

**PADRE ISLAND NATIONAL SEASHORE
KEMP'S RIDLEY SEA TURTLE PROJECT
AND TEXAS SEA TURTLE STRANDINGS
1998 REPORT**



**DEPARTMENT OF THE INTERIOR
U.S. GEOLOGICAL SURVEY
PADRE ISLAND NATIONAL SEASHORE**



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1998 REPORT

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ABSTRACT

Patrols for nesting and stranded sea turtles, public education efforts regarding sea turtles, incubation of sea turtle eggs, and necropsy of dead stranded sea turtles continued at Padre Island National Seashore (PAIS) during 1998. Additionally, a project using satellite telemetry to monitor the movements of Kemp's ridley turtles (*Lepidochelys kempi*) that nested in south Texas was continued in 1998.

PAIS employees and volunteers conducted patrols for nesting sea turtles and tracks on North Padre Island from 27 March through 30 July. During 1998, 9,478 hours were spent patrolling a total of 153,035 km of beach front, about one-third more patrol hours and kilometers patrolled than during 1997. Additional patrols for stranded sea turtles were conducted outside the Kemp's ridley nesting season.

Twenty-one confirmed sea turtle nestings were detected on the Texas coast during 1998. The 21 nests included 13 Kemp's ridley, five green (*Chelonia mydas*), two loggerhead (*Caretta caretta*), and one hawksbill (*Eretmochelys imbricata*). The 21 nests were located due to observations of either nesting turtles or tracks, 14 of which were found by patrollers and seven of which were found by the public. The 13 confirmed Kemp's ridley nests found on the Texas coast during 1998 were the only confirmed Kemp's ridley nests found in the U.S. that year, the most Kemp's ridley nests documented on the Texas coast during a single year, and an increase the number of Kemp's ridley nests found on the Texas coast for the fourth consecutive year. The five green turtle nests found during 1998 were the most documented on the Texas coast in a single year. The hawksbill nest found during 1998 was the first confirmed for this species on the Texas coast. However, fewer loggerhead nests were found in Texas during 1998 than during either 1996 or 1997.

Nesting Kemp's ridley turtles were examined by PAIS employees at seven of the 13 confirmed Kemp's ridley nests; one individual nested twice and the other five

individuals were documented nesting only once. Three of the six nesting Kemp's ridleys examined by PAIS employees had living and magnetic tags linking them to the project to establish a secondary nesting colony at PAIS. These three turtles were returnees from the 1984, 1986, and 1987 year-classes and represented the third, fourth, and fifth confirmed returnees from this project that were documented nesting on the Texas coast. One of the six turtles examined had a PIT tag that had been applied in 1996, while it nested in Tepehuajes, Mexico; this was the first confirmed record of an individual Kemp's ridley nesting both in Mexico and in the U.S. Satellite transmitters were applied to four of the six nesting Kemp's ridley turtles that were examined. All four eventually moved northward and eastward along the Gulf of Mexico shoreline and were last located in waters offshore from Louisiana, Mississippi, and Florida; transmissions continued to be received from three of the four transmitters through the end of 1998.

Most confirmed sea turtle nests located on the Texas coast were found at PAIS. Of the 13 Kemp's ridley nests found during 1998, nine were located on North Padre Island (at PAIS), two on Mustang Island, and two on South Padre Island. The other eight confirmed sea turtle nests found on the Texas coast during 1998 (five green, two loggerhead, and one hawksbill) were all located at PAIS.

Eggs from all confirmed clutches were packed into Styrofoam boxes and transported to the PAIS incubation facility for protected incubation. Overall, 63.1% of the 1,270 Kemp's ridley turtle eggs, 85.3% of the 511 green turtle eggs, 89.2% of the 212 loggerhead turtle eggs, and 95.7% of the 140 hawksbill turtle eggs incubated at the PAIS facility hatched. From these, 800 Kemp's ridley, 436 green, 188 loggerhead, and 133 hawksbill hatchlings were released on the beach at PAIS and entered the Gulf of Mexico.

From 1 January through 31 December 1998, 396 sea turtles were located stranded along the Texas coast. Among the 396 were 132 Kemp's ridley, 169

loggerhead, 59 green, 6 leatherback (*Dermochelys coriacea*), 16 hawksbill, and 14 unknown species turtles. The 396 found during 1998 is the fourth largest annual total number of turtles located stranded along the Texas coast since 1980 (when the Sea Turtle Stranding and Salvage Network [STSSN] was established). However, the 37 adult Kemp's ridley turtles (> 60.0 cm straight-line carapace length) located stranded on the Texas coast during 1998 far exceeded the number of adult Kemp's ridleys found during each year since 1980. Additionally, more stranded turtles were found offshore in Zones 20 and 21 (aggregated) than found in those Zones during any other year in STSSN history.

Fourteen sea turtle hatchlings and post-hatchlings were found stranded along Boca Chica Beach, South Padre Island, North Padre Island (including PAIS), and Mustang Island during 1998, between 24 June and 17 October. Among the 14 found state-wide were 11 Kemp's ridley, two green, and one hawksbill hatchlings. One Kemp's ridley, one green, and one hawksbill found likely originated from clutches laid, incubated, and released at PAIS. It is unlikely that any of the other stranded hatchlings emerged from south Texas nests.

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BACKGROUND

During each summer from 1978 to 1988, approximately 2,000 Kemp's ridley turtle (*Lepidochelys kempi*) eggs were shipped to Padre Island National Seashore (PAIS) from Rancho Nuevo, Mexico in an experimental attempt to establish a secondary breeding colony of this 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, 1989c; 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. In 1996, two turtles experimentally imprinted to PAIS were documented nesting there (Shaver, 1996a; 1996b; 1997a; 1997b; in press a; in press b). These two turtles were the first from this project confirmed to have nested outside of captivity.

Transfer of Kemp's ridley eggs to PAIS from Rancho Nuevo, Mexico was terminated after the 1988 incubation season. Now the primary objective of the PAIS Kemp's ridley project is to identify whether Kemp's ridleys return to nest at PAIS (Shaver, 1989b). Also significant in our efforts is the location, investigation, and protection of all nesting sea turtles, sea turtle nests, and stranded sea turtles occurring on local beaches. Public education programs, beach patrols, and protection and monitoring of nesting sea turtles, nests, and stranded turtles will continue in the future, as funds permit. Additionally, a project using satellite telemetry to monitor the movements of Kemp's ridley turtles that nested in south Texas was initiated in 1997 and continued in 1998.

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). The author serves as the Texas Coordinator of the STSSN, maintains records of all sea turtles found stranded in Texas since 1980, and tabulates sea

turtle strandings for Texas.

This report summarizes PAIS patrols for nesting and stranded sea turtles, public education efforts regarding sea turtles, incubation of sea turtle eggs, and satellite tracking of adult Kemp's ridley turtles during 1998. Also, sea turtle nestings and strandings that were documented on the Texas coast during 1998 are summarized. 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 National Marine Fisheries Service Shrimp Statistical Zones. Zones 17-21 are located from north to south along the Texas coast, with the majority of Zone 17 located in adjacent Louisiana and PAIS located in roughly the southern half of Zone 20 and northern half of Zone 21.

BEACH PATROLS FOR NESTING TURTLES

Management of the Padre Island National Seashore nesting beach, including beach patrols of the area, is listed as a priority 2 recovery task item in the Kemp's Ridley Sea Turtle Recovery Plan (U.S. Fish and Wildlife Service and National Marine Fisheries Service, 1992). As a result, seasonal beach patrols for nesting sea turtles, tracks, and nests began at PAIS in 1986 and continued through 1998.

From 27 March through 30 July 1998, PAIS employees and volunteers conducted patrols along North Padre Island. The 125 km long target patrol area extended from the Nueces County/Kleberg County line (20 km north of PAIS) to the Mansfield Channel. The target patrol area was divided into sections that varied in length, sometimes overlapped, and were repeatedly traversed during daylight hours.

Patrols began as early as 0600 hours (h) and terminated as late as 1830 h. Paid staff members that conducted patrols were placed on four, 10 hour shifts per

week to allow maximum coverage during daylight hours. Volunteers conducting patrols worked either half days (5-6.5 hours/day) or complete days (10 hours/day). Patrols of the central and southern sections of the target patrol area were conducted primarily by paid staff members and patrols of the northern sections were conducted primarily by volunteers.

Patrols originated from the northern end of PAIS (at Ranger Road or Malaquite Beach) or the southern end of PAIS (at the base camp at the PAIS 64 km marker). Campers alternated on a three day schedule and they repeatedly patrolled the areas from the base camp to the Mansfield Channel and from the base camp to the PAIS 32 km marker during the day. This is the first year that a base camp was maintained for the entire patrol season. Any given point along the target patrol area was searched from 2-20 times per day, with areas at the northern end of PAIS patrolled most frequently and areas at the southern end of PAIS patrolled least frequently.

Patrols were conducted seven days per week. From 27-31 March, when 1998 patrols were becoming organized, a reduced number of patrollers were deployed each day. Daily patrol coverage increased and remained relatively constant from 1 April through 30 July. However, additional patrollers were deployed on days when Kemp's ridley nesting was detected. Patrols were terminated at the end of July because Kemp's ridley nesting terminated in Mexico in July during 1998. Had additional funding been available to continue patrols in 1998, it is likely that additional nesting by other sea turtle species would have been detected on North Padre Island during 1998.

A total of 153,035 km of patrol distance was logged during 1998, more distance than recorded during any other patrol year and about one-third more distance than recorded during 1997 (Fig. 1). Since 1993, all-terrain four-wheel cycles (ATVs) were the primary patrol vehicle and during 1998 ATVs were used to conduct all

patrols. ATVs are considered the preferred vehicles for patrols because they: 1) have excellent vantage for sighting nesting sea turtles, sea turtle tracks, and stranded sea turtles; 2) can be operated by one individual; and, 3) can be operated at varying speeds and for varying distances, depending upon conditions.

During 1998, four-wheel drive trucks, sport utility vehicles, and HUMMERS were not used to conduct patrols but were used as support vehicles for the patrol program. These vehicles were used to: 1) transport gear to and from the base camp site; 2) transport broken ATVs from the beach and replace broken ATVs with functional ATVs; 3) transport personnel to investigate nesting emergencies; 4) transport sea turtle eggs to the incubation facility; 5) transport adult female Kemp's ridley turtles to the PAIS Ranger Station for application of satellite transmitters; and, 6) transport large stranded sea turtles to the PAIS Ranger Station. During patrol seasons from 1986-1992, before sufficient funding was available to purchase ATVs, four-wheel drive trucks were the main vehicle type available and used for patrols. However, trucks, sport utility vehicles, and HUMMERS are unsuitable for patrols because they: 1) have a reduced field of observation and are ineffective for sighting small turtles and faint sea turtle tracks; 2) are subject to relatively high levels of mechanical failure; and, 3) require two people to be present in order to conduct patrols (one driver and one observer).

During the 1998 nesting patrol season, 9,478 hours were spent patrolling, more time than during any other patrol year and about one-third more than the number of hours during 1997 (Fig. 2). Numerous individuals were needed to conduct patrols because of the extensive area (125 km linear distance) and lengthy season (4+ months). Among the 1998 patrollers were 15 biological technicians (PAIS employees) and 36 volunteers from the local community and elsewhere. Because of the extremely rigorous beach conditions, each individual was generally limited to no more than four patrol days/week. Patrol hours were nearly evenly split between PAIS employees (5,232 hours) and volunteers (4,246 hours) (Fig. 2).

PAIS staff participating in beach patrols included personnel employed by the National Park Service (Science, Resources Management, and Interpretation Division) and the U.S. Geological Survey (Biological Resources Division, Environmental and Contaminants Research Center, Padre Island Field Station). The 5,232 hours PAIS staff spent patrolling included 4,504 hours by the National Park Service and 728 hours by the U.S. Geological Survey. Unlike during some previous years, Marine Debris Surveys were not conducted during the 1998 patrol season and hence time spent and distance covered for that study are not included in patrol effort totals for 1998.

Although Maintenance Division and Visitor Protection Division employees traversed long distances of beach front during the course of their duties, their vehicle types (large sedans and four-wheel drive trucks) and high speeds (often in excess of 40 km/hour) typically prohibited them from being able to observe nesting sea turtles or tracks. Thus, no beach driving conducted by these employees qualified for inclusion in distance and time totals for PAIS beach patrol efforts during 1998.

STAFF AND VISITOR EDUCATION

The Kemp's Ridley Sea Turtle Recovery Plan lists addressing education/awareness and long-term education needs as a priority 2 recovery task item, with the National Park Service being one of the responsible agencies (U.S. Fish and Wildlife Service and National Marine Fisheries Service, 1992). Accordingly, efforts to educate the park staff and public about the Kemp's ridley project continued during 1998. Since PAIS is 105 km long and extensive areas are often devoid of park personnel, it is imperative that park employees and visitors assist with detection and reporting of turtle sightings. Therefore, great emphasis was placed on alerting them about the potential for observing nesting Kemp's ridleys and urging them to look for nesting turtles, tracks, and stranded turtles.

