DISTRIBUTIONS, RELATIVE ABUNDANCES, AND MORTALITY FACTORS FOR SEA TURTLES IN FLORIDA FROM 1980 THROUGH 2007 AS DETERMINED FROM STRANDINGS

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INTRODUCTION

Five species of sea turtles regularly occur in Florida's waters. These are the loggerhead (*Caretta caretta*), green turtle (*Chelonia mydas*), Kemp's ridley (*Lepidochelys kempii*), leatherback (*Dermochelys coriacea*), and hawksbill (*Eretmochelys imbricata*). The olive ridley (*Lepidochelys olivacea*) has only been documented three times in Florida (Foley et al., 2003). The loggerhead, green turtle, and leatherback nest in relatively large numbers on Florida's beaches and this activity is monitored and tabulated annually (Meylan et al., 1995; Witherington et al., in press). Unfortunately, the study of sea turtles in the water is more problematic. The most useful data come from projects that capture sea turtles for study. Thirty in-water sea turtle research projects have been conducted in Florida and have provided important data on the distribution and relative abundances of the various sea turtle species and their life stages around Florida (Eaton et al., 2007). These types of studies are labor-intensive and can only be conducted over relatively small areas. Consequently, there are large areas of Florida where in-water sea turtle research has not been conducted and where little is known about the distributions and relative abundances of the sea turtle species and their life stages (Eaton et al., 2007).

In a sense, sea turtles are also captured and studied when they are found and documented as strandings. These sea turtle strandings most commonly involve dead, sick, or injured animals and are documented in Florida by the Sea Turtle Stranding and Salvage Network (STSSN). The Florida STSSN functions as a part of the nationwide STSSN, coordinated by the National Marine Fisheries Service (NMFS). Since 1980, the State of Florida, through the Florida Fish and Wildlife Conservation Commission's (FWC) Fish and Wildlife Research Institute (FWRI) has coordinated and maintained the state's STSSN. This network comprises FWRI staff biologists and several hundred permitted participants located around the state. FWRI staff receive all reports of stranded sea turtles in Florida and review, edit, and enter all data into a computerized database. From 1980 through 2007, over 28,000 stranded sea turtles have been documented in Florida. The primary objective of the STSSN is to document sea turtle mortality and to identify sea turtle mortality factors but much of the same basic data that are collected by in-water sea turtle research projects are also collected by the STSSN.

The sea turtle stranding data are of particular value because they involve spatial and temporal scales that are not possible for in-water sea turtle research projects. Stranding data in Florida represent tens of thousands of sea turtles collected from virtually all of the coastal areas of Florida over a period of decades. In the current study, we used sea turtle stranding data from Florida to achieve two objectives. The first was to describe the distributions and relative abundances of sea turtles in Florida by species, size-class, and life stage. The second was to determine and assess the potential mortality factors for sea turtles in Florida by species, size-class, and life stage.

METHODS

Data from stranded sea turtles were collected during the period of 1980 through 2007 by the Florida STSSN. Strandings included carcasses that were found washed ashore or floating, live turtles that were found debilitated by injury or disease, and turtles that were reported as being caught on hook and line or entangled in commercial or recreational fishing gear. Although some stranded turtles were found floating far from shore, most were found beached along shorelines or floating close to shore.

Observers used a standardized form to document data collected from each stranded turtle (Fig. 1) and were encouraged to submit photographs showing various views of each turtle. The data used in our analyses included date, species, location, curved or straight-line carapace length (CCL and SCL, respectively; both measured from the nuchal notch to the posterior marginal tip), and documentation of anomalies associated with the stranded sea turtle (e.g., fibropapilloma-like tumors, emaciation, entanglement in fishing line, propeller wounds, shark wounds, etc.). These anomalies were not assumed to be the cause of death.

Point location data for each stranded turtle in Florida were further classified as either offshore or inshore. Offshore locations included any points in the Atlantic Ocean or Gulf of Mexico or along shorelines that were directly adjacent to either of these bodies of water. Inshore locations included any points in bays, bayous, bights, channels, cuts, coves, creeks, intracoastal waterways, lagoons, lakes, passes, rivers, or sounds or along shorelines that were directly adjacent to any of these bodies of water. The coastal counties and NMFS Fishery Statistical Zones in Florida are shown in Figure 2.

Strandings in most areas of Florida were likely to be discovered, reported, and documented with the exception of the area along the west coast from Pasco County through Jefferson County (area known as the Big Bend) and in the mainland portion of Monroe County (Everglades National Park). Both of these areas have long stretches of remote and undeveloped coastline.

Anomalies that were analyzed in this study were defined by specific criteria. For example, propeller wounds were parallel gashes across the head, carapace, or plastron. Shark wounds were indicated by crescent-shaped wounds that were usually most distinct on the carapace or plastron. Numerous cuts forming a crescent shaped ‘‘dotted line’’ also indicated a shark attack. Missing flippers or body damage without the distinct characteristics described were not accepted as evidence of propeller wounds or shark attacks. Emaciation was determined by appraising the overall body condition of the turtle. Typically, only severe cases of emaciation (i.e., turtles with a distinctly concave plastron and a prominent supraoccipital) were noted. A turtle was determined to have fibropapilloma-like tumors when at least one verrucose tumor was present. Typically, these tumors were easily detectable, but observers may have failed to report or notice tumors on some turtles, especially if tumors were small and few.

Adult male sea turtles of all species were identified by a tail that extended at least 20 cm beyond the posterior edge of the carapace. Adult female sea turtles of all species were identified by the presence of tags that were applied while the turtle was on the nesting beach, or by the observation of eggs or large follicles (> 2 cm diameter) in the body cavity, or by a tail that did not extend beyond the posterior edge of the carapace in combination with a curved carapace measurement of a species-specific minimum size (Table 1). It should be noted here that some of the adults identified by some of these methods may not have been mature (although we believe the majority were) and that many mature individuals could not be identified as such. Also, the number of stranded adult turtles of each species by gender cannot be used to estimate the sex ratio of adults because adult males were more likely to be identified as such than adult females were.

STSSN observers ranged from professional sea turtle biologists to volunteers with no prior data-collection training. Nevertheless, as a condition of the Endangered Species Act permits required to conduct work with the STSSN, individuals had to first gain adequate expertise (in the opinion of the FWC permitting staff) in the standardized data-collection methodology of the STSSN before being permitted to participate. In addition, we conducted periodic training workshops for STSSN observers to keep the quality and consistency of the data collected as high as possible. We also reviewed and edited all stranding reports as they were submitted. If there were questions or inconsistencies regarding the reliability of the species identification, carapace measurements, anomalies, or location, we contacted the original observer and asked for additional documentation or information. Any data fields that we felt were not adequately documented were left blank or marked unknown.

In all analyses, we excluded records that involved captive-reared sea turtles or nesting sea turtles that had been trapped, injured or killed while on the nesting beach. Also, many of the sea turtles involved in large-scale hypothermic stunning were not documented in the STSSN database. A description of the events not documented in the STSSN database are described in Foley et al. (2007) for a description of these events). In data analyses to describe distributions and relative abundances, we also excluded records where a sea turtle species was not identified and records with no carapace length measurement (except those unmeasured turtles that were known or believed to be adults). For these analyses, we included the relatively few records involving incidental captures. When assessing mortality factors, we excluded incidental captures of apparently healthy sea turtles and when describing the overall number of sea turtle strandings with a certain anomaly or the overall percentage occurrence of an anomaly, we included sea turtles that were not identified to species. In analyses of mortality factors where specific size-classes were not identified, we included stranding records for which no carapace length measurements were made. Unless otherwise specified, we excluded records of posthatchling sea turtles (CCL < 10 cm) in mortality factor assessments.

RESULTS AND DISCUSSION

STRANDING DATA

The Florida STSSN database from 1980 through 2007 contained 28,768 records. The numbers by species and those excluded from all analyses are given in Table 2. The numbers of stranding records by species (after making the exclusions shown in Table 2) with various carapace length measurements are given in Table 3. The CCL was the most common carapace length measurement taken and was used to differentiate size-classes of the strandings. In records where only an SCL measurement was made, the SCL was converted to CCL using a species-specific regression equation derived from records where sea turtles were measured for both CCL and SCL. We used SigmaStat for Windows Version 3.10, Systat Software to derive all the regression equations. We applied linear, power (log-log), polynomial, logarithmic, and exponential regressions to find the best fit. In all cases, power regressions proved to have the best fit (Figs. 3–7).

DISTRIBUTIONS AND RELATIVE ABUNDANCES

Stranding data collected along a shoreline could accurately reflect the distributions and relative abundances of sea turtles in nearby waters. In general, we expect the most common species and life stages to be the most common strandings. However, there are various factors that can blur this reflection. For example, sea turtle strandings in a few coastal areas of Florida (e.g., the Big Bend of Florida and Everglades National Park) are much less likely to be found and documented than strandings in the other coastal areas of Florida are. There are relatively few strandings from the Big Bend area of Florida and from Everglades National Park even though the relative abundances of sea turtles in these areas may be high for the west coast of Florida. Fortunately, sea turtle strandings in most of the other coastal areas of Florida are more equally likely to be found and documented.

Current patterns and wind regimes certainly play a role in determining where (and if) dead or moribund sea turtles wash ashore (Epperly et al., 1996; Hart et al., 2006). At least in some cases, dead or moribund sea turtles must be found far from the area where they were most recently living. We also believe it reasonable to assume that sea turtles occurring close to shore may be better represented in the stranding data than sea turtles occurring far from shore and that the carcasses of larger sea turtles may be more likely to be spotted than those of smaller sea turtles. Mortality factors that differentially impact sea turtle species or life stages could also work to reduce the veracity of stranding data as an indicator of relative abundances. Whenever possible, the distributions and relative abundances of sea turtle species and life stages as determined by strandings need to be corroborated by other data that are not vulnerable to the same biases that stranding data are.

Loggerhead Distributions and Relative Abundances

We used 13,302 loggerhead stranding records to describe the distributions and relative abundances of loggerheads in Florida by size-class or life stage (Table 4). About 80% (N = 10,514) of the stranded loggerheads were dead when found. About 2% (N = 270) of these stranding records involved loggerheads that were incidentally captured.

The size frequency distribution of the stranded loggerheads is given in Figure 8. There were three peaks. The first was a narrow peak of strandings from 5 to 10 cm CCL. These were posthatchling turtles that were prone to being washed ashore by onshore winds. The second was a broad peak from about 60 to 80 cm CCL and the third was also a broad peak from about 90 to 105 cm CCL. The smallest nesting female loggerheads in Florida are about 85 cm CCL (Dodd, 1988; Ehrhart, unpubl. data), indicating the second peak was primarily of immature turtles and the third peak was likely to have been largely of adult turtles.

The greatest relative paucity of individuals in the size frequency distribution of loggerhead strandings was found from 10 to 50 cm CCL. At these sizes, loggerheads are known to be oceanic (Carr, 1987). The only area where these turtles have been regularly found is around the Grand Banks offshore of Newfoundland and in the eastern North Atlantic in the vicinity of the Azores, and the Madeira and Canary Islands (Bolten, 2003). Nevertheless, the Florida STSSN documented several hundred stranded loggerheads in this size range (Table 4). There was another notable dip in the numbers of loggerhead strandings that occurred between 80 and 90 cm CCL. Loggerheads in this size range have been known to be comprised of a relatively large proportion of pubescent animals (Limpus and Limpus, 2003).

The size frequency distributions of loggerheads captured by in-water research projects in Florida also showed the same characteristics as the size frequency distribution of the stranded loggerheads. A majority of the almost one thousand loggerheads captured in the inshore waters of Brevard County over a 25-yr period were between 60 and 80 cm CCL (Ehrhart et al., 2007; converting SCL to CCL). Most of the more than four thousand loggerheads captured offshore of Brevard County over a ten-year period were also between 60 and 80 cm CCL (Henwood, 1987; Schmid, 1995). As with the loggerhead stranding data, the offshore projects (offshore as defined in this report) documented a broad peak in the numbers of loggerheads between 60 and 80 cm CCL, followed by a drop in the numbers of loggerheads that were between 80 and 90 cm CCL, and then followed by a rise in the numbers of loggerheads greater than 90 cm CCL (Henwood, 1987; Schmid, 1995). This same size frequency distribution also characterized the 1,623 loggerheads captured just offshore of St. Lucie County over a 13-yr period (Ernest et al., 1989).

The relatively low numbers of loggerhead strandings in the 80 to 89.9 cm CCL size-class may indicate that some of these loggerheads leave Florida. Loggerheads of this size are approaching maturity and may migrate to adult foraging areas. For many loggerheads, adult foraging areas are located on the continental shelf around Florida, especially offshore of southwest Florida (Schroeder et al, 2003). But for other loggerheads, adult foraging areas are located on continental shelves in other U. S. states, Mexico, Cuba, and the Bahamas (Ehrhart et al., 2003; Schroeder and Foley, 2003). The rise in the number of stranded loggerheads that were 90 cm CCL or greater may in part be caused by an influx of other large loggerheads approaching adulthood that have moved from areas outside of Florida to the continental shelves offshore of Florida.

Loggerheads in Florida nest from April through September (Meylan et al., 1995). Nightly numbers of nesting turtles increase into June, peak in mid-June to early July, and then gradually diminish through September (FWC unpubl. data). Given a likely incubation period between about 50 and 60 days (Witherington, 1986), hatchling loggerheads are expected to begin entering the waters off of Florida's nesting beaches sometime in late June. Looking at the numbers and sizes of posthatchling loggerhead strandings (< 10 cm CCL) each month beginning in June (Fig. 9), we see the expected outcome. These strandings rose as the number of hatched nests increased and the concentration of posthatchlings likely increased offshore of Florida (during June-October). These strandings then declined as the time of hatching ended, many posthatchlings likely dispersed to other areas, and any young of the year that were found as strandings were more and more likely to be larger than 10 cm CCL. The sizes of the stranded posthatchling loggerheads each month during the period of June (of one year) through May (of the next year) gradually increased (Table 5 and Fig. 10), indicating that they were all of similar age (originating from the same nesting season).

About 90% of loggerhead nesting in Florida occurs on the Atlantic coast of southeast Florida from Brevard County south through Broward County (Meylan et al., 1995). We might predict that hatchling loggerheads entering the water in southeast Florida would be transported north along the Atlantic coast of Florida by the Florida Current. Most of the strandings of posthatchling loggerheads occurred from Brevard County north through St. Johns County (Fig. 11A), matching the expected northward movement of hatchling loggerheads from the major nesting beaches in southeast Florida.

A few (11) of the strandings of posthatchling loggerheads were found during the first months of the year (January-May). These were likely hatchlings from the most recent nesting season and may have been in the Caribbean Sea or Gulf of Mexico before being carried into the Atlantic Ocean by the Loop Current, which is considered an upstream extension of the Florida Current. These (and at least a few others in our posthatchling group) probably originated from nesting beaches along the Gulf coast of Florida or along the Caribbean coast of the Yucatan Peninsula (Mexico). Almost all loggerhead nesting in Mexico occurs along the Caribbean coast of the Yucatan Peninsula (J. Zurita, unpubl. data) and this nesting aggregation is the largest in the western North Atlantic outside of the U. S. (Ehrhart et al., 2003). Hatchlings from the Yucatan would be transported into the Gulf of Mexico by the Yucatan Current. Loggerhead hatchlings from beaches along the Gulf coast of Florida or from beaches on the Yucatan Peninsula may eventually strand on either coast of Florida but hatchlings from the east coast of Florida would not be expected to strand on the Gulf coast of Florida because that would require moving against the Florida and Loop Currents.

The numbers of strandings of the next largest group of loggerheads (those from 10 to 19.9 cm CCL) by month also seemed to be consistent with a group of turtles originating from the most recent nesting season. The smallest turtles were found just after the nesting season (October) and the sizes of the stranded turtles steadily rose during the following months (Table 6 and Fig. 12). In concordance with being an older group of larger turtles (relative to the posthatchlings), strandings of this size-class started later in the year than those of the posthatchlings (October instead of June) and were more common in the first half of the following calendar year than the posthatchlings were (Fig. 13). The stranding data suggest that these turtles were in their first year of life. If true, the average stranded loggerhead was growing from about 5 cm CCL to about 16 cm CCL (with some surpassing 20 cm CCL) during their first year of life. Studies of loggerhead growth rates in captivity have revealed that they have the potential to grow to 8 or 9 cm SCL (about 8.7 to 9.8 cm CCL) in ten weeks (Stokes et al., 2006). A previous study (Bjorndal et al., 2000) estimated a first year average growth rate of 1 cm CCL $month^{-1}$ based on the timing of stranding in the Azores of seven loggerheads that were around 10 cm CCL. In the present study, we estimated the same average rate of growth for loggerheads in the first year of life based on data collected from 1,267 stranded loggerheads from 4.4 to 19.9 cm CCL.

The distribution and relative abundances of stranded loggerheads from 10 to 19.9 cm CCL are shown in Figure 11B. Most of these turtles were found in southeast Florida, upstream (relative to nearshore currents) of the stranding locations of the posthatchlings that likely originated in large part from the major nesting beaches in central-east and southeast Florida. The relatively extended time period between hatching and stranding for loggerheads of this size (probably at least four months as indicated by growth) makes it unlikely that they originated from the Atlantic coast of Florida because turtles entering the water in this area would have had ample time to already be carried north of Florida (or at least to northeast Florida) by the Florida Current. Hatchlings originating along the coast of the Gulf of Mexico or the northwestern Caribbean could be entrained in the Gulf of Mexico before being carried into the Atlantic by the Loop Current and then along the Atlantic coast of Florida by the Florida Current. In addition, the stranding locations of these turtles occurred in the area of greatest landfall probability for surface drifters originating in the Gulf of Mexico (Lugo-Fernández et al., 2001).

Stranded loggerheads in the size range of 20 to 29.9 cm CCL no longer showed a regular increase in size over some sequence of months, so we lose our ability to continue tracking the age of these turtles. However, based on the what we found for turtles in the next smallest size-class (that they were nearing one year in age), we believe a majority of the turtles that were from 20 to 29.9 cm CCL were likely to be two years-old and some may have been older. Loggerheads of this size found in the Azores are also believed to be about two years old (Bjorndal et al., 2000).

The numbers of loggerhead strandings in Florida in the first three 10-cm size-classes (< 10 cm, 10-19.9 cm, and 20-29.9 cm CCL) continually decreased (Table 4). This was consistent for a group of turtles that originated in or near Florida and then gradually dispersed over time. Strandings of loggerheads that were 20 to 29.9 cm CCL were the fewest in number and may represent the last of the dispersing loggerheads. However, there was some evidence that they may also represent some of the first loggerheads to recruit to Florida. We believe the stranding distributions of loggerheads from 20 to 29.9 cm CCL were, in part, indicative of directed movements to Florida (Fig. 11C). Some of these turtles stranded in southeast Florida, where surface drifters originating in the Gulf of Mexico would most likely have been found (Lugo-Fernández et al., 2001). But, a relatively large number of these stranded loggerheads were found along the northernmost area of northeast Florida, where surface drifters originating in the Gulf of Mexico have a probability of landfall near zero (Lugo-Fernández et al., 2001). We believe these turtles were living close to shore before stranding.

Beginning with loggerheads that were from 30 to 39.9 cm CCL, strandings steadily increased through the 60 to 69.9 cm CCL size-class. We believe this indicated that loggerheads recruited to coastal areas of Florida at sizes as small as 20 to 29.9 cm CCL, but that it was relatively rare. We think the stranding data also suggested that a slightly larger number of loggerheads recruited to Florida at sizes from 30 to 49.9 cm CCL and that the majority recruited to the coastal areas of Florida at sizes from 50 to 69.9 cm CCL.

In-water sea turtle research projects in Florida have also revealed that loggerheads as small as 20 to 39.9 cm CCL sometimes recruit to Florida. Loggerheads of this size are relatively rare but they have been captured in the coastal areas of six Florida counties (Gulf, Taylor, Dixie, Brevard, St. Lucie, and Monroe) (Eaton et al., 2007). In one case, a loggerhead that was 35.6 cm CCL at initial capture was captured again one year later in the same coastal area of Florida (Florida Bay, Monroe County; Schroeder, Foley, and Witherington, unpubl. data). A study of the oceanic stage of loggerheads has found that these turtles primarily depart oceanic habitats to presumably recruit to neritic habitats between 46 cm CCL and 64 cm CCL (Bjorndal et al., 2000). This fits well with our stranding data that we believe showed loggerheads primarily recruiting to Florida between 50 and 69.9 cm CCL.

The distributions and relative abundances of stranded loggerheads by various size classes and life stages that are likely resident in nearshore waters (Fig. 11 C-H) indicate a distribution pattern in Florida that shifts with size. The smallest loggerheads in this group (20-39.9 cm CCL, Fig. 11C) were found predominantly in northeast and northwest Florida. The next largest group (40-59.9 cm CCL, Fig. 11D) was found almost exclusively in northeast Florida. Loggerheads that were 60 to 79.9 cm CCL were concentrated in northeast Florida but also had a relatively high proportion of strandings along the coast of central-east Florida (Fig. 11E). Subadult loggerheads (80-87.1 cm CCL) were relatively common in northeast, southeast, and southwest Florida (Fig. 11F). Adult loggerheads were found almost exclusively in southwest and southeast Florida (Fig. 11G and Fig. 11H).

There were 538 stranding records for which a carapace length measurement was taken that we believe represented adult male loggerheads. The size frequency distribution of these turtles is given in Figure 14. There has been an impression that adult male loggerheads are larger than adult female loggerheads but there has been little presented data to support this (see Dodd, 1998 for a review). To compare sizes of adult male and female loggerheads in Florida, we used the adult male loggerheads with measurements that we identified in the Florida stranding data (N = 538) and the adult female loggerheads measured on a Florida nesting beach (Brevard County) by researchers from the University of Central Florida from 1980 through 2005 (N = 5,271) (L. Ehrhart, unpubl. data). We did not use the sizes of adult female loggerheads from the stranding data to compare to the adult males because in most cases we could only tentatively identify the largest, short-tailed loggerheads as adult females in the stranding data. Therefore, only a biased subset (number- and size-wise) of the stranded adult female loggerheads could be identified as such in the stranding data. We could, however, identify stranded adult male loggerheads of all sizes because of their long tail.

The adult male loggerheads in the Florida stranding data were larger than the adult female loggerheads from a Florida nesting beach, but only by an average of a little over 1 cm (Table 7). It is likely that some of the stranded turtles we identified as adult male loggerheads were still not mature. However, the growth of loggerheads nearing adult size is negligible (see Witherington, 2006, for a review) and we believe there would not be much difference in the size of a male that is almost mature and that same male when it becomes mature. If anything, the sizes of adult male loggerheads as determined from the stranding data would tend to be a little smaller than the true size of adult male loggerheads from Florida because some of the males we classified as mature were not mature and may have grown a little in carapace length before maturing. Correcting for the error of including some immature male loggerheads in our analysis could only increase the difference in size between adult male and female loggerheads.

Most (83.6%) of the loggerhead strandings were found in or adjacent to offshore waters. This was true for every 10-cm size-class and for adult males and adult females (Fig. 15). At least 80% of the strandings in every loggerhead size-class were found in or adjacent to offshore waters except those that were 40 to 49.9 cm CCL (only 75.4% of those strandings were offshore). This indicated that all sizes of neritic-phase loggerheads were found primarily in offshore areas (as defined for the stranding data). In-water research projects in Florida also suggested this. Loggerheads or Kemp's ridley were the most commonly captured turtle by projects operating in offshore areas (as defined for the stranding data) whereas green turtles dominated the captures of projects that operated in inshore waters (Eaton, 2007).

The percentages of strandings by month for adult female, adult male, and immature loggerheads were similar in some respects (Fig. 16). For example, all peaked in either April or May. However, there were also some differences. Over half (52.9%) of the strandings of adult female loggerheads occurred in just three months (May-July). Strandings of adult male loggerheads were also temporally skewed, but to a lesser degree. Over half (55.5%) of the strandings of adult male loggerheads occurred in four months (March-June). The numbers of strandings of immature loggerheads each month were more evenly spread than those of the adult turtles. The five months with the greatest numbers of strandings of immature loggerheads (April-August) accounted for just (58.9%) of the total number of strandings of these turtles.

The relative abundance of adult loggerhead turtles relatively close to shore around Florida has been known to increase during the nesting season (Henwood, 1987; Bolten et al., 1994; Schmid, 1995). Female turtles migrate from offshore forging grounds around Florida (as well as from foraging grounds in other states and in neighboring countries) to the vicinity of Florida nesting beaches in April and May, and then spend the nesting season in nearby offshore areas (Schroeder et al., 2003; Schroeder, Foley, and Witherington, unpubl. data). The numbers of adult female loggerheads offshore of Brevard County have been known to peak from May through July (Henwood, 1987). The stranding data indicated that this may be the case statewide. Adult male loggerheads may also make similar reproductive migrations but move from the foraging grounds toward the nesting beaches about a month before the females do and then move from the vicinity of nesting beaches back to the foraging grounds before the females do (Schroeder et al., 2003; Schroeder, Foley, and Witherington, unpubl. data). The abundance of adult male loggerheads offshore of Brevard County has been found to peak earlier than that of the adult females (April and May compared to May through July, respectively) (Henwood, 1987). Our statewide stranding data also indicated that adult males may have typically moved to the vicinity of nesting beaches about a month before the females did and then left that area to return to foraging grounds about a month or two before the females did.

Strandings of immature loggerheads were also found more commonly during the spring and summer then during the fall and winter. Perhaps these turtles tend to reside closer to shore during the warmer time of the year and move farther offshore during the colder time of the year. Some adult female loggerheads residing on the continental shelf around Florida have been known to exhibit this type of behavior (Schroeder and Foley, unpubl. data). If adult male loggerheads and immature loggerheads sometimes behave the same way, then this could also increase the density of non-reproductively active loggerheads relatively close to shore during the warmer time of the year. The increase in loggerhead strandings during the summer and decrease during the winter could also be caused in part by physical oceanographic features. Sea turtle strandings along the coast of North Carolina have been shown to be so influenced (Hart et al., 2006). At least offshore of Brevard County, the abundance of immature loggerheads does not appear to vary greatly during the year (Henwood, 1987; Schmid, 1995) and may even tend to peak during the winter (Schmid, 1995).

Green Turtle Distributions and Relative Abundances

We used 6,000 green turtle stranding records to describe the distributions and relative abundances of green turtles in Florida by size-class or life stage (Table 8). About 70% (N = 4,112) of the stranded green turtles were dead when found. A little more than 5% (N = 324) of these stranding records involved green turtles that were incidentally captured.

The size frequency distribution of the stranded green turtles is given in Figure 17. There was one large and two small peaks. The first was a small, narrow peak of strandings from 5 to 10 cm CCL. These were posthatchling turtles. The second was a large peak of strandings from about 30 to 40 cm CCL. The third was also a small peak of strandings from about 100 to 105 cm CCL. The smallest nesting female green turtles in Florida are about 90 cm CCL (D. Bagley, pers. comm.), indicating the second peak was of immature turtles and the third peak was likely of adults.

The monthly frequency distribution of green turtle posthatchling (< 10 cm CCL) strandings suggested that all of these turtles originated from the most recent nesting season. The strandings by month can be seen as beginning near the end of the green turtle nesting season (September), peaking a couple of months later (November), and then declining and ending over the following few months (December-February) (Fig. 18). Green turtle nesting in Florida begins about 1 month later than nesting by loggerheads (May instead of April) (Meylan et al., 1995). Given this, it was not surprising that the strandings of posthatchling green turtles began and peaked later in the year than the strandings of loggerhead posthatchlings did (September instead of July and November instead of October, respectively). We documented only 85 strandings of green turtle posthatchlings compared to 1,184 strandings of posthatchling loggerheads. This apparent difference in the relative abundances of these posthatchling turtles was expected because there were usually more than ten times more loggerhead nests than green turtle nests annually in Florida from 1980 through 2005 (Meylan et al., 1995; FWC, unpubl. data).

The distribution and relative abundances of stranded green turtle posthatchlings in Florida indicated that these turtles may have behaved differently during their initial dispersal than the loggerhead posthatchlings did. The relative proportions of green turtle and loggerhead nesting along the coast of southeast Florida was almost identical (Meylan et al., 1995), and yet, green turtle posthatchlings tended to strand farther south along the Atlantic coast of Florida than loggerhead posthatchlings did. Loggerhead hatchlings that likely originated from the major loggerhead nesting beaches in southeast Florida appeared to be transported north by the Florida Current and were then found as posthatchling strandings primarily north of Cape Canaveral (near the northern edge of those major nesting beaches) (Fig. 11A). Green turtle hatchlings that likely originated from the same nesting beaches in southeast Florida and in similar relative proportions were found as posthatchling strandings primarily south of Cape Canaveral (Fig. 19A). An in-water study of posthatchling sea turtles conducted offshore of Cape Canaveral documented almost 300 posthatchling loggerheads but no posthatchling green turtles (Witherington, 2002). Given the similar relative proportions of nests of each species along the Atlantic coast of Florida, it was unlikely that searches resulting in the discovery of almost 300 posthatchling loggerheads would fail to find any posthatchling green turtles if these neonates dispersed in a similar way, occupied the same pelagic habitat, and were equally observable (Witherington, 2002). We see from the stranding data that the neonate green turtles were probably not dispersing in the same way as the neonate loggerheads were. Most of the loggerhead posthatchlings from southeast Florida appeared to move north with the Florida Current and pass offshore of Cape Canaveral. Most of the green turtle posthatchlings from southeast Florida did not appear to move north with the Florida Current (at least not to the extent that loggerhead posthatchlings did) and were less likely to pass by Cape Canaveral.

We were not able to detect any gradual increase in carapace length for green turtle posthatchlings over time (Table 9). Nevertheless, there was a logical progression by size-class of stranded green turtles less than 20 cm CCL during a 17-month period beginning near the end of the green turtle nesting season (Fig. 20). In our arrangement of green turtle strandings by month, green turtle posthatchlings (< 10 cm CCL) were first found during September, gradually rose and then peaked in numbers during November, and then gradually diminished in numbers and were not found after February of the following year. Green turtles from 10 to 14.9 cm CCL were first found during October, gradually rose and then peaked in numbers during February of the following year, and then gradually diminished in numbers and were not found after May. Green turtles from 15 to 19.9 cm CCL were first found during January of the following year, gradually rose and then peaked in numbers during March, and then gradually diminished in numbers and were not found after November. These data indicate that, as with loggerheads, green turtles may reach 15 to 20 cm CCL within their first year of life (a likely average growth rate during the first year of life of about 1 cm $month^{-1}$).

The small number of green turtle posthatchling strandings in Florida relative to that of loggerhead posthatchlings was expected because the annual number of green turtle nests in Florida was small relative to that of the loggerhead. However, the number of stranded green turtles in the next largest 10-cm size-class (10-19.9 cm CCL) was about the same as that for loggerheads (83 loggerheads and 89 green turtles). The strandings of green turtles of this size were concentrated in southeast Florida (Fig. 19B) and were similar in distribution and relative abundances to those of similar-sized loggerheads (see Fig. 11B). Like with the loggerheads of this size, these green turtles stranded primarily in the area with the greatest landfall probabilities for surface drifters originating in the Gulf of Mexico (Lugo-Fernández et al., 2001) and may have come from nesting beaches in the Caribbean Sea or Gulf of Mexico. The greatest amount of green turtle nesting in the Atlantic takes place along the Caribbean coast of Costa Rica at Tortuguero (Bjorndal et al., 1999). There are about twice as many green turtle nests made annually on this nesting beach than there are of loggerhead nests in Florida. The large number of green turtle nests in Tortuguero may help to account for the relatively large number of green turtles in Florida that were 10 to 19.9 cm CCL. Green turtle hatchlings from Tortuguero may have been transported north into the Gulf of Mexico by the Yucatan Current and then into the Atlantic Ocean and along the southeast coast of Florida by the Loop and Florida Currents, respectively.

Alternatively, considering the possibility that green turtle posthatchlings disperse differently than posthatchling loggerheads, perhaps some of these larger green turtles originated from southeast Florida and stayed in that vicinity until stranding. The relatively large number of stranded green turtles that were 10 to 19.9 cm CCL may also suggest that green turtles were starting to make directed movement to Florida coastal areas at this relatively small size. Within this size-class, we see that the number of strandings began to rise for green turtles that were 15 to 19.9 cm CCL (Table 8), suggesting that some green turtles may spend a year or less in an oceanic stage. Although the smallest-sized green turtles that most in-water projects in Florida captured were > 20 cm CCL, one project working in the nearshore area of central-east Florida (St. Lucie County) did capture a green turtle between 15 and 19.9 cm CCL (converting SCL to CCL) (Eaton et al., 2007).

The stranding data indicated that more (but still relatively few) green turtles recruited to Florida at 20 to 24.9 cm CCL and that the majority of green turtles recruited to Florida between 25 and 34.9 cm CCL (Table 8). This observation was also corroborated by in-water studies conducted in the coastal waters of Florida. The minimum size of captured green turtles was most commonly between 25 and 35 cm CCL but several projects have captured green turtles between 20 and 25 cm CCL (Eaton et al., 2007). The numbers of stranded green turtles by 5-cm size-class peaked at the 30 to 34.9 cm CCL size-class. After that point, the numbers of green turtle strandings in each succeeding 5-cm size-class through 94.9 cm CCL steadily decreased (Table 9). A similar size-frequency distribution pattern was seen in the captures of green turtles in the nearshore and inshore areas of central-east Florida (Bresette et al., 1998; Ehrhart et al., 2007). We believe the stranding data revealed a steady rate of departure from Florida by immature green turtles. Immature green turtles captured and tagged in Florida have been recaptured again in Florida but have also been found later throughout the Caribbean (Ehrhart et al., 1996; Redfoot et al., 1996; Bresette et al., 1998; Schmid, 1998; Schroeder, Foley, and Witherington, unpubl. data).

Strandings of the smallest, neritic-phase green turtles (20-29.9 cm CCL) in Florida were most common along a part of the northeast coast (St. Johns County through Volusia County) and along a part of the central-east coast (central Brevard County through St. Lucie County) (Fig. 19C). The locations of stranded green turtles in the next largest group (30-49.9 cm CCL) were concentrated in these same areas but also included a relatively high concentration of turtles along more of southeast Florida (central Brevard County through Broward County), along part of central-west Florida (primarily Pinellas County), and in part of the Florida Panhandle (Gulf County) (Fig. 19D). Stranded green turtles that were 50 to 69.9 cm CCL were less common in northeast and southwest Florida and more common in the Florida Keys (Fig. 19E). The largest, likely immature stranded green turtles (70-89.3 cm CCL) and the adults were found primarily in central-east and southeast Florida (Fig. 19F, 19G, and 19H.

We identified 59 stranding records of adult male green turtles with a carapace length measurement. The size frequency distribution of these turtles is given in Figure 21. Adult male green turtles are clearly smaller than adult female green turtles in all populations studied (Limpus, 1993; Godley et al., 2002). Any differences in size between adult male and female green turtles in Florida have not yet been reported. To compare sizes of adult male and female green turtles in Florida, we used the adult male green turtles with measurements that we identified in the Florida stranding data (N = 59) and the adult female green turtles measured on a Florida nesting beach (Brevard County) by researchers from the University of Central Florida during 1982 through 2007 (N = 1,322) (L. Ehrhart, unpubl. data). We did not use the sizes of adult female green turtles from the stranding data to compare to the adult males because in most cases we could only tentatively identify the largest, short-tailed green turtles as adult females in the stranding data. Therefore, only a biased subset (number- and size-wise) of the stranded adult female green turtles could be identified as such. We could, however, identify stranded adult male loggerheads of all sizes because of their long tail.

The adult male green turtles found as strandings in Florida were smaller than the adult female green turtles intercepted on a Florida nesting beach by an average of about 5 cm (Table 10). It is likely that some of the stranded turtles we identified as adult male green turtles were still not mature. However, as with loggerheads, the growth of green turtles nearing adult size is negligible (Witherington et al., 2006). We believe there would not be much difference in size of a male green turtle that is almost mature and that same male when it becomes mature. Nevertheless, the sizes of adult male green turtles as determined from the stranding data could have been a little small because some of the males we classified as mature may not have been mature and may have grown some in carapace length before maturing. To assess the veracity of our comparison of adult male and female green turtles, we compared the sexual dimorphism index (SDI; CCL of the larger gender/CCL of the smaller gender) of the adult green turtles in our study to that found in other green turtle populations. Godley et al. (2002) found that the SDI remained surprisingly constant for 12 green turtle populations (1.04-1.11, with a mean of 1.07). The SDI for the Florida green turtle as determined by the present study (SDI = 1.05) fits well within the narrow range of SDI already established for other green turtle populations.

Green turtle strandings were found more often in or adjacent to offshore waters (65.3%) than in or adjacent to inshore waters (34.6%). There was a generally progressive increase in the proportion of inshore strandings with size of the stranded green turtle through the 60 to 69.9 cm CCL size-class (Fig. 22). At this size, there was an equal number of offshore and inshore green turtle strandings. With increasing size beyond this point, there was a general decrease in the proportion of inshore strandings. This suggests that many immature green turtles move from offshore areas to inshore areas as they increase in size and then move back to offshore areas as they approach adult size. In-water studies in Florida have found that the immature green turtles found in the nearshore areas on the oceanside of Florida's central-east coast (an area we designate as offshore) tended to be smaller than the immature green turtles found in adjacent lagoons and estuaries (Henwood and Ogren, 1987; Guseman and Ehrhart, 1990). This initial shift for some immature green turtles from offshore to inshore areas as they increase in size may be common. In southern Texas, juvenile green turtles found along the rocky shoreline of a pass opening to the Gulf of Mexico tend to be smaller than the juvenile green turtles found farther inshore in the adjacent bays and other estuaries (Coyne, 1994).

Strandings of immature green turtles were found in largely equal numbers throughout the year (Fig. 22). The strandings of adult green turtles were more seasonal (Fig. 22). About 85% of stranded adult green turtles were found from May through August. Because these strandings coincided in time with the green turtle nesting season and in space with the primary green turtle nesting beaches (southeast Florida), we believe these were strandings of adult turtles that were making reproductive migrations. Although not as pronounced as loggerheads, the stranding data indicated that adult male green turtles moved from foraging grounds to the vicinity of nesting beaches sooner than adult females did and then left this area to return to the foraging grounds sooner than the adult females did. A majority (66%) of strandings of adult male green turtles occurred during May and June and a majority (60%) of strandings of adult female green turtles occurred during June and July (Fig. 22). The only area of Florida where adult green turtles are known to be year-round residents is from Biscayne Bay (Miami-Dade County) through the Florida Keys (Monroe County) (Schroeder et al., 1996; Schroeder, unpubl. data). Of the strandings of adult green turtles that were not found during the nesting season (May through October), most (9/16) were found either in Monroe or Miami-Dade counties.

Kemp's Ridley Distributions and Relative Abundances

We used 1,597 Kemp's ridley stranding records to describe the distributions and relative abundances of Kemp's ridleys in Florida by size-class or life stage (Table 11). About 80% (N = 1,254) of the stranded Kemp's ridleys were dead when found. A little more than 10% (N = 187) of these stranding records involved Kemp's ridleys that were incidentally captured.

The size frequency distribution of the stranded Kemp's ridleys is given in Figure 24. There was a gradual rise in the numbers of strandings until the 35 to 39.9 cm CCL size-class and then there was a gradual decline in the stranding numbers of larger turtles. Unlike loggerheads and green turtles, which regularly nest in Florida, there was no peak in the number of strandings of either posthatchling or adult-sized Kemp's ridleys.

We documented only two strandings of posthatchling (< 10 cm CCL) Kemp's ridleys. Both were found along the east coast of Florida (Fig. 25A) during October. Kemp's ridleys nest from April through July along the western and southwestern Gulf of Mexico (TEWG, 2000). If the early growth of Kemp's ridleys was similar to that of loggerheads and green turtles (about 1 cm month^{-1}), these stranded posthatchling Kemp's ridleys were from the most recent nesting season and were likely transported out of the Gulf of Mexico and north along the east coast of Florida by prevailing currents.

There were eight strandings of Kemp's ridleys from 10 to 19.9 cm CCL (Fig. 25A2). The smallest one (12.2 cm CCL) was found in late October along the east coast of Florida (St. Lucie County) and may have been from the most recent nesting season. The larger ones (> 15 cm CCL) were all found during January through May and may also have originated from the most recent nesting season (during the previous year). Perhaps as with loggerheads and green turtles, Kemp's ridleys reach 15 to 20 cm CCL within their first year of life (a likely average growth rate during the first year of life of about 1 cm month^{-1}). However, a previous analysis of growth in Kemp's ridleys determined that it probably takes about two years for Kemp's ridleys to reach 20 cm SCL (about 21 cm CCL) and that this time likely varies from 1-4 years (TEWG, 2000).

The numbers of stranded Kemp's ridleys didn't begin to notably increase until the 20 to 24.9 cm CCL size-class (Table 11). This suggests that Kemp's ridleys begin directed movements to Florida coastal areas at this size. The numbers of stranded Kemp's ridleys continued to increase for the 25 to 29.9 and the 30 to 34.9 cm CCL size-classes, suggesting recruitment at these sizes too. The smallest Kemp's ridleys captured by in-water projects in Florida were between 20 and 29.9 cm CCL (Eaton et al., 2007).

The most common size for stranded Kemps ridleys in Florida was between 30 and 39.9 cm CCL (Table 11). The mean size of Kemp's ridleys captured by four of six in-water projects in Florida that captured relatively large numbers of Kemp's ridleys (total number of captures by project ranged from 40 to 253) was between 30 and 39.9 cm CCL (converting from SCL) (Schmid and Barichivich, 2006). The other two projects had mean capture sizes between 40 and 54.9 cm CCL. These larger sizes corresponded to the size-classes with the next highest numbers of strandings (Table 11). There may have been some net emigration from Florida of Kemp's ridleys that were larger than 35 cm CCL as evidenced by steadily decreasing numbers of strandings with increasing size.

The distribution and relative abundances of stranded Kemp's ridleys of all sizes (20 cm CCL through adult) were remarkably similar (Fig. 25B-E) and we could detect no appreciable shifts in distributions with increasing size. For all size-classes, strandings were most common in northwest Florida (Wakulla County through Bay County), central-west and southwest Florida (Pinellas County through Collier County), and northeast Florida (Nassau County through Volusia County). We should note that there are known to be relatively large numbers of Kemp's ridleys along the Big Bend area of Florida (Jefferson County through Pasco County) (Schmid and Barichivich, 2006). Most of the coasts that front offshore waters in Florida are sandy beaches with large human population centers nearby. Sea turtles that strand along such shores are likely to be discovered and reported. The coast along the Big Bend area of Florida is unusual because it is primarily marsh and primarily unpopulated. Sea turtle strandings along this coast are less likely to be found and reported than just about anywhere else in Florida.

We identified only two stranding records of adult male Kemp's ridleys. Their CCLs were 65.8 and 66.0 cm. Because all mature male Kemp's ridleys have a clearly recognizable tail, we believe these turtles were truly rare in Florida strandings. The size of adult male and female Kemp's ridleys might be the same (Pritchard and Marquez-M., 1973), but we could not evaluate this with the stranding data.

Stranded Kemp's ridleys were found more often in or adjacent to offshore waters (65.9%) than in or adjacent to inshore waters (34.1%). The highest proportion of inshore strandings was in the 30 to 34.9 cm CCL size-class (41.7%) and the proportion of inshore strandings in each subsequent 5-cm size-class through adult-size decreased (Fig. 26). Large juvenile and subadult Kemp's ridleys are generally characterized as occurring in nearshore benthic habitats (these could be either inshore or offshore as defined in the stranding data) and adult Kemp's ridleys are generally characterized as occurring in offshore benthic habitats (Ogren, 1989), but no gradual shift from inshore to offshore waters as Kemp's ridleys increase in size beyond 35 cm CCL has been detected by in-water studies.

Several studies have documented seasonal movements of Kemp's ridleys along the Atlantic coast of the U. S. (reviewed by Schmid and Barichivich, 2006). Kemp's ridleys captured north of Florida during the summer have been recaptured in Florida during the winter. The numbers of Kemp's ridley strandings by month from northeast to central-east Florida showed a pattern indicative of these types of seasonal movements (Fig. 27). Overall, Kemp's ridley strandings in this part of Florida were lowest during the summer (June through September). This corresponded to the time when many Kemp's ridleys would have been north of Florida. In general, the numbers of stranded Kemp's ridleys rose during the fall and winter as the turtles presumably moved into Florida and then declined again during the spring as the turtles presumably moved back out of Florida. In the northernmost Florida county along the east coast (Nassau County), the numbers of stranded Kemp's ridleys peaked earlier in the fall and later in the spring than they did in the counties to the south. We believe this corresponded to the movements of Kemp's ridleys that were north of Florida passing through Nassau County first during the fall on their way south and with Kemp's ridleys that overwintered farther south in Florida passing through Nassau County last during the spring on their way north. There were no Kemp's ridley strandings in Nassau County during January and February (and only two in December and one in March), indicating that they did not overwinter in this area. Finally, of the five counties immediately south of Nassau County, there were more stranded Kemp's ridleys in the two northernmost counties (Duval and St. Johns) during the fall than there were in the three southernmost counties (Flagler, Volusia, and Brevard) but there were more Kemp's ridley strandings in the three southernmost counties during the winter than there were in the two northernmost counties. We believe this showed that many Kemp's ridleys continued to move south during the fall through Duval and St. Johns Counties and that most overwintered in Flagler, Volusia, and Brevard Counties.

Several in-water studies provide corroborating evidence that the stranding data revealed a true pattern of seasonal movements of Kemp's ridleys in northeast and central-east Florida. Two Kemp's ridleys that were tracked using satellite telemetry moved from Georgia to central-east Florida (Brevard County) during October and November, remained in central-east Florida until March, and then moved from Florida to South Carolina during March and April (Renaud, 1995; Gitschlag, 1996). These documented movements were during the same months and through the same areas suggested by the stranding data. Two other in-water studies (Henwood and Ogren, 1987; Schmid, 1995) captured increasing numbers of Kemp's ridleys offshore of central-east Florida from January though March. The strandings of Kemp's ridleys in Brevard County peaked during March.

Strandings of Kemp's ridleys along central-west and southwest Florida were generally more numerous in the spring and summer than during the fall and winter (Fig. 28). Studies of Kemp's ridleys a little to the north of this area (along the Big Bend) revealed that these turtles migrated offshore during the winter (Schmid and Witzell, 2006). Perhaps the Kemp's ridleys farther south along the west coast of Florida make similar movements during the winter.

East-west movements of Kemp's ridleys in the northern Gulf of Mexico have been documented but there has been no clear indication of any seasonal pattern (reviewed by Schmid and Barichivich, 2006). Strandings of Kemp's ridleys in the Florida Panhandle (Franklin County through Wakulla County) were strikingly seasonal but different than that of Kemp's ridleys in any other area of Florida (Fig. 29). The number of strandings began to rise in April, peaked strongly in May and then quickly declined throughout the summer. We detected no appreciable differences to this pattern across the Panhandle area. No studies of movements of Kemp's ridleys found in the Florida Panhandle have been conducted but some type of seasonal movement would be expected given that Kemp's ridleys farther south along the west coast of Florida (and subject to less seasonal temperature change) exhibit seasonal movements.

Hawksbill Distributions and Relative Abundances

We used 516 hawksbill stranding records to describe the distributions and relative abundances of hawksbills in Florida by size-class or life stage (Table 12). About 50% (N = 266) of the stranded hawksbills were dead when found. Less than 2% (N = 7) of these stranding records involved hawksbills that were incidentally captured.

The size frequency distribution of the stranded hawksbills is given in Figure 30. There was a large, broad peak of hawksbill strandings from 5 to 30 cm CCL. These turtles included posthatchlings (< 10 cm CCL), possible oceanic-stage turtles, and small, neritic-stage turtles. The number of hawksbill strandings from 30 to 80 cm CCL remained at a relatively low and constant level. There was a drop in the number of stranded hawksbills of adult size (> 80 cm CCL).

Hawksbill nesting in Florida is rare with no more than four hawksbill nests ever identified in any one year during 1979 through 2003 (Meylan and Redlow, 2006). Given this, there was a surprisingly high number of strandings of posthatchling hawksbills. These were found primarily along the east coast of Florida, especially in southeast Florida (Fig. 31A). There were almost as many strandings of posthatchling hawksbills (N = 73) as there were of posthatchling green turtles (N = 85), a species that deposited from a few hundred to almost 10,000 clutches each year in Florida during our study period (FWC, unpubl data.). Hawksbills do nest in relatively large numbers along the Yucatan Peninsula in Mexico, and in lesser but significant numbers throughout the Greater and Lesser Antilles, and along the southwestern Caribbean coast (NMFS and USFWS, 2007). We concur with Meylan and Redlow (2006) that posthatchling hawksbills that stranded in Florida most likely originated from nesting beaches south of Florida and were carried to Florida's east coast by the various currents in the region. These hawksbill strandings in Florida were found in the area of greatest landfall probability for surface drifters originating the in Gulf of Mexico (southeast Florida, Lugo-Fernández et al., 2001).

Hawksbill nesting in the Caribbean can occur sporadically throughout the year, but is typically concentrated from mid-June through mid-November (Corliss et al., 1989). In Cuba, hawksbill nesting was reported to occur during the later part of the year and continue through February (Moncada et al., 1999). The greatest amount of hawksbill nesting around the Gulf of Mexico and Caribbean takes place along the Yucatan Peninsula of Mexico (Xavier et al., 2006). The hawksbill nesting season here is from April through September with peak activity in May and June (Perez-Castenada et al., 2007). With a mean incubation period of about 60 days (van Buskirk and Crowder, 1994), we expect posthatchling hawksbills from the Yucatan to typically first begin appearing in Florida no sooner than July. Arranging the number of posthatchling hawksbill strandings by month beginning in July, we see the potential timing of posthatchling hawksbill strandings in Florida (Fig. 32). These strandings may begin in October (just after or near the end of the hawksbill nesting season) and continue through the following June.

We could not detect an increase in size between what we'd think were the youngest posthatchlings (stranding in October) and oldest posthatchlings (stranding in May and June) (Table 13). Hatchlings from areas of the Caribbean with different nesting seasons may muddy this relationship. Nevertheless, as with green turtles, there was a logical progression by size-class of stranded hawksbills less than 20 cm CCL during a 17-month period beginning near the end of the hawksbill nesting season (Fig. 27). In our arrangement of hawksbill strandings by month, hawksbill posthatchlings (< 10 cm CCL) were found in relatively high numbers beginning in October at or near the end of the hawksbill nesting season. Strandings of these posthatchlings continued into June of the following year. Hawksbills from 10 to 14.9 cm CCL were first found in few numbers (one each month) during October and November, gradually rose and then peaked in numbers during March of the following year, and then gradually diminished in numbers and were not found after September. Hawksbills from 15 to 19.9 cm CCL were first found during December, gradually rose and then peaked in numbers during May of the following year, and then gradually diminished in numbers and were not found after November. These data suggest that, as with loggerheads, green turtles, and perhaps Kemp's ridleys, hawksbills may reach 15 to 20 cm CCL within their first year of life with a likely average growth rate during that time of about 1 cm $month^{-1}$).

The distribution and relative abundances of stranded hawksbills from 10 to 19.9 cm CCL were similar to that of the posthatchling hawksbills and similar to that of same-sized loggerheads and green turtles (Fig. 25A) (typical of surface drifters originating in the Gulf of Mexico, Lugo-Fernández et al., 2001). Oddly, there were more strandings of hawksbills from 10 to 19.9 cm CCL (N = 127) than there were of loggerheads (N = 83) or green turtles (N = 88) of the same size. This may be due in part to a larger number of small hawksbills than small loggerheads coming out of the Gulf of Mexico and being carried by currents along the east coast of Florida. Loggerhead nesting is primarily in southeast Florida and posthatchling loggerheads from this area might be carried north of Florida before reaching 10 to 19.9 cm CCL. There is a large amount of green turtle nesting in the Caribbean that could introduce many small green turtles into the Gulf of Mexico. For example, there were more green turtles nesting in Tortuguero alone

(Caribbean coast of Costa Rica) (Bjorndal et al., 1999) than of hawksbills or loggerheads nesting throughout the entire Caribbean and Gulf of Mexico. It is reasonable to expect the possibility that a larger number of small green turtles than of small hawksbills would be exiting the Gulf of Mexico and traveling with currents along the east coast of Florida. Perhaps there is a difference in the behavior of posthatchling green turtles and posthatchling hawksbills that results in more strandings of small hawksbills in Florida. The major hawksbill nesting beaches are also closer to the Gulf of Mexico than the green turtle nesting beach in Tortuguero and may result in a higher proportion of the small hawksbills being carried into the Gulf of Mexico than of the small green turtles.

It's not clear from the stranding data at what sizes hawksbills tend to recruit to Florida (Table 12). The numbers of hawksbill strandings peaked at turtles that were 10 to 19.9 cm CCL (N = 127) and decreased some for the next 10-cm size-class (20-29.9 cm CCL) (N = 120). The numbers of strandings decreased again for hawksbills that were 30 to 39.9 (N = 36) and remained around 30 to 40 stranded turtles for all of the subsequent 10-cm size-classes of immature hawksbills. Because no hawksbills less 20 cm CCL have been captured by in-water projects in Florida that sample in coastal, benthic habitats (Eaton et al., 2007), and based on other studies of hawksbills (reviewed by Meylan and Redlow, 2006), we assume hawksbills are oceanic until they surpass 20 to 25 cm CCL. The distribution and relative abundances of stranded hawksbills that were 20 to 59.9 cm CCL were similar and differed from that of the smaller hawksbills (< 20 cm CCL) in that strandings of the former group of hawksbills were found in relatively large numbers in central-west Florida (Fig. 31B). The larger immature hawksbills (≥ 60 cm CCL) and the adults were not found in any appreciable numbers in central-west Florida and were found almost exclusively in southeast Florida (Fig. 31C and D).

