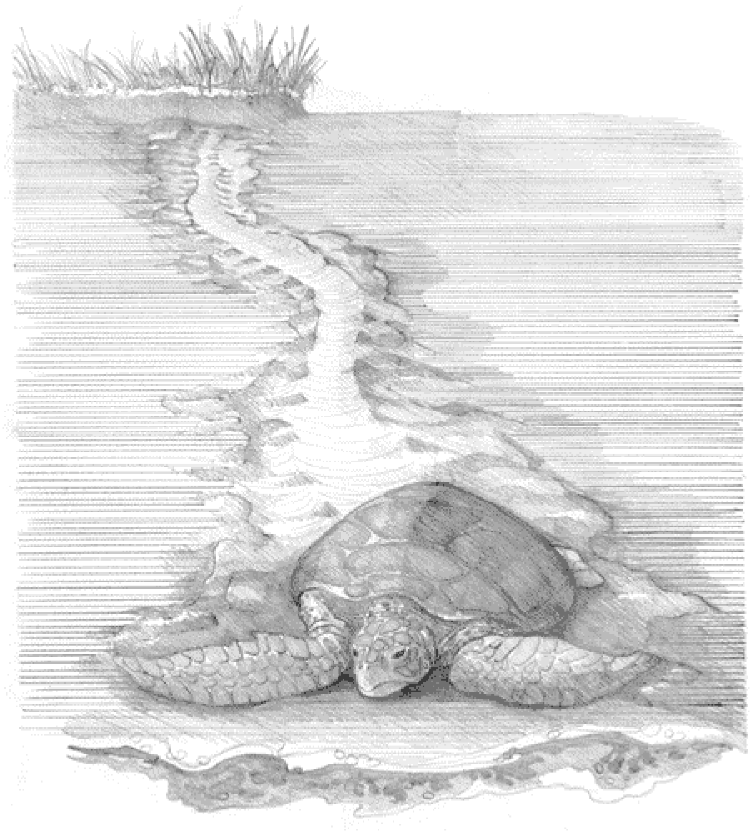
Florida's Sea Turtles



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Contents

The information in this booklet came from many sources and represents the work of many researchers. Many of the books and scientific papers used in writing this booklet are referenced in the section titled Citations. Anyone wishing to learn more about Florida’s sea turtles will find a wealth of information in these sources.

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Introduction

Sea turtles are air-breathing reptiles remarkably adapted to life in the sea. Their streamlined shape, large size and powerful foreflippers enable them to dive to great depths and travel long distances. Although at home in the ocean, sea turtles are tied to the land because females must leave the water to lay their eggs in a sandy beach. Much of the research on sea turtles has focused on nesting females and hatchlings emerging from nests because these are the easiest to find and study. Thousands of nesting turtles have been tagged to gather information about their reproductive cycles and movements. In recent years research efforts have broadened, and new technologies such as satellite tracking have been used to learn more about sea turtles during other phases of their lives. After decades of research, much has been learned - - and many questions remain.

Sea turtles once roamed the oceans by the millions, but over the past few centuries the demand for sea turtle meat, eggs, shell, leather and oil has greatly reduced their numbers. Populations continue to decline because of the trade in sea turtle products, commercial fishing, and the development of nesting beaches. Thousands of sea turtles drown in shrimp trawls every year and others die from pollutants and non-degradable debris in the ocean. Concern for the plight of sea turtles is growing and around the world, conservationists, governmental agencies, public and private organizations, corporations and individuals are working to protect sea turtles on nesting beaches and at sea.

Description

Sea turtles are large animals with long, paddle-shaped foreflippers. The shell, which consists of an upper and lower part joined on both sides by a bridge of cartilage, encloses and protects the internal organs. In most sea turtles the top shell, or carapace, is composed of many bones and covered with horny scales or scutes. The number and arrangement of these scutes is one of the ways to tell one kind of turtle from another. Turtles do not have teeth, but the jaws are shaped to provide crushing, biting or tearing surfaces appropriate for their diet. Like all reptiles, sea turtles lack external ears and the eardrum is covered with skin.

The smallest sea turtles, the ridleys, weigh about 35 to 45 kilograms (75 to 100 pounds) when mature, while adults of the largest species, the leatherback, can weigh more than 900 kilograms (almost 2,000 pounds) and reach a length of more than 2.5 meters (8 feet). Growth rates vary but most sea turtle species mature slowly and all have a long life span.

Female sea turtles must leave the safety of the sea to lay their eggs on land. The arduous process of nesting takes up to three hours. A turtle must drag her great weight ashore, dig a nest, deposit roughly one hundred eggs, and cover and conceal the nest before returning to the sea. The mother turtle leaves her eggs to incubate in the warm sand and never visits the nest again. A female will usually lay several nests during one season and may nest every two to three years.

Researchers use large calipers to measure nesting turtles. Thousands of nesting turtles have been measured and tagged to study nesting cycles, growth rates, and local and long-distance movements.

After incubating for about two months, the sea turtles hatch, erupt as a group from the nest at night, and scurry down the beach to the sea. Many years will pass before the few hatchlings that survive to maturity will be ready to reproduce. Although the are no successful methods for marking hatchlings, genetic studies have indicated that sea turtles return to nest in the region where they hatched.

Evolution and Taxonomy

In many ways turtles are living fossils that have changed little since they first appeared about 200 million years ago. Marine forms evolved from marsh-dwelling species early in the history of turtles. The earliest known marine turtle fossils are about 150 million years old. Sea turtles, as well as many other reptiles, flourished during this time of extensive shallow seas.

Turtles adapted to life in the sea by developing a shell and paddled-shaped forelimbs that enabled them to swim through the water with the motion of a bird. These changes meant that the head and flippers could no longer be pulled into the shell for protection, but a completely roofed-over skull and large body size compensated for this loss. Today's sea turtles are less specialized and diverse than earlier forms.

The adaptations that make sea turtles at home in the sea make them slow and vulnerable on land.

Currently, seven species belonging to six genera are recognized. Five of these species, the leatherback, green, loggerhead, Kemp's ridley and hawksbill turtles, inhabit the coastal waters of the U.S. including Florida. The olive ridley is a widespread species but is rarely found in Florida. The black turtle of Pacific Mexico is similar to the green turtle. It is still hotly debated whether this turtle is a separate species or a subspecies of the green. Black turtles are occasionally seen in California. The Australian flatback turtle is found only in Australia and Papua New Guinea.

Many populations of sea turtles of the same species are isolated and therefore do not interbreed. For this reason, they have evolved independently. The isolation of groups within a species has important implications for conservation because protection for one population will not ensure the survival of others. Sea turtle species share many characteristics because of their common ancestry and aquatic life, but each species is unique in its appearance, habitat preferences, diet, and behavior.

Range and Habitat

Sea turtles are found in all of the world's oceans, but nesting is restricted to tropical and subtropical beaches. In the continental United States, sea turtles are found in the Gulf of Mexico from Texas through Florida and along the eastern seaboard from the Florida Keys to as far north as Canada during the warmer months. Nesting has been recorded from as far north as New Jersey and Virginia and as far west as Texas, but most sea turtle nesting in the U.S. occurs in the southeastern states, particularly on the Atlantic coast of Florida.

The whereabouts of sea turtles between the time they enter the sea as hatchlings and their appearance as juveniles or subadults in coastal and inshore feeding grounds has long been a mystery. It is now theorized that the young turtles drift in open ocean currents (Carr 1986, 1987). Hatchlings find food and cover in the driftlines that form where ocean currents converge and sink; seaweed, driftwood, debris and anything floating in the surface waters form long bands along these convergence zones. Fishermen know that game fish are attracted to the food and cover of driftlines, but only in the past few decades has the significance of these areas to sea turtles been recognized.

At some point in their development, unknown cues prompt young turtles to leave the open ocean and take up residence in shallower coastal waters. The bays, estuaries and nearshore coastal waters of the U.S. east coast and Gulf of Mexico provide important developmental habitat for juvenile and subadult sea turtles. Once maturity is reached, most sea turtles move to permanent feeding grounds or travel through a series of feeding areas. Many turtles do not nest near their feeding grounds and so must migrate to nesting beaches.

Sea Turtle Nesting in Florida

Most of the sea turtle nesting in the continental U.S. occurs in Florida. Leatherback and green turtles rarely nest north of Florida and about 90 percent of the loggerhead nests found in the United States are in Florida. Florida's east coast from New Smyrna Beach south to Boca Raton accounts for more than 80 percent of the nesting crawls or tracks observed on the east coast of the U.S.

South Brevard County has the greatest density of sea turtle nests in Florida and probably produces more hatchlings per kilometer than any beach in Florida (Ehrhart and Witherington 1987). On the Gulf coast of Florida, most nesting occurs from Pinellas to Monroe Counties, but recently a genetically distinct sub-population has been identified in the Florida Panhandle.

Loggerhead Turtle

Description

The loggerhead turtle (*Caretta caretta*) is the most commonly found sea turtle in Florida. This reddish-brown turtle is named for its large head which may be 25-30 centimeters (10-12 inches) wide. Powerful jaw muscles allow the loggerhead to crush heavy-shelled clams, crustaceans and encrusting animals attached to rocks and reefs. The shell is very thick, particularly toward the back, which may serve as protection from sharks that occasionally prey on this relatively slow swimmer. It is estimated that loggerhead turtles reach maturity between 20 and 40 years of age and could have a reproductive lifespan of 30 years or more (Wood 2002).

Range and Population Estimates

The loggerhead turtle nests farther from the tropics than any other marine turtle and is found in temperate and subtropical waters in many parts of the world. Loggerheads forage along the inshore and coastal waters of the Gulf of Mexico, the Florida Keys and along the eastern seaboard as far north as New England. Thousands of subadult loggerhead turtles forage on horseshoe crabs in the river mouths and deeper channels of Chesapeake Bay during the summer months (Keinath et al. 1987). During the nesting season adult females remain in shallow areas near their nesting beaches (Hopkins and Murphy 1981, Stoneburner 1982). At other times loggerheads can range hundreds of kilometers out to sea.

The southeastern U.S. is one of the most important nesting areas in the world for this species. An estimated 18,000 female loggerheads nest in the southeastern U.S. annually (Turtle Expert Working Group 2000). The majority of sea turtles that nest on the mainland of the United States are loggerheads. Only the population of Masirah Island, Oman, in the Middle East, exceeds that of the southeastern U.S. (Ross 1982).

Loggerhead turtles nest in Florida from late April until September. The female digs a nest cavity in the sand with her rear flippers and deposits about 110 eggs. The eggs incubate in the warm sand for two months before hatching.

Important nesting sites are found on the coastal islands of North and South Carolina and Georgia. The most important sites are located along the mainland coasts of Florida. In Florida, loggerheads nest on all the sandy beaches, but most nest from Volusia to Broward Counties on the east coast, and from Monroe to Pinellas Counties on the west coast. In the Florida Panhandle, loggerheads generally nest from Franklin County west.

Loggerhead Turtle Facts

- Most common sea turtle in Florida
- Named for its large head
- Powerful jaws crush mollusks, crabs and encrusting animals attached to reefs and rocks
- An estimated 18,000 females nest in the Southeastern U.S. each year
- A large turtle: Adults weigh 200 to 350 pounds and measure about 3 feet in length
- Hatchlings: 2 inches long
- Nest in Florida from late April to September
- Survival in Florida threatened by drowning in shrimp trawls, loss of nesting beaches, and beach lighting

After nesting in Florida from late April to September, loggerheads disperse to feeding grounds throughout the Bahamas, Cuba, the Dominican Republic, north along the eastern U.S. coast, and south through the Florida Keys and the Gulf of Mexico. A loggerhead tagged at Melbourne Beach was recaptured 11 days later on the northwest coast of Cuba. To make this journey the turtle must have traveled at least 70 kilometers (40 miles) a day, often against powerful ocean currents. Another loggerhead that nested at Melbourne Beach was recaptured less than 10 months later 1,500 kilometers (almost 1,000 miles) away in the Dominican Republic (Meylan et al. 1983). It is not known why turtles travel so far to nest in Florida when seemingly suitable nesting beaches are available near their feeding grounds.