A variety of methods were used to educate park visitors about the possibility of

sighting nesting and stranded turtles. Posters, detailing the need to report sea turtle nestings 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 the park. 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. Sea turtle patrol shirts were worn by those patrollers that did not wear National Park Service or volunteer uniforms. Signs describing Canon U.S.A., Inc. contributions to the PAIS patrol and conservation efforts were erected at PAIS on the visitor contact desk at the Visitor Center, on the incubation facility door, and on the beach at some hatchlings releases. Also, a sea turtle pin inscribed with the words "Padre Island National Seashore" was provided to visitors who donated \$5 or more to help support PAIS sea turtle work.

The public was invited to attend the majority of hatchling releases. A Hatchling Hotline was established to provide the public with current information about anticipated releases. The hotline format was a recorded message that was regularly updated. Over 1,000 visitors attended hatchling releases at PAIS during 1998. Educational programs about sea turtles and PAIS efforts 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 park visitors. During the nesting season, sea turtles were the main topic of educational programs and several educational programs focusing on sea turtles were given each week.

INVESTIGATION OF NESTING TURTLES, TRACKS, AND NESTS

When nesting sea turtles or sea turtle tracks were detected by the public or PAIS

beach patrollers on North Padre or Mustang Islands, PAIS staff immediately traveled to the area to investigate and document the sightings more fully.

When nesting turtles were located, each was examined for tags (metal, magnetic, PIT, living) and tag scars and each was measured for straight-line carapace length (SLCL), straight-line carapace width (SLCW), curved carapace length (CCL), and curved carapace width (CCW). Each was tagged with PIT and metal tags when those tags were not present. A blood sample was removed from each and sent to Texas A&M University to determine the serum testosterone level (used to indicate the number of remaining clutches that would be laid during that season by that individual). Individuals that would be tracked using satellite transmitters were transported to the PAIS Ranger Station for application of the transmitter (see Movements of Nesting Kemp's Ridley Turtles).

Each emergence site was investigated to determine if eggs were laid and to protect eggs from a variety of threats. Sea turtle emergences at which eggs were found were considered confirmed nestings and sea turtle emergences at which eggs were not found were considered false crawls. Eggs were removed from the nest sites for all confirmed nests. Located eggs were shaded, counted, and packed into Styrofoam incubation boxes containing sand from the nest sites. Large Kemp's ridley clutches and all clutches laid by other species were split into two incubation boxes. The two boxes for divided clutches were designated as A and B. Although some clutches were divided evenly, clutch partitions differed by up to 48 eggs. Collected eggs were transported to the PAIS incubation facility in shaded conditions within a truck, sport utility vehicle, or HUMMER. Incubation, hatching, and release information for clutches located in 1998 is presented below (see Sea Turtle Egg Incubation Techniques and Sea Turtle Egg Incubation Results).

CONFIRMED SEA TURTLE NESTS AND FALSE CRAWLS

Confirmed nests

Twenty-one sea turtle nests were detected on the Texas coast during 1998, from 12 April through 18 July (Table 1). The 21 included 13 Kemp's ridley, five green, two loggerhead, and one hawksbill turtle nests. Seventeen of the 21 confirmed sea turtle nests located on the Texas coast during 1998 were found on PAIS (Table 1). The other four included two Kemp's ridley nests found on Mustang Island and two Kemp's ridley nests found on South Padre Island.

Patrollers located seven of the Kemp's ridley nest sites (four through observations of nesting turtles and three through observations of tracks) and other individuals located six of the Kemp's ridley nest sites (five through observations of nesting turtles and one through an observation of tracks) (Table 1). Patrollers located seven of the eight confirmed nests from other sea turtle species and beach visitors located one; all eight were located through observations of tracks (Table 1).

The 13 Kemp's ridley nests were located between 12 April and 15 June, the five green nests between 3 June and 18 July, the two loggerhead nests on 4 and 14 July, and one the hawksbill nest on 14 June (Table 1). For the 21 confirmed nests, Kemp's ridley turtles and tracks were detected between 0835 and 1830 h and green, loggerhead, and hawksbill tracks were all located during morning hours (Table 1).

The 13 confirmed Kemp's ridley nests found on the Texas coast during 1998 were the only confirmed Kemp's ridley nests found in the U.S. that year, the most Kemp's ridley nests documented on the Texas coast during a single year, and an increase the number of Kemp's ridley nests found on the Texas coast for the fourth consecutive year. Only 26 confirmed Kemp's ridley nests were located on the Texas coast from 1979-1997 (Shaver, 1995a; 1996a; 1996c; 1998). The five green turtle nests found during 1998 were the most documented on the Texas

coast in a single year. The only other green turtle nest confirmed for the Texas coast was one located at PAIS in 1987 (Shaver, 1989a). Two confirmed loggerhead turtle nests were located during 1998, fewer than found on the Texas coast during 1997 (four) and 1996 (five) but more than found during virtually all other years since 1979. Only 15 confirmed loggerhead nests were located on the Texas coast from 1979-1997. The hawksbill nest found at PAIS during 1998 was the first ever confirmed for this species on the Texas coast. During the last 20 years, other possible nestings could not be fully documented while others could have easily gone unnoticed or unreported. The recent increase in detected nesting on the Texas coast may reflect increased nesting, improved detection efforts by PAIS turtle patrollers, increased awareness and reporting by the public, or a combination of all of these factors.

PAIS employees saw and examined Kemp's ridley turtles from seven of the 13 confirmed nestings in south Texas by this species during 1998 (Table 2). One individual was documented nesting twice and five individuals were documented nesting once. Serum testosterone levels for the six individuals ranged from 4.25 to 25.3 pg/ml (Table 3). These low testosterone levels should have indicated that each of the turtles just laid their only or last clutch of the 1998 nesting season (Dr. David Owens, personal communication). However, one of the turtles definitely nested again during 1998 and, from movement patterns for two of the tracked turtles, it is possible that others also nested again (see Movements of Nesting Kemp's Ridley Turtles).

SLCL for the six individuals ranged from 59.7 to 66.3 cm (Table 2). Three of the six individuals had living and magnetic tags linking them to the project to establish a secondary nesting colony at PAIS (each of the three also had a metal flipper tag scar on the right front flipper). The three included a 14 year old from the 1984 year-class found nesting twice in 1998; 2) a 12 year old from the 1986 year-class found nesting once; and, 3) an 11 year old from the 1987 year-class found nesting

once (Table 3). Although it was initially thought remotely possible that the 1987 year-class turtle had been "imprinted" to Cayman Turtle Farm rather than PAIS (Shaver and Caillouet, 1998), the National Marine Fisheries Service later provided information that turtles from the 1987 year-class "imprinted" to Cayman Turtle Farm had not received living tags. Hence, all three turtles had been "imprinted" to PAIS as part of this project. These three nestings were the third, fourth, and fifth confirmed nestings on the south Texas coast (outside of captivity) by turtles from the project to establish a secondary nesting colony. The first two confirmed returnees were located nesting at PAIS in 1996 and included a 13 year old from the 1983 year-class and a 10 year old from the 1986 year-class (Shaver, 1996a; 1996b; 1997a; 1997b; in press a; in press b).

One of the other three nesting Kemp's ridley turtles examined in south Texas during 1998 contained a PIT tag implanted when she nested at Tepehuajes, Mexico as a neophyte on 23 April 1996 (Table 3); this is the first confirmed nesting in the U.S. by an individual Kemp's ridley turtle that previously nested in Mexico. The other two nesting Kemp's ridley turtles examined had no tags or tag scars (Table 2).

The nesting Kemp's ridley turtles were not examined by trained biologists at the other six Kemp's ridley nestings documented on the Texas coast during 1998. Two nesting Kemp's ridley turtles were observed by beach visitors but the turtles re-entered the water before biologists arrived. Four nests were detected by PAIS patrollers from tracks left in the sand by the nesting females. The nesting turtles were not observed by biologists at any of the green, loggerhead, or hawksbill turtle nestings documented on the Texas coast during 1998.

Unfortunately, since the nesting turtles were not examined at all nest sites, it was impossible to calculate the number of turtles that nested on the Texas coast during 1998. The minimum and maximum numbers of individual females of each species

that laid the confirmed clutches found on the Texas coast during 1998 were estimated based on lay dates, typical inter-nesting intervals, typical number of clutches laid per nesting season, nest locations, and movements of individuals that were satellite tracked. The typical inter-nesting interval for *L. kemp* is 18-22 days and inter-nesting intervals under 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 13 confirmed Kemp's ridley clutches on the Texas coast during 1998 ranges from a minimum of six (six different individuals were examined) to a maximum of 12 (one of the six examined was confirmed to have nested twice). The five green turtle clutches found on the Texas coast during 1998 could have been from a minimum of two different individuals to a maximum of four different individuals; two clutches were laid on the same day and hence must have been from different individuals. Since the two loggerhead clutches could have been laid by the same individual, as few as one loggerhead turtle nested in Texas in 1998. The hawksbill turtle nest was obviously from one nesting female.

False Crawls

Eight confirmed false crawls were also located on the Texas coast during 1998; all eight were found at PAIS by patrollers (Table 4). The female turtles were not observed at any of the false crawl sites. The eight likely included six Kemp's ridley crawls, found between 29 April and 3 June, and two green turtle crawls, found on 30 June and 4 July.

ADDITIONAL REPORTS OF NESTING TURTLES, TRACKS, AND EGGS

Two other observations of sea turtle tracks and one observation of eggs on the Texas coast during 1998 were relayed to the author. These three observations were likely credible but a lack of details and photographic documentation prohibit categorizing them as confirmed nestings or false crawls by particular species.

A volunteer from Aransas National Wildlife Refuge observed a set of sea turtle tracks on Matagorda Island sometime before July 14. The volunteer deemed the emergence a false crawl after he failed to locate eggs. Unfortunately, no photos were taken of the site and details about the observation were lost. Because of the lack of details it is impossible to determine which species made the tracks.

A former PAIS volunteer turtle patroller reported observing a "washed out nest" on St. Joseph's Island on 29 September 1998. Unfortunately, no photos were taken, no specimens were obtained, no measurements of egg size were obtained, and no precise information was given regarding the location that would allow follow-up investigation. Based upon the sketchy information and lack of corroboration, it is impossible to substantiate this report.

A set of sea turtle tracks was observed by a local Audubon Society member on South Padre Island, 17.5 miles north of the end of the paved road, at about 0830 h on 19 July. Unfortunately, it is impossible to discern with certainty the species that made the tracks or whether eggs were laid at the site. The member reported the tracks to Pat Burchfield (Gladys Porter Zoo), who thought that they might be from a leatherback turtle due to the track pattern described. The member paced the track width and estimated it to be 157 cm and noted that the flipper impressions appeared to be opposite, with the tail dragging through the center of the tracks. However, on 18 July (the previous day), two green turtle nests were located about 45 km north, at PAIS. The green turtle tracks found at PAIS in 1998 were also wide, prominent, with opposite flipper impressions, and with tail drag marks through the center of the tracks, and hence the possibility that the tracks found on South Padre Island were from a green turtle cannot be excluded. Unfortunately, no photos were taken and no investigation of the site was made. The member attempted to visit the site 45 days after the observation but extremely high tides had washed away materials that he used to mark the location. If eggs had been laid at this site, it is likely that they would have

succumbed due to the extremely high tides and severe dune erosion that occurred at least four times between August and mid-September.

PAIS patrollers immediately responded to numerous other reports from the public of sea turtle nesting activity that, after investigation, were disproved. Several reports of nesting sea turtles turned out to be live swimming sea turtles, live and dead stranded sea turtles (from hatchlings to adults), live red-eared sliders (*Trachemys scripta*), and coconuts. Most reports of sea turtle tracks turned out to be tracks from red-eared sliders and ghost crabs (*Ocypode quadrata*) and dragged lawn chairs, ice chests, trash bags, and logs. Materials reported as sea turtle eggs were actually chicken eggs, paint balls, partially buried rubber gloves, and roller balls from roll-on deodorants.

MOVEMENTS OF NESTING KEMP'S RIDLEY TURTLES

PTTs were used to study the inter-nesting and post-nesting movements of two Kemp's ridley turtles that nested in south Texas during 1997 and four that nested in 1998. The turtles selected for this study were the first individuals encountered during the nesting season that were deemed suitable for tracking; turtles with obvious injuries or unsuitable carapace characteristics were excluded.

Each of the selected turtles was placed on cushions, in the back of a sport utility vehicle, and transported at moderate temperatures to the PAIS Ranger Station for attachment of the satellite transmitter. A Telonics, ST-6, backpack style, satellite transmitter was attached to the anterior of each turtle's carapace using fiberglass cloth and resin. One transmitter (7686) was attached with a fairing at the posterior end of the transmitter and the other five transmitters were attached without a fairing. After transmitter attachment, all six turtles were released on Closed Beach at PAIS. One turtle (with transmitter 7686) was released on the day after nesting and the other five were released on the same day that they nested. Data were received from individual transmitters from a minimum of 5 months to a

maximum of 13.5 months. As of 31 December 1998, data continue to be received from two transmitters (7685A and 21811).

After release, all six tracked turtles eventually moved northward and eastward and all traveled along the coastline. Of the six transmitters deployed, location data within Gulf waters of Zones 20 and 21 were gathered for four turtles. Aggregated for those four turtles, 54% of their identified positions in offshore waters of Zones 20 and 21 were in 10 fathoms depth or less, within about 4.6 nautical miles from shore, and 90% of their identified positions in offshore waters of Zones 20 and 21 were in 20 fathoms depth or less, within about 17.0 nautical miles from shore.

