The Status of Loggerhead, *Caretta caretta*; Kemp's Ridley, *Lepidochelys kempi*; and Green, *Chelonia mydas*, Sea Turtles in U.S. Waters

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Introduction

This paper provides an overview of the distribution, abundance, sources of mortality, and status of stocks for three species of sea turtles in U.S. waters from Maine to Texas. The species discussed include the loggerhead, *Caretta caretta*; green, *Chelonia mydas*; and Kemp's ridley, *Lepidochelys kempi*, turtles.

The loggerhead turtle is currently listed as threatened throughout its U.S. range. One of the world's largest aggregations of nesting females emerges on southeastern U.S. beaches from May to August every year.

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ABSTRACT—Available information on the ecology and status of stocks is summarized for the loggerhead, Caretta caretta, *the green* Chelonia mydas, *and the Kemp's ridley,* Lepidochelys kempi, *sea turtles found in U.S. waters. These species are listed as threatened, endangered in Florida waters, and endangered, respectively. The most conspicuous and abundant species is the loggerhead turtle which appears to have been relatively stable in numbers since 1982. The green turtle, which once supported a significant U.S. fishery, appears to be increasing in Florida. It is not known if this increase is from an expansion of range of Caribbean stocks or if there is a real increase in the number of turtles in the U.S. stock. The Kemp's ridley, which once nested in Mexico in the tens of thousands, has been reduced to a nesting population of less than 600 females. If the status quo remains, this species will be reduced to 100 nesting females within 60 years.*

The green turtle is listed as endangered in Florida and as threatened elsewhere in U.S. waters. The green turtle historically was the primary focus of U.S. turtle fishery activities.

The Kemp's ridley turtle is listed as endangered throughout its range and was so heavily exploited during the 1950's and 1960's in Mexico that the annual numbers of nesting females has dwindled from at least 47,000 in 1947 to less than 600 today.

Loggerhead Turtle

Distribution and Abundance

This species ranges from Maine to Texas, including the U.S. Caribbean Sea (Rebel, 1974). Seasonal migrations probably occur, with autumnal movements southward from primarily New York waters effectively contracting its range to waters of the southeastern U.S. and Gulf of Mexico in the winter. In the spring, turtles concentrate along the Florida east coast from Brevard to Palm Beach Counties. Results from aerial surveys have demonstrated that nonbreeding adults and immature turtles migrate occasionally as far north as the Gulf of Maine, and predictably as far north as Long Island, N.Y.[1] In the fall, turtles migrate to southeast U.S. waters and the Gulf of Mexico. Therefore, this species is ubiquitous waters from Maine to Texas in the U.S.

Aerial surveys conducted off the southeast U.S. coast from 1982 to 1984 by the National Marine Fisheries Service (NMFS) showed that turtles are distributed randomly from the coast out to the Gulf Stream except in the winter[2,3]. From North Carolina to Key West, Fla., the western boundary of the Gulf Stream approximates the 500 m bathymetric contour. During the winter, turtles appear to aggregate within the western Gulf Stream boundary waters which can be 5-6°C warmer than coastal waters[2,3].

Within the Gulf of Mexico, loggerhead turtles appear to be concentrated along the central-west coast of Florida. Sightings of turtles have been summarized from NMFS-sponsored aerial surveys in the Gulf of Mexico for Brownsville, Tex., to Key West, Fla. This survey program, supported by the NMFS Southeast Fisheries Center's Marine Mammal Program, is called GoMex. Surveys were completed independently from Brownsville, Tex., to New Orleans, La. (Northwestern Gulf, 4 seasonal surveys, 1983-84), and from New Orleans, La., to Key West, Fla. (Northeastern Gulf, 3 seasonal surveys, 1985-86). The ratio of loggerhead turtle sightings for the northwestern Gulf to northeastern Gulf was about 1:25. The area of turtle concentration along the Florida west coast is primarily within 139 km (75 n.mi.) of shore in

[1]CeTAP Final Report 1982. A characterization of marine mammals and turtles in the Mid- and North-Atlantic areas of the U.S. Outer Continental Shelf. Final Report of the Cetacean and Turtle Assessment Program, University of Rhode Island, Kingston. U.S. Dep. Int., Bur. Land Manage. contr. #AA551-CT8-48, 450 p.

[2]Thompson, T. J., and C. R. Shoop. 1982. Final report to the National Marine Fisheries Service. Contract No. NA82-GA-C-00012. Aero-Marine Surveys, Inc., Groton, Conn., 71 p.

[3]Powers, J. E. (editor) 1983. Report of the Southeast Fisheries Center Stock Assessment Workshop, Aug. 3-6, 1982. NOAA Tech. Memo. NMFS-SEFC-127. Miami, Fla. 229 p.

state and Federal waters and includes the Dry Tortugas shrimping grounds[4].

