Sea Turtle Migration-Tracking & Coastal Habitat Education Program

An Educator's Guide

Information about sea turtle natural history, coastal habitat ecology, high technology research and conservation efforts to protect sea turtles and their habitats.

SEA TURTLE CONSERVANCY

Acknowledgments

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Edited by Daniel Evans, Rocio Johnson & David Godfrey

FIFTH EDITION

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A Word To Educators

Sea turtles are some of the most mysterious and time-honored creatures on earth. The Sea Turtle Conservancy (STC), through its educational programs and conservation initiatives, is helping ensure the gentle sea turtle remains a wild and thriving part of the natural landscape.

The most serious threats to sea turtle survival are directly caused by the actions of people. The same is true for many animal species now listed as endangered or threatened. It is also true that as humans we have the unique ability to learn about how we are affecting the world around us and to change our behavior accordingly. Education is the key.

The Sea Turtle Migration-Tracking & Coastal Habitat Education Program (Program) is designed to capture the interest of young minds in issues surrounding sea turtles, coastal habitats and cutting edge research techniques. This Program can harness their interest, and in the process, teach them about sea turtle biology, coastal habitat ecology, the threats both sea turtles and coastal habitats face, how they can get involved in conservation and take personal responsibility for their actions through the activities, lesson plans and a host of related scientific and geographic topics.

This Educator's Guide will provide the background information you need to incorporate the Program into your classroom. The Guide is designed as a resource for you. You can then download classroom activities, lesson plans and worksheets (for both primary and secondary levels) that you can easily photocopy for use as a handout. You will find activities that incorporate art, math, geography, political science, writing and biology.

As a way for students to take a personal interest in one of the satellite-tracked turtles, and as a way to support sea turtle conservation, we invite your class to "adopt" a turtle. Several classes will likely adopt each of the satellite tracked turtles, whose names have already been given. If you want to be the sole adoptive class of a green turtle and name the turtle yourselves, you can choose to adopt one we have flipper tagged while nesting in Costa Rica. Please visit the STC website or call 1-800-678-7853 to learn more.

In this Guide, you will find background material to begin teaching your students about sea turtle biology, navigation and migration, the threats sea turtles face and what must be done to protect them. In addition, you will find background information on coastal ecology and issues related to the protection of this natural resource. On STC's website (http://www.conserveturtles.org) you will find an "Educator's Corner" that includes classroom resources and activities, links to sea turtle tracking maps, photos and videos of sea turtles, self grading quizzes, and educational puzzles and games.

As you use the Guide and additional resources in the classroom, we encourage you to take note and let us know of any ideas you have about how we can improve its usefulness. We also welcome sharing any activities you develop with other educator's by allowing STC to post your idea on the STC website.

About the Sea Turtle Conservancy

The Sea Turtle Conservancy (STC) is a not-for-profit, 501(c)3 organization based in Florida with offices and projects in several other locations. Originally founded as the Caribbean Conservation Corporation, **STC is the oldest and most accomplished sea turtle organization in the world!** Since its founding in 1959, STC's work has greatly improved the survival outlook for several species of sea turtles. STC is a world-renowned leader in sea turtle research and conservation.

STC's mission is to protect endangered sea turtles and their habitats through research, education, advocacy and protection of natural areas.

STC, founded by Dr. Archie Carr and others, has as its mission the protection of sea turtles and the habitats upon which they depend. To achieve its mission, STC uses research, habitat protection, public education, community outreach, networking and advocacy as its basic tools. These tools are applied in both international and domestic programs focusing on geographic areas that are globally important to sea turtle survival.

Why Sea Turtles:

STC has chosen sea turtles as the focus of its conservation efforts in part because these ancient creatures are among the most important indicators of the health of the world's marine and coastal ecosystems. STC believes that whether sea turtles ultimately vanish from the planet or whether they remain a wild and thriving part of the natural world, will speak volumes about both the general health of the planet and the ability of humans to sustainably coexist with the diversity of life on Earth.

Geographic Focus:

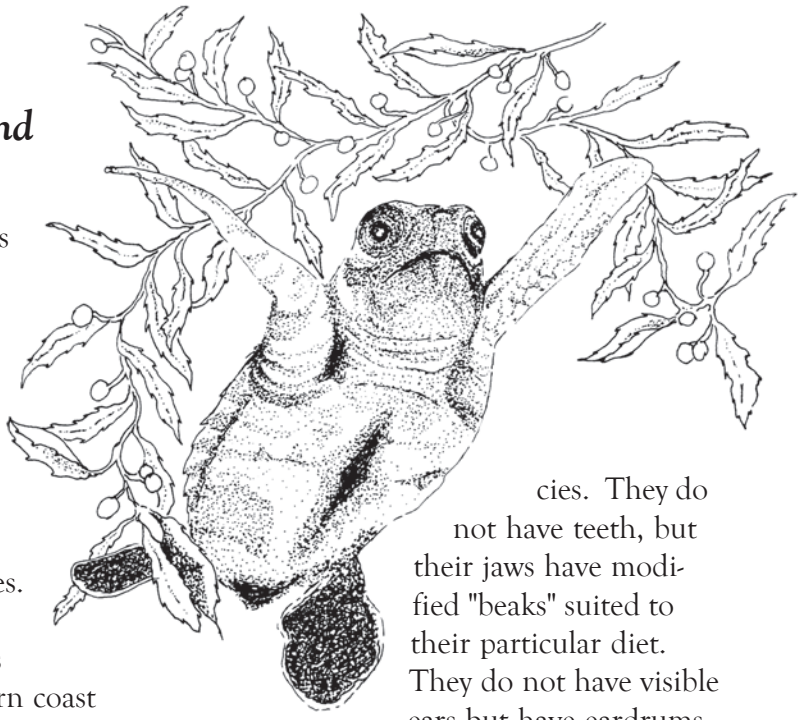
STC 's geographic focus is the Wider Caribbean and Atlantic because of the region's unique importance to the world's remaining sea turtle populations. The colonies of green turtles, loggerheads, hawksbills and leatherbacks that nest at Tortuguero in Costa Rica, Chiriquí Beach in Panama, and in Florida are among the largest remaining in the Western Hemisphere. In response, STC weights its efforts toward these critical nesting beaches. The highly migratory nature of sea turtles dictates that STC include the whole Caribbean basin within its geographic scope. Therefore, programs have been initiated in Bermuda, the Bahamas and in the eastern Caribbean because of the important roles these areas play in the life cycle of sea turtles. STC 's major programs include Research and Conservation in Tortuguero, Costa Rica and Chiriqí Beach, Panama; International Policy; U.S. Policy; Education & Outreach; and the Bermuda Turtle Project.

Sea Turtles:

A Brief Overview

Sea turtles are large, air-breathing reptiles that inhabit tropical and subtropical seas throughout the world. Their streamlined bodies and large flippers make them remarkably adapted to life at sea. However, sea turtles maintain close ties to land. Females must come ashore to lay their eggs in the sand; therefore, all sea turtles begin their lives as tiny hatchlings on land.

Research on marine turtles has uncovered many facts about these ancient creatures. Most of this research has been fo-cused on nesting females and hatchlings emerging from the nest, largely because they are the easiest to find and study. Thousands of sea turtles around the world have been tagged to help collect information about their growth rates, reproductive cycles and migration routes. After decades of studying sea turtles, much has been learned. However, many mysteries still remain. New technologies, such as satellite telemetry, are allowing scientists to monitor turtles throughout their range. The information gathered through satellite-tracking should answer many questions and help conservation groups like the Sea Turtle Conservancy to develop better strategies for protecting sea turtles.



Turtles and Humans

Sea turtles have long fascinated people and have figured prominently in the mythology and folklore of many cultures.

In the Miskito Cays off the eastern coast of Nicaragua, the story of a kind "Turtle Mother," still lingers. Unfortunately, the spiritual significance of sea turtles has not saved them from being exploited for both food and for profit. Millions of sea turtles once roamed the earth's oceans, but now only a fraction remain.

General Description

Each species of sea turtle looks and behaves distinctly, but they do have several common characteristics. Their shells consist of an upper part (carapace) and a lower section (plastron). Hard scales (or scutes) cover all but the leatherback turtle, and the number and arrangement of these scutes can be used to determine the species. They do not have teeth, but their jaws have modified "beaks" suited to their particular diet. They do not have visible ears but have eardrums covered by skin. They hear best at low frequencies, and their sense of smell is excellent. Their vision underwater is good, but they are nearsighted out of water.

Reproduction

Only females come ashore to nest; males rarely return to land after crawling into the sea as hatchlings. Most females return to nest on the beach where they were born (natal beach). Nesting seasons occur at different times around the world. In the U.S., nesting occurs from April through October. Most females nest at least twice during each mating season; some may nest up to ten times in a season. A female will not nest in consecutive years, typically skipping one or two years before returning.

Growth & Development

Researchers do not yet know how long baby turtles spend in the open sea, or exactly where they go. It is theorized that they spend their earliest, most vulnerable years floating around the sea in giant beds of sargasso weeds, where they do little more than eat and grow. Once turtles reach dinner-plate size, they appear at feeding grounds in nearshore waters. They grow slowly and take between 15 and 50 years to reach reproductive maturity, depending on the species. There is no way to determine the age of a sea turtle from its physical appearance. It is theorized that some species can live more than 100 years.

Status of the Species

The earliest known sea turtle fossils are about 150 million years old. In groups too numerous to count, they once navigated throughout the world's oceans. But in just the past 100 years, demand for turtle meat, eggs, skin and colorful shells has reduced their numbers. Destruction of feeding and nesting habitats and pollution of the world's oceans are all taking a serious toll on remaining sea turtle populations. Many breeding populations have already become extinct, and entire species are being wiped out. There could be a time in the near future when sea turtles are just an oddity found only in aquariums and natural history museums — unless action is taken today.

What is Extinction and Why Should You Care If Sea Turtles Go Extinct?

A plant or animal becomes extinct when the last living individual of its species dies, causing it to vanish from the earth forever. If there is ever a time when the last green turtle on earth dies, then never again will this magnificent creature grace our world.

Species have been going extinct for millions of years; it is a natural part of the evolutionary process. For example, most of the species that existed during the time of dinosaurs have perished. Many probably went extinct because of sudden geological or climatic changes – possibly because of a large volcanic eruption or because of a giant meteor hitting the earth.

Today, however, species are going extinct because of abrupt changes brought about by humans. Habitat destruction, pollution and overconsumption are causing species to decline at a rate never before seen in history. This loss of species is eroding the diversity of life on earth, and a loss of diversity can make all life vulnerable.

Much can be learned about the condition of the planet's environment by looking at sea turtles. They have existed for over 100 million years, and they travel throughout the world's oceans. Suddenly, however, they are struggling to survive – largely because of things people are doing to the planet's oceans and beaches. But what does this mean for the human species?

It is possible that a world in which sea turtles cannot survive may soon become a world in which humans struggle to survive. If, however, we learn from our mistakes and begin changing our behavior, there is still time to save sea turtles from extinction. In the process, we will be saving one of the earth's most mysterious and time-honored creatures. We might just be saving ourselves too.

How You Can Help

There are many things each of us can do to help sea turtles survive. First, we must remember that we share the oceans and the beaches with many other species. Second, become informed about the things that are killing sea turtles or destroying their habitat. Elected officials and other leaders are making decision on issues that affect sea turtles almost every day. As an informed citizen, you have the power to influence the outcome of these issues by making your voice heard. Third, take personal responsibility for your actions. By simply reducing the amount of plastic garbage, using biodegradable chemicals and not leaving trash on the beach when you leave, you can help save sea turtles and protect Florida's coastal habitats.

Sea Turtles:

Differences Between the Species

Sea Turtle Names

Each sea turtle has both a scientific name and a common name. The scientific name identifies the genus and species, and the common name typically describes some characteristic of the turtle's body. The **loggerhead**, for example, gets its name from its exceptionally large head. The **hawksbill** turtle gets its name because its narrow head and large beak make it look like a hawk. The **Australian flatback** gets its name because its shell is very flat. The **leatherback** is the only sea turtle without a hard shell. It is named leatherback because its shell is made of a layer of thin, tough, rubbery skin that looks like leather.

Other turtles are named for colors on their bodies. The shell of the **olive ridley** is olive green. The **green turtle** is a little bit trickier. You might think the shell of a green turtle would be green, but it's not. It can have a black, gray, or brown shell. The green turtle is actually named for the green color of its fat.

Last but not least is the **Kemp's ridley**. This turtle's first name, "Kemp's," was given to it because a man named Richard Kemp helped discover and study the turtle. The second part of its name is a mystery. No one is sure why it is called "ridley." Some think turtle researcher Dr. Archie Carr was the one who named it "ridley." The name "ridley" might be short for the word "riddle" or "riddler." The ridley would have gotten that name because it was like a riddle to researchers. It was hard for them to figure out where the turtle came from and what its breeding habits were.

