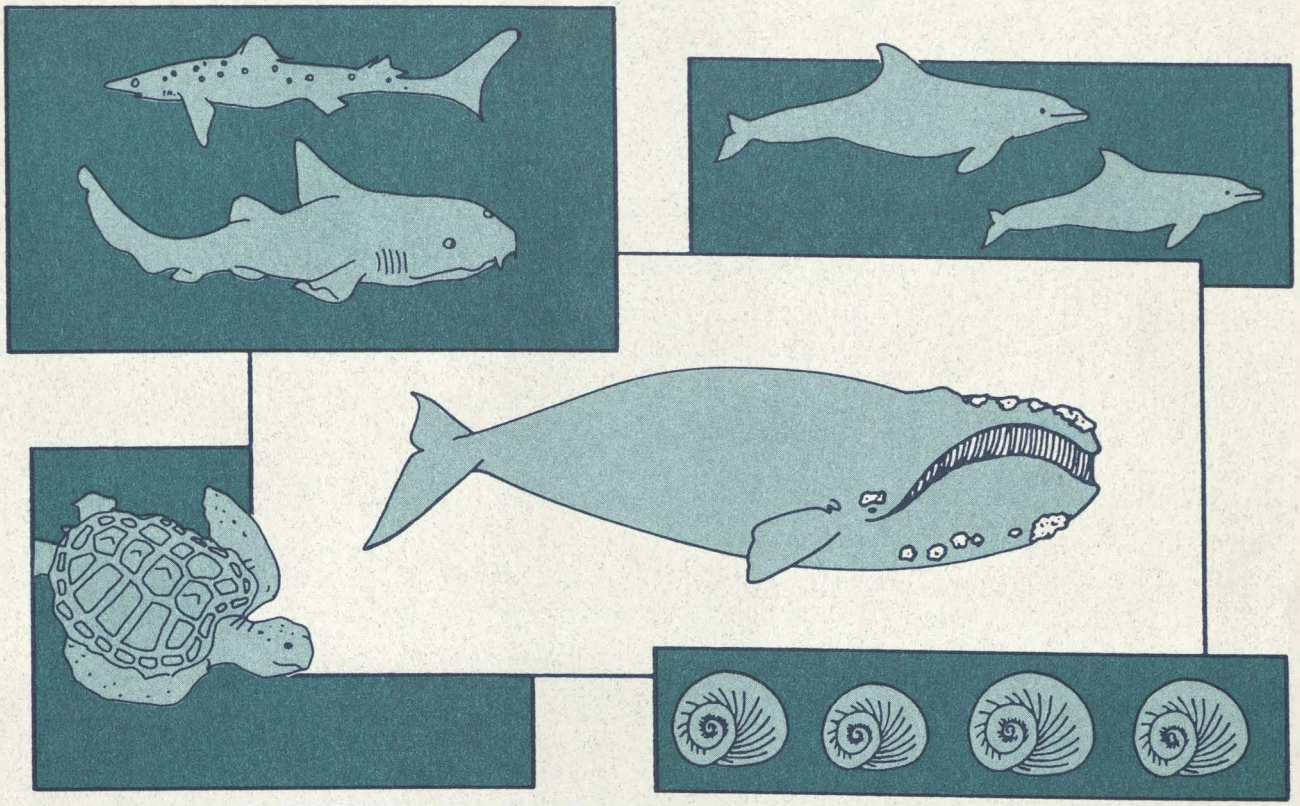
Tales of Whales, Turtles, Sharks, and Snails

An elementary level educational handbook

Produced by
The University of Georgia Marine Extension Service



For The

Gray's Reef National Marine Sanctuary

National Oceanic and Atmospheric Administration

Tales Of Whales, Turtles, Sharks And Snails

An Elementary Level Educational Handbook

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The University of Georgia Marine Extension Service
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MARINE STUDY FOR GRADES 4-6

INTRODUCTION TO THE TEACHER

Saltwater seas and oceans cover over 70% of the earth's surface. This system of water is a dominant influence on climatic conditions, local weather, including temperatures, rainfall and wind, and general atmospheric circulation.

The oceans contain the tallest mountains and the deepest canyons on earth. Life originated in the oceans, and the oceans continue to support more species of plants and animals than all the continents combined.

Human history, economics, trade, the development of cities, transportation, food resources, recreation, art, music and the outcome of wars have been closely linked to the oceans. Yet a review of the curriculum used in elementary schools reveals that the oceans are studied very little.

The purpose of this publication is to increase the awareness, knowledge and literacy of elementary students in marine-related subjects. It is written also for elementary teachers to use as a resource and guide to other environmental educational materials. Words underlined in the text are defined in a glossary in the back of the book.

The concepts and activities presented here can be infused into the curriculum singly or they can be used as a complete unit. While Gray's Reef is the model habitat for this publication, it's important to remember that marine education concepts apply to any coastal environment. Also, it's not necessary to be in proximity to a coastal environment in order to benefit from the activities presented in this handbook.

GRAY'S REEF NATIONAL MARINE SANCTUARY

Congress passed the Marine Protection, Research and Sanctuaries Act in 1972 in response to a growing awareness of the importance of the marine environment to the United States. The Act enabled the United States to designate as National Marine Sanctuaries areas within its boundaries that have significant ecological, historical, aesthetic, or recreational value.