Transmitter 7686 was deployed on 13 June 1997, on a turtle that nested on 12 June 1997 at the PAIS 44.8 km marker (Shaver, 1998). This turtle apparently did not nest again in 1997. She immediately moved northward, spent about one month off the mouth of the Mississippi River, and was last located in Gulf waters off the Alabama/Florida border on 5 November 1997 (Fig. 3).

Transmitter 7687 was deployed on 21 June 1997 on a turtle that nested that day on Mustang Island, 3.2 km south of Access road 1 (Shaver, 1998). This turtle apparently did not nest again in 1997 or 1998. She immediately moved northward, entered waters off Louisiana in mid-July 1997, spent the next year off Louisiana, and was last located there on 7 August 1998 (Fig. 4).

Transmitter 7685A was deployed on 10 May 1998 on a turtle that nested that day (Tables 1, 3). This particular individual was the one that was documented nesting in Tepehuajes, Mexico in 1996 and at PAIS in 1998. After attachment of the satellite transmitter, she apparently did not nest again in 1998. She immediately moved northward and quickly traveled through waters off Texas, Louisiana, Mississippi, Alabama, and Florida (Fig. 5). She was last located off the west coast of Florida on 5 January 1999.

Transmitter 7689 was deployed on 25 April 1998 on a turtle that nested that day (Tables 1, 3). This particular individual was a 1984 year-class returnee and the only Kemp's ridley documented nesting twice on the Texas coast. After attachment of the satellite transmitter she moved southward, nearly to the U.S./Mexico border, then northward, and laid eggs again on 21 May, relatively close to the first nest site. After the second nesting, she moved northward and quickly traveled through waters off Texas, Louisiana, Mississippi, Alabama, and Florida (Fig. 6). She was last recorded off the west coast of Florida on 8 December 1998.

Transmitter 7681A was deployed on 25 April 1998 on a turtle that nested that day (Tables 1, 3). This turtle moved extensively in waters off south Texas and northern Mexico in May. Although she was not documented nesting again during 1998 in south Texas or Mexico, she may have. The nesting could have gone undetected. Alternatively, based on tracked positions and nests at which females were not observed in south Texas, the nesting could have been clutch 6 laid on 21 May or clutch 10 laid on 1 June. In early-June, the turtle moved northward (Fig. 7). She traveled through waters off Texas, Louisiana, Mississippi, Alabama, and Florida and was last located off the west coast of Florida on 21 September 1998.

Transmitter 21811 was deployed on 22 May 1998 on a 1986 year-class returnee that nested that day (Tables 1, 3). This turtle moved extensively in waters off PAIS through mid-June. Although she was not documented nesting again in south Texas during 1998, she may have. The nesting could have gone undetected. Alternatively, based on tracked positions and nests at which females were not observed, the nesting could have been clutch 14 laid at PAIS on 8 June. In mid-June, the turtle moved northward (Fig. 8). She traveled through waters off Texas and Louisiana, remained off Louisiana and Mississippi, and was last located off Louisiana on 29 December 1998.

SEA TURTLE EGG INCUBATION TECHNIQUES

Sea turtle eggs were collected and transported to the PAIS incubation facility as soon as possible after detection. PAIS staff collected all clutches that were laid on Mustang Island and PAIS (Table 5). All Kemp's ridley clutches laid on Mustang Island and PAIS arrived at the PAIS incubation facility on the same day that they were laid. However, the two Kemp's ridley clutches laid on South Padre Island were collected and/or transported by staff from the University of Texas at Pan American Coastal Studies Laboratory or Gladys Porter Zoo on the day after the eggs were laid. Clutch 1 was laid on South Padre Island on 12 April, collected on 12 April, and transported to PAIS on 13 April. Clutch 10 was laid on South Padre Island on 1 June, collected on 2 June, and transported to PAIS on 2 June. All green, loggerhead, and hawksbill clutches arrived at the incubation facility within a maximum of 18 hours after the eggs were laid.

At the PAIS incubation facility, each of the smaller Styrofoam boxes containing the eggs was placed into a larger Styrofoam box. New smaller and larger Styrofoam incubation boxes were purchased, prepared, and used during 1998. Incubation procedures for Kemp's ridley eggs were similar to those used since 1986 (Shaver et al., 1986; 1988a) and for other sea turtle eggs were similar to those used since 1988 (Shaver et al., 1988a; Shaver, 1990; 1992b; 1996c; 1997b, 1998). All sea turtle clutches were held in the incubation facility throughout the incubation period; no eggs were moved to the adjacent laboratory for further temperature control during 1998.

Control box temperatures were monitored at the three shelf heights in the incubation facility throughout the entire time that eggs were held for incubation at PAIS. Incubation and control box temperatures were recorded at hourly intervals using a Data Acquisition System and entered directly into a computerized database.

Attempts were made to elevate incubation temperatures during the middle third of the incubation period in order 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. Such modifications proved successful in producing primarily female Kemp's ridley sea turtles at Padre Island National Seashore from 1985-1988 (Shaver et al., 1988b; Shaver, 1989c).

Attempts were also 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, 1989c; Shaver and Chaney, 1989). Plastic sheeting, plastic shades, foam pads, and cloth quilts were placed over the shed walls to reduce temperature fluctuations, light, and noise within the facility.

Eggs incubated at PAIS from 13 April through 13 September 1998. During that time, a few prolonged episodes of cold temperatures threatened to decrease incubation temperatures to dangerously low levels. A heater was installed on an automatic thermostat to ameliorate the cold temperatures.

During the last third of the incubation period, incubation temperatures could exceed lethal limits due to metabolic heat and high ambient temperatures (Shaver et al., 1987; Shaver, 1989c; 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 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 33.5 C (for *L. kempi*) and 31.5 C (for other species). Generally, lids were removed between 2200 and 0800 h and replaced by 1000 h. This pattern of lid removal decreased temperatures in accordance with thermal cycles that would be experienced by eggs incubated *in situ* (Shaver et al., 1988a; 1988b).

Styrofoam incubation boxes were opened approximately once every two weeks 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. All emerged hatchlings were transferred to other double Styrofoam boxes containing moist sand from PAIS, most on the morning that they were released. Activity levels of the hatchlings were monitored 24 hours a day to determine their appropriate release time. Some turtles entered their infantile frenzy while in Styrofoam boxes but others did not. Hatchlings that entered their infantile frenzy were immediately readied for release. Turtles that did not enter their frenzy in the boxes were evaluated to determine when they were ready for release. All turtles were measured for SLCL and weighed prior to release.

In 1995, the U.S. Fish and Wildlife Service's National Sea Turtle Coordinator determined that hatchlings incubated at the PAIS facility should be released on Closed Beach, PAIS. The Coordinator concluded that releases there would decrease stress to the hatchlings from transportation to other areas, would eliminate disorientation due to condominium and vehicle lights, and might facilitate the return of these turtles to this less-developed area after adulthood is attained. Hatchlings from all clutches were released on the northern end of Closed Beach during early morning hours. The hatchlings were guarded from beach predators

during release. For the second year, actions were employed to lure laughing gulls (*Larus atricilla*) away from the release site, to prevent them from harming any hatchlings. The releases were attended by PAIS staff and volunteers, visitors, and media personnel.

Unhatched eggs were allowed to incubate for up to five days after the remainder of the clutch had hatched. After that time, all unhatched eggs were preserved for later analysis. Unhatched eggs from all clutches were injected with, and stored in, F.A.A. solution. Large embryos were injected with 10% buffered formalin to preserve internal tissues. Eggs were examined and embryos classified according to procedures and guidelines used at PAIS since 1982 (Shaver et al., 1988a; Shaver and Chaney, 1989). Cratz (1982) was used to classify Kemp's ridley embryos and Miller (1985) to classify green, loggerhead, and hawksbill embryos.

INCUBATION OF EGGS LAID ON SOUTH TEXAS BEACHES

Incubation facility temperatures - Comparisons were made between control box temperatures recorded from the three shelf heights in the incubation facility during the time when eggs were incubating at PAIS (Table 6). Since temperatures were not normally distributed, non-parametric procedures were used to make comparisons. Median temperatures of control boxes located on top (29.8 C), middle (29.1 C), and bottom (28.3 C) shelves in 1998 were significantly different (Kruskal-Wallis One Way Analysis of Variance on Ranks, $H = 1972.762$, $df = 2$, $P < 0.001$). 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 - Incubation temperatures for the entire incubation periods of the 21 incubated sea turtle clutches were recorded (Table 6) but not compared due to differences in the dates of egg incubation, numbers of eggs, and various other parameters.

Attempts were made to maintain middle third of the incubation period temperatures slightly above the pivotal temperature for Kemp's ridley (30.2 C) (Shaver et al., 1988b), and green, loggerhead, and hawksbill turtles. These manipulations were apparently successful since the mean middle third of incubation period temperatures for virtually all clutches (Table 6) exceeded the pivotal temperatures for these species.

The incubation period for the Kemp's ridley clutches ranged from 46-52 days, for the green clutches ranged from 49-59 days, for the loggerhead clutches ranged from 56-60 days, and for the hawksbill clutch was 57 days (Table 5). Incubation period was measured as the number of days from egg laying until hatching was detected; generally hatching was detected at pipping but sometimes it was not detected until complete hatchling emergence and frenzy.

One Kemp's ridley clutch (clutch 10) never hatched. This clutch was laid on South Padre Island on 1 June, sometime before the tracks were detected at 1600 h that day, and was collected on 2 June at 1030 h. It is possible that the long time from egg laying to collection contributed to the clutch failure. The lack of visible embryos in the unhatched eggs (Table 8) is consistent with movement induced mortality (Limpus, 1979). However, Kemp's ridley eggs carefully collected several hours to a few days after egg laying can be successfully hatched, as evidenced by a clutch collected by Cynthia Rubio on Boca Chica Beach on 3 June 1996 (laid on 1 June) that had a 92.4% hatch (Shaver, 1997b) and a clutch collected by Cynthia Rubio on South Padre Island on 28 May 1997 (laid on 25 May) that had an 88.8% hatch (Shaver, 1998).

Overall, 63.1% of the 1,270 Kemp's ridley eggs that were incubated at PAIS hatched (Table 5). Of the 802 Kemp's ridley hatchlings produced, 800 were released on the beach and entered the Gulf of Mexico (Table 5). One Kemp's ridley hatchling (clutch 14) succumbed prior to release and one Kemp's ridley

hatchling (clutch 14) that was too weak to enter the surf when placed on the beach was transferred to the University of Texas Marine Sciences Institute (UTMSI) for prolonged care.

Overall, 85.3% of the 511 green turtle eggs incubated at PAIS hatched (Table 5). All 436 hatchlings produced were released on the beach and entered the Gulf of Mexico (Table 5).

Overall, 89.2% of the 212 loggerhead eggs incubated at PAIS hatched (Table 5). Of the 189 loggerhead hatchlings produced, 188 were released on the beach and entered the Gulf of Mexico (Table 5). One loggerhead hatchling (clutch 19) that was too weak to enter the surf when placed on the beach was transferred to UTMSI on 10 September for prolonged care. However, the hatchling succumbed on 13 September and was transported back to PAIS for necropsy.

Overall, 95.7% of the 140 hawksbill eggs incubated at PAIS hatched (Table 5). Of the 134 hawksbill hatchlings produced, 133 were released on the beach and entered the Gulf of Mexico (Table 5). One hawksbill hatchling (clutch 16) that was too weak to enter the surf when placed on the beach was transferred to UTMSI for prolonged care.

SLCLs and weights of live hatchlings from the 12 Kemp's ridley clutches that hatched and from the five green, two loggerhead, and one hawksbill clutches were recorded and summarized (Table 7). SLCLs and weights of the three hatchlings that were sent to UTMSI were included in the descriptive statistics for their three clutches of origin.

After 50 days of incubation no metabolic heat and hatching was detected in clutch 10. The eggs were examined, deemed non-viable, and preserved at that time. The unhatched eggs from all other clutches were preserved after full-term clutch

incubation and were determined to have ceased development at various times during the incubation period (Tables 8, 9).

No obvious external deformities were noted for any of the released sea turtle hatchlings. However, one deformed loggerhead and nine deformed Kemp's ridley embryos were found in unhatched eggs (Table 10).

Gonads were removed for histological sex determination from dead hatchlings and late-staged embryos (Tables 8, 9). Additionally, gonads were removed and analyzed from dead stranded hatchlings that were likely from released clutches, including a green turtle hatchling that was probably from clutch 12 and a Kemp's ridley hatchling that was probably from clutch 17 (Table 14). Gonads were shipped to 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 10 Kemp's ridley, three green, two loggerhead, and one hawksbill clutches. The percent females of the samples analyzed for the 10 Kemp's ridley clutches ranged from 0.0-72.2, with an overall mean percent females for these clutches of 46.1% (Table 11). The percent females of the samples analyzed for the three green turtle clutches ranged from 60.9-100.0%, with an overall mean percent females for these clutches of 76.6% (Table 11). The percent females of the samples analyzed for the two loggerhead clutches were 20.0% and 50.0%, with an overall mean percent females for these clutches of 35.0% (Table 11). The one hawksbill sample analyzed was a female (Table 11).