Appearance

Sea turtles come in many different sizes, shapes and colors. The olive ridley is usually less than 100 pounds, while the leatherback typically ranges from 650 to 1,300 pounds! The upper shell, or carapace, of each sea turtle species ranges in length, color, shape and arrangement of scales.

What They Eat

Different species of sea turtles like to eat different kinds of food. Sea turtles have mouths and jaws that are specially formed to help them eat the foods they like.

The **hawksbill** has a narrow head and jaws shaped like a beak. This allows the hawksbill to get food from crevices in coral reefs. They eat sponges, anemones, squid and shrimp.

Loggerheads are primarily carnivorous and feed mostly on shellfish that live on the bottom of the ocean. They eat horseshoe crabs, clams, mussels, and other invertebrates. Their powerful jaw muscles help them easily crush the shellfish.

Kemp's ridleys and **olive ridleys** are also carnivorous. Like loggerheads, the ridleys have powerful jaws that help them crush and grind crabs, clams, mussels, and shrimp. They also like to eat fish, sea urchins, squid and jellyfish.

Unlike loggerheads, Kemp's ridleys, and olive ridleys, **leatherbacks** have delicate, scissor-like jaws. Their jaws would be damaged by anything other than a diet of soft-bodied animals. Leatherbacks feed almost exclusively on jellyfish.

The diets of **green turtles** change significantly during their lives. Young green and black turtles eat a variety of food. Their diets may include worms, young crustaceans and insects, as well as grasses and algae.

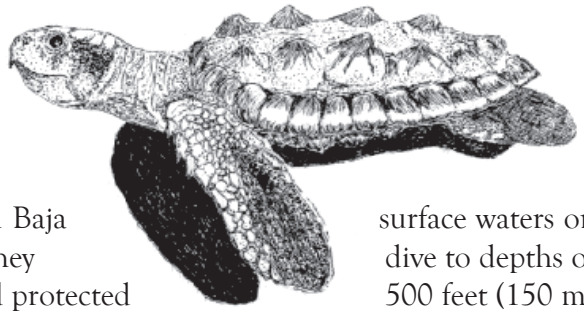
When green turtles reach 8 to 10 inches in length, their diets change. Adult green and black turtles are the only sea turtles that are strictly herbivorous. They mostly eat sea grass and algae. Their jaws are finely serrated which aids them in tearing vegetation. The **Australian flatback** apparently eats sea cucumbers, jellyfish, mollusks, prawns, bryozoans, and other invertebrates, as well as seaweed.

Habitat Preferences

Each species of sea turtle eats, sleeps, mates and swims in distinctly different areas. Sometimes their habitats overlap, but for the most part they each have different preferences.

Loggerheads can be found in temperate and subtropical waters throughout most of the world. Adults usually stay close to mainland shores. They prefer to feed in coastal bays and estuaries, as well as in the shallow water along the continental shelves of the Atlantic, Pacific and Indian Oceans. Loggerheads inhabit an enormous range from north to south. In the western hemisphere they are found as far north as Newfoundland and as far south as Argentina.

Green turtles are found in all temperate and tropical waters, including those near Central America, the Bahamas, and the U.S. They mainly stay near the coastline and around islands. They are also found along the west coasts of North, Central and South America, from central Baja California to Peru. They mostly live in bays and protected shores. Rarely are they observed in the open ocean.



Hawksbills are considered the most tropical of all sea turtles. They are typically found around coastal reefs, rocky areas, estuaries and lagoons of the tropical and subtropical Atlantic, Pacific and Indian Oceans.

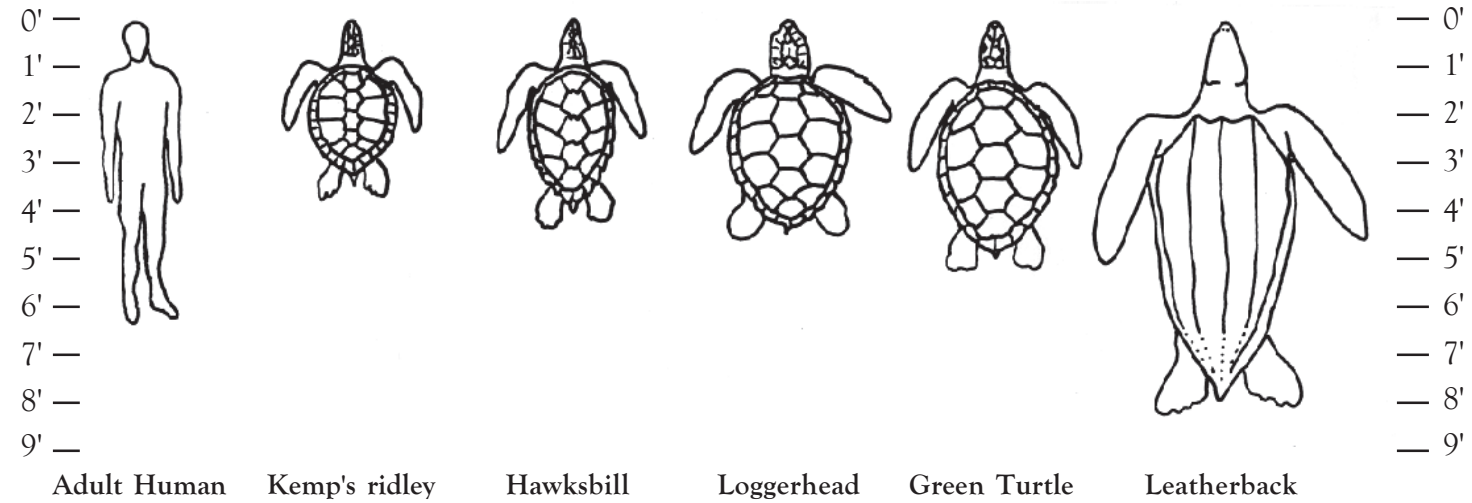
The range of the adult **Kemp's ridley** is mostly limited to the Gulf of Mexico. Juveniles range between tropical and temperate coastal areas of the northwest Atlantic Ocean and can be found up and down the east coast of the United States. They prefer shallow areas with sandy and muddy bottoms.

Olive ridleys live in tropical regions of the Pacific, Indian and Atlantic Oceans. They typically forage off shore in surface waters or dive to depths of 500 feet (150 m) to feed on bottom dwelling crustaceans.

Flatbacks have the most restricted range of all sea turtle species. Their range is limited to the coastal waters of the northwestern, northern and northeastern regions of Australia. Flatbacks do not venture beyond Australia's continental shelf; they prefer turbid inshore waters and bays.

Leatherbacks are the most widely distributed of all sea turtles. They are primarily found in the open ocean, as far north as Alaska and as far south as the southern tip of Africa. Leatherbacks are known to be active in water below 40 degrees Fahrenheit, the only reptile known to remain active at such a low temperature.

Sea Turtles Found in U.S. Waters ~ A Size Comparison



Sea Turtles:

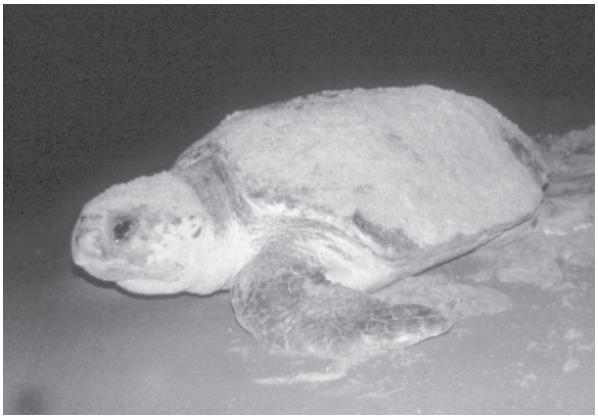
The Seven Species of Sea Turtles

Most scientists recognize seven living species of sea turtles, which are grouped into six genera.

Loggerhead

(*Caretta caretta*)

Of all the sea turtles that nest in the United States, the loggerhead is the one seen most often. While all other species found near the U.S. coastline are listed as endangered, the loggerhead is classified as threatened. This means loggerheads are more numerous than the other species, but they are still in danger of extinction.



Adult loggerhead sea turtle

Adult loggerheads weigh up to 350 pounds and have a reddish-brown carapace (upper shell) and a dull brown to yellow plastron (lower shell). Fully grown, a loggerhead's carapace is typically 32 to 41 inches long (82-105cm).

Loggerhead hatchling

Loggerheads lay eggs at intervals of 2, 3, or more years. Nesting season runs from May through September in the U.S. They lay 4 to 7 nests per season, approximately 14 days apart. The average number of eggs in each clutch ranges from 100 to 126, and the eggs incubate for about 60 days. Loggerhead nesting is concentrated in two main areas of the world -- at Masirah Island, Oman, in the middle east and on the coast of the southeastern United States. The Masirah Island's annual nesting population is about 30,000 females, while up to 25,000 loggerheads nest in the southeast U.S. each year. The majority of nesting in the southeast U.S. takes place on Florida's Atlantic coast between the inlet at Cape Canaveral and Sebastian Inlet, especially within the Archie Carr National Wildlife Refuge.

Green turtle

(*Chelonia mydas*)

Green turtles are an endangered species around the world, but they still nest in significant numbers on the east coast of Florida. They are easily distinguished from other sea turtles because they have a single pair of scales in front of their eyes rather than two pairs as other sea turtles have. The green turtle is the largest of the Cheloniidae family. Female green turtles that nest in Florida average more than three feet in carapace length, and average about 300 pounds in weight. The largest green turtle ever found was 5 feet in length and 871 pounds.

Green turtles nest at intervals of 2, 3, or more years. They lay an average of 3 to 5 egg clutches, with about 12 days

Adult green sea turtle

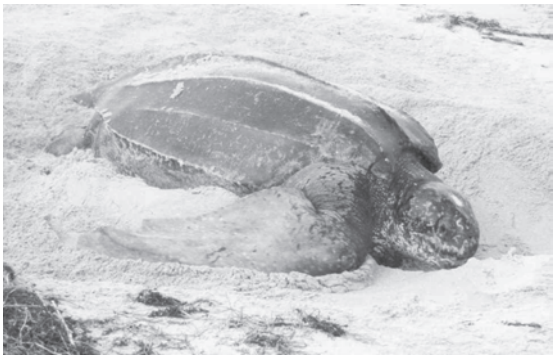
Green sea turtle hatchling

between each nesting. There are an average of 115 eggs per clutch and they incubate for about 60 days. Nesting season runs from June through October in the U.S. The largest nesting site in the western hemisphere is at Tortuguero, Costa Rica.

Leatherback

(*Dermochelys coriacea*)

Leatherbacks are also endangered, but a few nest on the east coast of Florida each year. The leatherback is the champion of sea turtles. This species grows the largest, dives the deepest, and travels the farthest of all sea turtles. Mature leatherbacks typically reach about 4 to 8 feet in length and weigh from 650 to 1,300 pounds. The largest leatherback ever recorded was almost 10 feet (3 m) from the tip of its beak to the tip of its tail and weighed in at 2,019 pounds (916 kg). The leatherback is the only sea turtle that lacks a hard shell. It is named for its large, elongated shell which is composed of a layer of thin, tough, rubbery skin, strengthened by thousands of tiny bone plates. Seven narrow ridges run down the length of the carapace, which is typically black with many white spots. The lower shell is whitish to black and marked by 5 ridges. The body of a leatherback is barrel shaped, tapering at the rear to a blunt point. With this streamlined body shape and the powerful front flippers, a leatherback can swim thousands of miles over open ocean and against fast currents.



Adult leatherback sea turtle

Leatherbacks feed almost exclusively on jellyfish. It is remarkable that this large, active animal can survive on a diet of jellyfish, which are composed mostly of water and appear to be a poor source of nutrients. Young leatherbacks in captivity can eat twice their weight in jellyfish each day.

Leatherbacks approach coastal waters only during breeding season. Nesting occurs throughout the Caribbean, on the northern coast of South America, the Pacific coast of Central America, and on the east coast of Florida. Nesting season runs from March through July. Leatherbacks nest every 2 to 3 years, laying 6 to 9 egg clutches in a nesting season. Each clutch contains approximately 80 fertilized eggs the size of billiard balls and 30 smaller, unfertilized eggs. There is an average of 10 days between nestings. The eggs incubate for approximately 65 days.

Adult hawksbill sea turtle

Hawksbill

(*Eretmochelys imbricata*)

Hawksbills are endangered in large part because people kill them to get their beautiful shells, which are used to make jewelry and other products. Although they are found in U.S. waters, they rarely nest in North America.

The hawksbill is one of the smaller sea turtles, measuring 30

Leatherback hatchling

to 36 inches in carapace length (76-91 cm) and weighing 100 to 150 pounds (40-60 kg).

Hawksbill turtles nest at intervals of 2, 3, or more years. An average of 2 to 4 egg clutches are laid approximately 15 days apart during nesting season. An average of 160 eggs per clutch are laid and they incubate for approximately 60 days. Although they nest on beaches throughout the Caribbean, they are no longer found anywhere in large numbers.