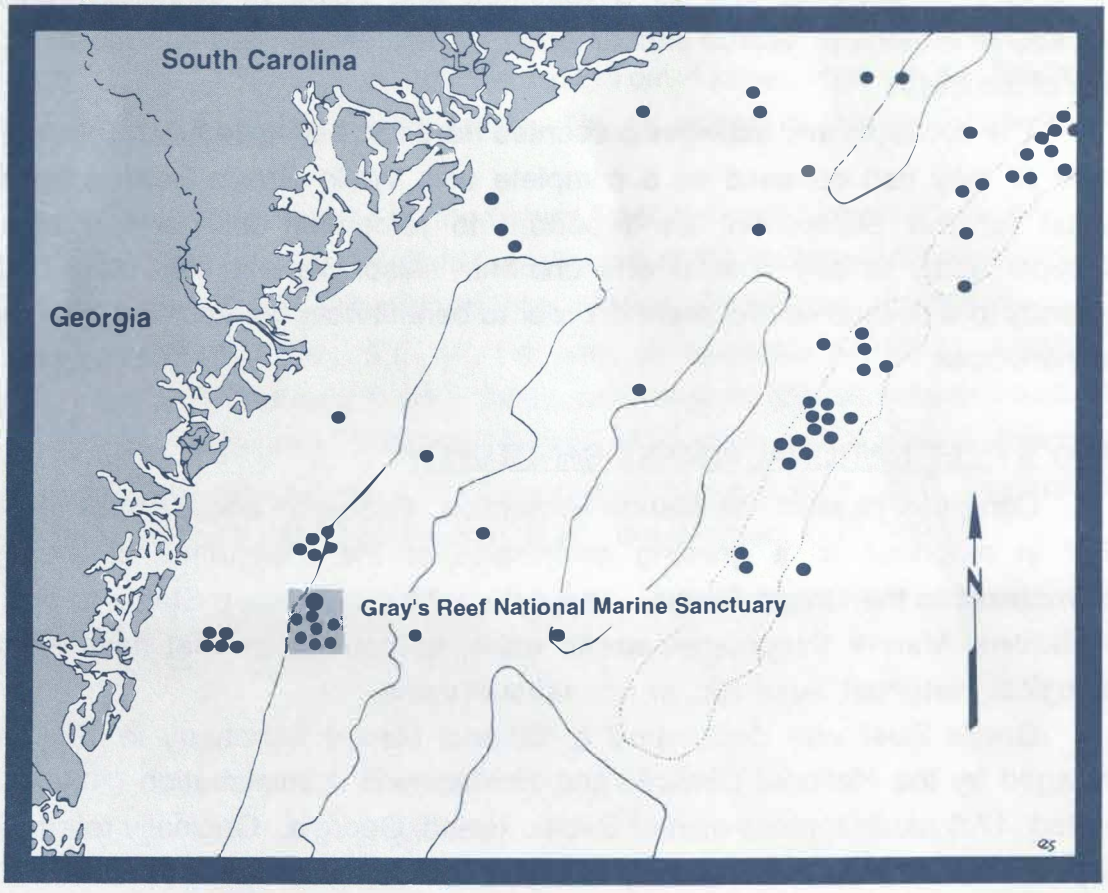
Gray's Reef was designated a National Marine Sanctuary in 1981 and is managed by the National Oceanic and Atmospheric Administration (NOAA). It is located 17.5 nautical miles east of Sapelo Island, Georgia. Originally referred to as "Sapelo Reef," it was subsequently renamed for biological collector, curator, Milton B. Gray, who worked at The University of Georgia Marine Institute on Sapelo in the 1960s.

Gray's Reef is not a coral reef such as those found in the tropics. It is a limestone rock outcropping, which stands above the shifting sands of the nearly flat continental shelf (Fig.1).

This rocky outcropping provides a solid place for algae and sessile marine invertebrates to attach. The attached organisms provide food and hiding places for other invertebrate animals and fishes. The rich diversity of life around these rocky areas makes it easy to understand why they are often referred to as "live bottoms."

Since Gray's Reef is well offshore and lies in 50 to 70 feet of water, most visitors are experienced scuba divers and sportfishermen familiar with offshore waters.

Figure 1. Map Showing Location Of Gray's Reef And Some Of The Other Natural Reef Formations Off The Southeastern Coast.



Interpretive and educational materials such as this publication have been developed by The University of Georgia Marine Extension Service under cooperative agreements with the NOAA Gray's Reef National Marine Sanctuary Program. These materials include:

1. The Common Fishes of Gray's Reef - poster
2. Invertebrates of Gray's Reef - poster
3. Gray's Reef National Marine Sanctuary: An Educational Handbook - 34 pages middle school/high school
4. Gray's Reef National Marine Sanctuary - brochure
5. Gray's Reef narrated slide show
6. Offshore Guide to Gray's Reef - map

For information on how to obtain these materials, write to :

Gray's Reef National Marine Sanctuary
NOAA
P.O. Box 13687
Savannah, GA 31416
(912) 598-2496/2497/2352

Each chapter of this publication provides the teacher with basic background information, which also can be read to the class. Students in grades 4 to 6 can read these background sections themselves.

The subjects chosen for this book involve marine animals of interest to students. It is hoped that the other related activities included here will inspire students to learn more about these animals and the marine environments they inhabit.

Organizations including NOAA's National Marine Sanctuary Program and National Sea Grant College Program, as well as the Center for Marine Conservation, and the education departments of large aquariums, such as the National Aquarium in Baltimore, have supported the development of many excellent marine education materials. This book will help you discover such materials. It will also provide the addresses of conservation organizations which have ecologically -oriented publications.

