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SEA TURTLES

In Louisiana's Coastal Waters

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Prepared for

Coastal Fisheries Institute
and
Louisiana Sea Grant College Program
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INTRODUCTION

Sea turtles are large, marine reptiles. Because they live most of their lives in the water and some species are quite rare, much is still unknown about their distributions, breeding habits, preferred habitats and foods, and population status. We do, however, know a few general facts about these animals.

Sea turtles inhabit tropical and subtropical marine waters around the world. They may nest throughout this range, but most nesting occurs on restricted areas of beaches that the turtles return to each time they nest. Because foraging areas are often very far from nesting beaches, turtles may migrate long distances to nest. Mating generally takes place in offshore waters near the nesting beach. Males rarely come ashore. Mature females usually emerge at night and dig nests near the upper limits of the beach. A female lays a "clutch" of approximately 100 eggs per nest. Females may nest several times in one season, but most species do not usually nest every year. Incubation takes about two months. The hatchlings dig out of the nest and make their way to the sea. Many are lost to predators, both on the beaches and in the water. Young turtles ("juveniles") are rarely seen in the oceans. Little is known about the first year of life, but mortality is probably great. Because of high juvenile mortality, rapid growth, and adult longevity, most turtle populations may consist mainly of larger turtles (Caldwell 1960).

Five of the seven species of sea turtles are found in the Gulf of Mexico and Caribbean Sea; all five of these have been observed in Louisiana's coastal waters. At one time three of these species, the green turtle, hawksbill, and loggerhead, were very plentiful and had great commercial value. But over the past few decades, sea turtle populations have seriously declined. Three species of sea turtles are listed as endangered and two as threatened under the Endangered Species Act of 1973. (The "endangered" status is applied to a species in danger of extinction throughout all or significant portions of its range. The "threatened" status applies to species whose prospects for survival and reproduction are in immediate jeopardy or that exist in such small numbers throughout their range that they may become endangered if their environment worsens.) The endangered sea turtle species are the Kemp's ridley (35 Federal Register F.R. 18319-18322), hawksbill (35 F.R. 8495-8497), and leatherback (35 F.R. 8495-8497). The loggerhead and green turtle are listed as threatened (43 F.R. 32800-32811). In addition to the overall threatened status, the green turtle's breeding populations in Florida and the Pacific coast of Mexico are also considered endangered.

Sea turtle populations are declining for several reasons. Commercial exploitation and destruction of nesting habitat are primary causes for the decline, and many turtles are also unintentionally killed during commercial or sport fishing (Caldwell 1960). Shrimp trawls are the gear most frequently responsible for incidental capture of turtles (Ogren et al. 1977), and trawling is considered a significant factor in the decline of turtle populations (Carr 1972). Recent studies have also found turtle mortality to be associated with oil and gas exploration and ocean pollution.

This report will briefly review the biological background of each of the five species of sea turtles inhabiting the Gulf of Mexico, discuss the chief causes of turtle mortality and the preservation measures being undertaken, and summarize the results of an investigation of the status of sea turtles in Louisiana's coastal waters.

BIOLOGICAL BACKGROUND

Introduction

The following biological summaries briefly describe the physical characteristics, distribution and breeding habits, foods and habitats, and population status of each of the five Gulf of Mexico sea turtle species. These turtles are discussed in decreasing order of abundance in the Gulf, based on current data. The Kemp's ridley and loggerhead are known to be the two most abundant species, although which of these is more abundant is still debated. The green turtle, leatherback, and hawksbill are known to be less abundant than the Kemp's ridley and loggerhead, but their relative abundance is also still being investigated.

Kemp's Ridley

Description

The Kemp's, or Atlantic, ridley (*Lepidochelys kempi*), one of the smallest sea turtles, grows to be from 50 to 70 cm long (Ernst and Barbour 1972). Its carapace is heart-shaped or nearly round and often wider than it is long (Figure 1). The carapace ranges from gray or grayish brown to olive green (Rebel 1974), and the plastron (ventral or lower portion of the shell) is white in juveniles and yellowish in adults.

Distribution and Breeding Habits

Distribution of the Kemp's ridley is very restricted compared to distributions of other sea turtles. The adults' primary range is in the Gulf of Mexico from Florida to Mexico (Rebel 1974). Juveniles also occur in the Gulf and along the Atlantic coast (Lazell 1980). This turtle nests mostly along a stretch of beach in Mexico from Boca San Vincente to Baha Coma near Rancho Nuevo, Tamaulipas (Rebel 1974). Some nesting does occur along the Gulf Coast between Corpus Christi, Texas, and southern Veracruz, Mexico (Ernst and Barbour 1972), and nesting has been recorded on Padre Island, Texas (Werler 1951). Nesting occurs from April through mid-August (Ernst and Barbour 1972).

Kemp's ridleys mate offshore of the nesting beaches. They nest in large groups (arribadas) and are the only one of these five species of sea turtles to nest during the day (Caldwell 1966). They usually dig their nests in fine sand on the beach or dunes 13-45 m from the water (Chavez et al. 1968). Females may nest up to three times a season, and unlike other sea turtles, Kemp's ridleys may nest in successive years (Ernst and Barbour 1972). Females lay an average of 110 eggs each time they nest. Their nests are easy prey for mammals and crabs, and hatchlings are also eaten by crabs, birds, fishes, and turtles.

Habitat and Foods

Kemp's ridley seems to prefer shallow, coastal waters. It feeds along the Gulf Coast from southern Florida to the Yucatan (Carr 1961), and Louisiana may provide important developmental and feeding habitat for this species (Hildebrand 1982). Kemp's ridley is primarily a carnivore and seems to be a bottom feeder (Ernst and Barbour 1972). Its food

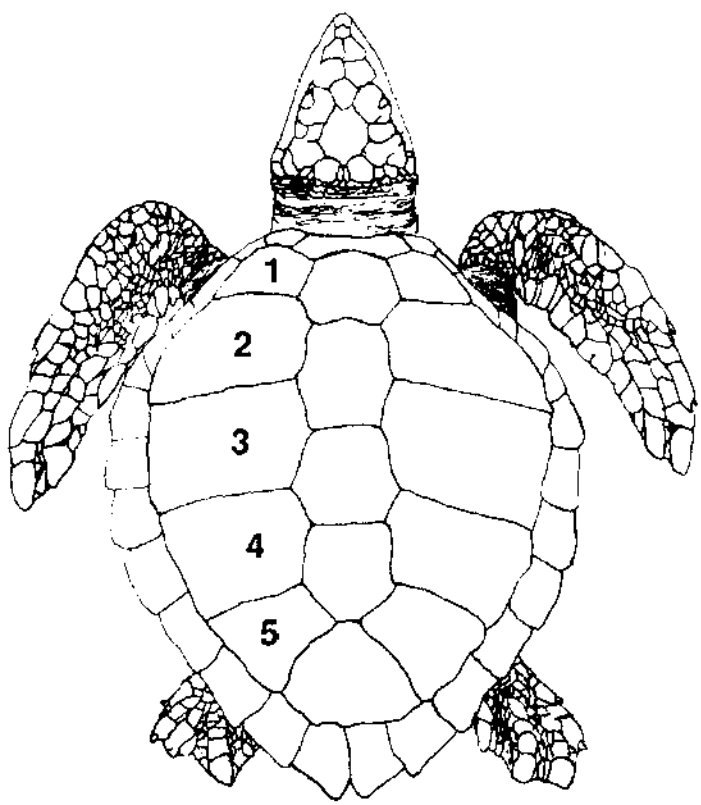

Figure 1. The Kemp's ridley sea turtle (*Lepidochelys kempi*). This species has five or more pairs of plates on its carapace.

includes crabs, fishes, and jellyfish (Smith and List 1950), barnacles (Liner 1954), and gastropods and clams (Dobie et al. 1961).

Population Status

Kemp's ridley is listed as an endangered species. Of all sea turtles, this species is probably the most in danger of extinction. Egg stealing, slaughter of nesting females, and fishing have drastically reduced its numbers (Ernst and Barbour 1972). Some researchers believe that accidental capture and drowning in shrimp trawls is now one of the most serious threats to Kemp's ridleys (Pritchard and Marquez 1973). Although as recently as 1947 approximately 40,000 of these turtles were observed at a major nesting beach (Carr 1963), the most recent estimate of the total Kemp's ridley population is less that 1,000. Of these, 600-800 are estimated to be sexually mature females (Mager 1985). There are presently no reliable estimates for other life stages of Kemp's ridleys.

Loggerhead

Description

The loggerhead turtle (*Caretta caretta*) averages 107 cm in length (Figure 2). Its carapace is oval and reddish brown to brown, and the plastron is yellow or cream colored. The large head is reddish or brown, and the scales often have a yellow border.

Distribution and Breeding Habits

The loggerhead's range is circumglobal, but it prefers temperate and subtropical waters (McDiarmid 1978). In the Atlantic Ocean, the loggerhead is commonly found from Argentina, throughout the Caribbean, and north to Virginia. It has been reported as far north as Nova Scotia and England (Carr 1952). On the Pacific coast, it is found from Chile to southern California and Hawaii.

Loggerheads have been observed nesting in the coastal states of the Atlantic and Gulf from North Carolina to Texas (Caldwell et al. 1959b). Most of these turtles breed along the Atlantic coasts of Florida, Georgia, and South Carolina. Loggerhead nesting has also been recorded in Africa, Australia, and the eastern Pacific (Ernst and Barbour 1972). In the South Atlantic, nesting begins in mid-May and continues through August.