Adult Kemp's ridley sea turtle

Kemp's ridley

(*Lepidochelys kempii*)

Kemp's ridleys are the most endangered of all sea turtles; they are also the smallest. Adults measure about 24 inches (62 cm) in carapace length and weigh between 77 and 100 pounds (35-45 kg). The carapace of adults is olive green and the plastron is yellowish.

Unlike other sea turtles, Kemp's ridleys nest annually. They lay about 2 clutches during each season, about 25 days apart. Each nest contains around 105 eggs, which incubate 55 days. The only major breeding site of the Kemp's ridley is on a small strip of beach at Rancho Nuevo, Mexico. Kemp's ridleys nest in mass synchronized nestings called *arribadas* (Spanish for "arrival").

The arribada of Kemp's ridleys occurs at regular intervals between April and June. In 1942, a Mexican architect filmed an estimated 42,000 ridleys nesting at Rancho Nuevo in one day. During 1995, only 1,429 ridley nests were laid at Rancho Nuevo.

Olive ridley

(*Lepidochelys olivacea*)

One of the most common of all sea turtles found worldwide; their numbers are in decline from the direct harvest of adults and eggs, incidental capture in commercial fisheries and loss of nesting habitat.

Adults measure around 30 inches (70 cm) in carapace length and weigh close to 100 pounds (45 kg). The carapace of adults is bony without ridges, has large scutes, and is grey green and the plastron is yellowish.

Similar to the Kemp's ridley, the olive ridley nests annually and in *arribadas*. They lay about 2 clutches during each season, about 25 days apart. Each nest contains around 110 eggs, which incubate from 52 to 58 days.

Adult olive ridley sea turtle

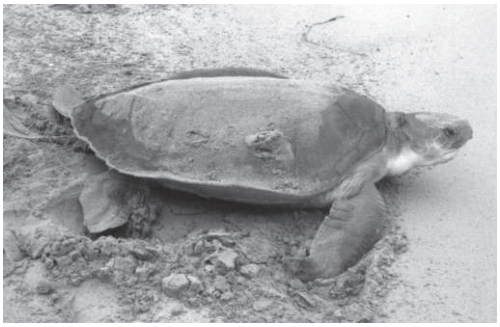
Australian flatback

(*Natator depressus*)

The Australian flatback is very limited in its range being found only in the waters around Australia and Papua New Guinea in the Pacific. Adults up to just over 36 inches (99 cm) in carapace length and weigh an average of 200 pounds (90 kg). The carapace of adults is bony without ridges, has large, non-overlapping scutes, and is olive-grey with pale brown and yellow tones on margins.

Adult females will nests 4 times per season, with an average of 50 eggs per nest. The eggs are quite large for their body size and incubate for about 55 days.

They are threatened with capture, harvesting of eggs, destruction of nesting beaches, ocean pollution, oil spills, and entanglement in fishing nets.



Adult flatback sea turtle

Sea Turtles:

Scientific Classification

The chart below shows the scientific classification of the sea turtles that still exist today.

KINGDOM ..... **Animalia**

PHYLUM ..... **Chordata**

CLASS ..... **Reptilia**

Class Reptilia includes snakes, lizards, crocodiles, and turtles. Reptiles are ectothermic (cold-blooded) and are vertebrates (have a spine). All reptiles have scaly skin, breath air with lungs, and have a three-chambered heart. Most reptiles lay eggs.

ORDER ..... **Testudines**

Order Testudines includes all turtles and tortoises. It is divided into three suborders. Pleurodira includes side-necked turtles, ***Cryptodira*** *includes all other living species of turtles and tortoises, and Amphichelydia includes all extinct species.*

SUBORDER ..... **Cryptodira**

Suborder Cryptodira includes freshwater turtles, snapping turtles, tortoises, soft-shelled turtles, and sea turtles.

FAMILY ..... **Cheloniidae** or **Dermochelyidae**

Sea turtles fall into one of two families. Family Cheloniidae includes sea turtles which have shells covered with scutes (horny plates). Family Dermochelyidae includes only one modern species of sea turtle, the leatherback turtle. Rather than a shell covered with scutes, leatherbacks have leathery skin.

GENUS and SPECIES

Most scientists currently recognize seven living species of sea turtles grouped into six genera. The black sea turtle is considered by some to be an eigth species.

Caretta caretta	***Chelonia mydas***	***Eretmochelys imbricata***	***Lepidochelys kempii***	***Natator depressus***	***Dermochelys coriacea***
loggerhead	green turtle	hawksbill	Kemp's ridley	Australian flatback	leatherback
	&		&		
	mydas agassizi black turtle		***olivacea*** olive ridley		

Sea Turtles:

Behavior Patterns

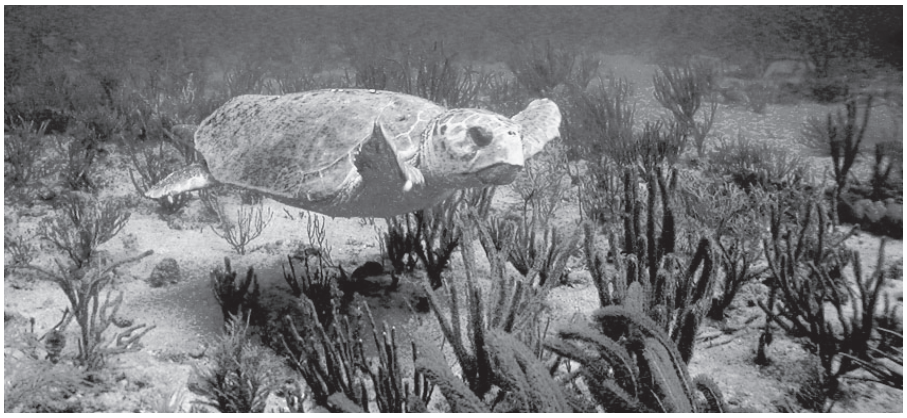
Sea turtles are generally solitary creatures that remain submerged for much of the time they are at sea, which makes them extremely difficult to study. They rarely interact with one another outside of courtship and mating. Ridleys, however, do come together in massive groups during their arribadas. But even when large numbers of turtles gather on feeding grounds or during migration, there is little behavioral exchange among individuals. Because of the difficulty in studying marine turtles in the open ocean, there are a great many things still unknown about their behavior. Decades of research, however, including observations at sea, have produced useful insights into daily activities and behaviors such as courtship, mating and nesting.

Daily Activities

Sea turtles are known to feed and rest off and on during a typical day. During the nesting season, research conducted in the southeast United States has shown that loggerheads follow regular patterns between the nesting beach and offshore reefs and other rocky structures. It is presumed that mating and/or feeding occur at these offshore areas. Sea turtles may migrate hundreds or even thousands of miles during their migations.

Sea turtles can sleep at the surface while in deep water or on the bottom wedged under rocks in nearshore waters. Many divers have seen green turtles sleeping under ledges in reefs and rocks. Hatchlings typically sleep floating on the surface, and they usually have their front flippers folded back over the top of their backs.

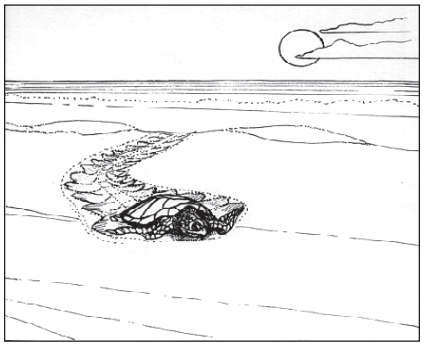
Courtship & Mating



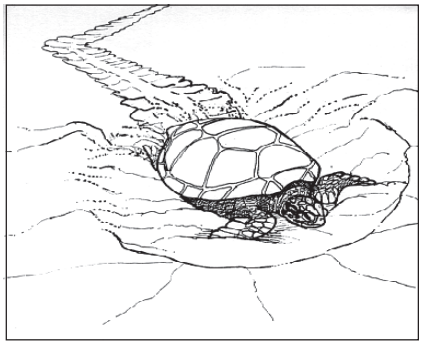
Courtship and mating for most sea turtles is believed to occur during a limited "receptive" period prior to the female's first nesting emergence. Afterwards, only females come ashore to nest; males almost never return to land once they leave the sand of their natal beach. During mating season, males may court a female by nuzzling her head or by gently biting the back of her neck and rear flippers. If the female does not flee, the male attaches himself to the back of the female's shell by gripping her top shell with claws in his front flippers. He then folds his long tail under her shell to copulate. Females observed on the nesting beach after recently mating often have scratched shells and may be bleeding from where the males were hooked to their shells.

Copulation can take place either on the surface or under water. Sometimes several males will compete for females and may even fight each other. Observers of sea turtle mating have reported very aggressive behavior by both the males and females.

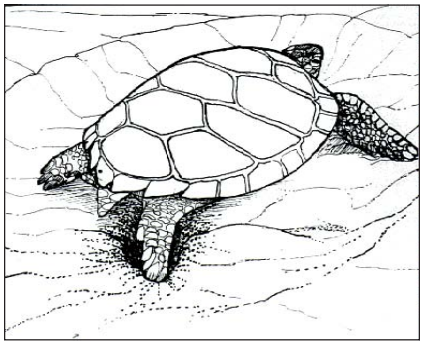
Females may mate with several males just prior to nesting season and store the sperm for several months. When she finally lays her eggs, they will have been fertilized by a variety of males. This behavior may help keep genetic diversity high in the population.



Step 1: Crawling to a suitable nesting site



Step 2: Digging the body pit



Step 3: Digging the egg chamber

Nesting, Incubation and Emergence

Very little is known about why sea turtles nest on some beaches and not on others. In Florida, loggerheads nest by the thousands on the central east coast, while identical looking beaches to the north see far fewer loggerheads. This nesting distribution may reflect conditions that existed centuries ago, when temperature, beach profiles or the lack of predation made some areas preferable to sea turtles.

Today, humans are affecting the places where sea turtles nest. Beach erosion caused by coastal armoring and navigational inlets, artificial lighting and beach renourishment are all impacting once pristine beaches. These changes will likely have lasting effects on future nesting patterns. The more we understand about how, where and when sea turtles nest, the better we will be able to protect their nesting habitat.

Beach Selection

Most females return faithfully to the same beach each time they are ready to nest. Not only do they appear on the same beach, they often emerge within a few hundred yards of where they last nested.

Nesting Behavior

Only the females nest, and it occurs most often at night. The female crawls out of the ocean, pausing frequently as if carefully scoping out her spot. Sometimes she will crawl out of the ocean, but for unknown reasons decide not to nest. This is a "false crawl," and it can happen naturally or be caused by artificial lighting or the presence of people on the beach.

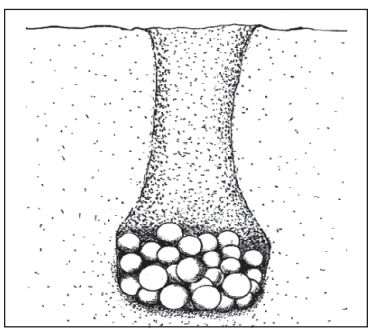
Most females nest at least twice during the nesting season, although individuals of some species may nest only once and others more than ten times. Sea turtles are generally slow and awkward on land, and nesting is exhausting work.

Constructing the Nest

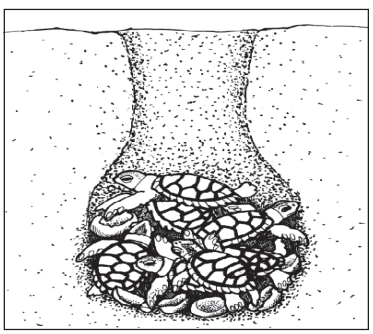
The female turtle crawls to a dry part of the beach and begins to flings away loose sand with her flippers. She then constructs a "body pit" by digging with her flippers and rotating her body. After completing the body pit, she digs an egg cavity using her cupped rear flippers as shovels. The egg cavity is shaped roughly like a tear drop and is usually tilted slightly.

Laying and Burying the Eggs

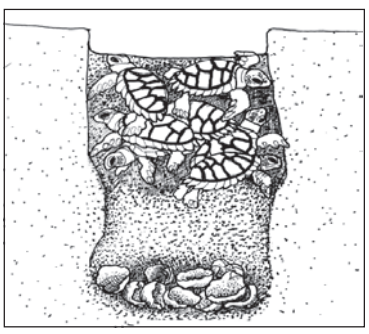
When the turtle has finished digging the egg chamber, she begins to lay eggs. Two or three eggs drop out at a time, with mucus being secreted throughout egg-laying. The average size of a clutch ranges from about 80 to 120 eggs, depending on the



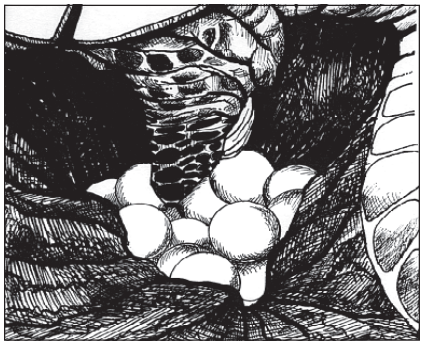
Eggs incubating in the nest.