Three NMFS-sponsored aerial and ground survey projects to census nesting females resulted in estimates of nests and nesting females for 1980, 1982, and 1983 (Shoop et al., 1985; Powers[3], Murphy and Hopkins[5]). During this period, an annual average of 52,073 (±16,459, 95 percent C.I.) nests were excavated. These values are the best available estimates for the annual number of nests from North Carolina to Key Biscayne, Fla.

Loggerhead turtles also nest along the Florida west coast and sporadically along the entire Gulf of Mexico coast. However, it is not known how many turtles nest there annually. Those numbers cited are a minimum estimate. It is likely, however, that outside the North Carolina-Key Biscayne shoreline there are no more than an additional 1,000 nests, or 400 turtles (at 2.5 nests/female). Thus, at least 98 percent of all nesting occurs between North Carolina and Key Biscayne, with a known area of nesting concentration from Brevard to Palm Beach Counties.

Four aerial surveys have been completed over water to index marine turtle abundance. All were multispecies and only one program (funded by NMFS) was designed primarily to target marine turtles (called SeTS for Southeast Turtle Survey)[2,3]. During the SeTS program, nine seasonal surveys were completed in 1982-84 from Cape Hatteras, N.C., to Key West. The number of turtles within this study area has been estimated for each seasonal survey and includes a correction factor for turtles in the water column but not observable at the surface. This correction factor was provided by the NMFS Pascagoula Laboratory turtle remote sensing project[3]. Radio tags placed on turtles indicated that 2.3 minutes per hour or 3.8 percent of total time in the water was spent at the surface. The number of turtles sighted was significantly greater in the spring and summer than during fall and winter. The mean number of turtles present during the peak spring and summer survey, from North Carolina to Key West out to the Gulf Stream was 387,594 (±20,154, 95 percent C.I.). This estimate includes all animals of at least 60 cm carapace length (subadults and adults), and represents turtles at and below the surface.

Comparable surveys have been completed from North Carolina northward to Maine up to 370 km offshore[1]. These surveys were funded by the Minerals Management Service of the U.S. Department of the Interior from 1979 to 1981. These surveys targeted marine mammals; turtle sightings were secondary. Their estimates are minimal values and do not include turtles below the surface of the water. The number of loggerhead turtles at the surface peaked in the summer and the average summer estimate over a 3-year survey period (1979-81) was 7,702 (±1,748, 95 percent C.I.)[1].

In the Gulf, similar estimates can be made using the sighting/census data from the GoMex program. The total number of sightings of loggerheads for the Gulf was 1,428, and these sightings were made primarily off the west coast of Florida[4].

Mortality

Seven known sources of incidental mortality are: 1) Shrimping, 2) pound nets and fish traps, 3) gill nets, 4) longlining, 5) hook and line, 6) entrapment by power plants, and 7) enganglement in ghost gear and debris throughout their range.

Sea turtle catches by commercial shrimp trawlers have been examined by Henwood and Stuntz (1987). Data from three separate sampling programs were merged to estimate catch per unit of effort (CPUE), where catch is defined as numbers of turtles and effort as total hours of shrimp trawling standardized to 100 feet of headrope. CPUE was determined from data collected during: 1) 1979-81 by observers on shrimp vessels, 2) 1978-80 during experimental excluder trawl surveys, and 3) intermittent 1973-78 shrimp discard observations which included NMFS observers on shrimp boats reporting total discards, including turtles. These three programs accounted for 27,578 total hours of observed trawling effort throughout the Gulf and Atlantic from North Carolina to Texas. Total turtle catch was estimated by multiplying CPUE values with total shrimping effort. Total turtle catches by species for the southeast Atlantic and three Gulf subregions were estimated and total number of turtles killed were estimated using average mortality rates from these three programs. Mortality by region for loggerhead turtles showed that at least 72 percent of the total mortality occurs along the southeastern United States from South Carolina to Florida (Table 1; Henwood and Stuntz, 1987).

Table 1.—Estimated number of turtles killed, ±95% confidence intervals, by shrimping by region.

Species	Region	No. killed ±95% C.I.	Percent of total killed by species
Loggerhead	S.C. to Fla.	7,293±326	72
	W. Gulf	998±249	10
	N. Gulf	1,210±330	11
	E. Gulf	675±183	7
Green	S.C. to Fla.	133±44	40
	W. Gulf	50±50	16
	N. Gulf	109±109	36
	E. Gulf	15±15	5
Kemp's Ridley	S.C. to Fla.	368±74	39
	W. Gulf	249±150	22
	N. Gulf	165±110	22
	E. Gulf	59±29	7

An examination of turtle captures by region and season was completed. However, because sampling was nonrandom, these results most likely reflect observer coverage rather than turtle distribution and abundance. Of the total turtles sampled along the Texas coast, 36 percent were caught during the spring and summer. In the eastern Gulf, 92 percent were caught in the winter. Along the southeast Atlantic coast, 64 percent were caught during the summer from northern Florida to South Carolina. This area accounted for 95 percent of all east coast turtle catches from April to December. All winter caught turtles

[4]Thompson, N. B. 1986. A summary of marine turtle sightings from NMFS/SEFC aerial census surveys for cetaceans and turtles in the Gulf of Mexico. SEFC, Miami Laboratory, Unpublished report, 9 p.

