

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

2001 Report



U.S. Department of the Interior
U.S. Geological Survey
Padre Island Field Research Station

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2001 Report

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In cooperation with National Park Service, Padre Island National Seashore

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ABSTRACT

U.S. Geological Survey and National Park Service employees and volunteers conducted patrols repeatedly each day to detect sea turtle nesting on North Padre Island [including Padre Island National Seashore (PAIS)] from 1 April through 20 July 2001. During 2001, 9,604 hours were spent patrolling the 125 km length of North Padre Island beachfront for a total of 135,059 km patrolled. From April through early August 2001, 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 2,022 hours patrolling 23,379 km on South Padre Island and Boca Chica Beach during 2001. 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.

Eleven sea turtle nests were confirmed on the Texas coast during 2001. The 11 included eight Kemp's ridley (*Lepidochelys kempii*) and three loggerhead (*Caretta caretta*) nests. One of the Kemp's ridley nests was found on Mustang Island, four on North Padre Island (including three at PAIS), two on South Padre Island, and one on Boca Chica Beach. Two of the loggerhead nests were located on North Padre Island (including one at PAIS) and one on South Padre Island. Only one other confirmed Kemp's ridley nest was located in the U.S. during 2001 and that nest was found in Alabama.

Nesting females were examined at four of the eight Kemp's ridley nests found on the Texas coast during 2001. Two of the four nests were from nesting turtles that were part of the experimental imprinting and head-starting project, including one nesting female that had been hatched in 1984 (1984 year-class) and documented nesting on the Texas coast in 1998 and one nesting female that had been hatched in 1987 and had not been documented nesting previously. The other two nesting Kemp's ridleys that were examined were not conclusively linked to the experimental imprinting and head-starting project; one of these two had been tagged while nesting on the Texas coast in 1999 and the other had no tags. At the other four Kemp's ridley nest sites, the nesting turtles

re-entered the water before biologists arrived and hence were not examined for tags.

Satellite transmitters were applied to three of the Kemp's ridley turtles that nested on North Padre Island in April and May 2001. By mid-June 2001, all had moved northward and then eastward within Gulf of Mexico waters. As of December 31, 2001, the three transmitters were still functioning and the turtles were located in the northern Gulf of Mexico.

Eggs from seven of the 11 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 76.9% for the 542 Kemp's ridley eggs (five nests) held in the incubation facility and 411 hatchlings were released. The hatching and emergence rates were 92.5% for the 226 loggerhead eggs (two nests) held in the incubation facility and 209 hatchlings were released.

The four sea turtle clutches laid on South Padre Island and Boca Chica Beach were transferred to a protective corral located on Boca Chica Beach and the resulting hatchlings were released there. The hatching and emergence rates were 58.6% for the 295 Kemp's ridley eggs (three nests) incubated in the corral and 173 hatchlings were released. The hatching and emergence rates were 63.3% for the 79 loggerhead eggs (one nest) incubated in the corral and 50 hatchlings were released.

During 2001, 397 wild (non-head-started) sea turtles were located stranded along the Texas coast. Among the 397 were 115 Kemp's ridley, 165 loggerhead, 73 green (*Chelonia mydas*), six leatherback (*Dermochelys coriacea*), 30 hawksbill (*Eretmochelys imbricata*), and eight turtles of unknown species. Of the 115 Kemp's ridleys, 25 were adults (≥ 60.0 cm straight-line carapace length). Twenty-two hatchlings and post-hatchlings (< 10.0 cm straight-line carapace length) were found stranded along the Texas coast during 2001, between 18 May and 17 November, including one loggerhead, three Kemp's ridleys, and 18 hawksbills. It is unlikely that any of the 22 were from south Texas nests.

In addition to the 397 wild sea turtles, two head-started Kemp's ridley turtles were located stranded on the Texas coast during 2001. One of the two was an adult from the 1985 year-class that had been experimentally imprinted to PAIS and head-started. The other was a juvenile (31.4 cm straight-line carapace length) that had been head-started but not experimentally imprinted to PAIS.

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BACKGROUND

Most Kemp's ridley turtles (*Lepidochelys kempii*) nest on the Gulf of Mexico coast in the vicinity of 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 south Texas (Shaver, 1989a; 1992a; 1995a). Also, 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 south Texas. During the last two decades, most Kemp's ridley nests located in the U.S. have been found in south 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).

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, I maintain 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 2001. 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 2001. This effort on North Padre Island was conducted by the U.S. Geological Survey (USGS) and National Park Service (NPS) 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 2001.

From 1 April through 20 July 2001, USGS and NPS employees and volunteers conducted patrols along North Padre Island. The 125 km long 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 135,059 km of patrol distance was logged on North Padre Island during 2001, slightly less than the patrol distance recorded there in 2000 (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 2001 totals. Four-wheel drive trucks, sport utility vehicles, and sedans 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 2001 patrol totals. During the 2001 nesting patrol season, 9,604 hours were spent patrolling on North Padre Island, slightly less than during 2000 (Fig. 2). Patrol hours were split between employees (6,041 hours) and volunteers (3,563 hours) (Fig. 2).

Systematic patrols to detect nesting were also conducted on South Padre Island and Boca Chica Beach during 2001; 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 early-August, 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 2,022 hours were spent patrolling approximately 23,379 km on South Padre Island and Boca Chica Beach.

The USGS 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

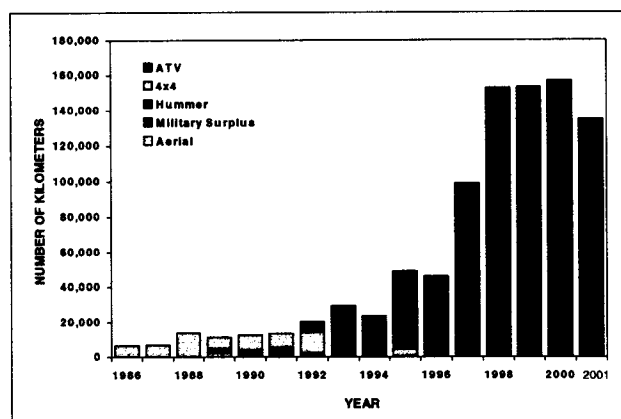


Figure 1. Number of kilometers patrolled on North Padre Island, Texas from 1986-2001.