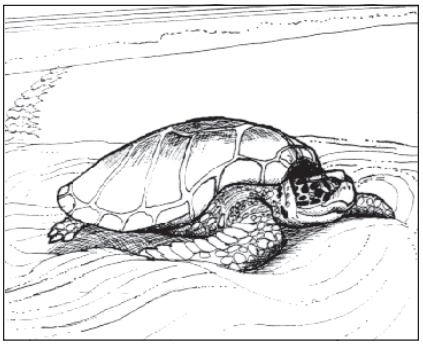
Hatchlings begin breaking out of shells.



Hatchlings work their way to top of nest.



Step 4: Laying the eggs



Step 5: Burying and disguising the nest

species. Because the eggs are flexible, they do not break as they fall into the chamber. This flexibility also allows both the female and the nest to hold more eggs.

Nesting sea turtles appear to shed tears, but the turtle is just secreting salt that accumulates in her body.

Many people believe that while laying her eggs a sea turtles goes into a trance from which she cannot be disturbed. This is not entirely true. A sea turtle is least likely to abandon nesting when she is laying her eggs, but some turtles will abort the process if they are harassed or feel they are in danger. For this reason, it is important that sea turtles are never disturbed during nesting.

Once all the eggs are in the chamber, the mother turtle uses her rear flippers to push sand over the top of the egg cavity. Gradually, she packs the sand down over the top. She then begins using her front flippers to refill the body pit and disguise the nest. By throwing sand in all directions, it is much harder for predators to find the eggs. After the nest is thoroughly concealed, the female crawls back to the sea to rest before nesting again later that season or before beginning her migration back to her feeding ground. Once a female has left her nest, she never returns to tend it.

Incubation

Incubation takes about 60 days, but since the temperature of the sand governs the speed at which the embryos develop, the hatching period can cover a broad range. Essentially, the hotter the sand surrounding the nest, the faster the embryos will develop. Cooler sand has a tendency to produce more males, with warmer sand producing a higher ratio of females.

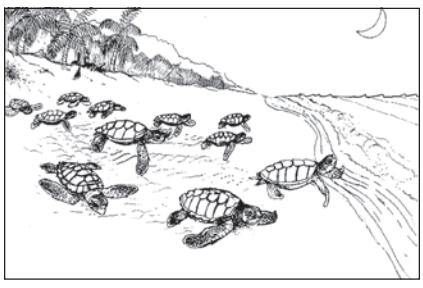
Emerging from the Nest

Unlike baby alligators, which are liberated from their nest by their mother, sea turtle hatchlings must do it all themselves. To break open their shells, hatchlings use a sharp, temporary egg-tooth, called a "caruncle." The caruncle is an extension of the upper jaw that falls off soon after birth.

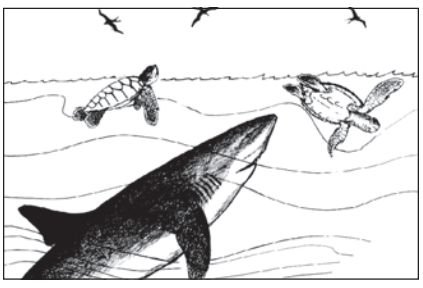
Digging out of the nest is a group effort that can take several days. Hatchlings usually emerge from their nest at night or during a rainstorm when temperatures are cooler. Once they decide to burst out, they erupt from the nest cavity as a group. The little turtles orient themselves to the brightest horizon, and then dash toward the sea. If they don't make it to the ocean quickly, many hatchlings will die of dehydration in the sun or be caught by predators like birds and crabs.

Once in the water, they typically swim several miles off shore, where they are caught in currents and seaweed that may carry them for years before returning to nearshore waters.

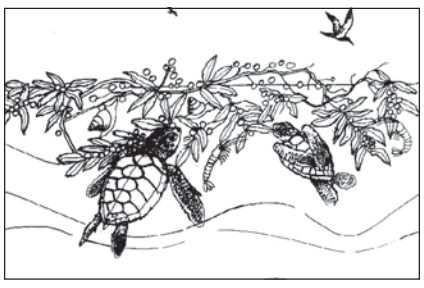
There are many obstacles for hatchlings in the open ocean. Sharks, big fish and circling birds all eat baby turtles, and they die after accidentally eating tar balls and plastic garbage. The obstacles are so numerous for baby turtles that only about one in 1,000 survives to adulthood.



Hatchlings erupt and head for water.



Many animals eat hatchlings in the ocean.



Hatchlings eat and drift in sargasso weed.

Sea Turtles:

Migration and Navigation Abilities

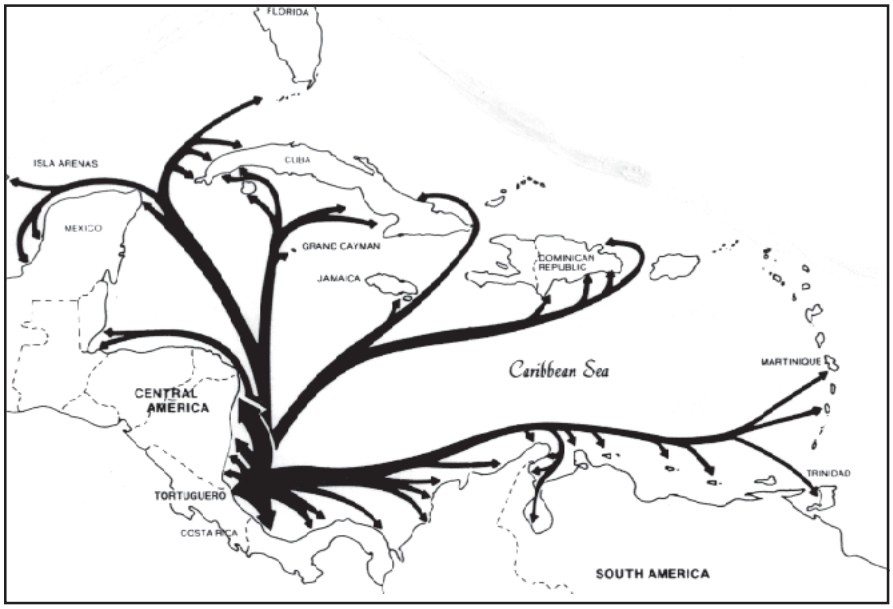
Migration

The ability of a sea turtle to migrate hundreds (and occasionally thousands) of miles from its feeding ground to its nesting beach is one of the most remarkable acts in the animal kingdom. That adult females return faithfully to nest on the very beach where they were born makes the feat even more amazing.

Research into where and how sea turtles migrate has been a focus of scientists for decades. The information collected is vital to the development of conservation strategies for the species.

We now know that sea turtles undergo migration throughout their lives, beginning with the first frenzied swim as a hatchling. During its first critical 48 hours, a hatchling must travel from the beach to a place in the ocean where it is relatively safe from predators and where it can find food. Many hatchlings in the Atlantic and Caribbean make their way into Gulfstream currents, which are filled with floating sargassum weed. There the young turtles find an ample food supply and few predators. After several years of floating around the Atlantic, these young turtles are big enough to venture back into nearshore waters.

Sea turtles typically spend their juvenile years eating and growing in nearshore habitats. Once they reach adulthood and sexual maturity, it is believed that they migrate to a new feeding ground. It is in this primary feeding area where adult turtles probably remain throughout their lives, except during breeding season. When it is their time to mate and nest, both males and females leave their feeding grounds and migrate to the nesting beach. This periodic migration will continue throughout their lives.

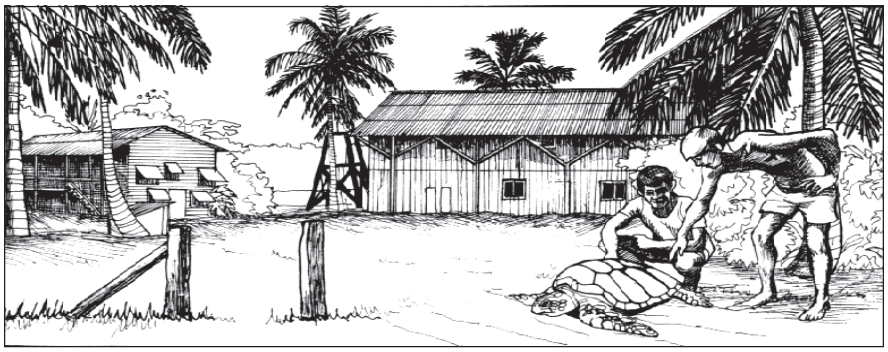


The Sea Turtle Conservancy has been tagging green turtles that nest at Tortuguero, Costa Rica, for over three decades. Tag recoveries from different parts of the Caribbean show some of the places where these turtles migrate after nesting.

Navigation

In the open ocean, sea turtles encounter strong currents; they have only modest vision; they can only raise their heads several inches out of the water; and there are often no visible land marks. Even with these limitations, sea turtles regularly navigate long distances to find the same tiny stretch of nesting beach. How they do it is one of the greatest mysteries in the animal kingdom, and finding an answer has been the focus of generations of researchers.

One promising new theory on how sea turtles navigate suggests that they can detect both the angle and intensity of the Earth's magnetic field. Using these two characteristics, a sea turtle may be able to determine its latitude and longitude, enabling it to navigate virtually anywhere. Early experiments seem to prove that sea turtles have the ability to detect mag-



One of the first groups to start tagging sea turtles was the Caribbean Conservation Corporation, under the leadership of Dr. Archie Carr. CCC began tagging green turtles on the nesting beach at Tortuguero, Costa Rica, in the early 1950s, and this important research continues to this day.

netic fields. Whether they actually use this ability to navigate is the next theory being investigated.

Studying Migration

The migratory nature of sea turtles creates a number of challenges for those working to fully understand and protect these creatures. In particular, to adequately protect sea turtles in all their habitats, we must know where these habitats are, how the turtles behave while there, and what routes the turtles take to migrate between them.

Most sea turtle research has been carried out on nesting beaches — and for very logical reasons. These areas are easier for researchers to access, and what occurs on the nesting beach (production of new sea turtles) is extremely important to the species' survival. Conservation efforts are also most easily directed at nesting beaches.

However, of all the places where sea turtles travel throughout their life cycle, the least amount of time is spent on the nesting beach. More than 90% of a sea turtle's life is spent in the water — feeding, mating, migrating and doing whatever else a sea turtle does when no one is watching. Consequently, the threats faced by sea turtles in the ocean present the greatest challenges to conservationists.

To fully protect sea turtles throughout their range, more must be known about their migratory patterns and their behavior in the water.

Several methods are used by researchers to determine where sea turtles move. One of the simplest methods involves placing a small, harmless metal tag on one of the turtle's flippers when she comes ashore to nest. Each tag includes a coded number and a message asking people to return the tag to a certain address if it is found. When people return a tag, they get a small reward and are asked where the turtle was encountered. In this way, researchers gradually learn about the many places to which turtles migrate.

In the case of turtles nesting at Tortuguero, Costa Rica, tag returns make it clear that turtles nesting there disperse to feeding areas throughout the Caribbean. A large portion of them go to the Miskito Coast of Nicaragua. Efforts are now focused on limiting the number of turtles killed there for food.

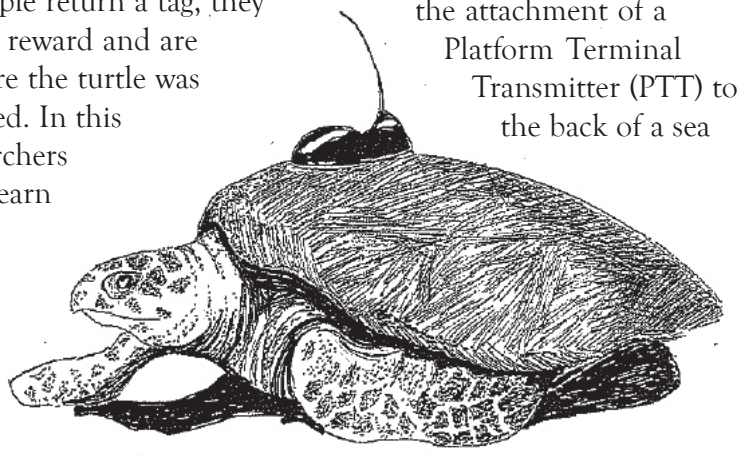
The use of flipper tags has provided vital information, but it still leaves many questions unanswered.

Satellite Telemetry

Since most research conducted on marine turtles has been carried out on nesting beaches and well over 90% of a sea turtle's life is spent in the water, we are missing important information that can help us better protect sea turtles.

This is where the technology of satellite telemetry becomes useful and important in protecting sea turtles. Researchers been utilizing satellite telemetry (following an object on the earth with the use of orbiting satellites) to track these highly migratory marine animals in the open ocean for over a decade.