[5]Murphy, T. M., and S. R. Hopkins. 1984. Aerial and ground surveys of marine turtle nesting beaches in the southeast region, U.S. Final Report to NMFS/SEFC. Contract No. NA83-GA-C-00021. Miami, Fla. 59 p.

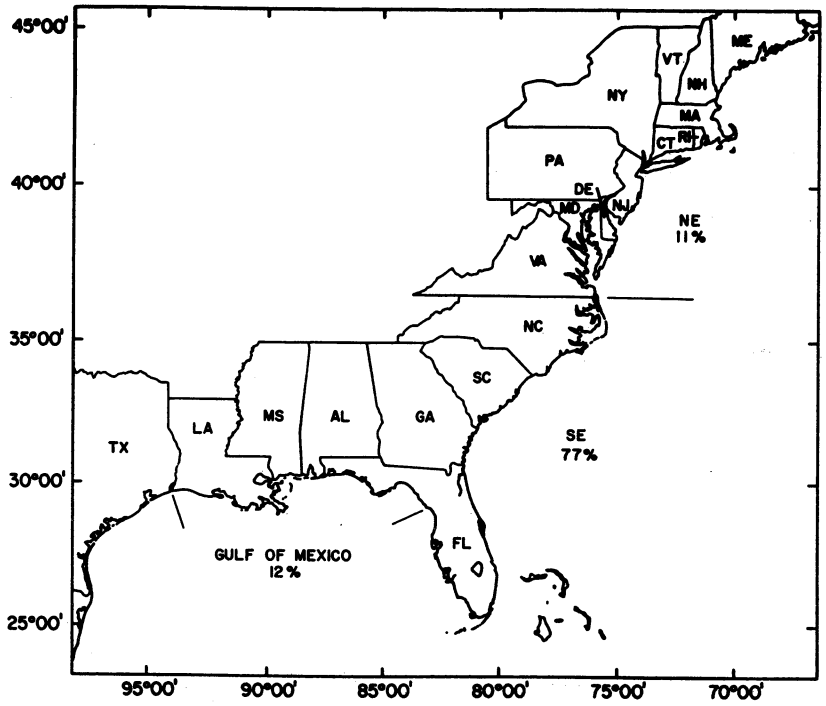

Figure 1.—Distribution of loggerhead turtle strandings reported by region along the Gulf of Mexico and Atlantic coasts. NE = Northeast; SE = Southeast; The relative proportion of total strandings are presented by region.

were reported from the Cape Canaveral area[6].

Mean depth of water when turtles were captured was 15.94 m (±13.92, 95 percent C.I.) for the Gulf and 9.43 m (±9.43, 95 percent C.I.) for the east coast. These capture depths represent where turtles were when caught and may not reflect the distribution of turtles by depth in the Gulf or off the east coast. In fact, from the SEFS aerial surveys, turtles were observed in water depths of 273 m.

The dependence of mortality (percent killed) on trawl tow time was examined using a least squares linear regression[6]. The percent mortality remains essentially zero through 60-minue tows, increases to about 10 percent at 90 minutes, and increases linearly to about 55 percent with 330-minute tows. Thus, it appears that mortality can be significantly minimized by restricting tow times to less than 90 minutes[6].

Loggerhead turtle mortality was estimated independently for the Atlantic. Published values of turtle catch per 1,000 pounds of shrimp landed were multiplied by annual shrimp landings[7]. The annual numbers of turtles killed ranged from 7,913 to 18,148. Published CPUE values (of turtle catch per 1,000 hours shrimp trawling) were expanded by the total shrimping effort to obtain estimates of annual turtle kill in the Gulf of Mexico yielding from 3,555 to 4,716 turtles killed annually. Adding these values yields an estimated annual turtle kill of between 11,468 and 22,864. These values are similar to those described previously. Thus, the best available information suggests that the annual estimate of turtles killed by commercial shrimpers ranges between 10,000 and and 23,000 since 1973.

Strandings on U.S. coasts from Texas to Maine are reported to the NMFS through the Sea Turtle Stranding and Salvage Network (STSSN). Causes of mortality are not always known, and reports are received opportunistically. Based on the voluntary nature of this network, it is assumed that all strandings are minimum estimates of mortality. Only animals that are dead or dying on the beach, in the surf, or in inshore waters are included in the STSSN numbers.