Green Turtle

Description

The green turtle (*Chelonia mydas*) is named for the greenish color of its body fat. Hatchlings are dark but adults have a smooth, olive-brown shell marked with darker streaks and spots. The bottom shell is white or yellowish and each paddle-shaped flipper usually has one claw. Green turtles can be distinguished from most other sea turtles by the single pair of scales on the front of the head.

Range

The green turtle is found in parts of the Atlantic, Pacific and Indian oceans, primarily in the tropics. The most important nesting grounds for green turtles in the Americas are Tortuguero, on the Atlantic coast of Costa Rica, a few beaches in Surinam, and Venezuelan-owned Aves Island in the eastern Caribbean.

Roughly 500 to 8,500 green turtle nests are reported each year on the east coast of Florida, most of them between Volusia and Broward counties. The nesting habits of green turtles exhibit a semi-annual pattern. A few nests are also found on the west coast, including the Florida Panhandle area, also known as the gulf coast. A population of immature green turtles can be found year round throughout the Indian River Lagoon system on Florida's east coast, and an increase in the number of smaller turtles captured suggests that this population may be growing. Mosquito Lagoon may be the northern limit of the winter range for green turtles (Witherington and Ehrhart 1989). Immature green turtles have also been reported from the nearshore waters of Brevard County, Indian River County, Hutchinson Island, Broward County, Florida Bay, in the Cedar Key-Crystal River area, St. Joseph Bay, and in the Florida Panhandle.

History of Green Turtles in the Atlantic

Green turtles were once abundant in the waters of south Florida and the Caribbean. In 1503, on his fourth and last voyage to the New World, Christopher Columbus reported that his ship came ". . . in sight of two very small and low islands, full of tortoises, as was all the sea about, insomuch that they looked like little rocks, for which reason those islands were called Tortugas." These islands, later renamed the Cayman Islands, were once the site of a large green turtle rookery.

For 300 years the vast flotillas of turtles played an important part in the exploration and exploitation of the region by Europeans, including pirates. Much of the early activity in the new world tropics was dependent in some way on turtles. Turtle meat and eggs provided a seemingly unending supply of protein, and turtles could be kept alive on ships for long voyages by turning them on their backs in a shaded area of the deck. Turtle oil was used for cooking, lamp fuel and as a lubricant.

Besides feeding the explorers and residents of the Caribbean, the green turtle was shipped to Europe, particularly England, where it was considered a great delicacy for its meat and the gelatinous "calipee," found along the lower shell that was made into soup. With the advent of steam travel, more turtles could be shipped alive. By 1878, 15,000 turtles a year were being shipped to England from the Caribbean (Parsons 1962).

The supply of turtles must have seemed endless as each year new individuals completed the long maturation process and emerged from the sea to nest, but by the early 1700s green turtles were becoming scarce in many areas. The first rookery to be decimated was that of Bermuda and then, one by one, the turtles disappeared from their nesting beaches throughout the region. The green turtles of Florida are a remnant of a much larger population that was hunted to the edge of extinction. Both nesting females and subadult turtles were hunted commercially. In the late 1890s, turtle hunting grounds extended from Marquesas Key to Alligator Light on the east coast, the Dry Tortugas, throughout Florida Bay and around the Cedar Key region. Despite the fact that Florida's green turtle population had been greatly reduced by the 1940s, Key West and other ports remained as processing centers for green turtles caught throughout the Caribbean. Although Florida's seagrass beds were once important feeding grounds, it is likely that green turtles once nested in large numbers only in the Keys and the Cape Sable region (Dodd 1982).

Habitat

Green turtles are found on broad expanses of shallow, sandy flats covered with seagrasses or on reefs where seaweed can be found. Scattered rocks, sandbars and coral heads are used as nighttime sleeping sites. Every morning the turtles head out to feed and every evening return to their particular shelter to sleep. The round trip may be several miles (Carr 1956).

Diet and Feeding Habits

Hatchling green turtles are carnivorous; juveniles and subadults eat many things including man-o-war and jellyfish. When green turtles reach 20 to 25 centimeters (8 to 10 inches) in shell length, however, they begin feeding on seagrasses on shallow flats or algae growing on nearshore rock reefs. No one knows how old the turtles are when this occurs (Bjorndal 1988). Adult green turtles are unique among sea turtles in being plant eaters.

Green turtles feed on the vast meadows of seagrasses found in the tropics. These turtles grow slowly because this diet is low in protein.

The vast beds of seagrasses found throughout the tropics serve as pastures for green turtles. Seagrass is high in fiber and low in protein. As an adaptation to this diet, green turtles maintain "grazing plots" of young leaves by feeding repeatedly in the same area. By eating young plants in the grazing plots, green turtles can avoid older leaves that are higher in fiber, and thus increase the percentage of protein in their diet (Bjorndal 1982).

Green Turtle Facts

- Only adult sea turtle with diet of seagrass and seaweed
- Named for greenish color of body fat
- 500 to 8,500 nests reported each year
- Medium to large sea turtle: nesting females in Florida average 3.3 feet in length and 300 pounds in weight

- Hatchlings: 2 inches long
- Nest in Florida from June through late September
- Survival in Florida threatened by beach lighting, habitat alterations and drowning in fishing gear

Some populations of green turtles feed on algae even if seagrass is available. Seagrasses and algae differ in their chemical composition so green turtles have specialized bacteria in their gut to aid in digestion (Bjorndal 1985). For this reason, green turtles cannot easily change their diet when other food sources become more abundant. The young green turtles found year-round in Mosquito Lagoon eat seagrass even when algae is more abundant.

Growth Rates

Since their diet is low in protein, green turtles grow slowly and sexual maturity is delayed (Bjorndal 1985). In captivity on a high-protein diet, green turtles can mate and lay eggs in 8 to 11 years (Wood 1980). This diet also results in more nests per season and a shorter interval between nesting seasons as compared with wild turtles. It has been estimated that green turtles in the wild may not reach maturity until 15 or even 30 to 35 years of age (Chaloupka and Musick 1997). Dramatic variations in growth rates have been observed from one feeding area to another, and the differences have been attributed to food quality and temperature. Green turtles have a constant and plentiful source of food with few competitors, but the trade-off is that their growth rate and reproductive output are lower than if their diet were more nutritious (Bjorndal 1985).

Migrations

One of the most intriguing aspects of green turtles is their ability to travel long distances and locate specific sites with remarkable precision. Caribbean turtle fishermen have many stories about capturing a distinctive green turtle, shipping it hundreds of miles to market in Key West where the turtle was washed out of its holding pen in a storm, and then recapturing the same turtle under the same rock as before (Carr 1967). Green turtles are as loyal to preferred feeding grounds or sleeping rocks as they are to nesting sites. Some populations of green turtles may nest and graze in the same region and others follow coastlines from feeding to nesting grounds and back. Other populations, however, travel great distances over open water. At some Brazilian feeding grounds, several populations share the same pastures but always return to their respective nesting beaches.

One of the best-studied migratory populations feeds along the Brazilian coast but nests on Ascension Island, which is 8 kilometers (5 miles) wide and 2,250 kilometers (1,400 miles) to the east of Brazil over open ocean (Carr 1975). We can only speculate as to why turtles would make such a difficult journey or how they can find this island in the vastness of the mid-Atlantic.

Leatherback Turtle

Description

The highly specialized leatherback turtle (*Dermochelys coriacea*) is the largest of the sea turtles; it travels the farthest, dives the deepest and ventures into the coldest water. The largest leatherback ever recorded was almost 3 meters (almost 10 feet) long from his nose across the curve of the shell to his tail (Davenport, et al. 1990).

A leatherback turtle cannot be confused with any other animal. Hatchlings are marked by white stripes and the foreflippers are as long as the shell. Adults have a smooth, scaleless black to brown shell raised into seven narrow ridges that extend the length of the back. The limbs, head and back are often marked by white, pink or grey blotches. The rubbery top shell has a thick layer of oily, vascularized, cartilaginous material, strengthened by a mosaic of thousands of small bones. The softer lower shell is whitish to black and marked by five ridges. The smooth transition between the two shells gives the leatherback a barrel-like appearance. Unlike other sea turtles, the leatherback has no claws on its flippers.

The leatherback turtle feeds on jellyfish. The largest of the sea turtles, the leatherback can dive to over 3,000 feet deep and travel thousands of miles over open ocean.

Powerful front flippers make the leatherback a strong swimmer, capable of traveling thousands of miles over open ocean and against fast currents. The keels on the carapace and the smooth transition between the head, limbs and shell streamline the body for cutting through the water. The coloration of the leatherback, dark above and lighter below, is typical of open-ocean inhabitants.

The leatherback is the largest of the sea turtles; it travels the farthest, dives the deepest and ventures into the coldest water.

Diet

Leatherback turtles eat soft-bodied animals such as jellyfish. Jellyfish are an energy-poor food source because they are mostly water, so it is remarkable that a large, active animal can live on this diet. Small animals found in association with jellyfish such as crabs may supplement the diet (Frazier, et al. 1985), but it is not known if these items are actually digested. Young leatherbacks in captivity can consume twice their weight in jellyfish daily (Pritchard 1979). Food is sucked into the mouth by expanding the large throat. The leatherback’s jaws are scissors-like and the mouth cavity is lined with stiff spines that point backwards and aid in swallowing soft prey.

Range and Population Estimates

The leatherback turtle is found throughout the Atlantic, Pacific and Indian oceans, from as far north as Labrador and Alaska to as far south as Chile, the Cape of Good Hope, and the southern end of New Zealand. The leatherback is known to travel as far as 5,000 kilometers (3,100 miles) from its nesting beaches. It was once thought that the leatherback spent most of its life far out at sea, but it is now known that in the U.S. it also inhabits relatively shallow waters along the northern Gulf of Mexico, the east and west coasts of Florida and north throughout coastal New England. Nesting occurs on tropical and subtropical mainland shores, especially in New Guinea, Indonesia, Central America, the Guianas, and the southern Pacific coast of Mexico. Many of the major nesting areas have been discovered only within the last few decades. At one time, estimates of the number of breeding female leatherbacks in the world ranged from about 70,000 to 115,000. Since then leatherback populations have been decimated worldwide due to interaction with fisheries and intense exploitation of the eggs. The Pacific leatherback population appears to be critically declining with an estimated number of less than 3,000 animals. Without immediate conservation measures the Pacific population of leatherback sea turtles could be extinct within ten years (Spotila et al. 2000). The Atlantic population, which includes the Western Atlantic, Caribbean and Eastern Atlantic, currently numbers about 24,000 nesting females. Nesting in Florida has moderately increased in recent years. The number of leatherback nests recorded in Florida currently ranges from 200 to 550. In 2001, Palm Beach County counted 334 leatherback nests, a record number for this species in the county.

Temperature Regulation

The frequency with which leatherback turtles are seen in northern waters suggests that they regularly migrate north in search of large concentrations of jellyfish. The presence of active, healthy leatherback turtles in cold regions is of interest because, as reptiles, their body temperature would be expected to be close to that of the water around them.

Leatherback hatchlings have distinctive white ridges along their dark shells. Hatchlings are 2 ½ inches long but adults can grow to over 8 feet in length.

Active leatherbacks have been reported at water temperatures below 6^{o}C (43^{o}F); no other reptile is known to remain active at this temperature (Lazell 1980). Leatherbacks can live in cold water because, unlike most other reptiles, their body temperature can be as much as 18^{o}C (32^{o}F) higher than that of the environment (Mrosovsky and Pritchard 1971; Frair, et al. 1972). In addition to retaining heat produced by muscular activity, leatherbacks may be able to actively regulate their temperature.

Leatherback Turtle Facts

- Largest and deepest diving of the sea turtles
- Named for smooth, rubbery shell
- Feeds on jellyfish
- About 550 nests a year are reported in Florida, estimates of 26,000 to 43,000 breeding females worldwide
- A huge turtle: adults weigh 700 to 2,000 pounds and measure 4 to 8 feet in length
- Hatchlings: 2 ½ inches long
- Nest in Florida from March through August
- Many leatherback turtles die from ingesting plastic debris mistaken for jellyfish

Diving Ability

The leatherback can dive to great depths. Turtles equipped with depth recorders dove to over 1,000 meters (3,300 feet) deep. This depth exceeds that reported for any air-breathing vertebrate with the possible exceptions of sperm whales and elephant seals. The shallowest dives occurred at dusk and the deepest at dawn. These leatherbacks were probably feeding on jellyfish that concentrate below 600 meters (2,000 feet) during the day and move into surface waters at dusk. The turtles dove almost continuously with only brief intervals at the surface to breathe (Eckert, et al. 1984, 1986, 1989).