Kemp's ridley clutch sex ratio estimates were also made based upon the mean middle third of incubation period temperature and incubation period, both of which have been correlated with clutch sex ratio (Shaver et al., 1988b; Shaver, 1989b). Values for the mean middle third of incubation period temperature and incubation period were inserted into equations previously derived correlating these variables

with percent females. 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 percent females estimated for each of the 12 clutches that hatched ranged from 61.5-100.0%, with a mean for those 12 clutches of 83.7% (Table 11). Using the equation correlating percent female with the incubation period [$Y = 772.343 - 14.634X$ (Shaver, 1989b)], the percent females estimated for each of the 12 clutches that hatched ranged from 10.9-98.8%, with a mean for those 12 clutches of 67.0% (Table 11). To estimate the overall percent females produced from the 12 Kemp's ridley clutches that hatched during 1998, mean percent females derived for the 12 clutches based on results from histological sex determination and both equations were compared. The three means varied considerably and ranged from 46.1-83.7% females.

SEA TURTLE STRANDINGS

General - Stranded sea turtles are those individuals located washed ashore or floating, either alive or dead. Stranded sea turtles found on the Texas coast are documented in conjunction with the STSSN and tabulated for the state by the author, who serves at the Texas Coordinator of the STSSN. Stranded sea turtles are located during systematic surveys and in response to information provided by the public, law enforcement officials, and beach workers. In Texas, outside PAIS, systematic surveys for stranded turtles are conducted from one to three times per week. At PAIS, systematic surveys for nestings and strandings are conducted repeatedly each day during the nesting patrol season and systematic surveys for strandings are conducted at least once a week outside the nesting patrol season. Each turtle found is documented on a standardized form and photographed. Live turtles are taken to rehabilitation facilities and dead turtles are often salvaged for specimen collection and/or necropsy. Typically, about 90% of 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 and ninety-six wild turtles (Table 12) and two head started Kemp's ridley turtles (Table 13) were located stranded along the Texas coast from 1 January through 31 December 1998. Fifty-four were located in inshore areas and 342 in offshore areas. Among the 396 wild turtles that were located stranded were 132 Kemp's ridley, 169 loggerhead, 59 green, 6 leatherback, 16 hawksbill, and 14 unknown species turtles.

Both the total number of turtles found stranded in Texas during 1998 and the number found stranded offshore in Texas during 1998 were the fourth highest annual totals since the STSSN was established. Annual stranding totals for each of the five sea turtle species during 1998 were the third to eighth largest in network history.

The 342 turtles found offshore in Texas during 1998 included none found in Shrimp Statistical Zone 17, 74 in Zone 18, 35 in Zone 19, 130 in Zone 20, and 103 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 1998 (233) exceeded the total numbers found stranded in Zones 20 and 21 during all other years. One hundred-thirty stranded turtles were found offshore at Padre Island National Seashore, 38% of the total number found stranded on Texas offshore beaches in 1998.

Strandings were more numerous in March and April than during any other months in 1998 (Table 12, Fig. 9). Far more turtles were located stranded in March than are usually found stranded in Texas offshore areas during that month. Strandings in March and April were concentrated in Zones 20 and 21 and strandings from mid-July through December were distributed throughout the state. Fewer turtles were found stranded on the Texas coast during July, August, September, and October 1998 than found during those same months in 1997. However, November stranding numbers were nearly the same during 1997 and 1998.

During both 1997 and 1998, a brief stranding pulse occurred in Zones 20 and 21 in early November.

Of the 396 stranded turtles, 54 were found alive and 342 were found dead. The 342 dead individuals included 36 that were fresh dead (code 1), 124 that were moderately decomposed (code 2), 146 that were severely decomposed (code 3), 21 that were a dried carcass (code 4), nine that were only a skeleton (code 5), and six that were unknown (code 9). Part or all of 190 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.

From January 1 through 31 December 1998, 51 of the 342 turtles found stranded offshore were linked to likely stranding causes (12 entangled in fishing line or onion sacs; nine with hooks imbedded in their throat, flippers, or digestive tract; four with boat propeller injuries; one with a large amount of ingested monofilament line; one with a large amount of ingested marine debris; 12 hatchlings and post-hatchlings that drifted onto shore with currents; two wedged in rocks; and, 10 in an emaciated condition). Thirty-two of the 54 turtles found stranded inshore were linked to likely stranding causes (12 hypothermic stunned; two entangled in fishing line; three with hooks imbedded in their throat, flippers, or digestive tract; seven with boat propeller injuries; four wedged in rocks; two in an emaciated condition; one dredge injury; and, one with a possible bullet injury). The bullet and propeller injuries could have been inflicted either pre- or post-mortem. Some stranded turtles found during 1998 had signs of interactions with sharks and other animals, but these injuries could have been the result of post-mortem scavenging.

As during many previous years (Shaver, 1994b; 1995b; 1996d; in press c), strandings increased in offshore areas during the spring (Shaver, 1995b), decreased when Gulf of Mexico waters off the Texas coast were closed to shrimp

trawling from 15 May through 8 July (Texas Closure), and increased after shrimp trawling resumed in the Gulf (Table 12, Fig. 9). During 1998, offshore strandings were far less numerous during the Texas Closure than before the Closure, as typically occurs. The total number of stranded turtles located on offshore beaches during the seven complete weeks before the Texas Closure in 1998 (125) exceeded the number found during that same time period in all other years except 1994 (143). However, the spike in strandings that is usually found after the Closure was greatly diminished in comparison to most recent years. Increased turtle excluder device (TED) enforcement activities were conducted in 1998, beginning in April.

Strandings of adult Kemp's ridley turtles - Thirty-seven adult Kemp's ridleys (> 60.0 cm SLCL) were located stranded on the Texas coast from 1 January through 21 December 1998. The 37 far exceeded the number found during each year since the STSSN was established in 1980; the second highest annual total number of adult Kemp's ridleys documented stranded on the Texas coast was 26, found in 1997. All 37 (including 12 females, 18 males, and seven undetermined sex) were located dead. The 37 comprised 28% of the 132 Kemp's ridleys found stranded in Texas during 1998. Unfortunately, more adult Kemp's ridleys are 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 (Figs. 3-8). Forty adult Kemp's ridleys were found stranded in the U.S. during 1998; all were located dead. Thirty-seven of the 40 (93%) were found in Texas, one in Louisiana, one in south Florida, and one in North Carolina. Thirty-eight of the 40 were found offshore and two were found inshore. Thirty-three of the 40 (83%) were located offshore in Zones 20 and 21.

Twenty-four of the 37 dead adult Kemp's ridleys found in Texas were located at PAIS, where nine of the 13 confirmed Kemp's ridley nests in the U.S. were found during 1998. Of the 24 dead adults found at PAIS, 14 were located between

March and July, during the Kemp's ridley mating and nesting seasons in 1998. In contrast, at the primary nesting beach in Mexico, Rancho Nuevo, six dead adults and 2,397 nests were tallied during 1998. Thus, for this time period, the number of dead adult Kemp's ridleys per Kemp's ridley nest was 620 times higher for PAIS than for Rancho Nuevo, where near shore waters are closed to shrimp trawling during the entire nesting season. Of the 33 dead adult Kemp's ridleys located stranded offshore on the Texas coast, in Zones 20 and 21 during 1998, 19 were found before the Texas Closure, none during the Texas Closure, and 14 after the Texas Closure. Roughly half of this mortality occurred in the Kemp's ridley mating and nesting seasons (Fig. 10) and, as found during 1997, nesting did not begin on the south Texas coast until adult deaths subsided here (Shaver, 1998).

Since 1992, offshore strandings of adult Kemp's ridleys in Texas have consistently been concentrated in Zones 20 and 21. From 1995-1998, when increased Kemp's ridley nesting was detected on the Texas coast, 77 dead adult Kemp's ridleys were found stranded offshore in Zones 20 and 21, 84% of the total number of dead adults found stranded offshore in Texas during those years. Roughly half were females and the loss of each female represents a loss of up to three clutches/nesting season, potentially for many years of nesting. Some of these females would likely have nested in south Texas and their deaths likely reduced Kemp's ridley nestings in south Texas. The success of efforts to establish a secondary nesting colony of Kemp's ridleys at PAIS could be threatened by continued mortality of adults in waters offshore from south Texas nesting beaches (Shaver, in press b).

Strandings of hatchlings - The number of hatchlings and post-hatchlings (hereafter referred to as hatchlings) found stranded on south Texas beaches during each year since 1980 has varied greatly. A considerable increase in these strandings occurred during 1990, when 53 were found on North Padre and Mustang Islands (Shaver, 1990). Since that time PAIS and UTMSI have expended considerable

effort to detect and rehabilitate these small stranded turtles.

Fourteen hatchlings were found stranded along the Texas coast during 1998. All were found in south Texas, including six on Mustang Island, five on North Padre Island (including PAIS), two on Boca Chica Beach, and one on South Padre Island (Table 14). Among the 14 were 11 Kemp's ridley, two green, and one hawksbill hatchlings. As during 1990-1997, most of the hatchlings were located by pedestrians in heavily visited beach areas (Shaver, 1990; 1991; 1992b; 1993; 1994a; 1996c; 1997b; 1998).

Stranding locations and dates were noted for each hatchling and most were measured for SLCL, SLCW, CCL, CCW, and weight (Table 14). To assess possible age and origin of the hatchlings, most were examined for the presence of an umbilical scar, egg tooth, internal yolk (if dead), gut contents (if dead), wounds, and epizoans (Table 14). Additionally, most that were found dead or died during rehabilitation were necropsied in an attempt to determine cause of death and remove gonads for histological sex determination. Gonads were shipped to Texas A&M University, Veterinary Diagnostic Laboratory, where histology was used to determine the gender of the dead hatchlings (Table 14).

Three of the stranded hatchlings (CM-98-22, LK-98-46, and the hawksbill) may have originated from clutches that were laid, incubated, and released at PAIS. Each was the size of a newly hatched turtle (Table 7) and possessed a prominent umbilical scar and egg tooth (Table 14). It is unlikely that they had been in the water for several days prior to stranding since each was without epizoans and the two dead individuals both had relatively large quantity of internal yolk and no gut contents. The green turtle hatchling (CM-98-22) was a female located dead on North Padre Island, 3.2 km north of PAIS, on 23 July. This hatchling was probably from clutch 17, which was released at PAIS on 23-24 July. A live, male Kemp's ridley hatchling (LK-98-46) was found stranded on North Padre Island,

near Access Road 6, on 4 August. The hatchling was taken to UTMSI for rehabilitation but died on 6 August. This hatchling was probably from clutch 17, which was released at PAIS on 2-3 August. A live hawksbill hatchling was found stranded on Mustang Island, just south of the south jetty, on 13 August. This hatchling almost certainly was from clutch 16 (the only confirmed hawksbill clutch documented on the Texas coast), which was released at PAIS on 9-13 August. CM-98-22 and the hawksbill hatchling were excluded from STSSN stranding totals because they could more conclusively be linked to released clutches. In contrast, the Kemp's ridley hatchling was included in STSSN totals since Kemp's ridley nestings and strandings of very small hatchlings are more frequent on the Texas coast and reduce confidence in linkage to a specific released clutch.

Based on the size and various attributes of the other 11 stranded hatchlings, it is unlikely that any of them originated from nests deposited along the Texas coast that were either incubated at PAIS or were not detected.

FUTURE PLANS

PAIS will continue public education programs, beach patrols, protection and monitoring of nesting sea turtles and nests, and satellite tracking of nesting Kemp's ridley turtles during 1999. It is hoped that PAIS employees will comprise the majority of the patrol force. However, attempts will be made to continue volunteer participation in this project. At least one base camp will be operated throughout the entire patrol season, to increase the effectiveness of the patrol program. ATVs will continue to be the vehicle type used to conduct most patrols. PAIS staff members and others will continue to protect clutches laid on the Texas coast that are threatened by various factors. Operation of the PAIS sea turtle egg incubation facility, the only such facility on the Texas coast, will continue. PAIS participation in the Sea Turtle Stranding and Salvage Network will continue and the author will continue to serve as the Texas Coordinator for the STSSN.

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Table 1. Locations and dates of the 21 confirmed sea turtle nests detected along the Texas coast during 1998.

Clutch Number	Species	Nest Site ¹	How Located	Time Tracks or Turtle	
				Lay Date	Detected (h)
1	LK	SPI-16.9 km N. of end of paved rd.	Turtle-public	12 April	unknown
2	LK	MI-post #5, Port Aransas	Turtle-public	25 April	0835
3	LK	PAIS-72.4 km marker	Turtle-patroller	25 April	1010
4	LK	PAIS-12.2 km marker	Turtle-public	10 May	0845
5	LK	PAIS-37.0 km marker	Tracks-patroller	15 May	1215
6	LK	PAIS-92.5 km marker	Tracks-patroller	21 May	1045
7	LK	MI-marker 37, Port Aransas	Turtle-public	21 May	1402
8	LK	PAIS-27.4 km marker	Turtle-patroller	22 May	1500
9	LK	PAIS-44.2 km marker	Turtle-patroller	31 May	0945
41 10	LK	SPI-41.4 km N. of Braz. Sant. Pass	Tracks-public	1 June	1600
11	LK	PAIS-46.7 km marker	Turtle-patroller	2 June	1830
12	CM	PAIS-37.5 km marker	Tracks-public	3 June	0800
13	CM	PAIS-87.7 km marker	Tracks-patroller	7 June	1049
14	LK	PAIS-57.9 km marker	Tracks-patroller	8 June	1440
15	CM	PAIS-78.8 km marker	Tracks-patroller	10 June	0830
16	EI	PAIS-95.3 km marker	Tracks-patroller	14 June	0900
17	LK	PAIS-69.2 km marker	Turtle-public	15 June	0920
18	CC	PAIS-66.0 km marker	Tracks-patroller	4 July	0815
19	CC	PAIS-7.2 km marker	Tracks-patroller	14 July	0700
20	CM	PAIS-64.4 km marker	Tracks-patroller	18 July	0745
21	CM	PAIS-67.6 km marker	Tracks-patroller	18 July	0900

¹ PAIS = Padre Island National Seashore; MI = Mustang Island; SPI = South Padre Island.