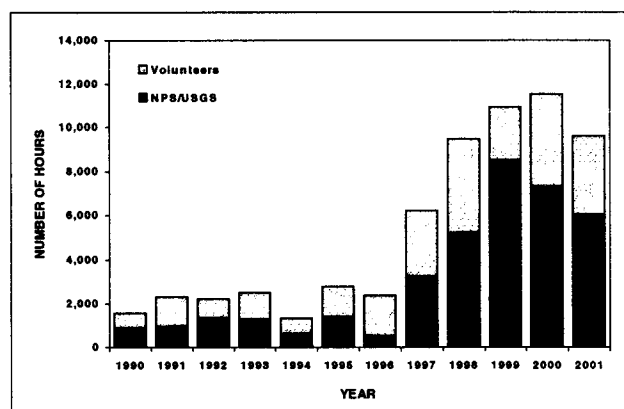


Figure 2. Number of hours various groups spent conducting patrols on North Padre Island, Texas from 1990-2001.

for work or recreation during 2001. 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.

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 report live sea turtle sightings immediately, 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 I wrote a bi-weekly column for a local newspaper detailing the sea turtle work.

The public was invited to attend three of the hatchling releases held at PAIS during 2001 and, cumulatively, over 1,000 visitors attended. A 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 my 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

USGS employees led investigation of all nesting sea turtles and most suspected nest sites detected by turtle patrollers and the public on the Texas coast during 2001, and many other entities assisted with these efforts.

Kemp's ridley turtles found nesting (or suspected of nesting) on the south Texas coast were examined 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, which was used to indicate the number of remaining clutches that would be laid during that season by that individual. Some 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 on the Texas coast during 2001. Eggs found on North Padre Island and Mustang 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 and Boca Chica Beach were transferred to a corral located on Boca Chica Beach.

CONFIRMED NESTS AND NON-NESTING EMERGENCES

Confirmed nests

Eleven sea turtle nests were detected on the Texas coast during 2001, from 24 April through 8 July (Table 1). Among the 11 were eight Kemp's ridley nests located between 24 April and 30 June and three loggerhead nests located between 11 May and 8 July. The 11 nests included one Kemp's ridley located on Mustang Island, four Kemp's ridley and two loggerhead on North Padre Island (including three Kemp's ridley and one loggerhead at PAIS), two Kemp's ridley and one loggerhead on South Padre Island, and one Kemp's ridley on Boca Chica Beach.

The eight confirmed Kemp's ridley nests documented during 2001 were fewer than the 12 during 2000, 16 during 1999, 13 during 1998, and nine during 1997. The 16 nests documented in 1999 were the highest number of Kemp's ridley nests documented during a single year (Shaver, 2000). Sixty-seven confirmed Kemp's ridley nests were located on the Texas coast from 1979-2000. Prior to 2000, there was an increase in the number of confirmed Kemp's ridley nests during each of the preceding five years. That increase in the number of nests detected from 1995 through 1999 may have reflected increased nesting, improved detection efforts, increased awareness and reporting by the public, or a combination of all of these factors (Shaver and Caillouet, 1998; Shaver, 2000; 2001). The decrease in the number of detected nests in 2000 and

2001 could have been due to the large amounts of *Sargassum* sp. that covered the beach and made track detection extremely difficult. However, the decrease could reflect a reduction in nesting on the Texas coast, since a negative trend in the number of Kemp's ridley nests standardized for patrol effort, began before 2000 (Fig. 3).

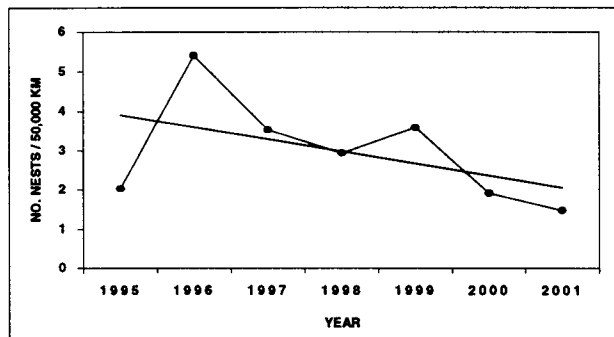


Figure 3. Number of Kemp's ridley nests per 50,000 km patrolled on the Texas coast from 1995-2001.

A Kemp's ridley nest was located in Alabama on 26 May 2001 (Celeste South, personal communication) and this was the only other Kemp's ridley nest documented in the U.S. that year.

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

The nesting Kemp's ridley turtles were measured and examined for tags at four of the eight confirmed Kemp's ridley nests found during 2001 (Tables 2, 3). SLCL for the four nesting individuals measured ranged from 61.9 to 64.8 cm. Two of the nesting Kemp's ridleys that were examined were not conclusively linked to the experimental imprinting and head-starting project; one of these two had been tagged while nesting on the Texas coast in 1999 and the other had no tags or tag scars. The other two nesting turtles examined were part of the experimental imprinting and head-starting project, including one nesting female that had been hatched in 1984 (1984 year-class) and documented nesting on the Texas coast in 1998 and one nesting female that had been hatched in 1987 and had not been documented nesting previously. To date, 10 turtles from the project have been documented laying a total of 16 clutches of eggs on the Texas coast (Shaver, 1996a; 1996b; 1997a;

1997b; 1998a; 1999a; 2000; 2001).

Confirmed non-nesting emergences

Six non-nesting emergences were documented on the Texas coast during 2001 (Table 4). The turtles were not observed at five of the sites. At one site on North Padre Island, a patroller saw an adult Kemp's ridley from the 1986 year-class that had been hatched at PAIS in 1986, experimentally imprinted to PAIS and head-started; 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 2001

During 2001, none of the four nesting Kemp's ridleys examined were documented nesting more than once and the Kemp's ridley examined during a non-nesting emergence was never found nesting. Blood samples were obtained from four of these five turtles and the serum testosterone levels for these four ranged from 2.9 to 32.1 pg/ml (Table 3). 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 testosterone levels were relatively low, and none of these turtles were observed nesting again, although it is possible that the mothers of clutches 1 and 3 nested again, but were not detected.