Satellite telemetry involves the attachment of a Platform Terminal Transmitter (PTT) to the back of a sea



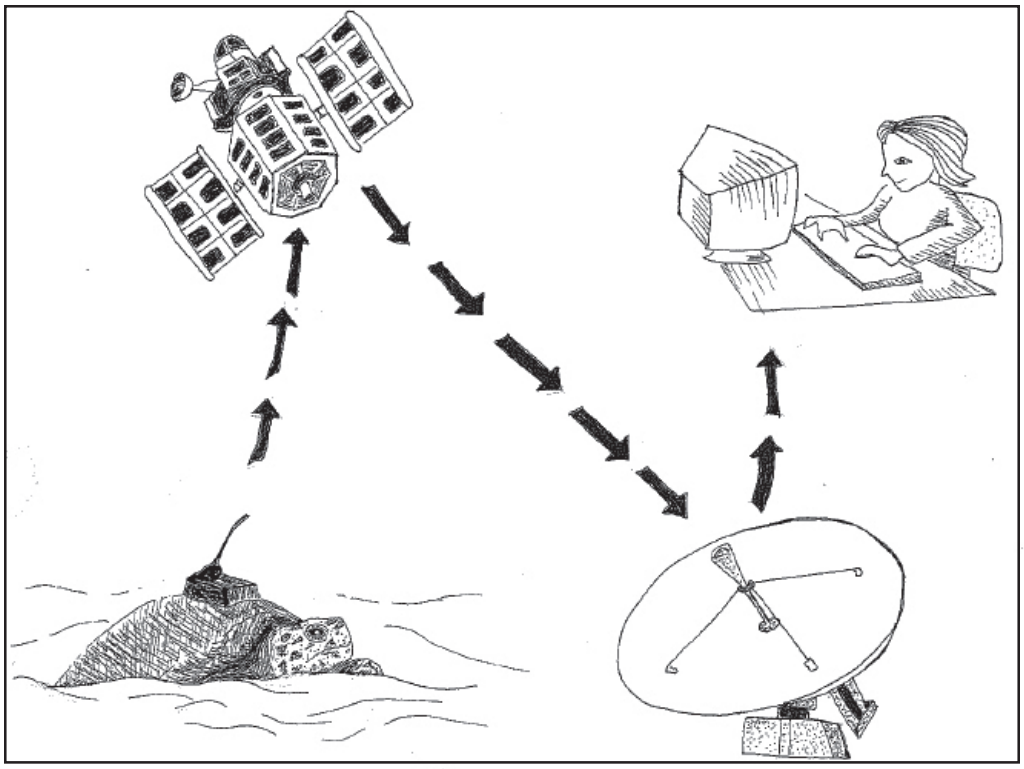


Diagram of how data is received, via global orbiting satellites, by researchers from a transmitter attached to a sea turtle.

turtle. The attachment process involves placing a small transmitter to the back of an adult or juvenile sea turtle. For all the sea turtle species, except the leatherback, the transmitter is attached directly to the turtle's carapace, behind the head, where the unit's small flexible antenna can break the surface to transmit a signal full of information to orbiting satelllites when the turtle is at the surface of the ocean to breathe.

The satellites are operated by the U.S. National Oceanic and Atmospheric Organization (NOAA) and are the same satellites used to monitor global weather patterns. Attached to these satellites are special instruments operated by a company called ARGOS. These special instruments are designed to listen for transmitters like those placed on turtles and to determine where those transmitters are located.

While such a task would seem simple, it is not. Each satellite circles the earth every 101 minutes, so it is only over any one place on the planet for about 10 minutes. At the equator, this means that the satellites make about 6-8 passes per day for 10 minutes each. For the satellite to determine the location of the transmitter, it must be on at the surface long enough to be detected; about 3 to 5 minutes.

The satellite re-transmits the data to a receiving station on earth, which researchers can access through a computer. Generally, after about a year the transmitters quit working and fall safely off the turtle.

The data received from the turtle's transmitter comes in the form of digital codes, which must be deciphered. The codes allow researchers to determine, with varying degrees of reliability, the latitude and longitude location of the turtle, the number of dives taken during the last 24 hours, the duration of the most recent dive, and the water temperature.

Using computer mapping programs, researchers can then see where the turtles migrate, what routes they travel and how fast they generally swim. If the map a researcher is using has enough detail, it is also possible to determine the habitat characteristics at the turtle's location.

While viewing the migration maps shown on STC's website, viewers should be aware that the plotted turtle movements represent the best data available; however, any given plot mark may not be 100% accurate. This limitation really doesn't detract from the overall value of the research. After monitoring a number of turtles in a specific population, researchers learn where that population's major feeding grounds are located and what threats they may be facing at sea. This information allows conservationists to focus efforts on the most important areas.

Sea Turtles:

Threats to their Survival

Each year thousands of hatchling turtles emerge from their nests along the southeastern coast of the United States and enter the Atlantic ocean. Sadly, only an estimated one in 1,000 to 10,000 will survive to adulthood. The natural obstacles faced by young and adult sea turtles are staggering, but it is the increasing threats caused by humans that are driving them to extinction. Today, all sea turtles found in U.S. waters are federally listed as endangered, except for the loggerhead, which is listed as threatened.

Natural Threats

In nature, sea turtles face a host of life and death obstacles to their survival. Predators such as raccoons, crabs and ants raid eggs and hatchlings still in the nest. Once they emerge, hatchlings make bite-sized meals for birds, crabs and a host of predators in the ocean. After reaching adulthood, sea turtles are relatively immune to predation, except for the occasional shark attack. These natural threats, however, are not the reasons sea turtle populations have plummeted toward extinction. To understand what really threatens sea turtle survival, we must look at the actions of humans.

Human-Caused Threats

In many cultures around the world, people still harvest sea turtle eggs for food. Most countries forbid the taking of eggs, but enforcement is lax. Poaching is rampant, and the eggs can often be found for sale in local markets. In these same areas, adult sea turtles are harvested for their meat. Turtle products, such as jewelry made from hawksbill shells, also create a direct threat to sea turtles. Lack of information about sea turtles leads many Americans to unwittingly support the international trade in these endangered species. Buying and selling turtle products within the U.S. is strictly prohibited by law, but turtle shell jewelry and souvenirs are the most frequent contraband seized by customs officials from tourists returning from the Caribbean.

Indirect threats are harder to quantify, but it is likely that they are causing the greatest harm to sea turtle survival.

Commercial Fishing

The waters of the Gulf of Mexico and west Atlantic coast are a major habitat for turtles, but are also the main shrimping grounds in the U.S. Each year, thousands of turtles become entangled in fishing nets and drown. Worldwide, shrimp trawling probably accounts for the incidental death of more juvenile and adult sea turtles

The killing of sea turtles for meat is still a significant problem in many Caribbean countries.

than any other source. At one time, as many as 55,000 sea turtles were killed each year in shrimp nets in the southeastern United States alone. Today, all U.S. shrimpers are required to put Turtle Excluder Devices (TEDs) in their trawl nets. Unfortunately, not all fishermen comply with the law, and sea turtles continue to drown in shrimp nets.

Ingestion of Debris and Plastic

Thousands of sea turtles die from eating or becoming entangled in nondegradable debris each year, including packing bands, balloons, pellets, bottles, vinyl films, tar balls, and styrofoam. Trash, particularly plastic bags thrown overboard from boats or dumped near beaches and swept out to sea, is eaten by turtles and becomes a deadly meal. Leatherbacks especially, cannot distinguish between floating jellyfish — a main component of their diet — and floating plastic bags.

Artificial Lighting

Nesting turtles once had no trouble finding a quiet, dark beach on which to nest, but now they must compete with tourists, businesses and coastal residents for use of the beach. U.S. beaches are rapidly being lined with seaside condominiums, houses and hotels. Lights from these developments discourage females from nesting and cause hatchlings to become disoriented and wander inland, where they often die of dehydration or predation.

Coastal Armoring

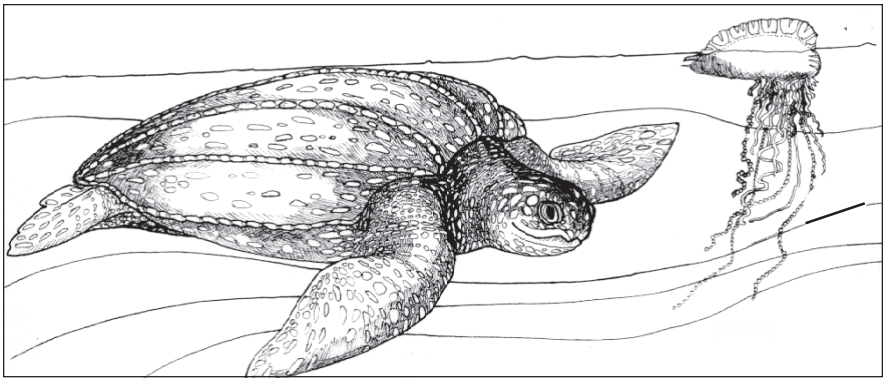
Coastal armoring includes structures such as sea walls, rock revetments and sandbags that are installed in an attempt to protect beachfront property from erosion. These structures often block female turtles from reaching suitable nesting habitat and accelerate erosion down the beach. Armoring is especially problematic along the east coast of Florida, where beach development is occurring in the very places where sea turtles come to nest by the thousands.

Beach Nourishment

Beach nourishment consists of pumping, trucking or otherwise depositing sand on a beach to replace what has been lost to erosion. While beach nourishment is often preferable to armoring, it too can negatively impact sea turtles. If the sand is too compacted for turtles to nest in or if the sand imported is drastically different from native beach sediments, it can affect nest-site selection, digging behavior, incubation temperature and the moisture content of nests. If renourishment is allowed to proceed during nesting season, nests can also be buried far beneath the surface or run over by heavy machinery.

Pollution

Pollution can have serious impacts on both sea turtles and the food they eat. New research suggests that a disease now killing many sea turtles (fibropapillomas) may be linked to pollution in the oceans and in nearshore waters. When pollution kills aquatic plant and animal life, it also takes away the food sea turtles eat. Oil spills, urban runoff of chemicals, including fertilizers and petroleum, all contribute to water pollution.



Leatherbacks feed on jellyfish, but can die by eating discarded plastic bags.

It may seem that the threats to sea turtles are almost too big to overcome, but they are not. Through personal actions, such as making sure that oil, paints and other toxic chemicals are disposed of properly, reducing the amount of fertilizer and chemicals used on lawns, participating in plastic recycling programs and teaching others about what they can do help are all ways to make a difference.

Sea Turtles:

Conservation Strategies

To truly protect sea turtles around the world, many different countries and cultures must cooperate and share responsibility. International laws and agreements, research, and the work of dedicated organizations and individuals each must play a part. Long-term protection of sea turtles also means developing solutions that reduce reliance on management methods requiring direct human involvement – such as moving nests or raising hatchlings in captivity. If sea turtles cannot survive and reproduce on their own, without help from humans, then they are doomed.

Feeding and nesting grounds must be protected, and a public wildlife conservation ethic must be fostered that can withstand gaps in government regulations, pressure from private interests, and changes in the political climate.

National Laws

Sea turtles are given legal protection in the United States and its waters under the **Endangered Species Act (ESA)**. The ESA lists the hawksbill, leatherback, Kemp's ridley and green turtle as endangered; and lists the loggerhead as threatened. This designation makes it illegal to harm, harass or kill any sea turtles, hatchlings or their eggs. It is also illegal to import, sell, or transport turtles or their products. In the United States, the National Marine Fisheries Service has jurisdiction over sea turtles in the water, while the U.S. Fish and Wildlife Service is responsible for them on land. Other countries have their own conservation laws and regulations that apply to sea turtles.

International Agreements

Some regulations affecting sea turtles are global in scope. The "Convention on International Trade in Endangered Species" (CITES) controls international trade in endangered and threatened species. Sea turtles are covered under Appendix I of this agreement and receive protection from international trade by all countries that have signed the treaty.

State and Local Protection

In many states where sea turtles nest, state laws have been passed to protect the species. These laws meet or exceed the requirements of the ESA. In Florida for instance, the Marine Turtle Protection Act was passed giving state agencies the power to enforce regulations protecting turtles and their habitat.

Some local governments have passed regulations to eliminate or control artificial beachfront lighting, which is known to deter females from nesting and disorient hatchlings.