Three regions are defined as: Gulf of Mexico from the Texas/Mexico border to Key West, Fla.; Southeast U.S. (SE) from Key Largo, Fla. to the North Carolina-Virginia border; and the northeast U.S. (NE) from the North Carolina-Virginia border to Maine. Within the Gulf of Mexico, three subregions are defined: Western Gulf (WG), representing the entire Texas coast; the Northern Gulf (NG), Louisiana, Mississippi, Alabama, and the Florida Alabama border to Apalachicola, Fla.; and the Eastern Gulf (EG), Apalachicola, Fla., to Key West. Loggerhead turtles strand along the entire Gulf and Atlantic coasts throughout the year. Analysis of strandings was for 1980-83, and it showed 7,468 reported strandings for loggerhead, green, and Kemp's ridley turtles, of which almost 90 percent (6,691) were loggerhead turtles. By region, 77 percent (5,150) of total loggerhead strandings were reported in the SE, 12 percent along the Gulf coast, and 11 percent in the NE (Fig. 1). Thus, three times as many loggerhead turtles were reported from the SE as along the Gulf and NE coasts combined, which is consistent with the known distribution of loggerhead turtles as shown in aerial surveys. Within the Gulf of Mexico, the proportion of loggerhead turtles relative to total strandings was from 65 percent in the WG to 77 percent in the NG and 82 percent in the EG. These proportions are consistent with the known distributions of loggerheads as described previously.

Seasonal peaks in strandings occur in

[6]Henwood, T. A., and W. E. Stuntz. 1986. Analysis of sea turtle captures and mortalities aboard commercial shrimp trawling vessels. NMFS/SEFC, Pascagoula Laboratory, Pascagoula, Miss. Unpubl. rep., 56 p.

[7]Thompson, N. B., and J. E. Powers. 1987. An assessment of the status of the loggerhead turtle (*Caretta caretta*) in the U.S. Natl. Mar. Fish. Serv., Southeast Fish. Cent., Miami, Fla., manuscr.

all regions in the spring and summer. In the SE, almost 84 percent of all reported strandings occurred from April to August; in the NE, 79 percent were reported from April to July; in the NG, 68 percent were reported from April to August; in the WG, 79 percent were reported from April to August and in the EG, 70 percent were reported from March to June. Because these data are reported opportunistically and there is no way to stratify sampling effort, no inferences can be made as to the cause of this spring-summer seasonal peak in reports.

In March 1986, large numbers of turtles stranded along the Texas coast. During the same period offshore oil platforms had been removed from Federal and state waters. Removal requires the use of explosives to dismantle platforms. NMFS is continuing to monitor this situation to determine if there is a cause and effect between oil platform removal and turtle mortality (Klima et al., 1988). Information on the other listed sources of mortality is limited and sometimes anecdotal; however, there is a need to describe and quantify all potential sources of mortality.

Status of Stocks

The survivorship requirements of the southeast U.S. loggerhead population were examined, assuming that their abundance (about 387,000) represents the major reproductive component and can be considered a "unit stock."[7] Analyses were also conducted assuming that fishing mortality was between 10,000 and 23,000 turtles annually[6]. Between 0.8 percent and 5.2 percent of the hatchlings entering the water must survive to maintain this population as stable. These values are not contradicted by estimates from other populations of loggerheads and of other sea turtle species which average about 1 percent, i.e., 1 percent of hatchlings must survive to become breeding adults for the population to maintain stability.

Based on the best available information for the abundance of nesting females and number of turtles in the water, it appears that since 1980 this population has remained stable. However, because turtles cannot be aged, it cannot be determined when conditions resulted in stability, that is, whether this stability reflects conditions 5, 10, or 20 years ago is not known. No long time series is currently available for any population statistic; thus, it is impossible to develop quantitative assessments on the status of this stock relative to levels prior to the Endangered Species Act of 1973, or to make predictions as to what will happen to the population beyond the next 10 years[7].

For example, shrimp-related mortality may have negatively impacted this population in the 1970's while at the same time protection of nesting beaches improved egg and hatchling survivorship. The 1980's population estimate of 387,000 is a result of both of these factors. We do not have an adequate data base to evaluate these conflicting effects on the population dynamics of this stock.

The level of loggerhead abundance in the water during 1980-84 was stable and relatively large. Given current existing levels of mortality there is no apparent risk of major declines over the next 10 years. However, this population needs to be monitored regularly over the long term with continued full protection to detect changes in population levels and develop a predictive data base.

Green Turtle

Distribution and Abundance

Within the United States, green turtles currently nest along the Florida coast, Puerto Rico, and the U.S. Virgin Islands (Rebel, 1974). Florida east coast from Brevard to Broward Counties (roughly Cape Canaveral to Ft. Lauderdale). Historically the most significant nesting was on beaches of the Dry Tortugas, but this aggregation was extirpated by exploitation early in the 20th century. Currently, sporadic nesting continues to be observed as far north as North Carolina.