Since the nesting turtles were not present or examined at four of the eight Kemp's ridley nests and two of the three loggerhead nests documented during 2001, 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 2001 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, personal communication). The number of individual Kemp's ridley turtles that might have laid the eight confirmed Kemp's ridley clutches on the Texas coast during 2001 ranges from a minimum of four to a maximum of eight. The three loggerhead clutches located on the Texas coast in 2001 could have been laid by the same individual, so from one to three loggerhead turtles laid these three

clutches.

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 three Kemp's ridley turtles that nested in south Texas in 2001. Also tracked during this study were two turtles that nested in south Texas in 1997, four in 1998, six in 1999, and three in 2000. 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 three turtles selected for tracking during 2001 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 three transmitters (24858, 29350, 29351) were attached with the antenna positioned to the anterior. After transmitter attachment, all three of the turtles were released on Closed Beach at PAIS, approximately 2 km east of the Turtle Laboratory. Two of the turtles (24858 and 29351) were released on the same day that they nested and one (29350) was 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). 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 three transmitters through December 2001. Based on the accepted locations, all three 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). The last locations identified for transmitters 24858 and 29350 were off Louisiana and for 29351 off the panhandle of Florida.

Transmitter 29351 was attached to the mother of clutch 1 on 24 April 2001. This turtle remained in south Texas from 24 April through 16 May (Fig. 4). Based on observations, tracked movements, and serum testosterone data, it appears that this turtle may have nested again on the northern end of Mustang Island or southern end of San Jose Island between 14-16 May 2001, but a second nest was not confirmed for her. Following a few days of receiving no tracking locations for this turtle, a tracking location was identified at the northern end of Mustang Island on 16 May, near where she nested twice in 1998. A Port Aransas, Texas Animal Control worker observed a sea turtle with a transmitter crawling on the beach at the northern end of Mustang Island on 14 May, but did not examine it closely, photograph it, or report it for over a week. It was very breezy from 14-16 May; four non-nesting emergencies were documented on North and South Padre Islands on 15 May; and a confirmed Kemp's ridley nest was located on North Padre Island on 16 May (Tables 1, 4). After 16 May, this turtle moved northward and remained in the northern Gulf of Mexico through the end of this reporting period (December 31, 2001).

Transmitter 24858 was attached to the mother of clutch 3 on 16 May 2001. Based on movements and serum testosterone data, it appears that this turtle may have nested again in south Texas during 2001. She may have nested sometime between 8-16 June, when she was in the vicinity of her original nesting site. She left south Texas waters on about 17 June 2001, traveled to waters off Louisiana, and remained there through the end of this reporting period (Fig. 5).

Transmitter 29350 was attached to the mother of clutch 4 on 20-21 May 2001. Based on movements and serum testosterone data, it is unlikely that this turtle nested again in south Texas during 2001. She left south Texas waters in late-June 2001, traveled to waters off Louisiana, and remained there through the

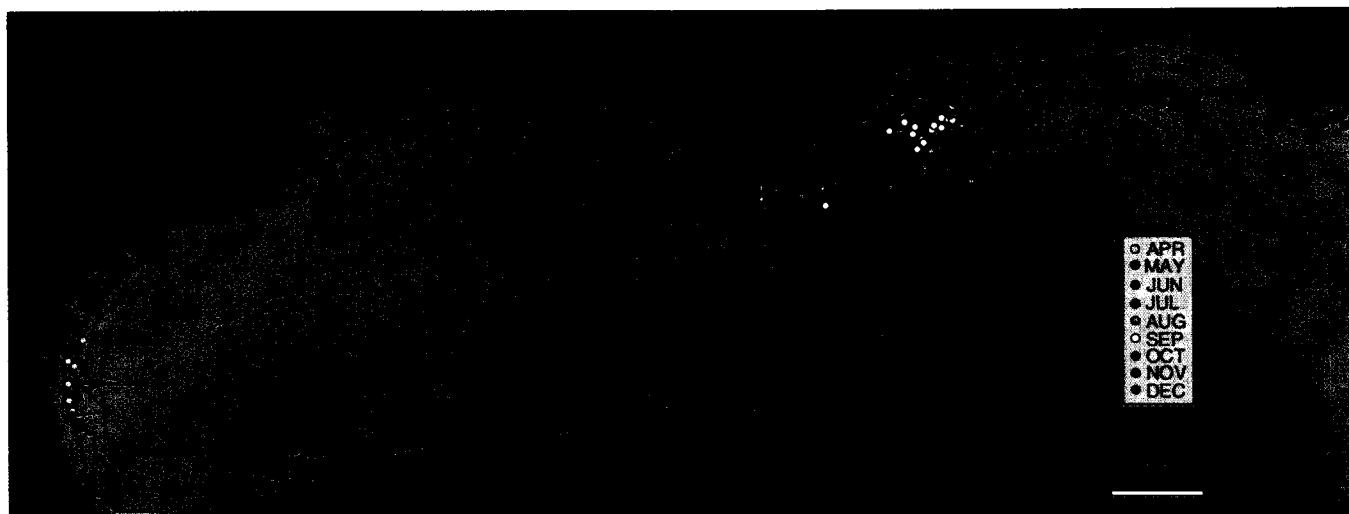


Figure 4. Movements of a Kemp's ridley sea turtle after deployment of transmitter 29351, 24 April 2001 – 31 December 2001.



Figure 5. Movements of a Kemp's ridley sea turtle after deployment of transmitter 24858, 16 May 2001 – 31 December 2001.



Figure 6. Movements of a Kemp's ridley sea turtle after deployment of transmitter 29350, 21 May 2001 – 31 December 2001.

end of this reporting period (Fig. 6).