Offshore to Gray's Reef National Marine Sanctuary

A Short Story

By Jay R. Calkins

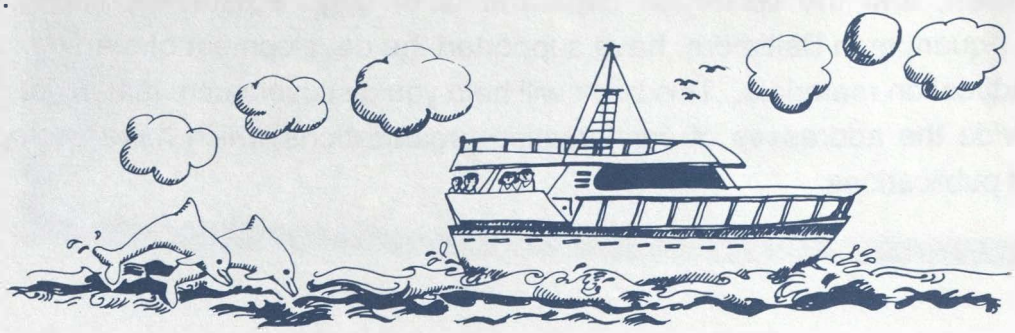
(For the teacher to read to the class)

As we leave the dock at Sapelo Island, Georgia aboard our boat, my senses are filled with the sights, sounds, and smells of the salt marsh, which dominate the shoreward side of Georgia's barrier islands. Cordgrass, now green and waving in the hot summer wind, stretches as far as you can see, broken only by the tea-colored tidal creeks and rippling waters of Doboy Sound. Great blue herons squawk as our noisy passage disturbs them from their concentrated fishing rites. Fiddler crabs scurry into their muddy holes as the wake from the boat splashes along the mudflats.

I can see an old lighthouse, long abandoned, marking the southern end of Sapelo Island as we leave the sound and enter the Atlantic Ocean. To the north are the beaches and dunes, which protect the island from the constant wash of ocean waves. Shorebirds scamper among the waves in search of food.

The water changes from the color of tea to a blue-green as we leave the sound and travel east across the continental shelf. Flocks of sea gulls and terns follow our boat hoping to get an easy meal. The birds have learned that workers on fishing boats throw scraps of fish overboard after picking out the delicious white shrimp. Some of the birds follow us for miles out to sea.

We, the captain, crew, and I are going to visit Gray's Reef National Marine Sanctuary today. This sanctuary is about 17 miles ahead of us. Behind us, Sapelo Island is shrinking into the horizon as we travel to the east. Suddenly, appearing like magic, the boat is surrounded by six dolphins. The sleek mammals swim around the boat with ease. They pass the boat, swim beneath it and surf on our wake.



They easily leap completely out of the water. I wish I could swim as fast and as easily as these small whales.

If we could swim to the bottom here, following the dolphins, we would see a flat sandy plane stretching for miles in all directions. The bottom is like a desert with 50 feet of salt water covering it.

Very little animal life is seen on the sandy bottom. A few migratory fish swim by with strange names like cobia, amberjack and wahoo. If I look closely, I might see an occasional sand perch or pearly razorfish dart quickly into the sand to hide. As in a desert, I must be very observant to see any life here.

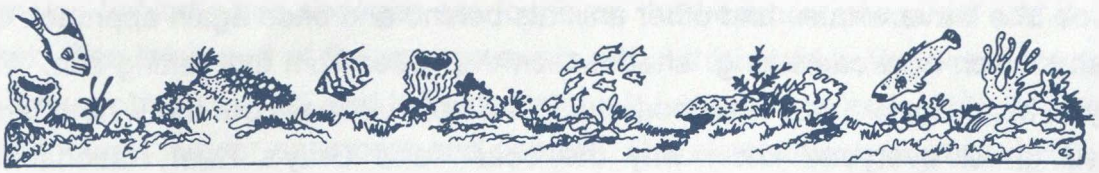
I cannot see the shoreline anymore. The ocean surrounds us. There is little to see except the waves and a few gulls resting on the waters. Schools of fish occasionally ripple the surface and a flying fish glides from wave top to wave top.

Two hours into our trip we enter Gray's Reef National Marine Sanctuary. No sign or fence or gate tells us we are in the sanctuary. There are large yellow buoys at the surface marking the corner boundaries of this protected reef. Our captain points to his nautical chart, a roadmap of the sea, and we see the boundaries of the sanctuary clearly defined.

The captain anchors the boat and we don our scuba equipment and pick up our underwater cameras. We are eager to see why this area, so far from land, has been named a marine sanctuary.

Trailing long streams of bubbles, we swim toward the bottom. The water is quite clear. Compared to the marshy waters around Sapelo Island, it is very clear. The bottom is covered with sponges, corals, sea urchins, and starfishes, over which swim schools of brightly colored fishes. Solid rock stands above the flat sandy bottom, making ledges and caves, which provide hiding places for many fishes, crabs, lobsters and even sea turtles.

Life is everywhere on Gray's Reef, swimming, crawling and attached to the rocks. As our cameras flash catching these images on film, we can see why this rocky area has been protected by the National Marine Sanctuary Program. Unlike the flat, sandy, nearly lifeless bottom we have been traveling over in our boat this place is covered with plants and animals. It is called a "live bottom" area for that reason.



As my diving partner swims over a ledge slightly ahead of me, he suddenly stops and gestures wildly for me to look below him. There, resting on the bottom is a six-foot-long shark. The theme song from the movie "JAWS" echoes through my head as visions of some "man-eater" biting me fill me with dread. But this is a nurse shark, a large docile fish, which would not bother anyone.

I know very well that few sharks are dangerous to humans. Of the 300 species of sharks, only a dozen have been known to bite humans. Many of those attacks are thought to be the result of mistaken identity. For instance, great white sharks are thought to attack swimmers because they mistake them for seals or sea lions. Actually, sharks have much more to fear from us, as thousands of sharks are killed yearly for human food. Still, some primeval fear lingers from the sight of any shark.

We swim back up to the boat and take off our scuba tanks. I hope we get some good pictures. Slightly chilled and tired, I lie on the deck and let the sun warm me. I have just seen sights that very few people will ever see, except in photographs.

As we head back to shore, I notice a couple of fishing boats trailing lines in hopes of catching some of the fish drawn to Gray's Reef. Somebody might be eating mackerel, or sea bass or snapper tonight.