Historically, fisheries for this species were centered along the Texas coast and the Florida east and west coasts (Ehrhart, 1983; Hildebrand, 1981; Rebel 1974). Juveniles (<60 cm carapace length or CL) and a few subadults (60-90 cm CL) were captured primarily in nearshore waters and in local estuaries. Landings were reported from Port Aransas, Tex.; Cedar Key, Fla. (west coast), and along the Indian River, Fla. (east coast). Juveniles were also predictably captured during the summer in the bays and inlets along the North Carolina coast. Historically and presently it appears that the majority of green turtles in U.S. waters are immature (<60 cm CL). It is likely that at least some turtles arrive seasonally from the Caribbean and therefore this "population" cannot be treated as "closed." Thus, it is unlikely that all immature turtles in U.S. waters are products of U.S. nesting females, and the potential impact from any cause of mortality cannot be evaluated at this time.

There are no historical or current estimates of abundance for nesting turtles within the United States. Notably, the only significant nesting assemblage was reported on the Dry Tortugas. It was estimated that in the 1800's up to 2,800 females nested per year on the Dry Tortugas but this nesting population was extirpated through exploitation by the 1900's.

No current U.S. abundance estimate of nesting females is available. In fact, there is only one index of nesting activity which is for a very restricted area within Brevard County, Fla., where it has been estimated that about 40 females nest annually. It is likely that nesting occurs on the many Florida keys, cays, and elsewhere along the Florida east coast. The minimum annual estimate is a "best guess" and is about 300 females.

Very limited information is available for the species in the water. However, it is known that the majority of turtles within U.S. waters are immature. Historically, within the Indian River system on the Florida east coast the maximum green turtle catch was reported as 2,500 turtles in 1886. By 1895, the annual turtle catch was about 500 animals or a decrease of 80 percent from the 1886 level. This decrease is attributed to fishery activities and on unusually cold water in 1894-95, which ultimately caused the collapse of this fishery (Ehrhart, 1983).

Fishery activities resumed in this area around 1970 and increased from 1,625

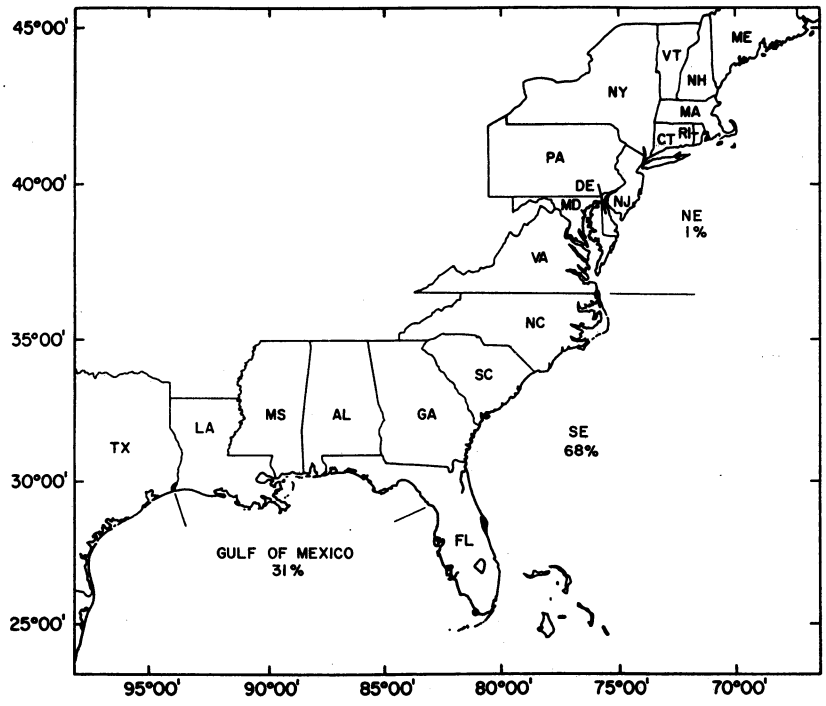

Figure 2.—Distribution of green turtle mortality by region along the Atlantic and Gulf coasts. The relative proportion of total strandings are presented by region.

kg landed in 1970 to 4,152 kg landed in 1974. Using the historical average weight per turtle caught of about 8 kg yields turtle catch values of 203 for 1970 to 519 for 1974. It is currently estimated that about 1,500 green turtles utilize this area (Ehrhart, 1983). Thus, within this restricted area, the number of turtles observed appears to be increasing since at least 1980.

Mortality

Turtles have been reported dead from the following sources: 1) Gillnet fisheries, 2) power plant entrapment, 3) hook and line fishing, 4) possibly from offshore oil platform removal by explosion, 5) shrimp fishing, 6) entanglement in ghost fishing gear and debris and 7) ingestion of debris.