SEA TURTLE EGG INCUBATION TECHNIQUES

USGS biological technician Toni Torres found the four sea turtle nests on South Padre Island and Boca Chica Beach while on patrol, excavated the nests, placed the eggs into the corral on Boca Chica Beach, 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 the seven clutches found on Mustang and North Padre Islands 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. I collected five of the clutches (1, 2, 3, 5, 6) and USGS biological technician Cynthia Rubio collected two of them (4, 11). 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). The eggs remained in this facility through the entire incubation period and I oversaw incubation using procedures described by Shaver et al. (1986; 1988a) and Shaver (1990; 1992b; 1996c; 1997b; 1998b; 1999b; 2000; 2001).

Eggs were held at the incubation facility from 24 April through 29 August 2001. 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 was completed. 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 seven clutches hatched at the incubation facility during 2001 were released on Closed Beach at PAIS. 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.

I examined unhatched eggs from both the incubation facility and corral as soon as they were deemed not viable (Shaver et al., 1988a; Shaver and Chaney, 1989). Eggs were not preserved prior to examination, but those from the Boca Chica Beach 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 embryos were staged according to criteria developed by Miller (1985).

INCUBATION OF EGGS LAID ON SOUTH TEXAS BEACHES

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 (30.0 C), middle (29.7 C), and bottom (28.9 C) shelves in 2001 were significantly different (Kruskal-Wallis One Way Analysis of Variance on Ranks, $H=1184.687$, $df=2$, $P<0.001$) (SigmaStat, 1995). 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, $P<0.05$) (SigmaStat, 1995).

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 (29.6 C), and bottom (28.7 C) shelves in 2001 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) and loggerhead clutches (Table 6).

The incubation period for the Kemp's ridley clutches ranged from 45-50 days and for the loggerhead clutches ranged from 49-53 days (Table 5). For eggs held in the incubation facility, incubation period was measured as the number of days from egg 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.

Overall, 70.5% of the 837 Kemp's ridley eggs that were incubated on the Texas coast hatched (Table 5). Of the 590 Kemp's ridley hatchlings produced, 584 were released on the beach and entered the Gulf of Mexico (Table 5). The hatching and emergence rates were 76.9% for the 542 Kemp's ridley eggs held in the incubation facility. Four hatchlings died after emergence on the sand surface, but prior to release; two hatchlings that were too weak to enter the surf when placed on the beach were transferred to the University of Texas Marine Sciences Institute (UTMSI) for prolonged care, but succumbed; and 411 hatchlings were released. The hatchling and emergence rates were 58.6% for the 295 eggs Kemp's ridley eggs incubated in the corral at Boca Chica

Beach and 173 hatchlings were released there.

Overall, 84.9% of the 305 loggerhead eggs incubated on the Texas coast hatched and all 259 hatchlings were released on the beach and entered the Gulf of Mexico (Table 5). The hatching and emergence rates were 92.5% for the 226 loggerhead eggs incubated at the incubation facility and 209 hatchlings were released. The hatching and emergence rates were 63.3% for the 79 loggerhead eggs incubated in the corral at Boca Chica Beach and 50 hatchlings were released.

The Kemp's ridley clutch found and incubated *in-situ* in Alabama contained 109 eggs. Twenty-seven of the eggs hatched (24.8% hatching success) and 16 hatchlings were released (14.7% emergence success); this relatively low hatching success may have been due to root penetration into the nest (Celeste South, personal communication). Overall, the nine Kemp's ridley nests found in the U.S. during 2001 contained 946 eggs. The hatching rate was 65.2% and the emergence rate was 64.1%. Six hundred hatchlings were released on the beach and entered the Gulf of Mexico from these nine nests.

Hatching and emergence success rates have been considerably larger for Kemp's ridley eggs hatched in the incubation facility than in corrals. During 2001, the emergence success for the five Kemp's ridley clutches held at the incubation facility (76.9%) was higher than for the three clutches incubated in the corral on Boca Chica Beach (58.6%) and the one clutch incubated *in-situ* in Alabama (14.7%). The yearly mean hatching success of Kemp's ridley eggs retrieved from south Texas beaches held at the incubation facility from 1978-2000 was 82%. 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).

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

The unhatched eggs from all 11 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 one deformed loggerhead embryo and five deformed Kemp's ridley embryos (Table 10).

Gonads were removed for histological sex determination from dead hatchlings and late-staged embryos (Tables 8, 9). Gonads were shipped to the Texas A&M University, Veterinary Diagnostic Laboratory, where histology was used to determine gender of the embryos and dead hatchlings. Some gonad samples were available and analyzed for three loggerhead clutches and seven Kemp's ridley clutches incubated on the Texas coast. The mean percent females for the three loggerhead clutches was 83.3% (Table 11). The mean percent females for the seven Kemp's ridley clutches was 67.6% (Table 11). 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 five clutches was 80.7% (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 five clutches was 61.3% (Table 11).

SEA TURTLE STRANDINGS

General

Stranded sea turtles are those individuals located washed ashore or floating, either alive or dead. Sea turtles known to have been 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 nestings 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.

Live stranded turtles are taken to rehabilitation facilities and dead turtles are often salvaged for specimen collection and/or necropsy. Most stranded turtles documented in Texas are found dead. However, the numbers of dead turtles reported by the network underestimate mortality, since only a portion of dead turtles actually wash ashore and then can be documented.

Three hundred ninety-seven wild (non-head-started) sea turtles were located stranded along the Texas coast during 2001 (Table 12). Two head-started sea turtles were also located stranded during this time (Table 13), including one adult from the experimental imprinting and head-starting project and one juvenile (31.4 cm straight-line carapace length) that was not experimentally imprinted to PAIS. The total number of wild turtles found stranded in Texas during 2001 (397) was the sixth highest annual total since the STSSN was established. Among the 397 turtles that were located stranded were 115 Kemp's ridley, 165 loggerhead, 73 green, six leatherback, 30 hawksbill, and eight turtles of unknown species. None of these species tallies for 2001 reached record annual levels.