For nesting, loggerheads along the eastern coast of the United States prefer a wide, sloping beach having dunes or vegetation that give the landscape a dark, broken horizon (Caldwell 1959). They commonly dig their nests above the high tide line on the seaward side of the dunes and nest at night, usually during high tide (Ernst and Barbour 1972).

Loggerheads usually breed and nest in 2- or 3-year cycles (Hughes 1982). Most females nesting on a given beach are not seen again in that same location. Mating takes place in the waters off the nesting beaches; females may nest four or five times during a season at intervals of 14-17 days (Pritchard 1979). Results of tagging studies reveal that these turtles may nest together several times and may stay together during the periods between nestings (Caldwell et al. 1959a). The entire nesting process takes about two hours (Kaufman 1968 cited by Rebel 1974), and females in Cape Romain have been observed to lay an average of 120 eggs each time they nest (Caldwell 1959).

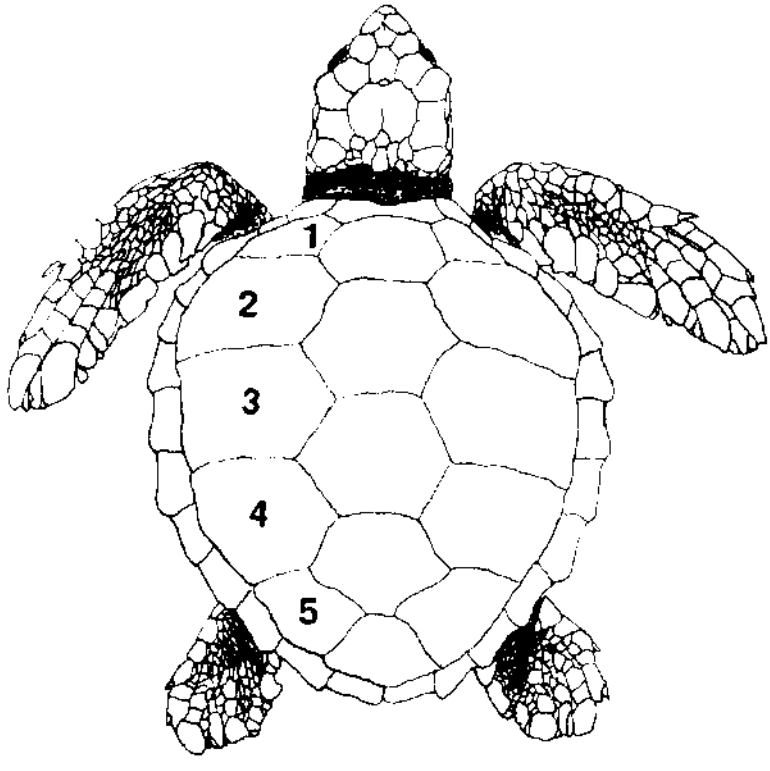

Figure 2. The loggerhead sea turtle (*Caretta caretta*). This species has five or more pairs of plates on its carapace.

Eggs and hatchlings may be victims of high predation. Land crabs and raccoons are the main nest predators, but ants also frequently attack nests (Rebel 1974). In addition, excessive rainfall can cause egg mortality (Ragotzkie 1959). Sand crabs, raccoons, gulls, crows, and other birds and mammals on the beach, as well as various fishes in the water, prey on hatchlings (Ernst and Barbour 1972). Commercial development along nesting beaches can also cause hatchling mortality.

Habitat and Foods

Although loggerheads seem to prefer the warm waters of the continental shelf (Rebel 1974), they have been found in a variety of habitats and are known to travel long distances (Bustard and Limpus 1971). They frequently forage around coral reefs, rocky places, and old boat wrecks, and often enter bays, lagoons, and estuaries (Ernst and Barbour 1972). Carr (1952) reported that loggerheads sometimes enter estuaries, coastal streams, salt marshes, and large river mouths. Loggerheads have also been found in the deeper waters of the oceans, as far as 804 km out in the open sea (Ernst and Barbour 1972). They have been caught on the red snapper banks of the Gulf of Mexico (Rebel 1974). Baby loggerheads sometimes are associated with drifting sargassum, which provides food and shelter (Carr 1986).

Loggerheads are omnivores. Their diet includes sponges, jellyfish, mussels, clams, oysters, conchs, borers, squid, shrimp, amphipods, crabs, barnacles, sea urchins, and various fishes, as well as some marine grasses and seaweeds (Ernst and Barbour 1972; Rebel 1974).

Population Status

The loggerhead is designated a threatened species. We know from this turtle's disappearance in some parts of its original range and its decreased numbers at some of its nesting grounds that its population is declining. In the southeastern United States, excluding the Gulf, the adult and subadult loggerhead population is estimated to number 387,594 (Thompson et al. 1986).

Loss of nesting grounds, increased predation by raccoons, and incidental catch are all factors responsible for the decline of this species. Humans eat the flesh of this turtle, and it has some commercial value. Other than man and sharks (Ernst and Barbour 1972), adult loggerheads have few predators.

Green Turtle

Description

The adult green turtle (*Chelonia mydas*) ranges in size from 81 to 152 cm (Figure 3). Its carapace ranges from light to dark brown and has darker mottled markings; the plastron is white or yellowish. The skin may be brown or gray, and many scales on the head have yellow margins.

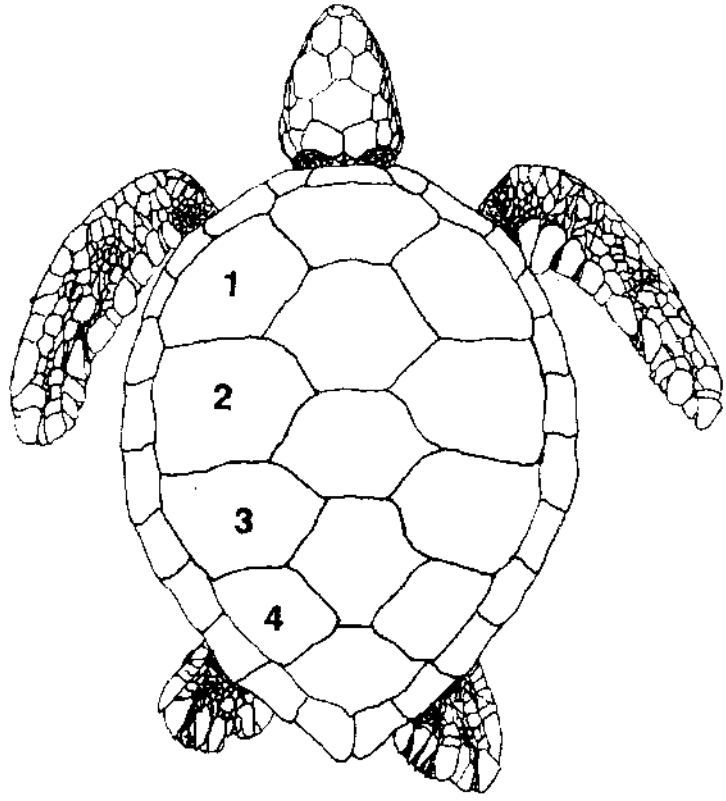

Figure 3. The green turtle (*Chelonia mydas*). This species has four pairs of plates on its carapace.

Distribution and Breeding Habits

The green turtle's distribution is worldwide; its nesting grounds are primarily concentrated between 35 degrees north and 35 degrees south latitudes (Rebel 1974). Along the western Atlantic, it has been observed as far north as Massachusetts and as far south as Necochea, Argentina (Carr 1952), and throughout the Gulf. Along the Pacific coast of North America, it roams as far north as southern British Columbia and as far south as Chiloe Island, Chile (Carr 1952; Mager 1985).

This turtle's nesting season varies from one region to another, but has been reported from May to August in Mexico and from May to November in Florida (Mager 1985). Substantial nesting occurs around the Yucatan Peninsula and the Caribbean, and some green turtles nest in Florida. Green turtles seem to prefer a nesting beach that has a steep slope, a beach platform high above flood tide, and lightweight, medium-coarse sand (Rebel 1974).

Most females that nest on a given beach are not seen again in the same location (Hughes 1982), but nesting can occur in 2-, 3-, or 4-year cycles. Copulation occurs in nearshore waters before and during the nesting season. The female takes approximately two hours to come ashore, dig a nest, deposit her eggs, cover the nest, and return to the sea. The average number of eggs laid per nest varies in different areas from approximately 80 to 140. Since nesting and foraging areas are often far apart, green turtles make long migrations between these areas.

Predators of the eggs and young probably include most of the carnivores and omnivores that live near a turtle nesting beach (Rebel 1974). Hatchlings are preyed upon by birds, crabs, and fishes. Fish predation is usually greatest when the hatchlings first cross reef areas on their way to sea (Frick 1976). Mortality rates in this age group are very high.

Habitat and Foods

Green turtles usually frequent shallow-water reefs and areas in shoals, lagoons, and bays where marine grasses and algae are plentiful (Rebel 1974). Mature turtles have been observed sleeping on the bottom with their shells lodged under a ledge or rock (Carr 1967).

Green turtles are mainly herbivores and feed upon marine grasses and algae (Rebel 1974). Small mollusks and crustaceans are also part of their diet. The young turtles are apparently more carnivorous than adults; they feed primarily upon weak marine invertebrates during their first year of life (Carr 1965).

Population Status

The green turtle is classified as an endangered species in Florida waters and as threatened throughout the rest of its range. Although sixteenth- and eighteenth-century populations have been estimated at 50 million turtles (Lund 1973), the most recent estimates of current populations are 62,500 sexually mature turtles in the west Caribbean and 100,000-400,000 sexually mature turtles of both sexes worldwide (NMFS 1978).