Table 2. Measurements and tags^{1,2} on the six Kemp's ridley sea turtles that nested along the Texas coast and were examined by biologists from Padre Island National Seashore during 1998.

Clutch Number	SLCL (cm)	SLCW (cm)	CCL (cm)	CCW (cm)	Tags present				Tags applied	
					PIT	Mag-netic	Living	Tag Scar	Metal	PIT
2	62.9	60.9	66.7	69.2	-	RF	LC5	RF	LF:SSQ091 LR:SSQ090	LF:4130604072
3	62.0	58.9	-	-	-	-	-	-	LF:SSQ092	LF:4130442013
4	66.3	62.2	69.1	71.2	LF:4039412708	-	-	RF,LF	LF:SSQ094 LR:SSQ095	-
8	61.0	59.4	64.1	68.0	-	LF	N4	RF	LF:SSQ096 LR:SSQ097	LF:41304D3A5C
9	63.8	62.3	66.2	69.2	-	-	-	-	LF:SSQ103 LR:SSQ104	LF:41307E4022
11	59.7	59.2	62.3	67.3	-	LF	RC1	RF	LF:SSQ098 LR:SSQ099	LF:4130764833

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

² Living tags that were present on scutes left costal 5 (LC5), neural 4 (V4), and right costal 1 (RC1).

Table 3. Comments regarding six Kemp's ridley sea turtles that nested along the Texas coast and were examined by biologists from Padre Island National Seashore during 1998.

Clutch Number	Year-Class (if Returnee)	Serum Testosterone (pg/ml)	Satellite Transmitter (if Applied)	Comments
2	1984	25.3	7689	Nested again on 22 May 98 (see clutch 7), small notch on left side of carapace
3	-	19.8	7681A	-
4	-	20.8	7685A	Previously nested and tagged in Tepehuajes, Mexico as a neophyte on 23 April 1996
8	1986	20.1	21811	Missing a piece of the left rear side of the carapace
43 9	-	4.25	-	-
11	1987	24.6	-	-

Table 4. Locations and dates of the eight confirmed sea turtle false crawls detected along the Texas coast during 1998.

Suspected Species	Location ¹	How Located	Date	Time Detected (h)	Comments
LK	PAIS-70.8 mi marker	Tracks-patroller	29 April	1530	U-shaped
LK	PAIS-14.2 mi marker	Tracks-patroller	2 June	0725	U-shaped
LK	PAIS-94.9 mi marker	Tracks-patroller	2 June	1445	extend base dunes
LK	PAIS-74.8 mi marker	Tracks-patroller	2 June	1600	extend mid-beach
LK	PAIS-Malaquite Visitor Center	Tracks-patroller	3 June	0640	U-shaped
LK	PAIS-1.6 mi N. Ranger Road	Tracks-patroller	3 June	0650	U-shaped
CM	PAIS-45.5 mi marker	Tracks-patroller	30 June	0900	extend base dunes
CM	PAIS-69.7 mi marker	Tracks-patroller	4 July	0845	extend mid-beach

¹ PAIS = Padre Island National Seashore; MI = Mustang Island; SPI = South Padre Island.

Table 5. Incubation and hatching information for the 21 confirmed sea turtle nests detected along the Texas coast during 1998.

Clutch Number	Number of Eggs Incubated ¹	Hatch Date	Incubation Period (Days)	Percent of Eggs Hatched ²	Number Hatchlings Died Prior to Release	Number Hatchlings Released ³	Hatchling Release Dates	Number Hatchlings Retained ⁴	
45	1	97	2 June	52	47.4	0	46	3-4 June	0
	2	97	10 June	47	77.3	0	75	13 June	0
	3	93	11 June	48	92.5	0	86	13-14 June	0
	4	106	27 June	49	51.9	0	55	27-30 June	0
	5	79	30 June	47	79.7	0	63	3 July	0
	6	105	6 July	47	98.1	0	103	7-8 July	0
	7	101	7 July	48	41.6	0	42	9 July	0
	8	98	10 July	50	31.6	0	31	11 July	0
	9	96	17 July	48	29.2	0	28	19 July	0
	10	92	-	-	0.0	0	0	-	0
	11	93	19 July	48	97.8	0	91	21 July	0
	12	114	21 July	49	93.0	0	106	23-24 July	0
	13	108	25-26 July	49-50	70.4	0	76	26-29 July	0
	14	102	25 July	48	76.5	1	76	26-28 July	1
	15	70	29 July-7 Aug.	50-59	68.6	0	48	30 July-13 Aug.	0
	16	140	9 Aug.	57	95.7	0	133	9-13 Aug.	1
	17	111	30 July	46	93.7	0	104	2-3 Aug.	0
	18	102	31 Aug.-1 Sept.	59-60	80.4	0	82	1-2 Sept.	0
	19	110	7-8 Sept.	56-57	97.3	0	106	8-10 Sept.	1
	20	91	9-11 Sept.	54-56	95.6	0	87	10-13 Sept.	0
	21	128	9 Sept.	54	93.0	0	119	9-10 Sept.	0

¹ Does not include one additional egg from clutches 8, 12, and 17 that were broken and not incubated.

Total number of eggs incubated: 1,270 LK, 511 CM, 212 CC, and 140 EI = 2,133 eggs all species.

² Calculated based on the number of eggs incubated.

Total hatched: 63.1% (802/1,270) LK; 85.3% (436/511) CM; 89.2% (189/212) CC; 95.7% (134/140).

³ Hatchlings that successfully entered the surf.

Total number of hatchlings released: 800 LK, 436 CM, 188 CC, and 133 EI = 1,557 all species.

⁴ Hatchlings measured but too weak to enter the surf and were transferred to UTMSI for prolonged care.

Table 6. Temperatures (Celsius) recorded at Padre Island National Seashore for clutch incubation boxes and control boxes during 1998¹.

Temperature Measured	Entire Incubation Period				Middle Third of Incubation Period			
	N	Range	Mean(S.E.)	Median	N	Range	Mean(S.E.)	Median
Clutch 1	1,179	26.9-33.4	30.8(0.0)	31.0	407	29.6-32.2	30.9(0.0)	31.0
Clutch 2	1,169	23.8-36.1	31.3(0.1)	30.8	360	29.8-31.8	30.7(0.0)	30.7
Clutch 3	1,169	24.3-34.7	31.0(0.1)	30.7	384	29.7-32.0	30.7(0.0)	30.7
Clutch 4	1,129	25.3-34.7	31.1(0.1)	31.1	384	28.5-34.1	31.2(0.1)	31.3
Clutch 5	1,083	27.5-34.7	30.7(0.1)	30.9	360	28.9-33.4	31.0(0.0)	31.1
Clutch 6	1,081	27.7-36.1	31.5(0.1)	31.2	348	28.8-32.9	31.0(0.0)	31.0
Clutch 7	1,120	27.6-34.5	30.7(0.0)	30.8	372	28.6-33.0	30.8(0.0)	30.8
Clutch 8	1,157	27.4-33.5	30.6(0.0)	30.9	372	29.3-32.6	30.9(0.0)	30.9
Clutch 9	1,114	27.8-32.9	30.4(0.0)	30.4	372	29.2-31.9	30.4(0.0)	30.4
Clutch 10	1,137	28.0-34.6	29.8(0.0)	29.8	N/A	N/A	N/A	N/A
Clutch 11	1,122	28.1-34.6	31.0(0.1)	31.1	379	29.6-33.2	31.1(0.0)	31.1
Clutch 12A	1,147	27.7-33.6	30.2(0.0)	30.0	379	28.4-31.6	30.0(0.0)	30.0
Clutch 12B	1,147	27.9-33.9	30.6(0.0)	30.4	379	28.9-32.3	30.5(0.0)	30.4
Clutch 13A	1,138	27.9-33.9	30.6(0.0)	30.9	382	29.2-33.4	30.9(0.0)	30.9
Clutch 13B	1,160	28.2-33.7	30.9(0.0)	31.0	382	29.7-33.4	31.1(0.0)	31.0
Clutch 14	1,100	28.2-34.1	31.3(0.0)	31.5	382	30.1-33.5	31.6(0.0)	31.5
Clutch 15A	1,327	26.7-30.7	29.0(0.0)	28.9	455	27.9-30.5	29.0(0.0)	28.9
Clutch 15B	1,140	27.9-33.6	30.7(0.0)	30.8	384	29.2-32.5	30.7(0.0)	30.7
Clutch 16A	1,316	28.1-33.6	30.4(0.0)	30.0	455	28.6-32.1	30.1(0.0)	30.0
Clutch 16B	1,317	27.8-32.7	30.1(0.0)	30.0	455	28.7-31.6	30.0(0.0)	29.9
Clutch 17	1,059	28.7-35.3	31.2(0.1)	30.5	360	29.1-33.2	30.8(0.1)	30.7
Clutch 18A	1,309	27.7-31.2	29.5(0.0)	29.6	443	28.0-31.2	29.8(0.0)	29.8
Clutch 18B	1,324	27.3-31.3	29.4(0.0)	29.5	467	27.9-31.3	29.8(0.0)	29.8
Clutch 19A	1,256	27.2-31.7	29.8(0.0)	29.7	401	27.2-30.8	29.3(0.0)	29.3
Clutch 19B	1,232	27.6-32.0	29.8(0.0)	29.7	377	27.6-31.0	29.4(0.0)	29.4
Clutch 20A	1,176	27.2-31.3	29.6(0.0)	29.6	377	27.2-31.3	29.7(0.0)	29.8
Clutch 20B	1,213	27.1-30.9	29.1(0.0)	29.1	377	27.1-30.9	29.4(0.0)	29.4
Clutch 21A	1,176	27.0-31.9	29.6(0.0)	29.5	377	27.0-31.0	29.4(0.0)	29.6
Clutch 21B	1,176	27.0-32.6	29.8(0.0)	29.8	377	27.0-31.2	29.6(0.1)	29.7
Control 1	3,489	23.8-32.4	29.5(0.0)	29.8				
Control 2	3,489	24.2-31.5	28.7(0.0)	29.1				
Control 3	3,489	23.9-30.8	28.0(0.0)	28.3				

¹ Control 1 = control box on top shelf of PAIS incubation facility.
Control 2 = control box on middle shelf of PAIS incubation facility.
Control 3 = control box on bottom shelf of PAIS incubation facility.

Table 7. Lengths and weights of live hatchlings from clutches detected along the Texas coast during 1998.

Clutch Number	N ¹	Straight-line Carapace Length (mm)			Weight (g)		
		Range	Mean(S.E.)	Median	Range	Mean(S.E.)	Median
1	46	35.14-44.29	41.61(0.30)	42.37	9.94-17.36	15.49(0.22)	15.85
2	75	38.78-45.38	43.05(0.16)	43.25	14.73-18.43	17.05(0.11)	17.24
3	86	39.27-43.44	41.59(0.10)	41.67	13.78-18.56	16.39(0.10)	16.32
4	55	37.37-44.41	41.50(0.24)	42.17	13.87-18.03	16.31(0.17)	16.59
5	63	38.80-45.77	42.15(0.18)	42.08	12.64-17.44	15.83(0.13)	15.85
6	103	38.68-45.04	42.47(0.11)	42.47	14.58-18.63	16.71(0.08)	16.77
7	42	39.32-44.95	42.06(0.19)	42.17	13.78-17.47	15.43(0.13)	15.26
8	31	38.56-44.31	41.21(0.29)	41.44	11.84-16.47	14.42(0.18)	14.28
9	28	33.10-46.99	44.57(0.56)	45.51	15.74-22.53	19.70(0.31)	19.69
10	0	-	-	-	-	-	-
11	91	39.93-44.21	42.36(0.09)	42.45	15.86-18.99	17.44(0.07)	17.49
12	106	46.46-54.80	52.03(0.14)	52.35	22.25-28.33	26.07(0.12)	26.31
13	76	47.45-55.16	51.49(0.20)	51.52	23.53-31.15	27.50(0.18)	27.75
14	77	36.99-44.32	40.77(0.18)	40.98	12.20-17.83	15.68(0.13)	15.74
15	48	46.91-52.61	49.95(0.25)	50.02	22.80-31.87	28.22(0.28)	28.58
16	134	42.12-48.65	46.02(0.10)	46.18	15.40-22.41	20.48(0.07)	20.55
17	104	37.75-43.34	41.38(0.11)	41.41	13.50-18.47	16.28(0.09)	16.30
18	82	42.11-48.39	46.14(0.16)	46.32	19.01-24.44	21.83(0.13)	21.94
19	107	40.41-48.40	45.14(0.17)	45.11	17.47-22.96	20.84(0.12)	20.94
20	87	49.22-54.10	51.91(0.11)	51.97	24.27-27.87	26.42(0.08)	26.35
21	119	52.52-56.70	54.74(0.08)	54.76	28.76-32.27	30.38(0.07)	30.42

¹ N = number measured.