This must be my lucky day as someone shouts "Whales off the starboard bow! Three of them! Big ones!" Sure enough I spot a spout of water and spray shooting into the air from a huge dark shape off to the right about 100 yards ahead. "Those are right whales," cries the captain. "They're larger than our boat so they must be 50 feet long!"

Taking care not to scare these wonderful mammals, we stand off and watch the whales from a distance. "How can one of the largest animals that ever lived be so graceful? " I wondered aloud.

I think back of the stories I've read about hunting whales and wonder how such a magnificent animal could be nearly extinct from such puny beings as ourselves. I take some comfort in knowing that these whales are now protected from whalers' harpoons.

We leave whales and other animals behind and once again approach Sapelo Island which now casts long shadows on the water from the setting sun. What a day! I hope our pictures are good enough to help us share our trip with others. We need to let everyone know why the ocean and Gray's Reef National Marine Sanctuary are so important to protect and conserve.

INVERTEBRATES

By Hugh R. Williams

Of the more than one million described species of animals in the world, approximately 95% fall under the heading of invertebrates. There are more anatomical differences between jellyfish and insects than there are between insects and elephants. The invertebrates comprise an extremely diverse assemblage of animals, from single celled protozoans to insects, crustaceans and starfish. There are more than thirty major groups, or phyla, of invertebrates. For our purposes here, we will discuss the general characteristics of just a few groups common along our coast and at Gray's Reef. A companion Gray's Reef poster to this section entitled "Invertebrates of the Reef," can be obtained from The University of Georgia Marine Extension Service, P.O. Box 13687 Savannah, GA 31416 ($2.00).

SPONGES

Vase Sponge

Finger Sponge

Sponges belong to the phylum *Porifera*, which means "pore bearer," and constitute the simplest of multicellular animals. They are sessile organisms, which means that they live attached to objects, and therefore are not able to move about. They have no true tissues or organs, rather various individual cells perform the life functions of the sponge. Most sponges are marine; only 150 or so freshwater species have been identified out of some 5,000 species within the group.

Structurally, sponges are supported by a matrix of fibrous material and interwoven spicules (tiny spikes), usually made of calcium or silica. This matrix is what remains behind when sponges are found on the beach or prepared and sold for market. The living part of the sponge exists within this matrix. Water enters the sponge through many pores, and is helped along by specialized cells which sweep the water through interior chambers and canals. The water circulating through the sponge supplies oxygen and food, and removes wastes as well. Sponges pump a surprising amount of water in a day. For example, one type of sponge that

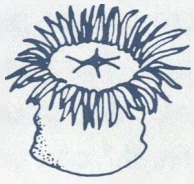
measures 5 inches by 1/2 inch (10cm. x 1cm.) will pump as much as six gallons (22.5 l) of water per day through its chambers.

Sponges eat very fine detritus particles and organisms such as bacteria and plankton. Sponge beds provide a significant amount of habitat for other animals, and they also may be responsible for filtering, i.e., cleansing, vast quantities of water in given areas.

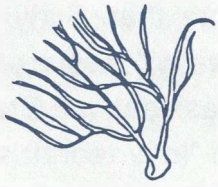
JELLYFISH, ANEMONES AND CORALS

Jelly Fish

Anemone



Sea Whip



These animals, along with the less familiar hydrozoans, belong to the phylum *Cnidaria.* They are the first group of animals to display differentiated tissues, limited organ development, and nerve cells. They possess an internal digestive cavity and a mouth, which permit a greater range of food sizes than exists with the sponges. The mouth is encircled by tentacles which aid in capturing and ingesting food.

Cnidarians may either be free-swimming, jellyfish-like animals, or solitary, sessile polyps, such as anemones. The hydrozoans and corals are colonial cnidarians with many individual polyps sharing a common structural form.

Anyone who has encountered a sea nettle or man-o-war in the ocean is aware of the stinging properties of these animals. The tentacles are lined with special pressurized cells which eject a harpoon-shaped barb which embeds itself in the tissue of its prey. This barb contains a toxin which immobilizes and kills small creatures, so they can be eaten by the jellyfish. Most jellyfish toxins are, at worst, irritating to creatures as large as humans, but those of the Pacific sea wasp and the Portuguese man-o-war can be fatal. The jellyfish and anemones feed on crustaceans and small fish, whereas the corals and hydrozoans feed principally by filtering plankton from the water.

FAN, TUBE AND BRISTLE WORMS

Fan Worm

Segmented Worm

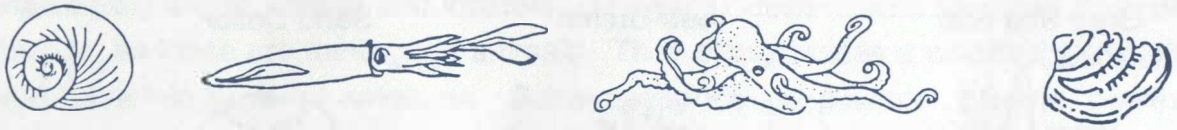
This group of common marine worms known as polychaetes is related to the common earthworm. Both belong to the phylum Annelida. Unlike the earthworms, their body segments possess lateral "legs" called parapodia. The fan and tube

worms construct burrows in the sediment or construct rigid limy tubes on the surface of solid objects, including the shells of other animals. Many of these worms possess mucous-covered tentacles which surround the mouth for capturing food. The bristle worms, which resemble caterpillars, live either on the ocean bottom, inside other animals (sponges, clams), or they swim or burrow through the sediments.

Polychaete worms feed in many different ways. Some are filter feeders, others are predators, detritus feeders, scavengers or deposit feeders. The latter consume sediment (sand and mud), take nutrition from whatever organic material is present, and eject the castings (cleansed sediment). On some beaches, deposit feeders occur in densities of up to 2,500 worms per square foot, and process as much as 14,000 tons of sand on a mile of beach in a year!