Commercial turtling, loss of nesting habitat, and incidental capture of this species are all factors in its decline. Green turtle adults and eggs have historically been sought as food in certain coastal areas, and this is probably the greatest cause for the decline of this species.

Commercial turtling has greatly decreased, but still poses a serious threat to green turtle populations (Mager 1985). Loss of coastal nesting areas to tourism and industry development and the incidental capture of green turtles by shrimp trawls have further decreased populations (Mager 1985).

Leatherback

Description

The adult leatherback (*Dermochelys coriacea*) is the largest of all sea turtles. Adults range from 152 to 183 cm long and can weigh from 1,760 to 2,860 kg. The leatherback's carapace does not have the horny shields that other sea turtles have, but instead has five to seven longitudinal ridges, or keels, covered with a leathery black skin imbedded with small, white, irregularly shaped bones that form a mosaic-like pattern (Figure 4). The plastron is whitish, and the head and neck are black or dark brown with yellow or white patches.

Distribution and Breeding Habits

The leatherback is found throughout the tropical waters of the Atlantic, Pacific, and Indian oceans (Ernst and Barbour 1972); Gulf of Mexico; and Caribbean (Carr 1952). Leatherbacks nest mainly on beaches between 30 degrees north latitude and 20 degrees south latitude and may roam into temperate areas to feed (Mager 1985). They travel great distances and have been found in higher latitudes more frequently than any other sea turtle (Rebel 1974). Although regular migration is not known to occur, the leatherback has been observed traveling in groups (Leary 1957). Nesting occurs from April to late July (Pritchard 1971). Courtship and mating are thought to occur in offshore waters during the nesting season (Ernst and Barbour 1972). For nesting, leatherbacks appear to prefer mainland beaches (Pritchard 1971) of coarse sand (McAllister et al. 1965 cited by Rebel 1974). They usually come ashore in areas free of rocks (McAllister et al. 1965) and lay an average of 50-170 eggs each time they nest (Ernst and Barbour 1972). Leatherbacks may nest several times a season, usually at intervals of 7-13 days (Pritchard 1971), probably in 2- or 3-year cycles (Rebel 1974). Hatchlings are preyed on by the same organisms as other sea turtles--crabs, gulls, and fishes.

Habitat and Foods

The leatherback is probably the most oceanic of all the sea turtles and appears to prefer deep waters (Rebel 1974). Although commonly found in waters over 46 m deep (Rebel 1974), this species occasionally enters shallow waters and estuaries, usually in more northern areas (Carr 1952; Ernst and Barbour 1972).

Leatherbacks are omnivorous (Carr 1952; Ernst and Barbour 1972). They feed primarily on jellyfish (Rebel 1974) and also consume tunicates, sea urchins, squids, crustaceans, fishes, some algae, and seaweeds (Ernst and Barbour 1972).

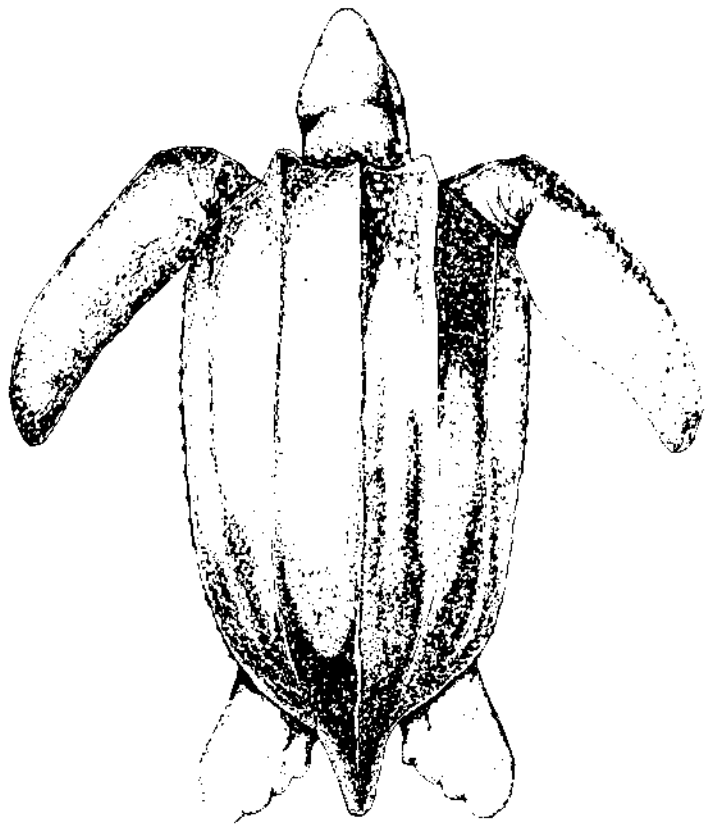

Figure 4. The leatherback turtle (*Dermochelys coriacea*). This species has five to seven lengthwise ridges on its leathery carapace.

Population Status

The leatherback is currently listed as an endangered species. In the 1960s, the world population of nesting pairs of leatherbacks was estimated to be approximately 1,000 (Fitter 1961). With the discovery of additional nesting beaches in the 1970s and 1980s, this estimate was revised to 120,000 nesting females (Pritchard 1983, cited in Mager 1985). The leatherback is not usually considered of commercial value, but its oil is occasionally used, and eggs are still collected in certain areas (Rebel 1974). Adult sea turtles have few natural enemies, other than sharks, killer whales (Caldwell and Caldwell 1969), and man (Ernst and Barbour 1972), although they may suffer from infestations of trematodes, intestinal amoeba, flat parasitic worms, and nematodes (Rebel 1974).

Hawksbill

Description

The hawksbill turtle (*Eretromechelys imbricata*) rarely exceeds 91 cm in carapace length or 68 kg in weight (Rebel 1974). This species has modified, beaklike jaws (Figure 5). The adult's carapace is amber, streaked with reddish brown, blackish brown, and yellow (Rebel 1974). The margin of the carapace is markedly serrate.

Distribution and Breeding Habits

The hawksbill is primarily distributed in tropical waters such as the warmer parts of the Atlantic Ocean, Gulf of Mexico, and Caribbean Sea (Carr 1952). In the Americas, it has been recorded from Woods Hole, Massachusetts, to southern Brazil, but is rarely found north of Florida. The hawksbill breeds and nests in diffuse areas within the warm waters between 25 degrees north and 25 degrees south latitude (Rebel 1974). No other sea turtle is such a solitary nester (Carr 1972). Depending on the location, nesting may occur from April through November (Carr et al. 1966; Pritchard 1969; Roze 1955, cited in Rebel 1974).

These turtles mate offshore of nesting beaches. For nesting, hawksbills prefer cleaner beaches with more oceanic exposure than do green turtles, although both are often found nesting on the same beach (Rebel 1974). Nests are usually on beaches of fine, gravelly textures (Rebel 1974). Females generally nest alone and lay an average of 160 eggs per nest (Carr et al. 1966); they may nest one to four times a season (Witzell 1983) at about 3-week intervals. Reproduction probably does not occur annually (Carr et al. 1966), but in 2- or even 3-year cycles (Rebel 1974). Hatchlings are subject to the same predators as green turtles (Rebel 1974).

Habitat and Foods

Hawksbill turtles are usually found in waters less than 15 m deep. They typically roam near coral reefs, shoals, lagoons, and lagoon channels and bays, where marine vegetation provides both protection (Carr et al. 1966) and plant and animal food (Rebel 1974). Carr (1952) found hawksbills to have a greater tolerance than green turtles for muddy bottoms and areas having less extensive vegetation. The common occurrence of barnacles on the carapace suggests that hawksbills generally lead a sedentary life (Carr et al. 1966).

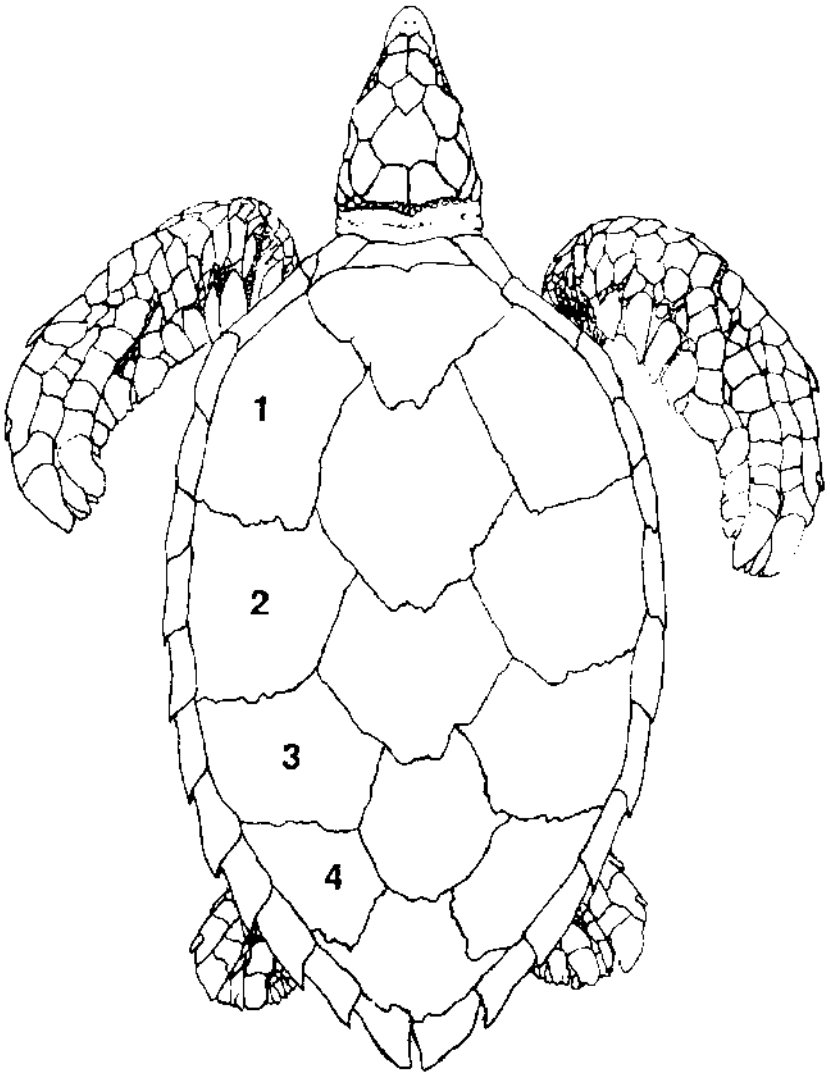

Figure 5. The hawksbill turtle (*Eretromechelys imbricata*). This species has four pairs of overlapping plates on its carapace and modified, beaklike jaws.