Conservation Goals

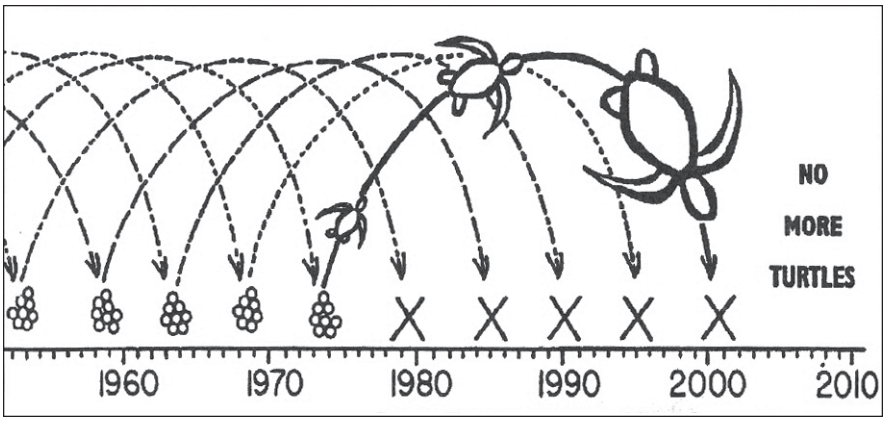
The threats facing sea turtles are numerous and, for the most part, humans are the problem. For those of us trying to protect sea turtles, it is a mixed blessing that so many threats are human-caused. On one hand, it is very hard to change human behavior. On the other hand, at least there is hope for eliminating threats. If sea turtles were going extinct because of geological or climatic changes, there would be very little we could do to help.

Some immediate goals for protecting sea turtles include:

* Crack down on illegal international trade in sea turtles and their products by enforcing laws and agreements.
* Decrease the turtle deaths caused by commercial fishing through enforcement of **Turtle Excluder Device (TED)** and gill net regulations.
* Protect nesting beaches by establishing parks and refuges or through regulations combined with public education initiatives.
* Eliminate disturbances at nesting beaches by decreasing artificial lighting, halting beach armoring, regulating beach nourishment and

limiting the impacts of people on the beach.

* Enforce national and international laws to minimize the dumping of pollutants and solid waste into the ocean and nearshore waters.
* Continue research and monitoring activities so that the population can be monitored and conservation efforts can be focussed where they are most needed.
* Increase public awareness and community participation in sea turtle conservation through educational programs such as this one.



As sea turtles continue to be killed around the world by poachers on the nesting beach, in commercial fishing nets or by pollution, it is very difficult to explain the severe consequences this has on the species when the numbers of nesting turtles seems to remain stable in areas. This visual aid, prepared by Dr. Jeanne Mortimer, is helpful in explaining how the complete harvesting of nesting females in a particular population (which is happening now in some parts of the world) may actually take decades to manifest itself on the nesting beach in reduced numbers of nesting adults. While there may seem to be a never-ending supply of adult turtles to harvest, at some point there will be no more maturing new generations of sea turtles to replace those that have been killed. And once these too have been slaughtered, the population will crash suddenly.

What to Do If You Encounter a Nesting Sea Turtle

In Florida and other states where sea turtles nest, turtle watches are conducted by trained and permitted individuals. The goal is to educate people about sea turtles through direct contact, without disturbing the turtles. If you are interested in going on a turtle walk, you can call the Sea Turtle Conservancy at (352) 373-6441 for a list of guides near you. Sometimes people encounter sea turtles on their own while walking on the beach at night during nesting season. If this happens to you, here are some simple rules to follow:

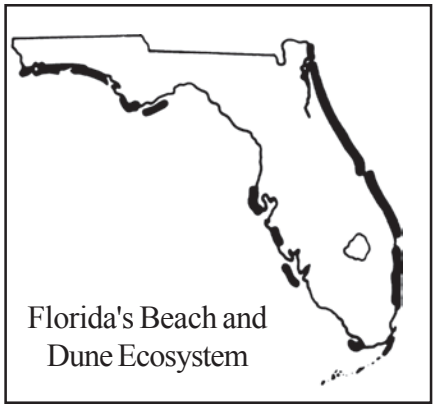
* *Do not walk on the beach with a flashlight or shine a light in the sea turtle's face. The light may cause the female to abort the nesting process, or other sea turtles nearby may be discouraged from nesting if there are lights on the beach.*

* *Do not take pictures using flashes. This high-intensity light can be even more disturbing than the flashlights.*
* *Stay clear and out of sight of the turtle until she begins laying eggs, otherwise you may scare her back into the sea.*
* *For your safety, stay away from the turtle's head. Sea turtles, especially loggerheads, have very strong jaws and can harm you if provoked.*
* *Do not handle the eggs or put any foreign objects into the nest. You can introduce bacteria or injure the eggs.*
* *Do not handle or ride the sea turtle. In addition to being illegal, you may injure the turtle or cause her to leave without finishing nesting.*
* *Do not disturb tracks left by turtles. Researchers sometimes use the tracks to identify the type of turtles that nested and to find and mark the nests.*
* *Do enjoy the experience and remember it for the rest of your life.*

Coastal Habitats:

Florida's Coastal Communities

Containing nearly 1,200 miles of diverse coastline covering several climate zones and including mangrove forest, lagoon, salt marsh, maritime hammock, barrier island, coastal strand and tropical key communities, Florida is a very unique state. The coastal communities are home to a wide variety of plant and animal species, including many endangered and threatened species. The beach and dune ecosystem is the most common coastal habitat, covering approximately two-thirds of Florida's coastline.



Florida's Beach and Dune Ecosystem

Native Species

Native animal species use the beach and dune ecosystem all year long as a source of shelter and food or as a nesting site during the summer. Resident animal species, such as beach mice, ghost crabs, sand fleas, racoons and several species of birds have adapted to survive in the harsh heat and drought conditions all year long. Migratory species only use the beach during certain seasons. Three species of sea turtles regularly use Florida's beaches as summer nesting habitat, while many species of shore birds use the beach as over-wintering habitat.

Native plants species, such as sea oats, beach cordgrass, dune sunflower and railroad vine, are saltwater and heat tolerant enabling them to survive long periods of dryness. Many native beach and dune plant species help to protect and stabilize beach dunes during storms with deep and multilayered root systems that help hold the soil and sand intact. If soil is eroded away during a storm, the newly exposed roots often form a root wall in front of the exposed dune. These roots act as a sand trap, catching sand in the roots and eventually helping to rebuild and stabilize the dune.

Beach Dynamics

Beach and dune systems, especially barrier islands, are active and are constantly being shaped by erosion (removal of sand from a beach), storms, accretion (addition of sand to a beach) and the natural drift of sand along the coast. Beach erosion and accretion are caused by ocean currents, wave action and changes in the sea level. Over the past century, a portion of Florida's beaches have been lost due to a gradual one-foot increase in the sea level.

With an ever-changing environment, beach and dune species have adapted over time to specialized roles, connecting the survival of animal species with the survival of plant species and the condition of the habitat.

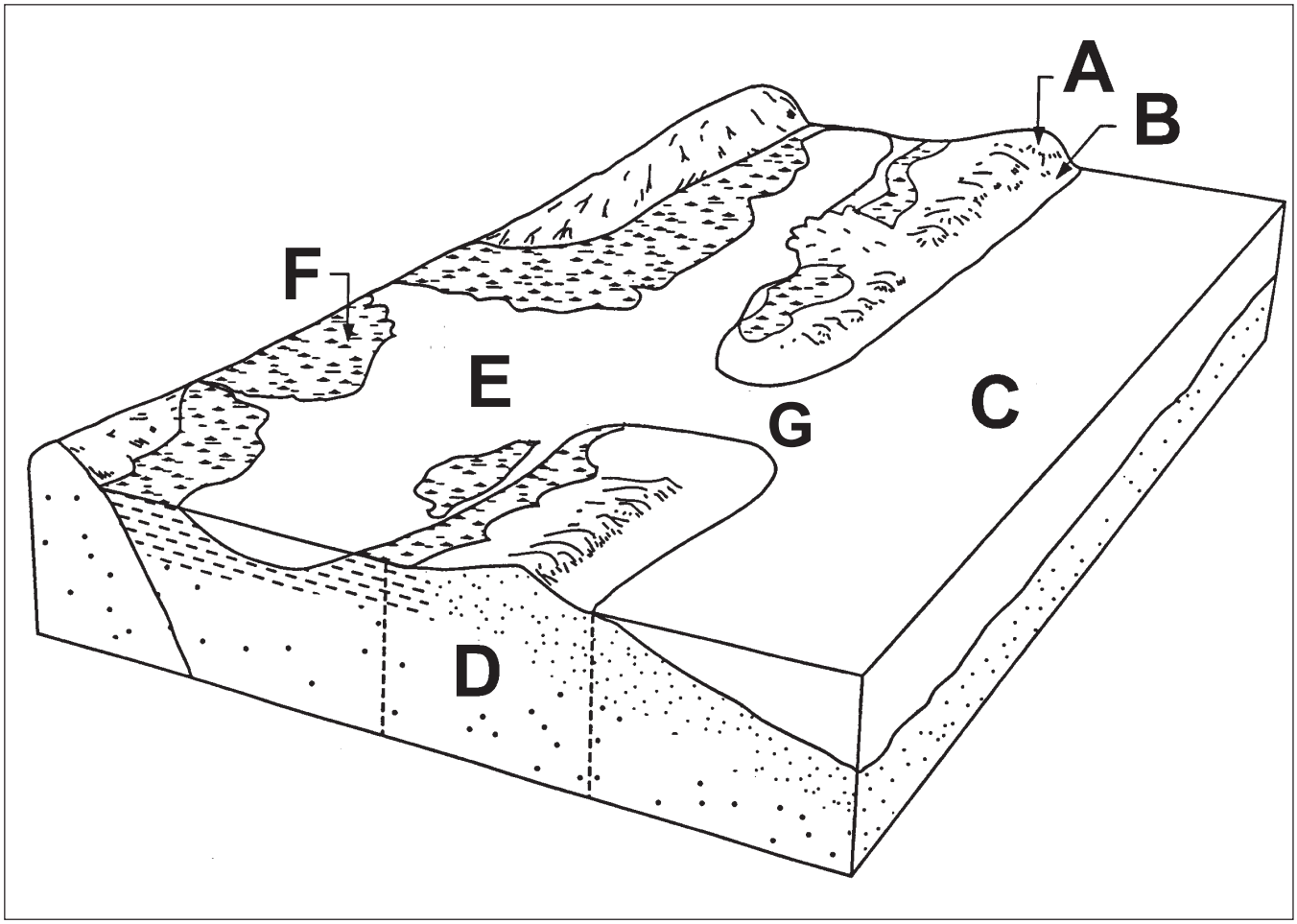
Longshore drift (the perpetual movement of sand along a coastline) and coastal winds constantly move sand along the shore, while storm events help build or erode the sand. During hurricanes and major storms, sand is removed from a beach and deposited off shore, forming sandbars. In contrast, the gentler waves shift the sand from the offshore sandbars back onto the beach. All of these forces interact to determine the slope, shape and size of a particular beach.

Beach Communities

There are three very important communities found in the beach and dune ecosystem: coastal strand, maritime hammock and barrier islands.

Coastal Strand

The coastal strand is a thin strip of fragile, woody vegetation that lies between the beach and the maritime hammock. This community is found only along



Coastal ecosystems can be a complex of several coastal communities. This diagram depicts the locations of the communities found on and around a barrier island. Maritime Hammocks and Coastal Strands (A) provide a stable soil for woody vegetation. Dunes (B) provide habitat for many species of plants and animals. Near Shore Waters (C) support a wide varity of fish and invertebrates in the shallow, sandy water. Barrier Islands (D) are formed by shifting sands that build up over time and support other communities. Lagoons (E) are areas where fresh and salt water mix. Salt Marshes (F) are areas of vegetation that are periodically flooded and are found on barrier islands and the mainland. The inlet (G) provides a tidal flow of water between the lagoon and ocean.

the east coast of Florida and provides a dense growth of native plants such as palmetto, sand live oak and Spanish palms. This dense vegetation is the perfect place for the southeastern beach mouse, gopher tortoise, indigo snake and other rare and endangered species.

Coastal strand habitat once formed a continuous band up and down the coast, but it is now vanishing quickly due to coastal development. In addition, introduced species (such as house cats) are wiping out beach mice and coastal birds. The coastal strand is now severely fragmented, leading to the loss of several local beach mouse populations.

The Archie Carr National Wildlife Refuge, Sebastian Inlet State Park and Canaveral National Seashore contain some of the last individuals of the southeastern beach mouse, as well as remnants of the coastal strand habitat upon which they depend.

Maritime Hammock

The maritime hammock community is found just inland from the coastal strand. This community becomes established on older dunes that are stable enough to support the growth of trees. Plant species include live oak, cabbage palms, wild coffee, coral bean and several species of ferns.

The maritime hammock provides habitat for many species of animals including tree frogs, squirrels, scrub jays, blue-tailed skinks and both resident and migratory song birds. Unfortu-

nately, these areas are well-suited for development because of the stable, well-drained soil, leading to the rapid decline of maritime hammock habitat.

Besides their ecological importance, many maritime hammocks contain shell mounds, or middens, left by Florida's original human inhabitants and provide an important archeological link to Florida's history.

Barrier Islands

Barrier islands make up more than 700 miles of Florida's coastline. They are naturally formed by shifting sands that build upon an existing sandbar to eventually form an island. The sand that has accumulated above the water surface becomes the home for the drifting seeds of beach plants. As the seeds grow and develop, their roots stabilize the soil, allowing the development of coastal strand and maritime hammock communities. Barrier islands support more than 35 species of plants and animals that are listed as either rare, threatened or endangered.