The numbers of turtles that are caught or die from sources 1-4 are unknown. Shrimp fishing mortalities have been estimated for green turtles by NMFS and for loggerhead turtles (Table 1; Henwood and Stuntz, 1987). The total estimated number of green turtles killed represents about 3 percent of the total estimated number of loggerhead, green, and Kemp's ridley turtles killed. Notably, 36 percent of the total estimated mortality occurred in the northern Gulf, which includes Louisiana, Mississippi, Alabama, and the Florida panhandle. These turtles were immature and probably in transit to the Florida west coast. Green turtles in the northern Gulf may be in the omnivorous feeding stage (up to 3 years) and migrate to the west coast of Florida upon reaching the herbivorous stage. Thus, it appears that only the immature, omnivorous stage turtles are vulnerable to trawl capture which may impact recruitment into breeding populations. All turtles were caught in waters of less than 20 m depth. The mean water depth of capture in the Gulf and off the east coast was about 10 m.

A total of 317 green turtle reports are maintained in the STSSN data base representing about 4 percent of the total records which is consistent with the proportional representation of green turtles killed by shrimping. Of these, 97 (31 percent) were reported from the Gulf; 214 (68 percent) from the southeast and 6 (1 percent) from the northeast (Fig. 2).

Seasonal peaks for reported strandings are variable by region. In the western Gulf, the peaks in strandings occurred in the summer and late fall-early winter. In the southeast, there was a peak from October to January. In the northeast, strandings were only reported in September, November, and December. This species is considered subtropical and tropical in range. However, it is likely that expansion or contraction in range is associated with seasonal changes in water temperature. The occurrence of green turtles north of Virginia is considered unusual at any time of year.

Status of Stocks

There are no consistent current indices of abundance for this species within U.S. waters. The proportional representation of green turtles from the STSSN and from the estimated total number of turtles killed by shrimping are similar at 4 percent and 3 percent, respectively. If green turtles represent 3-4 percent of total turtle numbers in the southeastern United States, or 3-4 percent of loggerhead numbers, then there are about 600-800 nesting females from May to August or about 11,000-16,000 total turtles within the southeastern United States throughout the year.

If the increase in the number of females nesting on continental U.S. beaches and the increase in the numbers of nonadult turtles within the Indian River complex are real and not simply a result of improved sampling, then it appears that this population has been slowly increasing since at least 1980. Historical estimates are unavailable, but must have been considerable since several commercial fisheries for this species existed in the Gulf, Florida, and Caribbean were supported for several decades. A restricted segment of the "population" appears to be vulnerable to shrimp trawl mortality. Yet this species appears to be increasing in U.S. waters which suggests that existing and potential international conservation ef-

forts may result in the recovery of this species throughout its U.S. and Caribbean range.

Turtle mortality by shrimping has been estimated as about 307 (±218) per year. Because green turtles are known long-distance migrants, and no regional abundance estimates are available for the species throughout the southeastern United States, Gulf, and Caribbean, the impact of any fishing mortality on this species cannot be determined. The similarity in proportional representation of green turtles killed as reported to the STSSN data base suggests that shrimpers catch and kill turtles at a level which directly reflects their proportional contribution to the total number of sea turtles in the southeastern United States.

The relatively small numbers of green turtles present in the United States and the rapidity with which they were depleted in the 1880's suggests that the current protective management regime is still needed to promote recovery of this species. If the number of females nesting on U.S. beaches and the number of turtles in the Indian River provide adequate population indices, then it appears that this "population" has been increasing at least since about 1980. To manage this species properly within U.S. waters requires an answer to the questions of whether turtles nesting on U.S. beaches are residents or transients and whether juvenile turtles in U.S. waters are products of these females.

Kemp's Ridley Turtle

Distribution and Abundance

The Kemp's ridley turtle is found from the Atlantic coast of South America throughout the Gulf of Mexico to New England. Their primary concentration appears to be within the Gulf of Mexico, and nesting is known primarily along 17 km of Mexican Gulf beach identified as "Rancho Nuevo" (Fig. 3), the name of a nearby fishing village (Marquez et al., 1981; Rebel, 1974).

Kemp's ridley turtles feed primarily on portunid crabs (e.g., blue crabs) and as a result concentrate in coastal waters of less than 100 m depth, which is why they are predictably observed in bays, sounds, and estuaries. While most turtles may spend their entire lives within the Gulf of Mexico, there are some which leave the Gulf probably via the Florida Straits and forage as far north as the Gulf of Maine during summer months, returning to Florida waters during the fall and winter. Whether these animals are ever recruited into the breeding population is not known. However, NMFS considers these turtles as potential recruits into the breeding population and therefore deserving of complete protection.