Hawksbills are omnivorous. They feed primarily on invertebrates such as sponges, sea urchins, barnacles, Portuguese man-of-wars, and smaller invertebrates; they also consume grasses and algae (Rebel 1974).

Population Status

Because of their large range and diffuse nesting habitats, hawksbill turtles are difficult to census. Their populations are known, however, to have declined drastically because of habitat destruction and overexploitation, and they are considered one of the sea turtles most in danger of extinction (Carr 1972). They are highly sought after for their shells, and this is the primary reason for their decline (Mager 1985). Adults are preyed upon by the same natural enemies as are green turtles, and one species of barnacle is known to bore into the carapace, plastron, and flippers (Hornell 1927 cited by Rebel 1974).

SEA TURTLE MORTALITY AND PRESERVATION MEASURES

Introduction

Exploitation and habitat loss are two major causes of the drastic declines in sea turtle populations. Incidental capture by shrimping and groundfishing operations is another factor becoming increasingly important as populations continue to decline. In addition, oceanic dumping and pollution (including such substances as oil, pesticides, and herbicides), oil and gas exploration, and dredge-and-fill activities have all been identified as sources of sea turtle mortality. These factors affect each species differently, depending on its range and socioeconomic importance. Preservation measures, such as habitat protection and "headstarting," are aimed at reducing adult and subadult mortality and increasing juvenile recruitment.

Exploitation and Protection

Exploitation of sea turtles in the Gulf of Mexico is best documented in southeastern Florida and Mexico. Green turtle populations most obviously show the impact of overexploitation; large populations in Florida were reduced almost to the point of nonexistence by the 1900s (King 1982). Kemp's ridleys and loggerheads were also taken commercially in Florida before the 1900s (Rebel 1974), and loggerhead eggs are still taken in most areas where this species nests (Hopkins and Richardson 1982).

Prior to the 1900s, populations of other species were also greatly reduced by commercial exploitation. Hildebrand (1982) mentions the existence in the 1800s of a Texas cannery for turtle meat that was closed by the 1900s. Hawksbill populations declined primarily because the eggs, meat, and shells were exploited. The high prices commanded by these items ensure their continued exploitation in countries not enforcing measures prohibiting commercial capture of sea turtles (Mager 1985).

The last figures available for the U.S. commercial turtle harvest prior to the enactment of the Endangered Species Act were collected in 1972. At this time, 59,474 kg of green turtle meat at a vale of $33,000 and 908 kg of loggerhead meat at a value of $230.00 were taken in the Gulf of Mexico (NMFS 1975).

Legislation now protects endangered and threatened sea turtles in U.S. waters. In addition to the Endangered Species Act, all the Gulf Coast states have laws protecting sea turtles or their eggs or both (Table 1). Strict law enforcement has reduced mortality due to commercial exploitation.

But because sea turtles' ranges are circumglobal, they need to be protected in waters outside U.S. jurisdiction as well. Over 70 conservation laws and regulations applying to sea turtles have been instituted worldwide (Navid 1982), two of them global in scope. Sea turtles and other endangered species are included in the Convention on International Trade in Endangered Species of Wild Fauna and Flora drafted in 1973 and signed by over 70 countries. Unfortunately, a few European and Asian countries do not agree that some species should be included, and these countries continue to trade in large quantities of turtle products. In addition, many countries that signed the agreement do not enforce it and thus have large-scale illegal trade (Van Meter 1983). Other countries, though, have instituted or

Table 1. Sea turtle conservation laws in effect in Gulf states.

State	Law
Florida	a) Unlawful to take, kill, or harass any marine turtles from Florida territory.
	b) Unlawful to take, disturb, or possess any marine turtle nest or eggs.
Alabama	Unlawful to take or possess marine turtles or their eggs.
Mississippi	Unlawful to take any turtles or eggs of species listed by the U.S. Fish and Wildlife Service as endangered or threatened.
Texas	Unlawful to take, kill, or disturb any sea turtles and eggs in or from waters of the state.
Louisiana	Unlawful to take the eggs of any species of turtle except the mobilian turtle (*Pseudemys* spp.) wherever found.

strengthened their own laws protecting sea turtles. For example, the Kemp's ridley turtle was subject to an extremely heavy harvest of eggs and nesting females outside U.S. jurisdiction before the 1960s. In 1966 the Mexican government began to patrol the nesting beach during breeding season (Chavez 1969), and this species is now protected by law in Mexico (Marquez 1976).

Loss of Beach and Nesting Habitat

Another factor that has greatly reduced sea turtle populations is loss of beach and nesting habitat. Beachside development has severely affected sea turtle populations. In some cases, nesting areas have been totally lost to construction of beachside dwellings. Artificial lighting, artificial barriers, riprap, and traffic can destroy a beach's value as sea turtle nesting habitat. Artificial lights not only discourage females from nesting, they can also disorient hatchlings as they emerge. Shading of beaches by tall buildings can also alter habitat by lowering sand temperatures, which affects the incubation of eggs.

Wildlife and other natural environmental factors on the beaches can also affect their suitability as nesting habitat. Some beaches suitable for nesting have extremely high populations of nest predators, such as raccoons, and little successful nesting occurs without human intervention. In other instances the introduction of exotic vegetation on beaches has made them poor nesting habitat. Natural erosion of beaches and flooding of nests can also alter nesting habitat.

To help ameliorate the problem of loss of beach and nesting habitat, Mexico has recently designated several areas as turtle sanctuaries. Many nesting beaches in the United States are already state or federally owned. In addition, human activities that could impact sea turtles, such as dredge-and-fill projects, are now subject to federal review.

Headstarting

A recently developed and still experimental technique, "headstarting," may represent one way of addressing both the problems of exploitation and loss of beach and nesting habitat.

Before turtle eggs on Mexico's Rancho Nuevo beach were protected in 1966, poaching probably prevented most Kemp's ridley eggs laid there from ever hatching. Since the 1970s, the Mexican and U.S. governments have been cooperating to protect nesting females and their nests. In 1978 the National Marine Fisheries Service (NMFS) began a program to rear Kemp's ridleys in captivity, the headstart program. Each year approximately 1,500-2,000 eggs are moved from Rancho Nuevo to the NMFS laboratory in Galveston, Texas (Caillouet 1987). There the eggs are hatched and the turtles raised in tanks until they are about one year old. Then they are tagged and released into the Gulf of Mexico. Researchers believe that keeping the turtles in captivity for a year increases their chances of survival by reducing their level of natural mortality. Nesting of headstarted Kemp's ridleys has not yet been observed, perhaps because they have not yet attained sexual maturity. Until nesting can be observed, the success of this program cannot be determined.

Incidental Capture and Protective Regulations

Because the Kemp's ridley, leatherback, hawksbill, and green turtle populations in Florida waters have been designated endangered under the U.S. Endangered Species Act, their incidental capture by commercial fishermen is prohibited.

Before the recent adoption of regulations regarding the use of turtle excluder devices (TEDs) and restricted towing times, incidental capture of sea turtles was not prosecuted providing that (1) fishing effort was not directed at the turtle; (2) any sea turtle incidentally taken was handled so as to avoid injury, returned to the sea whether alive or dead, and resuscitation was attempted if the turtle was alive and unconscious; and (3) any incidentally taken sea turtle was not consumed, landed, offloaded, transshipped, or kept below deck.

Regulations require that resuscitation be attempted on any turtles that are unconscious when landed if they are threatened species. Although the effectiveness of attempts to resuscitate sea turtles has been debated, Ulrich (1978) found that resuscitation and recovery periods do have merit. The appendix (p. 39) explains in detail the procedure for resuscitating an unconscious sea turtle.

Sea turtles are now further protected from incidental capture by regulations adopted in 1987 requiring specified categories of shrimp trawlers to use TEDs or restrict towing times under certain conditions.

Incidental Capture of Sea Turtles by Shrimp Trawlers

The shrimp trawl is believed to capture more turtles incidentally than any other gear (Hopkins and Richardson 1982). Many believe that the combination of the shrimp trawl's efficiency in capturing turtles and the large fishing effort of trawlers makes them a major cause of sea turtle mortality. NMFS has found that in some geographic areas seasonal peaks in sea turtle mortality correspond to seasonal peaks in shrimp trawling effort (U.S. Dept. Commerce 1987). In 1978 the Shrimp Management Plan for the U.S. Gulf of Mexico, developed for the federally mandated Gulf Council, made some of the first recommendations concerning the incidental capture of sea turtles by shrimp trawlers (Condrey 1980).