The leatherback does not have a rigid breastbone or lower shell like other sea turtles so the chest may collapse during deep dives. The large amount of oil found in leatherbacks may help prevent decompression problems during diving and resurfacing.

Nesting Habits

The leatherback turtle migrates between the cooler, open ocean waters that support the jellyfish on which it feeds and the subtropical and tropical beaches where the sand is warm enough to incubate its eggs. Studies in the Virgin Islands have shown that leatherbacks begin nesting within a week of arriving from temperate latitudes (Eckert and Eckert 1988).

Leatherbacks prefer beaches with a fairly steep slope adjacent to deep water. These high-energy beaches are often subject to erosion, but this topography makes the beach accessible and shortens the haul to dry sand above the high tide mark (Pritchard 1971). Leatherbacks are rarely seen around reefs and rocky areas where their skin could be easily cut. Even the crawl up a sandy beach can be enough to abrade the turtle's tender skin and cause bleeding.

Hawksbill Turtle

Description

The hawksbill turtle (*Eretmochelys imbricata*) is an agile, small to medium-sized sea turtle. The shell of this turtle is prized for its use in tortoiseshell jewelry and ornaments, and so this turtle is hunted throughout the world. For this reason, it is listed internationally as critically endangered. Despite its economic importance, very little is known about this species.

Diet

Hawksbills are reported to eat a wide variety of invertebrates, but the predominate food item in most parts of the world appears to be sponges. This is a very unusual diet because the sponges are made up largely of tiny, grasslike needles. No adaptations have been discovered that would explain how a hawksbill turtle can live on this diet. The tiny needles are routinely found embedded in the walls of the intestines but appear to cause no harm (Meylan 1988).

Hawksbill turtles can climb over reefs, rocks and vegetation to nest on beaches that would be inaccessible to larger, less agile sea turtles

Range and Habitat

The hawksbill may be the most tropical of all marine turtles. Although they occasionally stray into colder water, hawksbills usually are found in coastal reefs, bays, estuaries and lagoons of the tropical and subtropical Atlantic, Pacific and Indian oceans. Hawksbill turtles are observed regularly by scuba divers on reefs off the Atlantic coast of Florida and in the Florida Keys and may be more common in these coastal waters than previously thought (Lund 1985). Hawksbills can climb over reefs, rocks and rubble to nest among the roots of vegetation on beaches that would be inaccessible to larger, less agile sea turtles. Small, isolated beaches, often on offshore islands, are favored nest sites. Most nesting is by solitary females on scattered islands and shores but this may be because populations have been reduced. In recent times a few nests have been documented in the Keys, in Palm Beach and Martin counties and at the Canaveral National Seashore, and south of Port Everglades.

Kemp's Ridley Turtle

Description

The Kemp's ridley (*Lepidochelys kempii*) is the rarest of the sea turtles. It is a small turtle with a circular to heartshaped keeled carapace that in some adults is almost as wide as it is long. Estimates of age at maturity range from 7 to 15 years. In captivity a few females have become sexually mature at 5 years of age (Wood and Wood 1989). The Kemp's ridley is carnivorous and feeds on swimming crabs and other crustaceans, clams, mussels, fish and jellyfish. Blue crabs are the preferred food in many areas.

Range and Habitat

Adult Kemp's ridleys, are found in the Gulf of Mexico foraging in productive coastal and estuarine waters, particularly along the Louisiana coast near the mouth of the Mississippi River and the Campeche, Mexico region. Juvenile and subadult Kemp's ridleys are widely distributed throughout the coastal waters of the U.S. from Texas to Maine. When temperatures begin to drop, the turtles in northern regions head south to Florida and the Gulf of Mexico. Cold-stunned juveniles are regularly stranded in Long Island Sound, New York and in Cape Cod Bay during the winter.

Sea turtles sleep under ledges in inshore waters. When far out at sea, turtles rest at the surface.

Discovery of Nesting Beach

Although Kemp's ridleys were often seen in the Gulf of Mexico and in the southeastern U.S., the location of their nesting beaches remained a mystery for many years. Turtle fishermen maintained that there were no nesting beaches because the Kemp's ridley was an infertile hybrid between a loggerhead and a hawksbill turtle. The mystery was solved with the discovery of a film made in 1947 by a Mexican engineer. The film documented the mass emergence of tens of thousands of Kemp's ridley turtles in broad daylight onto a remote beach on the Gulf coast of Mexico. The beach was near Rancho Nuevo in the state of Tamaulipas about 300 kilometers (200 miles) south of Brownsville, Texas. The film showed the feverish activity of the females as they dug their nests and covered them. So many turtles were nesting at once that they climbed over each other and dug up each other's eggs.

Kemp’s Ridley Turtle Facts

- Rarest and most endangered of the sea turtles
- Nesting restricted to a 20-mile stretch of beach in western Gulf of Mexico
- Approximately 3,000 nests are deposited each year
- Females synchronize egg laying in mass nestings
- Nesting occurs during daylight
- Feeds on blue crabs, clams, mussels, fish and jellyfish
- A small sea turtle: Adults weigh 85 to 100 pounds and measure 24 to 30 inches in length
- Hatchlings: 1 ½ inches long
- Species threatened by drowning in shrimp trawls, habitat alterations and pollution

Nesting Habits

The reproductive strategy of Kemp’s ridley, like that of some populations of its close relative, the olive ridley, is to synchronize the emergence of nesting females. These mass nestings, called *arribadas* (Spanish for arrivals), occur at irregular intervals between April and June. Unlike the olive ridley, however, the nesting that occurs on this one 30 kilometer (20 mile) stretch of Mexican coastline represents virtually the entire reproductive effort of the species.

Perhaps using cues such as wind direction or velocity, lunar cycles or water temperature, male and female Kemp’s ridleys mass off the narrow strip of beach to mate. Scent produced by secretory pores may enable the turtles to find each other once they are in the area. Once they have mated, the females may stay offshore for days waiting for just the right conditions, which usually include heavy surf and high winds from the northeast. Wind may erase the scent of the nests and reduce predation. When conditions are finally right, the females emerge from the water to dig nests and lay their eggs, all within a few hours of each other and usually during daylight. *Arribadas* may be repeated several times during a season, and many females nest in successive years (Pritchard and Marquez M. 1973).

Why ridleys nest together in large groups is unknown but it may serve as a form of predator saturation or swamping. Local predators may be bewildered by the sudden abundance of prey and, although some adults and many eggs and, later, hatchlings will be taken, many will survive. Predators seem to know when an *arribada* is about to occur because coyotes and vultures move from inland areas to gather at the beach before the turtles arrive.

Conservation Programs

Although the location of the Kemp’s ridley nesting beach eluded scientists for many years, it was well known to egg traders. Prior to the 1960s, mule trains would carry hundreds of thousands of eggs collected on the beach to market and thousands of females were caught offshore and cut open just for their eggs. The population was reduced from as many as 30,000 nesting females in the 1940s to a low of 300 nesting females in 1985. Since 1985 the number of nests at Rancho Nuevo and nearby beaches has increased an average of 11.5% per year. Current nesting totals exceed 3,000 nests per year suggesting conservation efforts have begun to turn the tide and at the current rate of increase the number of nesting females may exceed 10,000 by the year 2020 (Turtle Expert Working Group 2000). In recent decades, population reductions have resulted in the fragmentation of the *arribadas* into small groups or nesting by solitary individuals. During the 1980s, the largest *arribadas* were less than 200 females spread over several kilometers of beach. At the lowest point, only about 750 nests were laid each season.

Rancho Nuevo was declared a Natural Reserve by Mexico in 1977 and programs were begun to protect the nesting beach and reduce the poaching and natural mortality of eggs and turtles. Eggs are moved to protected hatcheries to decrease losses to predators. The effort at Rancho Nuevo has been extensive and successful, as very few nests now are lost. As a result of this protection the number of Kemp's ridleys that nest each year has been increasing. Nesting surveys indicated over 6,000 nests in 2000 (Marquez M. et al. 2001). Given the rate of increase in nesting females there is optimism that this species is gradually increasing.

Olive Ridley Turtle

Description

The olive ridley (*Lepidochelys olivacea*) is the smallest of the sea turtles and named for the olive color of its heart-shaped shell. It forages offshore in surface waters or dives to depths of at least 150 meters (500 feet) to feed on bottom-dwelling shrimp, crabs, sea urchins and other animals. Olive ridleys are sometimes seen feeding on jellyfish in surface waters.

Olive ridleys once nested by the tens of thousands along the beaches of Pacific Mexico, but huge industrialized fisheries have decimated most populations.

Range

The olive ridley is found in the tropical waters of the northern Indian Ocean, the eastern Pacific Ocean, and in the eastern Atlantic along the coast of Africa. In the western Atlantic, most nesting occurs in Surinam along a short stretch of beach. Most populations nest on mainland shores near the mouths of rivers or estuaries and, therefore, are closely associated with low salinity and high turbidity water (Cornelius 1986). Although olive ridleys prefer to nest in these areas, they have occasionally been documented in Florida.

Nesting Habits

The olive ridley was once thought to be a solitary nester. Large flotillas occasionally were reported by passing ships or along coastlines but their destination was unknown. In the 1970s, however, it was discovered that, like the Kemp's ridley, some populations of olive ridleys synchronize their nesting in mass emergences or *arribadas*. Thousands and even tens of thousands of olive ridleys nested during *arribadas* that would continue for several nights. Today olive ridleys nest in relatively large numbers on a few protected beaches but most populations have collapsed as a result of overexploitation of egg and of skins for the leather trade.

Sea Turtle Behavior

Daily Activity Patterns

Turtles feed and rest intermittently during the day. Tracking studies in the southeastern U.S. have shown that during the nesting season loggerhead turtles follow regular routes between nearshore areas and offshore rocky areas or wrecks.

Hatchling turtles often sleep at the water's surface with their front flippers folded over their backs.

Turtles may travel hundreds or thousands of kilometers between nesting beaches and resident foraging grounds. Female loggerheads that nest in Florida travel back to foraging grounds that range from areas offshore of west and northeast Florida to areas offshore of the Bahamas, Cuba, Texas, and Mexico. These females typically remain in their resident foraging grounds, which are usually less than 100 km^2, until they return to the nesting beach several years later.

Sea turtles sleep at the surface in the open ocean or on the bottom or under ledges in inshore waters. Fishermen in the Caribbean catch green turtles by setting nets over the rocks where the turtles sleep. Hatchlings sleep floating at the surface with their flippers tucked over their backs.

Courtship and Mating

Underwater observations of green turtles in Australia have shown that a female may avoid a male by folding her hind flippers together or by assuming a "refusal position" in which she remains vertical in the water facing the male with her limbs widespread. Females rested in an underwater "reserve area" that males appeared to avoid (Booth and Peters 1972). A male may nuzzle the head of a female and gently bite her neck and rear flippers. If the female does not flee, the male grips the female by hooking his long front claws over the front of the top shell and folding his long tail under the female's lower shell. The shells of females may be scratched and scarred if they have recently mated.

Copulation can take place at the surface, bottom or in the water column. Surplus males may be in attendance, circling and biting the tail and flippers of the mating male and often causing extensive injuries (Balazs 1980). Males may fight with each other aggressively, pursue large moving objects, and attempt to dislodge mating males. Turtle fishermen sometimes take advantage of the aggressive frenzy of mating males by placing crude wooden turtle decoys in the water and capturing the males as they mount the decoys. However, the tendency to fight over females may be the result of changes in sex ratios caused by the selective killing of nesting females. In some places, females have been reported to fight over males (Pritchard 1979).