We identified only one adult male hawksbills (CCLs of 79.0 cm) and three adult female hawksbills (CCLs of 87.0 and 94.0 cm and one wasn't measured) in the stranding data. Because all mature male hawksbills have a clearly recognizable tail, we believe these turtles were truly rare in Florida strandings. Unfortunately, there is no such externally discernable characteristic to distinguish all stranded adult female hawksbills. It is certainly possible that we were unable to identify smaller, adult females. There is no clear evidence of a size difference between adult male and female hawksbills (reviewed by Meylan and Redlow, 2006) and we could not evaluate this with the stranding data.

Hawksbill strandings were found more often in or adjacent to offshore waters (80.6%) than in or adjacent to inshore waters (19.4%). This was true for every 10-cm size-class and for adult males and adult females (Fig. 34). There was no notable trend in the proportion of hawksbill strandings that were found inshore or offshore with increasing size. Almost all captures of hawksbills by in-water projects in Florida have been made in waters we define here as offshore (Eaton et al., 2007).

The only long-term in-water project in Florida that has regularly (although relatively rarely) captured hawksbills is the one at the intake canal of the St. Lucie Nuclear Power Plant (see Eaton et al., 2007 for a description of this project). No hawksbills have been captured here (St. Lucie County) during January or February

(Meylan and Redlow, 2006). This is the only hint of seasonal movements documented for hawksbills in Florida. The stranding data suggested that there were seasonal movements of hawksbills that were ≥ 20 cm CCL along both coasts of Florida. In southeast Florida, the numbers of hawksbill strandings rose during the spring and peaked in June. These strandings then decreased during the summer and were lowest in the fall (Fig. 35). In southwest Florida, hawksbill strandings occurred primarily during March. There were almost no hawksbill strandings here during the summer and fall (Fig. 36). In northeast Florida, where the most seasonality might be expected, hawksbill strandings occurred primarily during the late summer and early fall, but also occurred sporadically during most of the year (Fig. 37). In Monroe County, the southernmost county in Florida and the area where seasonal temperature changes are the least, hawksbill strandings peaked during the summer but also occurred in relatively large numbers throughout the year (Fig. 38).

Leatherback Distributions and Relative Abundances

We used 307 leatherback stranding records to describe the distributions and relative abundances of leatherbacks in Florida by size-class or life stage. About 90% (N = 282) of the stranded leatherbacks were dead when found. Less than 3% (N = 15) of these stranding records involved leatherbacks that were incidentally captured. Almost half (N = 276) of all the leatherback stranding records did not have a carapace length measurement and were excluded from these analyses. We noted that the descriptions or approximate measurements associated with these excluded records did not indicate that any of these animals were less than 100 cm CCL.

The size frequency distribution of the stranded leatherbacks is given in Figure 39. There was a small, broad peak of leatherback strandings from 10 to 30 cm CCL. We believe these turtles were less than one year-old and stranded following the most recent nesting season. Over our 28-year study period (1980-2007), we documented only two stranded leatherbacks between 30 and 100 cm CCL. There was a relatively large, broad peak of leatherback strandings primarily from about 130 to 180 cm CCL. This was the typical size range of adult female leatherbacks measured on the nesting beaches in Florida (reviewed by Stewart and Johnson, 2006).

Leatherback nesting in Florida begins in late February, peaks in May, and has been known to continue into August (Stewart and Johnson, 2006). During our study period, there was a general rise in the annual number of leatherback nests from around 100 nests to about 1,000 nests (FWC, unpubl. data). The incubation period of leatherback clutches is a little longer than that of loggerheads or green turtles (average closer to 70 days; Stewart and Johnson, 2006). Hatchlings could be found as early as May but the majority would hatch in August. The smallest stranded leatherback (10.2 cm CCL) was found in July. Arranging the number of strandings of small leatherbacks by month beginning in July, we see the potential timing of these strandings in Florida (Fig. 40). These strandings began in July, peaked in September, decreased over the following months, and then were not found after March of the year following the nesting season.

We detected a progressive increase in carapace length of the small stranded leatherbacks over a 9-month period beginning near the end of the nesting season (Fig. 41). We believe the largest of these leatherbacks (28.4 cm CCL) was probably about 8 months old (assuming the likelihood was greatest that it hatched in August with a majority of hatchlings). Zug and Parham (1996) predicted a first-year growth rate for leatherbacks of 34.9 cm yr^{-1} (or 2.9 cm CCL $month^{-1}$). Hatchling leatherbacks are about 6 cm CCL (Hirth, 1980). At 28.4 cm CCL, our putative 8 month-old leatherback had grown at a rate of 2.8 cm CCL $month^{-1}$.

Leatherback strandings were found throughout Florida but the highest numbers were found in northeast Florida from Nassau County through Volusia County (Fig. 42). The small leatherbacks were all found in southeast Florida (Fig. 42A), where the major leatherback nesting beaches are found (Meylan et al., 1995). The strandings of adult male leatherbacks were also concentrated in northeast Florida but more than half of the strandings of adult female leatherbacks were in southeast Florida (Fig. 42D and E).

We identified five adult male leatherbacks and six adult female leatherbacks in the stranding data that were measured for carapace length. Because all the females were identified by tags that were applied when they were on the nesting beach, we felt they represented a true range of adult female sizes. We compared the sizes of the two genders and found they did not differ (Table 14). A difference in size between adult male and female leatherbacks has also not been detected by any other study (reviewed by Stewart and Johnson, 2006).

Most (91.7%) of the leatherback strandings were found in or adjacent to offshore waters. Leatherbacks are not known to reside in or perhaps even to feed in inshore waters (Stewart and Johnson, 2006). Sick or injured leatherbacks from offshore areas may enter inshore areas before stranding or currents may carry leatherback carcasses from offshore areas to inshore areas. The percentage occurrence of leatherback strandings in inshore areas (8.3%) may reveal the potential error of using stranding locations to determine whether a turtle was living in an inshore or offshore area.

Seasonal changes in the numbers of leatherbacks around Florida were suggested by the stranding data. It's possible that the stranding data revealed a general movement of leatherbacks by season from the Atlantic Ocean to the Gulf of Mexico. Along the east coast of Florida, leatherback strandings rose in the fall, peaked in the late fall, and then decreased during the winter (Fig. 43). In Monroe County (at the southern terminus of Florida, sitting at the border of the Atlantic Ocean and the Gulf of Mexico), leatherback strandings began to rise in the late fall and peaked during the winter (two months later than the peak in leatherback strandings along the east coast of Florida) (Fig. 44). Along the west coast of Florida, leatherback strandings rose during the winter and peaked in the late winter and early spring (two months later than the peak in leatherback strandings in Monroe County) (Fig. 45). Leatherback strandings in all of Florida were relatively infrequent during the summer.

Olive Ridley Distributions and Relative Abundances

Only three stranded olive ridleys were documented in Florida from 1980 through 2005. Two were adult males that were found in Monroe County (one in 1999 and one in 2000). The third was a small olive ridley (24.9 cm CCL) that was found in Miami-Dade County during 2001. Details of these strandings can be found in Foley et al. (2003).

MORTALITY FACTORS

The cause of death was not usually determined for stranded sea turtles because most carcasses (about 70%) were at least moderately decomposed. Necropsies were conducted on 2,525 fresh dead sea turtles (about 20% of all fresh dead sea turtles) but a cause of death was not always determined in these cases because some mortality factors (such as incidental capture) usually left no discernable signs. To assess mortality factors, we relied primarily on observed carcass anomalies (e.g., injuries, gross signs of disease, evidence of entanglement, etc.) that indicated a potential mortality factor. For strandings where no potential mortality factor was indicated, we examined the temporal and spatial associations of these strandings with activities such as commercial fishing that are known to kill sea turtles and leave no anomalies.

Trauma

Propeller Wounds. The most common potential mortality factor noted in sea turtle strandings was propeller wounds. From 1980 through 2007, propeller wounds were noted in 4,101 stranding records (15.0%). This was an under representation of sea turtles in the stranding database with injuries from a collision with a boat because it only included cases with definitive propeller wounds. The stranding data also documented sea turtles with crushing injuries and no discernable propeller wounds. These turtles may have been hit by a part of a boat other than the propeller (e.g., the hull, skeg, or rudder) or the damage caused by the impact with the boat obscured the propeller wounds. Because crushing injuries can also be caused by other things such as dredges, the number of sea turtles with propeller wounds or crushing injuries would over represent sea turtles that collided with a boat. Regardless, relative to the number of turtles with distinct propeller wounds, there were few turtles with only crushing injuries. For example, if every stranded sea turtle with crushing injuries but no distinct propeller wounds did collide with a boat, those strandings with distinct propeller wounds would still represent about 85% of the stranded sea turtles that collided with a boat.

The number and percentage of stranded sea turtles with propeller wounds by species are given in Table 15. The number and percentage of stranded sea turtles with propeller wounds each year in Florida from 1980 through 2007 are shown in Figures 46 and 47. Both showed an increasing trend.

The greatest numbers of sea turtle strandings with propeller wounds were in southeast Florida and the fewest were in northwest Florida (Fig. 48A-E). By county, the percentage occurrence of propeller wounds in strandings was greatest in southeast Florida from Martin County through Miami-Dade County and lowest in the part of northwest Florida from Wakulla County through Gulf County (Table 16). Sea turtle strandings found in northeast Florida from Nassau County through Volusia County and in another part of northwest Florida from Bay County through Walton County also had a relatively low percentage occurrence of propeller wounds. The percentage of strandings found in the rest of Florida that had propeller wounds was similar and about midway between the extremes. The counties with the greatest numbers of registered boats tended to have the highest incidences of propeller wounds in sea turtle strandings and the counties with the lowest numbers of registered boats tended to have the lowest incidences of propeller wounds in sea turtle strandings (Fig. 49).

More (63.4%) of the sea turtle strandings with propeller wounds were found in or along offshore waters than in or along inshore waters (36.6%). However, a higher percentage of the strandings found in or along inshore waters had propeller wounds than those found in or along offshore waters (24.6% and 12.9%, respectively). This suggests that turtles living in inshore waters were about twice as likely to be struck by a propeller as those living in offshore waters. It is likely that both boats and sea turtles co-occur more often in inshore areas because both probably tend to travel in a relatively limited number of narrow channels.

Green turtle strandings had the highest percentage occurrence of propeller wounds (20.1%) (Table 15). By 10-cm size-class, the percentage of stranded immature green turtles (< 89.9 cm CCL) with propeller wounds progressively increased, peaked in the 60 to 69.9 cm CCL size-class, and then decreased (Fig. 50). The rise and fall in the percentage of green turtle strandings with propeller wounds by size-class was identical to the rise and fall in the percentage of green turtle strandings found in or along inshore waters (see Fig. 22). This suggests that immature green turtles were at an increased risk of being hit by a boat propeller when they moved from offshore areas to inshore areas and at less of a risk of being hit by a boat propeller when they moved back to offshore areas. The highest concentration of immature green turtle strandings with propeller wounds occurred from southern Brevard County through northern Miami-Dade County (Fig. 48B).

A higher percentage of adult green turtles had propeller wounds than of any size-class of immature green turtle. About 40 to 50% of stranded adult green turtles had propeller wound (see Fig. 50). Almost all of the stranded adult green turtles with propeller wounds were found in Palm Beach and Broward counties (see Fig. 2). This is north of the likely adult green turtle foraging areas (in Miami-Dade and Monroe Counties) and in the southern portion of the primary green turtle nesting beaches in Florida (Meylan et al., 1995). Most (88%) of the stranded adult green turtles with propeller wounds were also found during the green turtle nesting season in Florida (May through October) All of this suggested that adult green turtles were more susceptible to being hit by boat propellers during movements associated with reproductive activity.

Stranded leatherbacks had the second highest percentage occurrence of propeller wounds (18.9%) (Table 15). Most of these strandings were found along the east coast of Florida (Fig. 48C). Unlike the overall distribution and relative abundances of leatherback strandings (see Fig. 42), there was a relatively high concentration of leatherback strandings with propeller wounds in Martin and Palm Beach counties. These two counties were also where most (about 75-80% of) leatherback nesting in Florida occurs (Meylan et al., 1995). About 70% of the leatherback strandings with propeller wounds from Martin County or Palm Beach County were found during the leatherback nesting season (February-August). The stranding data suggested that these turtles too were more susceptible to being hit by boat propellers during movements associated with reproductive activity.

About 15% of the stranded loggerheads had propeller wounds (Table 15). By 10-cm size-class, the percentage of stranded loggerheads with propeller wounds progressively increased as the size of the stranded loggerheads increased and then peaked with adult turtles (Fig. 81). Stranded adult loggerheads were more likely than immature loggerheads to have propeller wounds. About 25% of the adult male and female loggerheads had propeller wounds. These strandings were almost all either in central-west, southwest, central-east or southeast Florida (Figs. 83 and 84). Most (70%) of the strandings of adult female loggerheads with propeller wounds were found during the months when these turtles were most likely to be reproductively active (May-June) (Fig. 52). A large portion (53%) of the strandings of adult male loggerheads with propeller wounds was found during the months when these turtles were most likely to be reproductively active (March-June) (Fig. 52). Although the reproductive status of the stranded loggerheads was generally unknown, we see another indication from the stranding data that reproductively active adult sea turtles were especially vulnerable to being hit by boats.

About 11% of stranded Kemp's ridleys had propeller wounds (Table 15). By 10-cm size-class, the percentage of stranded Kemp's ridleys with propeller wounds progressively increased and peaked in large, immature turtles (40-59.9 cm CCL) (Fig. 53). Unlike the stranded loggerheads and green turtles, strandings of the largest immature Kemp's ridleys and of adult Kemp's ridleys were less likely to have propeller wounds than the smaller Kemp's ridleys were. Also, the Kemp's ridley size-class with the greatest percentage occurrence of propeller wounds (40-59.9 cm CCL) only partially overlapped with the Kemp's ridley size-class where the percentage of inshore strandings peaked (30-49.9 cm CCL). Most of the stranded Kemp's ridleys with propeller wounds were found in central-west and southwest Florida (Fig. 48E). This was the only species where strandings with propeller wounds were not concentrated in central-east or southeast Florida (probably because this species is not often found in these parts of Florida).

The lowest percentage occurrence of propeller wounds was found in hawksbill strandings (Table 10). By 10-cm size-class, the percentage of stranded hawksbills with propeller wounds generally increased and peaked in large, immature turtles (60-69.9 cm CCL) (Fig. 87). Like Kemp's ridleys (another species that doesn't regularly nest in

Florida), strandings of the largest immature hawksbills and of adult hawksbills were less likely to have propeller wounds than the smaller hawksbills were. Most of the hawksbill strandings with propeller wounds were found in Broward and Miami-Dade counties (Fig. 48D).

Injuries from Dredges. Sea turtles in Florida have been injured or killed by the excavation activities of underwater dredges (Studt, 1987). There are 31 records (18 loggerheads, 11 green turtles, and two Kemp's ridleys) in the stranding database that are coded as dredge kills. There are also 804 records of stranded sea turtles in Florida from 1980 through 2007 with major, crushing injuries from an unknown source. The injuries in some percentage of these turtles came from collisions with boats or boat engines but some probably came from collisions with excavating dredges.

The STSSN database is not the best source for information on mortalities from dredges primarily because the carcasses are often retained on the screens in the dredge systems and would not later be found as strandings. The best source for this information comes from observers who work aboard dredges, continually inspect the dredge screens, and record any incidental takes of sea turtles. Data from dredging projects associated with the U. S. Army Corps of Engineers can be accessed on the web at their Sea Turtle Data Warehouse at the following link:
http://el.erdc.usace.army.mil/seaturtles/index.cfm.

Injuries from Entrainment at Power Plants. Many electrical-generating (power) plants in Florida draw water for cooling from areas where sea turtles occur. These plants use large impellors to draw in water through an intake canal. There are grates in front of the impellors to prevent debris from being drawn into them. Sea turtles can be injured when drawn up against these grates by the strong flow of water or they can drown if trapped underwater against a grate. Most of the intake canals are simply open to nearby marine waters but the St. Lucie Power Plant (St. Lucie County) is unique in that it draws its cooling water into a closed intake canal through three large diameter pipes (3.9 m) with openings that are 365 m offshore in about 7 m of water (close to a nearshore hardbottom area). Sea turtles that come too close to these intake pipes are pulled into the pipes and transported underground to the intake canal. The turtles can be injured or killed when drawn through these pipes or after arriving at the intake canal and being drawn up against a barrier net that is in front of the impellor grating.

There were 516 stranding records of sea turtles that were found in the intake canals of Florida power plants from 1980 through 2007. All of the regularly occurring species were represented except for leatherbacks. The power plants where sea turtles were reported and the number by species reported from each power plant are given in Table 17. Some of the turtles found in the intake canals (N = 59) were apparently healthy and uninjured and were immediately released. This is an under representation of the actual numbers of sea turtles that were found entrained in the intake canals of power plants but released healthy and unharmed because stranding forms were not typically completed in these cases. The St. Lucie Power Plant alone usually captures and releases several hundred sea turtles each year (Bresette et al., 2003).

About 20% of the sea turtles reported from the intake canals of power plants were dead (N =113). Some of these turtles were likely killed in the intake canals but some were already dead before being entrained. For example, nine of these dead turtles had injuries that indicated another potential mortality factor (e.g., propeller wounds, shark wounds). Another 25 turtles appeared to have been severely debilitated (as evidenced by the presence of fibropapillomatosis or by emaciation) and may have been unusually susceptible to mortality from entrainment.

Most of the live sea turtles reported from the intake canals of power plants (N = 340) were sick or injured and required rehabilitation. About half of these turtles had fibropapillomatosis or were described as emaciated (chronically ill) and about 25% of the remaining turtles had injuries that were not attributable to the entrainment (e.g., propeller wounds, shark wounds, healed injuries). We believe the generally weakened condition of debilitated turtles made them less likely to resist the flow of water toward the impellors and more likely to be brought up against the intake grates.

Mutilations. Sea turtles in Florida were known to have been or were suspected of having been mutilated. There were 18 sea turtle stranding records from Florida during the period of 1980 through 2007 that reported on an incident where formal charges were brought against an individual for killing a sea turtle or for having sea turtle products (e.g., fresh meat or a freshly obtained carapace) in their possession. Another 30 sea turtle stranding records involved a carcass that was apparently butchered. Holes (usually one to a few centimeters in diameter) were found on some part of the body (usually the head or carapace) of 102 sea turtle strandings. These holes were noted as possible wounds from a bullet, spear, or gaff. Apparent knife cuts were observed on 424 of the sea turtle strandings. These usually involved a cut across the throat or at the edges where one or more flippers or the carapace was missing.

The number of sea turtle strandings that were apparently mutilated and the percentage of strandings with apparent mutilations by species are given in Table 18. The number and percentage of stranded sea turtles that were apparently mutilated each year in Florida from 1986 through 2007 are shown in Figures 55 and 56. BBoth have been decreasing.

Shark Wounds. Shark wounds were noted in 948 (3.7%) of the stranded sea turtles. By species, the percentage occurrence of shark wounds was highest for leatherbacks (9.4%) and relatively low for the other species (3.2-3.9%) (Table 19). Like with propeller wounds, we often didn’t know whether or not a shark wound was inflicted prior to death. Certainly, some carcasses were fed upon by sharks. The number and percentage of stranded sea turtles with shark wounds each year in Florida from 1986 through 2007 are shown in Figures 57 and 58. Both have been increasing.

The greatest numbers of sea turtle strandings with shark wounds were found in central-east and southeast Florida and the fewest were found in northwest Florida (Fig. 59). More sea turtle strandings with shark wounds were found in or along offshore waters (87.5%) than in or along inshore waters (12.5%). Also, a higher percentage of the strandings found in or along offshore waters had shark wounds than those found in or along inshore waters did (3.7% and 1.8%, respectively). The numbers of sea turtle strandings with shark wounds were greatest during the spring and summer and least during the fall and winter (Fig. 60).

By 10-cm size-class, the percentage of stranded loggerheads with shark wounds tended to be greatest for loggerheads that were ≥80 cm CCL (Fig. 61). For green turtle strandings, the percentage of green turtles with shark wounds increased with increasing size (Fig. 62). Kemp's ridley strandings exhibited a pattern similar to that of green turtle strandings. The percentage of stranded Kemp's ridleys with shark wounds increased with increasing size but was then less for adults (Fig. 63). Only eleven stranded hawksbills with carapace length measurements had shark wounds but almost all 10-cm size-classes were represented (stranded hawksbills with shark wounds ranged in size from 27.9 to 86.5 cm CCL).

Disease

Emaciation. The second most common anomaly that indicated a potential mortality factor was emaciation. Emaciation was noted in 3,157 (12.3%) of the stranded sea turtles. Noticeably emaciated sea turtles were usually suffering from chronic, often systemic, terminal infections. It should be noted that not all sea turtles that died from disease were noticeably emaciated. Therefore, emaciated turtles only represented a subset of all diseased turtles in the stranding database.

The number and percentage of stranded sea turtles found each year in Florida from 1986 through 2007 that were emaciated are shown in Figures 64 and 65. Both have been increasing.

The greatest numbers of emaciated stranded sea turtles were found in central-east Florida (St. Johns County through Martin County) (Fig. 66). By month, the numbers of emaciated sea turtle strandings rose during the fall and winter, peaked during the early spring and then declined through the spring and summer (Fig. 67).

Green turtle strandings were the most likely to be noted as emaciated (9.5 %) (Table 20). The relatively large number of emaciated green turtles can be attributed to the occurrence of fibropapillomatosis (FP) in this species. Only 6.7% of the stranded green turtles without FP were emaciated whereas 19.4% of the stranded green turtles with FP were emaciated (Table 20). By 10-cm size-class, the percentage of stranded green turtles that were emaciated peaked in the 20 to 29.9 cm CCL size-class and progressively declined (Fig. 68). Green turtle strandings that were emaciated were found more seasonally than green turtle strandings that weren't emaciated. Most emaciated green turtle strandings (72.9%) were found from December through May. The numbers of these strandings increased beginning in December, peaked in March, and then declined during the following months (Fig. 69). The numbers of stranded green turtles that were not emaciated remained relatively constant throughout the year with a slight increase during the period of January through August (Fig. 69).

About 10% of the stranded loggerheads were emaciated (Table 20). By 10-cm size-class, the percentage occurrences of stranded loggerheads that were emaciated were highest in the smallest size-class (10 to 19.9 cm CCL) and in the middle size-classes (60 to 79.9 cm CCL) (Fig. 70). This was the opposite of the pattern seen in stranded green turtles. The highest percentage of green turtle strandings that were emaciated were in the smaller (but not the smallest) size-classes (20 to 49.9 cm CCL) (compare Figs. 68 and 70). Also in contrast to the green turtle strandings, at least 3% of the stranded loggerheads in all size-classes (including adults) were emaciated.

Emaciated loggerheads were most commonly found along the central-east coast of Florida (Fig. 55A). Almost half (49.3%) of the strandings of emaciated loggerheads were found in either Volusia County or Brevard County even though only a quarter (25.4%) of all loggerhead strandings were found in these two counties. The three months with the highest percentage of stranded loggerheads that were emaciated were March, April, and May. The three months with the highest percentage of stranded loggerheads that were not emaciated were May, June, and July (Fig. 71).

Almost 9% of stranded hawksbills were found to be emaciated (Table 20). By 10-cm size-class, the percentage of stranded hawksbills that were emaciated was highest for turtles that were 30 to 39.9 cm CCL (Fig. 72). Emaciated hawksbills were more likely to be found during the fall and winter (Fig. 73).

There were relatively few stranded Kemp's ridleys that were emaciated (3.1%) (Table 20). About 40% of stranded Kemp's ridleys that were 10 to 19.9 cm CCL were emaciated but the percentage of other-sized stranded Kemp's ridleys that were emaciated was low (Fig. 74).

We documented only one emaciated leatherback. It is likely that emaciated leatherbacks present differently than emaciated cheloniids and may not have been recognized as such by STSSN observers.

Fibropapillomatosis. FP is a disease characterized by single to multiple tumors ranging from 0.1 cm to greater than 30 cm in diameter (Herbst, 1994). The size, location, and number of tumors can contribute to progressive debilitation and eventual death. Tumors on the body, especially in the inguinal and axillary regions, can grow large enough to impair swimming activity and tumors growing around the eyes can eventually occlude vision (Jacobson et al., 1989). The increasing severity of FP (as determined by the size and number of tumors) correlates with deteriorating physiologic condition (Work and Balazs, 1999). Green turtles with FP are also chronically stressed and immunosuppressed (Aguirre et al., 1995) and are more likely to have systemic bacterial infections (Work et al., 2003) than are green turtles without FP.

The tumors associated with FP were documented in 1,531 (22%) of the stranded green turtles in Florida from 1980 through 2007. The number and percentage of green turtle strandings with FP each year in Florida from 1980 through 2007 are shown in Figures 76 and 77. Both increased during this time.

We included data collected from 1980 through 1985 in this particular trend assessment even though this was a period of inconsistent effort for Florida's STSSN. We felt this was justified for two reasons. The first was that the areas in Florida where green turtles with FP were typically found (the southern half of Florida) were more consistently monitored for sea turtle strandings in the early 1980s than other areas of Florida were. The second was that FP is an anomaly that would more often elicit comments than other anomalies because of the typically large, external tumors.

Stranded green turtles with FP that were found in Florida were more likely to be emaciated and more likely to be entangled in fishing line than stranded green turtles without FP were (Foley et al., 2005) (Table 20). The distributions of stranded green turtles from Florida with FP and the percentage occurrences of FP in different size-classes of stranded green turtles from Florida has been previously reported (Foley et al., 2005). As of 1999, the distribution in Florida of stranded green turtles with FP was limited to the southern half of Florida (south of 29° N latitude) (Foley et al., 2005). During the period of 2000 through 2007, stranded green turtles with FP were documented in Florida north of 29° N latitude (Fig. 78).

Spirorchidiasis. Spirorchidiasis (i.e., a blood fluke infection) has been suspected of causing a significant amount of debilitation and mortality in loggerheads (Wolke et al., 1982). The presence of large numbers of spirorchiids in the central nervous system was suspected of playing a role in a large-scale die-off of loggerheads in southern Florida during 2000 and 2001 (Jacobson et al., 2006).

Spirorchiids have been found in most of the stranded sea turtles from Florida where a multi-organ screening for parasites was conducted (B. Stacy, unpubl. data). These were often sea turtles that were chronically debilitated as evidenced by severe emaciation but spirorchiid infections have also been found in sea turtles that were not chronically debilitated. Spirorchiids have been documented in stranded loggerheads, green turtles, Kemp's ridleys, and leatherbacks found in Florida (B. Stacy, unpubl. data). Severe infections associated with spirorchiids have been seen in major arteries (primarily the aorta) and in the bile duct, colon, gall bladder, integument, small intestine, spleen, stomach, thymus, thyroid gland, and testes. In some cases, these spirorchiid infections were thought to have contributed to death or debilitation by disrupting organ function or by causing tissue damage that led to secondary bacterial infection. Additionally, moderate infections associated with spirorchiids in Florida sea turtle strandings have been found in the adrenal glands, brain, cloaca, kidney, heart, liver, lungs, pancreas, salt glands, and urinary bladder (B. Stacy, Unpubl. data).

Brevetoxicosis. Brevetoxin is a neurotoxin produced by microscopic algae (usually *Karenia brevis*). High concentrations of these organisms discolor the surrounding water and are known as red tides. Red tides have been documented as a mortality factor for birds and marine mammals and are suspected of being a mortality factor for sea turtles (Steidinger et al., 1973; Bossart et al., 1998; Kreuder et al., 2002; Landsberg, 2002). Live, debilitated sea turtles found in Florida during red tides have exhibited symptoms that could have been caused by a neurotoxin. The possible symptoms of brevetoxicosis as noted by rehabilitation facilities in Florida include unresponsiveness, apparent inability to move the flippers or raise the head, lack of a blink reflex, swelling of the periorbital region (eye), and swimming in circles and other uncoordinated motor functions.

Concentrations of *K. brevis* above 100,000 cells per liter (subsequently referred to as a strong red tide) are thought to cause mortality for Florida manatees (*Trichechus manatus latirostris*; Landsberg, 2002). We assumed that this concentration of *K. brevis* could also kill sea turtles. To assess brevetoxicosis as a potential mortality factor for sea turtles in Florida, we began by dividing Florida into seven areas using combinations of adjacent NMFS Fishery Statistical Zones (see Fig. 2). For southern Florida, we combined Zones 1, 2, and 24. For different parts of western Florida, we combined Zones 3 and 4, Zones 5 and 6, and Zones 7 through 10. For different parts of eastern Florida, we combined Zones 25 and 26, Zones 27 and 28, and Zones 29 and 30. We used the FWC/FWRI database of *K. brevis* counts in Florida from 1986 through 2005 to determine the months when strong red tides were detected in each of our areas of combined zones. We then compared the numbers of sea turtle strandings in these areas during strong red tides to the numbers of sea turtle strandings in these same areas when strong red tides were not detected.

The only areas in Florida that were systematically tested for brevetoxin were in NMFS Zones 4 and 5 beginning in the mid-1990s. Otherwise, water testing was most commonly conducted when red tide conditions were suspected because of fish kills, discolored water, or complaints by the public of respiratory irritation. We believe that most strong red tides that were near shore were detected at some point by water testing. However, every single month of strong red tide may not be revealed by the results of water testing because water samples were often collected opportunistically and the distribution of *K. brevis* was patchy.

To detect sea turtle mortality possibly caused by strong red tides, we compared the numbers of sea turtle strandings during strong red tides to the numbers of sea turtle strandings during times when strong red tides were not detected. Even if strong red tides did cause sea turtle mortality, at least some and perhaps many sea turtles in the area of a strong red tide were still likely subjected to other mortality factors. In our comparisons of stranding numbers, we would have ideally removed all the sea turtles that likely succumbed to mortality factors other than red tides. However, except for strandings of live sea turtles where behavior indicated that the turtle was not likely suffering from exposure to a neurotoxin, we had to include all strandings in our comparisons to detect sea turtle mortality from red tide. Even dead sea turtles with propeller wounds, or shark wounds, or evidence of chronic disease may have originally been debilitated or killed by red tide. Because of this, our analyses only allowed us to detect sea turtle mortality from strong red tides if that mortality was large relative to all the other mortality factors.

Strong red tides were detected most commonly along the central-west and southwest coast of Florida. In Zones 5 and 6, strong red tides were detected during 99 months (out of the 264 months during the time period of 1986 through 2007). The strong red tides in this area were documented during every month of the year and there was no consistent seasonal trend. The median monthly number of sea turtle strandings during the 99 months of known strong red tides (10.0, 95% CI = 1.0–38.6) was greater than the median monthly number of sea turtle strandings during the 165 months of no (or undetected) strong red tide (7.0, 95% CI = 2.0–21.3) (Mann-Whitney Rank Sum Test, $P < 0.05$). Of the ten months in Zones 5 and 6 with the greatest numbers of sea turtle strandings from 1986 through 2007, strong red tides were detected during eight of those months (and during four of the top five months).

In Zones 3 and 4, strong red tides were detected during 99 months (out of the 264 months during the time period of 1986 through 2007). As in Zones 5 and 6, the strong red tides in this area were documented during every month with no consistent seasonality. The median monthly number of sea turtle strandings during the 99 months of known strong red tides (5.0, 95% CI = 0–36.0) was not different from the median monthly number of sea turtle strandings during the 165 months of no (or undetected) strong red tide (5.0, 95% CI = 0–25.0) (Mann-Whitney Rank Sum Test, $P > 0.05$). Nevertheless, of the ten months in this area with the greatest numbers of sea turtle strandings from 1986 through 2007, a strong red tide was detected during seven of those months (and during each of the top six months). Strong red tides in this area probably caused some sea turtle mortality but not as much relative to other mortality factors as they did in Zones 5 and 6.

Strong red tides were detected during 30 months in Zones 7 through 10 (out of the 264 months during the time period of 1986 through 2007). In this area, the strong red tides were almost always detected from August through December (28 of the 30 months). The median number of sea turtle strandings during the months of August through December in the nine years when strong red tides were detected during one or more of these months (33.0, 95% CI = 8.0–55.0) was greater than the median number of sea turtle strandings during the same months each year when there was no strong red tide detected during any of those months (13.0, 95% CI = 5.2–24.6) (Mann-Whitney Rank Sum Test, $P < 0.01$).

In Zones 1, 2, and 24, strong red tides were detected during 19 months (out of the 264 months during 1986 through 2007). All were detected during the period of December through March and most (14 of 19 months) were detected in either January or February. The median number of sea turtle strandings during the months of January and February in the nine years when strong red tides were detected during one or more of these months (23.0, 95% CI = 2.3–18.7) was greater than the median number of sea turtle strandings during the same months each year when there was no strong red tide detected during January or February (10.0, 95% CI 18.0–32.3) (Mann-Whitney Rank Sum Test, $P < 0.001$).

No strong red tides were ever detected in Zones 25 and 26. In Zones 27 and 28, a strong red tide was detected only during five months (November of 1997, November and December of 2002, and November and December of 2007). The numbers of sea turtle strandings in November and December of 1997 and 2002 in this area of Florida were less than during any other November and December in that area since 1995. The number of sea turtle strandings during November and December of 2007 was greater than during any other November and December in these zones but only five stranded turtles greater than in November and December of 2006 (103 vs. 98, respectively), when no red tide was detected.

A strong red tide was detected in Zones 29 and 30 during September and October of 1999 and during September through December of 2007. The numbers of sea turtle strandings during the months of September through December of 2007 and 1999 were the second and sixth largest during the years from 1986 through 2007.

Samples of liver and stomach contents from sea turtles found dead in areas where strong red tides were detected had concentrations of brevetoxin ranging as high as 12,449 ng/g (Foley, unpubl. data). The brevetoxin concentrations in these turtles were often either similar to or much greater than those found in the tissues from manatees that were determined to have died from brevetoxicosis during an epizootic in southwest Florida during 1996 (manatee tissue concentrations ranged from 2 to 158 ng/g, Leanne Flewelling, unpubl. data) (Redlow et al., 2003). High levels of brevetoxin have been found in four species of sea turtles (loggerheads, Kemp's ridleys, green turtles, and hawksbills) from southwest and northwest Florida (Foley, unpubl. data).

Detailed necropsies of fresh dead sea turtles with relatively high levels of brevetoxin have not uncovered any histological changes that were specifically attributable to the effects of a neurotoxin. Although many aspects of the respiratory system were examined, there were no findings similar to those described for inhalational brevetoxicosis in manatees (B. Stacy and A. Foley, unpubl. data). However, brevetoxicosis has been known to show little or no pathology in other animals such as fish (Steidinger et al., 1973) and birds (Kreuder et al. 2002). Brevetoxicosis could not be directly identified by detailed necropsy but other primary causes of demise (major injury or systemic disease) were ruled out.

Hypothermic Stunning Events

Hypothermia in sea turtles can disrupt metabolic pathways, causing imbalances in blood chemistry (Lutz et al., 1989; Carminati et al., 1994.). When exposed to water temperatures below 10º C, sea turtles become lethargic and float at the surface (Schwartz, 1978). Turtles in this condition are commonly referred to as being cold-stunned.

There are only two areas in Florida where cold-stunning of more than a few sea turtles over a period of days to a week has been documented. One is in Brevard County, primarily in the southern end of the Mosquito Lagoon but also to a lesser extent in the northern end of the Indian River Lagoon and Banana River. Cold-stunning events here that involved more than 100 sea turtles were documented during January in 1977, 1981, and 1985 (Witherington and Ehrhart, 1989), and in December of 1989 (Schroeder et al., 1990). About 80% of the cold-stunned sea turtles in these events were green turtles and the rest, with the exception of one Kemp's ridley, were loggerheads. A minor cold-stunning event involving 28 green turtles was documented by the Florida STSSN in the southern end of the Mosquito Lagoon in January of 2003.

The other area in Florida where cold-stunning events have been documented is in Gulf County in the southern end of St. Joseph Bay. A total of 401 sea turtles were found cold-stunned here during late December 2000 and early January 2001 (Foley et al., 2007). Most (N = 388) of the sea turtles involved in this event were green turtles but there were also 10 Kemp's ridleys and three loggerheads. A relatively minor cold-stunning event involving 39 green turtles, two Kemp's ridleys, and one loggerhead was also documented by the Florida STSSN in the southern end of St. Joseph Bay during January of 2003. During all the cold-stunning events in both areas of Florida, STSSN participants collected the effected turtles and transported live animals to permitted facilities to be rehabilitated before release. Overall, the mortality of the sea turtles from all events was about 20%.

Interactions with Commercial and Recreational Fisheries

Our ability to detect sea turtle mortality from commercial fisheries (primarily trawling, gill netting, and long lining) is typically poor because these fisheries often leave no discernable signs on carcasses. We rely on indirectly assessing the impact of these fisheries by relating changes in the numbers of sea turtle strandings in a certain area over a certain period of time to similar changes in the effort of these fisheries. If sea turtle stranding trends accurately reflect the impact of a fishery that incidentally kills sea turtles, then stranding numbers will be greatest when effort in that fishery is greatest and lowest when effort in that fishery is lowest. However, unrelated variations in the relative abundances of sea turtles and in the magnitudes of other mortality factors (including other fisheries) may serve to conceal a positive relationship between sea turtle strandings and the fishing effort of one particular fishery. Additionally, sea turtles that are killed in fisheries operating far from shore are less likely to be well represented in strandings than sea turtles that are killed in fisheries operating close to shore.

Sea turtle strandings are comprised of turtles that succumbed to a wide variety of mortality factors and represent only a fraction (perhaps an inconsistent fraction) of overall sea turtle mortality. In our analyses of the impacts of commercial fisheries on sea turtle mortality, we removed sea turtle strandings for which mortality factors not related to commercial fisheries (e.g., propeller or shark wounds, entanglements, chronic debilitation, etc.) were indicated. This still left us with sea turtle strandings that likely represented mortality from several different commercial fisheries and from other, undetected sources. Unless mortality from one fishery dominated the strandings, we were unlikely to detect a relationship between changes in numbers of sea turtle strandings and in the effort of a particular fishery.

Commercial Trawling. Shrimp trawling fisheries have been known to capture and incidentally kill large numbers of sea turtles, especially loggerheads and Kemp's ridleys (Magnuson et al., 1990). Regulations to limit the incidental mortality of sea turtles in shrimp trawls by requiring the use of Turtle Excluder Devices (TEDs) took partial effect in the U.S. beginning in 1990 and were eventually implemented for almost all shrimping in the U. S. by the end of 1994 (see Epperly and Teas, 2002 for a review). These TEDs should have effectively allowed most of the green turtles and Kemp's ridleys of the size typically found in Florida to escape shrimp trawls; however, the openings permitted for TEDs were too small to allow most of the loggerheads and leatherbacks typically found in Florida to escape the shrimp trawls (Epperly and Teas, 2002).

The shrimp fishery in Florida primarily targets three species of shrimp: brown shrimp (*Farfantepenaeus aztecus*), pink shrimp (*Farfantepenaeus duorarum*), and white shrimp (*Liptopenaeus setiferous*). Brown shrimp are caught mainly along the coast of the Florida Panhandle, along the east coast of Florida, and in the southernmost area along the west coast of Florida. White shrimp are caught mostly along the coast of northeast and central-east Florida and in the Florida Panhandle. Pink shrimp are caught all around Florida but are the principal catch in southwest Florida (FWC, unpubl. data).

To assess the effects of variations in shrimp fishing effort in Florida on sea turtle mortality, we obtained commercial landings data for shrimp in Florida from 1986 through 2005 (FWC, unpubl. data). Determining fishing effort from these data was problematic because direct effort (the hours fished in a certain area) was not reported. The only indicators of effort that were reported were the pounds of shrimp caught and the number of shrimp fishing trips made. However, the pounds of shrimp caught does not accurately represent effort if catch per unit effort varies greatly and the number of shrimp fishing trips made does not accurately represent effort if the effort per fishing trip varies greatly. Also, the location associated with the effort (either pounds of shrimp caught or number of shrimp fishing trips made) was the place where the shrimp was landed (brought into port). The landing port could be far away from where the shrimp fishing was actually conducted. To possibly account for some of the biases introduced by these data, we used both the pounds of shrimp caught and the numbers of shrimp fishing trips made each month as indicators of relative shrimp fishing effort.

To represent the sea turtle mortality most likely caused by incidental capture in shrimp trawls, we used a specific subset of sea turtles strandings. We used only strandings of loggerheads, Kemp's ridleys, and leatherbacks, and we excluded strandings where a mortality factor other than incidental capture in a shrimp trawl was indicated. For example, we excluded strandings of live turtles and strandings of dead turtles that had propeller wounds, crushing injuries, shark wounds, any grossly observable signs of disease, or that were entangled in some material. For sea turtle strandings along parts of the coast where strong red tides appeared to influence sea turtle mortality, we also excluded most years when strong red tides were detected because during those years we could not separate sea turtles that likely succumbed to red tides from sea turtles that likely did not.

We combined the numbers of stranded sea turtles by month for all included years and compared these totals to the numbers of shrimp fishing trips made and the pounds of shrimp landed both combined by month for all included years. We tested for correlations using Spearman Rank Order Correlation.

To compare shrimp fishing effort to the numbers of sea turtle strandings in Zones 1, 2, and 24 (see Fig. 2), we used shrimp landings data for pink and brown shrimp from Monroe County and Miami-Dade County (see Fig. 2). Because we found that strong red tides were likely causing substantial and consistent sea turtle mortality in this area, we only used sea turtle stranding data from 1986 through 1994, 1997 through 1999, and 2004 (years when no strong red tides were detected). The dead turtles that were found in these zones during the included years and for which no other mortality factors were directly indicated included 181 loggerheads, 4 leatherbacks, and 2 Kemp's ridleys. We combined the numbers of stranded loggerheads by month for all included years and compared these totals to the numbers of shrimp fishing trips made and the pounds of shrimp landed both combined by month for all included years. None were correlated.

In Zones 3 and 4, we used shrimp landings data for pink and brown shrimp from Charlotte County through Monroe County and we used sea turtle stranding data from 1986 through 2007. We did not exclude years where strong red tides were detected here because these red tides did not appear to substantially influence the overall sea turtle mortality. The dead turtles that were found in these zones during these years and for which no other mortality factors were directly indicated included 1009 loggerheads and 227 Kemp's ridleys, and one leatherbacks. We combined the numbers of stranded loggerheads and the numbers of stranded Kemp's ridleys by month for all years and compared the totals to the numbers of shrimp fishing trips made and the pounds of shrimp landed also combined by month for all years. During this entire period, there was no correlation between the numbers of loggerhead or Kemp's ridley strandings by month and numbers of shrimp fishing trips made or pounds of shrimp landed by month.

We noted that strong red tides in Zones 3 and 4 were primarily documented after 1994. From 1986 through 1994, there were 13 months of strong red tides detected. From 1995 through 2007, there were 86 months or strong red tide detected. Even though we could not detect a consistent influence of strong red tides on the numbers of sea turtle strandings in this area, we thought it likely that strong red tides were causing some sea turtle mortality and that its effects would have been greatest after 1994. Additionally, TED regulations were universally implemented as of late 1994. Because the openings allowed on TEDs in the Gulf of Mexico were unlikely to release most loggerheads from shrimp trawls (see Epperly and Teas, 2002), we did not expect TED regulations to greatly reduce any loggerhead mortality but we did expect it to reduce any mortality of Kemp's ridleys. Because of these conditions, we wondered if sea turtle stranding numbers in Zones 3 and 4 might be correlated to shrimp fishing effort by month during the period of 1986 through 1994. The dead turtles that were found in these zones during these years and for which no other mortality factors were directly indicated included 285 loggerheads and 31 Kemp's ridleys (no leatherbacks). We combined the numbers of stranded loggerheads and the numbers of stranded Kemp's ridleys by month for these years and compared the totals to the numbers of shrimp fishing trips made and the pounds of shrimp landed also combined by month for these years. The numbers of loggerhead strandings by month were not correlated with either the numbers of shrimp fishing trips of to the pounds of shrimp landed by month. The numbers of Kemp's ridley strandings were positively correlated to the pounds of shrimp landed ($P < 0.005$, $\rho = 0.740$; Fig. 79) and to the number of fishing trips ($P < 0.001$, $\rho = 0.833$; Fig. 80).

In Zones 5 and 6, we used shrimp landings data for pink shrimp from central-west Florida (Citrus County through Sarasota County). Because we found that strong red tides were likely causing substantial and consistent sea turtle mortality in this area, we limited the sea turtle stranding data to years when the influence of red tide was minimal. There was only one year (1993) from 1986 through 2005 when no red tides where detected here. But, there were eight years (1988, 1989, 1993, 1997 through 2000, 2004, and 2007) in which strong red tides were detected during no more than two months. The dead turtles that were found in Zones 5 and 6 during those years and for which no other mortality factors were directly indicated included 341 loggerheads and 72 Kemp's ridleys (no leatherbacks). We combined the numbers of stranded loggerheads and the numbers of stranded Kemp's ridleys by month for all included years and compared the totals to the numbers of shrimp fishing trips made and the pounds of shrimp landed also combined by month for the same years. The numbers of loggerhead strandings by month were not correlated with either the numbers of shrimp fishing trips made or the pounds of shrimp landed by month. The numbers of Kemp's ridley strandings by month were not correlated with the pounds of shrimp landed by month but they were positively correlated to the numbers of shrimp fishing trips made ($P< 0.05$, $\rho = 0.600$; Fig. 81).

Similar to the situation in Zones 3 and 4, we noted that strong red tides in Zones 5 and 6 were more common after 1994. From 1986 through 1994, there were 29 months of strong red tides detected. From 1995 through 2007, there were 71 months of strong red tide detected. Even though there appeared to be a consistent influence of strong red tides on numbers of sea turtle strandings in this area, we thought it possible that strong red tides were causing less loggerhead mortality prior to 1995 and that the effects of shrimp fishing effort on loggerhead stranding numbers could be clearer then. There were 188 dead loggerheads that were found in these zones from 1986 through 1994 and for which no other mortality factors were directly indicated. We combined the numbers of stranded loggerheads by month for these years and compared the totals to the numbers of shrimp fishing trips made and the pounds of shrimp landed also combined by month for these years. The numbers of loggerhead strandings by month were not correlated with the pounds of shrimp landed by month or with the numbers of shrimp fishing trips made by month.

In Zones 7 through 10, we used shrimp landings data for brown, pink, and white shrimp from northwest and central-west Florida (Escambia County through Levy County). Because we found that strong red tides were likely causing substantial and consistent sea turtle mortality in this area, we limited the sea turtle stranding data to years when no strong red tides were detected (from 1986 through 1994, 1997, 1998, 2004, and 2006). The dead turtles that were found in these zones during the included years and for which no other mortality factors were directly indicated included 361 loggerheads, 98 Kemp's ridleys, and 18 leatherbacks. We combined the numbers of stranded loggerheads and the numbers of stranded Kemp's ridleys by month for all included years and compared the totals to the numbers of shrimp fishing trips made and the pounds of shrimp landed also combined by month for all included years. During these years, the numbers of stranded loggerhead by month were positively correlated with both the numbers of shrimp fishing trips made ($P < 0.001$, $\rho = 0.887$; Fig. 82) and the pounds of shrimp landed by month ($P < 0.005$, $\rho = 0.761$; Fig. 83). The numbers of stranded Kemp's ridleys by month were also positively correlated with both the numbers of shrimp fishing trips made ($P < 0.05$, $\rho = 0.641$; Fig. 84) and the pounds of shrimp landed by month ($P < 0.05$, $\rho = 0.578$; Fig. 85).

In Zones 28 through 30, we used shrimp landings data for brown, pink, and white shrimp from northeast and central-east Florida (Nassau County through Brevard County) and we used stranding data from 1986 through 2007. The dead turtles that were found in these zones during 1986 through 2005 and for which no other mortality factors were directly indicated included 5,154 loggerheads, 344 Kemp's ridleys, and 262 leatherbacks. We combined the numbers of strandings by month and species for all years and compared these to the numbers of shrimp fishing trips made and the pounds of shrimp landed also combined by month for all years. None were correlated.

In the event there was a change in the relationship between sea turtle strandings and shrimp fishing effort when TED regulations took full effect, we also compared the sea turtle strandings and shrimping effort in Zones 28 through 30 during the period of 1986 through 1994. The dead turtles that were found in these zones during this time and for which no other mortality factors were directly indicated included 2,337 loggerheads, 160 Kemp's ridleys, and 133 leatherbacks. We combined the numbers of strandings by month and species for these years and compared these to the numbers of shrimp fishing trips made and the pounds of shrimp landed also combined by month for the same years. Neither the numbers of loggerhead, Kemp's ridley, nor leatherback strandings were correlated to either indicator of shrimp fishing effort.

Commercial Gill Netting. Gill netting occurs statewide in Florida for a variety of fish. Some dead sea turtles in Florida have been documented in active gillnets but most of the strandings associated with gillnets involved entanglement in lost or discarded gillnets. One hundred and thirty one stranded sea turtles in Florida representing all the regularly occurring species were found entangled in gill netting from 1980 through 2007. Green turtles were found most often (N = 68), followed by loggerheads (N = 44), hawksbills (N = 12), leatherbacks (N = 5) and Kemp's ridleys (N = 2). A majority (52%) of the gillnet entanglements were found along the central-east coast of Florida from Brevard County through Martin County (Fig. 86).

Most gillnetting probably takes place too far offshore for sea turtle mortality associated with this activity to be consistently well represented in sea turtle strandings. However, until an amendment to Florida's State Constitution banned the use of large nets in State waters beginning in 1995, a gillnet fishery did operate close to shore over the nearshore hardbottom areas along the coast of central-east and southeast Florida. This fishery was suspected of incidentally killing immature green turtles that were residing along the nearshore hardbottom areas in that part of Florida (Ehrhart et al., 1990).

One apparent effect of Florida's Net Ban was to reduce the number of green turtles that were found entangled in gillnet. During the seven years prior to the net ban (1988-1994), 40 juvenile (< 80 cm CCL) green turtles were found in or along the shoreline directly adjacent to the Atlantic Ocean in the area of the nearshore gillnet fishery (Brevard County through Martin County) either entangled in gillnet (N=19) or with wounds that suggested net or line entanglement (N=21). Most (37) of these turtles were found dead. During the first seven years after the net ban (1996-2002), only four juvenile green turtles were found in this area entangled in gillnet (N=3) or with wounds that suggested net or line entanglement (N=1).

In addition to the stranded green turtles found entangled in gillnetting, the nearshore gillnet fishery may also have been responsible for some of the green turtle mortality in central-east and southeast Florida that could not be attributed to other mortality factors. Green turtles that are caught and killed in gillnetting can be removed from the net and bear no apparent or easily discernable signs of their capture. If true, then the reduction of nearshore gillnetting caused by the net ban (considering some continuing illegal activity and some continuing legal activity in the closest Federal waters) should have resulted in a reduction of green turtle strandings that couldn't be attributed to some other mortality factor. To compare the mortality of green turtles possibly attributable to gillnetting in Brevard County through Martin County during an equal number of years before (1988-1994) and after (1996-2002) the net ban, we excluded strandings of green turtles that were smaller (< 20 cm CCL) or larger (>80 cm CCL) than those known to occur in the nearshore hardbottom areas (Guseman and Ehrhart, 1990; Wershoven and Wershoven, 1992). We also excluded green turtles that were not measured for carapace length (because we could not be sure they were the appropriate size), those that were found in or adjacent to inshore waters, those that stranded alive, or those that had an anomaly indicating some other mortality factor (e.g., emaciation, tumors, propeller wounds, crushing injuries, entanglement in material not related to gillnetting) (Tables 21 and 22).

In the seven years prior to the net ban (1988-1994), the mean number of dead, immature green turtles (as defined) found each year in the five county area was 48.0 (SD = 24.0, range = 13-81). In the seven years after the net ban (1996-2002), the mean number of dead, immature green turtles (as defined) found each year in the five county area was 19.0 (SD = 8.3, range = 10-34) (the means were significantly different, t-test, P < 0.01). On average, the number of dead, immature green turtles (as defined) found each year after the net ban was less than half of what it was before the net ban. Considering the fact that strandings represent some fraction of overall sea turtle mortality and that as little as 7% of overall sea turtle mortality has been known to be represented by strandings (Epperly et al., 1996), the actual yearly decrease in green turtle mortality that we could attribute to the net ban in this case could be as high as 414 turtles ([48.0 – 19.0]/0.07).

The decrease in green turtle mortality attributable to the net ban was likely greater than we were able to demonstrate in our analysis because the relative abundance of immature green turtles along the central-east and southeast coast of Florida was likely greater during the seven-year period after the net ban. Captures of immature green turtles at the St. Lucie Power Plant intake canal, which takes in water from the nearshore area of St. Lucie County, almost tripled in the years following the net ban. The plant entrained an annual average of 80.7 immature green turtles during 1988 through 1994 and an annual average of 219.3/yr during 1996 through 2002 (M. Bresette, unpubl. data). Had the relative abundance of immature green turtles not risen so sharply during the seven-year period after the net ban, the numbers of strandings of green turtles possibly attributed to gillnetting during this time period would likely have been less.