All species of sea turtles have been caught incidentally by the shrimp fishery. Loggerheads are the most frequently captured sea turtle, followed by the Kemp's ridley. Because of their feeding habits, these species are the most likely to be concentrated in the areas favored by shrimpers. Some researchers also believe that the discard of by-catch by shrimping vessels may attract sea turtles to these areas (Shoop and Ruckdeschel 1982). Some turtles do survive incidental capture, but when trawling time exceeds 90 minutes, the likelihood is high that the turtle will drown or suffocate.

NMFS has recently undertaken studies to determine how much shrimp trawlers contribute to sea turtle mortality. On the basis of data gathered during more than 27,000 hours of observation aboard commercial shrimp trawlers, NMFS estimates that 47,973 sea turtles are captured and 11,179 drowned in offshore commercial shrimp trawls in southeastern U.S. waters (North Carolina to Texas) each year (U.S. Dept. Commerce 1987). These estimates, which NMFS believes conservative, support the general finding that, although the capture of sea turtles may be fairly uncommon for individual shrimpers, the total number of sea turtles caught and killed is considerable (U.S. Dept. Commerce 1987).

Development and Use of TEDs

In 1978, NMFS began research to develop gear or methods to reduce mortality of sea turtles in shrimp trawls at a minimum cost to shrimpers. By 1981 NMFS had developed its TED, which fits across the mouth of a standard shrimp trawl. NMFS's continued modifications of this TED have resulted in a smaller, lighter version that is collapsible for easier and safer handling (U.S. Dept. Commerce 1987).

Other TEDs have also been developed by people in the fishing community; four TEDs have been approved by NMFS as fulfilling the TED requirements. NMFS has established rules and a procedure for testing other TEDs that may be developed: the standard for qualification is that the device exclude 97% of the size sea turtles encountered in the areas where the device will be used, and all testing to determine turtle exclusion must be supervised by NMFS (U.S. Dept. Commerce 1987). Industry has recently developed a "soft TED" (made of netting) that is being tested off Cape Canaveral, Florida.

Final Rule on TEDs and Towing Times

In 1987, under the authority of the Endangered Species Act, NMFS formulated regulations regarding the use of TEDs and restrictions on towing times of shrimp trawlers. NMFS had previously tried to institute an effective voluntary program of TED use, but found that not enough TEDs were used on a regular basis for the program to be successful (U.S. Dept. Commerce 1987). By 1989, about 7,000 U.S. shrimp trawlers will be required to purchase and use TEDs (U.S. Dept. Commerce 1987).

The rules formulated by NMFS and adopted by the Secretary of Commerce require that in designated offshore waters at specified times shrimp trawlers 25 ft and longer use qualified TEDs. All shrimp trawlers smaller than 25 ft are required to restrict tow times to 90 minutes or less. In inshore waters, at the specified times, all shrimp trawlers not using a TED in each net must restrict tow times to 90 minutes or less (U.S. Dept. Commerce 1987). These regulations may be modified before their implementation in 1988.

Incidental Capture by Other Fisheries

In addition to capture by shrimp trawlers, sea turtles have been taken incidentally in set-net, pound-net, gill-net, hook-and-line, and trap fisheries. Exact capture rates and mortalities in these fisheries have not been documented.

Mortality Associated with Oil and Gas Exploration

Activities associated with oil and gas exploration can cause turtle mortality in several ways. Turtles can become entangled in debris (such as cables) associated with offshore rigs and drown. Lighting on offshore oil rigs may also attract hatchlings. In addition, the use of underwater explosives in oil rig removal and exploratory drilling have recently been cited as possible causes of sea turtle mortality. Underwater explosions are known to kill nearby sea turtles, but their impact on populations is difficult to assess because information is lacking on the number of turtles associated with oil rigs.

Several methods are being considered to reduce or eliminate the impact of rig removals on sea turtles. One method is to scare turtles away from the rigs prior to explosions.

Another method is putting a "curtain" around the rig to keep the shock waves confined to a restricted area.

Pollution of Ocean Habitat

Physical and chemical pollution of the marine environment can adversely affect sea turtles. Small pieces of oil, styrofoam, and plastics accumulate in sargassum beds where small turtles are commonly found. Ingestion of these items can kill juvenile and adult turtles. Young green turtles have been found dead with tar balls in their mouths and throats. River pollutants may also be at fault; Frazier (1980) has questioned the effect of pollutants in the Mississippi River on Kemp's ridley populations in the coastal waters receiving river flow.

REPORTED SIGHTINGS OF SEA TURTLES IN LOUISIANA WATERS

Introduction

The threatened/endangered population status of the five sea turtles known to inhabit Louisiana waters indicates their sensitivity to environmental impacts such as pollution, commercial fishing, and oil exploration and recovery. Very little information on sea turtles in Louisiana exists, even though the state is considered important habitat for juvenile turtles. Existing information consists of stranding reports and observations (Thompson et al. 1986) and aerial surveys (Ogren 1978; Fritts et al. 1983). In 1985-86 Louisiana State University's Coastal Fisheries Institute conducted the study described in this section to collect specific information on the species, ages, and seasonal and geographic distributions of sea turtles in Louisiana's coastal waters (Fuller and Tappan 1986).

Methods

Data for this study were collected primarily by interviewing fishermen and other marine-oriented people, including scuba divers, helicopter pilots, and state and university biologists. Informal interviews were conducted throughout coastal Louisiana (Figure 6). Letters were also sent to helicopter companies and state and university biologists requesting any information they could provide on sea turtles in Louisiana.

Results

Because the information collected was frequently based on recollections, the data were divided into two categories: (1) recent, covering 1982 to 1986, and (2) historical, covering sightings before 1982 and sightings without information on date of occurrence.

During 1985-86, 131 persons were interviewed. Commercial shrimpers were 79% of the total; those included had shrimped in Gulf Coast waters off Louisiana for an average of 19 years (Table 2). Divers accounted for 10% of the total, recreational shrimpers 6%, and fishermen 3%. The remaining 2% were offshore workers and pilots. Approximately one of every four persons interviewed had never seen a turtle.

Historical Sightings

The species was not identified in nearly one-half of all reported historical sightings (Table 3). When the species was identified, it was most often the Kemp's ridley. The sightings reported with known dates occurred throughout the year. Historical sightings were reported for the entire coast (Figure 7).

Recent Sightings

Data were collected on 108 sightings from 1982 to September 1986 (Table 4). The species could not be identified in one-third of these sightings.

Table 2. The percentage distribution of persons interviewed in coastal Louisiana in 1986, by NMFS fishing zones, for each category of marine activity and the average number of years of participation in that activity.

Zone	Commercial shrimper (n=103)	Recreational shrimper (n=8)	Fisherman (n=4)	Diver (n=13)	Pilot (n=1)	Offshore worker (n=2)
12	33	75	67	0	100	0
13	33	0	33	31	0	0
14	9	0	0	31	0	0
15	2	12	0	8	0	0
16	12	0	0	8	0	100
17	2	12	0	8	0	0
Gulf	10	0	0	15	0	0
Average years at activity	18.8	6.7	8.3	15.8	2	--

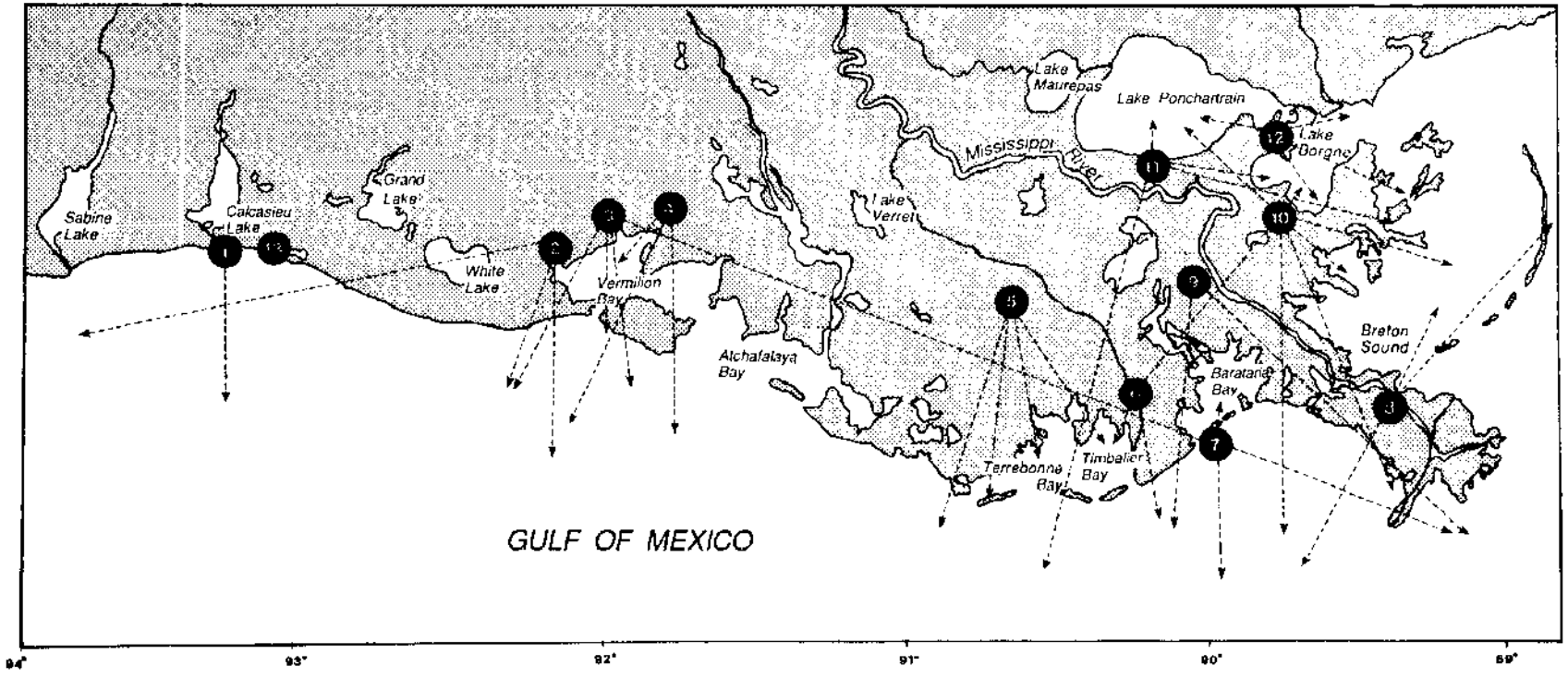

Figure 6. Locations of 1986 interviews and field observations. Arrows show general shrimping or fishing areas of those interviewed at these sights.