MOLLUSKS

Moon Snail Squid Octopus Venus Clam



Mollusks contain the second largest number of species of invertebrates after the arthropods. Seashells are among the most familiar remains of marine invertebrates. Mollusks include snails (gastropods), clams (bivalves), squid and octopus (cephalopods), and less familiar chitons and tusk shells. Most mollusks possess hard shells which remain long after the actual animal dies and are the delight of many beachcombers.

Gastropods are found in marine waters, fresh water and on land. Included in the group are limpets, snails (whelks, conchs, olive shells) and slugs. Nearly all possess a rasp-like feeding organ called a radula and have a single curled shell (except for slugs which have no shell). They may be herbivores, carnivores, scavengers, deposit feeders or filter feeders. Many have a discernible head, antennae and eyes. Along our shores we commonly find lightning, channeled and knobbed whelks, augers, moon snails and lettered olive snails. The deeper waters of Gray's Reef are home for the tulip whelk and helmet snails.

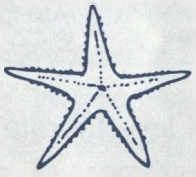
The bivalves include the oysters, clams and mussels. Their shells consist of two parts hinged at the back. They can completely close to protect the soft parts of the animal's body. Nearly all are filter feeders. Clams, angel wings, cockles and their close relatives bore into the substrate (sand, mud, wood) and are able to move

about. Oysters cement themselves into place and become permanently fixed in one spot (sessile). Mussels are also sessile using a thread-like material to anchor themselves to roots of plants or other surfaces. Scallops sit on top of the substrate, and are able to swim away from predators.

The cephalopods, which include the squid, octopus and nautilus, possess the most highly developed nervous systems and are the largest of all invertebrates. Most cephalopods utilize jet propulsion to swim by expelling water from the body cavity through a siphon. The octopus spends most of its time crawling along the bottom and uses jet propulsion only to escape predators; squids have fins for swimming but can jet propel themselves as well. Cephalopods are predators and use their tentacles to capture and manipulate prey. Squid possess ten tentacles whereas octopus have eight. They both possess a parrot-like beak and inject a poison to subdue prey. Giant squid may attain a length of 16 meters (over 50 feet).

ECHINODERMS

Gray Sea Star



Sea Urchin

Sand Dollar

Sea stars, sea urchins, sand dollars and sea cucumbers all belong to the group called echinoderms (meaning spiny skin.) They are found only in marine waters and most are bottom dwellers. Their bodies are divided into five parts arranged in a disc, sphere or cylinder. They also possess an internal water-vascular system (water-filled chambers and canals) typically used for locomotion. Most are scavengers or carnivores and feed on worms, mollusks, corals, sponges, crustaceans and even fish.

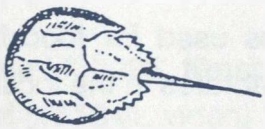
The sea stars possess sucker-like tube feet to help move them across the bottom and aid in capturing prey. The tube feet are located on the bottom of the five arms radiating out from a central disc. A sea star can exert enough prolonged suction on a clam or oyster to open its shell. It then inverts its stomach inside the clam and digests the soft tissue.

Sea urchins and sand dollars are, respectively, spherical or flattened animals that possess movable spines. Urchins usually live on firm bottoms and scrape food off the surface. Sand dollars are burrowers and feed on detritus found in the sediments.

ARTHROPODS

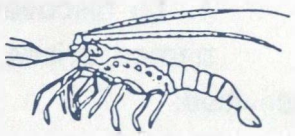
Hermit Crab

Horseshoe Crab



Acorn Barnacle

Spiny Lobster



This is the largest group of all animals, containing some three-quarters of a million described species. The major unifying trait within the group is the presence of jointed legs. Included within the group are crustaceans, spiders, insects and several less familiar organisms. Spiders and insects are found primarily on land and in fresh water. Crustaceans, on the other hand, are most common to marine and estuarine environments.

The most common marine arthropods are the decapod crustaceans, which include the crabs, shrimp and lobsters. The prefix *deca* means ten, and *pod* refers to legs, so these are ten-legged animals. They also possess a calcified exoskelton, and have two pairs of antennae. Some decapods are predators; Some, however, are scavengers, and others are herbivores and filter feeders. True crabs differ from other decapods in that their abdomen folds up under the carapace rather than extending like those of shrimp and lobsters. Hermit crabs are an exception because they lack a hard calcified abdominal shell. They utilize the abandoned shells of snails to house themselves for protection. As they grow they must continually move to larger and larger shells to accommodate their increased size.

Barnacles are also crustaceans. Similar to shrimp in many ways, they differ from most other crustaceans by living within a hard, cone-shaped, calcareous shell. As larvae they drift in ocean currents and eventually cement themselves head first onto a hard object. Their feet are modified and feather-like, and are used to sweep fine particles into their mouths.

The horseshoe crab is not really a crab at all. It is more closely related to spiders and scorpions. Horseshoe crabs live in shallow water and plow through the loose sediment while feeding on mollusks, worms and algae. They are also capable of swimming and use their page-like gills to propel themselves through the water.

Invertebrate Activities

Economics/Social Studies

Objective:

1. To discover the variety of invertebrates used for food by recording the names, prices, and packing origin of invertebrates in the local supermarket.

Activities:

1. Many types of invertebrates are a source of food for humans. Several examples can be discovered by students while shopping with an adult. Look in the canned, frozen and fresh food sections of your local supermarket. Mollusks (snails, clams, mussels, oysters) and crustaceans (crabs, lobsters, shrimp) should be easily located.

2. Ask students to make a table of prices for each item and the cities and countries where the seafood was packed. As a class, locate the cities and countries of origin for these products.