The only estimate of abundance available for this species are annual estimates of nesting females. This species is an aggregate nester (forming so-called "arribadas") which nests during the day along Rancho Nuevo beaches from May to August. Very little nesting is known to occur outside of Rancho Nuevo, and thus the Rancho Nuevo population is treated as a closed population. Beach surveys have concentrated on counting nests since 1978 and using a value of 1.3 nests per female per year (Marquez, et al., 1981) provides one way to estimate the annual number of nesting females (n) for years 1978 to 1987 as:

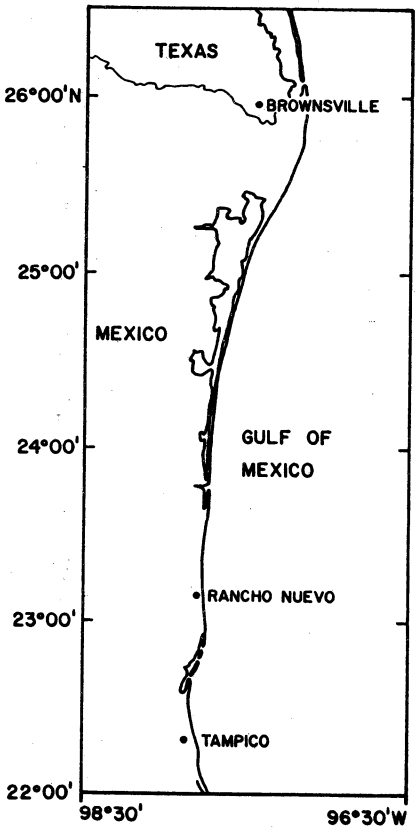

Figure 3.—Rancho Nuevo, Mexico, which is the focus of Kemp's ridley turtle nesting.

Year	*n*	*Year*	*n*
1978	642	1984	614
1980	636	1985	521
1981	690	1986	572
1982	577	1987	567
1983	574		

The annual average number of females nesting from 1978 to 1987 was 613 (±122, 95 percent C.I.). The largest estimate (734) was calculated for 1979 and the lowest for 1985 (521). Applying a simple linear regression to the natural log of numbers of nesting females vs. year shows a statistically significant ($P < .05$) decrease in number of nesting females of 3 percent per year. Recovery of this population to the only available historical annual estimate of 47,000 (from 1947) depends upon the rate of recruitment into the breeding population. At this time the annual recruitment appears to be less than annual mortality as demonstrated by the annual decrease in numbers of nesting females.

There are no estimates available for the numbers of nonnesting turtles throughout its range. However, it appears that the distribution of Kemp's ridley is very similar to the distribution of shrimping effort in the southeastern United States.

Mortality

A few records have been received by the STSSN indicating the following sources of incidental capture and death: 1) Pound nets (Virginia to Massachusetts, 2) fish traps (northeastern United States), 3) gill nets (sturgeon fishery, S.C.), 4) hook and line (surf fishing, Tex.), 5) power plant entrapment (southeast and northeast), 6) shrimping, and 7) entanglement in ghost fishing gear and debris and ingestion of debris.

A total of 460 Kemp's ridley turtle strandings have been archived in the SEFC/STSSN. By region, 49 percent

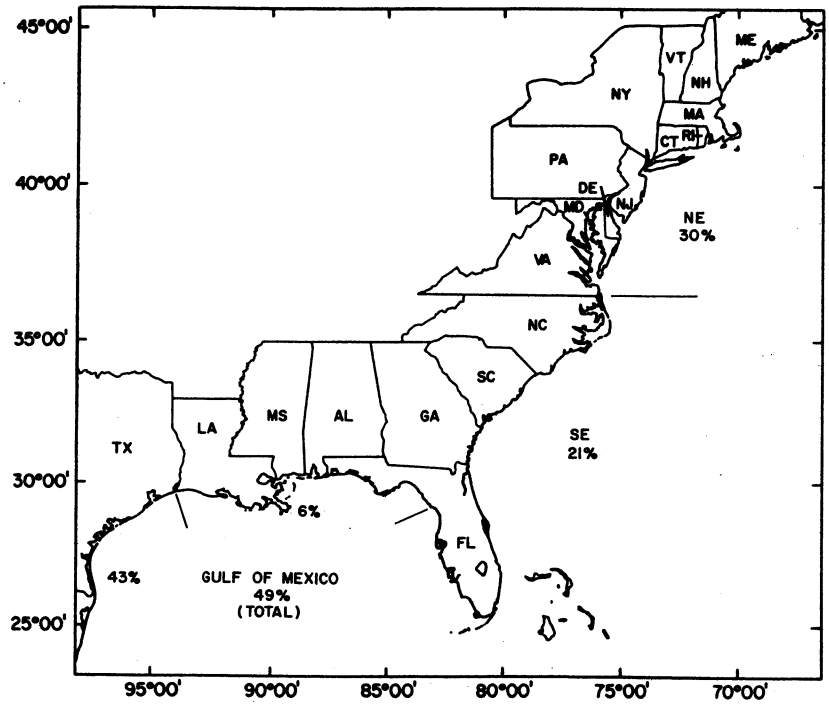

Figure 4.—Distribution of Kemp's ridley turtle strandings reported by region along the Gulf of Mexico and Atlantic coasts. The relative proportion of total strandings are presented by region.

were reported from the Gulf; 43 percent were reported only from the Texas coast; 30 percent were reported from the Northeast, primarily Virginia, New York, and Massachusetts, and 21 percent from North Carolina to the Florida east coast (Fig. 4). Within the southeast United States, 16 percent were reported from the western Gulf, 36 percent from the northern Gulf, and 5 percent from the eastern Gulf, and 43 percent from North Carolina to the Florida east coast.