Mating generally occurs during a receptive period prior to a female's first nesting emergence. Captive green turtles are receptive to males for about 30 days prior to laying their first nest (Wood and Wood 1980). Receptive females may produce a chemical that attracts males during this period (Owens and Morris 1985). Sperm is stored through a nesting season but there is no evidence that sperm can be retained to the next nesting season (Miller 1997). Water temperature and day length influence hormone levels and nesting cycles (Owens and Morris 1985; Owens 1980).

A mating male green turtle grasps the female by hooking his front claws over the top of her shell and folding his tail underneath her tail.

Nesting

Beach Selection

It is unclear why turtles nest on some beaches and not on others. One theory is that a turtle learns the identifying characteristics of a beach while still in the nest or during her first trip to the sea. Some of the cues that could be used include smell, low-frequency sound such as surf noise, magnetic fields, and the characteristics of seasonal offshore currents. Conversely, it may be that first-time nesters learn the location of nesting beaches not by recognizing cues they learned as hatchlings, but from experienced adults (Owens, et al. 1982).

Today's nesting distribution may reflect conditions that existed decades and even centuries ago. Past temperature changes or beach conditions may have made some areas preferable to others. Another factor may have been the introduction of domestic animals. The Spanish introduced pigs, cattle and horses in Florida in the 1500s. Feral pigs feeding on turtle eggs would have reduced hatchling production. The killing of nesting females and egg collecting eliminated many populations. Today it is changes in coastal areas brought about by human development that will influence future shifts in nesting patterns (Shoop, et al. 1985).

Beaches with open-water access are usually preferred, especially by larger sea turtles such as leatherbacks and loggerheads. The beach must be elevated to prevent flooding by tides, rain or ground water, and the sand must allow for gas diffusion, yet be moist enough to prevent collapse during digging. Other factors that may determine whether a turtle nests are beach slope, sand texture, offshore reefs, dune vegetation, artificial lighting and human activity on the beach.

The location of a nest is critical to the survival and development of eggs and hatchlings. If a nest is too near the water, the eggs will become saturated with sea water and fail to develop. If it is too far up the beach, roots from vegetation can invade the nest, the nest will be closer to predators and the hatchlings will have a longer way to travel to reach the water. However, some populations scatter their nests across the beach profile to increase their overall chances of survival (Wood 2002).

Preparing to Nest

Tracking studies show that female loggerheads about to nest move into the surf off the nesting beach in the late afternoon and early evening to wait for nightfall. If a crawl onto the beach does not result in a successful nest, a female will return to the water and swim parallel to the beach in the surf zone until another emergence is made or until sunrise. If nesting is successful, the turtle swims away from the beach to a shoal area to await dawn (Hopkins and Murphy 1981).

Sea turtles are heavy, slow and awkward on land. The loggerhead, hawksbill and both species of ridleys move on land by using diagonally opposite limbs at the same time. The leatherback and green turtle, however, haul themselves forward by moving all four flippers simultaneously. The tracks made by each species of sea turtle are distinctive and can be used to census nesting activity.

Nesting female sea turtles leave tracks on the beach that are different for each species. The track made by a nesting loggerhead is wavy and punctuated by alternating flipper marks. The nest site has a shallow body pit and small sand mound. A green turtle makes symmetrical flipper marks and the body pit is deep with a large adjacent sand mound. The track of a leatherback turtle is very wide and usually curves across rather than straight up the beach. The nest site is a rambling area of mounds and trenches that can span 15 to 30 feet.

Sea turtles usually nest at night but there are notable exceptions. Kemp's ridleys nest by day and some olive ridley *arribadas* occur in daylight. In Florida several instances of daylight nesting by loggerhead, green, and leatherback turtles have been reported, and daytime nesting may be more common than once thought. In populated areas, daytime nesters are usually disturbed by people or pets and may fail to complete nesting (Fritts and Hoffman 1982).

As they leave the water and proceed up the beach, many turtles will stop several times to dig their snouts into the sand. These turtles may be following a temperature gradient from the cool wet sand near the water to the warmer dry beach zone to select a suitable nest site (Stoneburner and Richardson 1981). This behavior may also be a way of appraising the smell, texture or water content of the sand.

Making the Nest

Once a nest site has been chosen, a body pit is excavated by digging with all four limbs and rotating the body. This removes the dry surface sand that could collapse, and places the egg cavity at a greater depth. When the body pit is complete, an egg cavity is dug using the cupped rear flippers as shovels.

The final depth of the egg cavity is determined by the combined depth of the body cavity and the length of the rear flippers.

Sea turtles alternate their hind limbs as they dig. After one rear flipper removes a scoop of sand, the other rear flipper shoots forward to spread sand to the side and front. The egg cavity is flask-shaped and usually tilted slightly. When the cavity is complete, the turtle proceeds to lay her eggs, often two or three at a time with brief rest periods in between. Mucus is often secreted between batches of eggs. The eggs do not break as they drop into the nest hole because the shells are leathery and flexible.

Florida's Sea Turtles

Leatherback
Green
Kemp's ridley
Hawksbill
Loggerhead

Two-thirds of the time involved in nesting takes place after the eggs have been laid as the female covers and disguises the nest. The egg cavity is filled with sand by raking and packing with the rear flippers. Ridley turtles finish their nests by rocking from side to side and slapping the sand, whereas the much heavier leatherback pivots with her weight to the rear of the body to pack the sand. Lastly, the body pit is filled, the nesting site concealed with swipes of the front flippers, and the turtle moves slowly back down the beach and into the surf.

Nesting sea turtles appear to shed tears but, in fact, these salty secretions are produced continuously and not just during nesting. Sea turtles rid their bodies of excess salts through glands located near the eyes.

Turtles are not easily disturbed once egg-laying has begun, but turtles about to emerge from the water, ascending the beach or digging a nest cavity may turn back if they are bothered by lights or unusual activity. A nest site may be abandoned if a root, rock or other obstacle is encountered, or if the sand does not have the correct consistency or moisture content. If a turtle ascends the beach but fails to nest and returns to the sea without laying her eggs, it is referred to as a "false crawl" or a "non-nesting emergence".

The interval between successive nests and the number of nests made during a season varies with the individual turtle, population and species. Loggerhead, green and hawksbill turtles tend to wait 12 to 15 days before renesting whereas leatherbacks renest in 9 to 10 days. Ridleys can delay nesting to synchronize egg laying with other females. Some sea turtles nest only once or twice during a season while others may nest 10 or 11 times. Some ridleys nest every year while other populations and species nest every 2 to 4 years.

Egg Production

Sea turtles have been called "egg-laying machines" (Mrosovsky 1983) because of the large number of eggs they produce. Green turtles in captivity on a high protein diet can lay up to 1,785 eggs per year and may nest annually for a decade (Wood and Wood 1980). Even in the wild most sea turtles will lay several hundred eggs during a nesting season. The strategy appears to be to lay large clutches as soon as possible to minimize the time the turtles must spend away from their feeding grounds (Owens and Morris 1985). The number of eggs in a clutch is a compromise that reflects many factors such as the need to compensate for high predation, space limitations inside the turtle's shell, and the size of the nest cavity (Mrosovsky 1983; Bjorndal and Carr 1989).

Hatchlings

Escaping from the Nest

Leaving the nest is a group activity that can take several days. The first turtles to hatch wait quietly until more nestmates are free of their eggshells. This creates a small air pocket that gives the hatchlings room to thrash around. The hatchlings do not instinctively dig upward but instead respond to the movement of nestmates in such a way that the turtles are brought to the surface. The activity of one turtle triggers the movement of others so that with sporadic outbursts the hatchlings move as a group towards the surface. As the ceiling and walls of the chamber collapse from the thrashing turtles, the floor rises until the hatchlings are near the surface. Turtles hatching alone or a few at a time have little chance of escaping from the nest (Carr and Hirth 1961).

Hatchling turtles emerge as a group from their nest at night and scramble to the sea. The little turtles face many perils and only a few will survive to maturity.

Hatchlings usually emerge from their nest at night in response to cooling surface temperatures. The first turtles to get near the surface become still if they sense high temperatures, and this lack of activity has a quieting effect on the lower hatchlings (Bustard 1967). Occasionally, turtles will emerge after a rainstorm, even if it is daytime, because the temperature is cooler (Mrosovsky 1968). When conditions are right, the hatchlings erupt from the nest so that a hundred or more may boil out together and head for the sea.

Finding Water

How hatchlings just out of the nest find the sea has been studied extensively and is still not completely understood. The most widely accepted view is that hatchlings have a complex reaction to light that causes them to move toward the brightest and most open horizon (Mrosovsky and Kingsmill 1985).

As hatchlings move down the beach, the activity of one stimulates others in the group to move just as it did in the nest. This keeps the turtles moving so they cross the dangerous beach as quickly as possible. Once the hatchlings reach the water the crawling motion is replaced by a swimming stroke and the turtle dives to the bottom and rides the undertow. This diving response prevents the hatchling from being thrown back onto the beach.

Out to Sea

Hatchling turtles swim continuously for up to 24 hours after entering the water. This "swim frenzy" gets the hatchlings into deeper water and away from predators. Hatchling green turtles released from a beach were clocked at an average speed of 1.5 kilometers/hour (1 mile/hour) (Frick 1976). These turtles maintained a straight course even after they could no longer see the shore and oriented perpendicular to wave action (Salmon and Lohmann 1989). Leftover yolk retained in the abdomen provides food during the first few days.

Social Interactions

Sea turtles for the most part are solitary animals. No parental care is given to eggs or hatchlings and contact between adults is limited to courtship, mating and the *arribadas* of the ridleys. Hatchlings, however, must work together to escape from the nest and cross the beach and turtles of all species may be found in large groups of their own kind feeding or traveling. Except during courtship and mating there appears to be little interaction between individuals in a group.

Migrations

A sea turtle in the open ocean is buffeted by strong ocean currents, nearsighted when looking through air and capable of raising its head only a few inches above the water. How it is possible under these conditions for a turtle to regularly travel hundreds or thousands of miles and find a favorite sleeping site or a nesting beach is one of the great mysteries of nature.

Among the theories suggested to explain sea turtle navigation are that turtles navigate by the stars, sun or polarized light, determine latitude by sensing the speed of the earth's rotation, or follow a gradient of the special taste or smell of water emanating from coastlines and rivers. Small amounts of a highly magnetic substance have been found in the brains of sea turtles and this may aid in detecting the earth's magnetic fields or providing a map and compass sense. The area of the brain that controls the sense of smell is particularly well developed in sea turtles and perhaps sea turtles can follow scent trails in the ocean. It may be that different guidance cues and mechanisms are used, depending on whether a turtle is traveling through the open ocean, locating a broad region of coastline or homing in on a particular beach (Carr 1967). Research has shown that sea turtles can detect both the inclination and the magnitude of the earth's magnetic field (Lohmann et al. 1996).

Physiology

Effect of Temperature

Temperature affects many phases of a sea turtle's life because, as a reptile, body temperature is usually within a few degrees of that of the environment. The importance of temperature begins with the eggs in the nest because temperature is critical to egg development and influences the sex of the growing embryo. Incubation temperatures above 30°C (86°F) produce mostly females while temperatures below 28°C (82.4°F) produce mostly males. The critical time for sex determination occurs during the middle third of incubation. During this period, oxygen and carbon dioxide levels as well as other factors also may be influential (Standora and Spotila 1985).

The activities of sea turtles are influenced by temperature. Females nest during summer months when water temperatures are about 75°F.

Incubation temperature determines the number of days eggs take to hatch. A 1°C (1.8°F) decrease in temperature from shading or excessive rain may add five days to the incubation period (Mrosovsky 1980; Mrosovsky and Yntema 1980). Incubation temperature can vary with the location of a nest on the beach and the degree of shading. On beaches that are fairly uniform fewer females may be produced during the cooler ends of the nesting season. Even the location of an egg within the nest may determine whether it will be male or female because temperatures in the center of a clutch tend to be higher than at the periphery of the egg chamber (Spotila et al. 1987).

At high temperatures, hatchlings will not leave the nest and once in the water their swimming speed is slowed. At lower temperatures turtles will stop feeding, become immobile and eventually die. Temperatures below 8°C (46°F) cause cold stunning and sometimes death in immature green and Kemp's ridley turtles. Water temperature is one of the cues used to regulate the onset of the nesting season and the interval between nesting emergences.