Science

Objectives:

1.To familiarize students with the names of several different kinds of marine invertebrates.

2. To familiarize students with the many varied forms of marine invertebrate life.

3. To identify a variety of mollusks.

4. To familiarize students with the life histories and characteristics of selected invertebrate groups.

Activities:

1. Ask students to complete the word search activity located in this chapter.

2. Obtain a variety of snail and bivalve shells (teacher's collection, student collections, or order from a biological supply company) and set them out on a table or counter. Students may use this as an independent learning station to identify specific shells.

3. Ask students to compile a list of the shells that they are able to identify.

4. Post the Gray's Reef invertebrate poster in the classroom to use as a reference.

5. Divide the class into small groups and ask each group to report on an invertebrate phylum (mollusks, crustaceans, sponges, echinoderms).

6. Obtain a copy of any or all of the following National Geographic audio-visuals and use their teacher's guides for activities and questions.

Invertebrate (#30296, filmstrip)
Coral Reef (#51041, video)
Sealife:
(1) Shell Builders
(2) The Octopus (#03733, filmstrip)

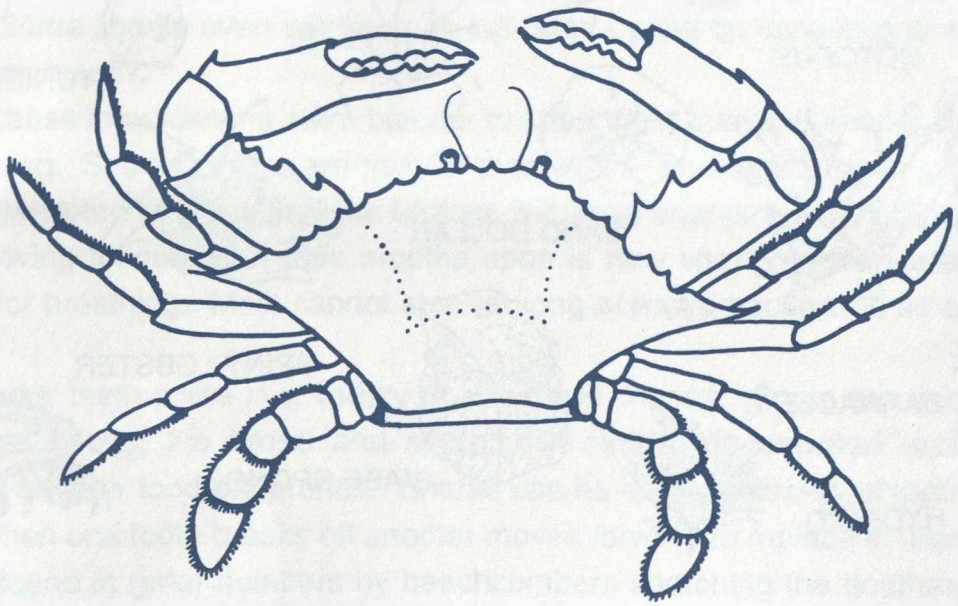
Art

Objective:

1. To have the students create an illustration representing the diverse assemblage of marine invertebrates.

Activity:

1. Ask the students to collect pictures of marine invertebrates from magazines and assemble a collage. This can be assigned on an individual or small group basis, or it can be used as a project for the entire class depending on the available resources.



Invertebrate Word Search

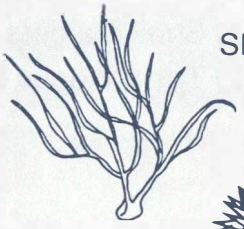
AT THE REEF

These invertebrates live at the reef.
Find their names in this hidden word puzzle.
The words may appear vertically, horizontally, and diagonally.

S	E	A	C	U	C	U	M	B	E	R	P	T
H	E	H	S	A	N	D	D	O	L	L	A	R
E	D	A	R	Z	O	Y	K	C	K	U	R	V
R	A	N	W	O	Z	X	O	T	Y	F	R	A
M	W	E	P	H	Y	D	R	O	I	D	O	S
I	O	M	E	T	I	P	Z	P	R	J	W	E
T	D	O	R	P	U	P	X	U	O	K	C	S
C	S	N	A	F	A	Z	V	S	I	Z	R	P
R	Q	E	S	E	A	F	A	N	J	W	A	O
A	U	Z	C	J	U	R	C	H	I	N	B	N
B	I	T	U	N	I	C	A	T	E	I	L	G
G	D	D	M	O	O	N	S	N	A	I	L	E
E	E	B	A	R	N	A	C	L	E	C	T	Z
S	S	P	I	N	Y	L	O	B	S	T	E	R

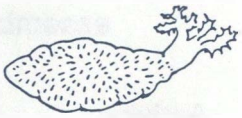
SQUID

MOON SNAIL



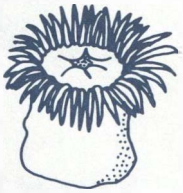
SEA WHIP

URCHIN

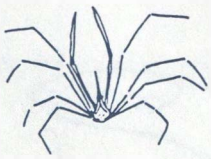


SEA CUCUMBER

ANEMONE

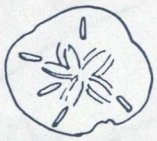


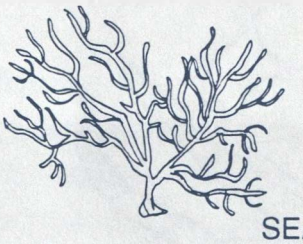
ARROW CRAB



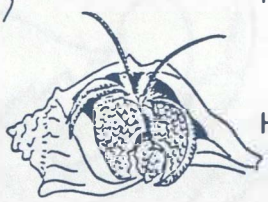
OCTOPUS

TUNICATE





SAND DOLLAR

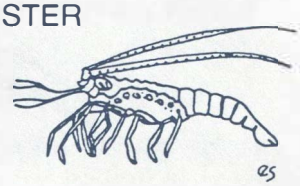


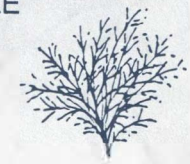
HERMIT CRAB

SEA FAN

SPINY LOBSTER

BARNACLE





VASE SPONGE

HYDROID

SHARKS

By Jay R. Calkins

Sharks are a fascinating group of fishes that strike fear into the minds of humans. This fear is really a fear of the unknown, for little evidence exists that indicates sharks are really very dangerous. Sharks have much more to fear from humans than humans have to fear from sharks. Each year thousands of tons of sharks are killed by fishermen for food and other products while very few humans are ever bitten, and fewer still die from shark bites.