Seasonal peaks in reported strandings by region were determined to be: April through November along Texas accounting for 93 percent of all Gulf strandings; and, November and December from the northeast Gulf and southeast Gulf. This late autumn peak in the northeast Gulf probably reflects turtle mortality resulting from "cold-stunning" or death from exposure to decreasing water temperatures. There were too few records in the remaining Gulf areas to discern any trends.

Estimates of CPUE were used to calculate the numbers of turtles killed by shrimping on a regional basis (Table 1). The total estimated catch in the southeastern United States, 1,409 (±282), was similar to that estimated for the Gulf, 1,726 (±863). All estimated CPUE values are one order of magnitude less than for loggerhead turtles, and thus loggerhead turtles are caught at least 10 times more frequently than Kemp's ridleys.

Mean water depth of capture in the Gulf and the Atlantic was 7.3 m (±4.82 m, 95 percent C.I.). While data collected by NMFS observers result in extremely precise estimates of mortality and provide insight into turtle distributions, they cannot alone be used to estimate numbers of turtles in the water. These data reflect the distribution of shrimping coincidental to turtle distributions. To sample for turtles requires sampling beyond shrimping grounds.

Total estimated numbers of Kemp's ridleys killed by shrimping are about equal for the Gulf and southeastern U.S. However, reported strandings were not evenly distributed between these two regions, with 43 percent reported from Texas alone. Thus, it is unlikely that all Kemp's strandings resulted from shrimping mortality. However, there is no way to partition mortality into fishing or natural.

Status of Stocks

The only index available to evaluate this species is the number of females nesting annually at Rancho Nuevo, Mexico. It appears that this value has decreased at an annual average of about 3 percent since 1978. The current average annual nesting population of 624 is about 1.3 percent of the minimum estimate of 47,000 reported in 1947 (Hildebrand, 1981). Depletion of this stock resulted from harvesting eggs and nesting females on the nesting beach from the 1950's to the early 1970's. Under the current regime of 3 percent loss of nesting females per year, it will take about 208 years for this nesting population to become extinct and about 59 years for it to be reduced to 100. However, with the number of nesting females currently less than 600, it is likely that extinction could occur sooner than predicted from the annual rate of loss of nesting females due to unpredictable environmental effects.

Marquez et al. (1981) presented an analysis showing an increase of 6 percent per year in numbers of nesting females using mark-recapture data collected since 1978. That is, they estimated annual recruitment into the nesting population as 6 percent based on the assumption that females arriving at Rancho Nuevo without tags were newly "recruited" into the nesting population. Thus, they assume no tag loss. There is no alternative evidence that recruitment has been enhanced. To the contrary, annual numbers of nesting females have been decreasing since 1978. Thus, if the current conditions remain, this nesting population will continue to decrease.

Conclusion

Of the three species discussed, loggerheads comprise about 90 percent of the total turtle numbers from Texas to

Maine. The Kemp's ridley turtle may represent as much as 6 percent, with green turtles comprising about 4 percent of the total turtle biomass. These relative proportions are represented within reported strandings and by the composition of turtles killed by commercial shrimping. However, discrepancies in the regional distributions of turtles killed by shrimping and turtles washing ashore dead indicate that reported strandings do not always reflect shrimp-related mortality. This is particularly true for the Kemp's ridley turtle which annually strands along the northeastern U.S. coast in significant numbers during the late autumn. Cause of mortality is rarely definitively identified from stranded turtles and the proportion of dead turtles washing ashore in the southeastern United States which result from shrimping cannot be determined. To evaluate turtle mortality resulting from shrimping or turtle mortality associated with any fishery activity, on-board observation provides the most precise data. This was shown as a result of the surveys conducted by the SEFC's Pascagoula Laboratory (Henwood and Stuntz, 1987).

The best available information for loggerhead, green, and Kemp's ridley turtles was evaluated on a regional basis. The population of loggerhead turtles from Texas to Maine appears to have been stable since 1980. Green turtles may be slowly increasing in numbers in specific areas, but no information is available on numerical abundance throughout its range from Texas to Florida. At the current rate of decrease of 3 percent per year for nesting Kemp's ridley turtles it is predicted that there will be 100 turtles nesting by the year 2196.

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