Table 8. Results of analyses of unhatched Kemp's ridley eggs^{1,2} and histological sex determination for Kemp's ridley clutches detected along the Texas coast during 1998.

Parameter	Clutch Number												
	1	2	3	4	5	6	7	8	9	10	11	14	17 ³
<u>Analyses of unhatched eggs</u>													
no. unhatched	51	22	7	51	16	2	59	67	68	92	2	24	7
no. infertile	1	1	0	2	1	0	4	7	1	1	0	1	0
no. fertile w/o embryos	16	5	4	2	2	2	10	17	64	91	0	3	1
no. decomposed embryos	0	0	0	0	0	0	0	0	0	0	0	0	0
no. stage 11 embryos	1	0	0	1	1	0	0	2	0	0	1	1	0
no. stage 12 embryos	0	0	0	0	0	0	0	1	0	0	0	0	1
no. stage 13 embryos	0	0	0	0	0	0	1	0	0	0	0	0	0
no. stage 16 embryos	0	0	0	0	0	0	0	0	1	0	0	0	0
no. stage 19 embryos	0	0	0	1	0	0	4	2	0	0	0	0	0
no. stage 20 embryos	0	0	0	0	0	0	0	1	0	0	0	0	0
no. stage 21 embryos	0	0	0	1	0	0	1	0	0	0	0	0	0
no. stage 22 embryos	0	0	0	1	0	0	2	4	0	0	0	0	0
no. stage 23 embryos	0	0	0	2	0	0	1	0	0	0	0	0	0
no. stage 24 embryos	0	0	0	1	0	0	0	0	0	0	0	0	0
no. stage 25 embryos	1	0	0	0	0	0	0	0	0	0	0	0	0
no. stage 26 embryos	0	0	0	0	0	0	2	0	0	0	0	0	0
no. stage 27 embryos	2	2	0	3	1	0	7	4	0	0	1	0	0
no. stage 28 embryos	3	0	0	8	0	0	6	4	0	0	0	0	0
no. stage 28-29 embryos	12	2	0	10	4	0	6	12	1	0	0	9	0
no. stage 29 embryos	7	4	0	5	0	0	4	9	0	0	0	0	0
no. stage 29-30 embryos	3	3	3	5	7	0	4	3	1	0	0	5	3
no. stage 30 embryos	5	5	0	9	0	0	7	1	0	0	0	5	2
no. stage 31 embryos	0	0	0	0	0	0	0	1	0	0	0	0	0
<u>Histological sex determination for late-staged embryos and dead hatchlings³</u>													
no. analyzed	25	12	3	20	10	0	18	15	1	0	0	18	5
no. males	8	8	2	8	4	0	5	7	1	0	0	8	4
no. females	17	4	1	12	6	0	13	8	0	0	0	10	1

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

² Twins (stage 27 and stage 28-29) were found in one egg from clutch 8.

³ A stranded hatchling found on North Padre Island on 4 August that was probably from clutch 17 (released PAIS on 2-3 August) that was transported to UTMSI for rehabilitation (died 6 August) was included in sex determination results for this clutch.

Table 9. Results of analyses of unhatched green, loggerhead, and hawksbill eggs¹ and histological sex determination for green, loggerhead, and hawksbill clutches detected along the Texas coast during 1998.

Parameter	Clutch Number							
	12	13	15	16	18	19	20	21
<u>Analyses unhatched eggs</u>								
no. unhatched	8	32	22	6	20	3	4	9
no. infertile	0	0	0	1	0	0	1	1
no. fertile w/o embryos	8	4	4	3	6	2	3	5
no. decomposed embryos	0	0	0	0	0	0	0	0
no. stage 18 embryos	0	0	0	0	1	0	0	0
no. stage 20 embryos	0	0	0	0	1	0	0	0
no. stage 21 embryos	0	0	0	0	2	0	0	1
no. stage 23 embryos	0	1	0	0	0	0	0	1
no. stage 24 embryos	0	0	0	0	2	0	0	0
no. stage 25 embryos	0	0	0	0	1	0	0	1
no. stage 26 embryos	0	0	0	1	0	0	0	0
no. stage 27 embryos	0	1	2	0	0	0	0	0
no. stage 28 embryos	0	4	4	0	0	0	0	0
no. stage 29 embryos	0	22	9	1	4	1	0	0
no. stage 30 embryos	0	0	3	0	3	0	0	0
<u>Histological sex determination for late-staged embryos and dead hatchlings²</u>								
no. analyzed	1	23	16	1	5	2	0	0
no. males	0	9	5	0	4	1	0	0
no. females	1	14	11	1	1	1	0	0

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

² A dead stranded green turtle hatchling found on North Padre Island on 23 July that was probably from clutch 12 (released PAIS on 23-24 July) and a loggerhead hatchling from clutch 19 that was too weak to enter the surf when released and was sent to UTMSI for prolonged care on 10 September (died on 13 September) were included in sex determination results for these clutches.

Table 10. Deformed embryos found within unhatched sea turtle eggs from those 21 clutches detected along the Texas coast during 1998.

Clutch Number	Species	Stage	Deformity Observed
1	LK	28-29	Partial albino (white except for tips of flippers), no eyes, no upper jaw
4	LK	21	Partial albino (white except for tips of flippers), no egg tooth, no snout
7	LK	28	Saddleback
8	LK	20	No snout
8	LK	22	Crossed jaw
9	LK	16	Right front flipper extends from anterior top of carapace, left front flipper tiny, no head
9	LK	29-30	Partial albino (white except for tips of flippers), no upper jaw, eyes pointed in corners
11	LK	27	Snout missing, lacking most pigment
17	LK	29-30	Saddleback
18	CC	29	Snout twisted, part of upper jaw missing, top of head and eyes missing

Table 11. Estimated and identified sex ratios for sea turtle clutches detected along the Texas coast during 1998.

Clutch Number	Estimated % Female Based on Temperature ¹	Estimated % Female Based on Incubation Period ²	Identified % Female Based on Histology ³
1	83.8	10.9	68.0
2	74.9	84.1	33.3
3	74.9	69.5	33.3
4	97.2	54.8	60.0
5	88.3	84.1	60.0
6	88.3	84.1	-
7	79.4	69.5	72.2
8	83.8	40.2	53.3
9	61.5	69.5	0.0
10	-	-	-
11	92.8	69.5	-
12	-	-	100.0
13	-	-	60.9
14	100.0	69.5	55.6
15	-	-	68.8
16	-	-	100.0
17	79.4	98.8	20.0
18	-	-	20.0
19	-	-	50.0
20	-	-	-
21	-	-	-
Overall ⁴			
<i>L. kempi</i>	83.7	67.0	46.1
<i>C. mydas</i>			76.6
<i>C. caretta</i>			35.0
<i>E. imbricata</i>			100.0

¹ Calculated using equation relating % female and mean middle third of incubation period temperature for Kemp's ridley (Shaver et al., 1988b).

² Calculated using equation relating % female and incubation period for Kemp's ridley (Shaver, 1989b).

³ 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).

⁴ Mean for the 10 Kemp's ridley, three green, and two loggerhead clutches from which samples were analyzed and percentage for one hawksbill clutch from which samples were analyzed.

Table 12. Wild sea turtles found stranded along the Texas coast during 1998.

Species	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sep.	Oct.	Nov.	Dec.	Total
CC	4	2	29	35	16	8	22	18	9	6	13	7	169
LK	4	5	20	38	15	4	15	7	8	4	9	3	132
CM	1	3	3	9	7	6	8	5	4	2	2	9	59
DC	0	0	1	1	4	0	0	0	0	0	0	0	6
EI	1	1	1	0	5	3	0	1	1	1	0	2	16
UN	0	0	3	4	0	0	2	2	0	0	0	3	14
Total	10	11	57	87	47	21	47	33	22	13	24	24	396

CC = Loggerhead (*Caretta caretta*)
 LK = Kemp's ridley (*Lepidochelys kemp*i)
 CM = Green (*Chelonia mydas*)
 DC = Leatherback (*Dermochelys coriacea*)
 EI = Hawksbill (*Eretmochelys imbricata*)
 UN = Unknown

Table 13. Head started Kemp's ridley sea turtles found stranded along the Texas coast during 1998.

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

Table 14. Sea turtle hatchlings and post-hatchlings (<10.0cm SLCL) found stranded on the Texas coast during 1998.

I.D.	Species	SLCL (cm)	SLCW (cm)	CCL (cm)	CCW (cm)	Weight (g)	Stranding Location ¹	Stranding Date	Condition Facility ²	Fate ³	Sex ⁴	Comments ⁵
LK	LK	4.5	4.2	5.2	5.1	16	MI, Mayan Princess Condominium	24 June	live UTRF	H	U	ep, wf
LK-98-55	LK	4.9	4.4	5.0	5.5	19	NPI, Holiday Inn	27 June	live UTRF	D 3 July	F	us, ep, wf, g
LK	LK	4.4	4.4	-	-	-	BCB	2 July	live GPZ	D 3 July	U	wu
Parky	LK	5.0	4.5	5.1	5.5	21	MI, Mustang Island State Park	4 July	live UTRF	H	U	ep, wf
LK-98-41b	LK	5.2	4.9	5.5	6.0	-	NPI, 2.4 km S. of Bob Hall Pier	4 July	dead	-	F	us, ep, wf, g
LK	LK	4.8	4.3	4.8	4.7	18	PAIS, 1.6 km marker	5 July	live UTRF	H	U	ep, wu
LK	LK	4.8	4.4	4.8	5.3	18	BCB, close to jetties	5 July	live GPZ	H	U	wu
LK	LK	4.8	4.6	4.9	5.3	17	MI, 1.9 km S. of Access Rd. 2	6 July	live UTRF	H	U	wh
53 CM-98-22 ⁶	CM	5.3	4.0	-	-	25	NPI, 3.2 km N. of PAIS	23 July	dead	-	F	et, us, y, wf
LK-98-46 ⁶	LK	4.2	3.6	4.5	4.4	13	NPI, Access Rd. 6	4 Aug.	live UTRF	D 6 Aug.	M	et, us, y, wf
EI ⁶	EI	4.8	3.7	5.1	4.8	22	MI, just S. of south jetty	13 Aug.	live UTRF	H	U	et, us
Wally jr.	LK	6.3	5.8	6.6	7.1	39	MI, Mustang Island State Park	23 Aug.	live UTRF	H	U	ep, wh
CM	CM	7.0	5.5	7.0	6.5	-	SPI	6 Sept.	live	D 10 Sept.	U	
LK	LK	8.2	7.0	8.6	8.8	85	MI, Mustang Island State Park	17 Oct.	live UTRF	H	U	wu

¹ NPI = North Padre Island, PAIS = Padre Island National Seashore, MI = Mustang Island, BCB = Boca Chica Beach, SPI = South Padre Island

² UTRF = University of Texas Marine Sciences Institute rehabilitation facility, GPZ = Gladys Porter Zoo

³ D = died, H = still being held for rehabilitation

⁴ M = male, F = female, U = unknown

⁵ y = internal yolk, et = egg tooth, us = umbilical scar, ep = epizoon, wf = fresh external wounds, wh = healed external wounds, wu = wounds (unknown fresh or healed), g = gut contents present

⁶ CM-98-22 likely from clutch 12, LK-98-46 likely from clutch 17, EI likely from clutch 16



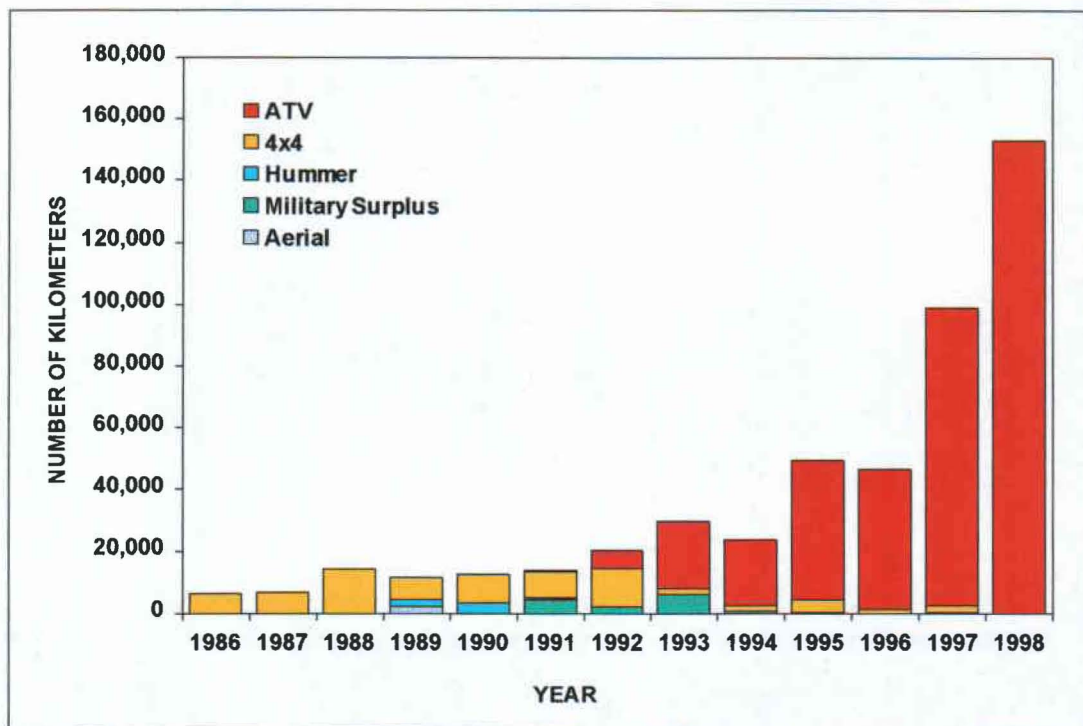


Figure 1. Number of kilometers patrolled on North Padre Island, Texas from 1986-1998.