Commercial Long lining. Longline fisheries occur throughout Florida's offshore waters and also target a variety of fish. From 1980 through 2007, 34 stranded sea turtles were reported with longline hooks. These reports always involved loggerheads except in two cases. The latter reports were both of adult-sized Kemp's ridleys. Most (65%) of the turtles with longline hooks were found along the east coast of Florida from Volusia County through Martin County (Fig. 87).

Our documentation of potential sea turtle mortality in the long line fishery was an under representation of the true mortality because not all hooks in dead sea turtles were found or identified as long line hooks and not all hooked turtles were likely released with the gear still attached. As with gillnetting, most long lining probably takes place too far from shore for any sea turtle mortality associated with this activity to be consistently well represented in the sea turtle strandings.

Commercial Trap and Pot Fishing. The trap and pot fisheries in Florida primarily target stone crabs (*Menippe mercenaria*, and *M. adina*), blue crab (*Callinectes sapidus*), and spiny lobster (*Panulirus argus*). There are also smaller-scale pot fisheries that target fish. The blue crab fishery is open year-round and occurs statewide. The stone crab fishery is open from 15 October-15 May and occurs statewide but with the majority of effort occurring along the west coast of Florida, especially in Collier County and Monroe County. The spiny lobster fishery is open from 6 August through 31 March and occurs primarily in Monroe County and Miami-Dade County.

Only three of the stranded sea turtles were actually captured in traps or pots, but 243 sea turtles were found entangled in the buoy line of a trap or pot in Florida from 1980 through 2007. Almost half (N = 117) were found in Monroe County with the rest occurring primarily along the southwest coast of Florida from Pinellas County through Collier County (N = 71) and in Miami-Dade County (N = 12) (Fig. 88). The number and percentage of stranded sea turtles found entangled in the buoy line of a trap or pot each year in Florida from 1986 through 2007 are shown in Figures 89 and 90.

About 1% of Florida's sea turtle strandings from 1980 through 2007 were reported to be entangled in the buoy line of a trap or pot. By species, leatherbacks had the highest percentage occurrence of buoy line entanglement at 7.7%. All the other species had a percentage occurrence of buoy line entanglement between 0.6 and 0.8% (Table 23).

For loggerheads and green turtles, the percentage of strandings that were entangled in the buoy line of a trap or pot generally increased with size, and turtles in the smallest size-classes were never found entangled in these buoy lines (Figs. 91 and 92). The numbers of loggerheads and green turtles found entangled in the buoy line of a trap or pot were greatest from April through August (Fig. 93). In contrast, the numbers of leatherbacks found entangled in the buoy lines of traps or pots were greatest from October through February (Fig. 94). The latter corresponded to the time of the year when, based on the leatherback stranding data (see the earlier section on leatherback distributions and relative abundances), we believe leatherbacks were moving from the Atlantic Ocean to the Gulf of Mexico and passing through the southern part of Florida (where most of the buoy line entanglements occurred).

Beginning in the 1990's, there was an effort to reduce the numbers of traps set for spiny lobsters (Muller et al., 1997). The number of traps peaked at 939,000 in 1991 and was reduced to about 500,000 by 2005 (Muller et al., 1997, FWC unpubl. data). However, there has been no trend in the annual numbers of buoy line entanglements in Monroe County and Miami-Dade County during this time (Fig. 95).

Recreational Hook and Line Fishing. Sea turtles in Florida are incidentally captured on hook and line by recreational fisherman. From 1980 through 2007, we received 190 reports of sea turtles that were caught by recreational fishermen on hook and line gear and another 418 reports of stranded sea turtles with one or more hooks (not including those believed to be from commercial long lining) in the mouth or G.I. tract or on some part of the body. The highest density of hooked turtles was found in Broward County (Fig. 96). There were also relatively high numbers of hooked turtles found along the central-east coast of Florida and in Wakulla County and Lee County along the west coast of Florida (Fig. 96). The number and percentage of sea turtles caught by recreational fishermen on hook and line or found with one or more hooks in the body each year in Florida from 1980 through 2007 are shown in Figures 97 and 98. Both increased over this time period.

All of the regularly occurring sea turtle species in Florida were known to be hooked by recreational fishermen (Table 24). Almost 7% of Kemp's ridley strandings involved some interaction with recreational hook and line fisherman. More Kemp's ridleys were reported incidentally captured by recreational hook and line fishermen than any other species and the majority of these (69%) were caught in Wakulla County in the Florida Panhandle. Kemp's ridleys in the three smallest 10-cm sizes classes (not including posthatchlings) were those that were predominantly hooked (Fig. 99).

Fewer green turtles and loggerheads were reported incidentally captured by recreational hook and line fishermen but more strandings of these species were found with one or more hooks in the body than any other species (Table 24). Almost all sizes of green turtles and loggerheads regularly found in Florida were impacted by recreational hook and line fishing (Figs. 100 and 101). Only one hawksbill was reported to be caught on hook and line and no leatherbacks were known to be caught. The incidence of hooks in the strandings of these latter two species was also rare (Table 24).

We believe the incidental capture of sea turtles on hook and line by recreational fishermen was largely unreported in Florida. Most fishermen would not know how to report such an incident. The exception was in Wakulla County when Kemp's ridleys were caught on hook and line. The staff at the Gulf Specimens Marine Laboratory (Panacea, Florida) regularly distributed requests to be notified about hook and line captures of these turtles. This effort alone in one Florida county accounted for 33% of all reported hook and line captures of sea turtles by recreational fishermen.

Our data showed that small- to intermediate-sized sea turtles were those most often caught on hook and line. However, this may have been a bias in data collection. Small sea turtles were probably more likely to be landed by fishermen than large sea turtles were. Once in hand, it was probably more likely the fishermen would have called someone to help if the hook couldn't be removed or if the turtle had some other injuries. This was the scenario that accounted for a large number of our reports of hook and line captures. Large-sized sea turtles were probably more likely to have broken the line before being landed or to have been cut free without being landed.

Some stranded sea turtles were found with fishing line coming out of the mouth or cloaca and some of these may have been caught on hook and line. Including these turtles still does not indicate that hawksbills or leatherbacks were caught very often on hook and line. Only one leatherback was noted with fishing line coming out of the mouth or cloaca and no hawksbills were noted as such. An additional 70 loggerheads and 62 green turtles were noted as having fishing line coming out of the mouth or cloaca. It should be noted that at least some of these latter turtles ingested the fishing line incidental to feeding.

Sea turtles were sometimes snagged in the body by recreational hook and line fishermen but many sea turtles were hooked when they intentionally ate baited hooks. It is interesting to note that a relatively large number of green turtles were caught on hook and line, apparently eating bait such as shrimp, squid, or fish. The size-classes of green turtles that were caught on hook and line in Florida are known to be almost exclusively herbivorous (Mendonça, 1983; Burke et al., 1992; Wershoven and Wershoven, 1992; Coyne, 1994; Redfoot, 2000; Foley et al., 2007).

Interactions with Pollution

Sea turtles can be directly harm by pollution either through chemical means (i.e., absorbing toxins) or through physical means (i.e., becoming entangled in debris or ingesting debris that can injure the G.I. tract). The sea turtle stranding data allowed us to evaluate the physical interactions of sea turtles and pollution in Florida.

Monofilament Fishing Line. The most common form of pollution found associated with sea turtles was monofilament fishing line. From 1980 through 2007, 852 stranded sea turtles were found to have been entangled in or to have ingested monofilament fishing line. These strandings were found throughout Florida with the highest concentrations occurring along the east coast of Florida from Brevard County south through Broward County (Fig. 102). A majority of these cases (N = 623) were of sea turtles that were entangled in fishing line and a smaller number (N =229) were of sea turtles that ingested fishing line. The number and percentage of stranded sea turtles found to have been entangled in or to have ingested monofilament fishing line each year in Florida from 1986 through 2007 are shown in Figures 103 and 104. Both have increased.

We were likely to accurately represent the numbers of sea turtle strandings that were entangled in fishing line because these entanglements were usually easy to see. However, we were also likely to under represent the numbers of sea turtle strandings that ingested fishing line because we would only detect this if line was coming out of the mouth or cloaca or if the turtle was necropsied. Only about 10% of all the sea turtle strandings in Florida from 1986 through 2007 were necropsied.

The most common injuries associated with fishing line entanglements were ligature wounds. These wounds were often at the base of a flipper and often resulted in the eventual loss of that flipper. The infections associated with these wounds were also a potential mortality factor. Sea turtles that ingested fishing line were susceptible to injury in the G. I. tract from the fishing line, especially if the intestines became plicated. Some of the sea turtles in the stranding database died from being trapped underwater by entangling fishing line and never washed ashore. Some of these were reported by divers who found turtles entangled in fishing line that was also entangled in an underwater artificial structure such as a sunken ship or an artificial reef. We believe this may be a problem that is not well represented by the strandings. We've heard anecdotal reports from divers about large amounts of monofilament fishing line around sunken ships or artificial reefs that are popular fishing spots. These then become underwater traps for sea turtles.

Tar and oil. The next most common type of pollution found in association with stranded sea turtles was tar or oil. From 1980 through 2007, 280 stranded sea turtles (including posthatchlings) were found to be covered to some extent by tar or oil and one additional stranded green turtle was found to have tar in the G.I. tract. The stranded posthatchlings that were found with tar or oil were all either loggerheads or green turtles and most (71%) washed ashore in Brevard County south of Cape Canaveral (Fig. 105). Other sea turtle strandings associated with tar or oil were primarily found farther south along the east coast from St. Lucie County through Miami-Dade County (Fig. 105). The number and percentage of stranded sea turtles found with tar or oil each year in Florida from 1986 through 2007 are shown in Figures 106 and 107.

Tar or oil was found on about 9% of the stranded hawksbills (Table 26). Half of the measured hawksbills with tar or oil were from 10 to 19.9 cm CCL and almost all (93%) were from 10 to 29.9 cm CCL (Fig. 172). None of the 73 hawksbill posthatchling strandings (< 10 cm CCL) were found with tar or oil. Relatively small percentages of the strandings of other sea turtle species were found with tar or oil (Table 26), but these strandings too were primarily of the smallest size-classes for each species. Half of the stranded green turtles with tar or oil were from 10 to 19.9 cm CCL and most (74%) were from 10 to 29.9 cm CCL. In contrast to the stranded hawksbill posthatchlings, about 15% of the stranded green turtle posthatchlings had tar or oil (Fig. 109). A majority (79%) of the stranded loggerheads with tar or oil were posthatchlings, but a slightly higher percentage of loggerhead strandings that were 10 to 19.9 cm CCL had tar or oil (Fig. 110). The one leatherback found with tar or oil was 16.5 cm CCL and the three Kemp's ridleys found with tar or oil were 20.0, 23.0, and 33.2 cm CCL. The only stranding of an immature olive ridley (24.9 cm CCL) ever documented in Florida was covered with tar. Even though most of the sea turtle strandings found with tar or oil were less than 20 cm CCL, 18 of the loggerheads, 4 of the green turtles, and two of the hawksbills found with tar or oil were greater than 50 cm CCL (including 5 adult loggerheads and one adult green turtle).

Our data indicate that sea turtles were fouled with tar or oil offshore of central-east and southeast Florida and that all species were affected. The distinct separation between the locations of stranded posthatchlings with tar and oil and those of slightly larger sea turtles with tar and oil (Fig. 105) was typical of the general differences between the stranding locations of posthatchlings and of slightly larger turtles (see previous sections on the distributions and relative abundances of sea turtle strandings). The size-classes of sea turtles that were most likely found in association with tar or oil indicated that turtles in an oceanic, epipelagic phase came into contact with tar or oil more often than those in a neritic, benthic stage did. Given this, we cannot explain why none of the 73 stranded posthatchling hawksbills found in southeast Florida were reported to have tar or oil. The strandings of other species of posthatchlings and of slightly larger sea turtles still likely to be in an oceanic, epipelagic phase (including hawksbills from 10 to 19.9 cm CCL) were often found to be covered to some extent with tar or oil and were found at the same time and in the same part of Florida as the posthatchling hawksbills were.

Other Persistent Marine Debris. Stranded sea turtles in Florida were also found associated with pollution other than monofilament fishing line, tar, or oil. From 1980 through 2007, 193 stranded sea turtles were found to have been entangled in or ingested other persistent marine debris. All of the regularly occurring species of sea turtles in Florida were found to have been entangled in and to have ingested persistent marine debris other than monofilament fishing line, tar, or oil. By species, hawksbill were the most likely to be associated with these materials (Table 27).

Stranded sea turtles entangled in or that had ingestion other types of persistent marine debris were found throughout the coastal areas of Florida but were more common along the east coast (Figs. 111). The number and percentage of stranded sea turtles found to have been entangled in or to have ingested other persistent marine debris in Florida during 1985 through 2007 are shown in Figures 112 and 113.

The most common entangling material was rope, which was found on 45 sea turtle strandings. Many of these ropes were probably from the buoy line of a trap or pot but some were a buoy line from something else such as a mooring anchor or a marker for swimming areas. The next three most common entangling materials were pieces of fishing net (in 13 strandings), lawn or deck chairs (in 10 strandings), and pieces of string, twine, or line (in 9 strandings). The relatively large number of dead sea turtles found trapped within lawn or deck chairs was unexpected. Loggerheads, green turtles, and Kemp's ridleys were all found trapped in these chairs. The sizes of these turtles ranged from 43.4 to 76.2 cm CCL. All of the other entangling materials were found on less than five strandings and included burlap bags, plastic strapping, balloons with attached string or ribbon, plastic bags, nylon mesh bags, parasail or parachute materials, tarp-like sacks, cargo nets, cloth, a wig, a baseball cap, a six-pack ring, a tire, a diver's locator net, a plastic cord, a garbage bag, a piece of construction fence, and a piece of wire cable.

Most of the sea turtles that had ingested marine debris (58%) were found to have eaten plastic. Some of the types of plastics described included plastic bags, plastic beads, plastic film, and a plastic tube. The next most common material ingested was balloons. Eight turtles (5 green turtles and three loggerheads) were found to have ingested balloons. Other ingested materials (found in less than five strandings each) included rope, twine or string, ribbon, and styrofoam. Ingested materials could only be detected in turtles that were necropsied (N = 2,525) or live turtles that defecated the materials while at a rehabilitation facility. Considering only sea turtles that were necropsied, persistent marine debris (including monofilament fishing line) was found in 136 cases (5.4% of necropsied turtles). The percentage occurrence of ingested marine debris in Florida's sea turtle strandings is relatively low. For example, a little over half of the 340 sea turtles found in south Texas during 1983 through 1995 and necropsied were found to have ingested persistent marine debris (Shaver and Plotkin, 1998).

ACKNOWLEDGMENTS

This work would not have been possible without the work of former STSSN coordinators and coordinating staff Barbara Schroeder, Carrie Keske-Crady, Ron Mezich, Tony Redlow, Kristin Fick-Child, Ed deMaye, Nashika Brewer, Ross Witham, Colleen Coogan, Patricia Castenada, Matilde Lores, Walt Conley, Jamie Serino, and Allison Trotter; or without the dedicated efforts of hundreds of past and present STSSN participants throughout Florida.

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Table 1. The minimum size by species used to identify a sea turtle with a tail that did not extend beyond the posterior edge of the carapace as an adult female. These are the minimum sizes used by the Sea Turtle Stranding and Salvage Network for identifying a female turtle when the tail does not extend beyond the carapace. It is based on the average size of nesting turtles by species. The carapace length was measured from the nuchal notch to the posterior marginal tip.

Species	Curved carapace length (cm)
Loggerhead	98.6
Green turtle	101.1
Kemp's ridley	63.5
Hawksbill	84.0

Table 2. The total number of records by species in the Florida Sea Turtle Stranding and Salvage Network database from 1980 through 2007 and the numbers and types excluded in the analyses of the present study. Captive-reared turtles were raised in captivity, released, and then subsequently documented as a stranding. Turtles that were trapped, killed, or injured while nesting were adult females that had emerged onto the beach to nest.

Species	Total number	Number of captive-reared	Number trapped, killed, or injured while nesting	Total number used in analyses
Loggerhead	17,457	163	133	17,161
Green turtle	7,187	39	57	7,091
Kemp's ridley	1,905	41	0	1,864
Hawksbill	562	1	0	561
Leatherback	584	0	0	584
Olive ridley	3	0	0	3
Not identified	1,070	N/A	N/A	978

Table 3. The total number of records by species in the Florida Sea Turtle Stranding and Salvage Network database from 1980 through 2007 that had a carapace length measurement. In analyses by size-class, all records with either a curved carapace length (CCL) or a straight carapace length (SCL) were used. The CCL was the most common carapace length measurement taken and the SCL was converted to CCL using a regression equation derived for each species from records where both a CCL and SCL were taken (see text). The carapace length was measured from the nuchal notch to the posterior marginal tip.

Species	Total number available for analyses	Number with CCL or SCL	Number with CCL	Number with SCL	Number with SCL only	Number with CCL and SCL
Loggerhead	17,161	13,302	11,225	6,197	2,077	4,120
Green turtle	7,091	6,000	5,448	3,901	552	3,349
Kemp's ridley	1,864	1,597	1,416	1,041	181	860
Hawksbill	561	516	450	361	66	256
Leatherback	584	307	269	82	38	44

Table 4. The numbers of stranded loggerheads documented in Florida from 1980 through 2007 by 10-cm size-class. The carapace length was measured from the nuchal notch to the posterior marginal tip. Among these strandings, we identified 701 adult male loggerheads and 682 adult female loggerheads. The adult males had a tail that extended at least 20 cm beyond the posterior edge of the carapace. The adult females had a tail that did not extend beyond the posterior edge of the carapace and a curved carapace measurement of at least 98.2 cm, tags that were applied when the turtle was on a nesting beach, or eggs in the oviduct. The gender of many adult-sized stranded loggerheads could not be determined because the tail was missing or the tail was not measured and was not entirely visible in submitted photographs. The numbers of strandings of adults by gender cannot be used to estimate the adult sex ratio because adult males were more likely to be identified than adult females were.

Curved carapace length (cm)	Number of loggerhead strandings
0-9.9	1,184
10-19.9	83
20-29.9	54
30-39.9	103
40-49.9	121
50-59.9	764
60-69.9	2,425
70-79.9	2,771
80-89.9	1,762
90-99.9	2,537
100-109.9	1,331
110-119.9	150
≥ 120	17

Table 5. The curved carapace lengths (CCL) in cm of stranded posthatchling loggerheads found each month in Florida during the period of June through May from 1980 through 2007. The carapace length was measured from the nuchal notch to the posterior marginal tip.

Month	Number of strandings	Mean CCL (cm)	Standard Deviation of CCL (cm)	Range of CCL (cm)
June	1	5.5	N/A	N/A
July	7	5.8	1.4	4.5-8.9
August	23	6.4	1.3	4.8-8.9
September	290	6.0	0.8	4.7-9.5
October	586	6.0	0.8	4.4-9.5
November	241	6.5	1.1	4.5-9.8
December	27	7.7	1.5	4.8-9.9
January	1	8.6	N/A	
February	3	6.9	0.9	5.9-7.7
March	3	7.2	1.7	5.4-8.8
April	0	N/A	N/A	
May	2	7.8	N/A	7.5 and 8.0

Table 6. The curved carapace lengths (CCL) in cm of loggerhead strandings (10-19.9 cm CCL) found each month in Florida during the period of October through August from 1980 through 2007. The carapace length was measured from the nuchal notch to the posterior marginal tip.

Month	Number of strandings	Mean CCL (cm)	Standard Deviation of CCL (cm)	Range of CCL (cm)
October	9	10.8	0.6	10.0-12.1
November	9	11.1	0.7	10.0-12.2
December	11	13.3	2.1	10.1-17.2
January	8	14.1	3.2	10.6-19.7
February	11	13.8	1.8	11.1-16.3
March	9	13.8	1.1	12.1-15.2
April	10	15.0	2.5	10.7-18.0
May	6	17.0	2.4	14.0-19.5
June	4	15.4	4.0	11.5-19.7
July	2	16.4	N/A	15.2 and17.6
August	4	15.0	3.9	10.0-18.9

Table 7. The curved carapace lengths (CCL) in cm of adult male and female loggerheads from Florida. The adult male loggerheads were found as strandings in Florida from 1980 through 2007. Adult male loggerheads were identified by a tail that extended at least 20 cm beyond the posterior edge of the carapace. The adult female loggerheads were measured while nesting in Brevard County, Florida from 1980 through 2005. The adult male loggerheads were larger than the adult female loggerheads (t-test, $P < 0.001$)

	Number of turtles	Mean CCL (cm)	95% Confidence Interval	Range of CCL (cm)
Adult males	538	99.7	89.9-110.0	81.0-119.4
Adult females	5,271	98.8	89.4-108.5	74.3-119.6

Table 8. The number of stranded green turtles documented in Florida from 1980 through 2007 by 5-cm size-class. The carapace length was measured from the nuchal notch to the posterior marginal tip. Among these strandings, we identified 84 adult male green turtles and 79 adult female green turtles. The adult males had a tail that extended at least 20 cm beyond the posterior edge of the carapace. The adult females had a tail that did not extend beyond the posterior edge of the carapace and a curved carapace measurement of at least 101.1 cm, tags that were applied when the turtle was on a nesting beach, or eggs in the oviduct. The gender of many adult-sized stranded green turtles could not be determined because the tail was missing or the tail was not measured and was not entirely visible in submitted photographs. The numbers of strandings of adults by gender cannot be used to estimate the adult sex ratio because adult males were more likely to be identified than adult females were.

Curved carapace length (cm)	Number of strandings
0-9.9	85
10-14.9	41
15-19.9	48
20-24.5	95
25-29.9	604
30-34.9	992
35-39.9	843
40-44.9	780
45-49.9	634
50-54.9	499
55-59.9	364
60-64.9	241
65-69.9	205
70-74.9	132
75-79.9	90
80-84.9	53
85-89.9	39
90-94.9	27
95-99.9	65
100-104.9	72
105-109.9	52
≥ 110	39

Table 9. The curved carapace lengths (CCL) in cm of stranded posthatchling green turtles found each month in Florida during the period of September through February from 1980 through 2007. The carapace length was measured from the nuchal notch to the posterior marginal tip.

Month	Number of strandings	Mean CCL (cm)	Standard Deviation of CCL (cm)	Range of CCL (cm)
September	8	7.4	1.1	5.5-9.1
October	21	6.7	1.1	5.3-9.5
November	40	6.9	1.2	5.2-9.8
December	9	7.5	1.3	6.1-9.9
January	5	7.1	1.5	5.0-8.7
February	2	8.0	N/A	7.0 and 8.9

Table 10. The curved carapace lengths (CCL) in cm of adult male and female green turtles in Florida. The adult male green turtles were found as strandings in Florida from 1980 through 2007. Adult male green turtles were identified by a tail that extended at least 20 cm beyond the posterior edge of the carapace. The adult female green turtles were measured while nesting in southern Brevard County, Florida from 1982 through 2007 (Ehrhart, unpubl. data). The adult male green turtles were smaller than the adult female green turtles (t-test, $P < 0.001$)

	Number of turtles	Mean CCL (cm)	95% Confidence Interval	Range of CCL (cm)
Adult males	59	102.1	94.3-112.9	87.9-116.8
Adult females	1,014	107.4	98.1-116.2	89.4-125.1

Table 11. The number of stranded Kemp's ridleys documented in Florida from 1980 through 2007 by 5-cm size-class. The carapace length was measured from the nuchal notch to the posterior marginal tip. Among these strandings, we identified two adult male Kemp's ridleys and 32 adult female Kemp's ridleys. The adult males had a tail that extended at least 15 cm beyond the posterior edge of the carapace. The adult females had a tail that did not extend beyond the posterior edge of the carapace and a curved carapace measurement of at least 63.5 cm, tags that were applied when the turtle was on a nesting beach, or eggs in the oviduct. The gender of many adult-sized stranded Kemp's ridleys could not be determined because the tail was missing or the tail was not measured and was not entirely visible in submitted photographs. The numbers of strandings of adults by gender cannot be used to estimate the adult sex ratio because adult males were more likely to be identified than adult females were.

Curved carapace length (cm)	Number of strandings
0-9.9	5
10-14.9	5
15-19.9	5
20-24.5	43
25-29.9	130
30-34.9	273
35-39.9	240
40-44.9	204
45-49.9	192
50-54.9	177
55-59.9	133
60-64.9	119
65-69.9	58
70-74.9	13

Table 12. The number of stranded hawksbills documented in Florida from 1980 through 2007 by 5-cm size-class. The carapace length was measured from the nuchal notch to the posterior marginal tip. Among these strandings, we identified one adult male hawksbill and three adult female hawksbills. The adult male had a tail that extended at more than 15 cm beyond the posterior edge of the carapace. The adult females all had eggs in the oviduct. The gender of many adult-sized stranded hawksbills could not be determined because the tail was missing or the tail was not measured and was not entirely visible in submitted photographs. The numbers of strandings of adults by gender cannot be used to estimate the adult sex ratio because adult males were more likely to be identified than adult females were.

Curved carapace length (cm)	Number of strandings
0-9.9	73
10-14.9	72
15-19.9	55
20-24.5	66
25-29.9	54
30-34.9	19
35-39.9	17
40-44.9	13
45-49.9	19
50-54.9	27
55-59.9	14
60-64.9	26
65-69.9	19
70-74.9	11
75-79.9	16
80-84.9	9
≥ 85	6

Table 13. The curved carapace lengths (CCL) in cm of posthatchling hawksbill strandings found in Florida by month during the period of October through June from 1980 through 2007. The carapace length was measured from the nuchal notch to the posterior marginal tip.

Month	Number of strandings	Mean CCL (cm)	Standard Deviation of CCL (cm)	Range of CCL (cm)
October	5	8.3	1.2	6.3-9.6
November	7	7.3	0.5	6.7-7.9
December	16	8.0	1.2	6.0-9.9
January	6	7.0	0.8	6.0-7.9
February	6	7.6	1.6	5.6-9.8
March	12	7.3	1.2	5.4-9.6
April	9	8.0	0.4	7.5-8.8
May	11	8.5	0.9	6.5-9.8
June	1	7.6	N/A	N/A

Table 14. The curved carapace length (CCL) cm of stranded adult male and female leatherbacks in Florida from 1980 through 2005. Adult male leatherbacks were identified by a tail that extended at least 20 cm beyond the posterior edge of the carapace. The adult female leatherbacks were identified by the presence of tags that were applied while the turtle was on the nesting beach. The two groups of adult turtles were not different in size (t-test, $P > 0.05$)

	Number of turtles	Mean CCL (cm)	Standard Deviation of CCL (cm)	Range of CCL (cm)
Adult males	5	160.7	2.7	157.0-162.0
Adult females	6	155.9	7.4	146.1-167.0

Table 15. The number and percentage of stranded sea turtles with propeller wounds by species in Florida from 1980 through 2007. Stranded green turtles, loggerheads, Kemp's ridleys, and hawksbills less than 20 cm curved carapace length (CCL) from the nuchal notch to the posterior marginal tip were not included. Leatherbacks less than 30 cm CCL were not included.

Species	Total number of strandings	Number with propeller wounds	Percentage with propeller wounds
Green Turtle	6,918	1,374	19.9 %
Leatherback	572	108	18.9 %
Loggerhead	15,894	2,385	15.0 %
Kemp's ridley	1,849	202	10.9 %
Hawksbill	361	32	8.9 %

Table 16. The percentage of stranded sea turtles with propeller wounds by groups of adjacent counties in Florida from 1980 through 2007. These groups of counties were determined based on their similarity in the percentage of stranded sea turtles with propeller wounds.

Counties	Percentage of stranded sea turtles with propeller wounds
Martin−Miami-Dade	33.6 %
Okaloosa-Escambia	17.9 %
Monroe-Charlotte	17.7 %
Pinellas	16.7 %
Brevard−St. Lucie	13.4 %
Pasco-Taylor	11.5 %
Sarasota-Hillsborough	10.7 %
Nassau−Volusia	5.8 %
Bay-Walton	5.7 %
Wakulla-Gulf	3.1 %

Table 17. The numbers of sea turtles by species reported to the Sea Turtle Stranding and Salvage Network (STSSN) that were found in the intake canals of various electrical generating (power) plants in Florida from 1980 through 2007. The total numbers of sea turtles reported to the STSSN from the intake canal at FPL's St. Lucie Nuclear Power Plant and at Progress Energy's Crystal River Nuclear Power Plant are only a subset of all the sea turtles entrained at these locations. Sea turtle entrainments at these facilities are usually not reported to the STSSN unless a turtle is found dead, sick, or injured in the intake canal.

		Species				
Power plant	County	Loggerhead	Green turtle	Kemp's ridley	Hawksbill	Total
JEA's Northside Generating Plant	Duval	3	2	1	0	6
FPL's Port St. John Power Plant	Brevard	2	1	0	0	3
City of Vero Beach Power Plant	Indian River	0	2	0	0	2
FPL's St. Lucie Nuclear Power Plant	St. Lucie	173	128	0	0	301
FPL's Riviera Beach Power Plant	Palm Beach	11	2	0	0	13
FPL's Port Everglades Power Plant	Broward	14	2	0	2	18
FPL's Turkey Point Power Plant	Miami-Dade	1	1	0	1	3
FPL's Ft. Myers Power Plant	Lee	0	0	1	0	1
TECO's Big Bend Power Station	Hillsborough	1	0	2	0	3
TECO's H. L. Culbreath Bayside Power Station	Hillsborough	0	0	1	0	1
Progress Energy's Anclote Power Plant	Pasco	2	10	2	0	14
Progress Energy's Crystal River Nuclear Power Plant	Citrus	14	54	82	1	151
Total		221	202	89	4	516

Table 18. The number and percentage of stranded sea turtles with apparent mutilations by species in Florida from 1980 through 2007. Mutilations included wounds believed to have been caused by things such as a knife, gun, gaff, or spear gun. Stranded green turtles, loggerheads, Kemp's ridleys, and hawksbills less than 20 cm curved carapace length (CCL) from the nuchal notch to the posterior marginal tip were not included. Leatherbacks less than 30 cm CCL were not included.

Species	Total number of strandings	Number with mutilations	Percentage with mutilations
Leatherback	572	16	2.8 %
Kemp's ridley	1,849	41	2.2 %
Loggerhead	15,894	297	1.9 %
Green turtle	6,918	116	1.7 %
Hawksbill	361	6	1.7 %

Table 19. The number and percentage of stranded sea turtles with shark bite wounds by species in Florida from 1980 through 2007. Stranded green turtles, loggerheads, Kemp's ridleys, and hawksbills less than 20 cm curved carapace length (CCL) from the nuchal notch to the posterior marginal tip were not included. Leatherbacks less than 30 cm CCL were not included.

Species	Total number of strandings	Number with shark bite wounds	Percentage with shark bite wounds
Leatherback	572	54	9.4 %
Hawksbill	361	14	3.9 %
Green turtle	6,918	262	3.8 %
Loggerhead	15,894	559	3.5 %
Kemp's ridley	1,849	59	3.2 %

Table 20. The number and percentage of stranded sea turtles that were emaciated by species in Florida from 1980 through 2007. Green turtles with and without the tumors associated with fibropapillomatosis (FP) are listed separately.

Species	Total number of strandings	Number that were emaciated	Percentage that were emaciated
Green turtle (with FP)	1,533	298	19.4 %
Loggerhead	17,161	1,708	10.0 %
Green turtle (all)	7,091	671	9.5 %
Hawksbill	561	48	8.6 %
Green turtle (no FP)	5,558	373	6.7 %
Kemp's ridley	1,864	58	3.1 %
Leatherback	584	1	0.2 %

Table 21. The numbers of stranded green turtles found in Brevard County, Indian River County, St. Lucie County, and Martin County (Florida) from 1988 through 1994 and the numbers in various categories that were excluded from the comparison of mortality before and after the Florida Net Ban took effect. The numbers from 1995 were not used in the comparison because the net ban took effect in mid-year (1 July 1995). An individual turtle may be represented in more than one exclusion column. Turtles listed with FP had tumors characteristic of fibropapillomatosis. Boat-related injuries included wounds that appeared to be from propellers, skegs, or boat hulls (propeller wounds or crushing injuries). The CCL is the curved carapace length from the nuchal notch to the posterior marginal tip. The numbers of turtles given with no carapace length measurement were after all the turtles in the previous categories were already excluded.

Year	Total number of stranded green turtles	Number inshore	Number alive	Number with FP	Number with boat-related injuries	Number with shark bite wounds	Number emaciated	Number < 20 cm or > 80 cm CCL	Number without carapace length measurement	Number used in comparison
1988	78	9	5	3	6	0	4	1	4	49
1989	111	21	5	2	4	0	1	1	4	75
1990	135	25	6	4	4	8	1	1	7	81
1991	89	19	5	3	2	2	4	3	7	50
1992	72	15	10	4	2	0	7	4	2	37
1993	61	23	15	0	7	1	10	1	2	13
1994	118	31	27	6	16	1	9	16	4	31
Total	664	143	73	22	41	12	36	27	30	336

Table 22. The numbers of stranded green turtles found in Brevard County, Indian River County, St. Lucie County, and Martin County (Florida) from 1996 through 2002 and the numbers in various categories that were excluded from the comparison of mortality before and after the Florida Net Ban took effect. The numbers from 1995 were not used in the comparison because the net ban took effect in mid-year (1 July 1995). An individual turtle may be represented in more than one exclusion column. Tumors were typical of fibropapillomatosis. Boat-related injuries included wounds that appeared to be from propellers, skegs, or boat hulls (propeller wounds or crushing injuries). The CCL is the curved carapace length from the nuchal notch to the posterior marginal tip. The numbers of turtles given with no carapace length measurement were after all the turtles in the previous categories were already excluded.

Year	Total number of stranded green turtles	Number inshore	Number alive	Number with FP	Number with boat-related injuries	Number with shark wounds	Number emaciated	Number < 20 cm or > 80 cm CCL	Number without carapace length measurement	Number used in comparison
1996	195	82	42	26	12	2	26	7	7	34
1997	114	44	9	20	18	1	11	1	3	25
1998	125	57	15	14	12	5	6	9	6	21
1999	108	61	11	13	9	3	6	1	8	10
2000	102	53	11	6	21	8	2	7	2	13
2001	116	56	26	10	16	4	7	3	4	14
2002	121	53	12	9	16	7	6	9	6	16
Total	881	406	126	98	104	30	64	37	36	133

Table 23. The number and percentage of stranded sea turtles found entangled in the buoy line of a trap or pot by species in Florida from 1980 through 2007. Stranded green turtles, loggerheads, Kemp's ridleys, and hawksbills less than 20 cm curved carapace length (CCL) from the nuchal notch to the posterior marginal tip were not included. Leatherbacks less than 30 cm CCL were not included.

Species	Total number of strandings	Number entangled in buoy line	Percentage entangled in buoy line
Leatherback	572	44	7.7 %
Kemp's ridley	1,849	14	0.8 %
Green Turtle	6,918	51	0.7 %
Loggerhead	15,894	118	0.7 %
Hawksbill	361	2	0.6 %

Table 24. The number and percentage of stranded sea turtles by species caught on hook and line by recreational fishermen or found with one or more hooks in the mouth or other part of the G.I. tract or on some part of the body in Florida from 1980 through 2007. None of the hooks in these categories were believed to have originated from commercial longlining fisheries. An individual turtle may be represented in more than one category. Stranded green turtles, loggerheads, Kemp's ridleys, and hawksbills less than 20 cm curved carapace length (CCL) from the nuchal notch to the posterior marginal tip were not included. Leatherbacks less than 30 cm CCL were not included.

Species	Total number of strandings	Number caught on hook and line	Number found with hook(s) in mouth or G.I. tract	Number found with hook(s) on body	Percentage with hook or caught on hook and line
Kemp's ridley	1,849	86	33	3	6.6 %
Green Turtle	6,918	67	84	104	3.7 %
Loggerhead	15,894	36	126	63	1.4 %
Hawksbill	361	1	1	2	1.1 %
Leatherback	572	0	0	2	0.3 %

Table 25. The number and percentage of stranded sea turtles by species found entangled in or to have ingested monofilament fishing line in Florida from 1980 through 2007. An individual turtle may be represented in more than one category. Stranded green turtles, loggerheads, Kemp's ridleys, and hawksbills less than 20 cm curved carapace length (CCL) from the nuchal notch to the posterior marginal tip were not included. Leatherbacks less than 30 cm CCL were not included.

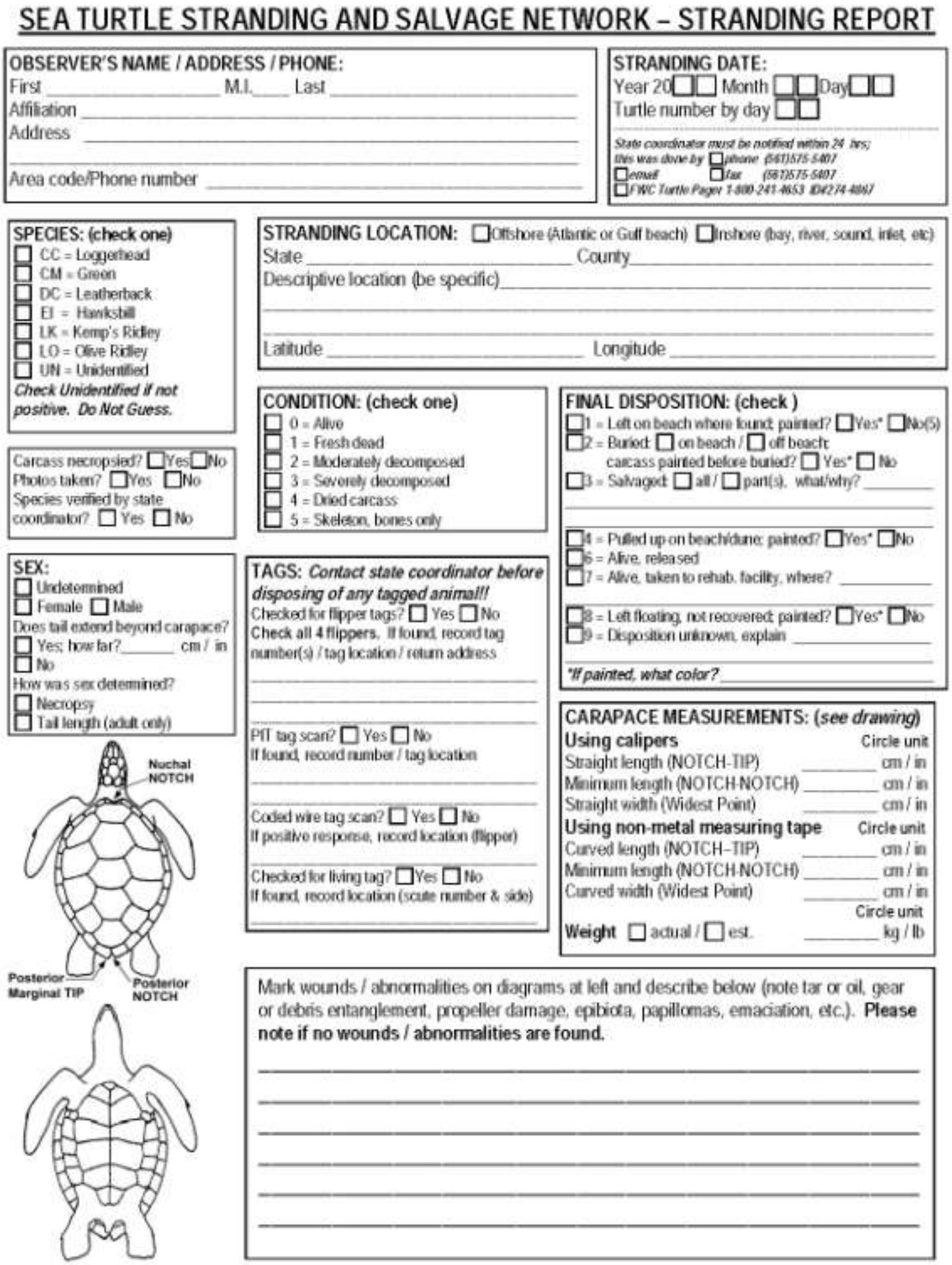
Species	Total number of strandings	Number entangled in fishing line	Number that ingested fishing line	Percentage entangled in or that ingested fishing line
Hawksbill	361	29	0	8.0 %
Green Turtle	6,918	337	117	6.6 %
Kemp's ridley	1,849	40	12	2.8 %
Loggerhead	15,894	213	99	2.0 %
Leatherback	572	4	1	0.9 %

Table 26. The number and percentage of stranded sea turtles found to be covered to some extent by tar or oil by species in Florida from 1980 through 2007. One green turtle that was included was found to have tar in the G.I. tract. There was one olive ridley that was found to be covered by tar.

Species	Total number of strandings	Number with tar or oil	Percentage with tar or oil
Hawksbill	561	50	8.9 %
Green Turtle	7,091	92	1.3 %
Loggerhead	17,161	134	0.8 %
Kemp's ridley	1,864	3	0.2 %
Leatherback	584	1	0.2 %

Table 27. The number and percentage of stranded sea turtles found to be entangled in or to have ingested persistent marine debris other than monofilament fishing line, tar, or oil by species in Florida from 1980 through 2007.

Species	Total number of strandings	Number entangled in or that ingested other marine debris	Percentage entangled in or that ingested other marine debris
Hawksbill	561	19	3.4 %
Green Turtle	7,091	97	1.4 %
Leatherback	584	4	0.7 %
Kemp's ridley	1,864	12	0.6 %
Loggerhead	17,161	61	0.4 %



SEA TURTLE STRANDING AND SALVAGE NETWORK – STRANDING REPORT

OBSERVER'S NAME / ADDRESS / PHONE:
First ________ M.I.____ Last ________
Affiliation ________
Address ________
____
Area code/Phone number ________

STRANDING DATE:
Year 20☐☐ Month ☐☐ Day ☐☐
Turtle number by day ☐☐

State coordinator must be notified within 24 hrs; this was done by ☐ phone (561)575-5407 ☐ email ☐ fax (561)575-5407 ☐ FWC Turtle Pager 1-800-241-4653 ID#274-4867

SPECIES: (check one)
☐ CC = Loggerhead
☐ CM = Green
☐ DC = Leatherback
☐ EI = Hawksbill
☐ LK = Kemp's Ridley
☐ LO = Olive Ridley
☐ UN = Unidentified
Check Unidentified if not positive. Do Not Guess.

STRANDING LOCATION: ☐ Offshore (Atlantic or Gulf beach) ☐ Inshore (bay, river, sound, inlet, etc)
State ________ County ________
Descriptive location (be specific) ________
____
____
Latitude ________ Longitude ________

Carcass necropsied? ☐ Yes ☐ No
Photos taken? ☐ Yes ☐ No
Species verified by state coordinator? ☐ Yes ☐ No

CONDITION: (check one)
☐ 0 = Alive
☐ 1 = Fresh dead
☐ 2 = Moderately decomposed
☐ 3 = Severely decomposed
☐ 4 = Dried carcass
☐ 5 = Skeleton, bones only

FINAL DISPOSITION: (check)
☐ 1 = Left on beach where found; painted? ☐ Yes* ☐ No(5)
☐ 2 = Buried: ☐ on beach / ☐ off beach;
carcass painted before buried? ☐ Yes* ☐ No
☐ 3 = Salvaged: ☐ all / ☐ part(s), what/why? ________
____
☐ 4 = Pulled up on beach/dune; painted? ☐ Yes* ☐ No
☐ 6 = Alive, released
☐ 7 = Alive, taken to rehab. facility, where? ________
____
☐ 8 = Left floating, not recovered; painted? ☐ Yes* ☐ No
☐ 9 = Disposition unknown, explain ________
____
**If painted, what color?* ________

SEX:
☐ Undetermined
☐ Female ☐ Male
Does tail extend beyond carapace?
☐ Yes; how far? ______ cm / in
☐ No
How was sex determined?
☐ Necropsy
☐ Tail length (adult only)

TAGS: ***Contact state coordinator before disposing of any tagged animal!!***
Checked for flipper tags? ☐ Yes ☐ No
Check all 4 flippers. If found, record tag number(s) / tag location / return address
____
____
____
PIT tag scan? ☐ Yes ☐ No
If found, record number / tag location
____
____
Coded wire tag scan? ☐ Yes ☐ No
If positive response, record location (flipper)
____
Checked for living tag? ☐ Yes ☐ No
If found, record location (scute number & side)
____

CARAPACE MEASUREMENTS: (*see drawing*)

Using calipers		Circle unit
Straight length (NOTCH-TIP)	________	cm / in
Minimum length (NOTCH-NOTCH)	________	cm / in
Straight width (Widest Point)	________	cm / in
Using non-metal measuring tape		Circle unit
Curved length (NOTCH–TIP)	________	cm / in
Minimum length (NOTCH-NOTCH)	________	cm / in
Curved width (Widest Point)	________	cm / in
		Circle unit
Weight ☐ actual / ☐ est.	________	kg / lb

Nuchal NOTCH
Posterior Marginal TIP
Posterior NOTCH

Mark wounds / abnormalities on diagrams at left and describe below (note tar or oil, gear or debris entanglement, propeller damage, epibiota, papillomas, emaciation, etc.). **Please note if no wounds / abnormalities are found.**
____
____
____
____
____
____

Figure 1. The data reporting form of the Sea Turtle Stranding and Salvage Network.

Figure 2. The coastal counties and NMFS Fishery Statistical Zones in Florida.

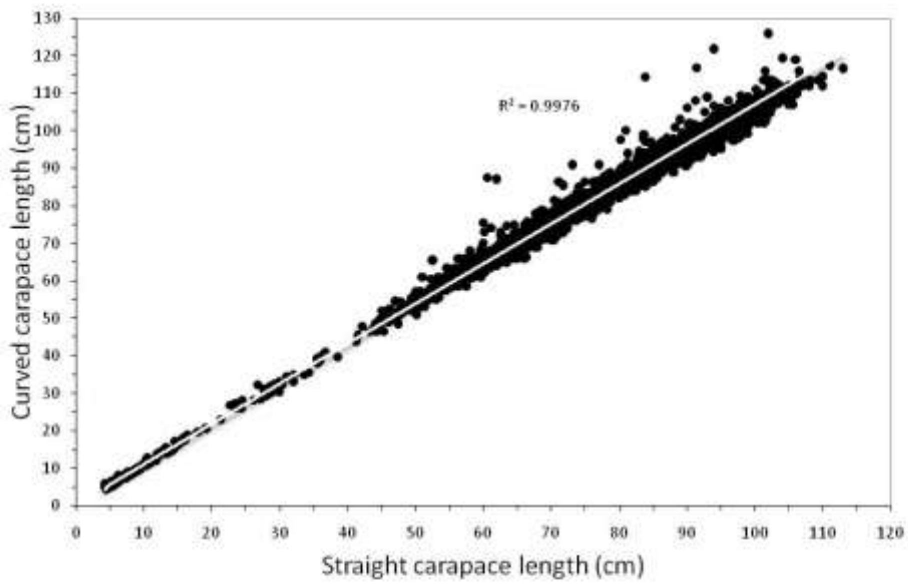


Figure 3. The straight carapace length (SCL) versus the curved carapace length (CCL) for 4,120 stranded loggerheads found in Florida from 1980 through 2007. Both carapace lengths were measured from the nuchal notch to the posterior marginal tip. The equation for the power regression shown here is CCL = 1.108($SCL^{0.9922}$).

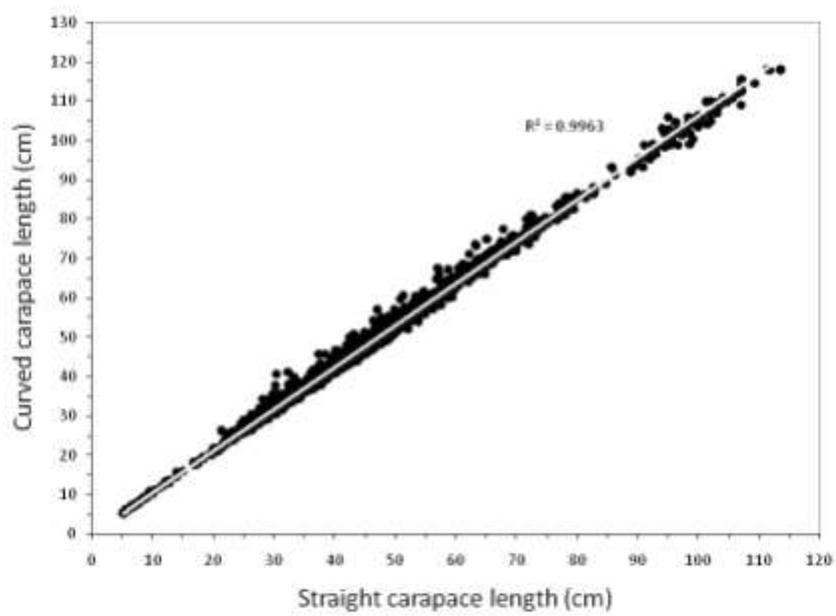


Figure 4. The straight carapace length (SCL) versus the curved carapace length (CCL) for 3,349 stranded green turtles found in Florida from 1980 through 2007. Both carapace lengths were measured from the nuchal notch to the posterior marginal tip. The equation for the power regression shown here is CCL = 1.0439($SCL^{1.0043}$).

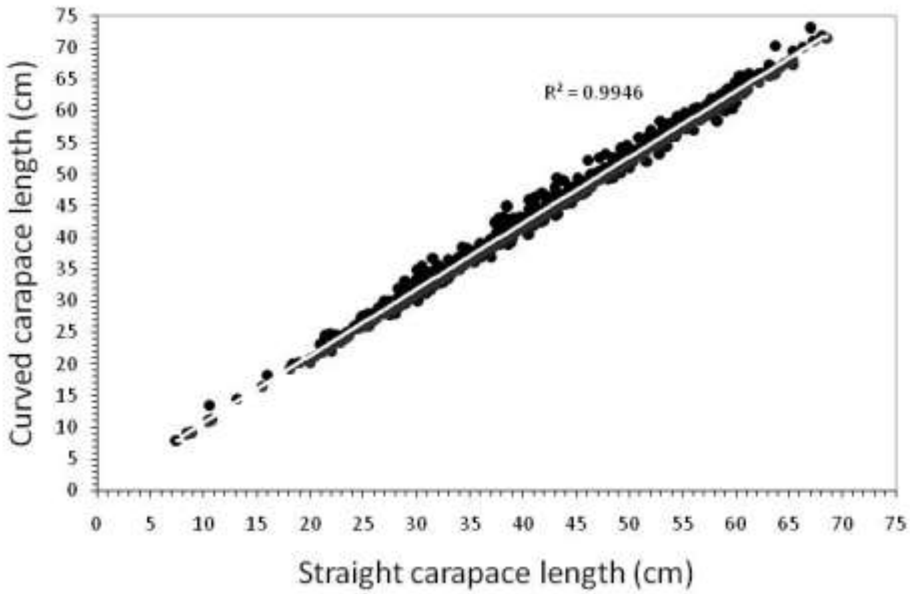


Figure 5. The straight carapace length (SCL) versus the curved carapace length (CCL) for 860 stranded Kemp's ridleys found in Florida from 1980 through 2007. Both carapace lengths were measured from the nuchal notch to the posterior marginal tip. The equation for the power regression shown here is $CCL = 1.0973(SCL^{0.9897})$.

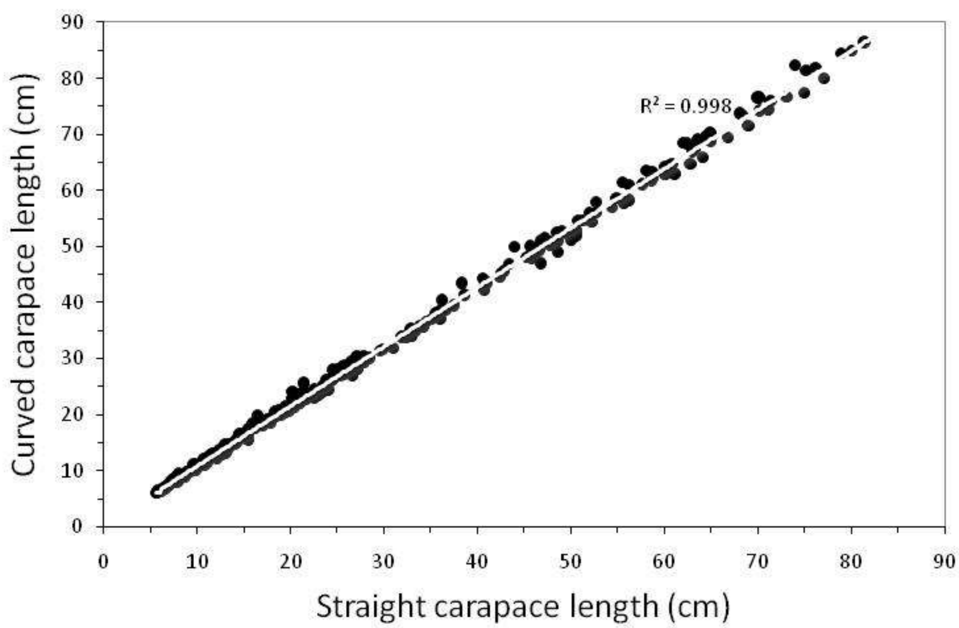


Figure 6. The straight carapace length (SCL) versus the curved carapace length (CCL) for 256 stranded hawksbills found in Florida from 1980 through 2007. Both carapace lengths were measured from the nuchal notch to the posterior marginal tip. The equation for the power regression shown here is $CCL = 1.1073(SCL^{0.9902})$.