Sea turtles can raise their body temperature by basking at the water surface and by swimming vigorously. Heat is lost in water but on land the body temperature could quickly reach lethal levels if a turtle were to emerge in the heat of the day. Ridley turtles that nest by day usually do so when it is windy (Spotila and Standora 1985).

Adaptations for Diving

Sea turtles spend almost all their lives submerged but must breathe air for the oxygen needed to meet the demands of vigorous activity. With a single explosive exhalation and rapid inhalation, sea turtles can quickly replace the air in their lungs. The lungs are adapted to permit a rapid exchange of oxygen and to prevent gasses from being trapped during deep dives (Jackson 1985). The blood of sea turtles can deliver oxygen efficiently to body tissues even at the pressures encountered during diving. During routine activity green and loggerhead turtles dive for about 4 to 5 minutes and surface to breathe for 1 to

3 seconds. A female loggerhead tracked at sea made up to 500 dives every 12 hours (Byles and Dodd 1989).

Turtles can rest or sleep underwater for several hours at a time but submergence time is much shorter while diving for food or to escape predators. Breath-holding ability is affected by activity and stress, which is why turtles drown in shrimp trawls and other fishing gear within a relatively short time.

Hearing, Sense of Smell and Vision

Sea turtles hear well, particularly at lower frequencies, and their sense of smell is well developed. They can see well underwater but are nearsighted when looking through air (Ehrenfeld and Koch 1966). Research with hatchling loggerhead and green turtles has shown that they can see light at wavelengths invisible to humans. These hatchlings were attracted to light in the ultraviolet, violet and blue-green part of the spectrum and moved away from light in the yellow-orange range. The response to light is complex and may differ among species or between hatchlings and adults (Witherington 1989).

Mortality Factors

The large size of adult sea turtles discourages most natural predators, but hatchlings and young turtles are subject to heavy predation. In undisturbed populations the loss of many eggs and hatchlings is compensated for by the large number of eggs laid during a nesting season, low mortality of larger turtles, and a long reproductive lifespan. The activities of humans, however, have greatly increased the mortality rate of turtles during all life stages. As a result many juveniles are not surviving to maturity and adults are not surviving to reproduce for many years as they would in an unstressed population (Reviewed in Ehrhart 1989).

Natural Causes

Eggs can fail to hatch as a result of flooding from heavy rains or prolonged tidal inundation, and nests are washed away by beach erosion. Hurricanes, tropical storms, and northeasters can bring high tides that flood nests over large areas of the coastline. Predators also destroy many nests, causing the loss of many thousands of hatchlings a year in the U.S. In the southeastern U.S., the major predator is the raccoon. In 2001, over 30,000 hatchlings were lost to raccoon predation in Florida's Archie Carr National Wildlife Refuge. On some South Carolina beaches, raccoons were destroying more than 95 percent of the loggerhead nests until protective measures were taken (Stancyk et al. 1980). In the Archie Carr National Wildlife Refuge in Florida, the only refuge in the U.S. established to protect sea turtle nesting beaches, raccoon predation averages about 7% of all nests. In predation "hot spots" the percentage of nests lost to raccoons can be 50% or higher. In these areas raccoon populations are unnaturally high due to people feeding the animals, campgrounds, and the proximity of public and private trash receptacles. Predators that could not locate or dig up a nest on their own will finish off a nest discovered by raccoons. Today, active nest protection and raccoon control programs on many beaches have greatly increased hatchling production. Ants, ghost crabs, foxes, coyotes, vultures and human-introduced pigs and dogs also destroy nests. Armadillos, as well as raccoons, prey on nests in both Hobe Sound and Merritt Island National Wildlife Refuges on Florida's east coast (Drennen et al. 1989).

Hatchlings scurrying down the beach are vulnerable to many of the same predators that dig up nests for eggs. Once the hatchlings reach the water, fish and birds lay in wait.

The raccoon is the major predator of the sea turtle eggs in Florida. Active nest protection and raccoon control programs have increased hatchling production on many beaches.

Adult turtles may die while attempting to nest if they are caught in driftwood and vegetation or wedged between rocks, because they cannot crawl backwards to escape. Turtles at sea are attacked by sharks and killer whales. Sharks are assumed to be the major natural predator on adults, judging from the number of nesting turtles with mutilated shells or missing flippers.

Many of Florida's green turtles have tumorous warts called fibropapillomas on their bodies. These growths are thought to be viral in origin although no particular pathogen has been implicated. A herpes virus has been associated with these tumors, but it has not been confirmed as the cause (Herbst et al. 1999). Some turtles with fibropapillomas die while others appear to recover. This disease is not new nor is it restricted to Florida, but there is concern that the percentage of green turtles in Florida with these growths is increasing. Fibropapillomas were first reported on a green turtle in the Indian River Lagoon in 1982 and now large numbers of the immature green turtles in the lagoon system are afflicted with this disease (Ehrhart et al. 1986). An alarming number of immature green turtles found in Florida Bay also exhibit fibropapillomas.

Human-Induced Mortality

Subsistence and Commercial Exploitation

Worldwide, hundreds of thousands of adult turtles and millions of eggs are taken each year. Turtles and their eggs have long been a source of food for people throughout the tropics because turtles are easy to catch, taste good and, until the past century, were abundant. Turtle eggs are desired for their supposed aphrodisiac value in some cultures. Unstressed turtle populations can withstand some hunting for local consumption but in areas of human overpopulation, even subsistence hunting can take a high toll. Nicaragua maintains a large green turtle fishery, harvesting about 11,000 turtles a year for local consumption.

Turtles are an important part of many cultures. Conservation practices, such as protecting nesting females, are built into some local traditions. However, throughout the world, cultures that were once self-sufficient now have monetary economies and this has changed the traditional use of natural resources. Sea turtles, once regarded as a shared community resource, are now viewed as individual property to be converted to cash to pay for taxes, school and church costs, outboard motors, fuel and other expenses in places with few job opportunities (Eley 1989). The distinction between subsistence and commercial hunting becomes less clear as cultural and economic systems change.

In Baha, Mexico and elsewhere throughout the Caribbean, conservation groups are working to raise awareness for sea turtle preservation. For years, the Caribbean culture has embraced eating sea turtle meat on special occasions and many Caribbean residents do not consider sea turtles to be red meat. Recently, sea turtle conservation groups have begun promoting a community-based education program to reduce sea turtle captures for the consumption of sea turtle meat, especially during religious holidays. In addition, some coastal villages are trying to switch from a harvest-based use of sea turtles to a tourism based non-consumptive use of sea turtles. A successful example of this can be found in Tortuguero, Costa Rica.

The international trade in sea turtle products, such as shells and meat, was banned by most countries in 1975 when the Convention on International Trade in Endangered Species (CITES) came into force. However, despite the ban, the commercial exploitation of turtles for luxury items remains threat to sea turtles worldwide. The major sea turtle products traded internationally are tortoise shell, raw skin and processed leather, whole stuffed turtles, oil for use in cosmetics, cartilage for soup and green turtle meat (Canin 1989).

Until recently many Asian and European countries fueled the demand for turtle products as major importers. Despite CITES, the hawksbill turtle has been driven toward extinction by the continuing shell trade, fueled in large part by Asian markets. In the past, Japan was the world's largest trader in wildlife products and imported about 20,000 kilograms (44,000 pounds) of raw hawksbill shell a year. About two-thirds of the hawksbill shell entering the trade came from the Caribbean with the rest originating from Asia, Africa and the Pacific islands. The equivalent of 712,000 hawksbills were imported by Japan between 1970 and 1992. French fishermen and buyers take a heavy toll on hawksbills in the important developmental habitats found around the Caribbean islands under French jurisdiction (Donnelly 1989).

Some of the major Caribbean exporters used to be Cuba, Panama, Jamaica, Belize, Honduras, Nicaragua, the Cayman Islands and Haiti. Several exporting countries were exploiting regional stocks since they no longer had local turtles. Today, trade of any sea turtle products, such as shells and meat, is prohibited by CITES. Unfortunately, illegal trade in turtle products still occurs. Many countries have laws protecting turtles, but without enforcement or conservation programs, little actual protection is provided.

Large industrialized turtle fisheries have greatly increased the pressure on turtles hunted for their skins. Government sanctioned fisheries in Mexico and Ecuador are responsible for depleting the once large olive ridley populations of the eastern Pacific. In recent years olive ridleys have failed to nest at many of their traditional nesting beaches, and populations in other areas are also collapsing. Millions of turtles have been slaughtered for the small piece of skin from the neck, shoulder and flippers. The rest of the turtle is discarded or used for pet food, frankfurters and fertilizer. The demand for turtle leather has grown over the last two decades with the decline in the availability of other reptiles such as crocodiles (Mack et al. 1982).

The Mexican government has announced a ban on the trade of sea turtle skins and shells but enforcement is uncertain and turtles continue to be harvested in large numbers on the Pacific side of the country. The ban also does not address the millions of sea turtle eggs that are taken each year.

Fishing Gear

Each year thousands of turtles drown in trawls, drift nets, long lines, sturgeon nets and other types of fishing gear. Shrimp trawls drown many sea turtles, particularly loggerheads and Kemp's ridleys. In 1987 it was estimated that the shrimping fleet throughout the Gulf of Mexico and the South Atlantic region caught more than 45,000 turtles each year and of these more than 11,000 die (Murphy and Hopkins-Murphy 1989). Some studies suggested that the mortality rate of captured turtles may be 3 to 4 times higher than this (Committee on Sea Turtle Conservation of the National Research Council 1990). In 2001, Florida documented the highest number of stranded turtles since 1980. In December 2001, there were 116 sea turtle strandings, more than double the previous ten-year average. In addition, during November and December, 20 leatherback sea turtles washed up dead in northeast Florida. This coincided with an increase in shrimp trawling in the same area (Florida Sea Turtle Stranding and Salvage Network 2001).

From 2,000 to 2,500 dead turtles are reported along the coastal U.S. from Maine through Texas each year. The state of Florida consistently has the highest number of dead or injured turtles in the nation, particularly in areas where trawling and gill netting effort is high.

Shrimpers catch more turtles than other fisheries because shrimp are found in relatively shallow coastal waters and often the most important trawling grounds are in close proximity to nesting beaches. Over the past few years there has been a dramatic increase in the amount of shrimp fishing in the inshore bays, sounds and estuaries of the southeastern states. These inshore waters provide important habitat for sea turtles.

A simple device to prevent turtles from drowning in shrimp nets has existed for many years. Implementing its use, however, has caused a long and bitter debate. The Turtle Excluder Device (TED) comes in several configurations but is basically a grid placed at an angle in the throat of a net that guides objects larger than shrimp out of the net. This device allows debris, turtles and other bycatch to escape from the net without diminishing the shrimp catch. TEDs reduce waste by eliminating a large percentage of the valuable fish and invertebrates that are caught as bycatch. Without TEDs this bycatch must be tediously hand sorted and thrown overboard, much of it dead. The U.S. shrimp fleet catches millions of tons of fish and invertebrates as bycatch and this loss depletes the food chains on which many species depend. TEDs are commonly called Trawling Efficiency Devices because of the benefits beyond the conservation of turtles.

Threats to Sea Turtle Survival

- Commercial exploitation for luxury products
- Drowning in fishing gear intended for other species
- Disturbance of nesting beaches – development, beach lighting, sea walls, jetties, erosion control structures and nighttime activity on the beach
- Disturbance of inshore and coastal feeding areas and developmental habitats
- Pollution and non-degradable debris in the ocean

State and federal agencies spent several million dollars testing and promoting the use of TEDs in the hope that their use would be voluntarily, but there was strong opposition from the shrimping industry. In 1989, federal regulations regarding the use of TEDs went into effect that apply seasonally to shrimp trawlers of a certain size operating in federal waters from Texas to North Carolina. Florida law requires the use of TEDs year-round in state waters. Conservationists are encouraging the use of TEDs in other countries such as Mexico where turtle entrapment is a problem.

Along the central coast of Florida, increases in strandings of green turtles in the 1990s were linked to intensive gill netting over nearshore worm rock reefs. These reefs provide important foraging habitat for a large assemblage of immature green turtles (Ehrhart et al. 1990). Regulations to reduce the incidental capture of turtles in this gill net fishery were implemented by the state of Florida in 1991. In July of 1995, a constitutional amendment banning the use of commercial gill nets in State Waters went into effect.