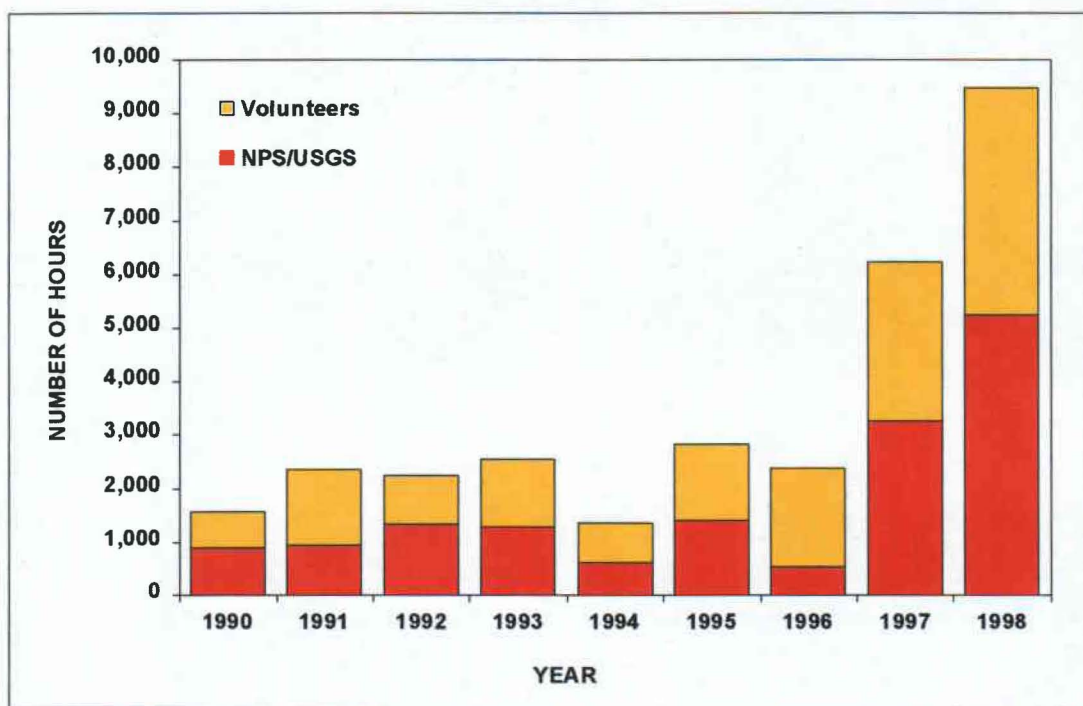


Figure 2. Number of hours various groups spent conducting patrols on North Padre Island, Texas from 1990-1998.

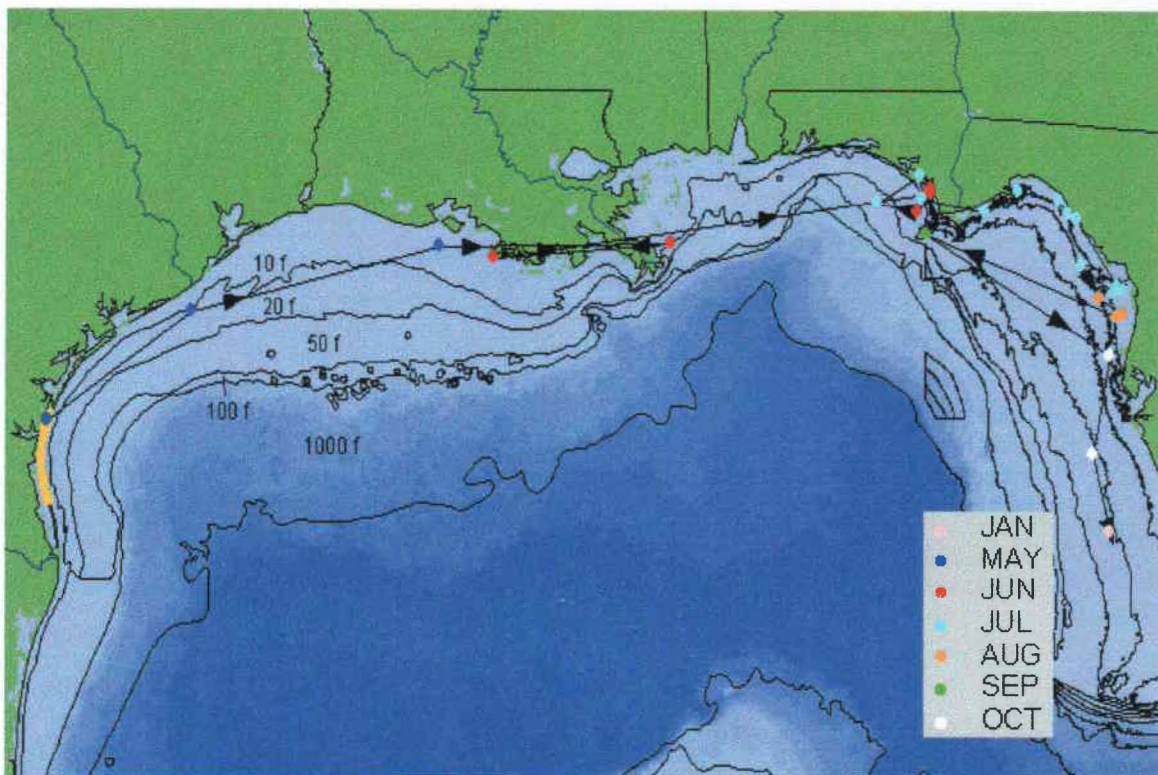


Figure 5. Movements of a Kemp's ridley sea turtle after deployment of transmitter 7685A, 10 May 1998 – 5 January 1999.

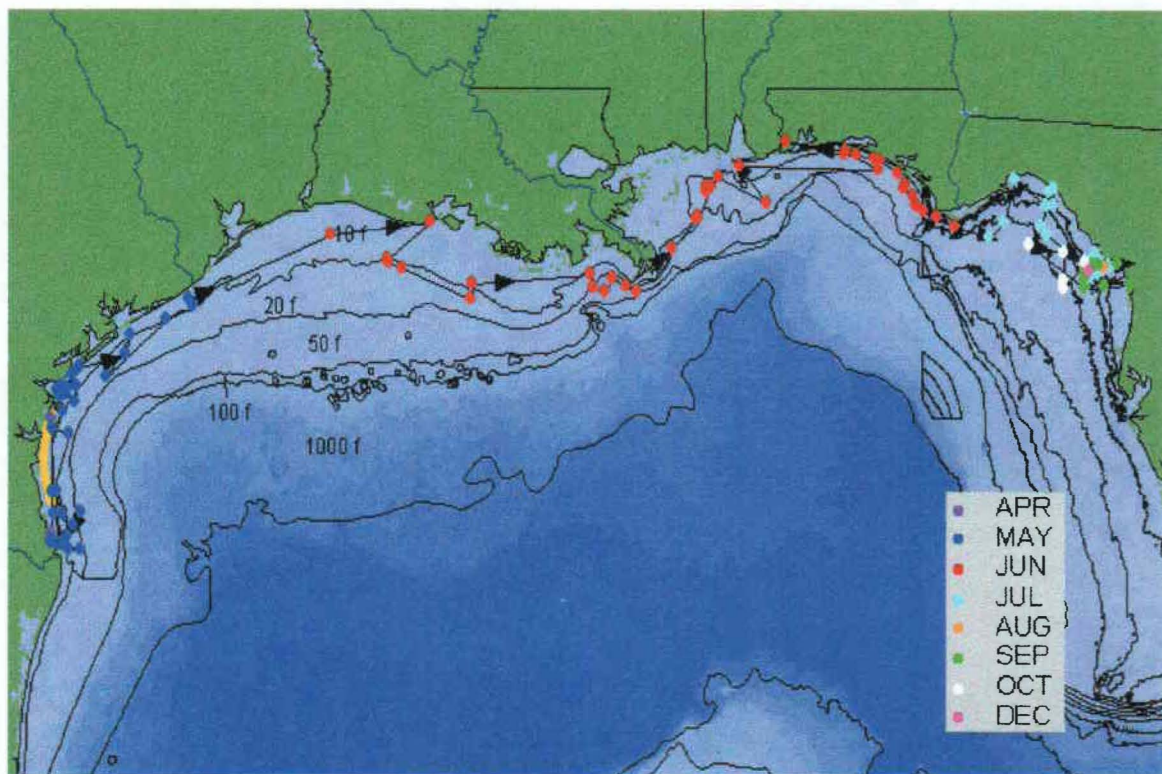


Figure 6. Movements of a Kemp's ridley sea turtle after deployment of transmitter 7689, 25 April 1998 - 8 December 1998.

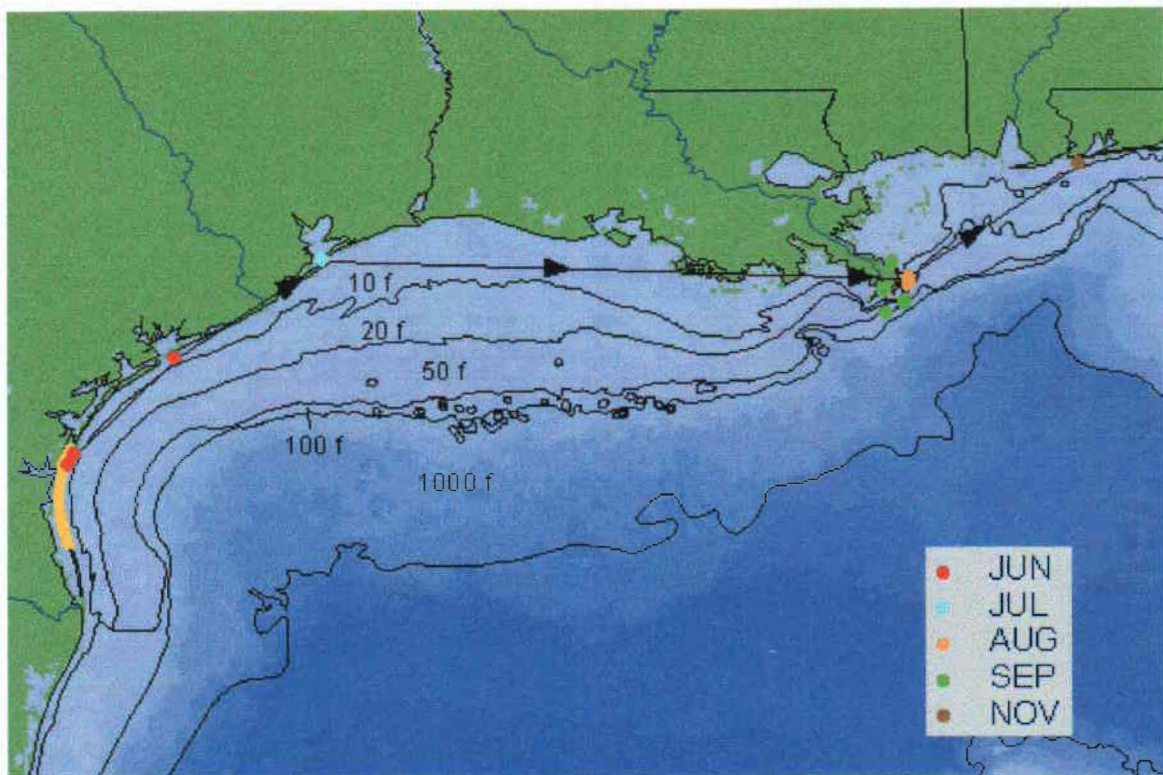


Figure 3. Movements of a Kemp's ridley sea turtle after deployment of transmitter 7686, 13 June 1997 - 5 November 1997.