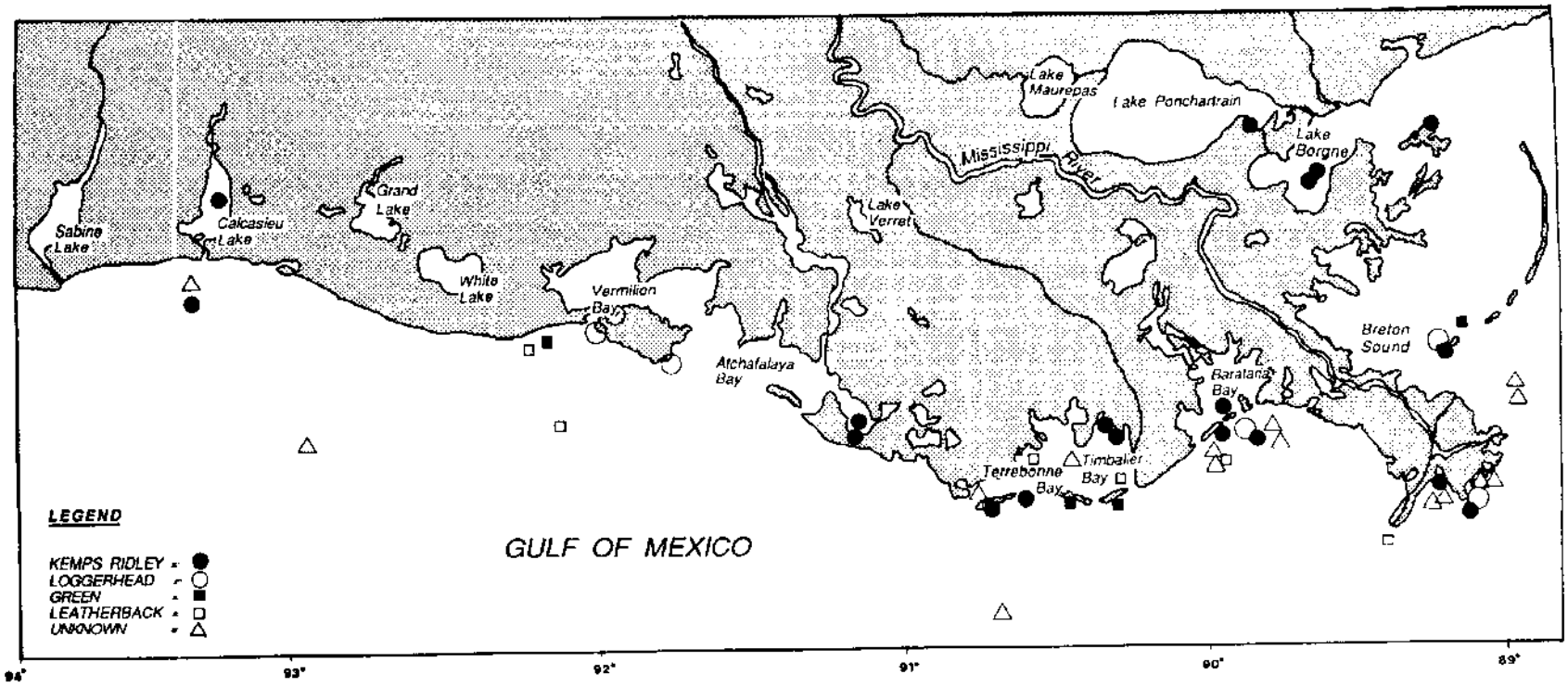

Figure 7. Locations of historical sightings of sea turtles along the Louisiana coast.

Table 3. Numbers of historical sea turtle sightings along the Louisiana coast, by species, reported during 1986 interviews.

Species	Reported by shrimpers and fishermen (n=28)	Reported by others (n=16)	Percentage of species composition	Mean carapace length[a] (m)
Kemp's ridley	4	11	27	0.5 (9)
Loggerhead	5	0	9	0.8 (2)
Green	3	0	5	0.6 (2)
Hawksbill	0	0	0	----
Leatherback	5	2	13	2.4 (3)
Unknown	17	8	45	----

[a]Numbers of carapace measured to calculate each mean length are given in parentheses.

Table 4. Numbers of recent sea turtle sightings along the Louisiana coast, by species, reported during 1986 interviews.

Species	Reported by shrimpers and fishermen (n=41)	Reported by others (n=27)	Reported strandings	Percentage of species composition
Kemp's ridley	30	10	25	46
Loggerhead	11	2	4	12
Green	9	1	0	7
Hawksbill	0	1	0	1
Leatherback	0	2	2	3
Unknown	25	17	2	31

Kemp's Ridley

Kemp's ridley was the most frequently reported species, accounting for 67% of the identified turtles (Table 4). These sightings seem to confirm the value of Louisiana waters as habitat for this species. The Kemp's ridley turtle was present throughout the year and most abundant in the extreme southwestern and southeastern parts of the coast (Figure 8). Kemp's ridleys were also observed in inshore waters more frequently than any other species. The average shell length reported was 0.43 m, indicating that these were juvenile turtles.

Loggerhead

Loggerheads were the second most frequently reported species (Table 4). Sightings were reported from May through January; most sightings occurred east of the Vermilion River (Figure 9). The average shell length of loggerheads was 0.79 m, indicating that most of them were juvenile turtles.

Green Turtle

Green turtles were the next most reported species, but only ten were sighted (Table 4). Most of the reported sightings were in the southeastern part of the state (Figure 9). The average shell length for this species was similar to that of the Kemp's ridley and loggerhead, again indicating primarily juvenile turtles.

Leatherback

Only two leatherback sightings were reported (Table 4), both of these by pilots. A comparison of this with other observations on leatherbacks suggests that they usually remain offshore, where fishing effort is generally low (Figure 9).

Hawksbill

Only one hawksbill was sighted during the study (Table 4); it was caught in a gill net in Cameron Parish (Figure 9). This supports the general belief that hawksbills are scarce in Louisiana waters.

Study Conclusions

The majority of the sea turtle sightings were reported by commercial fishermen who fish along the entire coast of Louisiana. Most of their effort was concentrated in southeastern Louisiana. Approximately one of every four persons interviewed had never seen a sea turtle.

In decreasing order of abundance, the species observed were the Kemp's ridley, loggerhead, green turtle, leatherback, and hawksbill. Kemp's ridleys were observed in inshore waters more frequently than any other species. Inshore bays and lakes may be important habitat for this species.

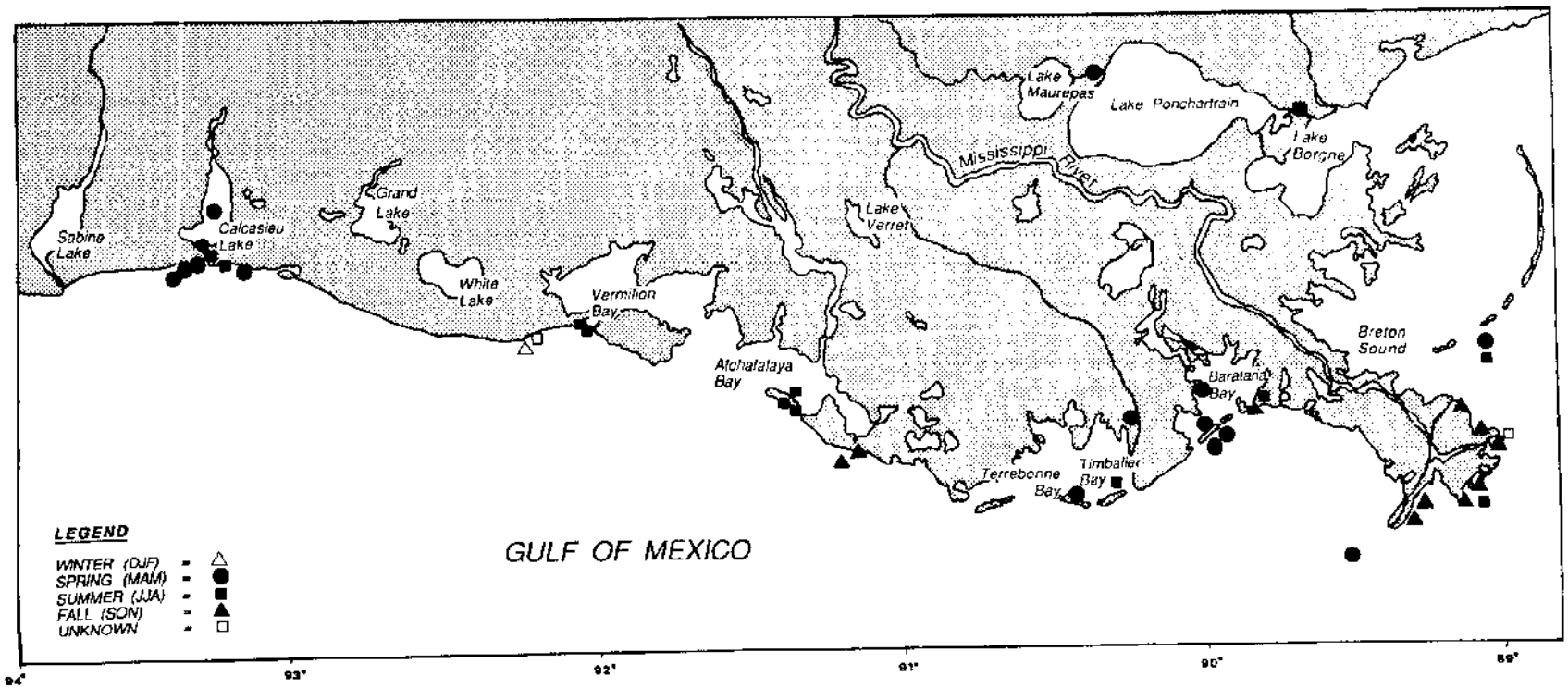

Figure 8. Locations of recent Kemp's ridley sightings along the Louisiana coast.