Sharks belong to the class *Chondrichthyes*, a group which also includes rays, skates and chimeras. Unlike other vertebrates, sharks have a skeleton made of cartilage rather than bone. Only about 800 species of cartilaginous fish are known to exist compared to over 20,000 known species of bony fishes.

Sharks differ from the more common bony fishes in several ways. Besides having no bones, sharks and their relatives do not have the overlapping scales that cover many bony fish. Nor do they have a swim bladder, the air-filled balloon-like organ that keeps most fish upright. Sharks have gill slits but no gill-cover, which is common to the bony fish.

Sharks vary greatly in size from the enormous 40-foot-long whale shark to tiny two-to three foot dogfish and angel sharks. Despite its huge size, the whale shark is not an active predator. It feeds rather passively by swimming with its mouth open to collect plankton and small fish.

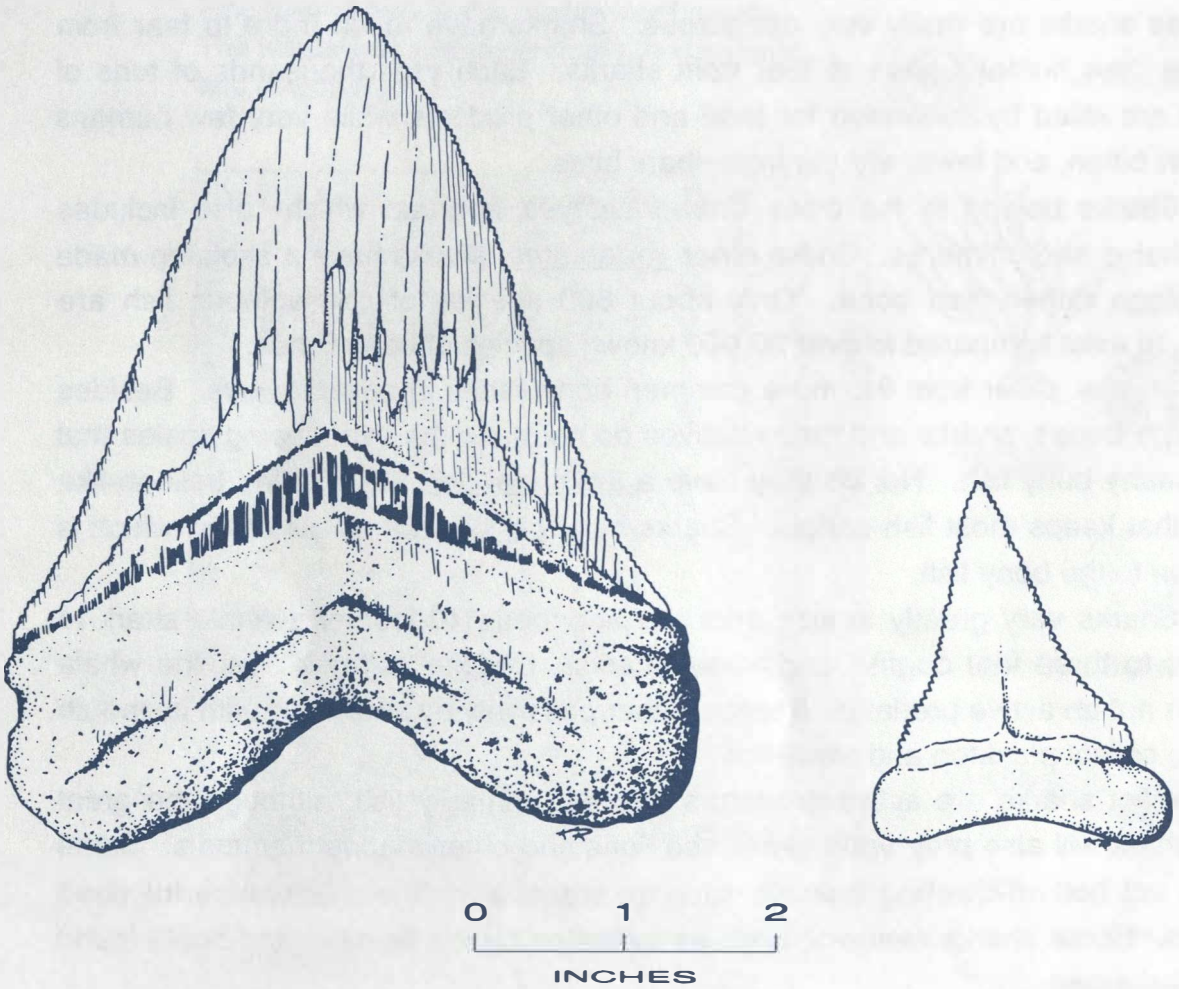
Most sharks are active predators and eat primarily fish, although the great white shark will also prey upon seals, sea lions and other marine mammals. Some sharks eat bottom-dwelling animals such as crabs, and others scavenge for dead animals. Some sharks even eat trash as indicated by the tin cans and boots found in sharks' stomachs.