Each year thousands of sea turtles become entangled and die in monofilament fishing line nets and traps. This problem is a growing concern because gear lost or discarded during commercial and recreational fishing continues to pose a hazard to turtles and other wildlife. Untended nets and traps can continue "ghost fishing" for years. Tens of thousands of sea birds, seals and other marine mammals as well as tons of commercially valuable fish, crabs and lobsters are lost in this gear each year. Efforts are underway to remove abandoned traps and discarded monofilament fishing line from our oceans.

Commercial fishing fleets from Japan, Taiwan and South Korea fish in the north Pacific using lightweight synthetic nets that drift through the ocean to catch squid. More than 30,000 miles of nearly invisible net may be set by 800 ships a night. The toll on all forms of marine life is staggering.

Boats and Jet Skis

Boats are hazardous to turtles traveling or resting near the surface as evidenced by the many injured and dead turtles found with propeller wounds. This is particularly a problem during the nesting season because turtles concentrate near shore where boat traffic is heaviest. The impact of jet skis on turtles and other inshore wildlife has not yet been assessed but the noise and harassment associated with the growing use of this equipment may stress turtles feeding, mating or waiting to nest near popular beaches.

Habitat Alterations

Development, sea walls, boat traffic and pollution in inshore and coastal waters has eliminated or reduced the value of many areas as habitat for sea turtles. These areas are critical as developmental habitat for young turtles and as feeding grounds for adult turtles. The catastrophic blowout of an offshore oil well near Campeche, Mexico in 1979 polluted an important part of the Kemp's ridley's habitat.

Nesting beach alterations such as beach lighting, sea walls, jetties and erosion-control structures can make beaches unsuitable or inaccessible to nesting sea turtles. Artificial lighting along beaches, particularly if directly visible from a nest site, often disorients hatchlings and causes them to head towards buildings and roads instead of the ocean. Nesting adult turtles may also become confused by bright lights and head towards land instead of back into the ocean. Once on land, both hatchlings and adult turtles can be killed crossing highways or die from exposure.

Parties, bonfires and untrained people looking for nesting turtles on beaches at night deter turtles from nesting. Off-road vehicles, beach cleaning equipment and even horses can collapse nests or leave depressions in which hatchlings become trapped. The replacement of native beach vegetation by exotic Australian pines has made some Florida beaches less suitable for nesting because of shading effects and loss of habitat (Schmelz and Mezich 1988).

Sea turtles are attracted to the food and cover found on offshore oil platforms. Explosives used to remove these structures can kill or injure sea turtles in the vicinity if special precautions are not taken. Worldwide, tropical coral reefs are being damaged or destroyed by mining of minerals or sediment run-off from construction, dredging for landfill, collecting for the aquarium fish and shell trades, and by destructive fishing methods. This is causing habitat loss for species such as the hawksbill that depend on reefs.

Looming over all these issues is the specter of global warming. As carbon dioxide from the burning of fossil fuels and other gases build up in the atmosphere, solar radiation is trapped, which may cause the earth's temperature to increase. If the planet warms, sea levels will rise, causing erosion and the loss of many nesting beaches. Even small increases in temperature could be enough to alter the sex ratios of sea turtles and lead to extinction.

Pollution and Non-degradable Debris

The world's oceans have become the dumping ground for huge amounts of non-degradable debris, much of which floats at or just beneath the surface. The debris includes lost and discarded fishing gear, synthetic ropes and line, plastic strapping bands, plastic bags, balloons, styrofoam, many types of manufactured plastic items and small plastic pellets from manufacturing processes (Wolfe 1987). Some of this debris is washed from rivers and beaches or is dumped from land-based sources, but much comes from ships at sea.

Besides being an aesthetic problem, the tons of debris dumped daily into the sea is taking a heavy toll on wildlife. Floating debris tends to accumulate in the driftlines that form where currents meet. Young turtles dependent on driftlines for food and shelter are put at risk by the burden of trash. Many turtles die each year from becoming entangled in debris or ingesting floating trash that they mistake for food. Plastic bags and balloons resemble jellyfish in color, shape and texture and so may be mistaken for a common food item. Baby turtles often ingest tar and plastic weeks after being born, when they journey 25 to 45 miles offshore to feed in the Gulf Stream (Tampa Tribune & Associated Press 2002). Plastics block the gut and prevent absorption of food. In a recent study of 66 post-hatchling loggerhead turtles sampled from a driftline habitat, 10 turtles, or 15% of the sample, were reported to have ingested plastics (Witherington 2000). The ingestion of plastics is likely to have both lethal and sublethal effects (McCauley and Bjorndal 1999).

Every year millions of non-degradable, gas-filled balloons are released into the air at special events, theme parks, political rallies, military ceremonies and other occasions. These balloons can travel for hundreds of miles and often land in the ocean and on beaches. In response to the growing number of reports of wildlife dying from ingesting balloons, Florida law now prohibits the outdoor release of more than 10 lighter-than-air balloons within a 24-hour period.

Many sea turtles die each year from ingesting floating trash mistaken for food.

Turtles of all sizes die from entrapment in lost or discarded fishing gear and debris or from swallowing plastic bags, pellets, bottles, vinyl films and tarballs. These are not isolated incidents but rather frequent occurrences that should be viewed with alarm. Non-degradable debris and pollutants in the ocean are part of the progressive disruption of the ecological organization of marine systems (Carr 1987).

Conservation

Legislation and Agreements

Under the federal Endangered Species Act, the hawksbill, leatherback and Kemp’s ridley are listed as endangered, the green turtle is listed as endangered in Florida and Pacific Mexico and threatened throughout the rest of its range, and the loggerhead is listed as threatened. It is illegal to import, sell or transport turtles or their products in interstate or foreign commerce. This law applies to someone digging up turtle eggs as well as tourists bringing turtle souvenirs home from other countries.

Many federal, state, local and private groups are working to protect sea turtles and promote their recovery. At the federal level, the National Marine Fisheries Service has jurisdiction over sea turtles in the water and the U.S. Fish and Wildlife Service has jurisdiction over turtles on land. In Florida, the

Fish and Wildlife Conservation Commission, in cooperation with federal agencies, oversees sea turtle programs.

The U.S. Fish and Wildlife Service, the State of Florida, County Governments and private foundations are working cooperatively to purchase the remaining parcels of undeveloped land that make up The Archie Carr National Wildlife Refuge. The Archie Carr National Wildlife Refuge, a 33 kilometer (20.5 mile) stretch of beach between Melbourne Beach and Wabasso Beach along Florida's east central coast, was designated by Congress in 1989 in order to preserve a globally important sea turtle nesting ground. About 15,000 to 30,000 loggerhead nests are deposited each year along the beaches of Brevard and Indian River Counties making the Refuge the most productive loggerhead nesting site in the Western Hemisphere. These same beaches attract more nesting green turtles than any other place in the continental U.S. Over 4,500 green nests were recorded at the Refuge during the 2000 nesting season. In addition, beaches in northern Palm Beach County have equivalent loggerhead nesting densities to those located in the Archie Carr refuge. These beaches have an average of 1000 nests per mile.

Founded by Dr. Archie Carr in the 1950s, the Caribbean Conservation Corporation, based in Gainesville, Florida is the oldest sea turtle research and conservation group in the world. Through its Sea Turtle Survival League, this group is helping to protect sea turtles and their habitat and to raise awareness about sea turtles and the threats to their survival. The Ocean Conservancy, based in Washington, D.C., also works to promote sea turtle conservation. This group funds sea turtle projects around the world and is active in many sea turtle issues such as trade in turtle products, fishing practices that threaten turtles, marine debris and beach lighting. Throughout Florida, local governments, conservation groups and corporations are sponsoring programs to involve local citizens in protecting turtles. Local organizations such as the Marinelife Center of Juno Beach, provide public education programs, sea turtle rehabilitation and a platform for sea turtle research.

Florida Power & Light Company (FPL) maintains a number of federal permits that require their facilities to cause “no harm” to sea turtles. FPL also is promoting the conservation of sea turtles and other endangered species by funding educational programs and research. FPL’s sea turtle projects include public awareness programs such as an educational booklet, bumper stickers and bill enclosures encouraging people to minimize beach lighting, and state-permitted “turtle walks” on Hutchinson Island at FPL’s St. Lucie power plant. FPL has funded research on beach lighting through the Archie Carr Center for Sea Turtle Research at the University of Florida. This study looked at the effect of various forms of light on the behavior of hatchlings and nesting females, and has helped address the problem of artificial lighting near nesting beaches. A survey of nesting turtles conducted since 1971 by FPL on Hutchinson Island on Florida’s east coast is one of the longest running studies of its kind and has yielded much valuable information.

International Agreements

Because sea turtles are migratory, protection at the national level is not enough. Worldwide, there are more than 70 conservation laws and regulations that apply to sea turtles. Two of these are global in scope. The Convention on International Trade in Endangered Species of Wild Fauna and Flora

(CITES) controls international trade in endangered and threatened species. All sea turtles, as well as many other endangered species, are addressed in this agreement, which has been signed by many countries. However, a few Asian countries, including Japan, have taken exception to the inclusion of some species and continue to trade in large quantities of turtle products. Extensive illegal trade occurs in many countries that are participants in the agreement.

The Convention on the Conservation of Migratory Species of Wild Animals addresses endangered species that travel from one governmental jurisdiction to another. This convention provides a framework on which to base future conservation agreements as well as a mechanism for governments to unilaterally conserve endangered migratory species.

A third international measure for sea turtle conservation is in the process of ratification. The Inter-American Convention for the Protection and Conservation of Sea Turtles (IAC) is the first comprehensive regional agreement protecting sea turtles and their habitats. The United States played a leading role in negotiating the Convention, which was completed in 1996. The United States ratified the Convention in 2000. The IAC will not enter into force, however, until it is endorsed by eight nations. Of the original 12 countries that were signatories of the treaty, five now sanction it. Three more countries must do so as well before the treaty comes into force. It appears that Honduras and Belize will soon join the list.

Federal laws now address ocean dumping. The ratification of Annex V of the International Convention for the Prevention of Pollution from Ships (MARPOL) makes it illegal for any vessel to dump plastic trash anywhere in the ocean or navigable waters of the U.S. and restricts dumping of other garbage. Marinas and public and private terminals are required to provide waste reception facilities. Compliance and enforcement of these regulations is another matter, and to date, pollution from land-based sources such as sewage treatment plants and plastics manufacturers has not been addressed. The problem of non-degradable debris in the oceans will be with us for years.

Research

An important part of conservation is research aimed at understanding the biology of sea turtles so that intelligent management decisions can be made. In Florida an ambitious research project has begun under the direction of the Florida Fish and Wildlife Conservation Commission's Marine Turtle Protection Program and the U.S. Fish and Wildlife Service. Thirty-three nesting beaches totaling about 400 kilometers (250 miles) and representing about 75 percent of the nesting activity in the state are being studied using standardized procedures to obtain long-term data on the status of Florida's nesting sea turtles. Many research and monitoring projects are providing new information about sea turtles such as the role of inshore and coastal areas as developmental habitat for immature turtles.

Management Methods

Conservation efforts over the past few years have focused on developing long-term solutions to the problems facing sea turtles and reducing reliance on manipulative management methods, such as moving nests or raising hatchlings in captivity. For example, many early turtle protection programs relied on moving nests to protected hatcheries where the eggs were incubated in sand-filled styrofoam boxes. We now know that a temperature change of only a few degrees can determine whether a hatchling will be male or female. Since the temperature in the hatchery boxes tends to be cooler than on the beach, this practice produced an unusual number of males and has been discontinued.

"Head starting" was another manipulative technique in which hatchlings were raised in captivity for 6 to 12 months or more and then released in the wild. Larger turtles are thought to be less vulnerable to predation. By giving turtles a "head start" it has been hoped that a larger percentage of the turtles would survive to adulthood. Extensive head start programs have been conducted with Kemp's ridleys and Florida green turtles. However, in Florida the program was discontinued in 1988.