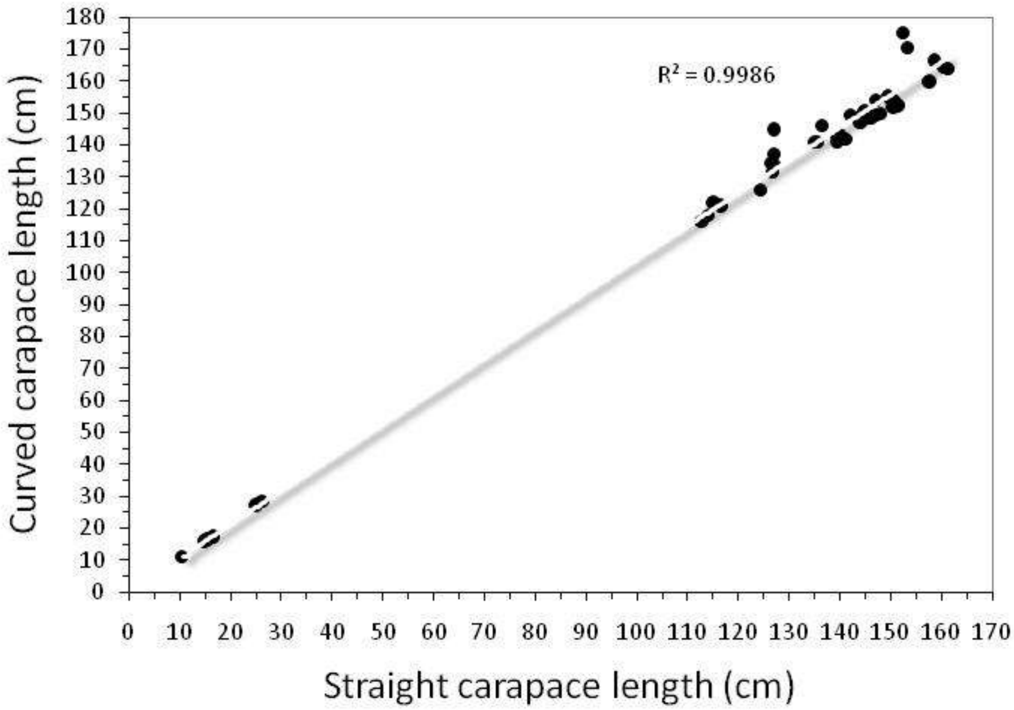


Figure 7. The straight carapace length (SCL) versus the curved carapace length (CCL) for 44 stranded leatherbacks found in Florida from 1980 through 2007. Both carapace lengths were measured from the nuchal notch to the posterior marginal tip. The equation for the power regression shown here is CCL = $1.1208(SCL^{0.985})$.

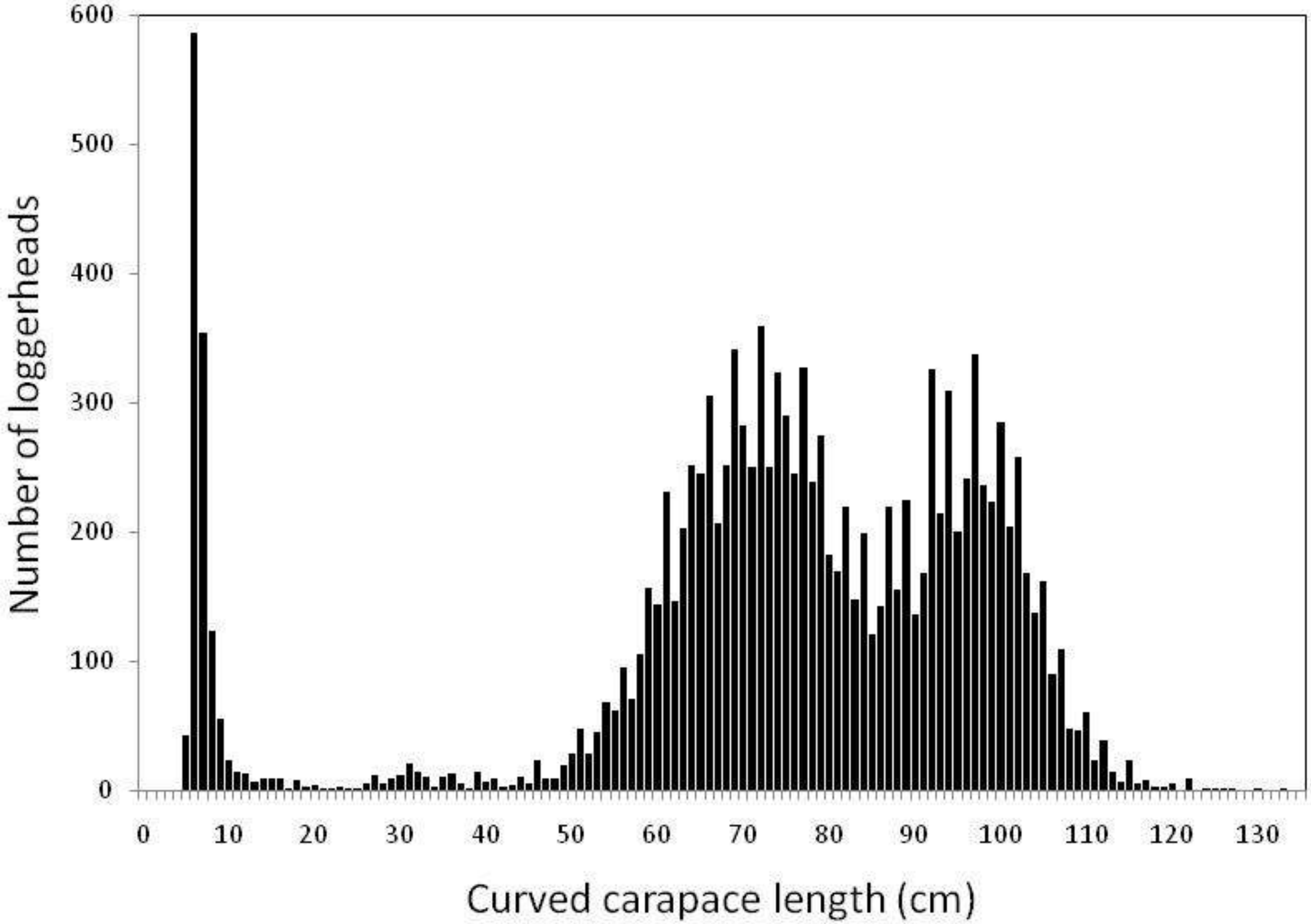


Figure 8. The size frequency distribution of stranded loggerheads found in Florida from 1980 through 2007. Carapace length was measured from the nuchal notch to the posterior marginal tip.

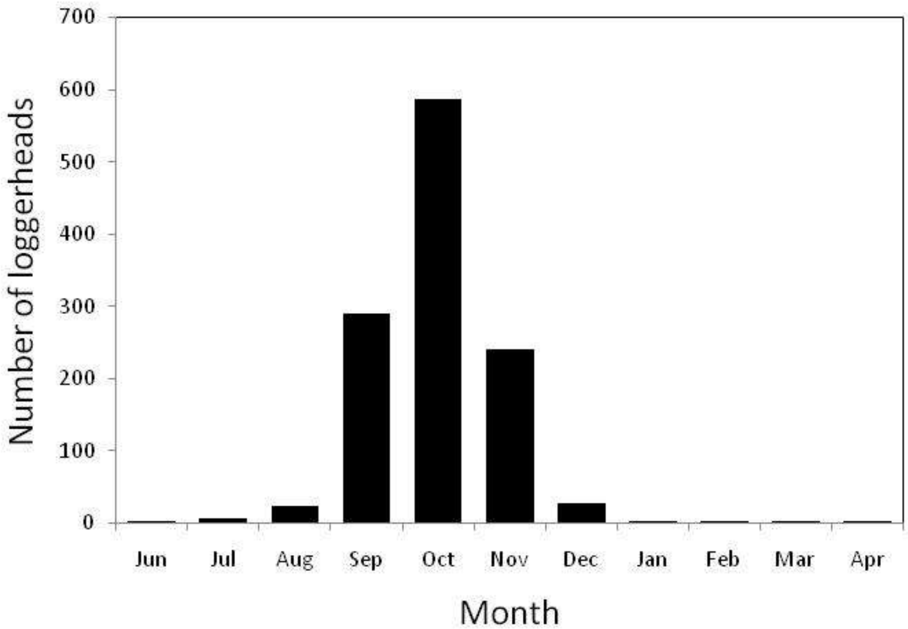


Figure 9. The number of stranded posthatchling loggerheads (< 10 cm curved carapace length) found in Florida by month from 1980 through 2007. Carapace length was measured from the nuchal notch to the posterior marginal tip.

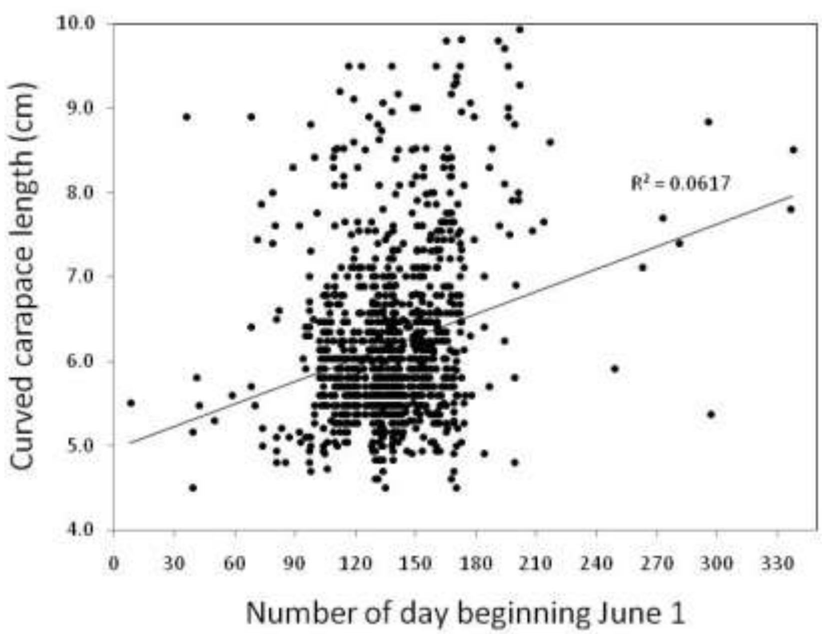


Figure 10. The curved carapace length (CCL) in cm of stranded post-hatchling loggerheads found in Florida by day beginning each year on June 1 and extending through May of the following year from 1980 through 2007. Carapace length was measured from the nuchal notch to the posterior marginal tip. There was a tendency for the CCL to increase over these days (linear regression, $P < 0.001$).

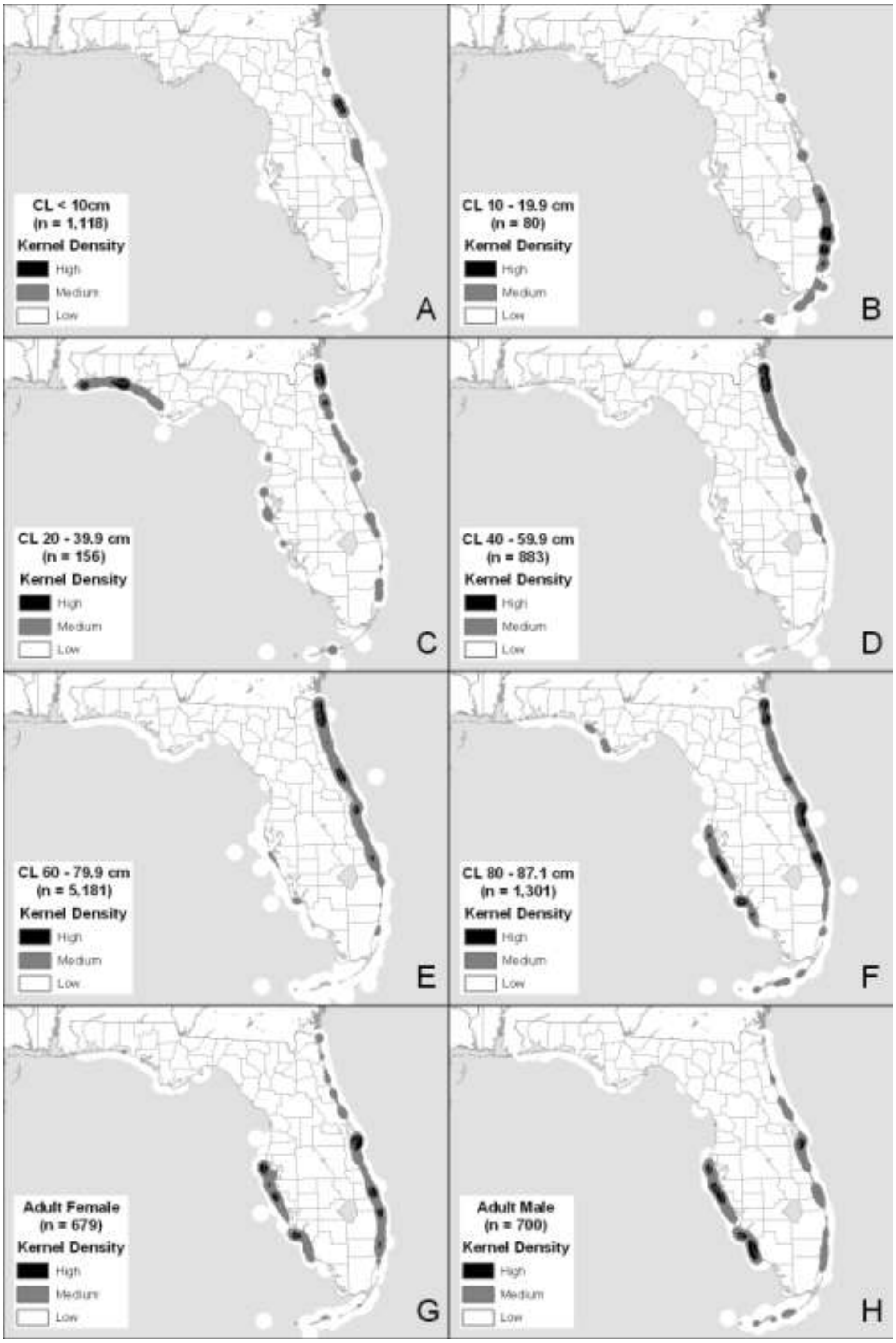


Figure 11. The relative kernel densities of stranded loggerheads by various size classes and for adult males and females found in Florida from 1980 through 2007. CL is curved carapace length in cm measured from the nuchal notch to the posterior marginal tip. See text for criteria regarding the identification of adult turtles. The kernel densities were estimated using Hawth's tools (http://www.spatialecology.com/htools/overview.php).

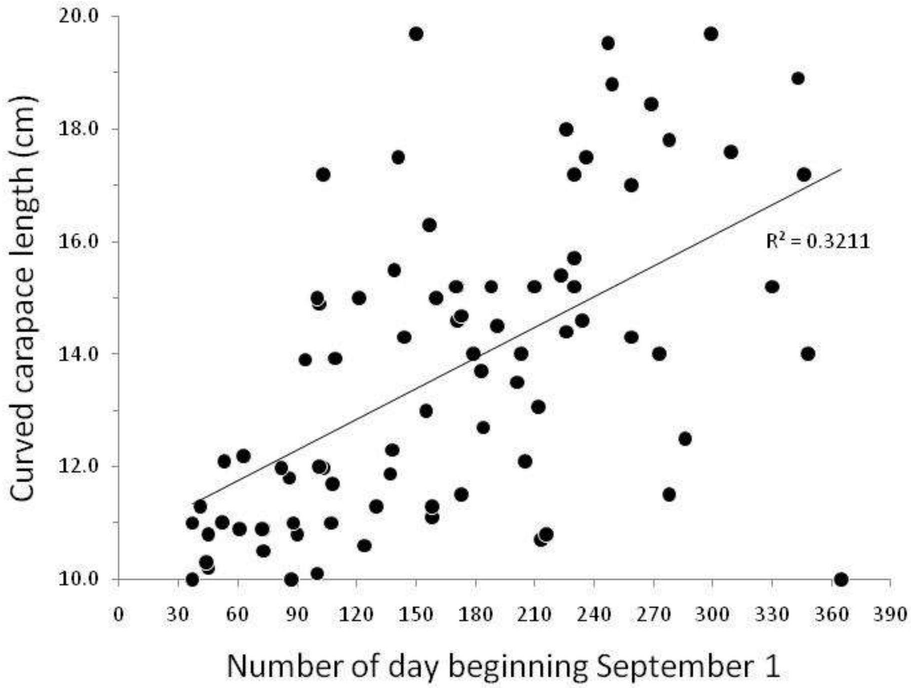


Figure 12. The curved carapace length (CCL) in cm of stranded loggerheads 10 to 19.9 cm CCL found in Florida by day beginning each year on September 1 and extending through October of the following year from 1980 through 2007. Carapace length was measured from the nuchal notch to the posterior marginal tip. There was a tendency for the CCL to increase over these months (linear regression, $P < 0.001$).

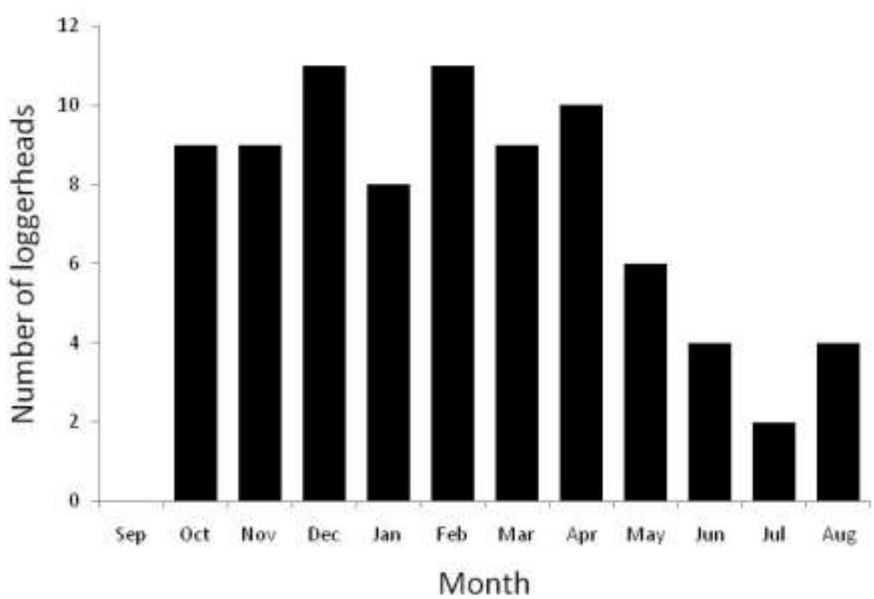


Figure 13. The number of stranded loggerheads 10 to 19.9 cm curved carapace length found in Florida by month from 1980 through 2007. Carapace length was measured from the nuchal notch to the posterior marginal tip.

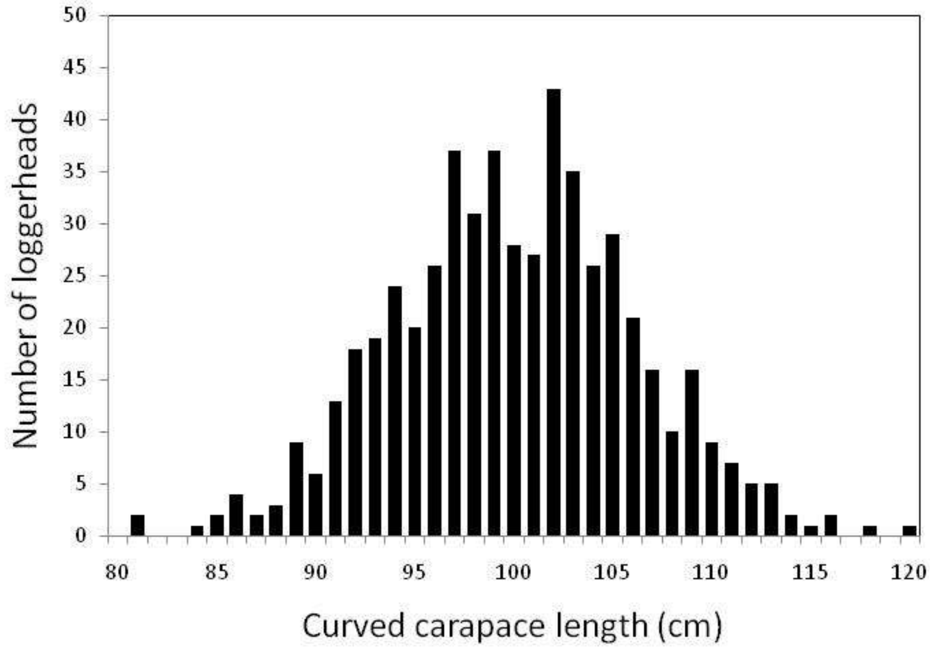


Figure 14. The size frequency distribution of 538 stranded adult male loggerheads found in Florida from 1980 through 2007. Adult male loggerheads were identified by a tail that extended at least 15 cm beyond the posterior edge of the carapace. Carapace length was measured from the nuchal notch to the posterior marginal tip.

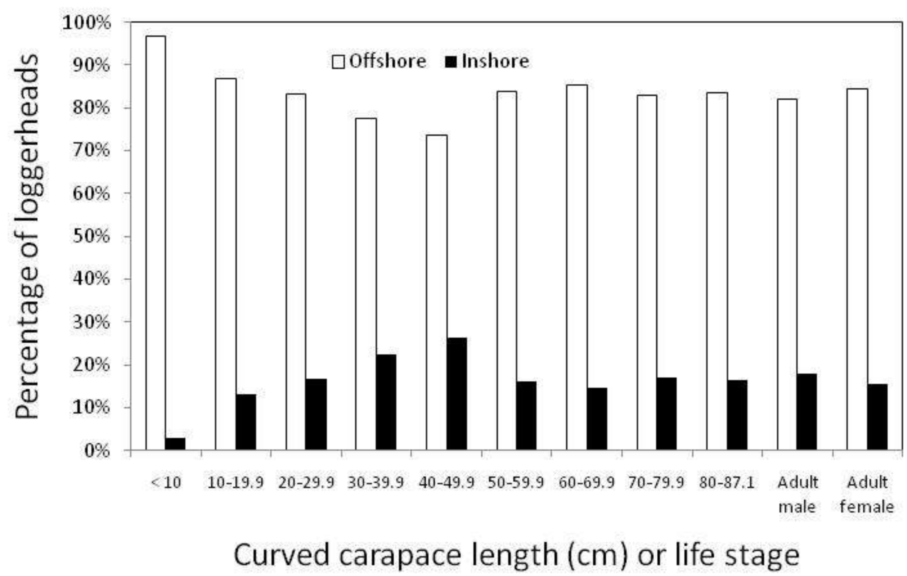


Figure 15. The percentage of stranded loggerhead found in or adjacent to inshore or offshore waters by 10-cm size-class and for adult males and adult females. All strandings were found in Florida from 1980 through 2007. Carapace length was measured from the nuchal notch to the posterior marginal tip. See text for criteria regarding the identification of adult turtles.

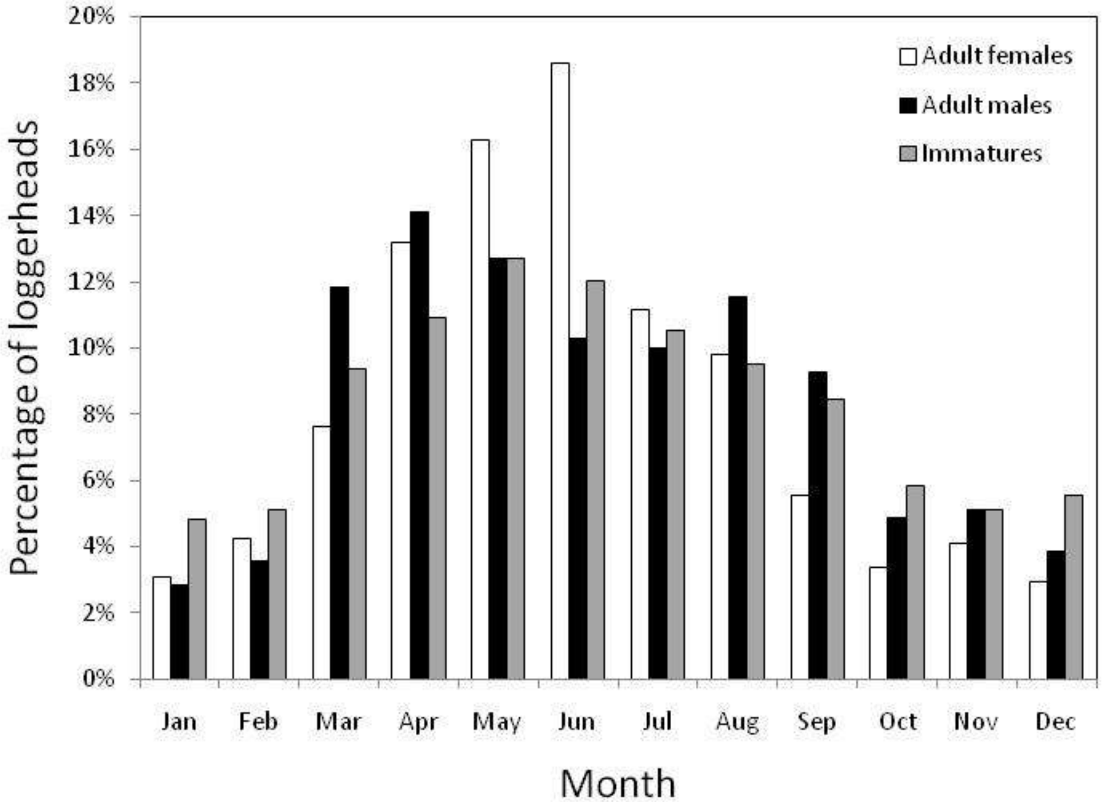


Figure 16. The percentage of stranded loggerhead by month for adult females, adult males, and immature turtles. All strandings were found in Florida from 1980 through 2007. See text for criteria regarding the identification of adult turtles. The immature loggerheads were from 20 to 87.1 cm curved carapace length as measured from the nuchal notch to the posterior marginal tip.

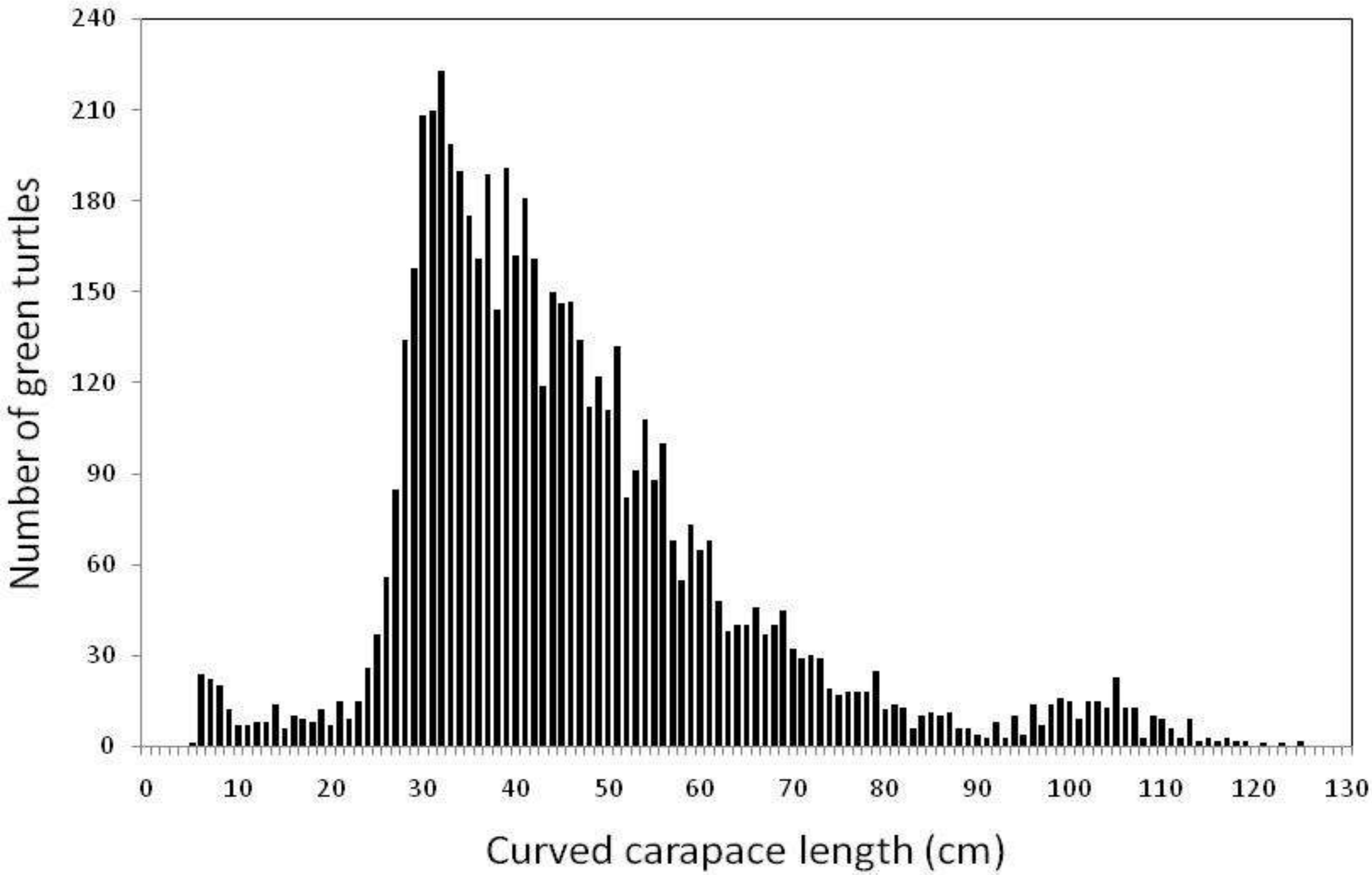


Figure 17. The size frequency distribution of stranded green turtles found in Florida from 1980 through 2007. Carapace length was measured from the nuchal notch to the posterior marginal tip.

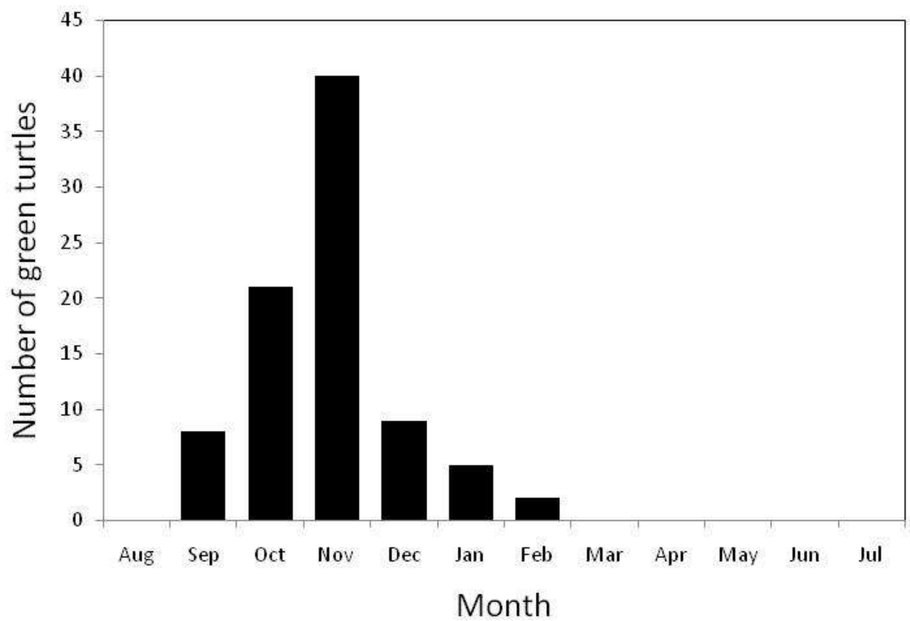


Figure 18. The number of stranded posthatchling green turtles (< 10 cm curved carapace length) found in Florida by month from 1980 through 2007. Carapace length was measured from the nuchal notch to the posterior marginal tip.

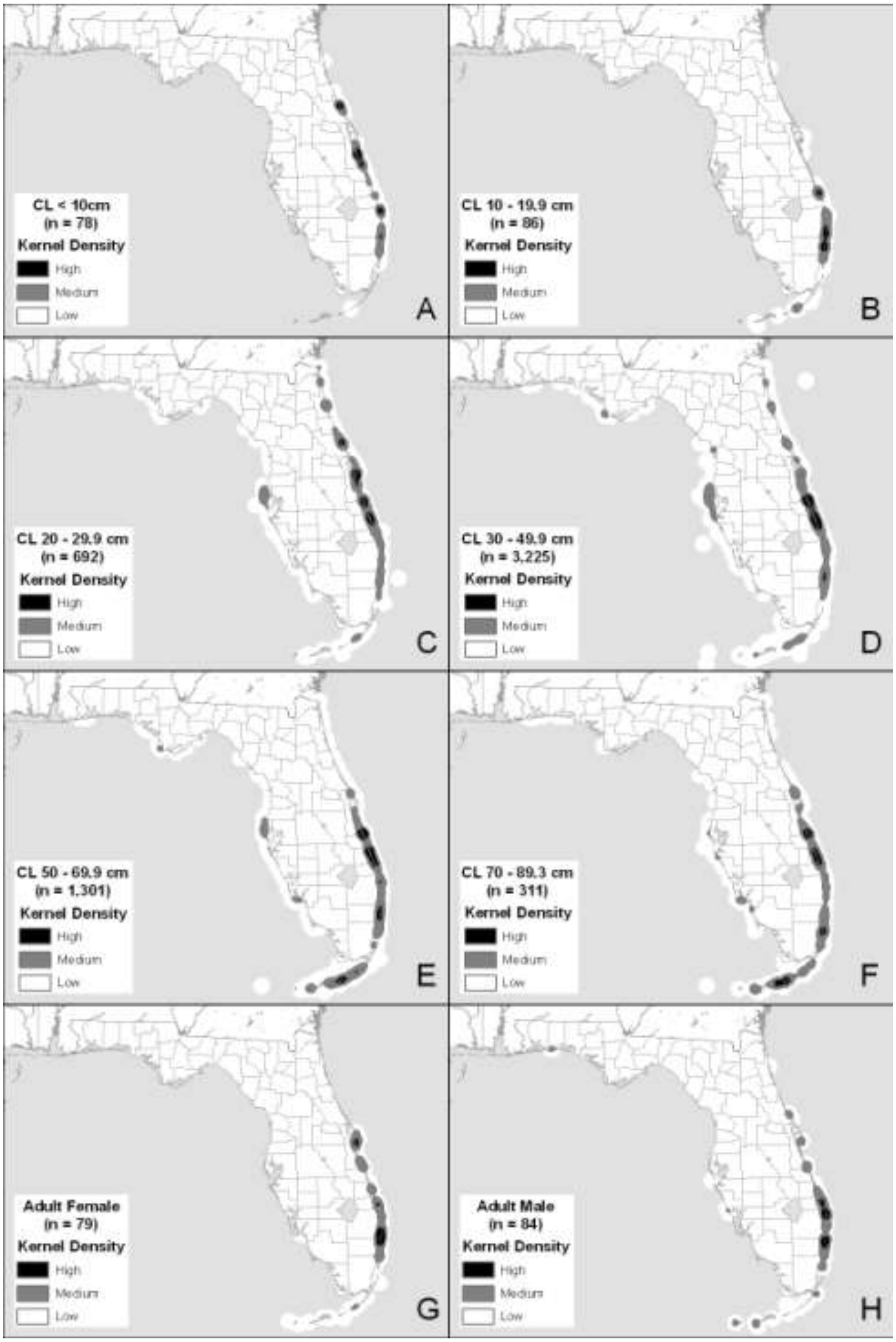


Figure 19. The relative kernel densities of stranded green turtles by various size classes and for adult males and females found in Florida from 1980 through 2007. CL is curved carapace length in cm measured from the nuchal notch to the posterior marginal tip. See text for criteria regarding the identification of adult turtles. The kernel densities were estimated using Hawth's tools (http://www.spatialecology.com/htools/overview.php).

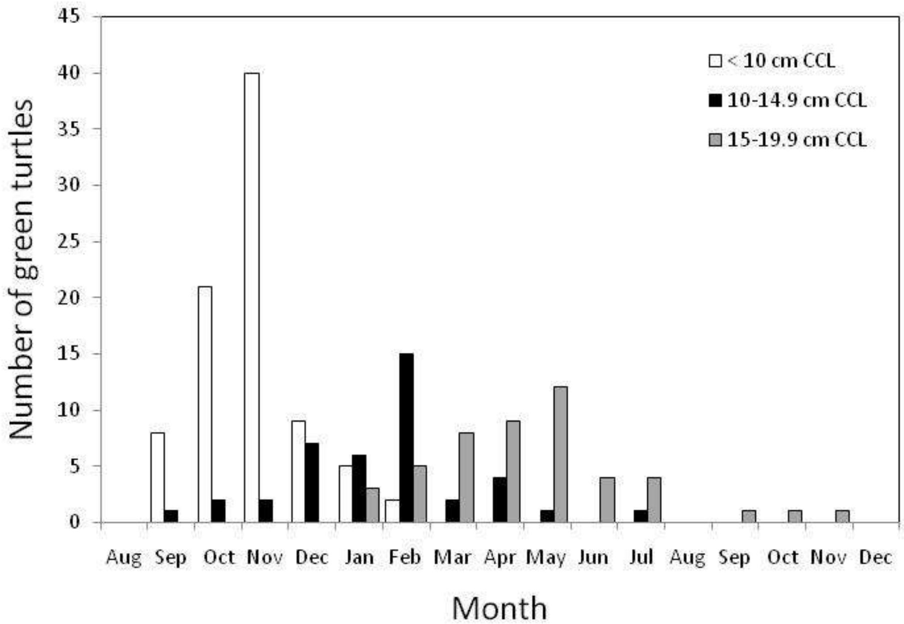


Figure 20. The number of stranded green turtles less than 20 cm curved carapace length by 5-cm size-class and by month in Florida from 1980 through 2007. In this arrangement of the strandings over a 17-month period beginning near the end of the green turtle nesting season, the numbers of strandings of green turtles in each 5-cm size-class began and peaked about three months before those of the next largest 5-cm size-class. Carapace length was measured from the nuchal notch to the posterior marginal tip.

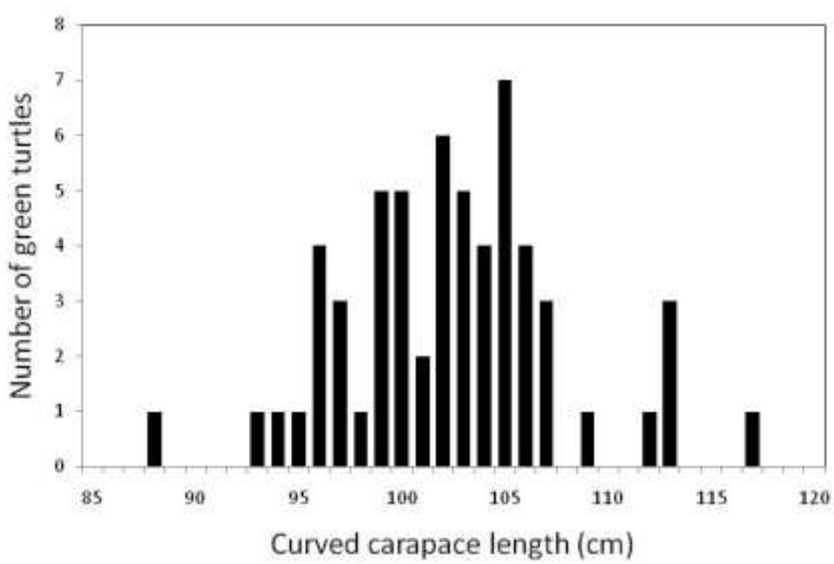


Figure 21. The size frequency distribution of 59 stranded adult male green turtles found in Florida from 1980 through 2007. Adult male green turtles were identified by a tail that extended at least 15 cm beyond the posterior edge of the carapace. Carapace length was measured from the nuchal notch to the posterior marginal tip.

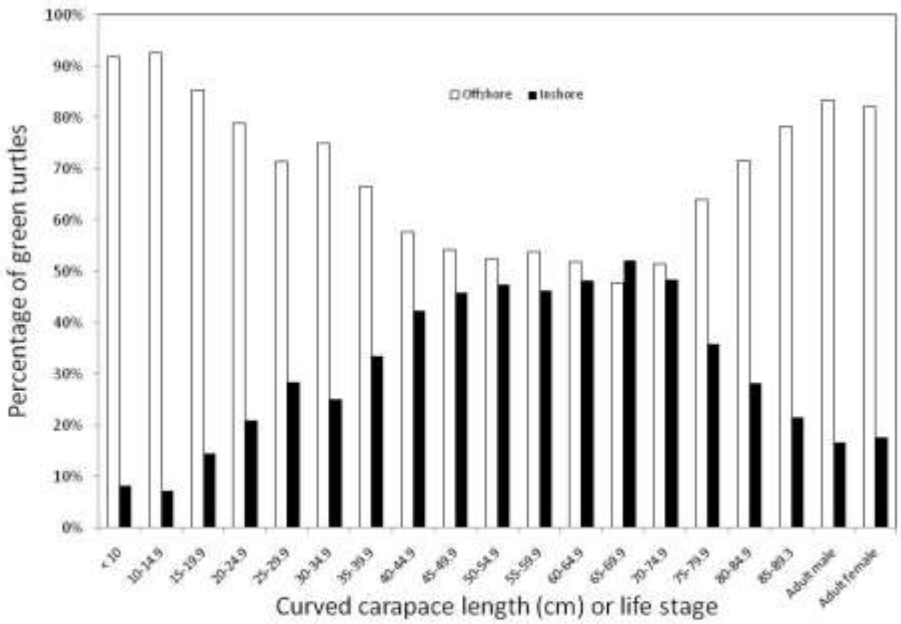


Figure 22. The percentage of green turtle strandings found in or adjacent to inshore or offshore waters by 5-cm size-class and for adult males and adult females. All the strandings were found in Florida from 1980 through 2007. Carapace length was measured from the nuchal notch to the posterior marginal tip. See text for criteria regarding the identification of adult turtles.

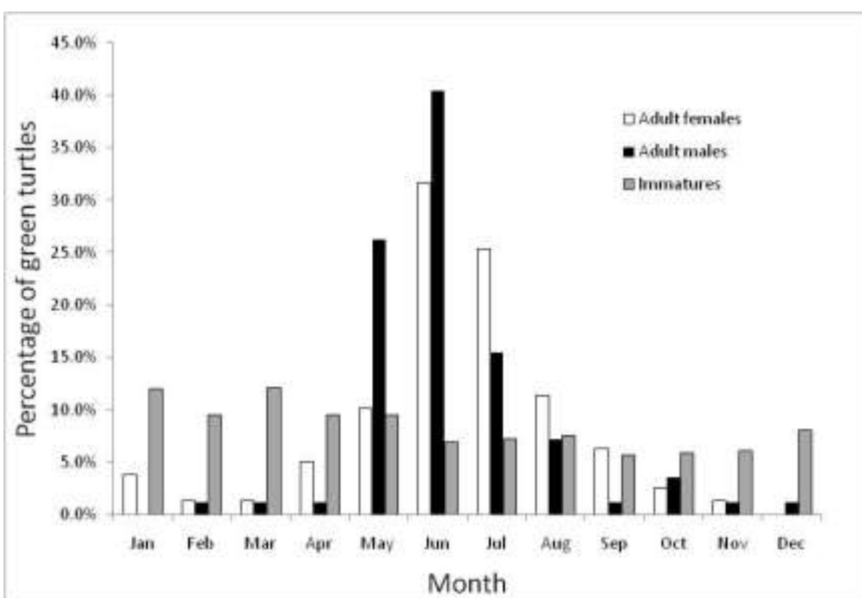


Figure 23. The percentage of stranded green turtles by month for adult females, adult males, and immature turtles. All strandings were found in Florida from 1980 through 2007. See text for criteria regarding the identification of adult turtles. The immature green turtles were from 20 to 89.3 cm curved carapace length as measured from the nuchal notch to the posterior marginal tip.

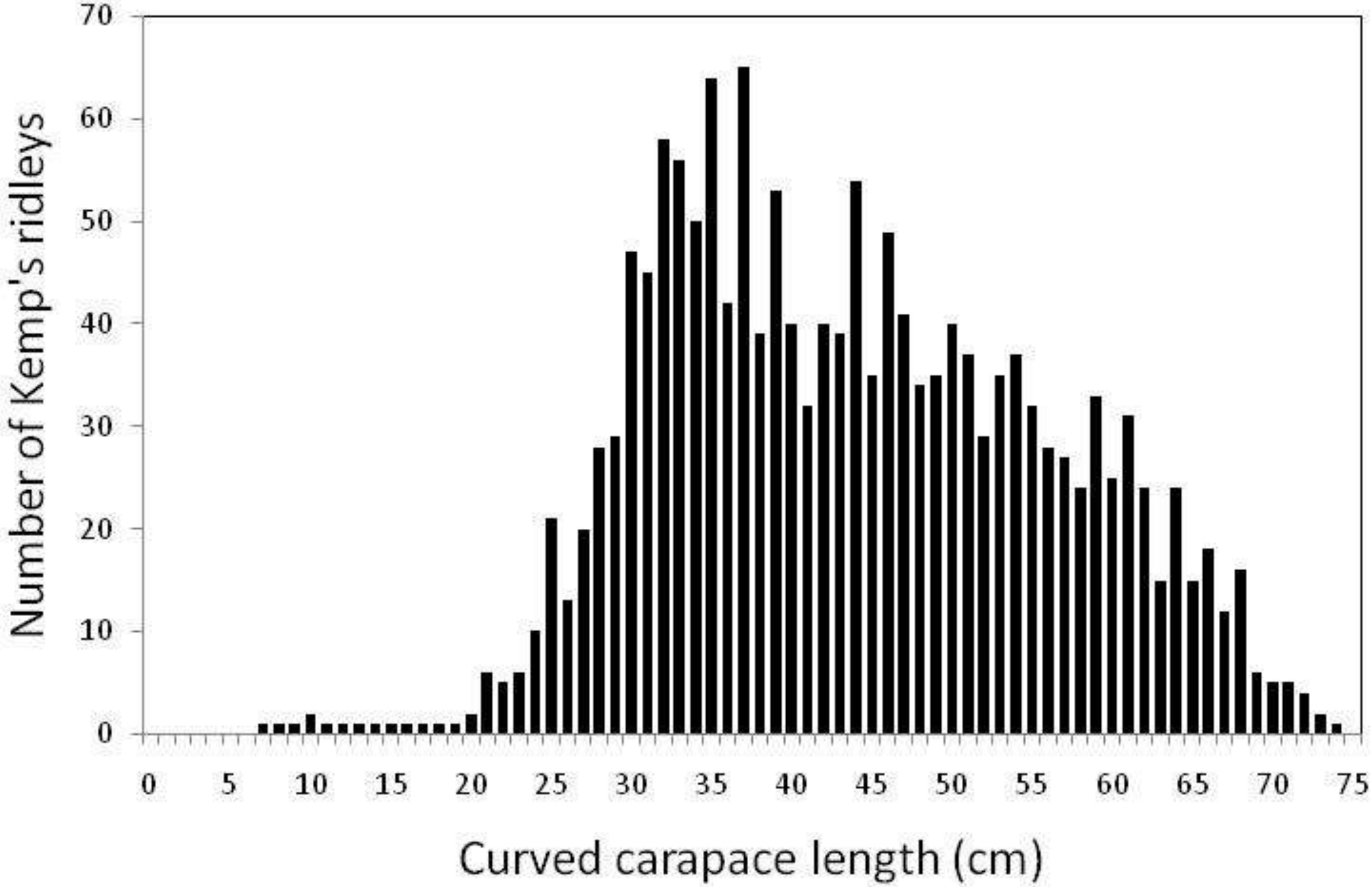


Figure 24. The size frequency distribution of stranded Kemp's ridleys found in Florida from 1980 through 2007. Carapace length was measured from the nuchal notch to the posterior marginal tip.

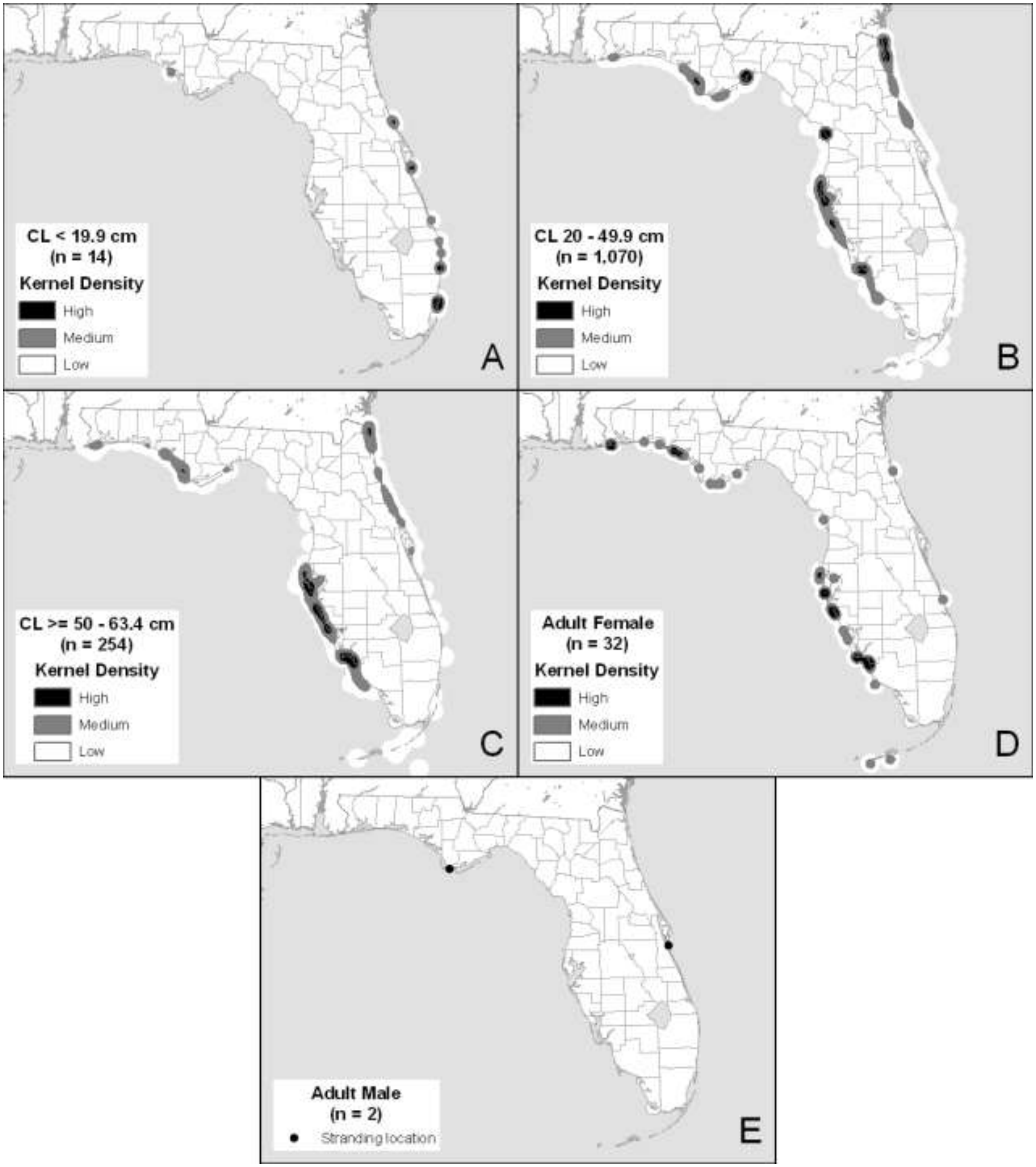


Figure 25. The relative kernel densities or locations of stranded Kemp's ridleys by various size classes and for adult males and females found in Florida from 1980 through 2007. CL is curved carapace length measured from the nuchal notch to the posterior marginal tip. See text for criteria regarding the identification of adult turtles. The kernel densities were estimated using Hawth's tools (http://www.spatialecology.com /htools/overview.php).

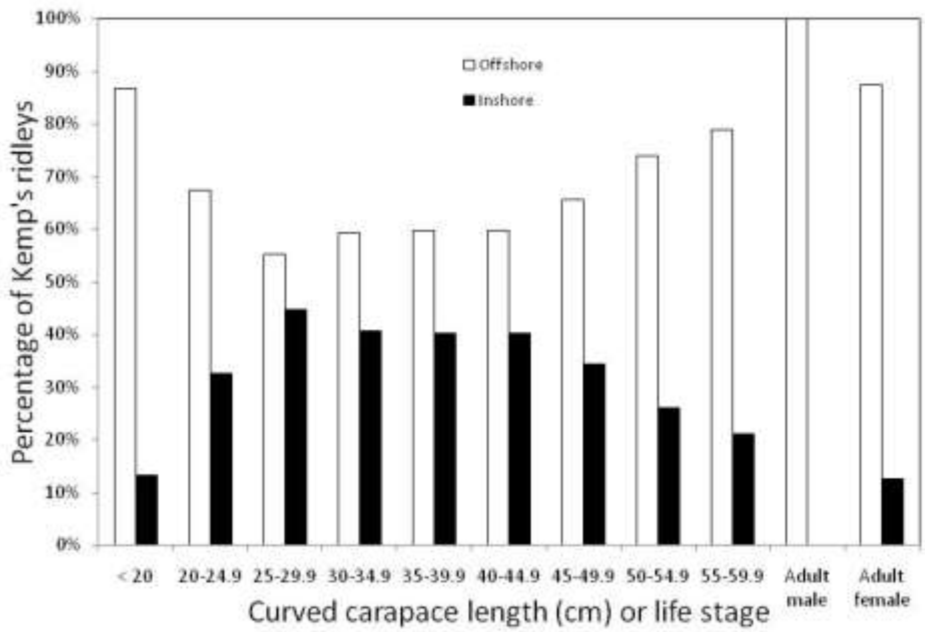


Figure 26. The percentage of stranded Kemp's ridleys found in or adjacent to inshore or offshore waters by 5-cm size-class and for adult males and females. All the strandings were found in Florida from 1980 through 2007. Carapace length was measured from the nuchal notch to the posterior marginal tip. See text for criteria regarding the identification of adult turtles.