Of the 397 wild stranded turtles, 69 were located in inshore areas and 328 in offshore areas. The 328 turtles found offshore in Texas during 2001 included none found in statistical zone 17, 73 in zone 18, 32 in zone 19, 160 in zone 20, and 63 in zone 21. Overall, 68% of Texas offshore strandings were located in zones 20 and 21. The total number of sea turtles found stranded offshore in zones 20 and 21 during 2001 (223) was less than the total number found stranded in zones 20 and 21 during 2000 (257), but the numbers found stranded in zones 18 and 19 were nearly identical in both years. This was the first year for the Texas Parks and Wildlife Department regulation prohibiting shrimp trawling in 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. This reduction in offshore strandings in zones 20 and 21 provides preliminary evidence that this regulation may be effective at reducing sea turtle strandings within the closed area without elevating strandings within offshore areas in Texas that are not closed, but additional years of data collection are needed.

Strandings were more numerous in April, May, July, August, and November than during any other months in 2001 (Table 12, Fig. 7). Strandings of sea turtles measuring more than 10.0 cm SLCL decreased slightly when Gulf of Mexico waters off the Texas coast were closed to shrimp trawling during the Texas Closure (15 May through 8 July 2001) (Fig. 7), as typically occurs (Shaver, 1994b; 1995b; 1996d; 1998c).

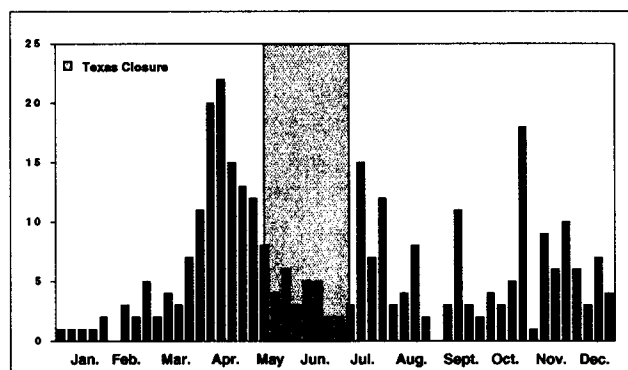


Figure 7. Number of stranded sea turtles located on offshore beaches along the Texas coast each week from January through December, 2001.

Of the 397 wild stranded turtles, 68 were found alive and 329 were found dead. The 329 dead individuals included 48 that were fresh dead (code 1), 102 that were moderately decomposed (code 2), 129 that were severely decomposed (code 3), 41 that were a dried carcass (code 4), and 9 that were only a skeleton (code 5). Part or all of 156 dead individuals were salvaged for specimen collection or necropsy (final disposition = 3). Specimen collections and necropsies were also conducted on several turtles that died during rehabilitation efforts.

During 2001, 35 of the 328 turtles found stranded offshore were linked to likely stranding causes (two hypothermic stunned; 21 hatchlings and post-hatchlings that drifted onto shore with currents; five wedged in jetty rocks; one with a rope tied around it; three entangled in non-fishing gear medium; two with a hook in the mouth; and one with

a possible tumor. Thirty-five of the 67 turtles found stranded inshore were linked to likely stranding causes (25 hypothermic stunned; five entangled in fishing line; one with possible mutilation; two wedged in jetty rocks; one with a hook in the mouth or other body part; and one post-hatchling that drifted onto shore with currents. Additionally, 12 stranded turtles (six offshore, six 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 2001 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-five wild (non-head-started) adult Kemp's ridleys (≥ 60.0 cm SLCL) were located stranded on the Texas coast during 2001. This is slightly more than the 23 found during 2000, but fewer than the record 37 found during the entire year in 1998. These 25 stranded adults found during 2001 were documented between 24 March and 25 December. All 25 were located dead.

The 25 included 10 females, two males, and 13 of undetermined sex. One of the 25 had PIT tag 41014B296F linking it to nesting in Rancho Nuevo, Mexico on 14 June 1998 (Jaime Pena, personal communication); one had PIT tag 4136111816 linking it to nesting in Rancho Nuevo on 14 May 2000; and none of the remaining 22 had evidence of living, magnetic, PIT, or metal tags, but many of these turtles with no tags were missing flippers and/or scutes and thus could not be thoroughly 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. Forty-three adult Kemp's ridleys were found stranded in the U.S. during 2001; including 25 found in Texas, 10 in Florida, five in Louisiana, and three in Georgia (Wendy Teas, personal communication). Ten of the 25 were found stranded in zone 20 and nine in zone 21. More adult Kemp's ridleys were found in each of these two zones than in any other U.S. zone that year.

In addition to the 25 wild adult Kemp's ridleys, one adult Kemp's ridley from the

experimental imprinting and head-starting project was found stranded on the Texas coast in 2001. This turtle had been hatched at PAIS in 1985 (1985 year-class) and was found dead there, in zone 21, on 14 May 2001. Due to the decomposition, it was impossible to identify the sex of this individual.

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 by Kemp's ridleys 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. Twenty-two hatchlings were found washed ashore along the Texas coast during 2001, between 18 May and 17 November (Table 14). Among the 22 hatchlings were one loggerhead, three Kemp's ridleys, and 18 hawksbills. As during 1990-2000, pedestrians located most of the hatchlings (Shaver, 1990; 1991; 1992b; 1993; 1994a; 1996c; 1997b; 1998b; 1999b; 2000; 2001).

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). Based on size and various attributes (lack of egg tooth, umbilical scar, internal yolk, and gut contents), it is unlikely that any of the 22 stranded hatchlings originated from detected or undetected 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 may be

decreasing 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 adult Kemp's ridley turtles be maximized 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 11 confirmed sea turtle nests detected along the Texas coast during 2001.