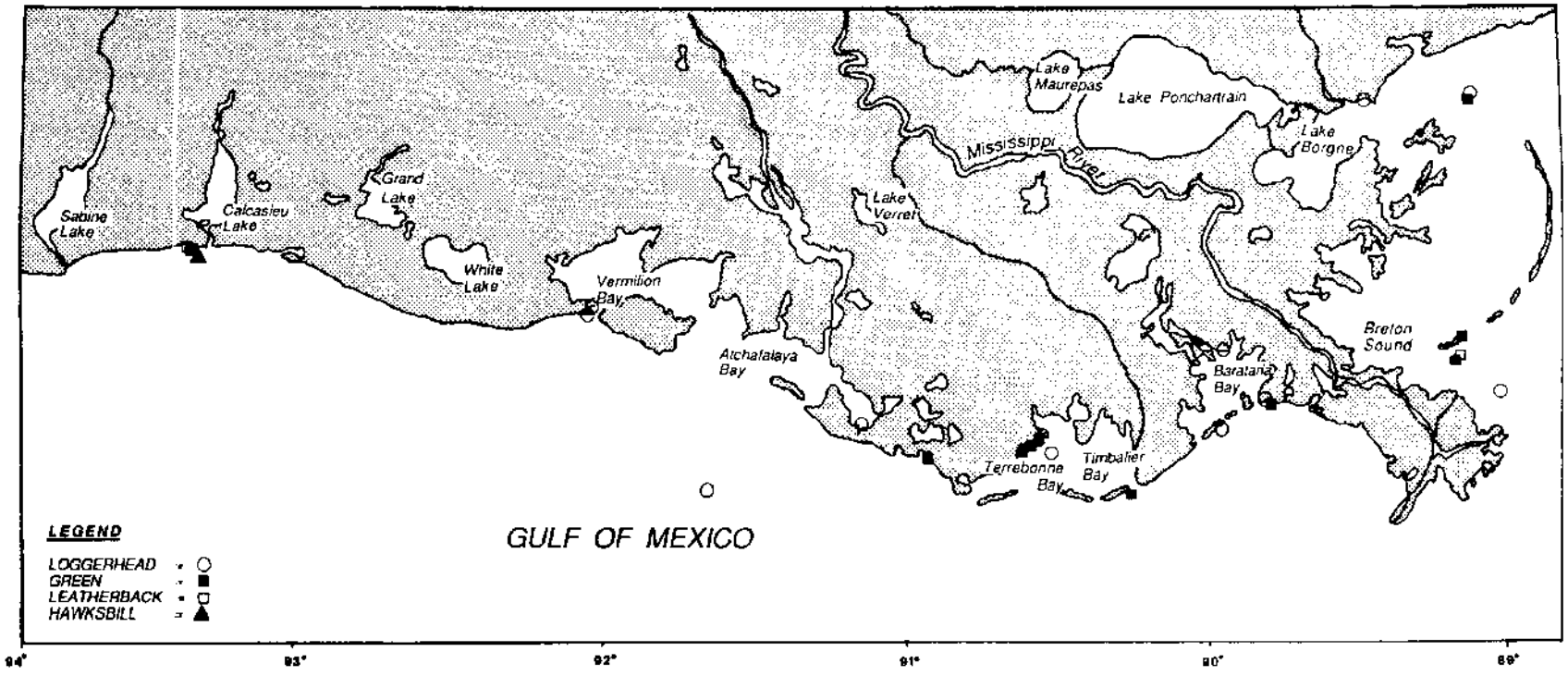

Figure 9. Locations of recent sightings of loggerhead, green, leatherback, and hawksbill turtles along the Louisiana coast.

Although this information is a good beginning toward filling some of the gaps in our knowledge of sea turtles, the findings reported here depended greatly on the amount, timing, and location of fishing effort. We now need information that is independent of fishing effort to attain more complete knowledge of sea turtle distribution in Louisiana coastal waters.

CONCLUSIONS

Even though many gaps remain in our knowledge of sea turtles, we do know that their populations are in danger of extinction. The historical overexploitation of sea turtles has left them highly vulnerable to many types of mortality. And it may be many years before we see results from our current conservation measures.

It is becoming increasingly evident that Louisiana's coastal waters provide important habitat for juvenile turtles. Unfortunately, many activities occurring in our waters could adversely affect turtle populations. We need to learn more about these turtles and how to preserve the environment that they need for survival--before it is too late.

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Diane K. Baker of Louisiana State University's Center for Wetland Resources designed and executed the cover illustration. The sea turtle drawings were prepared by Eileen Hill, and Talik Sarkar of the Louisiana Sea Grant College Program drafted the other figures. Bonnie Grayson of the Louisiana Sea Grant College Program prepared the manuscript on the word processor, and Elizabeth Coleman coordinated manuscript production and distribution.

REFERENCES CITED

Bustard, H. R., and C. Limpus. 1971. Loggerhead turtle movements. British Journal of Herpetology 4:228-229.

Caillouet, C. W., Jr. 1987. Report on efforts to prevent extinction of Kemp's ridley sea turtle through headstarting. NOAA Technical Memorandum NMFS-SEFC-188. Galveston, Tex.: National Marine Fisheries Service, Southeast Fisheries Center, Galveston Laboratory.

Caldwell, D. K. (ed). 1959. The loggerhead turtles of Cape Romain, South Carolina. Bull. Florida State Museum of Biological Sciences 4(10):319-348.

Caldwell, D. K. 1960. Sea turtles of the United States. U.S. Fish and Wildlife Service Fisheries Leaflet 492.

Caldwell, D. K. 1966. A nesting report on the American ridley. International Turtle and Tortoise Society Journal 1(1):10-13.

Caldwell, D. K., F. H. Berry, A. Carr, and R. A. Ragotzkie. 1959a. Multiple and group nesting by the Atlantic loggerhead turtle. Bull. Florida State Museum of Biological Sciences 4(10):309-318.

Caldwell, D. K., A. Carr, and L. H. Ogren. 1959b. Nesting and migration of the Atlantic loggerhead turtle. Bull. Florida State Museum of Biological Sciences 4(10):295-308.

Caldwell, D. K., and M. C. Caldwell. 1969. Addition of the leatherback sea turtle to the known prey of the killer whale, *Orcinus orca* . Journal of Mammology 50(3):636.

Carr, A. F. 1952. Handbook of turtles--the turtles of the United States, Canada, Baja California. New York: Comstock Publishing Assoc.

Carr, A. F. 1961. The ridley mystery today. Animal Kingdom 64(1):7-12.

Carr, A. F. 1963. Panspecfic reproductive convergence in *Lepidochelys kempi* . Ergebnisse der Biologie 26:298-303.

Carr, A. F. 1965. The navigation of the green turtle. Scientific American 212(5):79-86.

Carr, A. F. 1967. So excellent a fishe. Garden City, N.Y.: The Natural History Press.

Carr, A. F. 1972. Great reptiles, great enigmas. Audubon 74(2):24-34.

Carr, A. F. 1986. Rips, FADS, and little loggerheads. Bioscience 36(2):92-100.

Carr, A. F., H. Hirth, and L. Ogren. 1966. The ecology and migrations of sea turtles: the hawksbill turtle in the Caribbean Sea. American Museum Novitiates 2248.

Chavez, H. 1969. Tagging and recapture of the lora turtle (*Lepidochelys kempi*). International Turtle and Tortoise Society Journal 3(4):14-19, 32-36.

Chavez, H., M. Contreras G., and T. P. E. Hernandez D. 1968. On the coast of Tamaulipas II. International Turtle and Tortoise Society Journal 2(5):16-19, 27-34.

Condrey, R. E. 1980. Fishery management plan for the Gulf of Mexico. Federal Register 45(218):74178-74308.

Dobie, J. L., L. H. Ogren, and J. F. Fitzpatrick, Jr. 1961. Food notes and records of the Atlantic ridley turtle (*Lepidochelys kempi*) from Louisiana. Copeia 1961 (1):109-110.

Ernst, L. H., and R. W. Barbour. 1972. Turtles of the United States. Lexington, Ky.: University of Kentucky Press.

Fitter, R. S. R. 1961. The leathery turtle or luth. Oryx 6:116-125.

Frazier, J. G. 1980. Marine turtles and problems in coastal management. Pp. 2395-2411 in B. C. Edge (ed.), Coastal Zone '80: Proceedings of the Second Symposium on Coastal and Ocean Management, Vol. 3. New York: American Society of Civil Engineers.