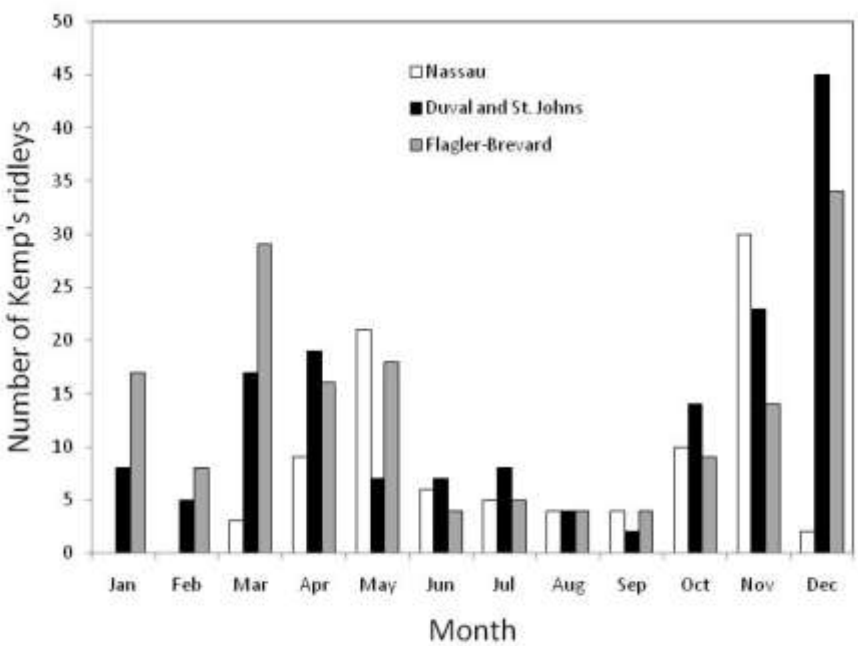


Figure 27. The number of stranded Kemp's ridleys in northeast and central-east Florida by month and by county or group of counties from 1980 through 2007. Nassau is the northernmost county along the east coast of Florida followed in sequence towards the south by Duval, St. Johns, Flagler, Volusia, and Brevard.

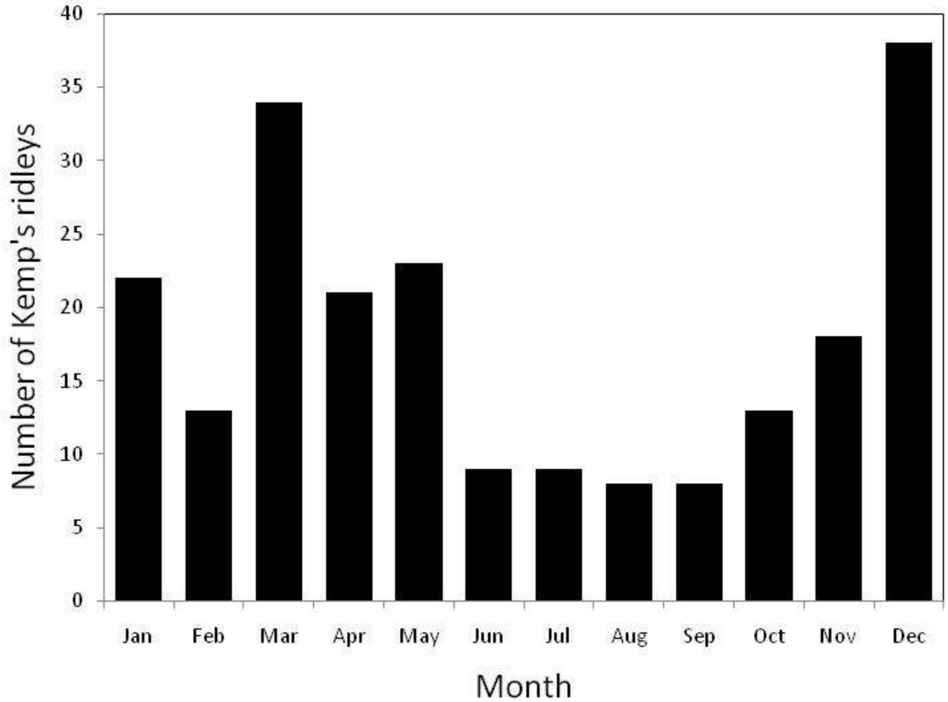


Figure 28. The number of stranded Kemp's ridleys by month in central-west and southwest Florida (Pinellas County through Collier County) from 1980 through 2007.

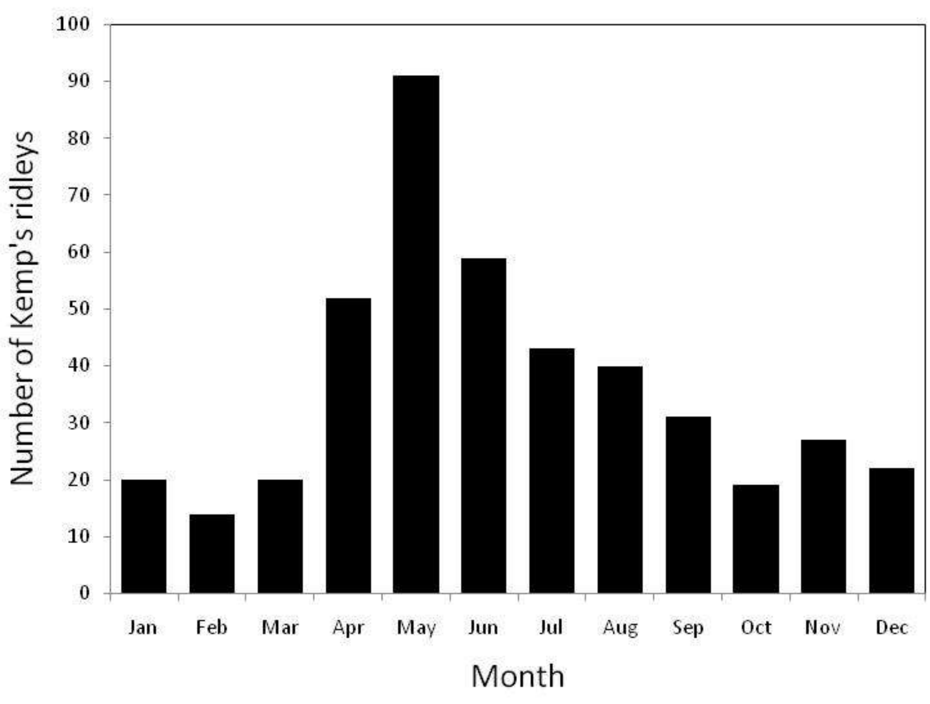


Figure 29. The number of stranded Kemp's ridleys by month in northwest Florida (Wakulla County through Escambia County) from 1980 through 2007.

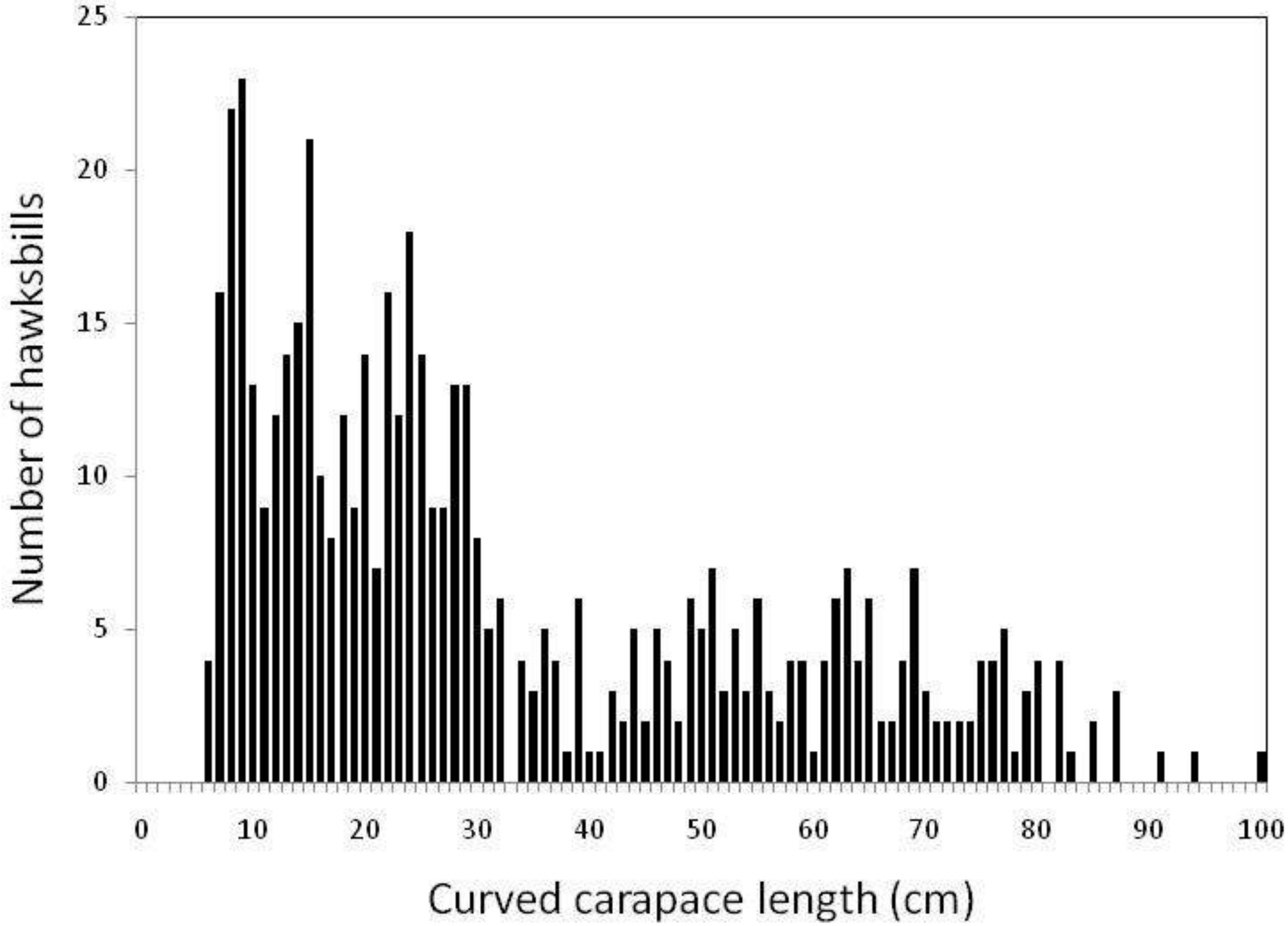


Figure 30. The size frequency distribution of stranded hawksbills in Florida from 1980 through 2007. Carapace length was measured from the nuchal notch to the posterior marginal tip.

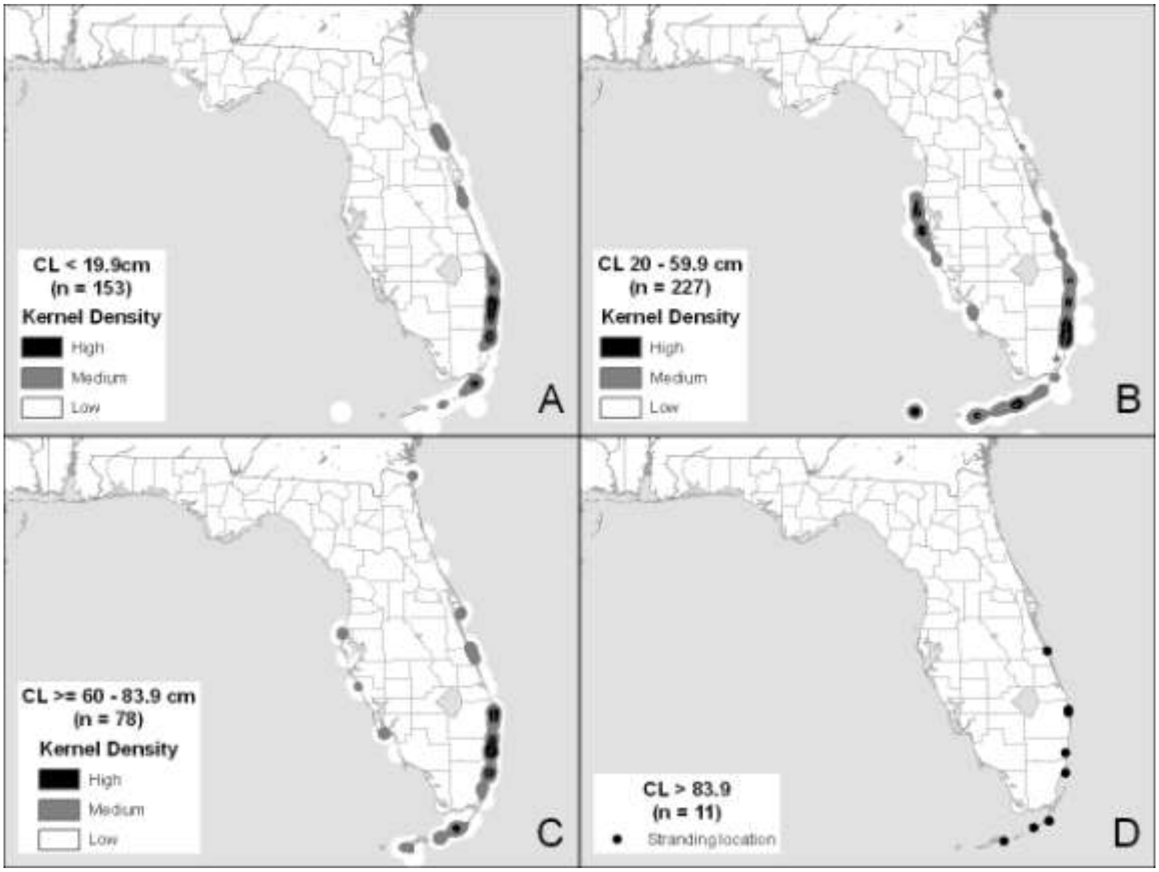


Figure 31. The relative kernel densities or locations of stranded hawksbills by various size classes and for adult males and females found in Florida from 1980 through 2007. CL is curved carapace length measured from the nuchal notch to the posterior marginal tip. See text for criteria regarding the identification of adult turtles. The kernel densities were estimated using Hawth's tools (http://www.spatialecology.com/htools/overview.php).

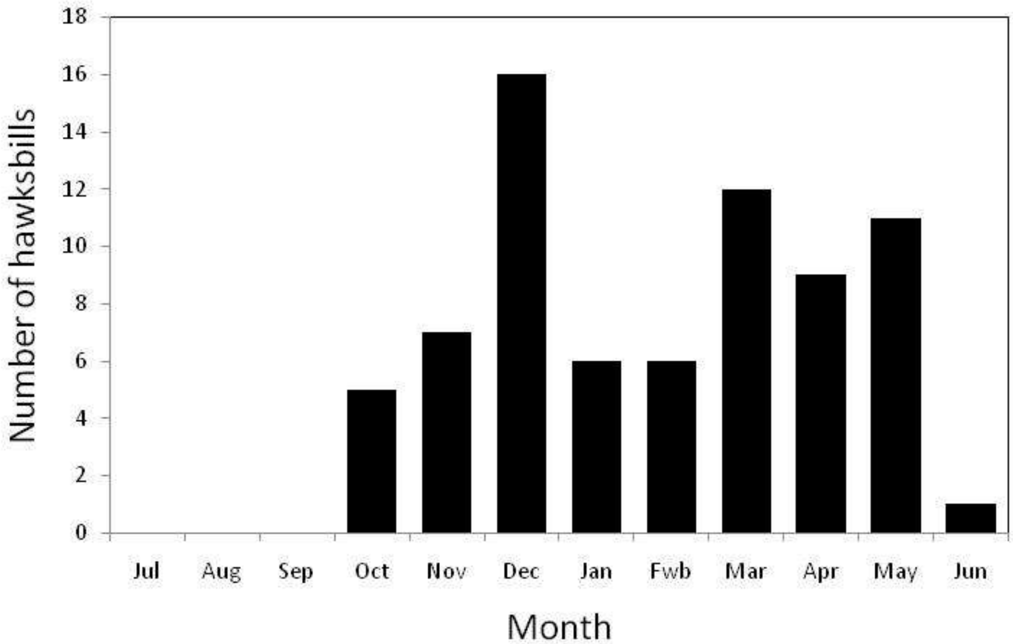


Figure 32. The number of stranded posthatchling hawksbills (< 10 cm curved carapace length) by month in Florida from 1980 through 2005. Carapace length was measured from the nuchal notch to the posterior marginal tip.

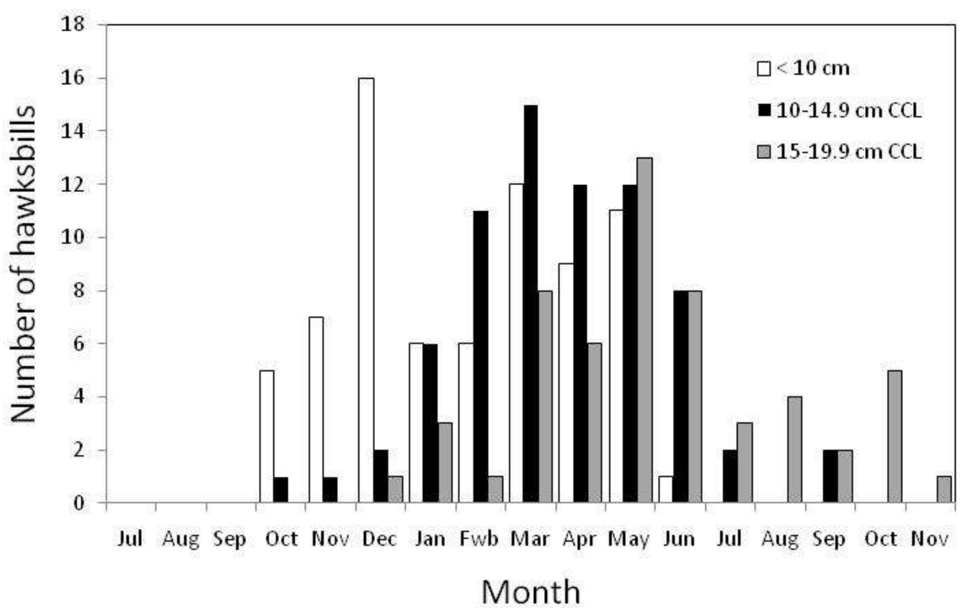


Figure 33. The number of stranded hawksbills less than 20 cm curved carapace length (CCL) by 5-cm size-class and by month in Florida from 1980 through 2007. In this arrangement of the strandings over a 17-month period beginning near the end of the hawksbill nesting season, the numbers of strandings of hawksbills in each 5-cm size-class began and peaked about three months before those of the next largest 5-cm size-class. Carapace length was measured from the nuchal notch to the posterior marginal tip.

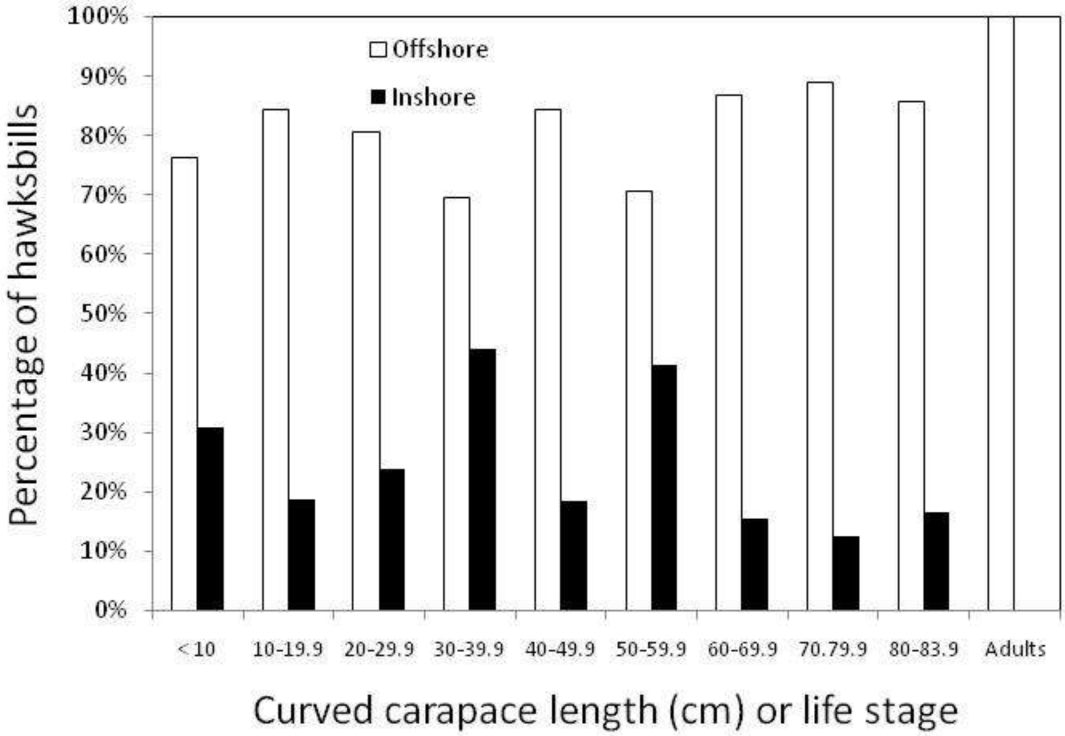


Figure 34. The percentage of stranded hawksbills found in or adjacent to inshore or offshore waters by 10-cm size-class and for adults. All the strandings were found in Florida from 1980 through 2007. Carapace length was measured from the nuchal notch to the posterior marginal tip. See text for criteria regarding the identification of adult turtles.

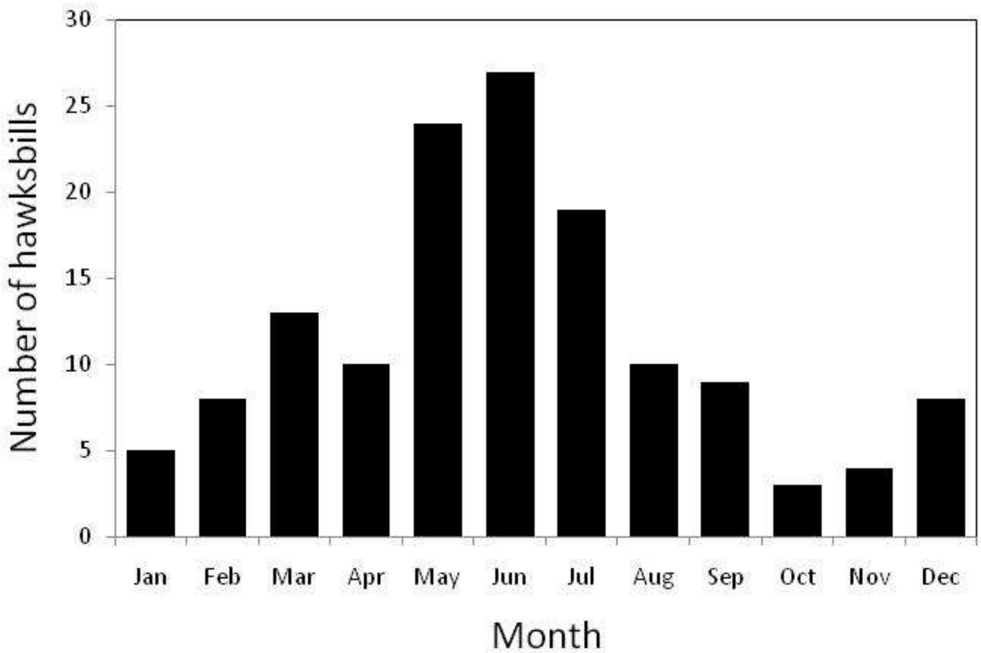


Figure 35. The number of stranded hawksbills ≥ 20 cm curved carapace length by month along the southeast coast of Florida from Indian River County through Miami-Dade County from 1980 through 2007. Carapace length was measured from the nuchal notch to the posterior marginal tip.

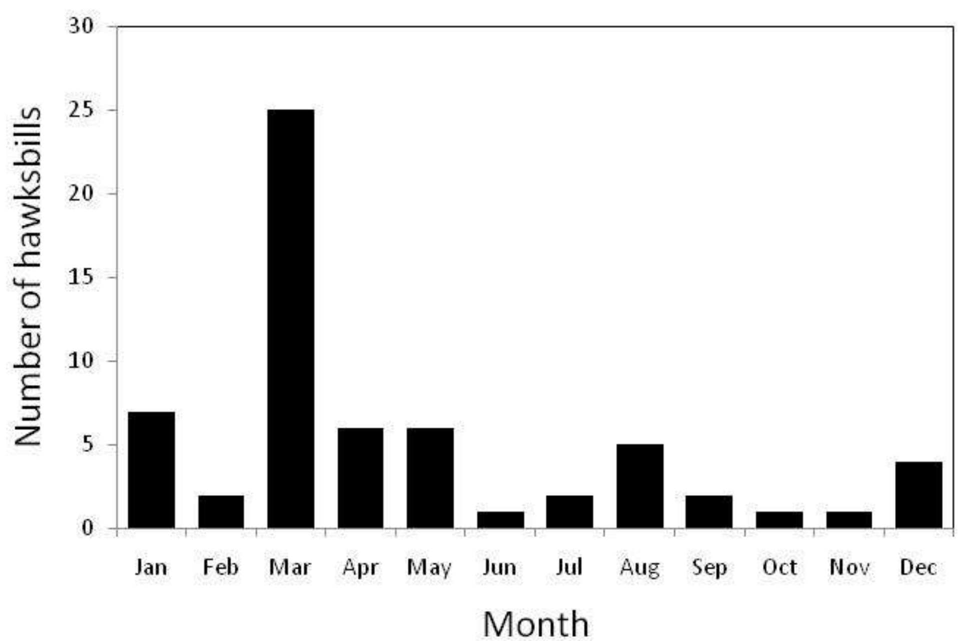


Figure 36. The number of stranded hawksbills ≥ 20 cm curved carapace length by month along the southwest coast of Florida from Pinellas County through Collier County from 1980 through 2007. Carapace length was measured from the nuchal notch to the posterior marginal tip.

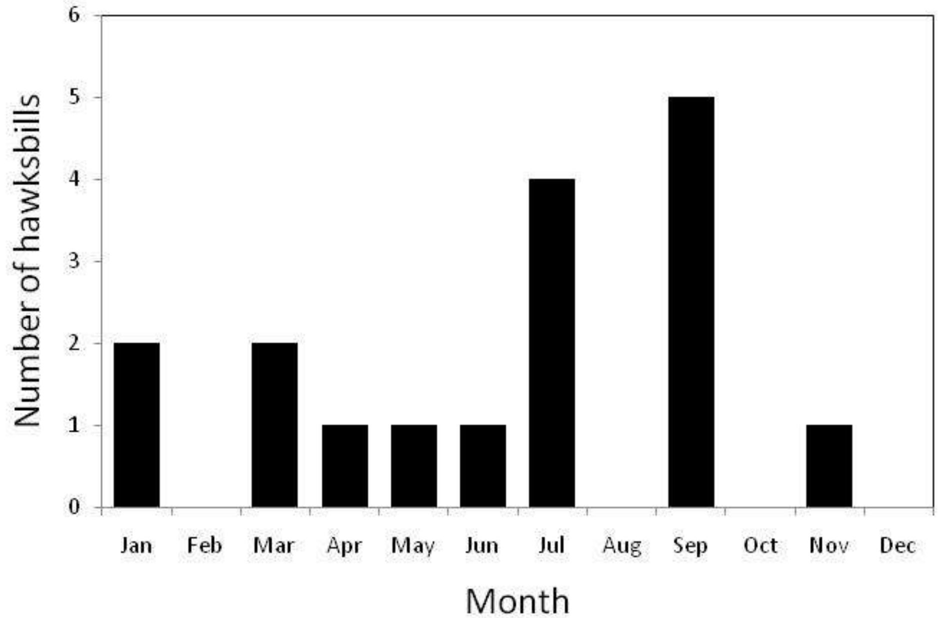


Figure 37. The number of stranded hawksbills ≥ 20 cm curved carapace length by month along the northeast coast of Florida from Nassau County through Brevard County from 1980 through 2007. Carapace length was measured from the nuchal notch to the posterior marginal tip.

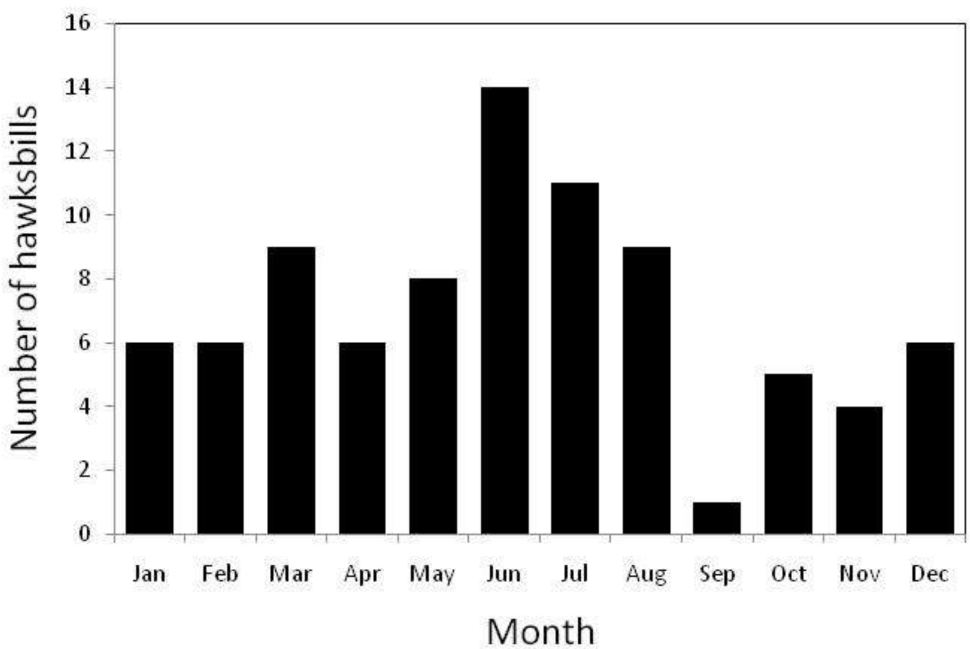


Figure 38. The number of stranded hawksbills ≥ 20 cm curved carapace length by month in Monroe County, Florida from 1980 through 2005. Carapace length was measured from the nuchal notch to the posterior marginal tip.

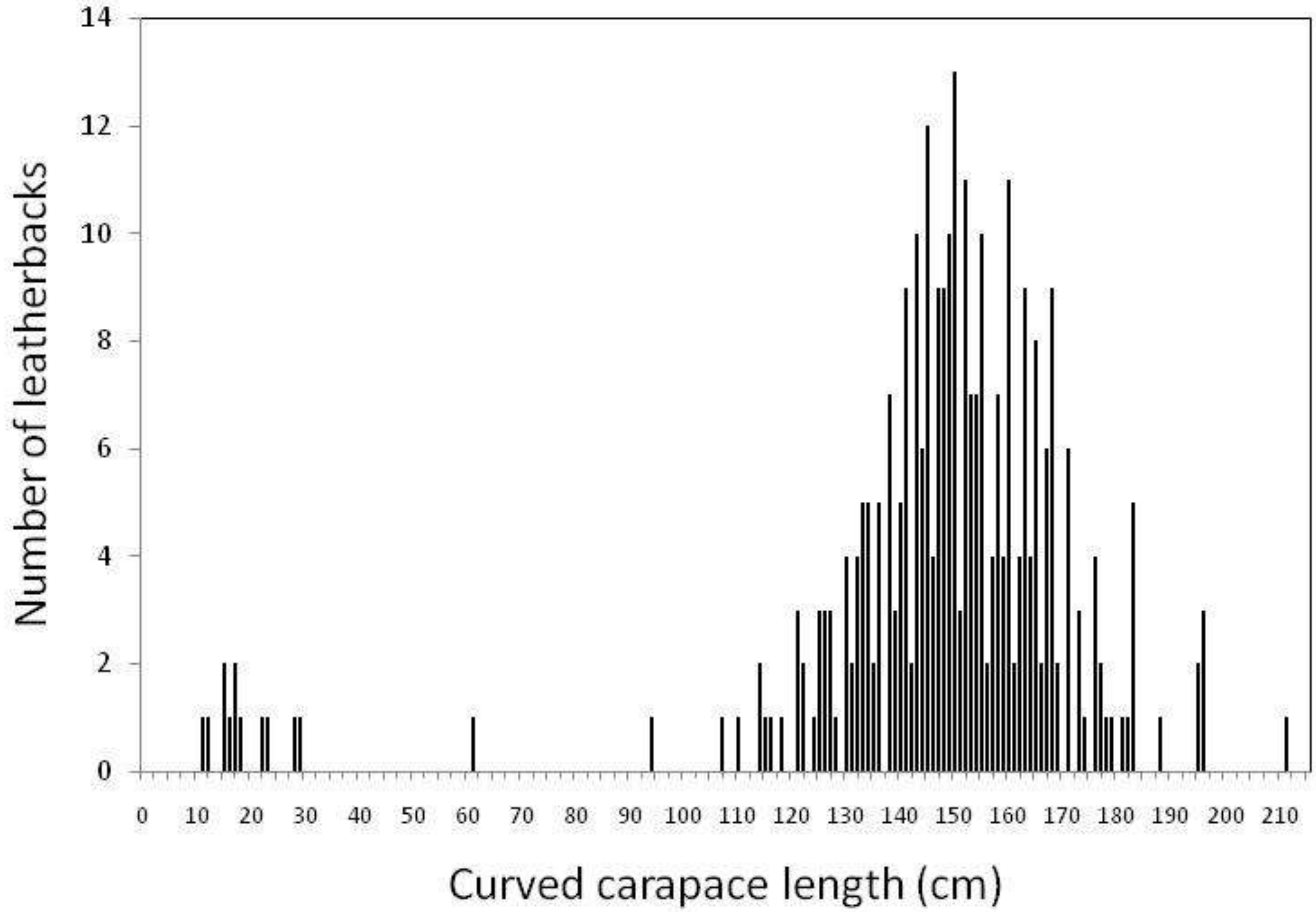


Figure 39. The size frequency distribution of stranded leatherbacks in Florida from 1980 through 2007. Carapace length was measured from the nuchal notch to the posterior marginal tip.

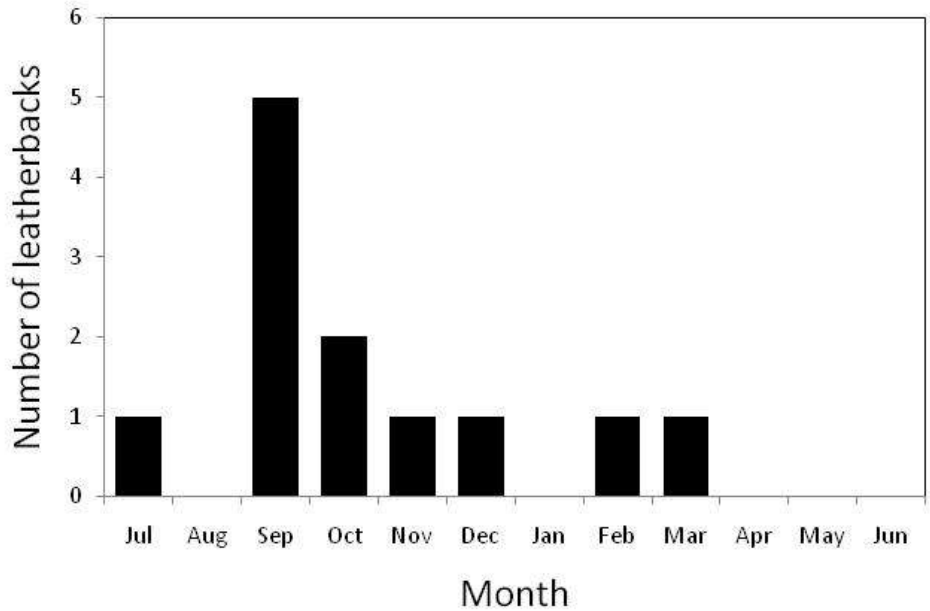


Figure 40. The number of stranded leatherbacks < 30 cm curved carapace length by month in Florida from 1980 through 2007. Carapace length was measured from the nuchal notch to the posterior marginal tip.

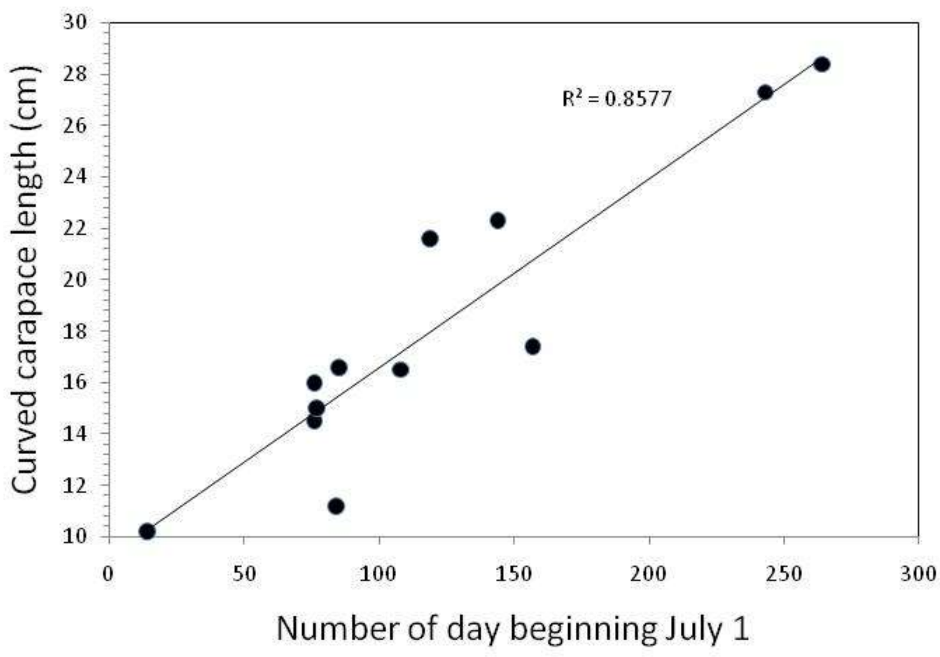


Figure 41. The curved carapace length (CCL) in cm of stranded leatherbacks < 30 cm CCL found in Florida by day beginning each year on July 1 and extending through June of the following year from 1980 through 2007. Carapace length was measured from the nuchal notch to the posterior marginal tip. There was a tendency for the CCL to increase over these months (linear regression, $P < 0.001$).

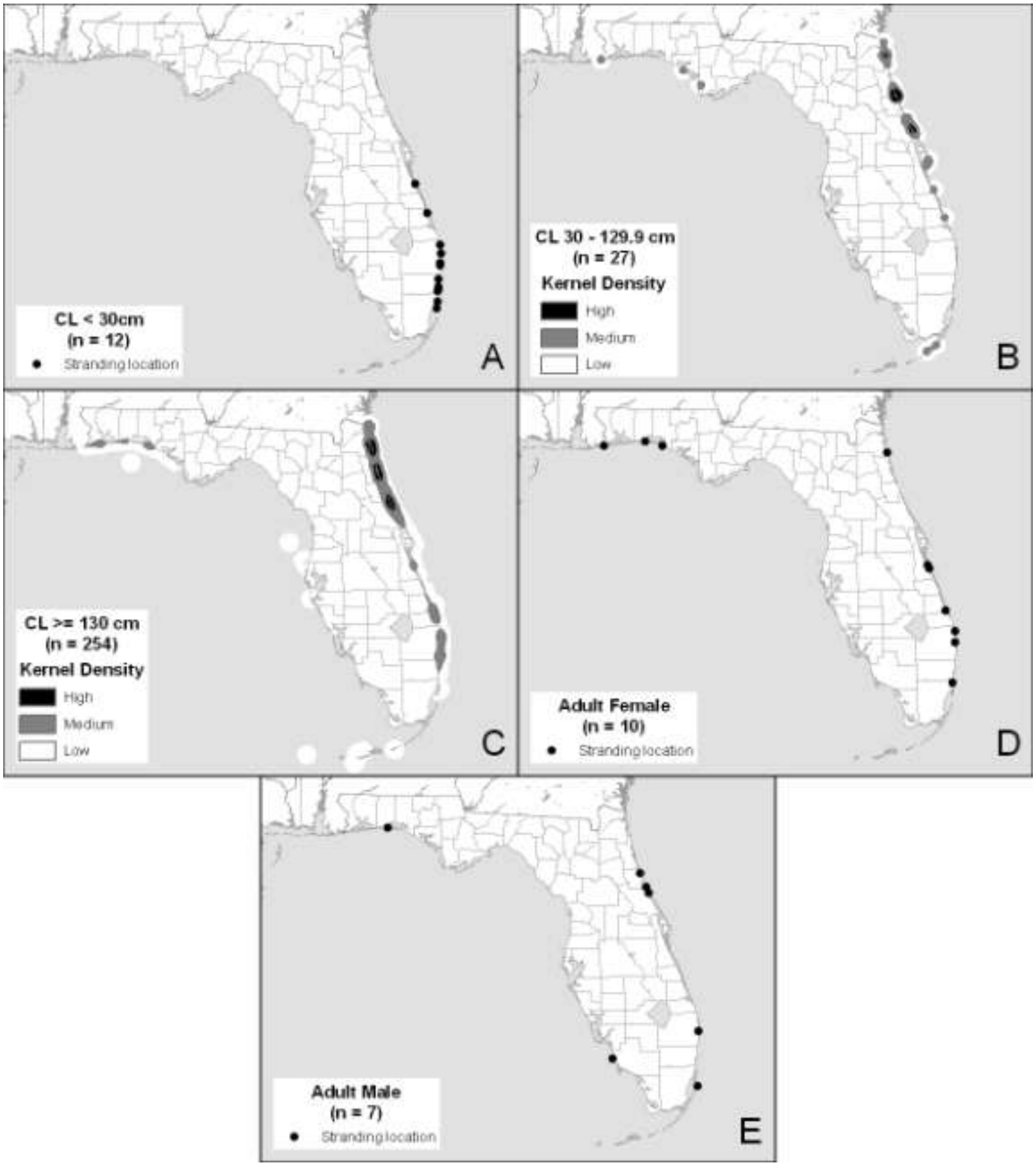


Figure 42. The relative kernel densities or locations of stranded leatherbacks by various size classes and for adult males and females found in Florida from 1980 through 2007. CL is curved carapace length measured from the nuchal notch to the posterior marginal tip. See text for criteria regarding the identification of adults. The kernel densities were estimated using Hawth's tools (http://www.spatialecology.com/htools/overview.php).

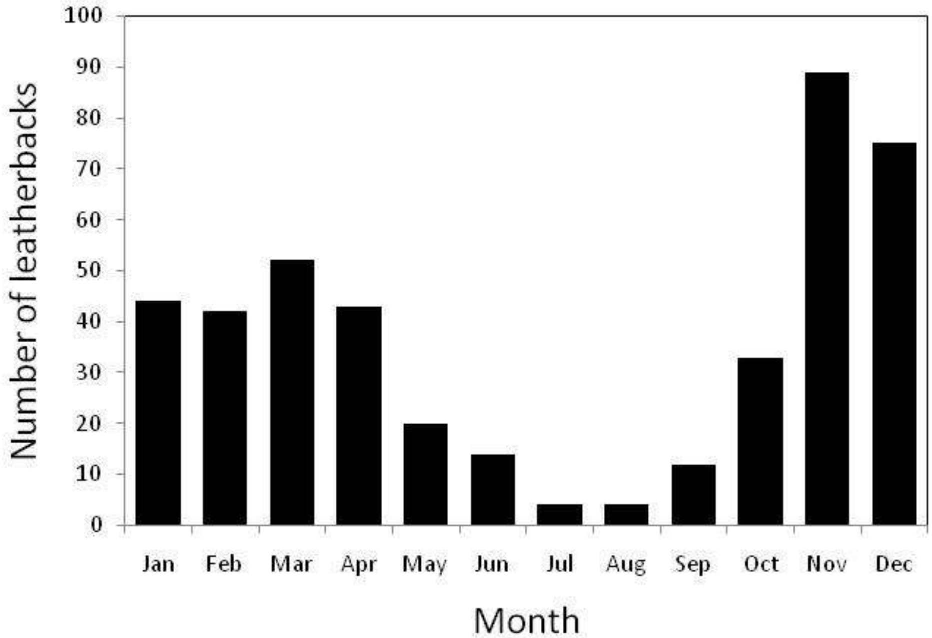


Figure 43. The number of large stranded leatherbacks (≥ 100 cm curved carapace length) by month along the east coast of Florida (Nassau County through Miami-Dade County) from 1980 through 2007. Carapace length was measured from the nuchal notch to the posterior marginal tip.

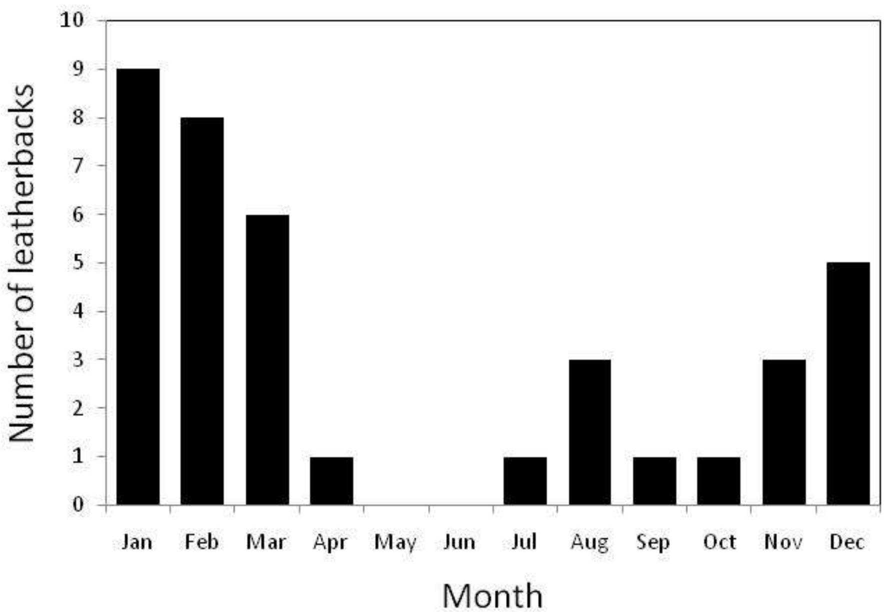


Figure 44. The number of large stranded leatherbacks (> 100 cm curved carapace length) by month in southernmost Florida (Monroe County) from 1980 through 2007. Carapace length was measured from the nuchal notch to the posterior marginal tip.

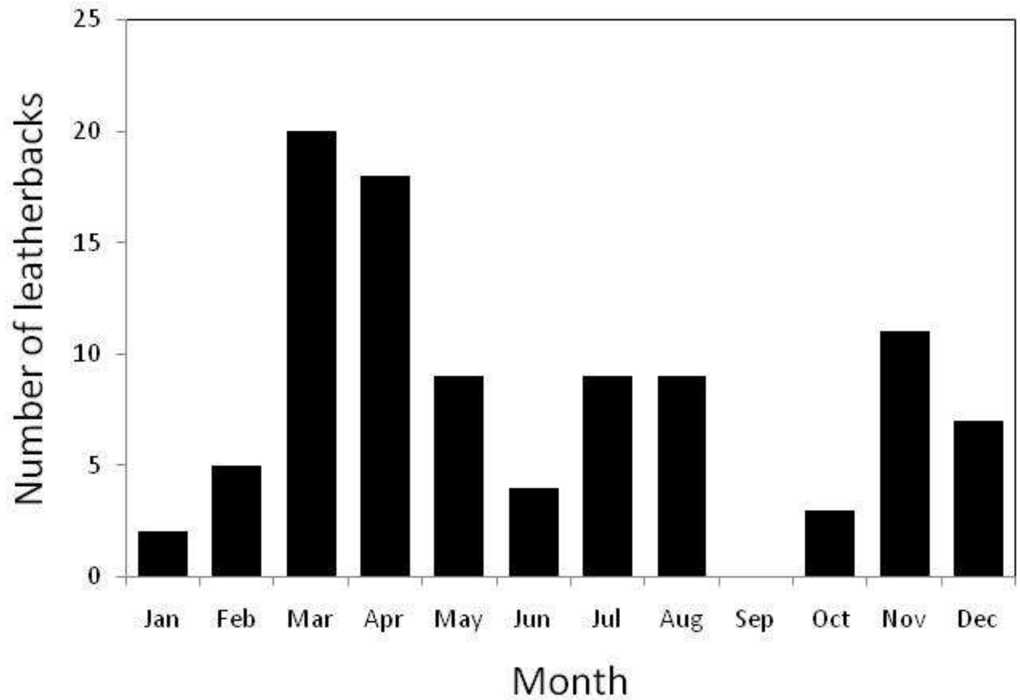


Figure 45. The number of large stranded leatherbacks (> 100 cm curved carapace length) by month along the west coast of Florida (Escambia County through Collier County) from 1980 through 2007. Carapace length was measured from the nuchal notch to the posterior marginal tip.

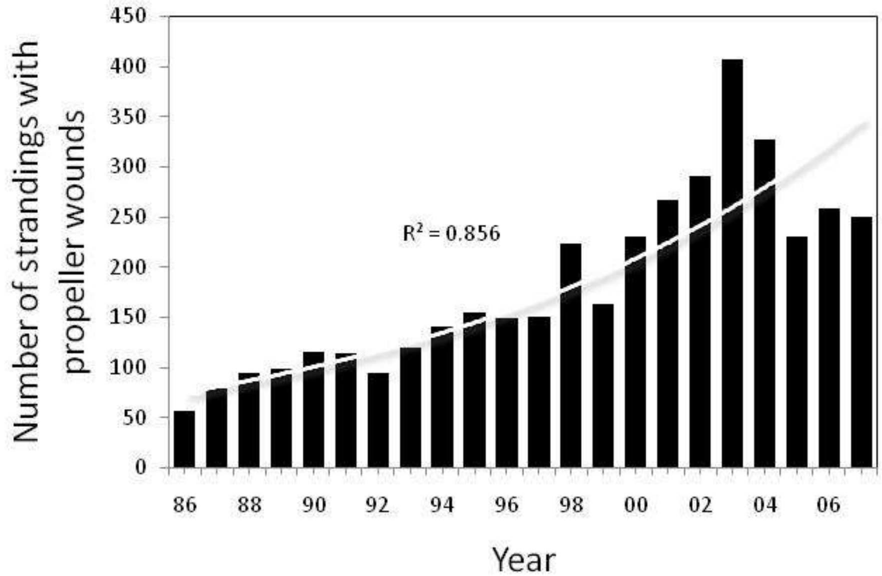


Figure 46. The number of stranded sea turtles with propeller wounds in Florida each year from 1986 through 2007. The increasing trend is best represented by the exponential regression shown. Stranded sea turtles with propeller wounds were documented since 1980 but the effort to document strandings statewide was not consistent prior to 1986.

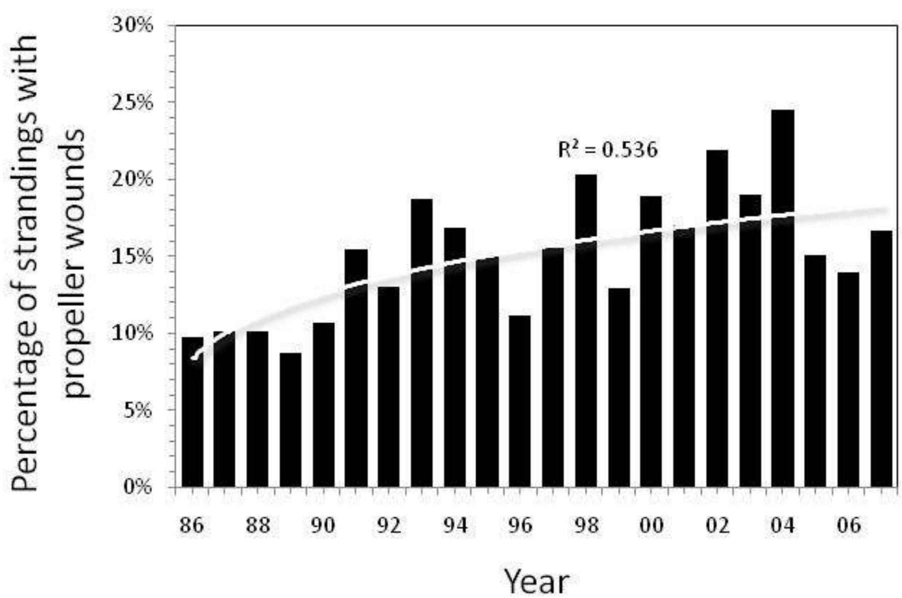


Figure 47. The percentage of stranded sea turtles with propeller wounds in Florida each year from 1986 through 2007. The trend was best represented by the power regression shown. Stranded sea turtles with propeller wounds were documented since 1980 but the effort to document strandings statewide was not consistent prior to 1986.