Clutch (Species ¹)	Nest Site ²	How Located	Lay Date	Time Tracks or Turtle Detected (h)
1(LK)	NPI, 1.6 km S. of Bob Hall Pier	Turtle-patroller	24 April	0900
2(CC)	NPI, 5.0 km S. of Bob Hall Pier	Turtle-public	11 May	2330
3(LK)	NPI, PAIS, 9.7 km marker	Turtle-ranger	16 May	1145
4(LK)	NPI, PAIS, 56.6 km marker	Turtle-patroller	20 May	1313
5(LK)	NPI, PAIS, 3.2 km marker	Tracks-patroller	22 May	0700
6(LK)	MI, 0.8 km N. of Ave. G	Turtle-public	22 May	0825
7(LK)	SPI, 22.8 km N. of STI	Tracks-patroller	24 May	1000
8(LK)	SPI, 25.7 km N. of STI	Tracks-patroller	14 June	1250
9(CC)	SPI, 16.4 km N. of STI	Tracks-patroller	17 June	1100
10(LK)	BCB	Tracks-patroller	30 June	1250
11(CC)	NPI, PAIS, 69.2 km marker	Tracks-patroller	8 July	0715

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

² NPI = North Padre Island, PAIS = Padre Island National Seashore, MI = Mustang Island, SPI = South Padre Island, STI = Sea Turtles Inc., BCB = Boca Chica Beach.

Table 2. Measurements and tags^{1,2} for emergent sea turtles documented on the Texas coast during 2001.

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)	63.0	60.7	66.2	69.5	LF:4130604072	RF	LC5	LF:SSQ090	RF	RF:SSQ826 LR:SSQ827	-
2(CC)	-	-	97.5	91.5	-	-	-	-	-	-	-
-(LK) ⁴	-	-	64.8	67.5	-	LF	V4	-	RF	LF:SSQ873 LR:SSQ872	RF:4130796C02
3(LK)	61.9	59.9	65.7	67.2	LF:4130354649	-	-	-	LF,LR	LF:SSQ975 RR:SSQ976	-
4(LK)	63.1	61.8	66.0	69.5	-	LF	RC1	-	RF	LF:SSQ977 LR:SSQ978	RF:4077263B5B
6(LK)	64.8	60.7	68.2	69.0	-	-	-	-	-	LF:SSQ805 LR:SSQ806	LF:413054507B

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 left costal 5 (LC5), vertebral 4 (V4), or right costal 1 (RC1) scute.

³ LK = Kemp's ridley, CC = loggerhead.

⁴ This turtle did not nest during this emergence.

Table 3. Comments regarding emergent sea turtles documented on the Texas coast during 2001.

Clutch (Species) ¹	Year-class	Serum Testos- terone (pg/ml)	Satellite Transmitter (if Applied)	Comments
1(LK)	1984	26.1	29351	antenna forward, previously documented nesting on Mustang Island in 1998, notch on left rear side of carapace
2(CC)	-	-	-	small notch on trailing edge of right rear flipper
- (LK)	1986	2.9	-	hump on left side of carapace, right side of carapace flattened, did not nest during this emergence
3(LK)	-	32.1	24858	antenna forward, previously documented nesting on North Padre Island in 1999, two nicks on right rear side of carapace
4(LK)	1987	4.3	29350	antenna forward
6(LK)	-	-	-	-

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

Table 4. Locations and dates of confirmed non-nesting emergences (no eggs located) documented on the Texas coast during 2001.

Suspected Species ¹	Location ²	How Located	Date	Time (h)	Comments
CC	NPI, 6.0 km S. of BHP	Tracks-patroller	12 May	0910	U-shaped
LK	SPI, 41.8 km N. of STI	Tracks-patroller	15 May	1400	U-shaped
LK	NPI, PAIS, 18.2 km marker	Turtle-patroller	15 May	1610	observed crawling ³
LK	NPI, PAIS, 20.3 km marker	Tracks-patroller	15 May	1800	ended at disturbed area
LK	NPI, PAIS, 6.4 km marker	Tracks-patroller	15 May	1900	disturbed area only
LK	NPI, PAIS, 66.0 km marker	Tracks-patroller	12 June	1630	tracks ended tide line

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

² NPI = North Padre Island, BHP = Bob Hall Pier, SPI = South Padre Island, STI = Sea Turtles Inc., 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 11 confirmed sea turtle nests documented on the Texas coast during 2001.

Clutch (Species) ¹	Number of Eggs Incubated ²	Hatch Date ³	Incubation Period (Days)	Percent of Eggs Hatched ⁴	Number Hatchlings Died Prior to Release	Number Hatchlings Released ⁵	Hatchling Release Dates	Number Hatchlings Retained ⁶
1(LK)	113	12 June	50	93.8	0	106	14-15 June	0
2(CC)	115	2 July	53	92.2	0	106	3 July	0
3(LK)	110	3-4 July	49-50	55.5	0	61	6-8 July	0
4(LK)	96	6 July	48	61.5	3	56	10 July	0
5(LK)	112	5-10 July	45-50	90.2	0	101	11-12 July	0
6(LK)	111	5-9 July	45-49	81.1	1	87	11-13 July	2
7(LK)	86	10 July	48	69.0	0	60	10-11 July	0
8(LK)	90	2 Aug.	50	91.1	0	82	2 Aug.	0
9(CC)	79	7 Aug.	52	63.3	0	50	7 Aug.	0
10(LK)	119	16 Aug.	48	26.1	0	31	16 Aug.	0
11(CC)	111	25-27 Aug.	49-51	92.8	0	103	27-29 Aug.	0

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

² Total number of eggs incubated: 837 LK and 305 CC = 1,142 eggs all species.

³ Hatch date is the date that hatching was detected for eggs incubated in boxes and is the date that emergence from the nest was detected for eggs incubated in a corral.

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

Total hatched: LK = 70.5% (590/837); CC = 84.9% (259/305); Total all species = 74.3% (849/1,142).

⁵ Hatchlings that successfully entered the surf. Total number of hatchlings released: 584 LK and 259 CC.

⁶ Two hatchlings were measured, but too weak to enter the surf and were transferred to UTMSI for prolonged care and later died there.

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 2001¹.