Barrier islands are greatly affected by the forces of wind and waves and are constantly moving towards or away from the mainland. Because barrier islands provide mainland protection from hurricanes and large storms by absorbing the impact of waves and storm water over flow, entire barrier islands can be severely reshaped or completely destroyed by a major storm.

Brackish Communities

Lagoons lie between barrier islands and the mainland, while estuaries are found directly on the coast and are open to the near shore area. Estuaries and lagoons are areas where saltwater oceans and freshwater rivers mix together, forming brackish water. Because lagoons receive some protection from a barrier island, they have less tidal flow and more standing water, while estuaries have strong tidal flows and little standing water. Lagoons and estuaries are very important because they support a diversity of plants and wildlife.

The most impressive example of a lagoon in Florida is the 156-mile-long Indian River Lagoon. This area is adjacent to the Archie Carr National Wildlife Refuge and is an important feeding area for juvenile sea turtles. Unfortunately, marine pollution has caused the health of the lagoon to deteriorate, and wildlife and plant abundance has decreased. There are numerous efforts now underway to restore the health of the Indian River Lagoon.

Salt Marshes

Salt marshes contain mostly tall grassy plants that are periodically flooded by ocean tides. The plant cover differs within the marsh according to small changes in elevation.

Marshes help stabilize sediments and buffer inland areas from storms. These communities are also very biologically diverse, supporting a wide variety of species ranging from fish to oysters. Salt marshes are also important feeding areas for wading birds, such as herons and egrets. The species that live in salt marshes have adapted to sudden changes in water level, water and air temperatures and oxygen levels in the water.

What about Sea Grass Beds?

Florida has 1.5 million acres of sea grass beds. These beds are important feeding and breeding habitats for many marine species, including sea turtles.

Unfortunately, sea grass beds have been on the decline since 1940 and more than one-third of the original sea grass around the state has been lost. These areas are declining due to pollution and are being damaged by boat propellers and anchors.

Mangrove Swamps and Forests

Florida has about 500,000 acres of mangrove forests along its coastline. Mangroves receive an abundant supply of fresh water and perform important functions such as filtering out pollution, holding sediments, protecting the shoreline from erosion and providing habitat for a variety of animals.

Mangroves are the most biologically diverse of all the lagoon and estuary communities. They provide habitat for at least 220 fish species, 24 reptile and amphibian species, 18 species of mammal and 181 species of birds. Commercial fishermen also depend on mangroves for the production of lobster, shrimp and snapper. Mangroves can be very susceptible to coastal development and pollution.

Coastal Habitats:

Threats to Coastal Communities

This section describes some of the major threats to Florida's coastal habitat and wildlife. The one thing that all of these threats have in common is that they are primarily caused by humans. While it is disturbing to know that our own actions can have such negative impacts, the fact that we are to blame leaves hope that we can change our behavior to protect the resources we enjoy so much and depend upon.

Development

Rapid coastal development threatens the future of Florida's beach and dune ecosystems. As new houses and condominiums are built on beaches and barrier islands, many fragile and important coastal communities are being lost forever. Unfortunately, as more and more people move into the state, many of them gravitate toward the coastline--resulting in even faster rates of development. The gradual disruption of coastal habitat not only affects the survival of plant and animal species, but also reduces the overall health of coastal ecosystems.

Coastal Armoring

Coastal armoring, such as sea walls, rock revetments and other man-made structures, can negatively affect coastal ecosystems and wildlife by interfering with natural beach shaping forces and disturbing habitat--especially sea turtle nesting habitat. Armoring is built in an effort to slow or prevent the erosion of sand in front of houses or other coastal structures. Unfortunately, sea walls provide only temporary relief from the natural process of erosion and often increase the rate of erosion on adjacent sections of beach. As erosion and sea-level rise puts more coastal structures at risk, armoring will become even more of a problem in Florida.

Inlet Jetties

Inlets provide ocean access for recreational and commercial boats. Jetties, such as those at Sebastian Inlet, are built to stabilize inlets by trapping sand that would otherwise constantly reshape the inlet. Unfortunately, by trapping sand, jetties prevent the natural flow of sand along a coastline--causing the beach on one side of the inlet to erode faster than normal. Sometimes, sand can be "bypassed" around the inlet, but this process is very expensive.

Pollution

Coastal waters and beaches are under constant threat from pollution. Coastal ecosystems, such as lagoons, mangroves and salt marshes, are often polluted by runoff from the mainland. Rivers that empty into these coastal waters carry pollution from inland sources, such as runoff from lawns and farms. Pesticides, fertilizers, oil spills and sewage plant discharges also pollute our coastal waters.

Beach-goers can also pollute coastal ecosystems. Beach driving causes oil and other toxic fluids to accumulate in the sand, eventually reaching the ocean. Litter left by beach visitors is blown into the water and may be eaten by marine animals, including sea turtles. As pollutants accumulate over time, our oceans may eventually no longer be able to support the plants and animals that depend on them to survive.

Exotic Vegetation

Non-native, or exotic, vegetation has invaded many coastal areas. Most exotic species were introduced by humans as ornamental plants for landscaping. Invasive coastal species, such as Australian pine, melaleuca and Brazilian pepper, out-compete Florida's native plants, such as sea oats, sea grape and dune grass, degrading the quality of wildlife habitat. Invasion of the coast by species that are less effective at stabilizing dunes also leads to increased beach erosion.

Coastal Habitats:

Protecting Beach and Dune Ecosystems

As Florida's human population continues to grow and urban development spreads across the state, it becomes more and more important to protect the remaining undeveloped areas of the beach and dune ecosystem and its diversity of communities, plants and animals. The creation of state and federal protected areas through the purchase of undeveloped land is an important step in the conservation and survival of Florida's threatened and endangered species, including sea turtles. One of the most important sea turtle nesting habitats in the world is being protected by the Archie Carr National Wildlife Refuge, a cooperative effort between federal, state and county agencies and several private organizations.

Archie Carr National Wildlife Refuge

Refuge History

The Archie Carr National Wildlife Refuge was designated by Congress in 1989 to protect one of the most important sea turtle nesting sites in the world.

Long stretches of quiet, undisturbed sandy beaches, with little or no artificial light, are essential to the reproductive success and survival of sea turtles. This fact is recognized in sea turtle recovery plans developed by the U.S. Fish and Wildlife Service (USFWS), which call for purchasing and protecting the best remaining nesting beaches.

In North America, sea turtles primarily nest from North Carolina through Florida, with more than 90% occurring in Florida. Within that range is the Archie Carr National Wildlife Refuge, a 20.5-mile stretch of beach between Melbourne Beach and Wabasso, along Florida's east central coast. The refuge attracts more nesting, threatened loggerhead turtles than virtually anyplace else on earth. These Brevard and Indian River County beaches also attract more nesting green turtles, an endangered species, than anyplace in the continental United States. Even the endangered leatherback occasionally climbs up these beaches to deposit her eggs in the sand. Protection of these beaches is essential to the survival of loggerheads and green turtles in North America.

To preserve this globally important nesting ground, the USFWS is in the process of acquiring the remaining undeveloped lands between Melbourne Beach and Wabasso. The state of Florida, Brevard and Indian River counties, the private Mellon Foundation and the USFWS are each contributing money in the effort to buy land from willing sellers within the proposed refuge boundary. By mid-1996, more than $60 million had been spent to purchase 4.7 miles of beachfront out of 9.3 miles targeted for acquisition.

How Was the Refuge Named?

The idea to establish a national wildlife refuge to protect sea turtles began in the late 1980s as a direct result of the work of world-renowned ecologist Dr. Archie Carr. When Congress approved the refuge proposal, it was decided to name the refuge in honor of Dr. Carr's contributions to the understanding and conservation of sea turtles.

Dr. Carr was a zoology professor at the University of Florida, and his ability to translate science into literature brought international attention to the plight of sea turtles. Dr. Carr helped found the Sea Turtle Conservancy (STC) to conduct research, education and advocacy on behalf of sea turtles; he wrote 11 books and more than 120 scientific articles about sea turtles and their habitats before his death in 1987. Through its Sea Turtle Survival League program, STC is today helping enhance, protect and promote the Archie

Carr National Wildlife Refuge.

Sea Turtles and Other Coastal Wildlife in the Refuge

Thorough scientific studies of sea turtle nesting activity along the beaches of the refuge have continued each nesting season for almost a decade. Studies by Dr. Llewellyn Ehrhart, University of Central Florida, confirm the global importance of the refuge to loggerheads and green turtles.

During recent nesting seasons, which run from May to October each year, between 16,000 and 20,000 loggerhead nests were counted in the refuge. Nesting like this makes the refuge the most productive nesting site for loggerheads in the Western Hemisphere, and possibly in the world. Each season, between 200 and more than 1,000 green turtle nests are counted in the refuge. A few rare leatherbacks also nest there each year.

The refuge provides habitat for other threatened and endangered species, such as the Florida scrub jay, gopher tortoise, beach mouse and numerous plant species by supporting coastal strand, maritime hammock and barrier island communities.

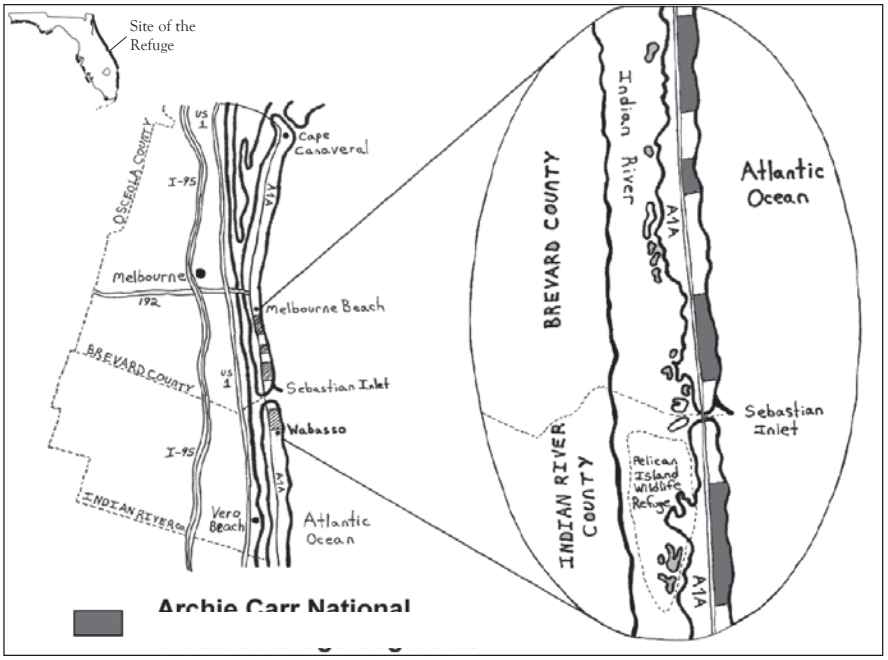
A Wildlife Refuge at Risk

The Archie Carr Refuge represents the nation's most significant land acquisition effort to protect the world's populations of marine turtles. Unfortunately, rapid coastal development in Brevard and Indian River counties continue to threaten the future effectiveness of the refuge. Supporters of the refuge work towards acquiring the best remaining parcels of undeveloped land. Unfortunately, funds available for land acquisition, especially from the federal level, are scarce.

Successful completion of the Archie Carr National Wildlife Refuge depends on an increase in funding for land acquisition efforts and wide public support for the refuge. Since the dedication of the refuge by Congress, the financial contributions of local and state governments and private, nonprofit organizations has surpassed the federal commitment. Scientists, conservationists and land managers consider completion of the acquisition phase of the refuge as the most essential step.

How the Sea Turtle Conservancy is helping the Refuge

The Sea Turtle Survival League (STSL) engages in education, research and advocacy designed to protect, promote and enhance the globally important sea turtle nesting beaches of the Archie Carr National Wildlife Refuge. Educational programs target the media, the public and schools with information about the importance of the area and the threats it faces. Increased awareness is helping raise public support for land acquisition funding. Through advocacy, the STC works with decision-makers to ensure that sea turtles and their habitat receive the greatest level of protection. The Sea Turtle Survival League supports and publicizes research in the refuge, including nesting surveys and tracking of green turtle migratory patterns.



Getting Involved:

What You Can Do To Get Involved

*** Adopt-A-Turtle to Support Sea Turtle Conservation**

Have the class take a personal interest in one of the satellite-tagged turtles or a turtle tagged in Costa Rica. The $25 donation directly supports sea turtle conservation.

*** Reduce the Amount of Plastic Garbage You Produce**

Have each class member bring in all the plastic trash collected at home in a 24-hour period. Discuss the amount all the students in the school might produce in a day; the whole city; the state; the nation. As a class, discuss how people can get through each day using less plastic and where to recycle plastic – then agree to do it.

*** Tell People How Helium Balloons Harm Sea Turtles**

Helium-filled balloons are frequently released into the sky to celebrate events. Like plastic trash, helium balloons end up in the ocean, especially when released near the coast. Sea turtles mistakenly eat the balloons and die. Ask groups planning a ballon release to consider another attention getter.