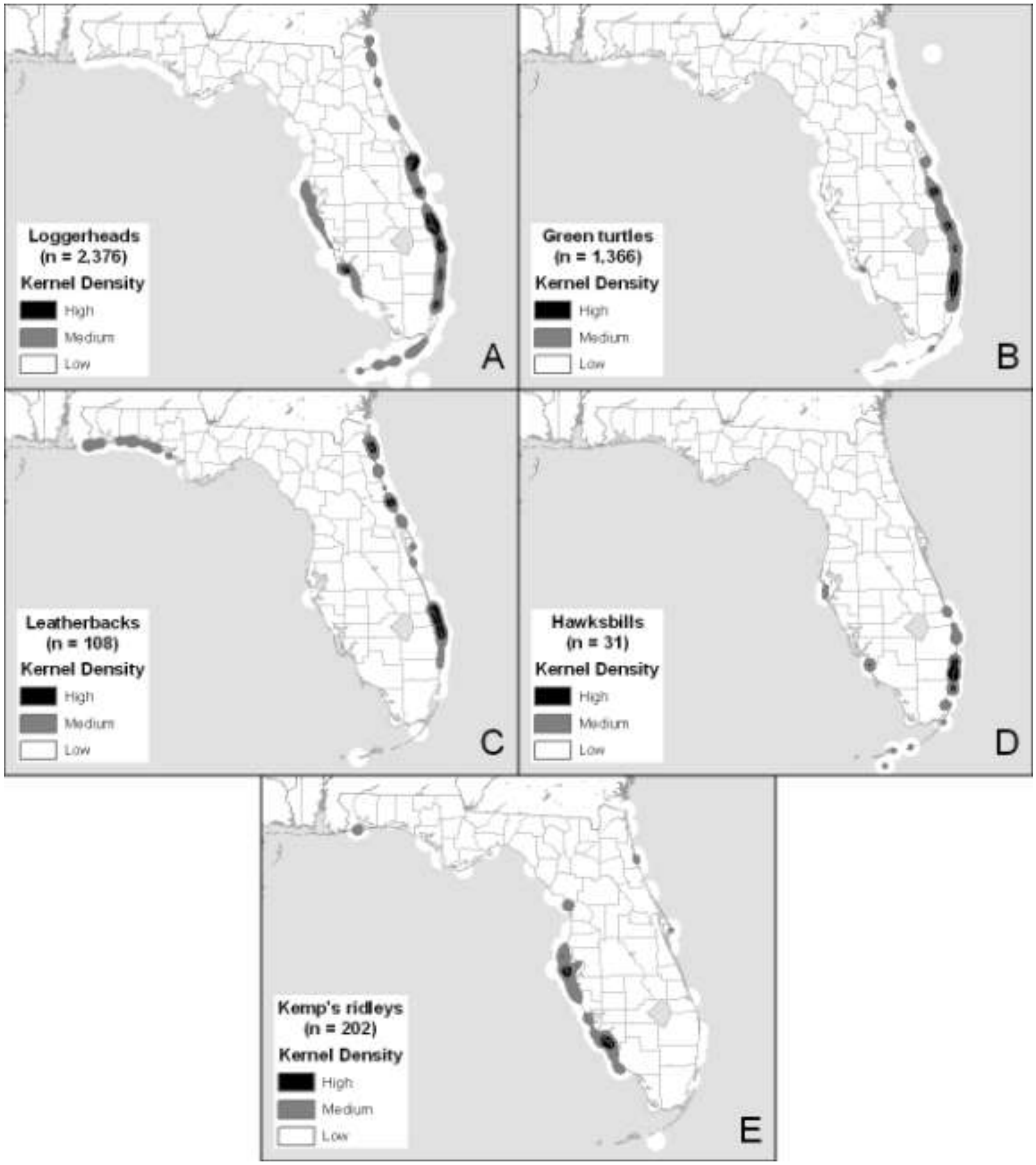


Figure 48. The relative kernel densities of stranded sea turtles with propeller wounds by species found in Florida from 1980 through 2007. The kernel densities were estimated using Hawth's tools (http://www.spatialecology.com/htools/overview.php).

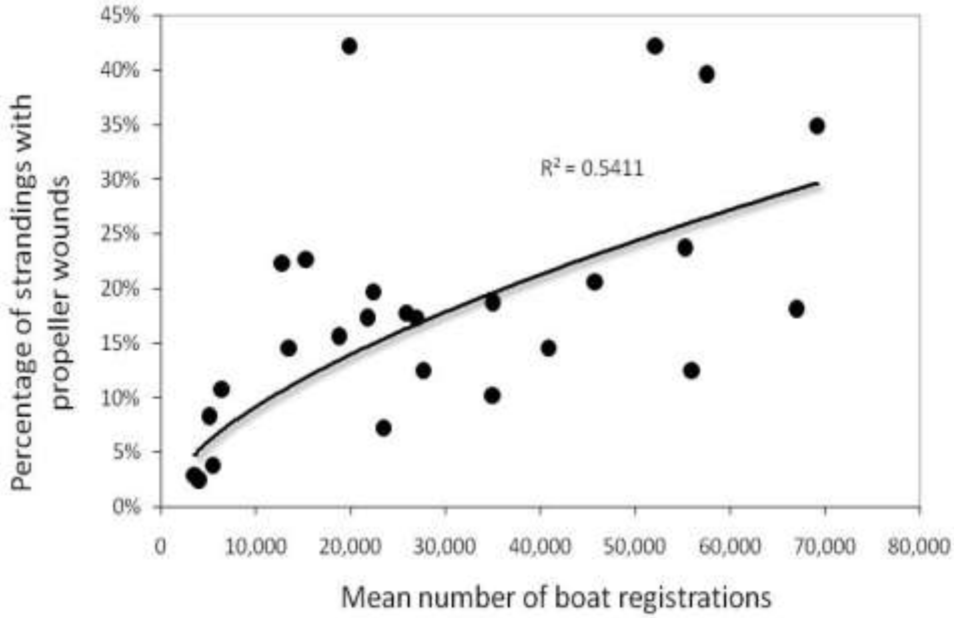


Figure 49. The percentage of stranded sea turtles with propeller wounds and the mean number of boat registrations by county in Florida from 2000 through 2005. The trend was best represented by the power regression shown. Only coastal counties with 50 or more sea turtle strandings from 2000 through 2005 were used. The coastal counties not used in this analysis were Manatee, Pasco, Hernando, Levy, Dixie, Taylor, Jefferson, Wakulla, and Santa Rosa.

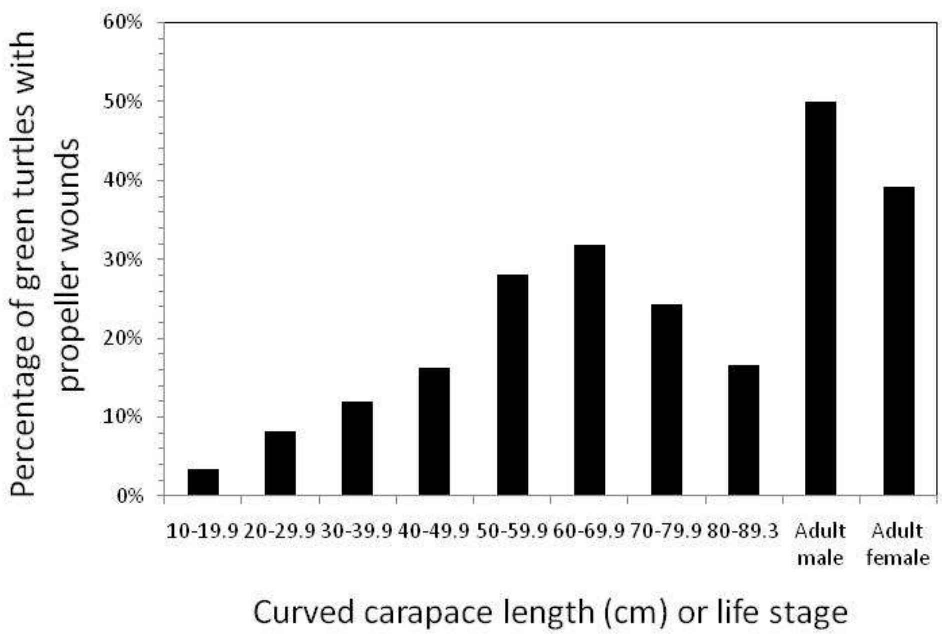


Figure 50. The percentage of stranded green turtles with propeller wounds by 10-cm size-class and by adult gender in Florida from 1980 through 2007. See text for criteria regarding the identification of adults.

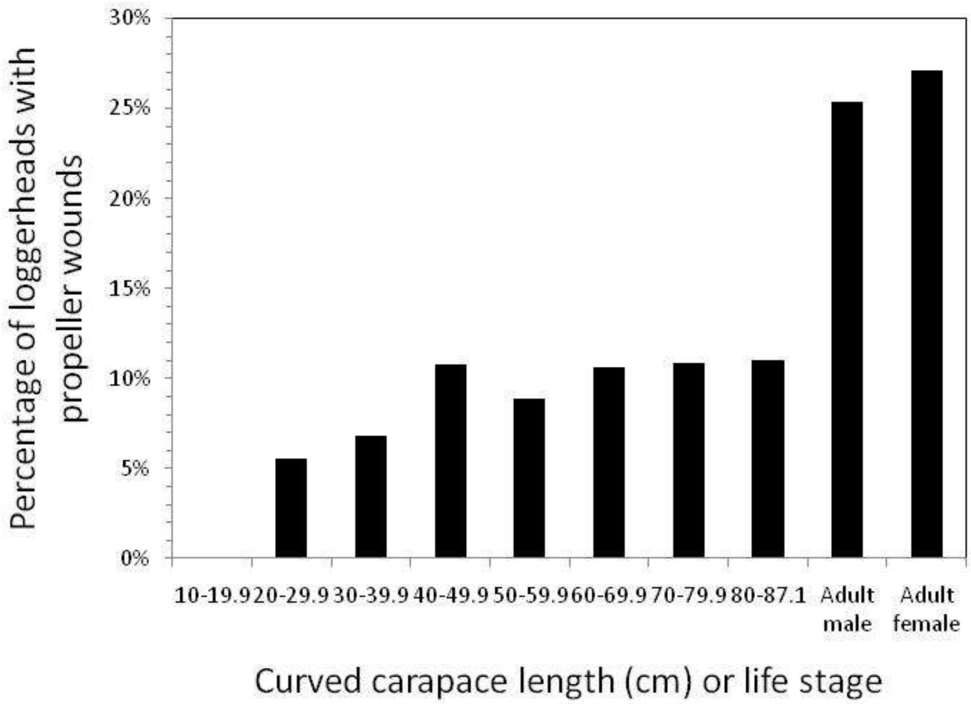


Figure 51. The percentage of stranded loggerheads with propeller wounds by 10-cm size-class and by adult gender in Florida from 1980 through 2007. See text for criteria regarding the identification of adults.

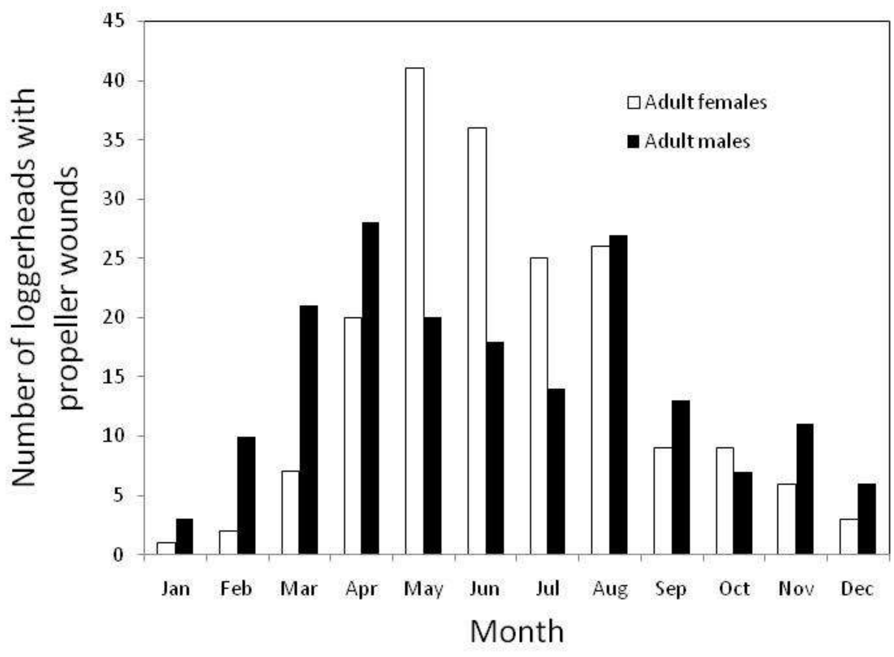


Figure 52. The number of stranded adult loggerheads with propeller wounds by gender and by month in Florida from 1980 through 2007. See text for criteria regarding the identification of adults.

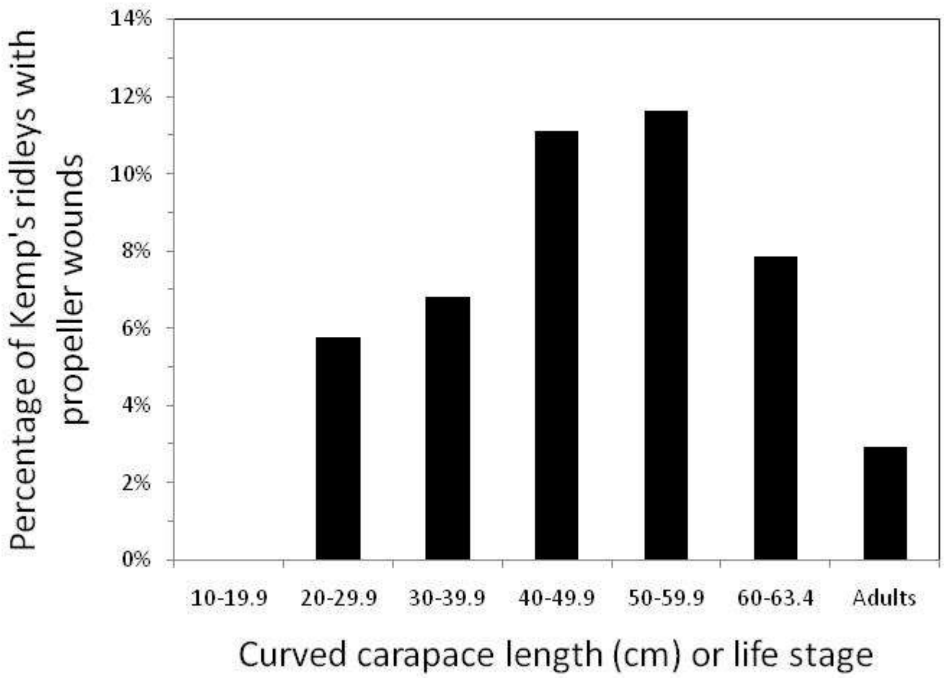


Figure 53. The percentage of stranded Kemp's ridleys with propeller wounds by 10-cm size-class and by adults in Florida from 1980 through 2007. See text for criteria regarding the identification of adults.

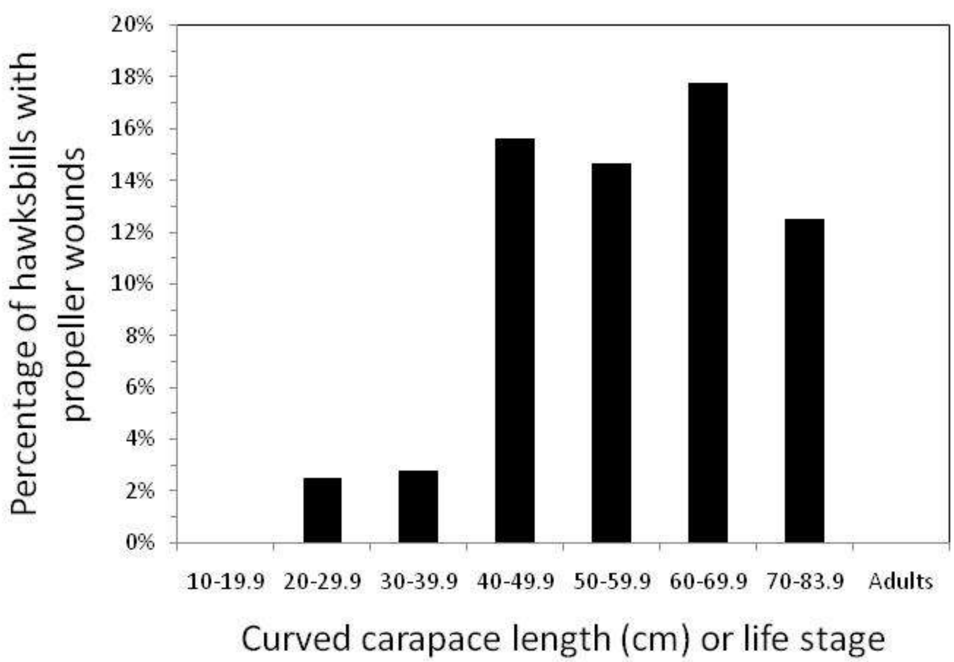


Figure 54. The percentage of stranded hawksbills with propeller wounds by 10-cm size-class and by adults in Florida from 1980 through 2007. See text for criteria regarding the identification of adults.

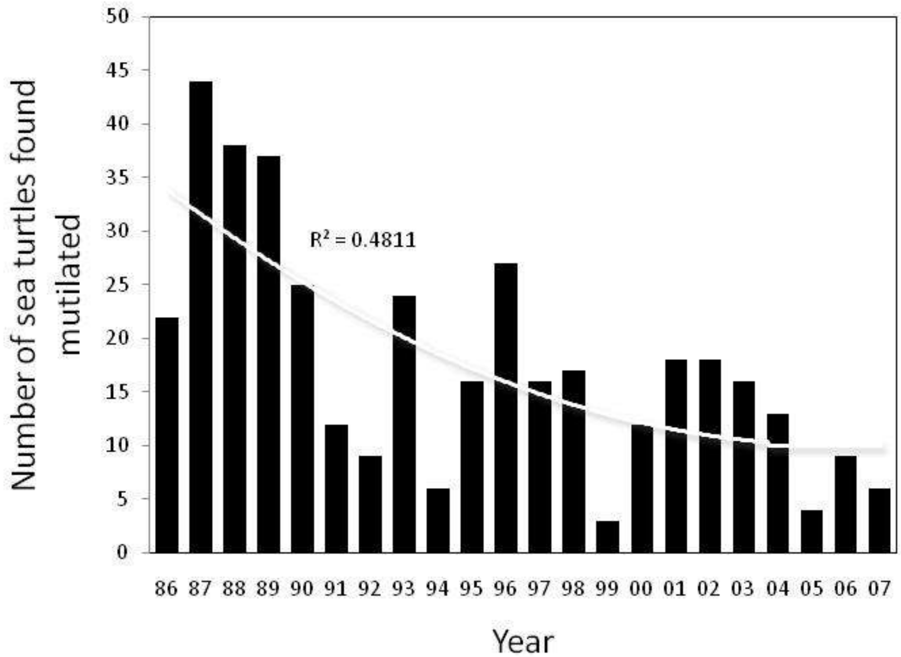


Figure 55. The number of stranded sea turtles found mutilated in Florida each year from 1986 through 2007. The decreasing trend is best represented by the polynomial regression shown. Stranded sea turtles with mutilations were documented since 1980 but the effort to document strandings statewide was not consistent prior to 1986.

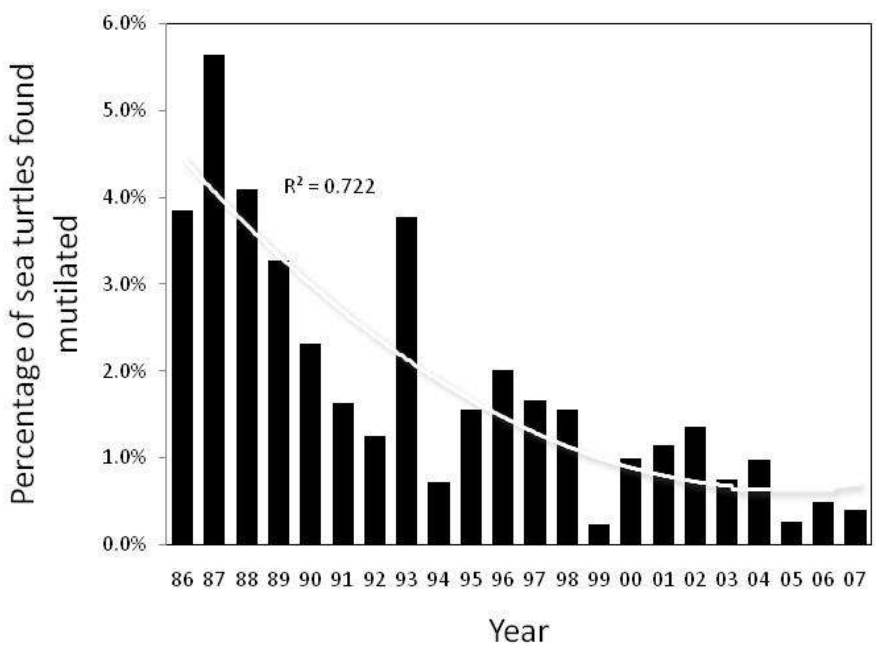


Figure 56. The percentage of stranded sea turtles found mutilated in Florida each year from 1986 through 2007. The trend was best represented by the polynomial regression shown. Stranded sea turtles with propeller wounds were documented since 1980 but the effort to document strandings statewide was not consistent prior to 1986.

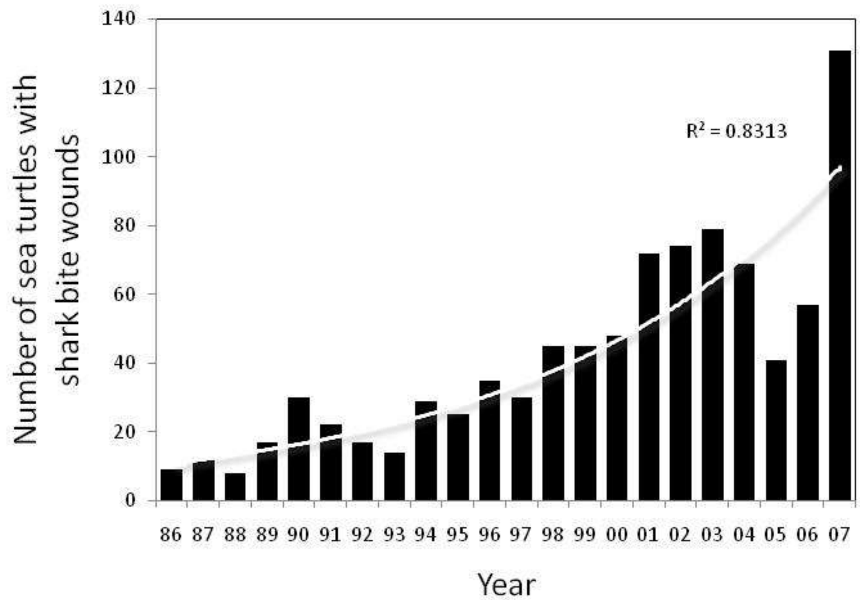


Figure 57. The number of stranded sea turtles with shark bite wounds in Florida each year from 1986 through 2007. The increasing trend is best represented by the exponential regression shown. Stranded sea turtles with shark bite wounds were documented since 1980 but the effort to document strandings statewide was not consistent prior to 1986.

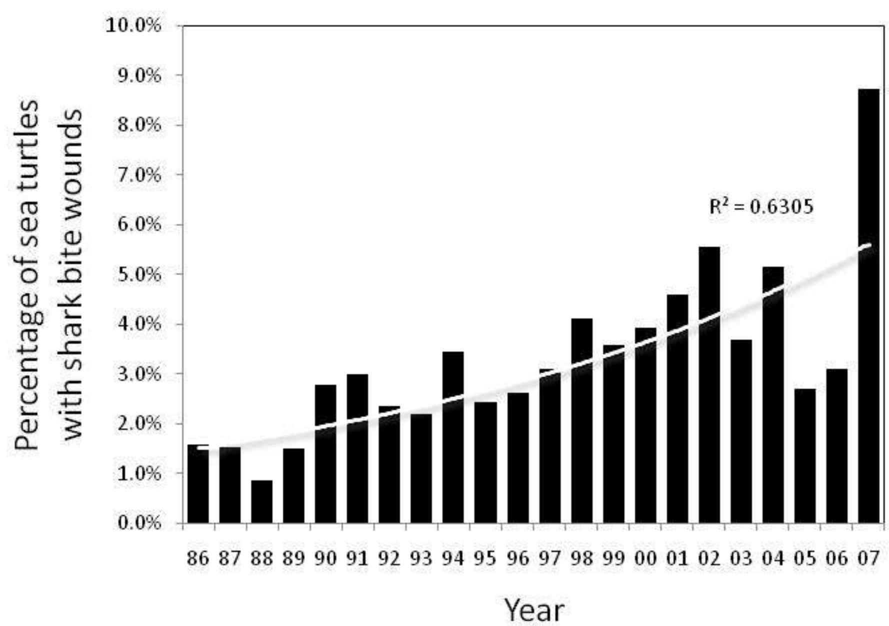


Figure 58. The percentage of stranded sea turtles with shark bite wounds in Florida each year from 1986 through 2007. The trend was best represented by the exponential regression shown. Stranded sea turtles with propeller wounds were documented since 1980 but the effort to document strandings statewide was not consistent prior to 1986.

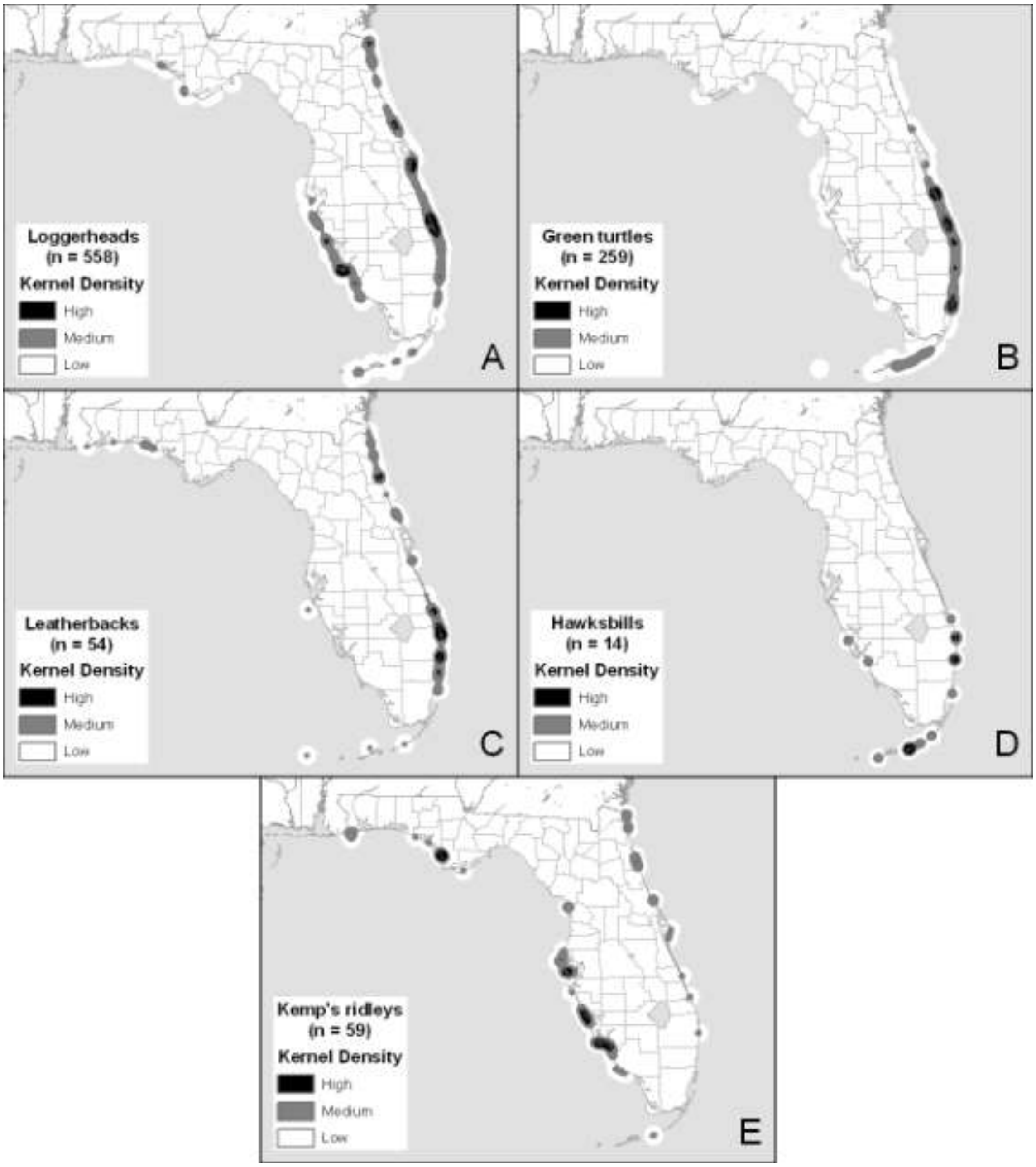


Figure 59. The relative kernel densities of stranded sea turtles with shark bite wounds by species found in Florida from 1980 through 2007. The kernel densities were estimated using Hawth's tools (http://www.spatialecology.com/htools/overview.php).

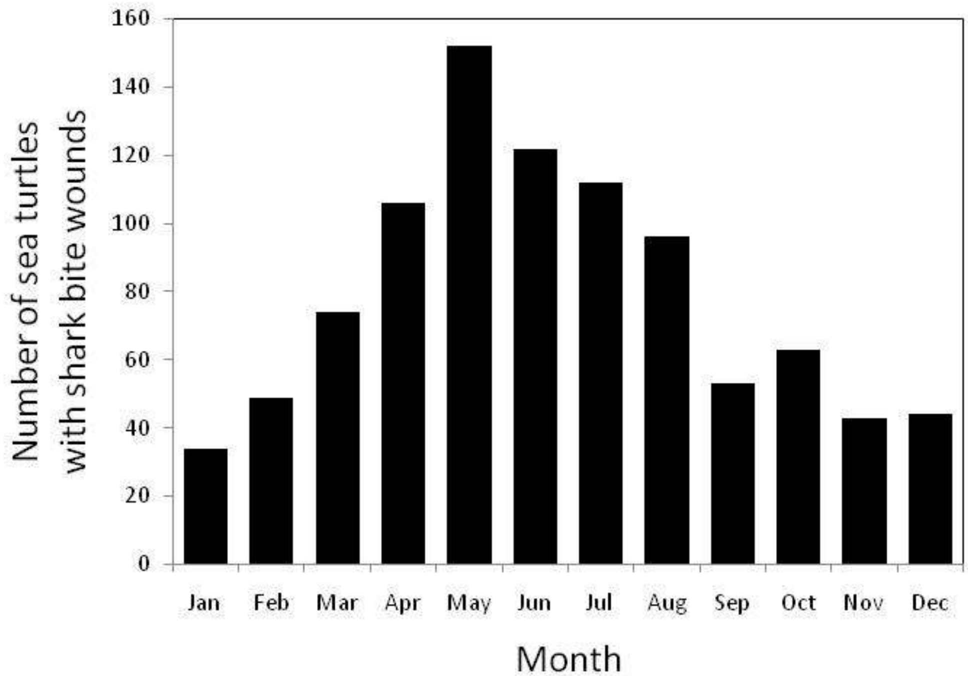


Figure 60. The number of stranded sea turtles with shark wounds by month in Florida from 1980 through 2007.

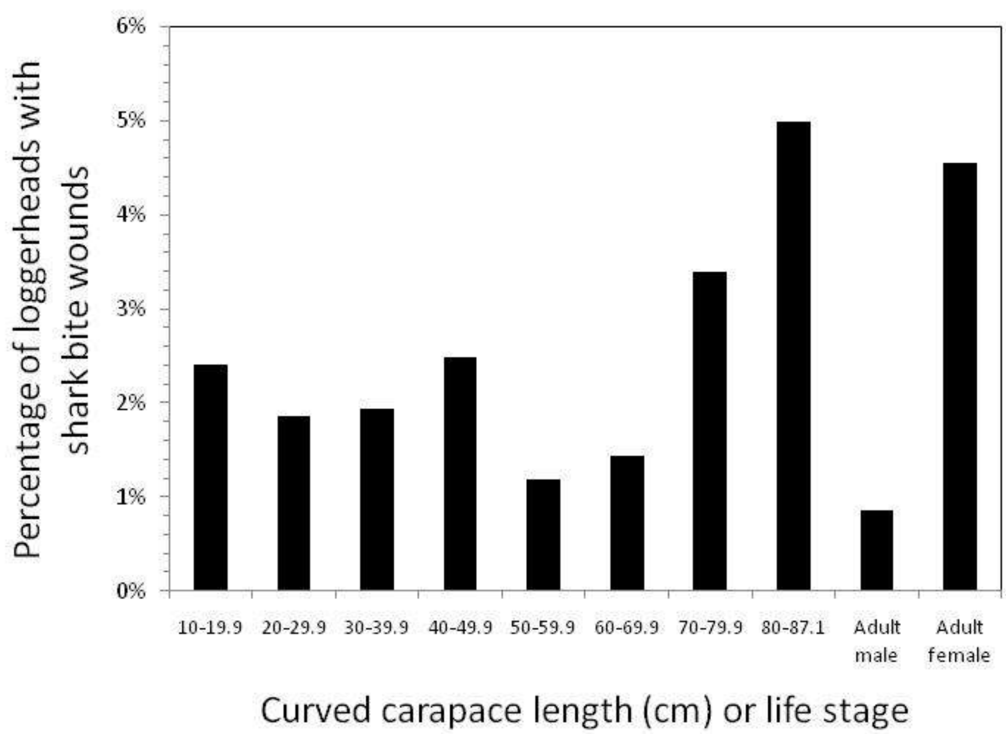


Figure 61. The percentage of stranded loggerheads with shark bite wounds by 10-cm size-class and by adult gender in Florida from 1980 through 2007. See text for criteria regarding the identification of adults.

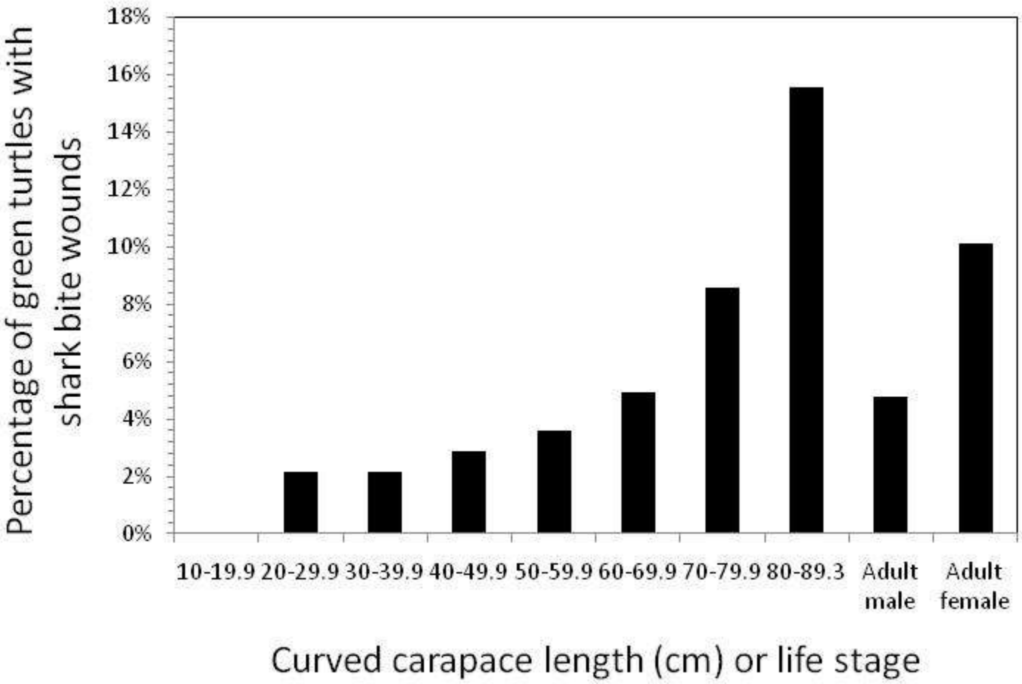


Figure 62. The percentage of stranded green turtles with shark bite wounds by 10-cm size-class and by adult gender in Florida from 1980 through 2007. See text for criteria regarding the identification of adults.

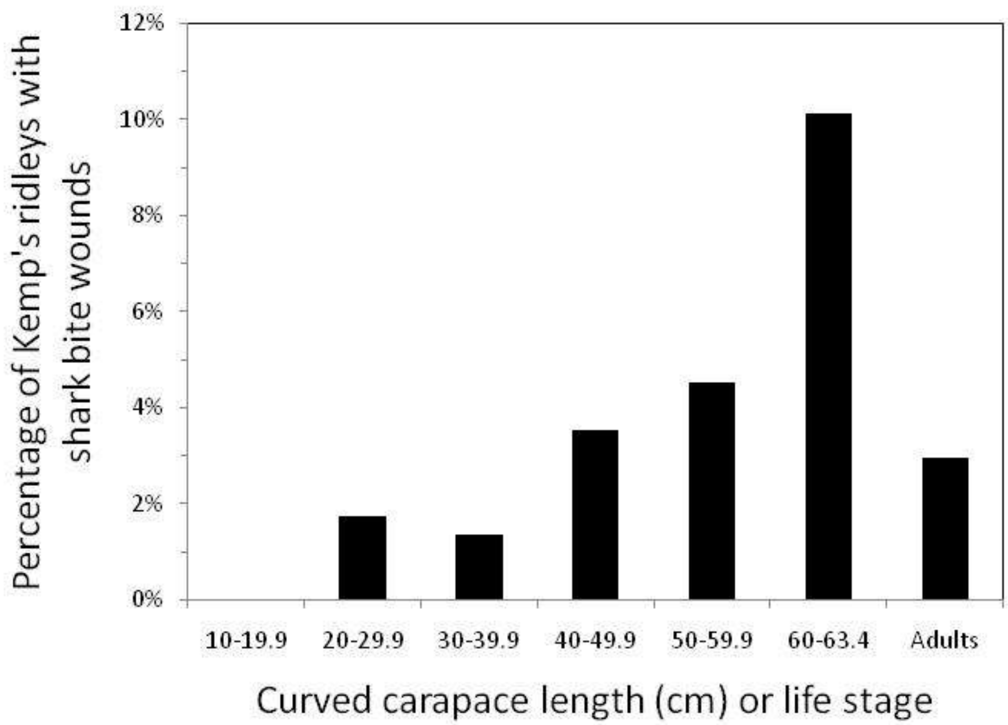


Figure 63. The percentage of stranded Kemp's ridleys with shark bite wounds by 10-cm size-class and by adult gender in Florida from 1980 through 2007. See text for criteria regarding the identification of adults.

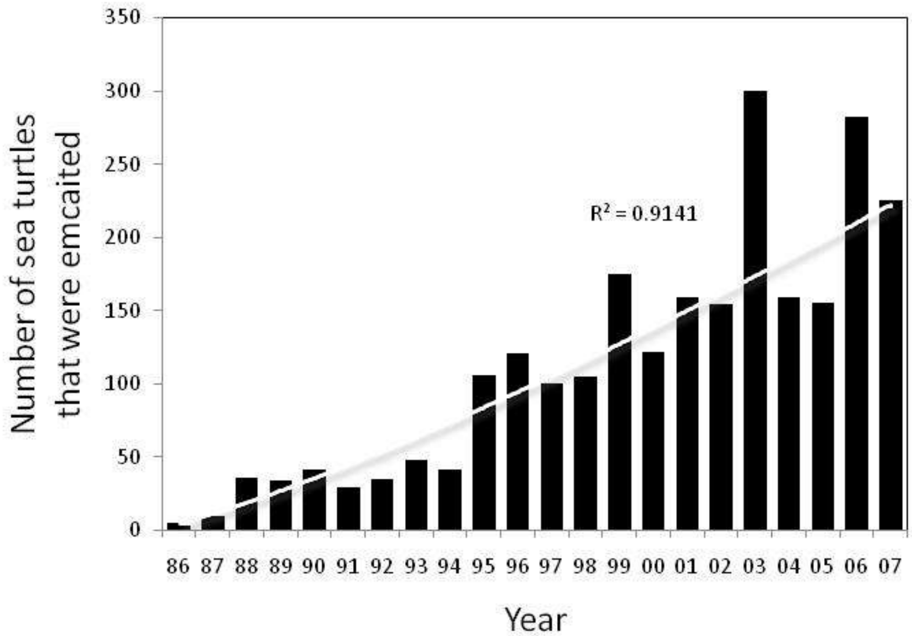


Figure 64. The number of stranded sea turtles that were emaciated in Florida each year from 1986 through 2007. The increasing trend is best represented by the power regression shown. Stranded sea turtles with shark bite wounds were documented since 1980 but the effort to document strandings statewide was not consistent prior to 1986.

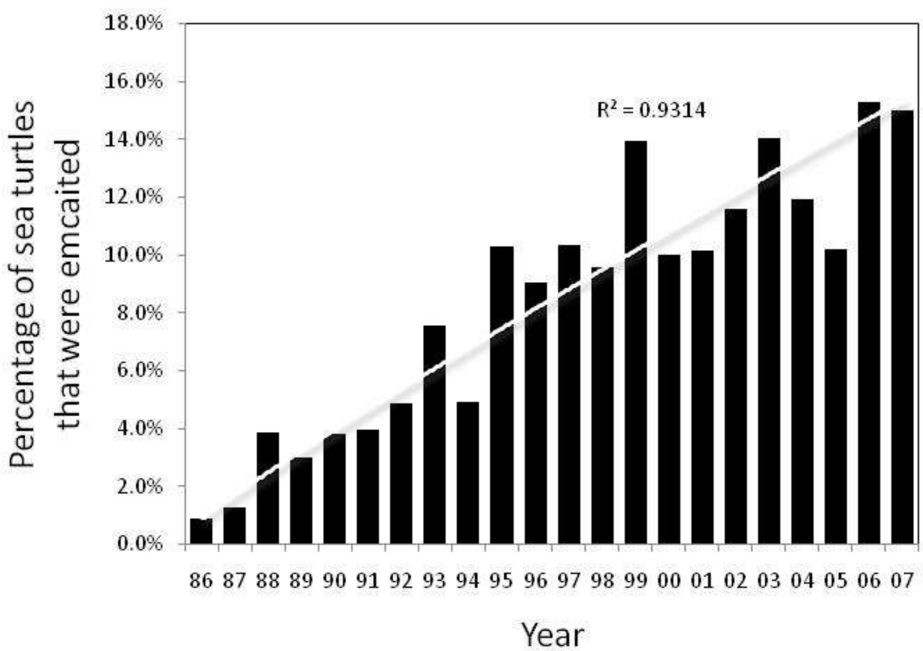


Figure 65. The percentage of stranded sea turtles that were emaciated in Florida each year from 1986 through 2007. The increasing trend is best represented by the power regression shown. Stranded sea turtles with shark bite wounds were documented since 1980 but the effort to document strandings statewide was not consistent prior to 1986.

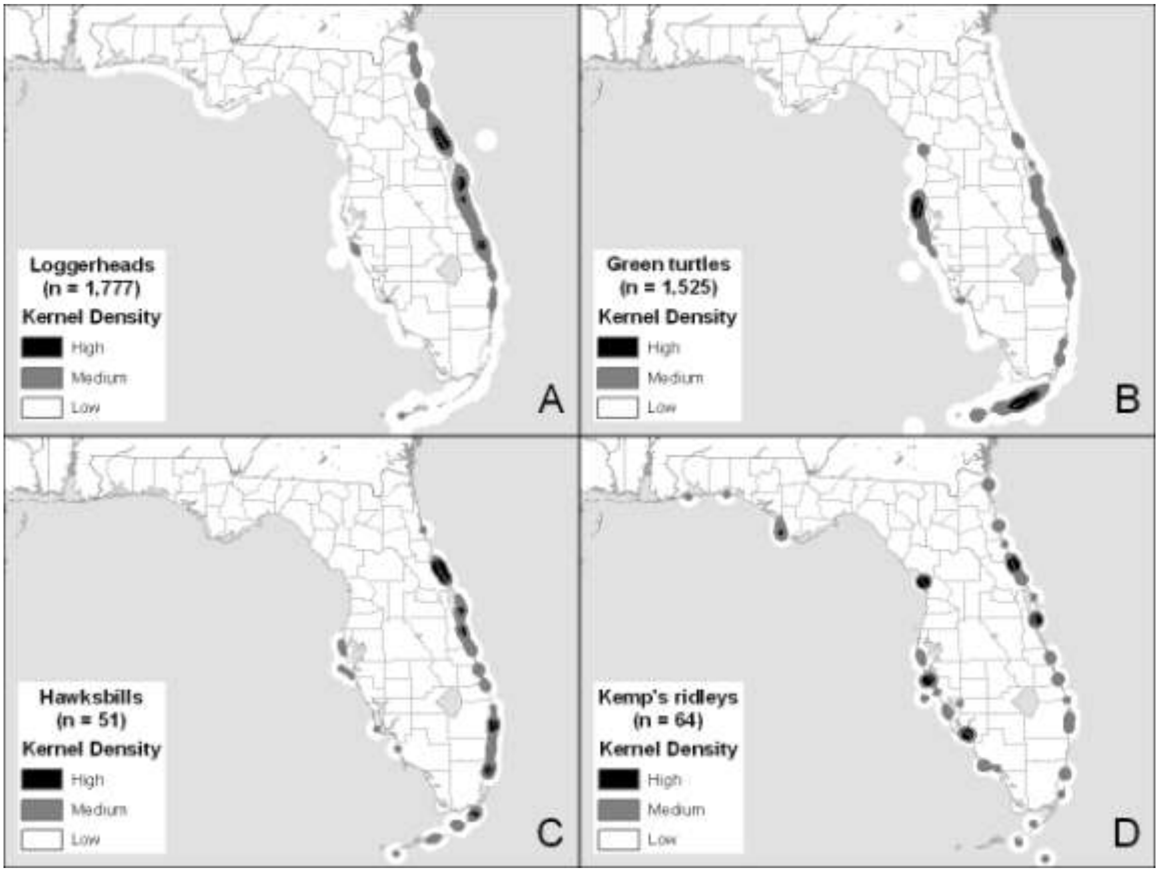


Figure 66. The relative kernel densities of stranded sea turtles with external evidence of disease by species found in Florida from 1980 through 2007. Evidence of disease included emaciation, tumors (usually typical of fibropapillomatosis), skin lesions, and lethargy. The kernel densities were estimated using Hawth's tools (http://www.spatialecology.com/htools/overview.php).

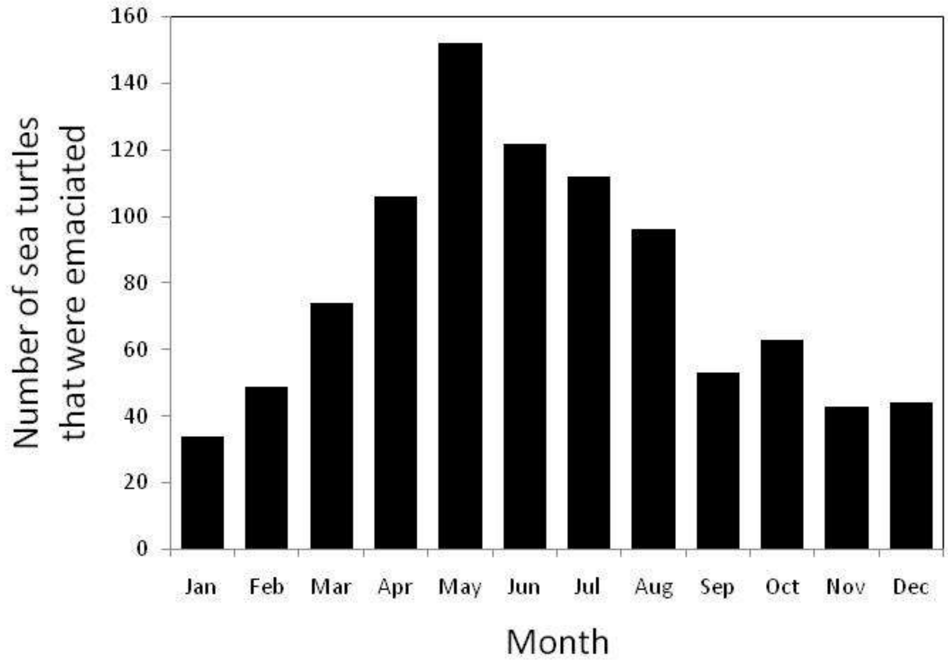


Figure 67. The number of stranded sea turtles that were emaciated by month in Florida from 1980 through 2007.

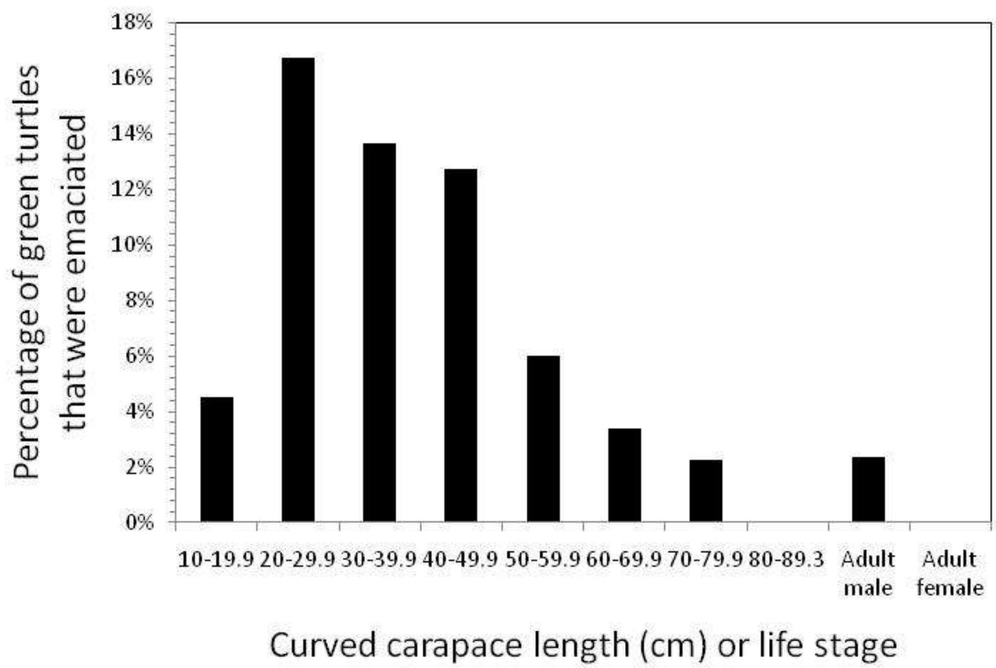


Figure 68. The percentage of stranded green turtles that were emaciated by 10-cm size-class and by adult gender in Florida from 1980 through 2007. See text for criteria regarding the identification of adults.

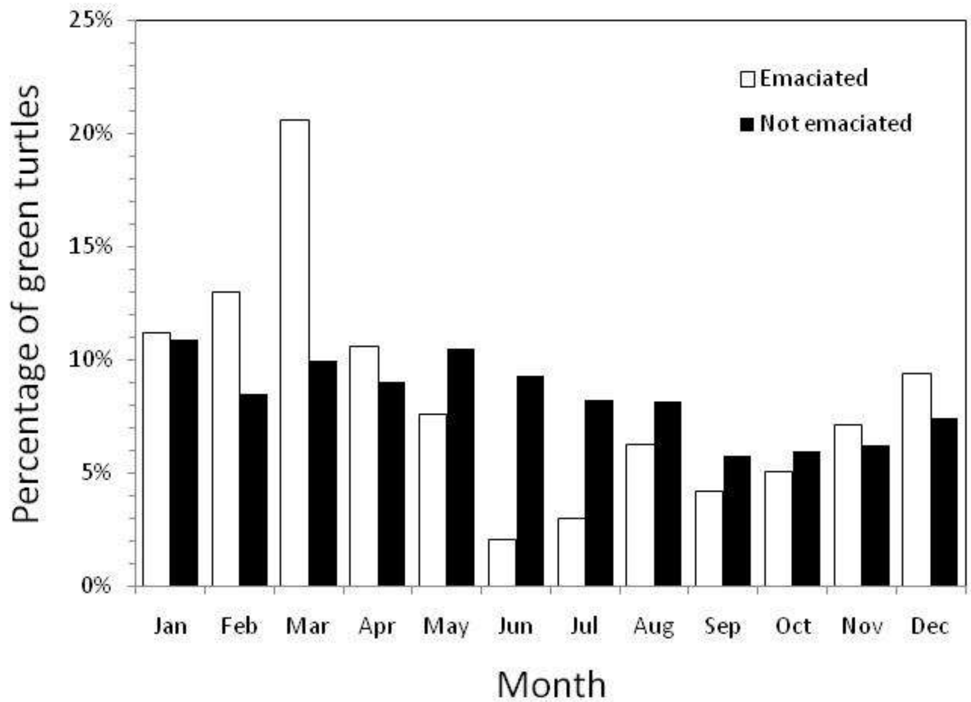


Figure 69. The percentage of stranded green turtles that were and were not emaciated by month in Florida from 1980 through 2007.