The future of the sea turtle must not be dependent upon people moving nests or raising turtles in captivity. Our goal should be self-sustaining populations that do not rely on human intervention. We must address the problem of why our beaches have become unsuitable for turtle nesting and why so many turtles die at sea. The major categories of conservation programs that will allow this goal to be met are:

1. Increasing public awareness and participation in sea turtle conservation through public education.

2. Banning international commerce in sea turtles and their products through laws and agreements.

3. Decreasing the loss of turtles to commercial fishing through enforcement of Turtle Excluder Device (TED) and gill net regulations and addressing the problems of drift net, pound net, and other fishing methods known to kill turtles.

4. Preserving and restoring developmental, feeding and nesting habitats.

5. Making nesting beaches acceptable to turtles by eliminating the impact of artificial lighting through technology, ordinances and public education, halting shore armoring (e.g., seawalls, revetments, rip-rap), revising beach cleaning programs and controlling predators.

6. Minimizing solid waste and pollutant dumping into the marine environment.

7. Regulating channel and port dredging as well as beach and dune restoration projects and other coastal construction activities.

8. Continuing research and monitoring programs.

9. Conducting beach nourishment with the least amount of impact to sea turtle habitat.

So far, there is no conclusive evidence that Florida's turtle populations are responding to protective measures. The continuing loss of larger turtles and disruptions in developmental habitats may be offsetting the gains made in protecting the nesting beaches. Given the slow maturation time for sea turtles it will be many years before we know if the hard work of sea turtle conservationists is beginning to show results.

On the Road to Recovery

In 1998, the Florida Legislature authorized the creation of a sea turtle license plate. Proceeds from the sale of this plate fund the state's Marine Turtle Protection Program as well as a small grants program for marine turtle conservation projects. These funds not only protect endangered sea turtles through research and recovery efforts but also protect nesting beaches and coastal habitat. Tags are available at your local tax collector's office along with waterproof decals for your car or boat. When you place a sea turtle license plate on your car, you'll be doing your part to ensure the survival of these magnificent animals.

How can you help

There are many things we can do to promote the survival of sea turtles:

- First, we must remember that we share the beach and ocean with many other species. Never approach turtles emerging from the sea or disturb or harass nesting turtles by making noise, shining lights or trying to ride them. To observe nesting turtles, join one of the many state-permitted "turtle walks" conducted by experienced guides during the nesting season.
- Watch out for hatchlings or turtles that may be disoriented by lights and lured onto the road.
- Be careful while boating to avoid collisions with turtles and never throw trash in the water or on the beach.

- Participate in coastal cleanups and other efforts to remove trash and debris from our oceans and beaches.
- Coastal residents can contact their local governments about ordinances to decrease the impact of beach lighting on sea turtles.
- Be mindful of beachfront lighting during sea turtle nesting season.
- Help sea turtle survival by supporting conservation groups that are active in sea turtle issues such as the Ocean Conservancy (1-800-262-3567) and the Caribbean Conservation Corporation (1-800-678-7853).
- Support and visit local sea turtle rehabilitation centers, like the Marinelife Center of Juno Beach (561-627-8280) and participate in organized public turtle walks.
- Never buy products made from endangered species.
- If you find an injured or dead turtle in Florida, call the Fish and Wildlife Conservation Commission Law Enforcement at (1-888-404-FWCC).
- Buy a Sea Turtle Specialty License Plate for your vehicle. Revenue from the sale of the Sea Turtle License Plate goes to support sea turtle research, conservation and education in Florida.

We can share the beaches and ocean with sea turtles, but it requires commitment and effort on our part. We can make certain that future generations will have the opportunity to know these unusual animals. The late Dr. Archie Carr, a scientist and author who almost single-handedly began to turn the tide on the extinction of sea turtles, summed it up when he wrote, "For most of the wild things on earth the future must depend upon the conscience of mankind." Our planet has come to an unprecedented point in its history where the actions of one species - humans - will determine the fate of life on earth. It is not too late to ensure a sustainable future for sea turtles.

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The illustrations for this booklet draw on photographs and illustrations from a variety of sources. These include: Florida Power & Light Company photographs; Pritchard, P.C.H., P.R. Bacon, F.H. Berry, J. Fletemeyer, A.F. Carr, R.M. Gallagher, R.R. Lankford, R. Marquez M., L.H. Ogren, W.G. Pringle, H.M. Reichart and R. Witham. 1982. Sea Turtle Manual of Research and Conservation Techniques.

Prepared for the Western Atlantic Turtle Symposium, July 1983, San Jose, Costa Rica. 94pp.; the poster "Sea Turtles of the World," sponsored by the National Marine Fisheries Service and the Center for Marine Conservation now known as the Ocean Conservancy, Marvin Bennet, Jr., artist; Booth and Peters 1972; and a South Carolina Wildlife and Marine Resources publication on the loggerhead turtle.

Citations

Associated Press. May 13, 2002. Florida Researchers: Tar, Plastic Plague Baby Sea Turtles. Tampa Tribune Online. http://ap.tbo.com/ap/florida/MGAIY8MQ61D.html.

Balazs, G.H. 1980. Synopsis of biological data on the green turtle in the Hawaiian Islands. NOAA Technical Memorandum NMFS. NOAA-TM-NMFS-SWFC-7. 141 pp.

Bjorndal, K.A. 1982. The consequences of herbivory for the life history pattern of the Caribbean green turtle, *Chelonia mydas*. Pages 111-116 *in* K.A. Bjorndal (Editor). Biology and Conservation of Sea Turtles. Proceedings of the World Conference on Sea Turtle Conservation, 26-30 November 1979, Washington, D.C. Smithsonian Institution Press, Washington, D.C. 583 pp.

Bjorndal, K.A. 1985. Nutritional ecology of sea turtles. Copeia 1985(3):736-751.

Bjorndal, K. and A.B. Bolten. 1988. Growth rates of immature green turtles, *Chelonia mydas*, on feeding grounds in the southern Bahamas. Copeia 1988(3):555-564.

Bjorndal, K.A. and A. Carr. 1989. Variation in clutch size and egg size in the green turtle nesting population at Tortuguero, Costa Rica. Herpetologica 49(2):181-189.

Booth, J. and J.A. Peters. 1972. Behavioral studies on the green turtle (*Chelonia mydas*) in the sea. Animal Behavior 20:808-812.

Bustard, H.R. 1967. Mechanism of nocturnal emergence from the nest in green turtle hatchlings. Nature 214:317.

Bustard, H.R. 1974. Barrier reef sea turtle populations. Pages 227-234 *in* Proceedings of the Second International Coral Reef Symposium. 1. Great Barrier Reef Committee, Brisbane, Australia.

Byles, R.A. and C.K. Dodd. 1989. Satellite biotelemetry of a loggerhead sea turtle (*Caretta caretta*) from the east coast of Florida. Pages 215-217 in S.A Eckert, K.L. Eckert and T.H. Richardson (Compilers). Proceedings of the Ninth Annual Workshop on Sea Turtle Conservation and Biology. NOAA Technical Memorandum NMFS-SEFC-232. 306 pp.

Canin, J. 1989. International trade in sea turtle products. Pages 27-29 *in* S.A. Eckert, K.L. Eckert and T.H. Richardson (Compilers). Proceedings of the Ninth Annual Workshop on Sea Turtle Conservation and Biology. NOAA Technical Memorandum NMFS-SEFC-232. 306 pp.

Carr, A. 1956. The Windward Road. Alfred A. Knopf. 258 pp.

Carr, A. 1967. So Excellent a Fishe. A Natural History of Sea Turtles. The Natural History Press. 248 pp.

Carr, A. 1975. The Ascension Island green turtle colony. Copeia 1975(3):547-555.

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

Carr, A. 1987. Impact of non-degradable marine debris on the ecology and survival outlook of sea turtles. Marine Pollution Bulletin 18(6B):352-356.

Carr, A. 1987. New perspectives on the pelagic stage of sea turtle development Conservation Biology 1(2):103-121.

Carr, A. and H. Hirth. 1961. Social facilitation in green turtle siblings. Animal Behavior 9 (1-2):68-70.

Chaloupka, M.Y. and Musick, J.A. 1997. Age, growth and population dynamics, p. 256 *in* “The Biology of Sea Turtles”, (P. L. Lutz & J. A. Musick, eds.), CRC Press, Boca Raton.

Committee on Sea Turtle Conservation of the National Research Council. 1990. Decline of the Sea Turtle: Causes and Prevention. National Academy Press. Washington, D.C. 286 pp.

Cornelius, S.E. 1986. The sea turtles of Santa Rosa National Park. Fundacion de Parues Nacionales, Costa Rica. 64 pp.

Davenport, J., J.Wrench, J. McEvoy and V. Camacho-Ibar. 1990. Metal and PCB concentrations in the “Harlech” leatherback. Marine Turtle Newsletter 48:1-6.

Dodd, C.K. 1982. Historical review of the decline of the green turtle and the hawksbill. Pages 183-188 *in* K.A. Bjorndal (Editor). Biology and Conservation of Sea Turtles. Proceedings of the World Conference on Sea Turtle Conservation, 26-30 November 1979, Washington, D.C. Smithsonian Institution Press, Washington, D.C. 583 pp.

Donnelly, M. 1989. International trade in hawksbill sea turtle shell in the wider Caribbean. Pages 45-47 *in* S.A. Eckert, K.L. Eckert and T.H. Richardson (Compilers). Proceedings of the Ninth Annual Workshop on Sea Turtle Conservation and Biology. NOAA Technical Memorandum NMFS-SEFC-232. 306 pp.

Drennen, D., D. Cooley and J.E. Devore. 1989. Armadillo predation on loggerhead turtle eggs at two national wildlife refuges in Florida, USA Marine Turtle Newsletter 45:7-8.

Eckert, K.L. and S.A. Eckert. 1988. Pre-reproductive movements of leatherback sea turtles (*Dermochelys coriacea*) nesting in the Caribbean. Copeia 1988(2):400-406.

Eckert, S.A, K.L. Eckert, P. Ponganis and G.L. Kooyman. 1989. Diving and foraging behavior of leatherback sea turtles (*Dermochelys coriacea*). Canadian Journal of Zoology 67:2834-2840.

Eckert, S.A., D.W. Nellis, K.L. Eckert and G.L. Kooyman. 1984. Deep diving record for leatherbacks. Marine Turtle Newsletter 31:4.

Eckert, S.A., D.W. Nellis, K.L. Eckert and G.L. Kooyman. 1986. Diving patterns of two leatherback sea turtles (*Dermochelys coriacea*) during internesting intervals at Sandy Point, St.Croix, U.S. Virgin Islands. Herpetologica 42(3):381-388.

Ehrenfeld, D.W. and A.L. Koch. 1966. Visual accommodation in the green turtle. Science 155(3764):827-828.

Ehrhart, L.M., B.E. Witherington. 1987. Human and natural causes of marine turtle nest and hatchling mortality and their relationship to hatchling production on an important Florida nesting beach. Florida Game and Fresh Water Fish Commission. Non-game Wildlife Program. Tech. Rept. 1.

Ehrhart, L.M., P. Raymond, J.L. Gussman, R. Owen. 1990. A documented case of green turtles killed in an abandon gill net: the need for better regulation of Florida’s gill net fisheries. Pages 55-58 *in* T.H. Richardson, J.I. Richardson, and M. Donnelly (Compilers). Proceedings of the Tenth Annual Workshop on Sea Turtle Biology and Conservation. NOAA Tech. Memo. NMFS SEFC-278, 286pp.

Ehrhart, L.M., R.B. Sindler and B.E. Witherington. 1986. Preliminary investigation of papillomatosis in green turtles: Phase I - Frequency and effects on turtles in the wild and in captivity. Final report to U.S. Department of Commerce NOAA. National Marine Fisheries Service. Order NO. 40GENF-6-00601.

Eley, T.J. 1989. Sea turtles and the Kiwai, Papua New Guinea. Page 49 *in* S.A Eckert, K.L. Eckert and T.H. Richardson (Compilers). Proceedings of the Ninth Annual Workshop on Sea Turtle Conservation and Biology. NOAA Technical Memorandum NMFS-SEFC-232. 306 pp.