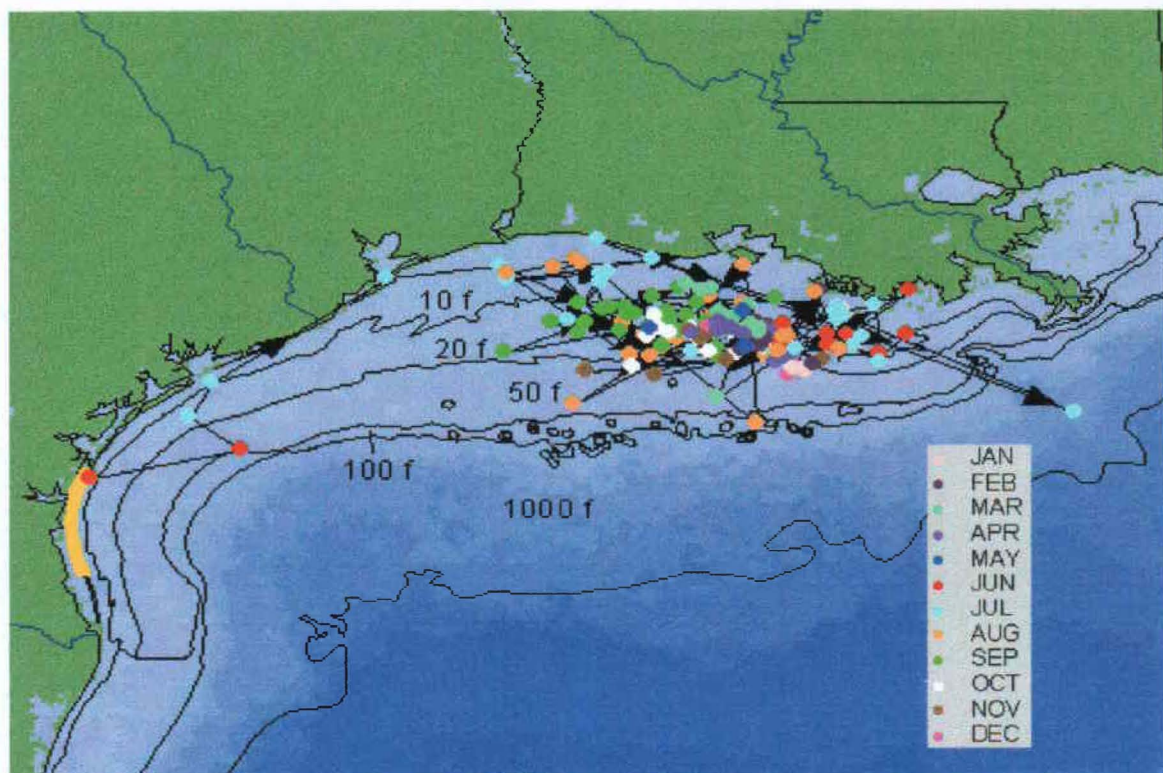


Figure 4. Movements of a Kemp's ridley sea turtle after deployment of transmitter 7687, 21 June 1997 - 7 August 1998.

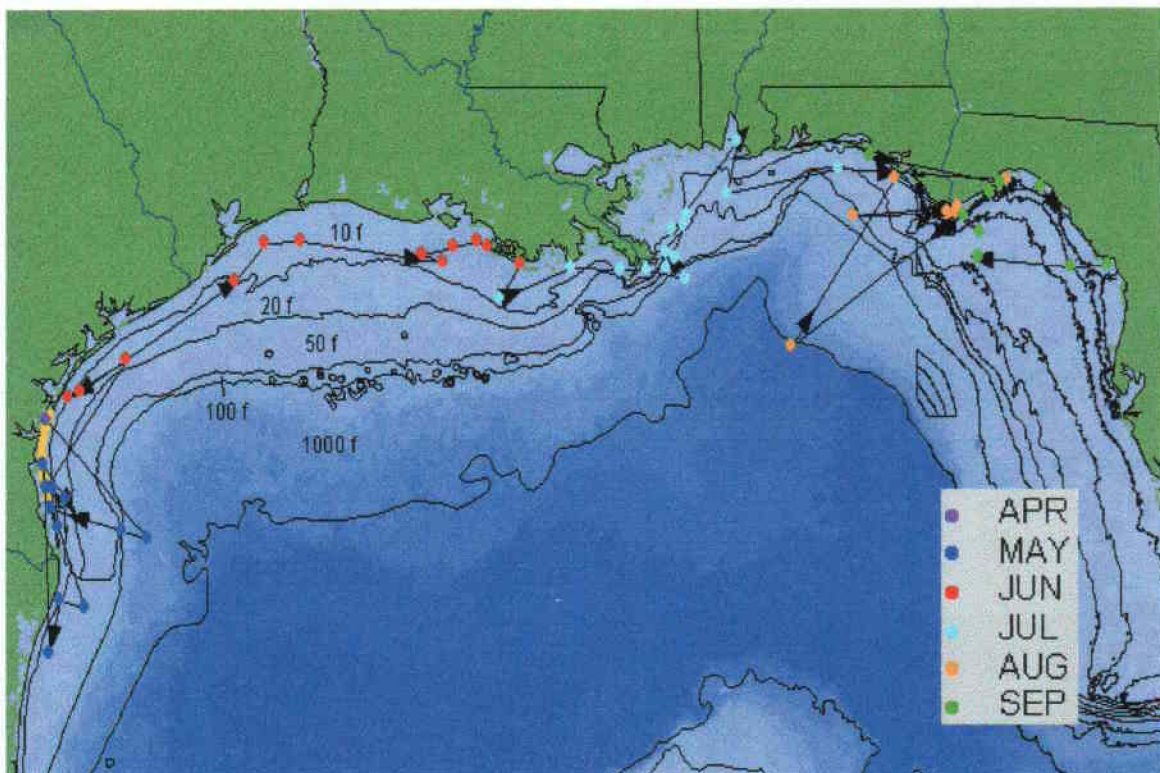


Figure 7. Movements of a Kemp's ridley sea turtle after deployment of transmitter 7681A, 25 April 1998 – 21 September 1998.

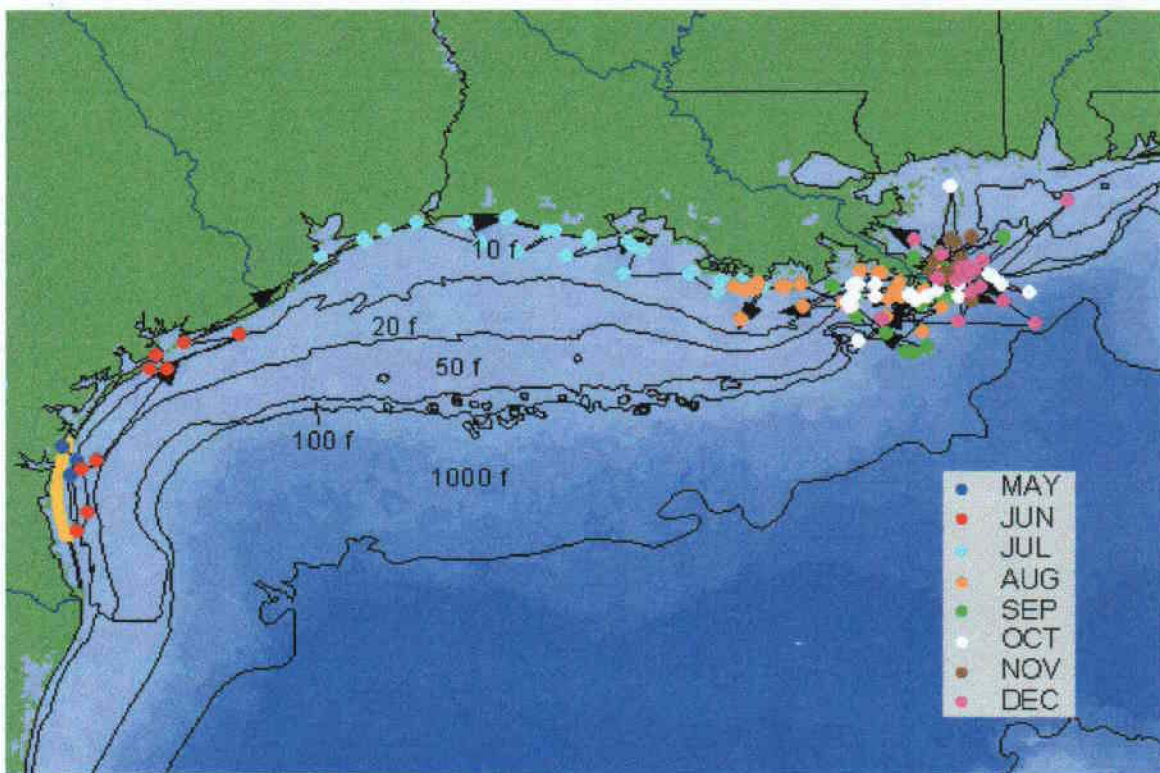


Figure 8. Movements of a Kemp's ridley sea turtle after deployment of transmitter 21811, 22 May 1998 – 29 December 1998.

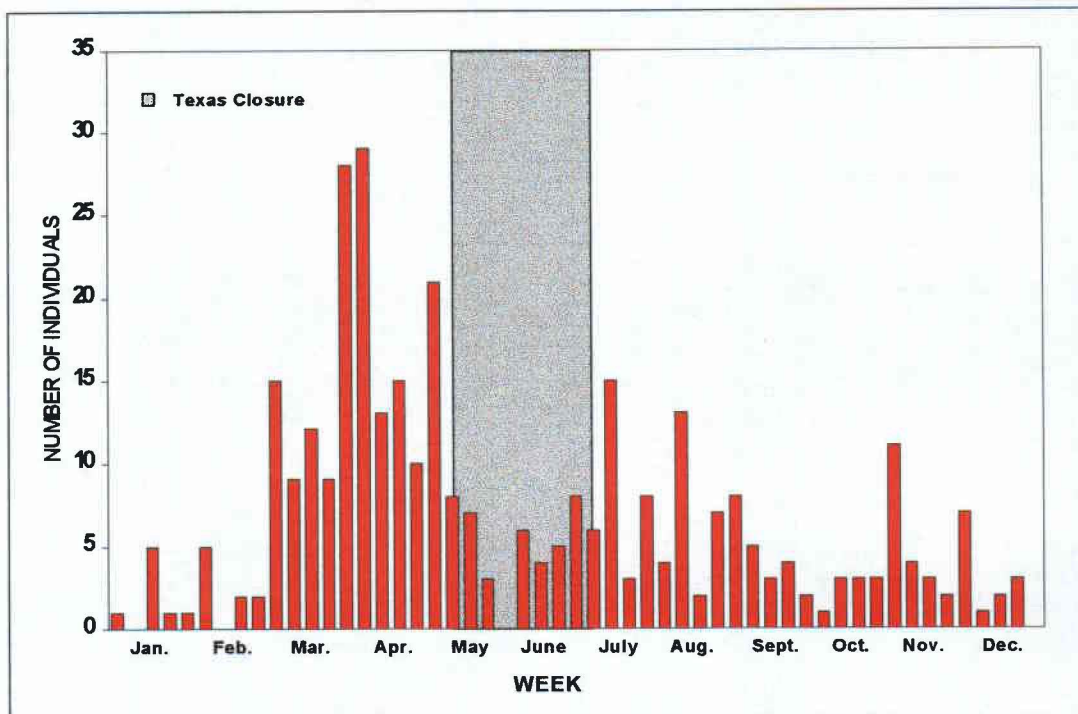


Figure 9. Number of non-headstarted sea turtles located stranded on offshore beaches along the Texas coast during each week in 1998.

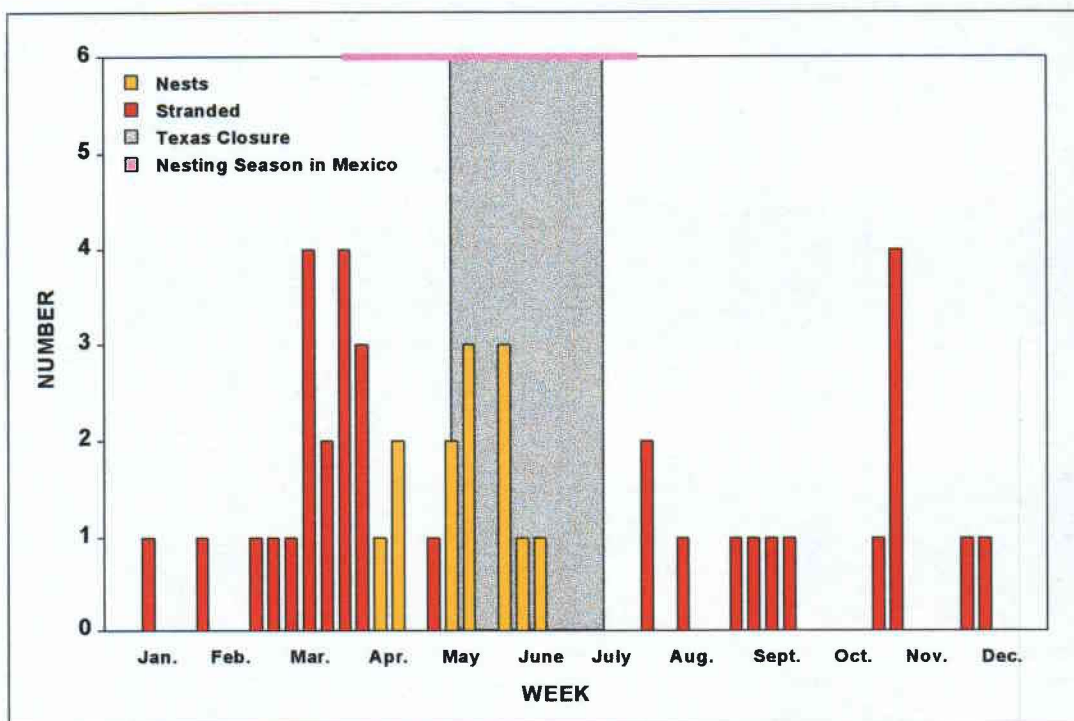


Figure 10. Number of Kemp's ridley sea turtle nests and adults located stranded on offshore beaches along the Texas coast, zones 20 & 21, during each week in 1998.