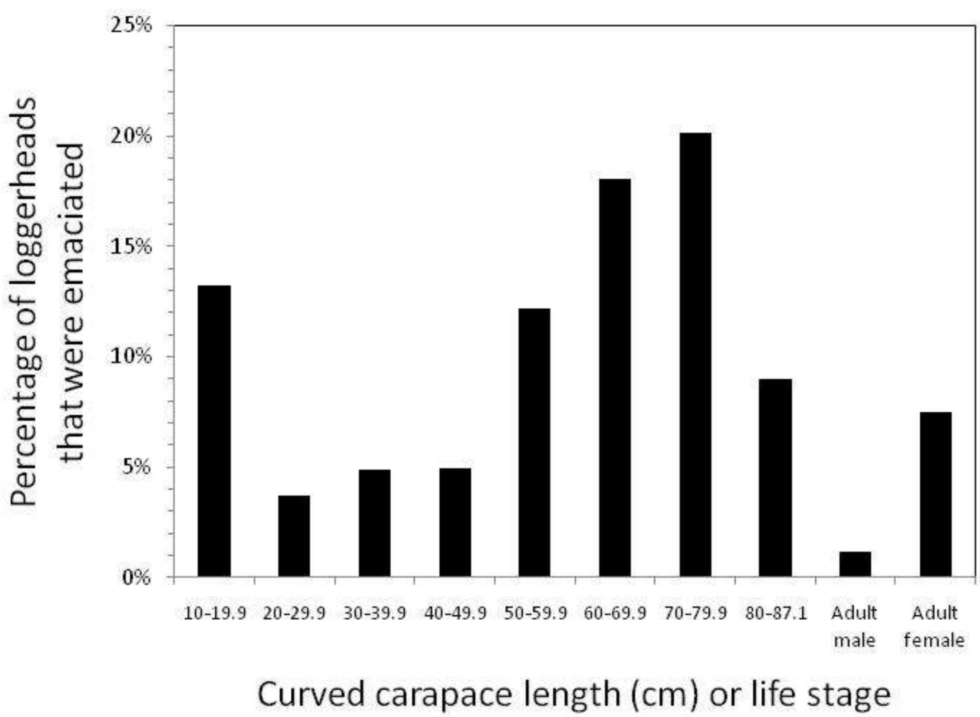


Figure 70. The percentage of stranded loggerheads that were emaciated by 10-cm size-class and by adult gender in Florida from 1980 through 2007. See text for criteria regarding the identification of adults.

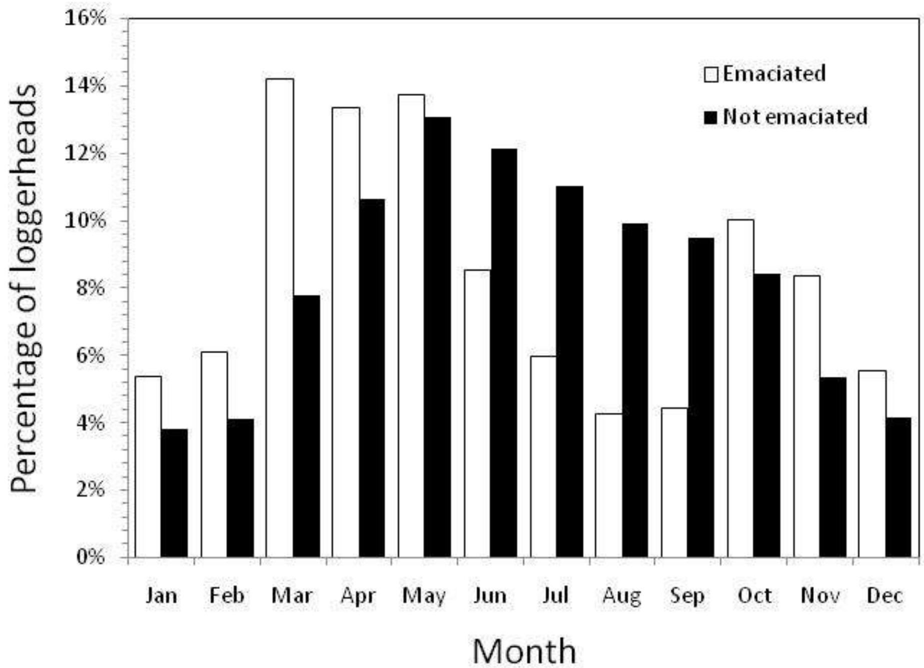


Figure 71. The percentage of stranded loggerheads that were and were not emaciated by month in Florida from 1980 through 2007.

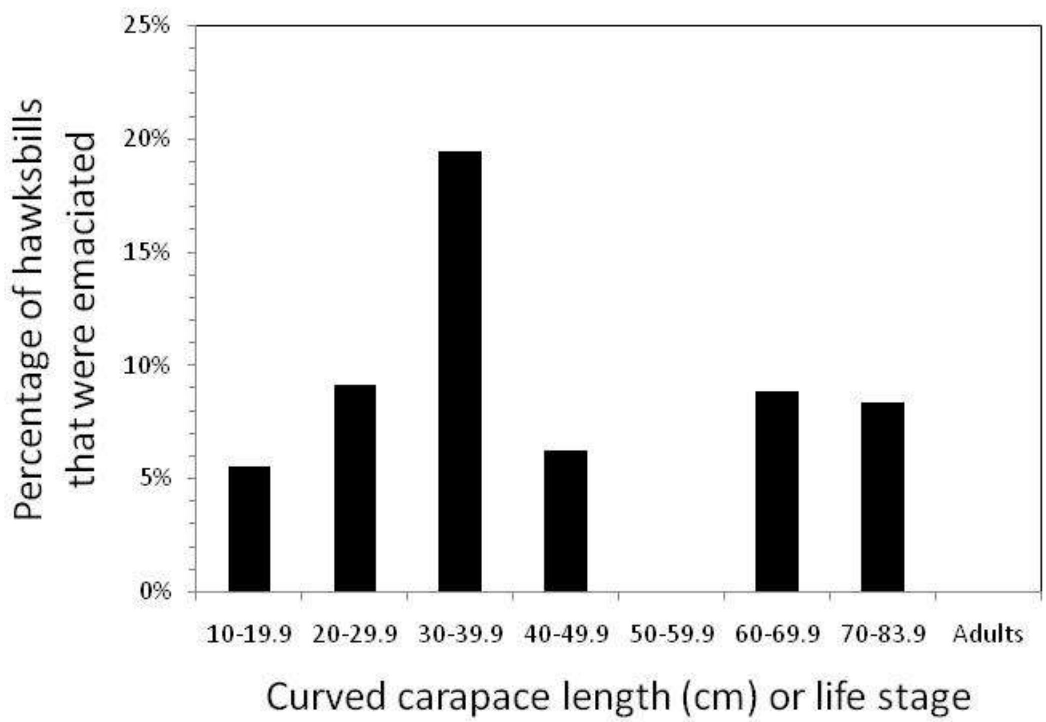


Figure 72. The percentage of stranded hawksbills that were emaciated by 10-cm size-class and by adults in Florida from 1980 through 2007. See text for criteria regarding the identification of adults.

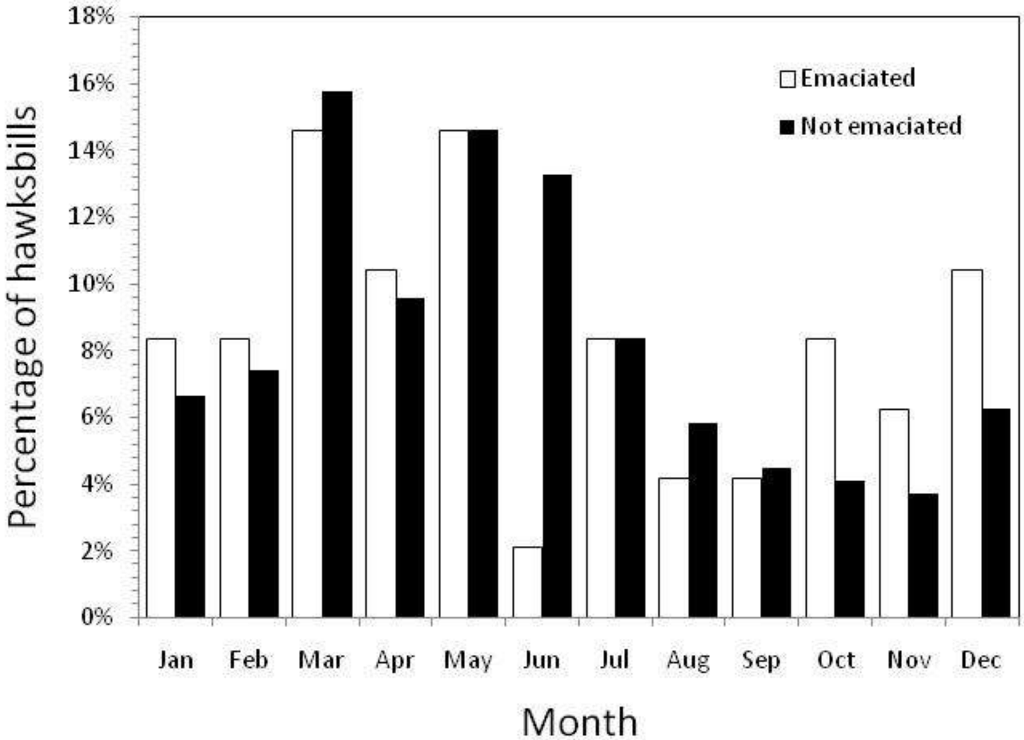


Figure 73. The percentage of stranded hawksbills that were and were not emaciated by month in Florida from 1980 through 2007.

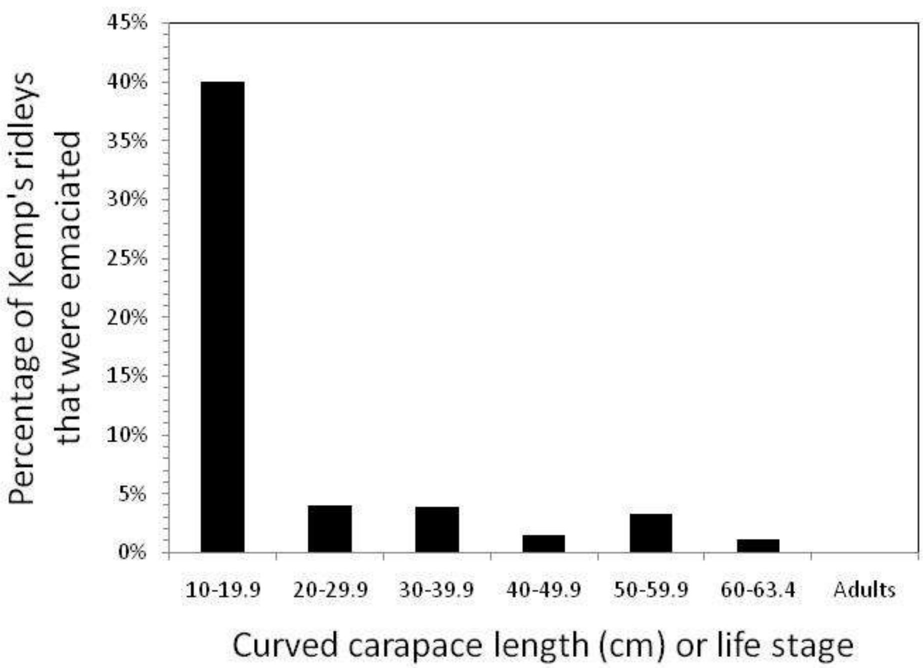


Figure 74. The percentage of stranded Kemp's ridleys that were emaciated by 10-cm size-class and by adults in Florida from 1980 through 2007. See text for criteria regarding the identification of adults.

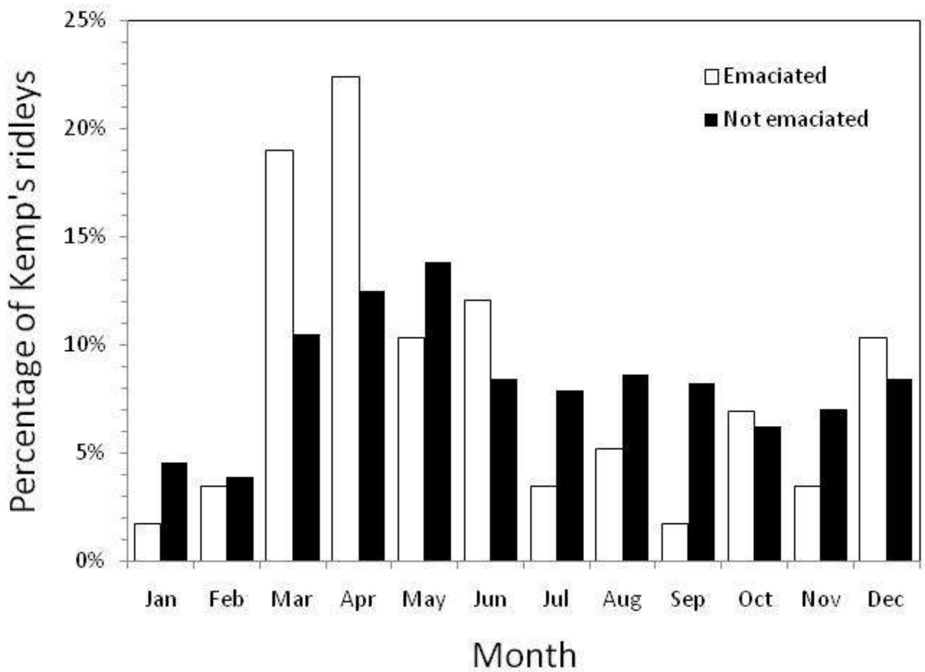


Figure 75. The percentage of Kemp's ridleys that were and were not emaciated by month in Florida from 1980 through 2007.

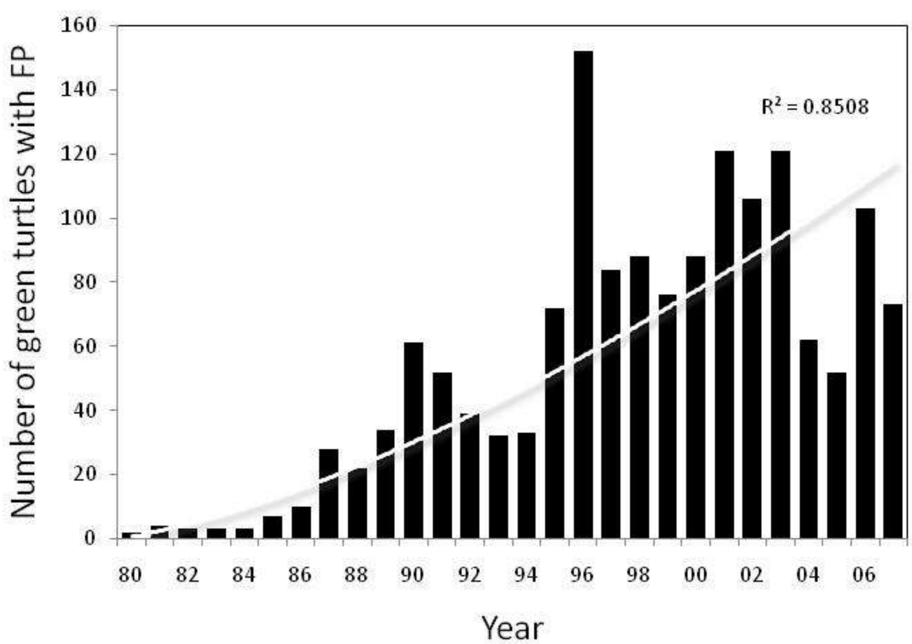


Figure 76. The number of stranded green turtles with fibropapillomatosis (FP) each year in Florida from 1980 through 2007. The increasing trend is best represented by the power regression shown. The effort to document strandings where FP occurs in Florida has been consistent since 1980.

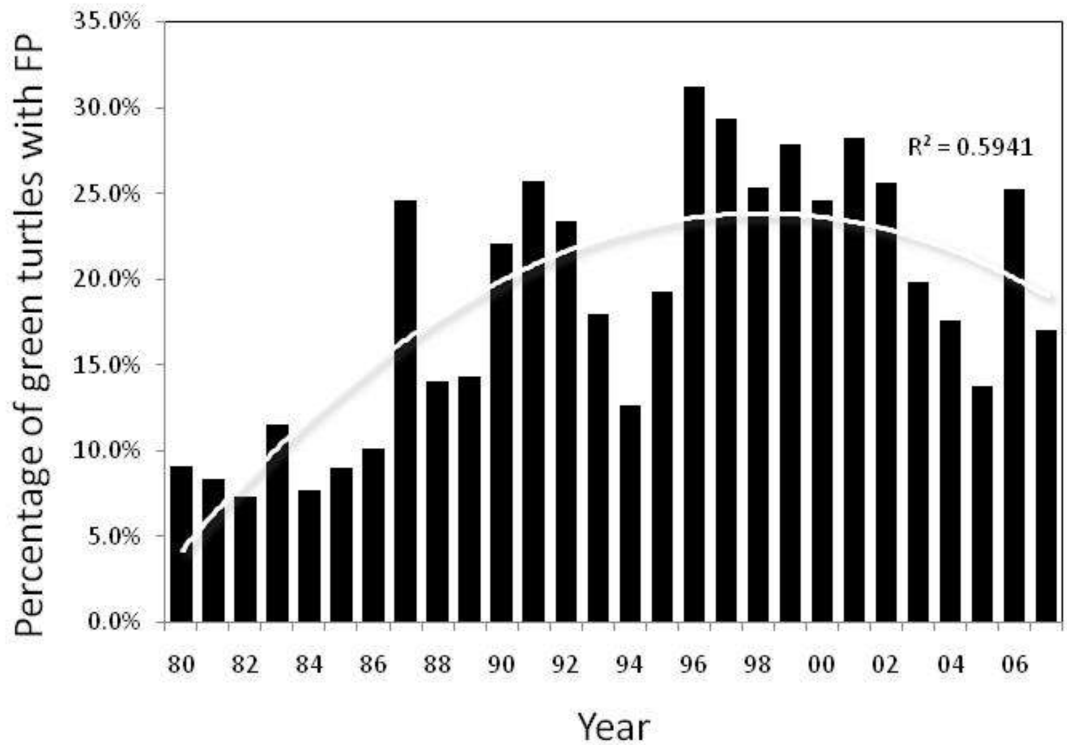


Figure 77. The percentage of stranded green turtles with fibropapillomatosis (FP) each year in Florida from 1980 through 2007. The increasing and then decreasing trend was best represented by the polynomial regression shown. The effort to document strandings where FP occurs in Florida has been consistent since 1980.

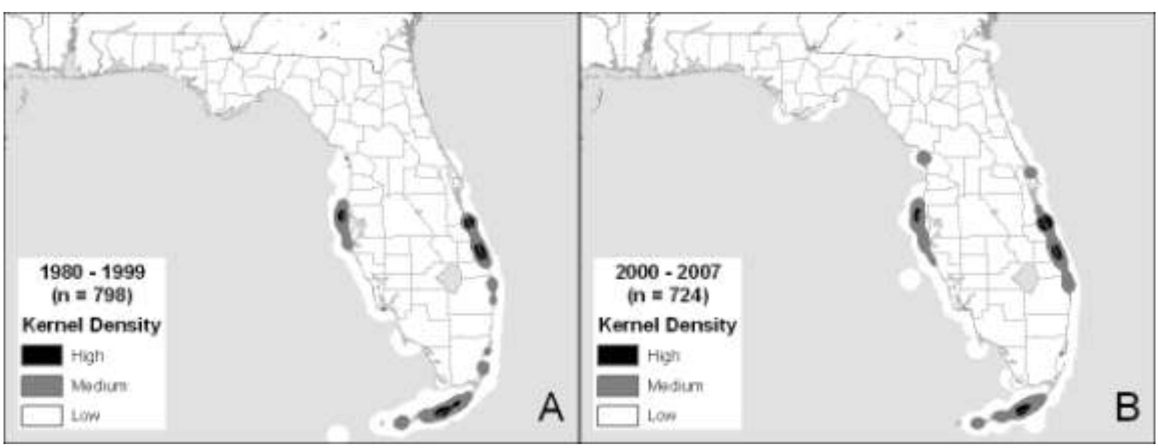


Figure 78. The relative kernel densities of stranded green turtles with fibropapillomatosis from 1980 through 1999 and from 2000 through 2007. The kernel densities were estimated using Hawth's tools (http://www.spatialecology.com/ htools/overview.php).

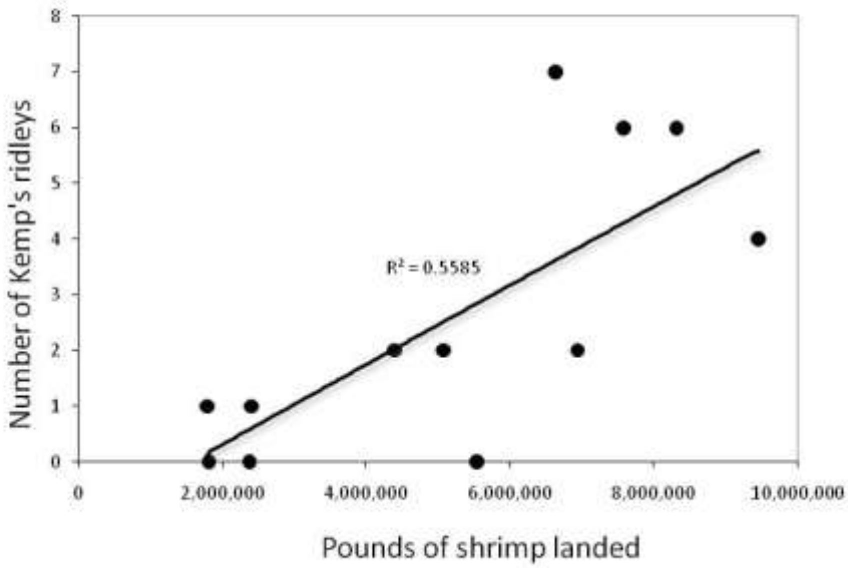


Figure 79. The numbers of Kemp's ridley strandings combined by month for all years from 1986 through 1994 in Zones 3 and 4, and the pounds of shrimp (pink and brown shrimp) landed in southwest Florida (Charlotte County through Monroe County) combined by month for the same years. The trend was best represented by the polynomial regression shown. The two were correlated (Spearman Rank Order Correaltion, $P < 0.005$, $\rho = 0.740$).

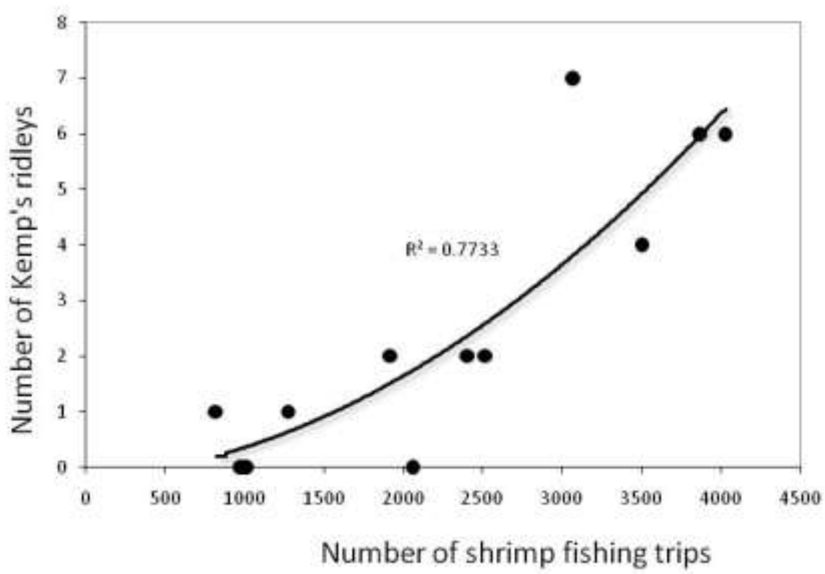


Figure 80. The numbers of Kemp's ridley strandings combined by month for all years from 1986 through 1994 in Zones 3 and 4, and the number of shrimp fishing trips (pink and brown shrimp) reported in southwest Florida (Charlotte County through Monroe County) combined by month for the same years. The trend was best represented by the polynomial regression shown. The two were correlated (Spearman Rank Order Correaltion, $P < 0.001$, $\rho = 0.833$).

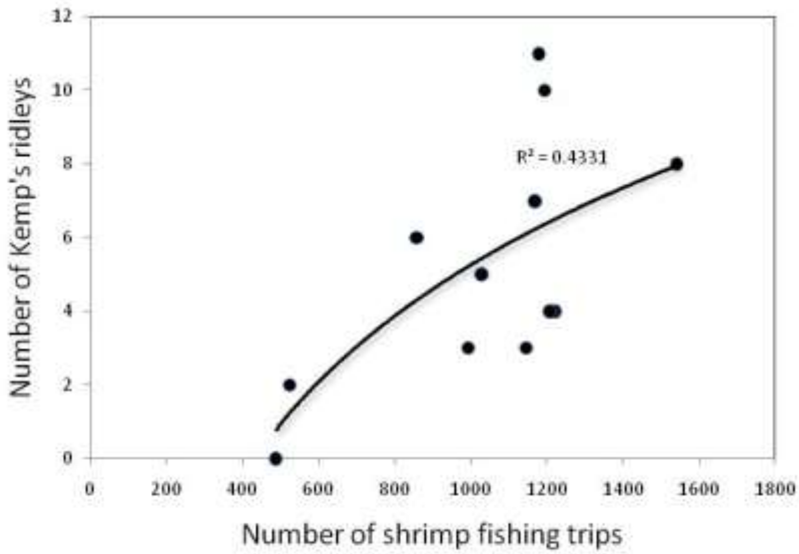


Figure 81. The numbers of Kemp's ridley strandings combined by month for all years from 1988, 1989, 1993, 1997 through 2000, and 2004 in Zones 5 and 6, and the numbers of shrimp fishing trips (for pink shrimp) reported in central-west Florida (Citrus County-Sarasota County) combined by month for the same years. The trend was best represented by the logarithmic regression shown. The two were correlated (Spearman Rank Order Correlation, $P < 0.05$, $\rho = 0.600$).

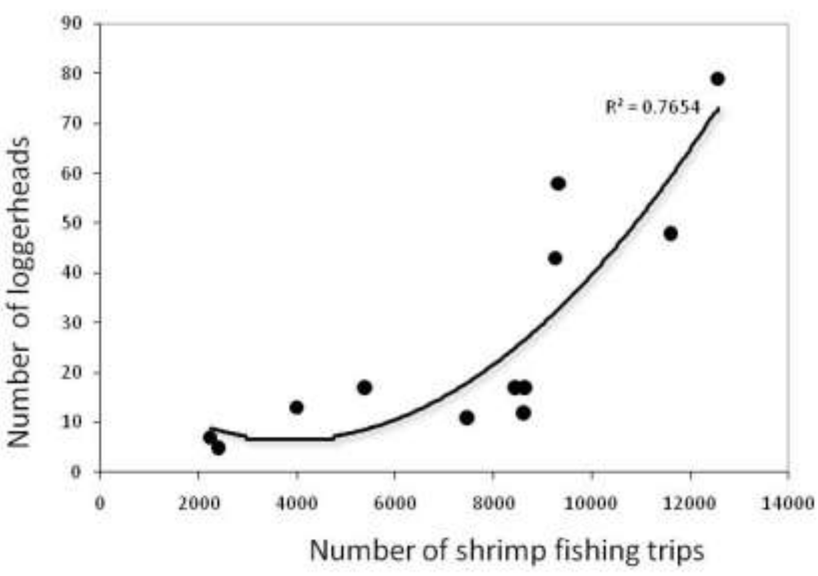


Figure 82. The numbers of loggerhead strandings combined by month for all years from 1986 through 1994, 1997, 1998, and 2004 in Zones 7 through 10 (years when no strong red tide was detected), and the numbers of shrimp fishing trips (for brown, pink, and white shrimp) reported in northwest Florida (Escambia County through Wakulla County) combined by month for the same years. The trend was best represented by the polynomial regression shown. The two were correlated (Spearman Rank Order Correlation, $P < 0.001$, $\rho = 0.887$).

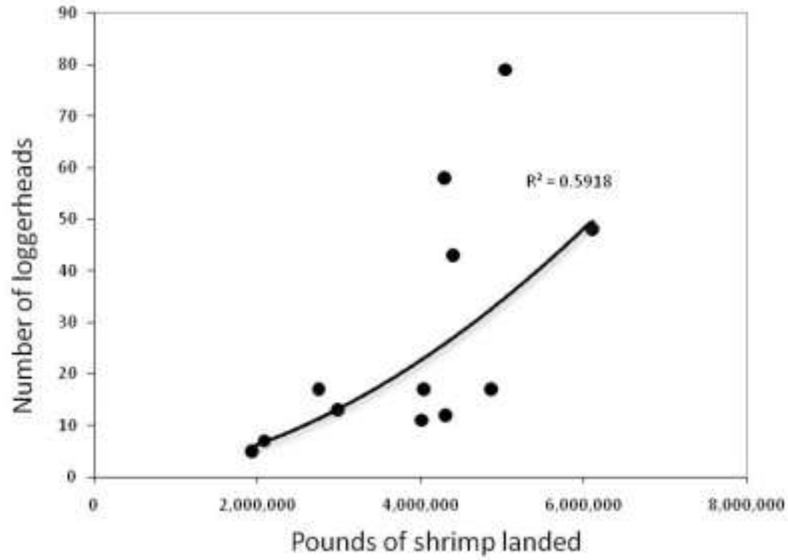


Figure 83. The numbers of loggerhead strandings combined by month for all years from 1986 through 1994, 1997, 1998, and 2004 in Zones 7 through 10 (years when no strong red tide was detected), and the pounds of brown, pink, and white shrimp landed in northwest Florida (Escambia County through Wakulla County) combined by month for the same years. The trend was best represented by the power regression shown. The two were correlated (Spearman Rank Order Correlation, $P < 0.005$, $\rho = 0.761$).

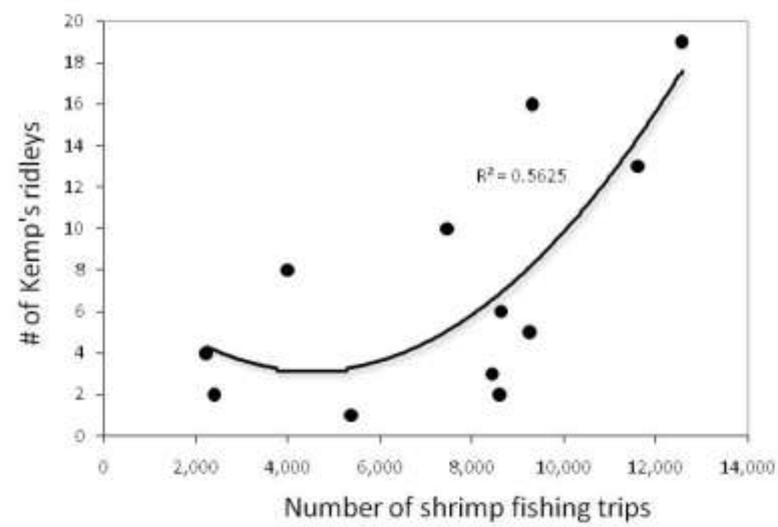


Figure 84. The numbers of Kemp's ridley strandings combined by month for all years from 1986 through 1994, 1997, 1998, and 2004 in Zones 7 through10 (years when no strong red tide was detected), and the numbers of shrimp fishing trips (for brown, pink, and white shrimp) reported in northwest Florida (Escambia County through Wakulla County) combined by month for the same years. The trend was best represented by the polynomial regression shown. The two were correlated (Spearman Rank Order Correlation, $P < 0.05$, $\rho = 0.641$).

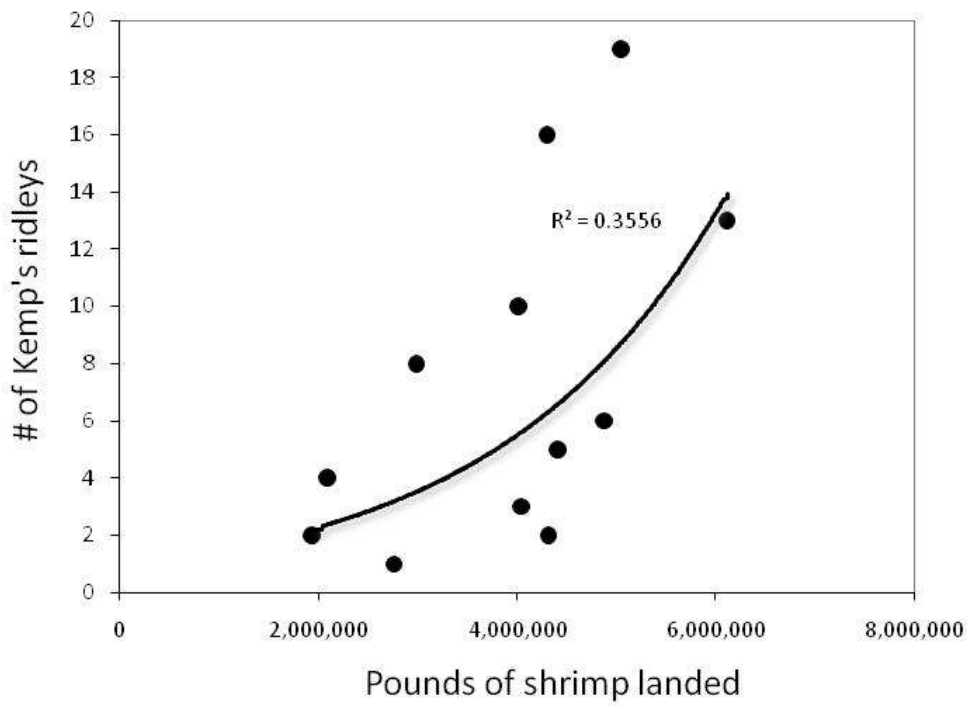


Figure 85. The numbers of Kemp's ridley strandings combined by month for all years from 1986 through 1994, 1997, 1998, and 2004 in Zones 7 through10 (years when no strong red tide was detected), and the pounds of brown, pink, and white shrimp landed in northwest Florida (Escambia County through Wakulla County) combined by month for the same years. The trend was best represented by the exponential regression shown. The two were correlated (Spearman Rank Order Correlation, $P < 0.05$, $\rho = 0.578$).

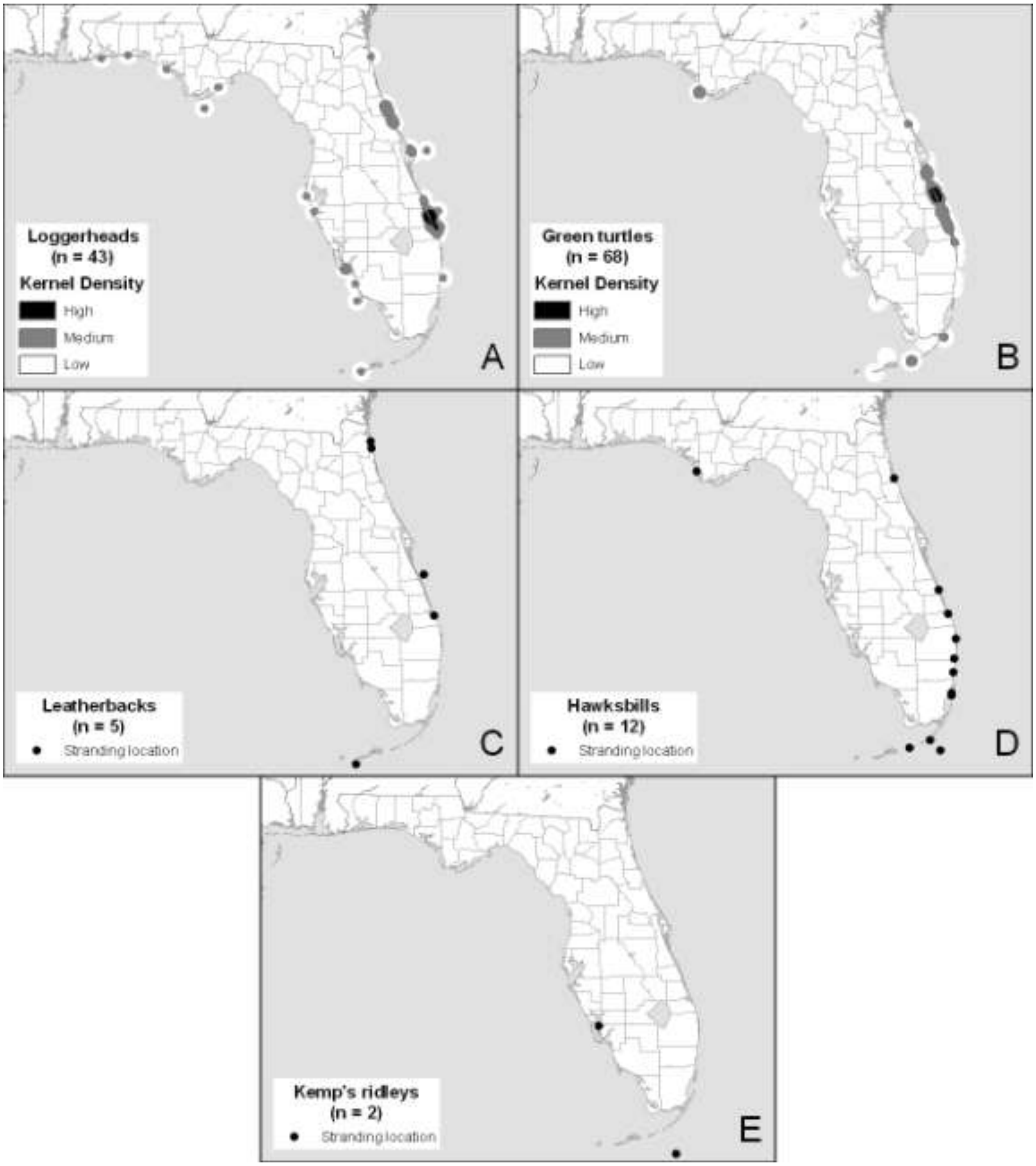


Figure 86. The relative kernel densities or locations of stranded sea turtles found entangled in gillnetting by species in Florida from 1980 through 2007. The kernel densities were estimated using Hawth's tools (http://www.spatialecology.com/htools/overview.php).

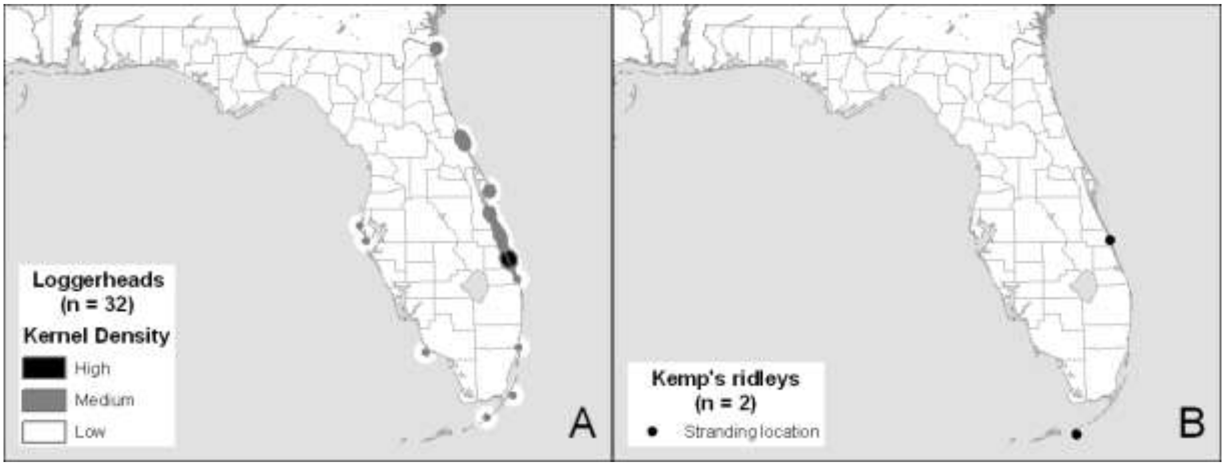


Figure 87. The relative kernel densities or locations of stranded sea turtles found with one or more long line hooks by species in Florida from 1980 through 2007. The kernel densities were estimated using Hawth's tools (http://www.spatialecology.com/htools/overview.php).

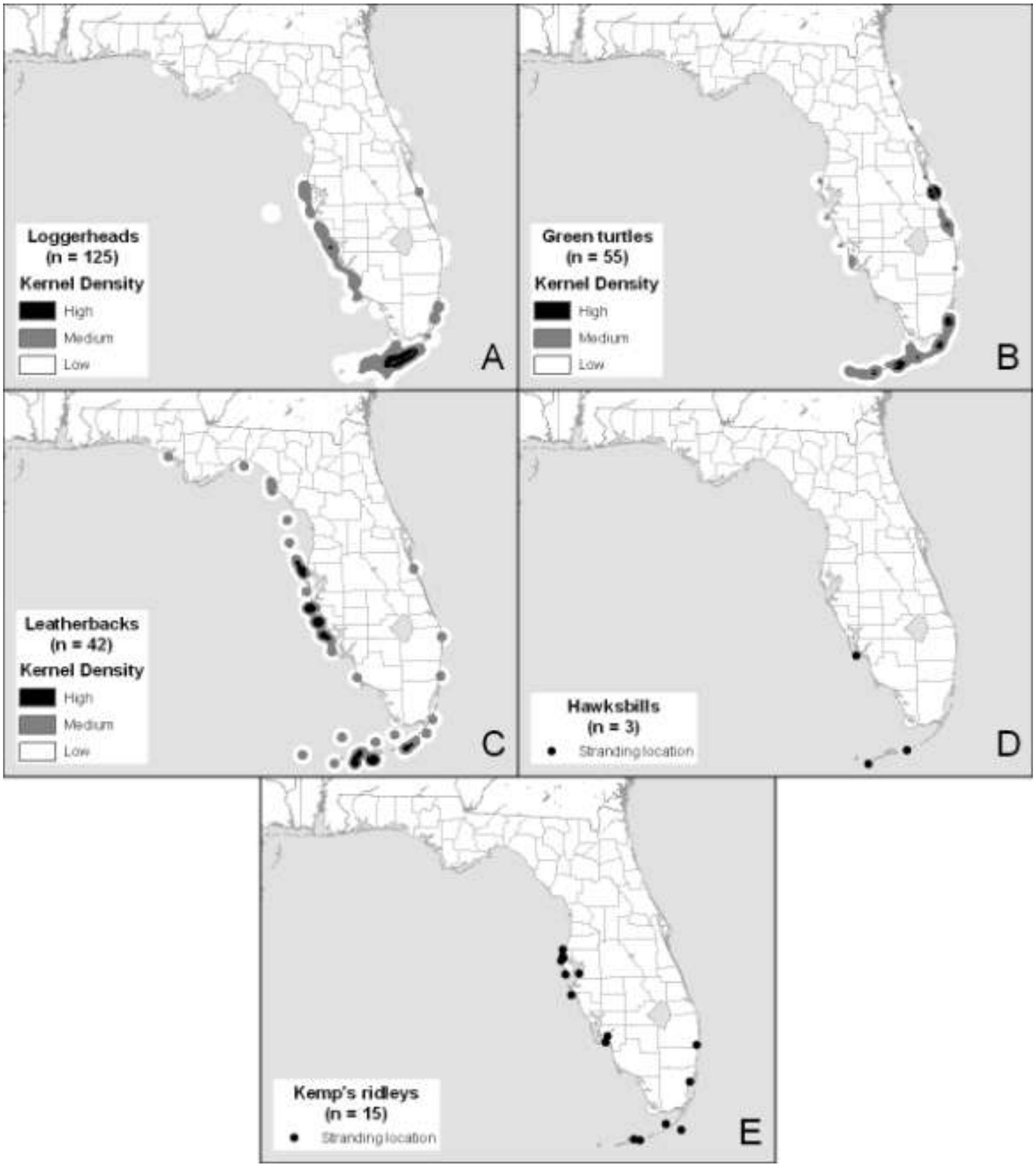


Figure 88. The relative kernel densities or locations of stranded sea turtles found entangled in the buoy line of a trap or pot by species in Florida from 1980 through 2007. The kernel densities were estimated using Hawth's tools (http://www.spatialecology.com/htools/overview.php).

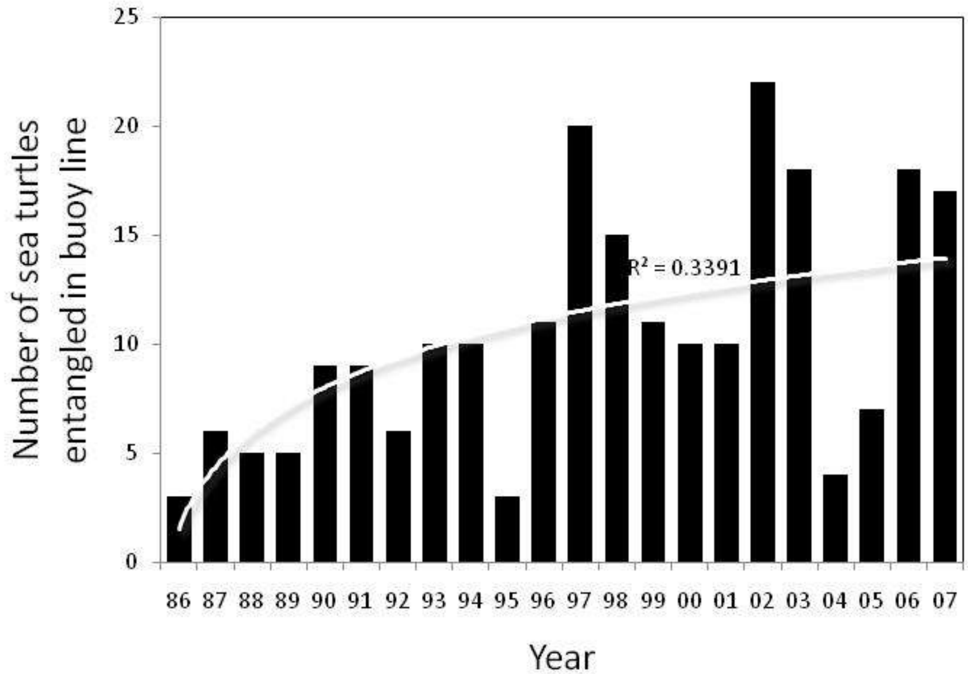


Figure 89. The number of stranded sea turtles found entangled in the buoy line of a trap or pot each year in Florida from 1986 through 2007. The increasing trend is best described by the logarithmic regression shown.

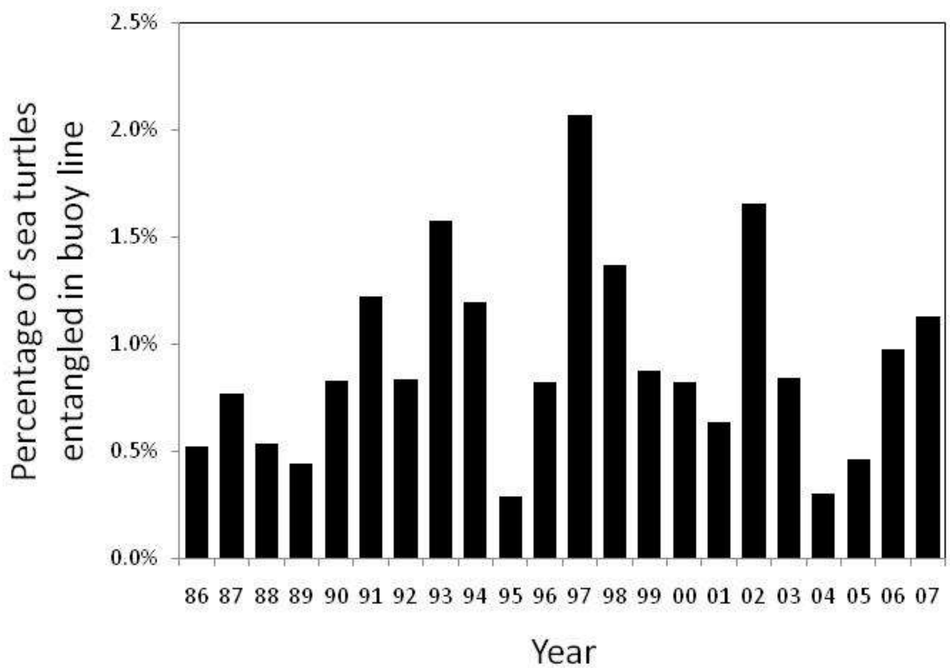


Figure 90. The percentage of stranded sea turtles found entangled in the buoy line of a trap or pot each year in Florida from 1986 through 2005.

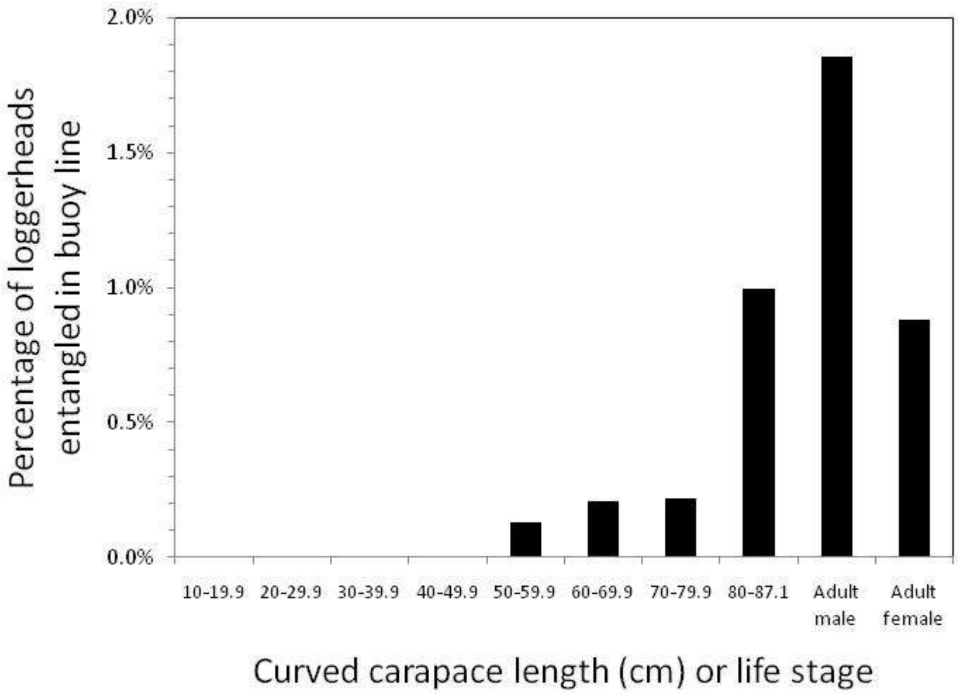


Figure 91. The percentage of stranded loggerheads found entangled in the buoy line of a trap or pot by 10-cm size-class and for adults by gender in Florida from 1980 through 2007. See text for criteria regarding the identification of adults.

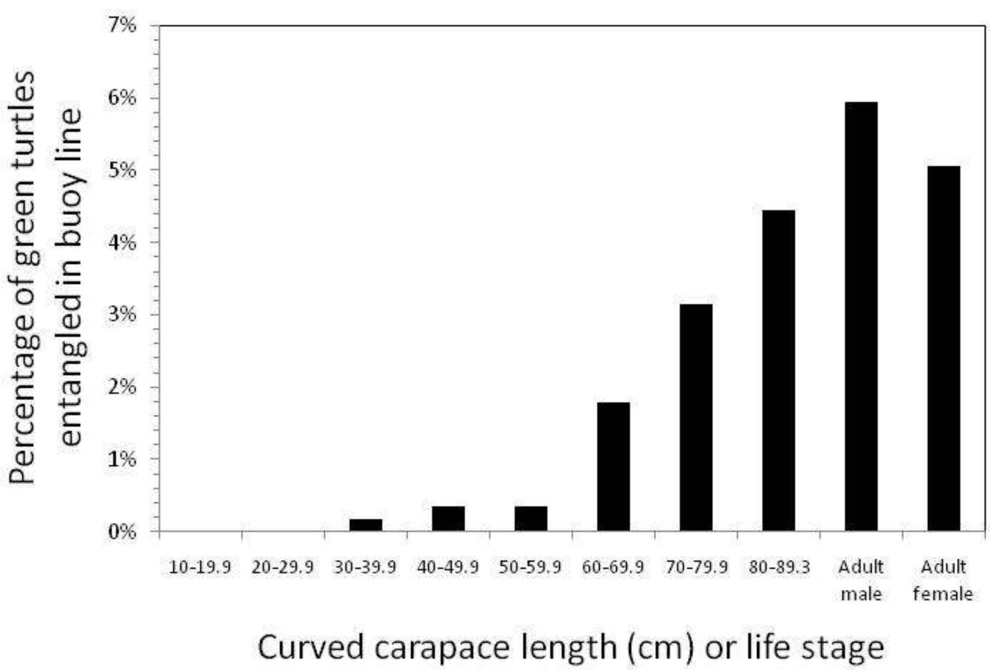


Figure 92. The percentage of stranded green turtles found entangled in the buoy line of a trap or pot by 10-cm size-class and for adults by gender in Florida from 1980 through 2007. See text for criteria regarding the identification of adults.