*** Write a Letter to the Editor of Your Local Newspaper**

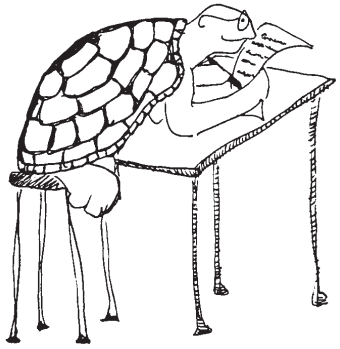
Find out how to submit a "Letter to the Editor" to your local paper. Have students write letters that inform your community about the plight of sea turtles and other marine wildlife. You might even let people know about this program. If you live near the coast, ask people to do their part to protect nesting turtles and hatchlings by turning off beachfront lights during nesting season or opposing the use of coastal armoring.

*** Write Letters to or Call Your Elected Officials**

There are a number of ongoing issues affecting sea turtles or their habitats that are being debated by the State Legislature. First, discuss the layout of a letter with students (*see the adjacent article for tips on writing to politicians*). Next, have students write or call in support or opposition to a particular issue. STSL can provide information on current issues.

*** Reduce the Amount of Chemicals You Use**

Many people use chemicals and fertilizers on their lawns and gardens. Used motor oil and paints are deadly to plants and animals if not disposed of correctly. Many of these chemicals get washed into coastal lagoons and wash up on beaches. Have the class find biodegrad-able lawn and garden products and facilities that properly dispose of toxic chemicals.



Tips for Writing Letters to Decision-Makers

1) Original letters count most. Express your views in your own words and, if possible, include a personal experience in your letter.

2) Address one issue at a time and be brief. One page is perfect, but you could go to two. Legible handwritten letters are fine.

3) Your first sentence should state where you live, especially if you are a constituent of the elected official to whom you are writing.

4) The first paragraph should explain why you are writing and what you want the person to do.

5) Ask for a response. For example: "I look forward to hearing how you will vote."

6) Be polite in the letter and thank the reader for considering your views.

7) Remember, when elected officials receive enough letters about a particular issue, their opinions can be influenced.

Glossary of Terms:

Accretion - the addition of sand to a beach by a gradual, natural process.

Arribada - Spanish for "arrival," used to refer to the mass, synchronized emergence of nesting sea turtles.

Artificial Lighting - Light created by human-made sources, such as lamp posts and porch lights.

Beach Renourishment - the addition of sand to a beach by humans to replace sand lost through erosion.

Body Pit - the upper part of a turtle nest where the turtle removes the surface layers of sand before digging the egg chamber.

Brackish - somewhat salty water usually found in marshes, lagoons and estuaries along the coast.

Carapace - the dorsal or upper portion of a turtle's shell.

Carnivore - an organism that eats only other animals.

Caruncle - a temporary, sharp egg-tooth on hatchlings used to tear open the egg shell.

Clutch - a nest of eggs.

Coastal Armoring - anything built along a beach to protect structures from beach erosion.

Community - a group of animal and plant species that live in the same area and interact with each other through food chains and other interrelationships.

Convention on International Trade in Endangered Species (CITES) - agreement to control the international trade of endangered and threatened species.

Crustacean - organisms such as lobsters, shrimp and crabs that have hard outer shells, jointed limbs and usually live underwater and have gills.

Ecosystem - a system made up of biological communities and the physical and chemical environment.

Egg Chamber (Cavity) - the part of a turtle nest where the eggs incubate.

Endangered Species - an organism that is in danger of becoming extinct.

Endangered Species Act (ESA) - a law that protects endangered and threatened species in the United States of America.

Erosion - the removal of sand from a beach by either a gradual process or during a storm event.

Estuary - an area where fresh water and salt water mix with a strong tidal flow and little standing water.

Exotic Species - species that are introduced into an area where they are not naturally occuring.

Extinct - when the last living individual of a species dies, causing the species to no longer exist.

False Crawl - term used to describe when a turtle crawls onto the beach but does not nest.

Fibropapillomas - a disease that casues cauliflower-like tumors to grow on sea turtles and other animals.

Habitat - a place where a plant or animal naturally lives.

Herbivore - an organism that eats only plants.

Incubate - process during which eggs develop into hatchings.

Lagoon - an area where fresh water and salt water mix with a weak tidal flow and standing water.

Latitude - distance in degrees north or south of the equator.

Longitude - distance in degrees east or west on the Earth's axis.

Longshore Drift - the perpetual or constant movement of sand along a coastline.

Magnetic Field - a region in which there is a magnetic force, found in the materials of the earth's crust.

Middens - a garbage heap, usually referring to ancient mounds of artifacts, bones and discarded shells.

Migration - the act of moving from one place to another.

Natal Beach - the beach where a sea turtle was born.

Native Species - species that are indigenous or belong to an area.

Nest - the structure made for laying and incubating eggs.

Plastron - the lower or ventral portion of a turtle's shell.

Poach - to hunt illegally.

Predator - an organism that lives by capturing and feeding on other animals or their eggs

Pristine - an area that is untouched or unspoiled.

Satellite Telemetry - technology that uses a radio transmitter to transmits signal to satellites orbiting the Earth.

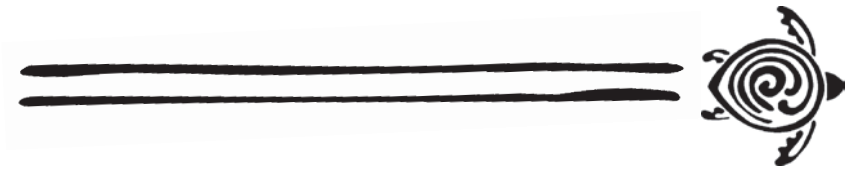
Scutes - the hard scales covering a turtle's shell.

Storm Event - a disturbance, usually having strong winds, rain, thunder and lighting.

Threatened Species - an organism that may become endangered.

Turtle Excluder Devices (TEDs) - a device attached to a shrimp net to allow sea turtles and other large organisms to escape from the net while allowing shrimp to be caught.

Appendix A:



National Standards

National Science Education Standards:

Science as Inquiry
* Identify science questions
* Use evidence to describe, explain, predict and model
* Use critical thinking logic to relate evidence to explanations
* Recognize and analyze alternative explanations
* Use math in all phases of inquiry

Life Science
* Structure and function in living systems
* Reproduction and heredity
* Regulation and behavior
* Population and ecosystems
* Diversity and adaptation of organisms

Unifying Concepts & Processes
* Form and Function

Science in Personal & Social Perspective
* Personal Health
* Populations, resources and environments
* Natural hazards
* Risks and benefits
* Science and technology in society

History and Nature of Science
* Science as human endeavor
* Nature of science

National Council of Teachers of Mathmatics:

Data Analysis & Probability
* Formulate questions that can be addressed with data and collect, organize, and display relevant data to answer them
* Understand and apply basic concepts of probability

National Council of Teachers of English:

Standard 4
Students adjust their use of spoken, written, and visual language (e.g., conventions, style, vocabulary) to communicate effectively with a variety of audiences and for different purposes.

Standard 7
Students conduct research on issues and interests by generating ideas and questions, and by posing problems. They gather, evaluate, and synthesize data from a variety of sources (e.g., print and non-print texts, artifacts, people) to communicate their discoveries in ways that suit their purpose and audience.

National Geographic Education Standards:

Standard 1
How to use maps and other geographic representations, tools, and technologies to acquire, process, and report information.

Standard 14
How human actions modify the physical environment.

National Techology Education Standards:

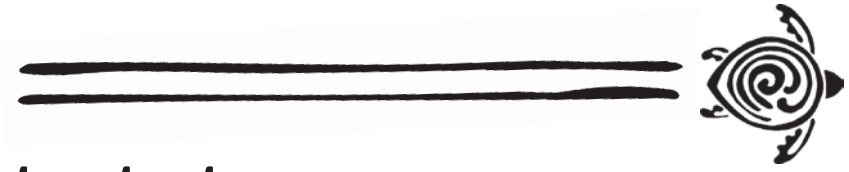
Social, ethical and human issues
* Students practice responsible use of technology systems, information, and software.
* Students develop positive attitudes toward technology uses that support lifelong learning, collaboration, personal pursuits, and productivity.

Technology productivity tools
* Students use technology tools to enhance learning, increase productivity, and promote creativity.

Technology research tools
* Students use technology to locate, evaluate, and collect information from a variety of sources.

Technology problem-solving and decisionmaking tools
* Students use technology resources for solving problems
and making informed decisions.

Appendix B:



Sunshine State Standards

Science Standards (K-2, 3-5, 6-8):

SC.D.1.2 The student recognizes that processes in the lithosphere, atmosphere, hydrosphere, and biosphere interact to shape the Earth.
SC.D.1.2.4- knows that the surface of the Earth is in a continuous state of change as waves, weather, and shifts of the land constantly change and produce many new features.
SC.D.2.2 The student understands the need for protection of the natural systems on Earth.
SC.D.2.2.1- knows that using, recycling, and reducing the use of natural resources improve and protect the quality of life.
SC.F.1.2 The student describes patterns of structure and function in living things.
SC.F.1.2.2- knows how all animals depend on plants.
SC.F.2.1 The student understands the process and importance of genetic diversity.
SC.F.2.1.2- knows that living things have offspring that resemble their parents
SC.G.1.1 The student understands the competitive, interdependent, cyclic nature of living things in the environment.
SC.G.1.1.2- knows that plants and animals are dependent upon each other for survival.
SC.G.1.1.3- knows that there are many different plants and animals living in many different kinds of environments (e.g., hot, cold, wet, dry, sunny, and dark).
SC.G.1.2 The student understands the competitive, interdependent, cyclic nature of living things in the environment
SC.G.1.2.1- knows ways that plants, animals, and protists interact.
SC.G.1.2.5- knows that animals eat plants or other animals to acquire the energy they need for survival
SC.G.2.1 The student understands the consequences of using limited natural resources.
SC.G.2.1.2- knows that the activities of humans affect plants and animals in many ways.
SC.G.2.2 The student understands the consequences of using limited natural resources.
SC.G.2.2.3- understands that changes in the habitat of an organism may be beneficial or harmful.
SC.H.1.1 The student uses the scientific processes and habits of mind to solve problem.
SC.H.1.1.1- knows that in order to learn, it is important to observe the same things often and compare them.
SC.H.3.2 The student understands that science, technology, and society are interwoven and interdependent.
SC.H.3.2.1- understands that people, alone or in groups, invent new tools to solve problems and do work that affects aspects of life outside of science.
SC.H.3.2.2- knows that data are collected and interpreted in order to explain an event or concept.

Language Arts Standards (K-2, 3-5, 6-8):

LA.A.2.2 The student constructs meaning from a wide range of texts.
LA.A.2.2.5- reads and organizes information for a variety of purposes, including making a report, conducting interviews, taking at test, and performing an authentic task.
LA.A.2.2.8- selects and uses a variety of appropriate reference materials, including multiple representations of information, such as maps, charts and photos, to gather information for research projects.
LA.B.1.2 The student uses writing processes effectively.
LA.B.2.2 The student writes to communicate ideas and information effectively.
LA.C.1.2 The student uses listening strategies effectively.

Math Standards (K-2, 3-5, 6-8):

MA.A.4.2 The student uses estimation in problem solving and computation.
MA.A.4.2.1- uses and justifies different estimation strategies in a real-world problem situation and determines the reasonableness of results of calculations in a given situation.
MA.E.2.2 The student identifies patterns and make predictions from an orderly display of data using concepts of probability and statistics.

Geography Standards (K-2, 3-5, 6-8):

SS.B.1.2 The student understands the world in spatial terms.
SS.B.1.2.1- uses maps, globes, charts, graphs, and other geographic tools including map keys and symbols to gather and interpret data and to draw conclusions about physical patterns.
SS.B.2.2 The student understands the interactions of people and the physical environment.
SS.B.2.2.3- understands how human activity affects the physical environment.

"People tend to think of the productions of the sea as without limit,
as fed by the limitless energy of the sun
falling on the five-sevenths of the earth's surface that the oceans are.
But this comforting thought does not apply to sea turtles.
Huge nesting colonies of sea turtles have been wiped out before-
in Florida, in the Bahamas and all about the Caribbean.
The dependence on wild shore for nesting,
combined with the heavy natural predation on eggs and hatchlings
deprives sea turtles of the resilience that many pelagic fishes have.
Turtle food comes mainly from the bottom in the shallow fringes of the sea,
and turtles require peace on the seashore to breed successfully.
Sea turtle populations are small; and as man increases everywhere, they grow smaller."

~Dr. Archie Carr, "So Excellent A Fishe"

Sea turtles remain some of the most mysterious
and time-honored creatures on earth.
The Sea Turtle Conservancy,
through its conservation initiatives
and education programs,
is helping ensure the gentle sea turtle
remains a wild and thriving part of the natural landscape.

SEA TURTLE CONSERVANCY

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