Frick, J. 1976. Orientation and behavior of hatchling green turtles (*Chelonia mydas*) in the sea. Animal Behavior 24(47):849-857.

Fritts, T. H., W. Hoffman, and M. A. McGehee. 1983. The distribution and abundance of marine turtles in the Gulf of Mexico and nearby Atlantic waters. Journal of Herpetology 17(4):327-344.

Fuller, D. A., and A. M. Tappan. 1986. The occurrence of sea turtles in Louisiana coastal waters. LSU-CFI-86-28. Baton Rouge, La.: Louisiana State University, Center for Wetland Resources.

Hildebrand, H. H. 1982. A historical review of the status of sea turtle populations in the western Gulf of Mexico. Pp. 447-453 in K. A. Bjorndal (ed.), Biology and conservation of sea turtles. Washington, D.C.: Smithsonian Institution Press.

Hopkins, S. R., and J. J. Richardson (eds.). 1982. Recovery plan for marine turtles. Technical report prepared by the Marine Turtle Recovery Team for the National Marine Fisheries Service. St. Petersburg, Fla.: National Marine Fisheries Service, Southeast Region, Protected Species Management Branch.

Hornell, J. 1927. The turtle fisheries of the Seychelles Islands. London, England: H. M. Stationery Office.

Hughes, G. R. 1982. Nesting cycles in sea turtles--typical or atypical? Pp. 81-89 in D. A. Bjorndal (ed.), Biology and conservation of sea turtles. Washington, D.C.: Smithsonian Institution Press.

Kaufman, R. 1968. Zur Brutbiologie der Meeresschildkrote *Caretta caretta caretta*. L. Mitt. Inst. Colombo-Aleman Invest. Cient. 2:45-56.

King, F. W. 1982. Historical review of the decline of the green turtle and the hawksbill. Pp. 183-188 in K. A. Bjorndal (ed.), Biology and conservation of sea turtles. Washington, D.C.: Smithsonian Institution Press.

Lazell, J. D. 1980. New England waters: critical habitat for marine turtles. Copeia 1980 (2):290-295.

Leary, T. R. 1957. A schooling of leatherback turtles, *Dermochelys coriacea*, on the Texas coast. Copeia 1957(3):232.

Liner, E. A. 1954. The herpetofauna of Lafayette, Terrebonne, and Vermilion parishes, Louisiana. Louisiana Academy of Sciences 17:65-85.

Lund, F. 1973. Foreign status of sea turtles. Report to the U.S. Fish and Wildlife Service, Pacific ridley, Washington, D.C.

Mager, Andreas, Jr. 1985. Five-year status reviews of sea turtles listed under the endangered species act of 1973. St. Petersburg, Fla.: National Marine Fisheries Service.

Marquez, R. M. 1976. Natural reserves for the conservation of marine turtles of Mexico. Pp. 56-60 in G. E. Henderson (ed.), Proceedings of the Florida and Interregional Conference on Sea Turtles, 24-25 July 1976, Jensen Beach, Fla. Florida Marine Research Publications No. 33. St. Petersburg, Fla.: Florida Department of Natural Resources, Marine Research Laboratory.

McAllister, H. J., A. J. Bass, and H. J. van Schoor. 1965. Marine turtles on the coast of Tongaland, Natal. I. Lammergeyer 3(2):12-40.

McDiarmid, R. W. 1978. Rare and endangered biota of Florida, vol. 3: amphibians and reptiles. Gainesville, Fla.: University Presses of Florida.

Navid, D. 1982. Conservation and management of sea turtles: a legal overview. Pp. 523-535 in K. A. Bjorndal (ed.), Biology and conservation of sea turtles. Washington, D.C.: Smithsonian Institution Press.

NMFS (National Marine Fisheries Service). 1975. Draft Environmental Impact Statement: Proposed listing of the green sea turtle (*Chelonia mydas*), loggerhead sea turtle (*Caretta caretta*), and Pacific ridley sea turtle (*Lepidochelys olivacea*) as threatened species under the endangered species act of 1973. Washington, D.C.: National Marine Fisheries Service, U.S. Dept. Commerce.

NMFS (National Marine Fisheries Service). 1978. Listing and protecting the green sea turtle (*Chelonia mydas*), loggerhead sea turtle (*Caretta caretta*), and Pacific ridley sea turtle (*Lepidochelys olivacea*) under the Endangered Species Act of 1973. Final Environmental Impact Statement. Washington, D.C.: National Marine Fisheries Service, U.S. Dept. Commerce.

Ogren, L. H., J. W. Watson, Jr., and D. A. Wickham. 1977. Loggerhead sea turtles, *Caretta caretta*, encountering shrimp trawls. Marine Fisheries Review 39(11):15-17.

Ogren, L.H. 1978. Survey and reconnaissance of sea turtles in the northern Gulf of Mexico. Miami, Fla.: National Marine Fisheries Service, Southeast Fisheries Center.

Pritchard, P. C. H. 1969. Sea turtles of the Guianas. Bull. Florida State Museum of Biological Sciences 13(2):85-140.

Pritchard, P. C. H. 1971. The leatherback or leathery turtle, *Dermochelys coriacea*. Morges, Switzerland: IUCN Monograph No. 1.

Pritchard, P. C. H. 1979. Encyclopedia of turtles. Englewood Cliffs, N.J.: T. F. H. Publications.

Pritchard, P. C. H. 1983. Leatherbacks. Paper presented at the Third Annual Sea Turtle Research Workshop, 7-8 April 1983, Charleston, S.C.

Pritchard, P. C. H., and R. Marquez. 1973. Kemp's ridley turtle or Atlantic ridley, *Lepidochelys kempi*. Morges, Switzerland: IUCN Monograph 2.

Ragotzkie, R. A. 1959. Mortality of loggerhead turtle eggs from excessive rainfall. Ecology 40(2):303-305.

Rebel, T. P. 1974. Sea turtles and the turtle industry of the West Indies, Florida, and the Gulf of Mexico. Coral Gables, Fla.: University of Miami Press.

Roze, J. A. 1955. Las tortugas marinas de Venezuela. Rev. Pecuaria (Caracas) No. 240:9-11.

Shoop, C. R., and C. Ruckdeschel. 1982. Increasing turtle strandings in the southeast United States: a complicating factor. Biological Conservation 23:213-215.

Smith, P. W., and J. C. List. 1950. Notes on Mississippi amphibians and reptiles. American Midl. Nat. 53(1):115-125.

Thompson, N. B., T. Henwood, W. E. Stuntz. 1986. A summary of information on three species of marine turtles in U.S. waters. Miami, Fla.: National Marine Fisheries Service, Southeast Fisheries Center.

Ulrich, G. F. 1978. Incidental catch of loggerhead turtles by South Carolina commercial fisheries. St. Petersburg, Fla.: National Marine Fisheries Service, Southeast Region.

U.S. Department of Commerce. 1987. Sea turtle conservation; Shrimp trawling requirements; final rule. Federal Register 52(124):24244-24262.

Van Meter, V. B. 1983. Florida's sea turtles. Miami, Fla.: Florida Power and Light Company, Corporate Communications.

Werler, J. E. 1951. Miscellaneous notes on the eggs and young of Texas and Mexican reptiles. Zoologica 36(3):37-48.

Witzell, W. N. 1983. Synopsis of biological data on the hawksbill turtle, *Eretmochelys imbricata* (Linnaeus, 1776). FAO Fisheries Synopsis 137:78.

APPENDIX: RESUSCITATION OF APPARENTLY DROWNED SEA TURTLES

Note: This information is taken from
Hopkins, S. R., and J. J. Richardson (eds.). 1982. Recovery plan for marine turtles. Technical draft report prepared by the Marine Turtle Recovery Team for the National Marine Fisheries Service. St. Petersburg, Fla.: Protected Species Management Branch, Southeast Region, NMFS, NOAA, U.S. Dept. Commerce.

Sea turtles caught and held under water are physiologically stressed and often become comatose and appear lifeless. These stressed turtles may appear to be dead, but death cannot usually be determined by the turtle's appearance or lack of movement. When the turtle has a chance for the lungs to drain, it often recovers to an active state. This recovery may require 1, 2, or as many as 24 hours. Throwing a comatose turtle into the water will drown it. For this reason, the following steps should be taken to attempt resuscitation of turtles caught that are not moving.

1. When a sea turtle is brought on board a fishing vessel (in a net or on a line), observe it briefly for activity.

2. If the turtle is actively moving, return it to the water without harm or damage (away from the propeller, or with the vessel in neutral) in an area where recapture is unlikely.

3. If the turtle is not moving or is apparently lifeless (comatose), then

   a. Place the turtle on its belly (plastron).

   b. Prop up the rear end of the turtle (several inches, higher with larger turtles).

   c. Keep the turtle shaded and wet or moist.

   d. If the turtle recovers and begins to move actively, return it to the water according to instruction no. 2 above.

   e. If the turtle does not move within several hours (up to 24 if possible), it is presumed dead. Then the turtle must be returned to the water.

Other Important Information:

1. Some sea turtles caught in nets or on lines may have been dead for some time before being brought on board. These turtles will usually be extremely bloated and have a strong, bad smell. Return them to the water immediately.

2. All records of captured or killed sea turtles are important. Records of loggerhead sea turtles caught (including where, when, and how caught and released) should be kept and made available to scientists upon request.

3. Do not return to dock or shore with any sea turtle on board. It is illegal to catch Kemp's ridley, hawksbill, or leatherback sea turtles and Florida breeding populations of green sea turtles. It is illegal importation to bring a loggerhead turtle to dock without a federal or state permit.