPI = North Padre Island, PAIS = Padre Island National Seashore, GI = Galveston Island, SPI = South Padre Island.

³ U = unknown, F = female, M = male.

⁴ et = egg tooth, ep = epizoan, wf = fresh external wounds, wh = healed external wounds, wu = wounds (unknown fresh or healed), g = gut contents present (not all were examined for gut content), y = internal yolk, us = umbilical scar.

⁵ Likely from clutches 10, 11, or 12. Possibly stranded due to intense wave action during release.

⁶ Possibly from an undetected clutch that was laid in south Texas.

⁷ Likely from clutch S2.

⁸ From clutch 27.

⁹ From clutch 33, died same day.