Temperature Measured	Entire Incubation Period				Middle Third of Incubation Period			
	N	Range	Mean(S.E.)	Median	N	Range	Mean(S.E.)	Median
Clutch 1A	1,182	21.7-32.5	30.3(0.0)	30.8	385	28.0-32.5	30.9(0.0)	31.0
Clutch 1B	1,182	21.8-32.6	30.2(0.0)	30.6	385	27.0-31.7	30.5(0.0)	30.6
Clutch 2A	1,222	24.4-31.6	30.1(0.0)	30.2	408	29.8-31.2	30.6(0.0)	30.6
Clutch 2B	1,222	24.9-31.7	30.1(0.0)	30.4	408	29.6-31.4	30.6(0.0)	30.6
Clutch 3A	1,164	25.9-31.9	30.2(0.0)	30.2	384	29.8-31.7	30.6(0.0)	30.5
Clutch 3B	1,147	26.3-32.2	30.3(0.0)	30.3	384	29.8-32.2	30.8(0.0)	30.7
Clutch 4	1,121	26.8-33.9	30.8(0.0)	30.9	384	30.3-32.3	31.0(0.0)	30.9
Clutch 6A	1,057	18.9-32.6	30.5(0.0)	30.7	360	29.7-31.8	30.7(0.0)	30.7
Clutch 6B	1,167	19.7-33.1	30.6(0.0)	30.7	384	29.7-31.8	30.8(0.0)	30.8
Clutch 6A	1,046	22.0-32.3	30.6(0.0)	30.7	360	29.7-31.9	30.9(0.0)	30.9
Clutch 6B	1,150	21.3-32.5	30.7(0.0)	30.9	384	29.6-32.5	31.1(0.0)	31.1
Clutch 11A	1,156	28.6-32.3	30.3(0.0)	30.3	384	29.6-31.5	30.4(0.0)	30.4
Clutch 11B	1,149	28.8-32.3	30.3(0.0)	30.3	384	29.7-31.5	30.4(0.0)	30.4
Air 1	2,956	23.6-36.6	30.9(0.0)	31.0				
Air 2	2,956	23.6-35.7	30.5(0.0)	30.5				
Air 3	2,956	23.4-32.8	29.6(0.0)	29.7				
Control 1	2,956	24.3-32.3	30.2(0.0)	30.4				
Control 2	2,956	24.0-31.7	29.6(0.0)	29.6				
Control 3	2,956	23.8-30.4	28.6(0.0)	28.7				

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 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 2001.

Clutch (Species) ¹	N ²	Straight-line Carapace Length (mm)			Weight (g)		
		Range	Mean(S.E.)	Median	Range	Mean(S.E.)	Median
1(LK)	106	38.81-46.13	43.77(0.15)	44.20	14.64-19.75	17.79(0.11)	18.03
2(CC)	106	45.19-50.08	47.93(0.09)	47.83	22.43-25.38	23.95(0.07)	24.00
3(LK)	61	37.93-45.14	42.51(0.21)	42.70	13.27-17.06	15.60(0.13)	15.83
4(LK)	56	38.91-44.72	42.18(0.21)	42.72	12.72-18.66	16.17(0.17)	16.44
5(LK)	101	42.45-46.10	44.45(0.08)	44.50	18.66-24.15	20.38(0.07)	20.44
6(LK)	59	34.24-43.98	40.34(0.21)	40.61	11.72-18.20	15.27(0.13)	15.40
11(CC)	103	42.15-48.29	46.20(0.09)	46.26	17.39-23.83	19.99(0.10)	19.97

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

² N = number measured.

Table 8. Results of analyses of unhatched Kemp's ridley eggs¹ and histological sex determination for Kemp's ridley clutches documented on the Texas coast during 2001.

Parameter	Clutch							
	1	3	4	5	6	7	8	10
<u>Analyses of unhatched eggs</u>								
no. unhatched	7	49	37	11	21	26	8	88
no. infertile	2	0	0	2	0	2	0	3
no. fertile w/o embryos	3	11	14	7	4	16	7	68
no. stage 10 embryos	0	0	0	1	0	0	0	0
no. stage 11 embryos	0	1	0	1	0	0	0	2
no. stage 12 embryos	0	2	1	0	0	0	0	0
no. stage 13 embryos	0	0	1	0	0	0	0	0
no. stage 18 embryos	0	2	0	0	0	0	0	0
no. stage 20 embryos	0	0	1	0	0	0	0	0
no. stage 21 embryos	0	0	1	0	0	0	0	0
no. stage 22 embryos	0	1	0	0	0	0	0	0
no. stage 25 embryos	0	0	0	0	0	0	0	1
no. stage 26 embryos	0	0	0	0	0	0	0	1
no. stage 27 embryos	0	1	0	0	1	0	0	0
no. stage 28 embryos	0	3	2	0	0	0	0	2
no. stage 28-29 embryos	0	6	7	0	2	2	0	0
no. stage 29 embryos	0	10	4	0	4	1	0	5
no. stage 29-30 embryos	0	9	4	0	2	1	0	6
no. stage 30 embryos	2	3	2	0	7	4	1	0
no. stage 30-31 embryos	0	0	0	0	1	0	0	0
<u>Number of dead hatchlings</u>	0	0	3	0	3	0	0	0
<u>Histological sex determination for late-staged embryos and dead hatchlings</u>								
no. analyzed	2	20	10	0	14	8	1	11
no. males	1	16	3	0	2	2	0	3
no. females	1	4	7	0	12	6	1	8

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

Table 9. Results of analyses of unhatched loggerhead turtle eggs¹ and histological sex determination for loggerhead turtle clutches documented on the Texas coast during 2001.

Parameter	Clutch		
	2	9	11
<u>Analyses unhatched eggs</u>			
no. unhatched	9	29	8
no. infertile	0	3	2
no. fertile w/o embryos	5	21	5
no. stage 18 embryos	0	1	0
no. stage 21 embryos	1	0	0
no. stage 22 embryos	0	1	0
no. stage 23 embryos	0	1	0
no. stage 25 embryos	1	0	0
no. stage 27 embryos	0	1	0
no. stage 28 embryos	0	1	0
no. stage 29 embryos	1	0	0
no. stage 30 embryos	1	0	1
<u>Number of dead hatchlings</u>	0	0	0
<u>Histological sex determination for late-staged embryos and dead hatchlings</u>			
no. analyzed	2	2	1
no. males	1	0	0
no. females	1	2	1

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

Table 10. Deformed embryos from sea turtle clutches documented on the Texas coast during 2001.