Florida Marine Research Institute. July 2002. Leatherback Nesting Data for Southeast Florida. http://floridamarine.org/features/view_article.asp?id=8225

Florida Sea Turtle Stranding and Salvage Network. 2001. Summary Memorandum.

Frair, W., R.G. Ackman and N. Mrosovsky. 1972. Body temperature of *Dermochelys coriacea*: warm turtle from cold water. Science 177:791-793.

Frazer, N.B. 1983. Survivorship of adult female loggerhead sea turtles, *Caretta caretta*, nesting on Little Cumberland Island, Georgia, U.SA Herpetologica 39(4):436-447.

Frazier, J., M.D. Meneghel, and F. Achaval. 1985. A clarification on the feeding habits of *Dermochelys coriacea*. Journal of Herpetology 19(1):159-160.

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

Fritts, T.H. and W. Hoffman. 1982. Diurnal nesting of marine turtles in southern Brevard County, Florida. Journal of Herpetology 16(1):84-86.

Herbst, L.H., E.R. Jacobson, P.A. Klein, G.H. Balazs, R. Moretti, T. Brown, J.P. Sundberg. 1999. Comparative Pathology and Pathogenesis of Experimentally Induced and Spontaneous Fibropapillomas of Green Turtles (*Chelonia mydas*). Vet. Pathol. 36, 557-564.

Hopkins, S.R. and T.M. Murphy. 1981. Reproductive ecology of *Caretta caretta* in South Carolina. South Carolina Wildlife and Marine Resources Department, Division of Wildlife and Freshwater Fisheries. Study Number VI-A-I. 97 pp.

Jackson, D.C. 1985. Respiration and respiratory control in the green turtle. Copeia 1985 (3):664-671.

Keinath, J.A., J.A. Musick and R.A. Byles. 1987. Aspects of the biology of Virginia's sea turtles: 1979-1986. Virginia Journal of Science 38(4):329-336.

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

Lohmann, K., B.E. Witherington, C.M.F. Lohmann, and M. Salmon. 1996. Orientation, navigation and natal beach homing in sea turtles, pp. 107-135 *in* "The Biology of Sea Turtles", (P. L. Lutz & J. A. Musick, eds.), CRC Press, Boca Raton.

Lund, P.F. 1985. Hawksbill turtle (*Eretmochelys imbricata*) nesting on the east coast of Florida. Journal of Herpetology 19(l):164-166.

Mack, D., N. Duplaix and S. Wells. 1982. Sea turtles, animals of divisible parts: international trade in sea turtle products. Pages 545-563 *in* K.A. Bjorndal (Editor). Biology and Conservation of Sea Turtles. Proceedings of the World Conference on Sea Turtle Conservation, 26-30 November 1979, Washington, D.C. Smithsonian Institution Press, Washington, D.C. 583 pp.

Marquez M., R., A. Villanueva O., and P.M. Burchfield. 1989. Nesting population and production of hatchlings of Kemp's ridley sea turtle at Rancho Nuevo, Tamaulipas, Mexico. Pages 16-19 *in* C.W. Caillouet, Jr. and A.M. Landry, Jr. (Editors). Proceedings of the First International Symposium on Kemp's Ridley Sea Turtle Biology, Conservation and Management October 14, 1985. Texas A&M University at Galveston. TAMU-SG-89-105. 260 pp.

Marquez M., R., P.M. Burchfield, M.A. Carrasco, C. Jimenez, J. Diaz, M. Garduno, A. Leo, J. Pena, R. Bravo and E. Gonzalez. 2001. Update on the Kemp's Ridley Turtle Nesting in Mexico. Marine Turtle Newsletter 92:2-4.

McCauley S.J., Bjorndal K.A. 1999. Conservation implications of dietary dilution from debris ingestion: sublethal effects in post-hatchling loggerhead sea turtles. Conservation Biology 13:925-929.

Meylan, A. 1988. Spongivory in hawksbill turtles; a diet of glass. Science 239(4838):393-395.

Meylan, A.B., K.A. Bjorndal, and B.J. Turner. 1983. Sea turtle nesting at Melbourne Beach, Florida, II. Post-nesting movements of *Caretta caretta*. Biological Conservation 26:79-90.

Miller, J.D., 1997. Reproduction in sea turtles, page 58 *in* “The Biology of Sea Turtles”, P.L. Lutz and J.A. Musick, Ed., CRC Press, Boca Raton.

Mrosovsky, N. 1968. Nocturnal emergence of hatchling sea turtles: control by thermal inhibition of activity. Nature 220:1338-1339.

Mrosovsky, N. 1980. Thermal biology of sea turtles. American Zoologist 20:531-547.

Mrosovsky, N. 1983. Conserving Sea Turtles. British Herpetological Society, London. 176 pp.

Mrosovsky, N. and C.L. Yntema. 1980. Temperature dependence of sexual differentiation in sea turtles: implications for conservation practices. Biological Conservation 18:271-280.

Mrosovsky, N. and P.C.H. Pritchard. 1971. Body temperatures of *Dermochelys coriacea* and other sea turtles. Copeia 1971(4):624-631.

Mrosovsky, N. and S.F. Kingsmill. 1985. How turtles find the sea. Z. Tierpsychol. 67:237-256.

Murphy, T.M. and S.R. Hopkins. 1984. Aerial and ground surveys of marine turtle nesting beaches in the southeast region, U.S. Report to National Marine Fisheries Service. Contract No. NA83-GA-00021. 73 pp.

Murphy, T.M. and S.R. Hopkins-Murphy. 1989. Sea Turtle and Shrimp Fishing Interactions: a Summary and Critique of Relevant Information. Center for Marine Conservation. Washington, D.C. 52 pp.

Owens, D.W. 1980. The comparative reproductive physiology of sea turtles. American Zoologist 20:549-563.

Owens, D.W. and Y.A. Morris. 1985. The comparative endocrinology of sea turtles. Copeia 1985(3):723-735.

Owens, D.W., M.A. Grassman and J.R. Hendrickson. 1982. The imprinting hypothesis and sea turtle reproduction. Herpetologica, 38(1):124-135.

Parsons, J.J. 1962. The Green Turtle and Man. University of Florida Press, Gainesville. 126 pp.

Pritchard, P.C.H. 1971. The leatherback or leathery turtle. IUCN Monograph Number 1: Marine Turtle Series. 39 pp.

Pritchard, P.C.H. 1979. Encyclopedia of turtles. TFH Publications, Inc., Neptune, New Jersey. 895 pp.

Pritchard, P.C.H. 1982. Nesting of the leatherback turtle, *Dermochelys coriacea* in Pacific Mexico, with a new estimate of the world population status. Copeia 1982 (4):741-747.

Pritchard, P.C.H. and R. Marquez M. 1973. Kemp’s Ridley Turtle or Atlantic Ridley *Lepidochelys kempi*. IUCN Monograph No 2. Marine Turtle Series. 30 pp.

Reviewed in Ehrhart, L.M. 1989. Status report of the loggerhead turtle. Pages 122-139 *in* L. Ogren (Editor-in-Chief). Proceedings of tile Second Western Atlantic Turtle Symposium. October 2-16, 1987. Mayaguez, Puerto Rico. NOAA Technical Memorandum NMFS SEFC-226.

Ross, J.P. 1982. Historical decline of loggerhead, ridley, and leatherback sea turtles. Pages 189-195 *in* K.A. Bjorndal (Editor) Biology and Conservation of Sea Turtles. Proceedings of the World

Conference on Sea Turtle Conservation, 26-30 November 1979, Washington, D.C. Smithsonian Institution Press, Washington, D.C. 583 pp.

Salmon, M. and K.J. Lohmann. 1989. Orientation cues used by hatchling loggerhead sea turtles (*Caretta caretta L.*) during offshore migration. Ethology 83:215-228.

Schmelz, G.W. and R.R. Mezich. 1988. A preliminary investigation of the potential impact of Australian pines on the nesting activities of the loggerhead turtle. Pages 63-66 *in* B.A. Schroeder (Compiler). Proceedings of the Eighth Annual Workshop on Sea Turtle Conservation and Biology. 24-26 February 1988. NOAA Technical Memorandum NMFS-SEFC-214.

Schroeder, B.A. and C.A. Maley. 1989. Fall/winter strandings of marine turtles along the northeast Florida and Georgia coasts. Pages 159-161 *in* S.A. Eckert, K.L. Eckert and T.H. Richardson (Compilers). Proceedings of the Ninth Annual Workshop on Sea Turtle Conservation and Biology. NOAA Technical Memorandum NMFS-SEFC-232. 306 pp.

Shoop, C.R., C.A. Ruckdeschel, and N.B. Thompson. 1985. Sea turtles in the southeast United States: nesting activity as derived from aerial and ground surveys, 1982. Herpetologica 41(3):252-259.

Spotila, J.R. 1988. Archie Carr: to the edge of hope 1909-1987. Herpetologica. 44 (1):128-132.

Spotila, J.R. and E.A. Standora. 1985. Environmental constraints on the thermal energetics of sea turtles. Copeia 1985(3):694-702.

Spotila, J.R., E.A. Standora, S.J. Morreale, and G.J. Ruiz. 1987. Temperature dependent sex determination in the green turtle (*Chelonia mydas*): effects on the sex ratio on a natural nesting beach. Herpetologica 43(1):74-81.

Spotila, J.R., A.E. Dunham, A.J. Leslie, A.C. Steyermark, P.T. Plotkin, and F.V. Paladino. 1996. Worldwide population decline of *Dermochelys coriacea*: Are leatherback turtles going extinct? Chelonian Conservation and Biology 2 (2): 209-222.

Spotila, J.R., R.D. Reina, A.C. Steyermark, P.T. Plotkin, and F.V. Paladino. 2000. Pacific leatherback turtles face extinction. Nature 405:529-530.

Stancyk, S.E., O.R. Talbert and J.M. Dean. 1980. Nesting activity of the loggerhead turtle *Caretta caretta* in South Carolina, 2. Protection of nests from raccoon predation by transplanting. Biological Conservation 18(4):289-298.

Standora, E.A. and J.A. Spotila. 1985. Temperature dependent sex determination in sea turtles. Copeia 1985(3):711-722.

Stoneburner, C.L. 1982. Satellite telemetry of loggerhead sea turtle movement in the Georgia Bight. Copeia 1981(2):400-408.

Stoneburner, D.L and J.I. Richardson. 1981. Observations on the role of temperature in loggerhead turtle nest site selection. Copeia 1981(l):238-241.

Turtle Expert Working Group. 2000. Assessment Update for the Kemp's Ridley and Loggerhead Sea Turtle Populations in Western North Atlantic. U.S. Dept. Commerce. NOAA Technical Memorandum NMFS-SEFSC-444, 155 pp.

Witherington, B.E. 1989. Beach lighting and the seaward orientation of hatchling sea turtles. Pages 189-190 *in* S.A. Eckert, K.L. Eckert and T.H. Richardson (Compilers). Proceedings of the Ninth Annual Workshop on Sea Turtle Conservation and Biology. NOAA Technical Memorandum NMFS-SEFC-232. 306 pp.

Witherington, B.E. and L.M. Ehrhart. 1989. Hypothermic stunning and mortality of marine turtles in the Indian River Lagoon system, Florida. Copeia 1989 (3):696-703.

Witherington, B.E. 2001. Ecology of neonate loggerhead turtles inhabiting lines of downwelling near a Gulf Stream front. Marine Biology, 2002 140: 843-853.

Wolfe, D.A. 1987. Persistent plastics and debris in the ocean: an international problem of ocean disposal. Marine Pollution Bulletin 18(6B):303-305.

Wood, J.R. and F.E. Wood. 1980. Reproductive biology of captive green sea turtles *Chelonia mydas*. American Zoologist 20:499-505.

Wood, J.R. and F.E. Wood. 1989. Captive rearing and breeding Kemp's ridley sea turtle at Cayman Turtle Farm (1983) Ltd. Pages 237-240 *in* C.W. Caillouet, Jr. and A.M. Landry, Jr. (Editors). Proceedings of the First International Symposium on Kemp's Ridley Sea Turtle Biology, Conservation and Management. October 14, 1985. Texas A&M University at Galveston. TAMU-SG-89-105. 260 pp.

Wood, L. Personal Communication. April 10, 2002.

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