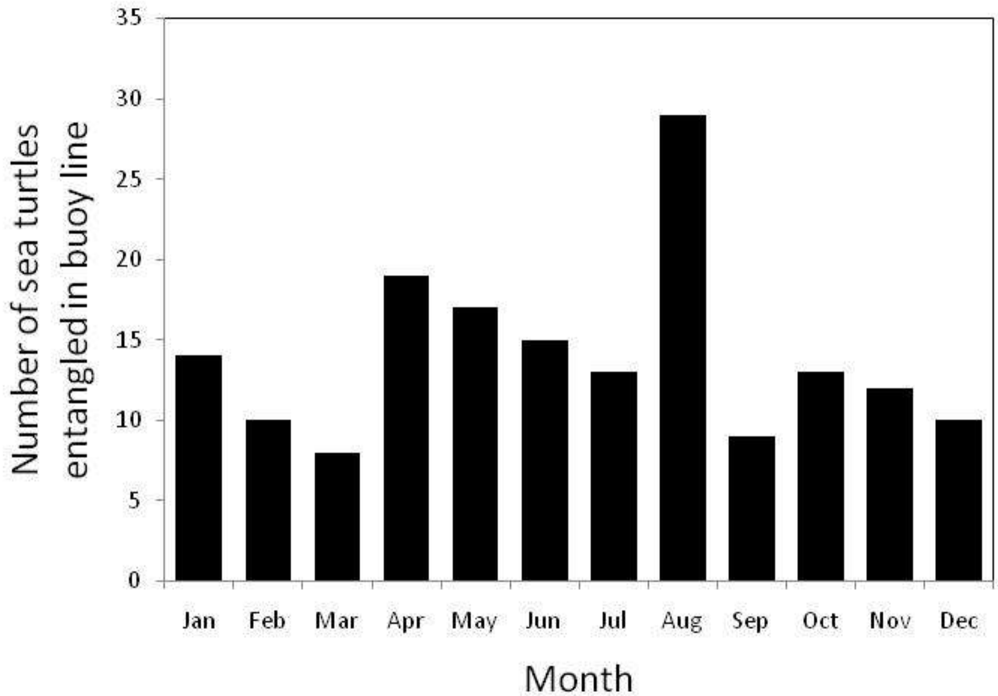


Figure 93. The number of stranded loggerheads and green turtles found entangled in the buoy line of a trap or pot by month in Florida from 1980 through 2007.

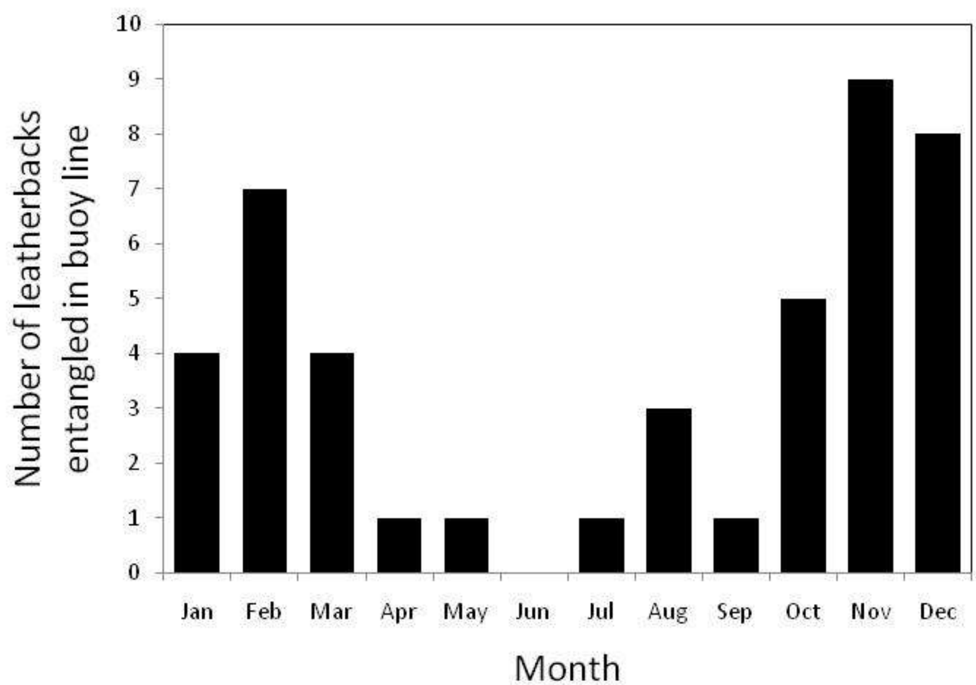


Figure 94. The number of stranded leatherbacks found entangled in the buoy line of a trap or pot by month in Florida from 1980 through 2007.

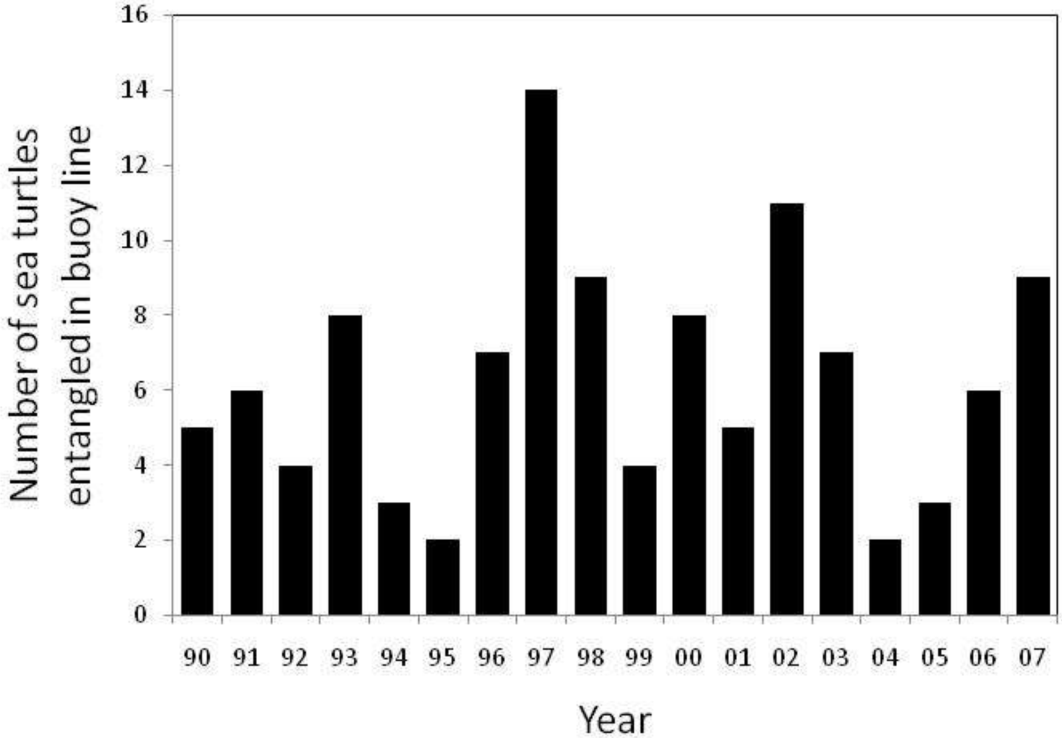


Figure 95. The number of sea turtle strandings that were entangled in the buoy line of a trap or pot each year in southern Florida (Monroe County and Miami-Dade County) from 1990 through 2007. There was no trend.

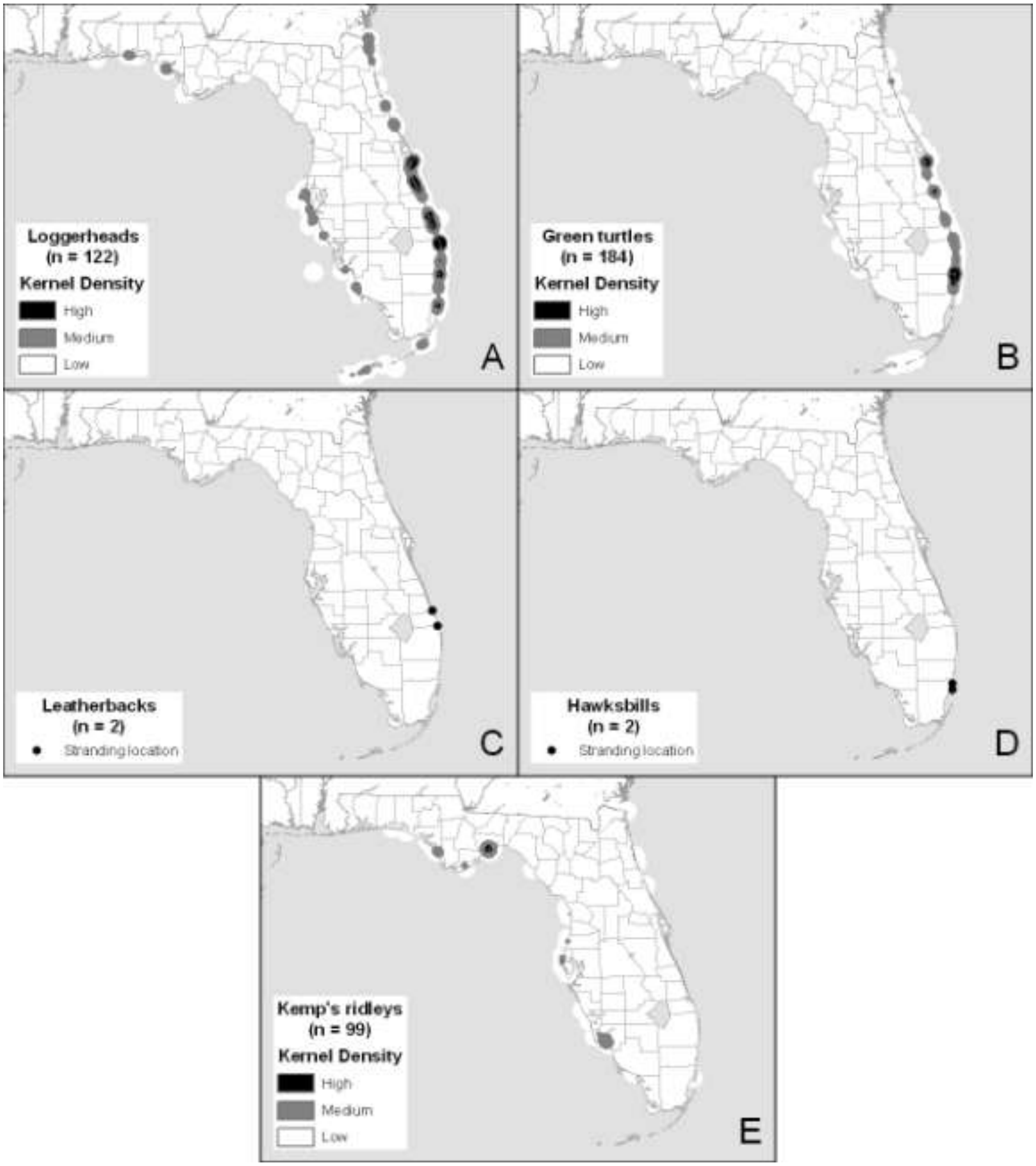


Figure 96. The relative kernel densities or locations of stranded sea turtles caught by on hook and line (recreational) or found with one or more hooks (not thought to be associated with commercial long lining) in some part of the body by species in Florida from 1980 through 2007. The kernel densities were estimated using Hawth's tools (http://www.spatialecology.com/ htools/overview.php).

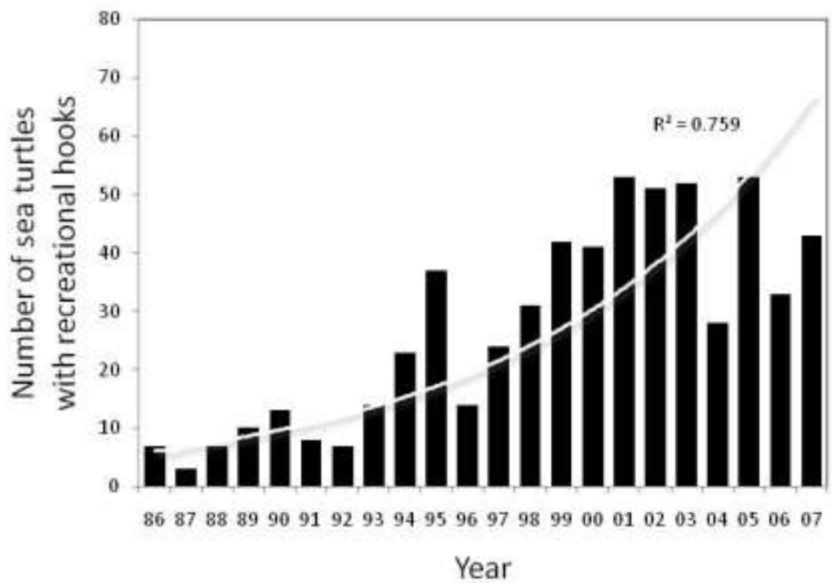


Figure 97. The number of stranded sea turtles caught by recreational fishermen on hook and line or found with one or more hooks (not thought to be associated with commercial long lining) in some part of the body each year in Florida from 1980 through 2007. The trend was best represented by the exponential regression shown. Stranded sea turtles with recreational fishing hooks were documented since 1980 but the effort to document strandings statewide was not consistent prior to 1986.

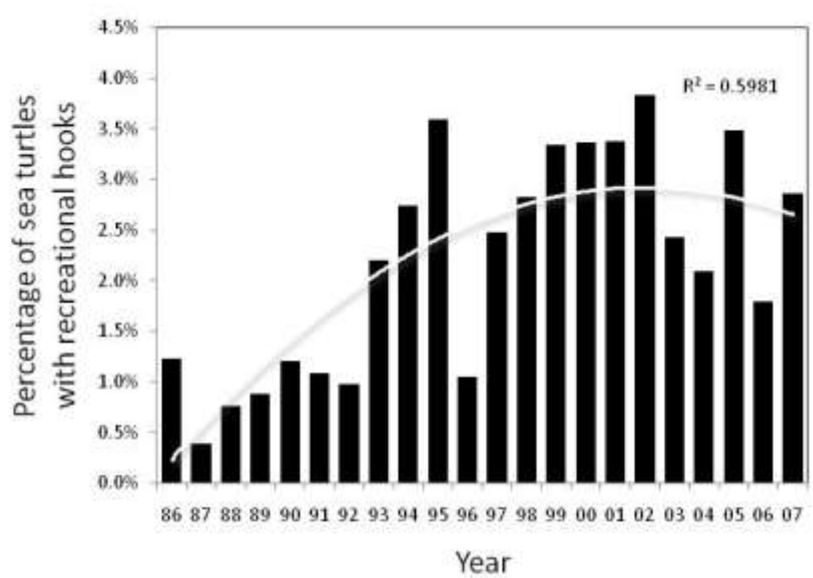


Figure 98. The percentage of stranded sea turtles caught by recreational fishermen on hook and line or found with one or more hooks (not thought to be associated with commercial long lining) in some part of the body each year in Florida from 1980 through 2007. The trend was best represented by the polynomial regression shown. Stranded sea turtles with recreational fishing hooks were documented since 1980 but the effort to document strandings statewide was not consistent prior to 1986.

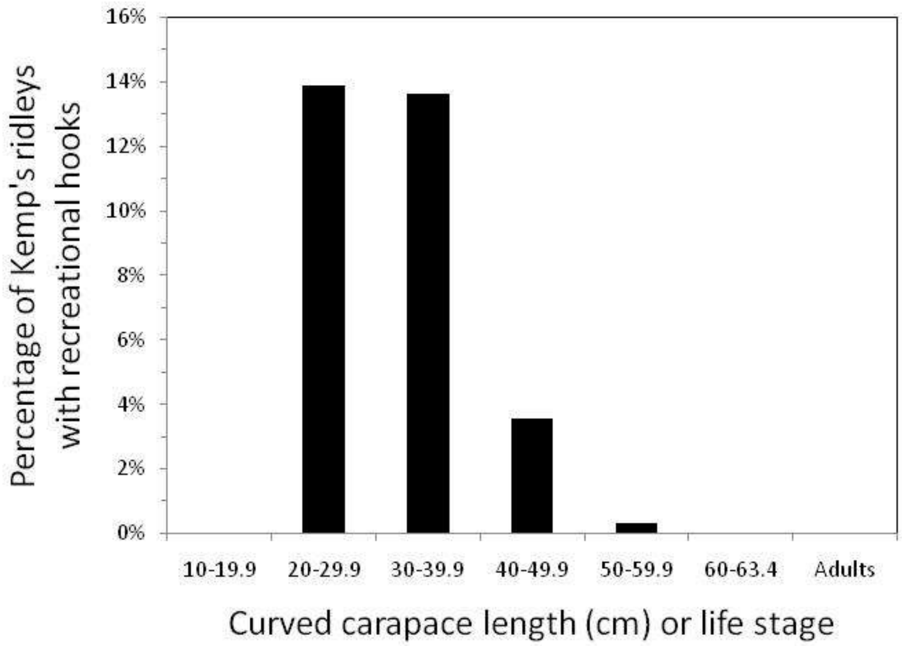


Figure 99. The percentage of stranded Kemp's ridleys by 10-cm size-class and by adults that were caught by recreational fishermen on hook and line or that were found as strandings with one or more hooks (not thought to be associated with commercial long lining) in some part of the body in Florida from 1980 through 2007. See text for criteria regarding the identification of adults.

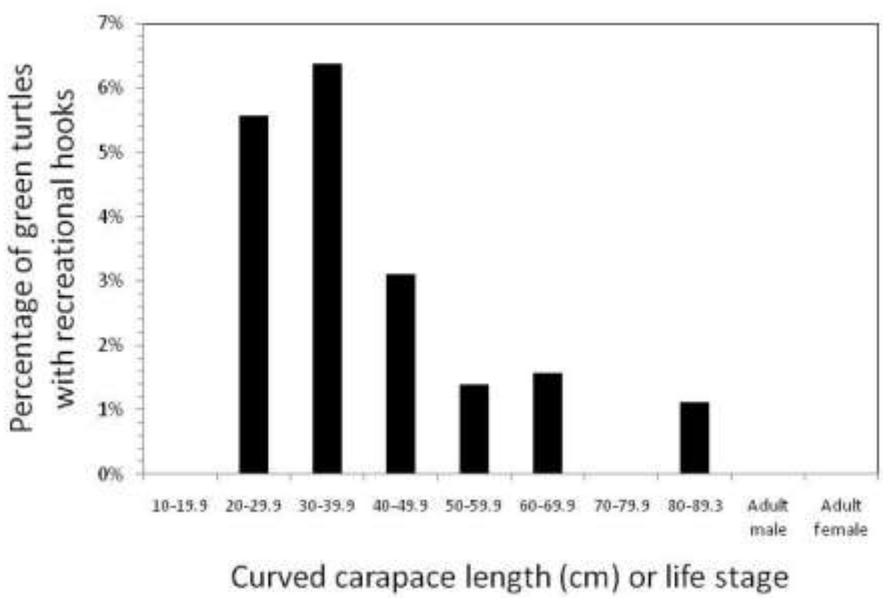


Figure 100. The percentage of stranded green turtles by 10-cm size-class and by adults that were caught by recreational fishermen on hook and line or that were found as strandings with one or more hooks (not thought to be associated with commercial long lining) in some part of the body in Florida from 1980 through 2005. See text for criteria regarding the identification of adults.

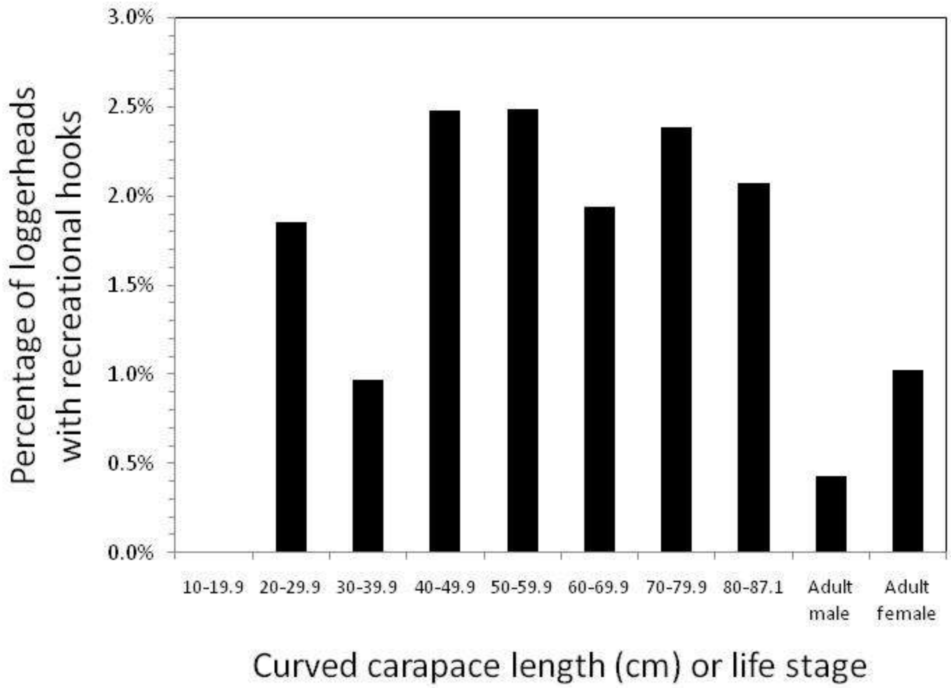


Figure 101. The percentage of stranded loggerheads by 10-cm size-class and by adults that were caught by recreational fishermen on hook and line or that were found as strandings with one or more hooks (not thought to be associated with commercial long lining) in some part of the body in Florida from 1980 through 2005. See text for criteria regarding the identification of adults.

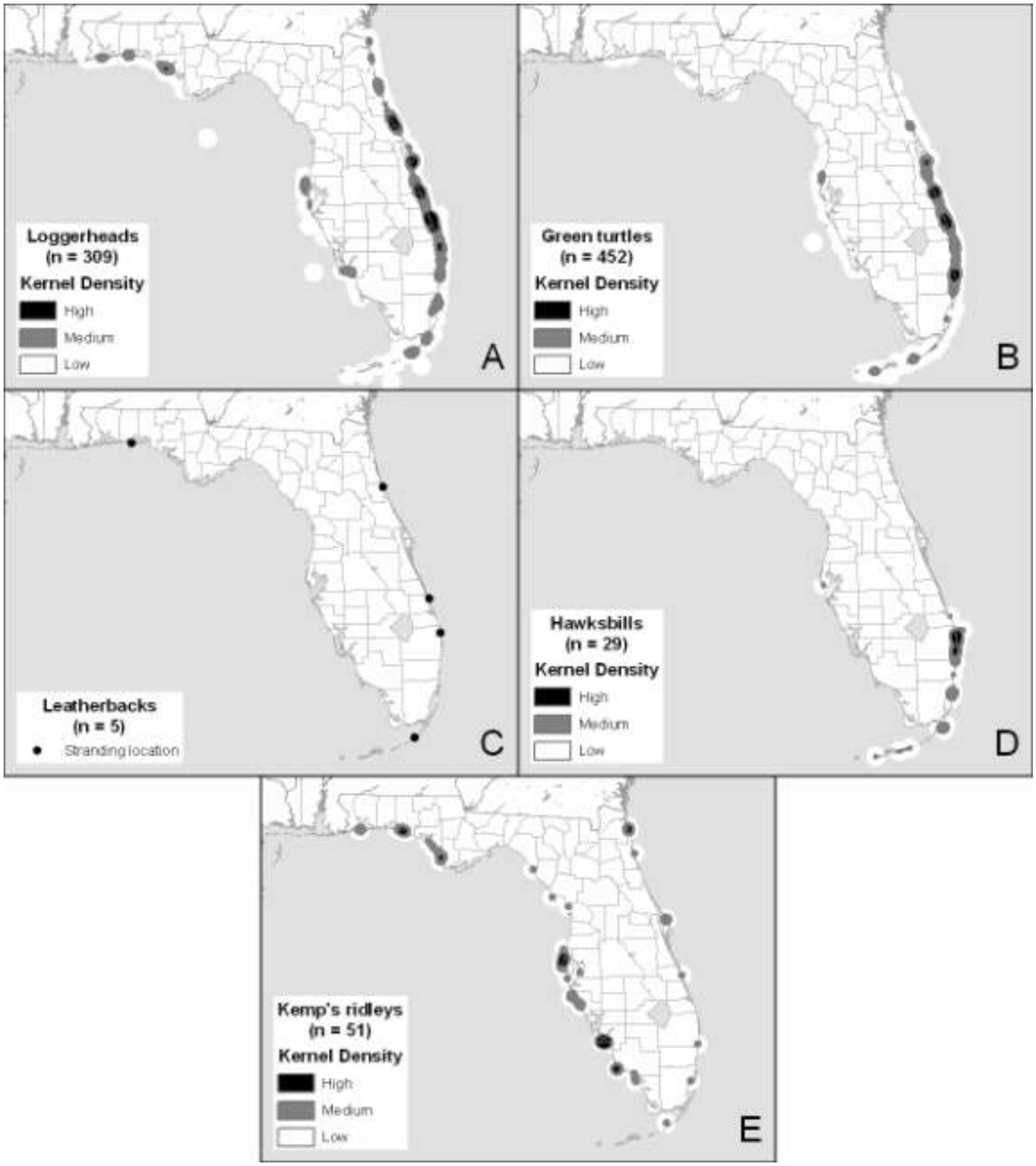


Figure 102. The relative kernel densities or locations of stranded sea turtles found to be entangled in or to have ingested monofilament fishing line by species in Florida from 1980 through 2007. The kernel densities were estimated using Hawth's tools (http://www.spatialecology.com/ htools/overview.php).

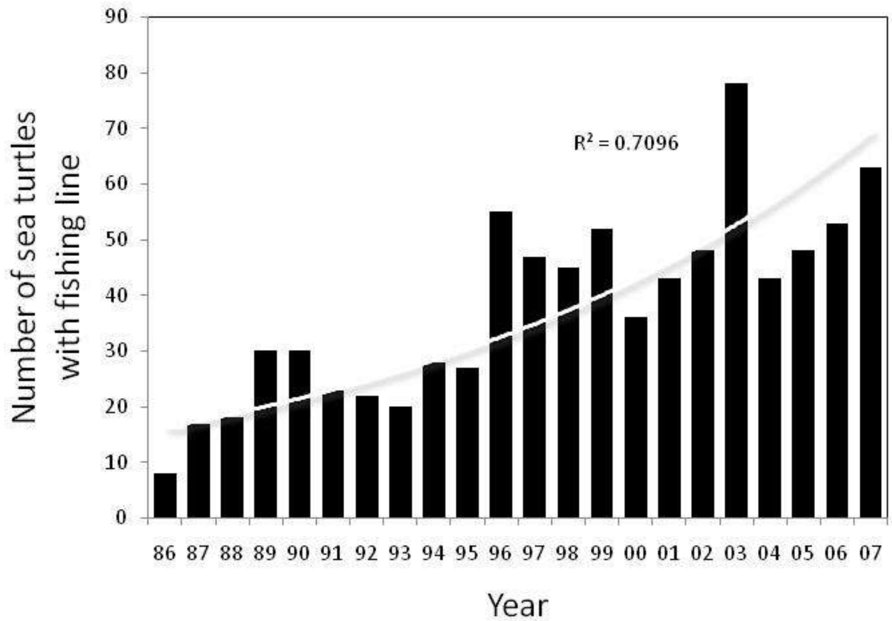


Figure 103. The number of stranded sea turtles found to be entangled in or to have ingested monofilament fishing line each year in Florida from 1980 through 2007. The trend was best represented by the exponential regression shown. Stranded sea turtles with monofilament fishing line were documented since 1980 but the effort to document strandings statewide was not consistent prior to 1986.

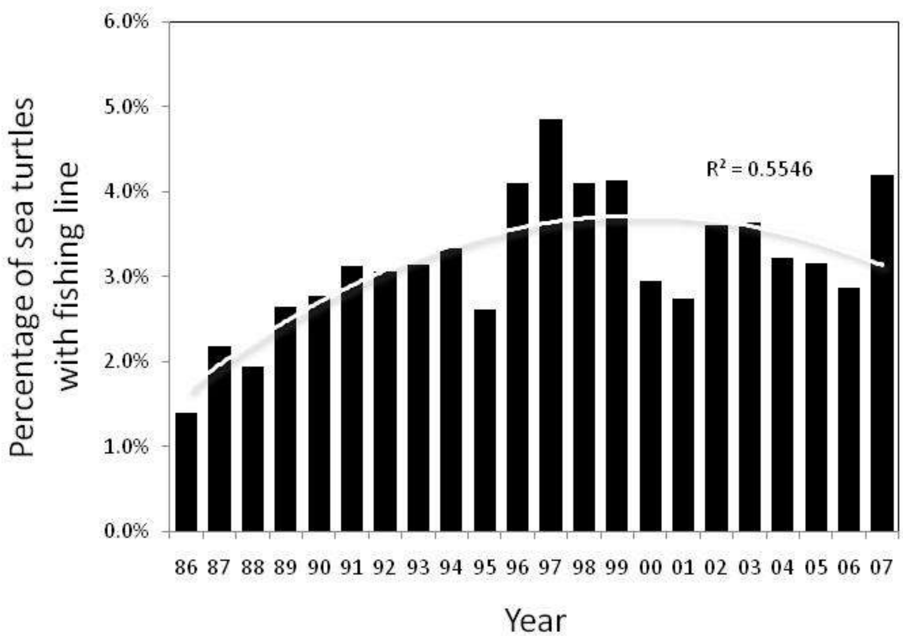


Figure 104. The percentage of stranded sea turtles found to be entangled in or to have ingested monofilament fishing line each year in Florida from 1980 through 2007. The trend was best represented by the polynomial regression shown. Stranded sea turtles with monofilament fishing line were documented since 1980 but the effort to document strandings statewide was not consistent prior to 1986.

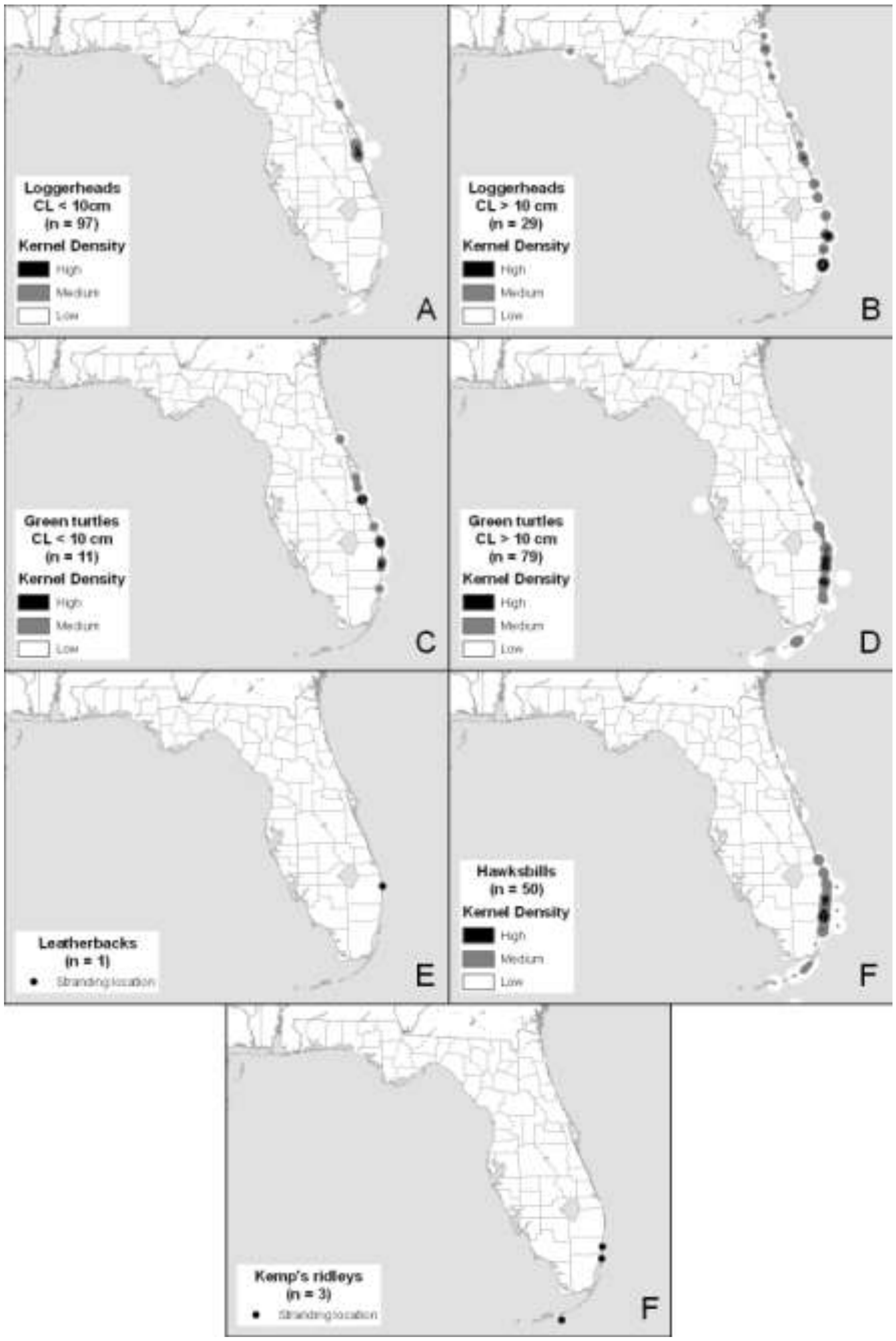


Figure 105. The relative kernel densities or locations of stranded sea turtles covered to some extent by tar or oil by species in Florida from 1980 through 2007. The kernel densities were estimated using Hawth's tools (http://www.spatialecology.com/ htools/overview.php).

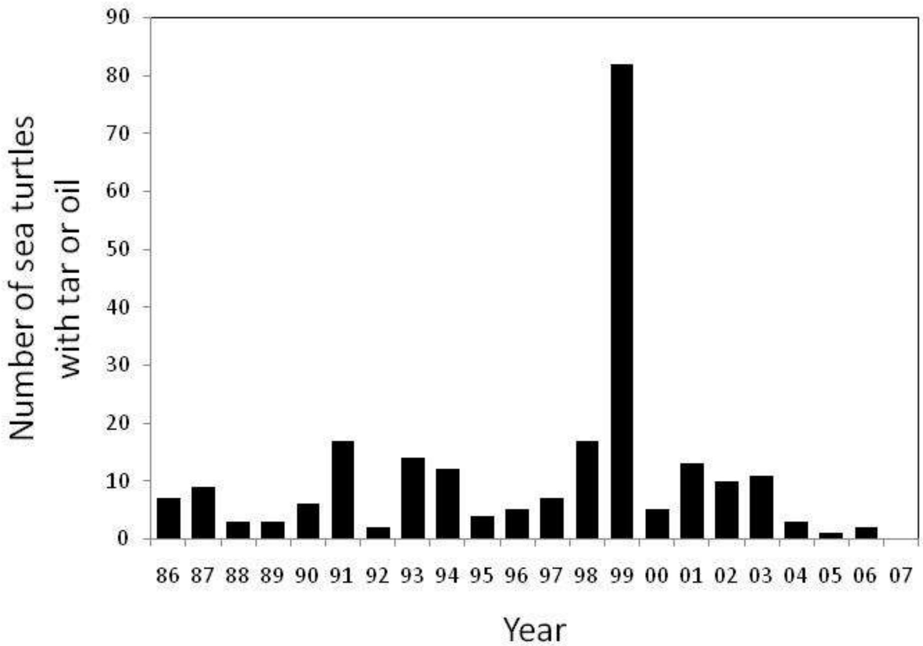


Figure 106. The number of stranded sea turtles covered to some extent by tar or oil each year in Florida from 1980 through 2007. Stranded sea turtles with tar or oil were documented since 1980 but the effort to document strandings statewide was not consistent prior to 1986.

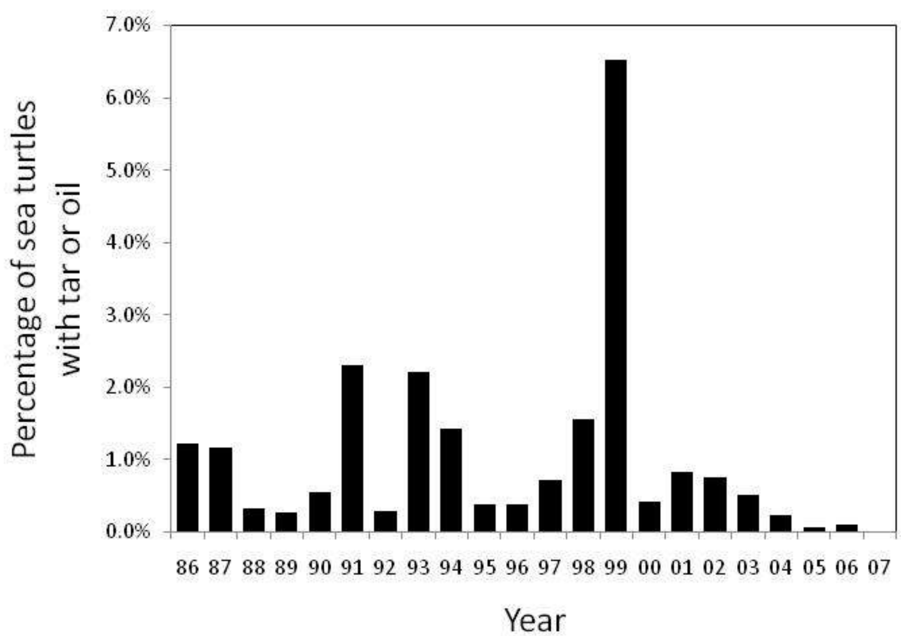


Figure 107. The percentage of stranded sea turtles covered to some extent by tar or oil in each year in Florida from 1980 through 2007. Stranded sea turtles with tar or oil were documented since 1980 but the effort to document strandings statewide was not consistent prior to 1986.

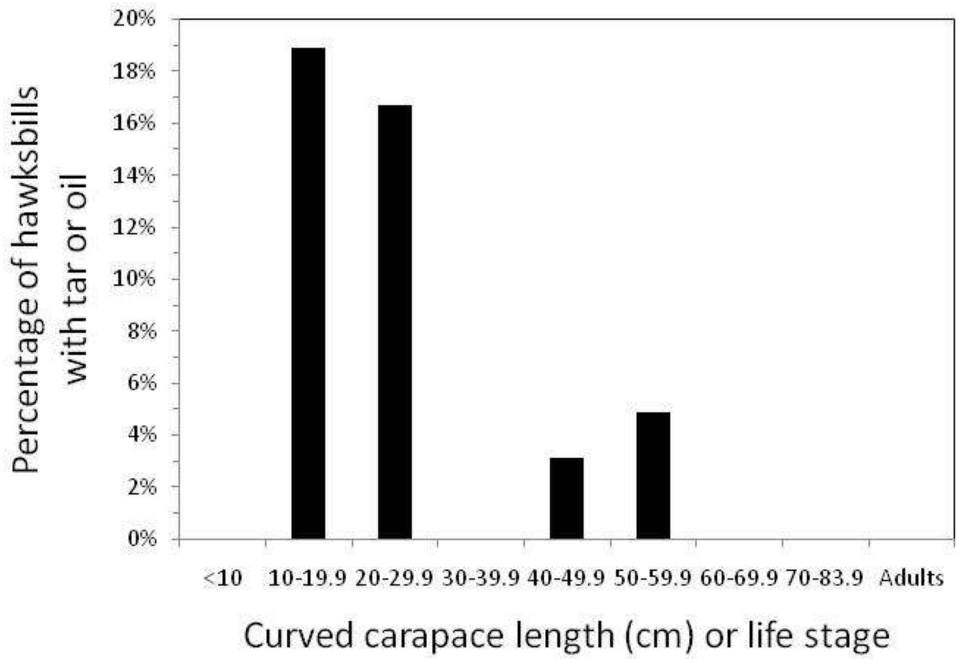


Figure 108. The percentage of stranded hawksbills by 10-cm size-class and by adults that were covered to some extent by tar or oil in Florida from 1980 through 2007. See text for criteria regarding the identification of adults.

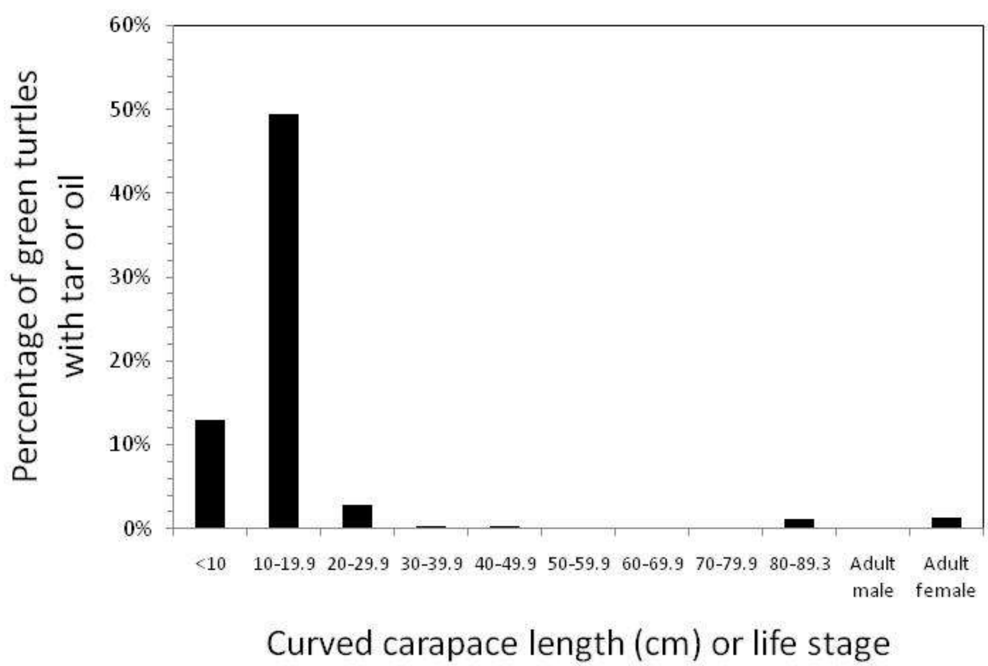


Figure 109. The percentage of stranded green turtles by 10-cm size-class and by adults that were covered to some extent by tar or oil in Florida from 1980 through 2007. See text for criteria regarding the identification of adults.

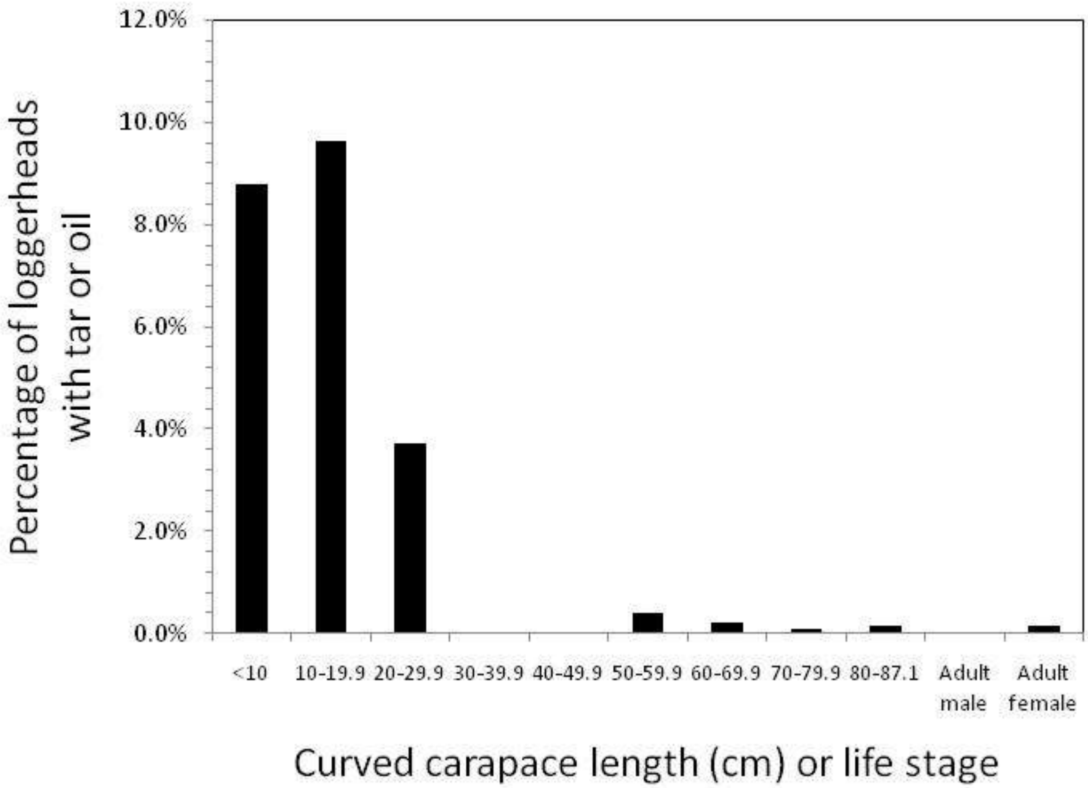


Figure 110. The percentage of stranded loggerheads by 10-cm size-class and by adults that were covered to some extent by tar or oil in Florida from 1980 through 2007. See text for criteria regarding the identification of adults.

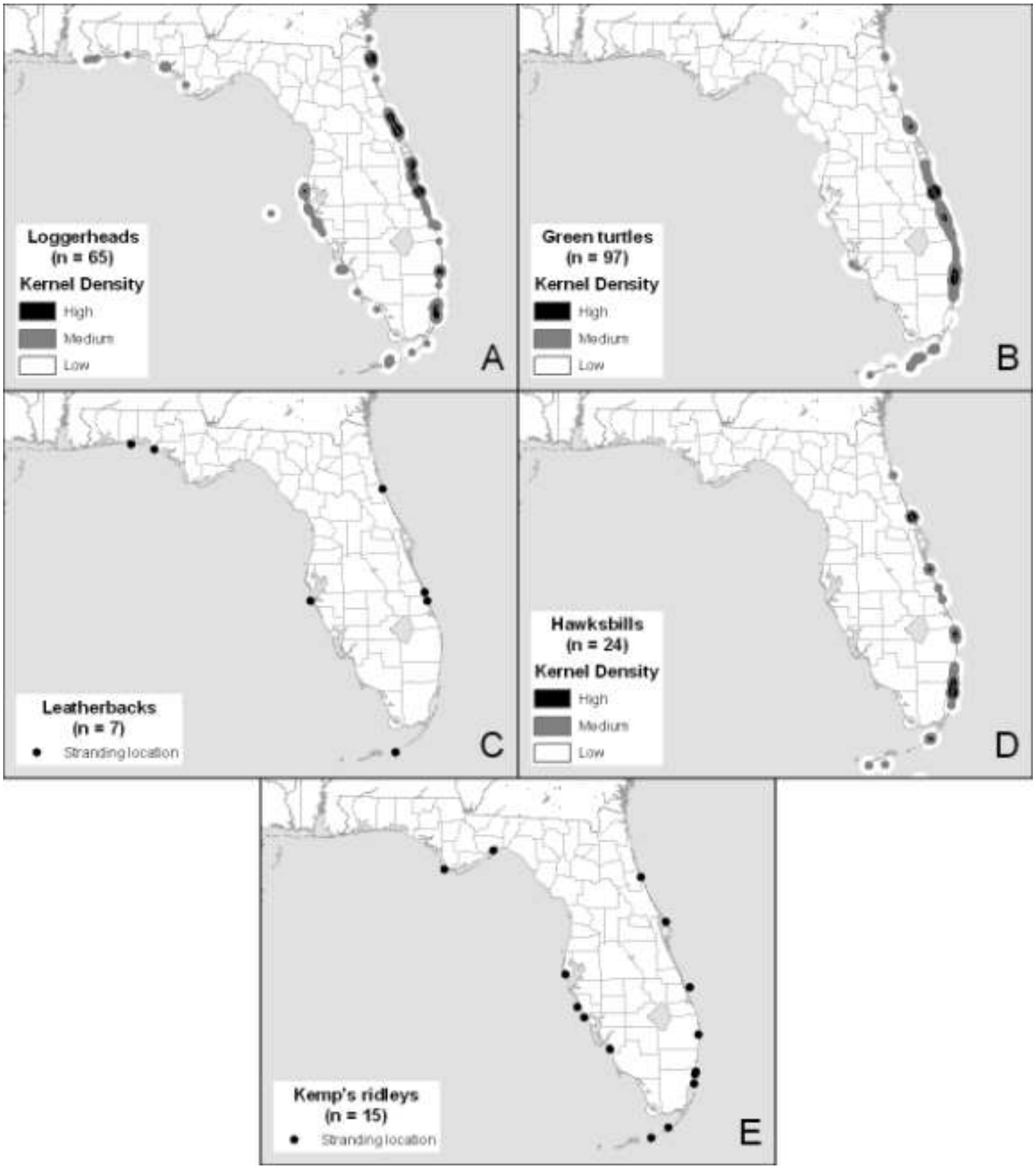


Figure 111. The relative kernel densities or locations of stranded sea turtles found to be entangled in or to have ingested persistent marine debris other than fishing line, tar, or oil by species in Florida from 1980 through 2007. The kernel densities were estimated using Hawth's tools (http://www.spatialecology.com/ htools/overview.php).

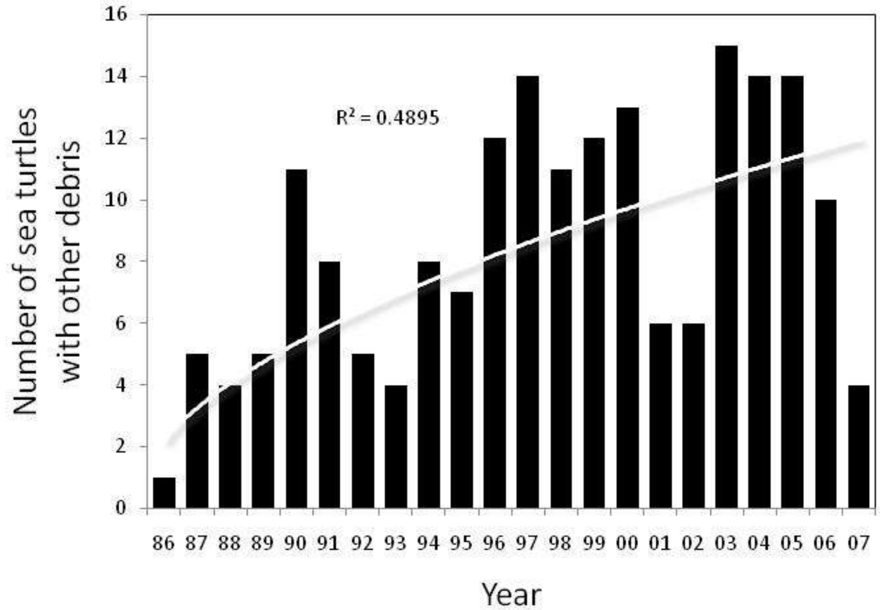


Figure 112. The number of stranded sea turtles found to be entangled in or to have ingested persistent marine debris other than fishing line, tar, or oil each year in Florida from 1980 through 2007. The trend was best represented by the power regression shown. Stranded sea turtles with marine debris were documented since 1980 but the effort to document strandings statewide was not consistent prior to 1986.

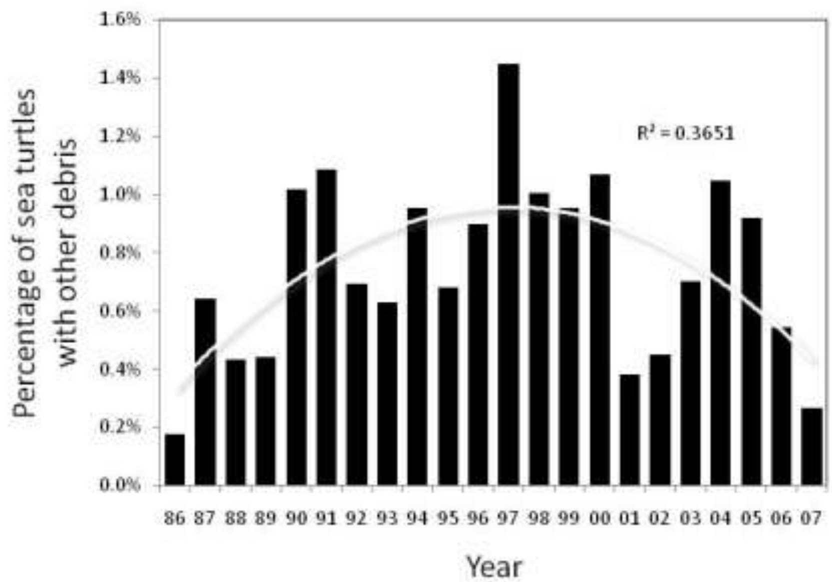


Figure 113. The percentage of stranded sea turtles found to be entangled in or to have ingested persistent marine debris other than fishing line, tar, or oil in stranded sea turtles each year in Florida from 1980 through 2005. The trend was best represented by the polynomial regression shown. Stranded sea turtles with marine debris were documented since 1980 but the effort to document strandings statewide was not consistent prior to 1986.