Clutch (Species) ¹	Stage	Deformities Observed and Comments
2(CC)	29	Dead embryo - partial albino, no upper jaw, no egg tooth, no eyes
3(LK)	29-30	Dead embryo - notch on right rear side of carapace
4(LK)	29-30	Dead embryo - missing patch of marginals near right rear flipper
4(LK)	30	Dead embryo - missing patch of marginals near right rear flipper
7(LK)	30	Dead embryo - patch of skin missing on neck
10(LK)	29-30	Dead embryo - partial albino, heart and liver protruded through abdomen and plastron, snout curved to the right

¹LK = Kemp's ridley, CC = loggerhead.

Table 11. Estimated sex ratios for sea turtle clutches documented on the Texas coast during 2001.

Clutch (Species) ¹	Estimated % Female Based on Temperature ²	Estimated % Female Based on Incubation Period ³	Identified % Female Based on Histology ⁴
1(LK)	85.7&65.8	40.6	50.0
2(CC)	-	-	50.0
3(LK)	69.6&78.7	40.6&55.3	20.0
4(LK)	88.3	69.9	70.0
5(LK)	74.4&80.0	40.6&100.0	-
6(LK)	83.4&92.8	55.3&100.0	85.7
7(LK)	-	-	75.0
8(LK)	-	-	100.0
9(CC)	-	-	100.0
10(LK)	-	-	72.7
11(CC)	-	-	100.0
Overall ⁵			
<i>L. kempii</i>	80.7	61.3	67.6
<i>C. caretta</i>	-	-	83.3

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

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 seven Kemp's ridley and three loggerhead clutches from which samples were analyzed.

Table 12. Sea turtles found stranded along the Texas coast during 2001¹.

Species ²	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sep.	Oct.	Nov.	Dec.	Total
CC	2	10	12	26	12	10	24	16	15	17	14	7	165
LK	0	0	4	42	17	5	6	10	2	3	14	12	115
CM	28	3	4	2	8	7	1	3	1	5	6	5	73
DC	0	0	0	3	2	0	0	0	0	1	0	0	6
EI	1	0	0	1	5	1	2	10	9	0	0	1	30
UN	0	0	0	2	1	0	2	1	1	0	0	1	8
Total	31	13	20	76	45	23	35	40	28	26	34	26	397

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 2001.

Species ¹	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sep.	Oct.	Nov.	Dec.	Total
LK	0	0	0	1	1	0	0	0	0	0	0	0	2

¹ LK = Kemp's ridley.

Table 14. Sea turtle hatchlings and post-hatchlings (<10.0cm SLCL) found stranded on the Texas coast during 2001.

I.D.	Species ¹	SLCL (cm)	SLCW (cm)	CCL (cm)	CCW (cm)	Weight (g)	Location ²	Date	Sex ³	Comments ⁴
EI	EI	9.9	7.7	10.4	8.7	119.0	MI, markers 203-204	18 May	U	wh
EI	EI	9.8	9.3	11.2	10.7	-	NPI, PAIS, 8.0 km marker	20 May	U	wu
LK-01-32	LK	5.1	5.0	5.3	5.5	22.8	NPI, near Bob Hall Pier	8 Aug.	F	et, g
LK-01-33	LK	5.7	6.2	6.2	7.2	40.0	MI, S. of Lanton St.	13 Aug.	F	wf, g
EI	EI	-	-	-	-	-	NPI, 5.6 km S. Bob Hall Pier	18 Aug.	U	-
EI	EI	-	-	-	-	-	NPI, 6.6 km S. Bob Hall Pier	18 Aug.	U	-
EI-01-05	EI	7.2	7.0	7.7	7.0	48.9	MI, Horace Caldwell Pier	19 Aug.	F	wf, ep, et, g
EI-01-06	EI	6.1	5.0	6.4	6.0	31.0	MI, marker 28	19 Aug.	F	wf, ep, et, g
EI-01-07	EI	6.3	5.1	6.6	5.9	39.0	MI, Port Aransas Ranger Office	20 Aug.	F	wf, ep, et, g
EI-01-08	EI	6.8	5.3	7.2	6.3	39.6	MI, markers 32-33	21 Aug.	F	wf, ep, et, g
EI	EI	5.1	4.1	5.3	5.0	26.8	MI	24 Aug.	U	ep
EI-01-09	EI	8.1	6.5	8.7	7.9	62.2	NPI, PAIS, 29.4 km marker	24 Aug.	F	wf, ep, g
EI	EI	7.0	5.5	-	-	-	GI, GI State Park	30 Aug.	U	-
EI	EI	6.9	5.3	-	-	-	GI, 61 st & Seawall	2 Sept.	U	wu
EI	EI	6.8	5.4	-	-	-	GI, 0.4 km E. of GI State Park	13 Sept.	U	-
EI	EI	6.8	5.3	-	-	-	Brazoria County	15 Sept.	U	-
EI	EI	7.2	6.1	8.0	7.5	59.3	NPI, PAIS, 21.2 km marker	16 Sept.	U	wh, ep
EI	EI	7.5	6.0	7.6	6.8	49.0	SPI, Bahia Mar Resort	18 Sept.	U	wf
LK	LK	6.8	6.6	7.1	7.8	50.9	MI, Horace Caldwell Pier	19 Sept.	U	wf, wh, ep
EI	EI	8.0	6.4	8.5	7.7	71.5	NPI, near Bob Hall Pier	23 Sept.	U	wf, wh, ep
EI	EI	-	-	7.5	6.5	39.0	SPI, inshore, Laguna Heights	27 Sept.	U	wu
CC	CC	9.7	8.0	10.4	9.8	122.8	MI, MI State Park	17 Nov.	U	wf, ep

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

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 contents).