Because they have no swim bladder to keep them buoyant, sharks sink when not swimming. Sharks' bodies are heavier than water. The nurse shark, skates and rays have adapted to resting on the bottom, but most sharks are constantly on the move. Moving forward with their mouths open is how sharks move water across their gills for breathing. Most cannot stop for long or move backwards as can bony fishes.

Sharks' teeth come in a variety of sizes and shapes. Some are narrow and pointed and others are broad and sharp; still others are serrated and jagged depending on their food preference. Sharks can have several rows of teeth in their mouth. When one tooth breaks off another moves forward to replace it. Fossil teeth are often found in great numbers by beachcombers searching the southeast coast

of the United States. Great collections of teeth are also found along Gulf of Mexico beaches.

Examples of Sharks' Teeth



Tooth From Extinct Giant White Shark *Carcharodon megalodon* (33 Feet)

Tooth From Modern Great White Shark *Carcharodon carcharias* (17 Feet)

Sharks are well adapted to their watery environment. They have good eyesight and the ability to see colors. Their eyelid closes from the bottom of the eye. Even when the water is not clear, or when it is dark, sharks can easily locate their prey. They have an excellent sense of smell and can smell the odor of their prey from over one-quarter of a mile away.

Even better than its sense of smell is a shark's ability to detect the vibrations of other animals in the surrounding water. These vibrations are picked up by the

lateral line, a row of sensitive fluid-filled sacks extending from the head to the tail of a fish. Even in the dark, a shark can sense the movement of prey or enemies through its lateral line.

Through pores in their skin, sharks also can detect the weak electrical charges produced by other animals. This sense allows them to find prey in the dark or buried in the sand .

Most sharks do not lay eggs for external fertilization as do most fish. Sharks practice internal fertilization more resembling the habits of mammals. Many sharks also bear their young alive, fully developed, and few in number. Because sharks produce so few young with each mating, fishermen and other predators can quickly reduce a population of sharks.

Some sharks do lay fertilized eggs, which are sometimes found on the beach. These eggs are commonly called "mermaids' purses." In southern waters of the United States most "mermaids' purses" come from skates.

Most sharks are high on the ocean's food chain. They typically eat thousands of smaller fish during the course of their lives. As predators, they conserve energy by eating the slow, weak or sick fish in a school. They are, therefore, important to the ecological balance of the marine environment in that they eliminate the genetically weaker animals in a population.

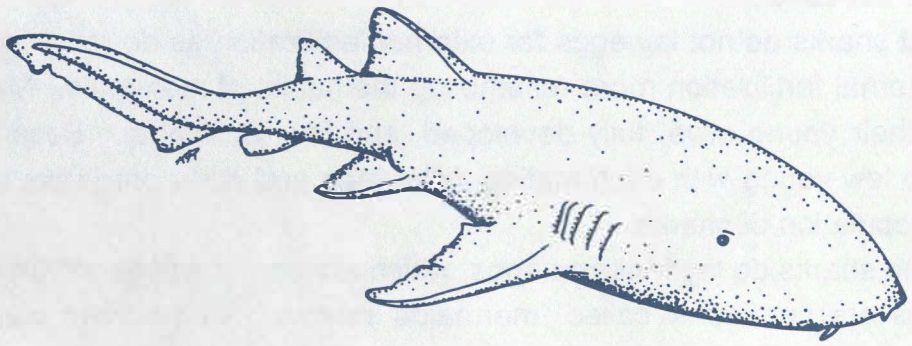
The role of sharks in the marine environment is similar to the role of the great cats (lions, tigers and cougars) in terrestrial environments. Cats eliminate the weak or slow animals in a herd of wildebeests or deer in the same way as sharks eat the slower fish in a school of mackerel or herring.

Sharks provide many products that are utilized by humans. The flesh of sharks is excellent food, although Americans have not traditionally considered shark meat as a favorite food. An enormous shark fishery does exist in the United States for export to other countries. Sharks are often caught only for their fins which are used in shark-fin soup, an Asian delicacy. The livers of sharks are rich in oil, which is used for its vitamin A content and as a lubricant. The skin of sharks is used as leather and as fine sandpaper, called shagreen.

In general, sharks are much maligned. They are considered dangerous, wanton killers by many people. Their job is to live by eating, breathing and reproducing like other animals on this planet. Sharks evolved millions of years before humans. They eat fish and other marine animals, which exist in their environment. People are not part of a shark's normal diet. Most "shark attacks" are accidental, a case of mistaken identity. Perhaps a dozen of the 300+ species of sharks have been implicated in killing humans.

Twenty families of sharks have been described in the waters off North America. The following section briefly describes the five species found around Gray's Reef National Marine Sanctuary.

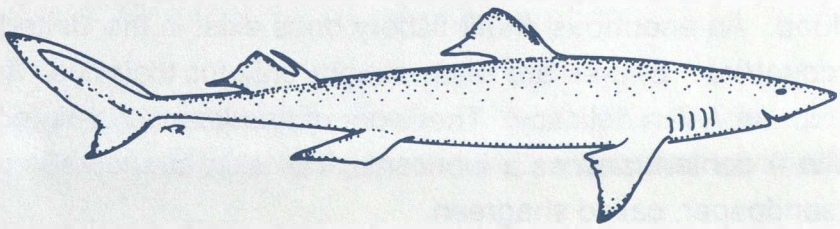
The Nurse Shark



The nurse shark is a relatively slow, sluggish shark often seen resting on the bottom. These sharks feed on benthic (bottom-dwelling) animals such as crabs and shrimp. They can be recognized by the barbels (fleshy appendages) that hang below their nose. Barbels are sensory organs, which help the nurse shark locate food on the bottom.

Nurse sharks reach an average length of 6' to 10' and an average weight of 300 pounds. They are considered dangerous to humans only if aggravated.

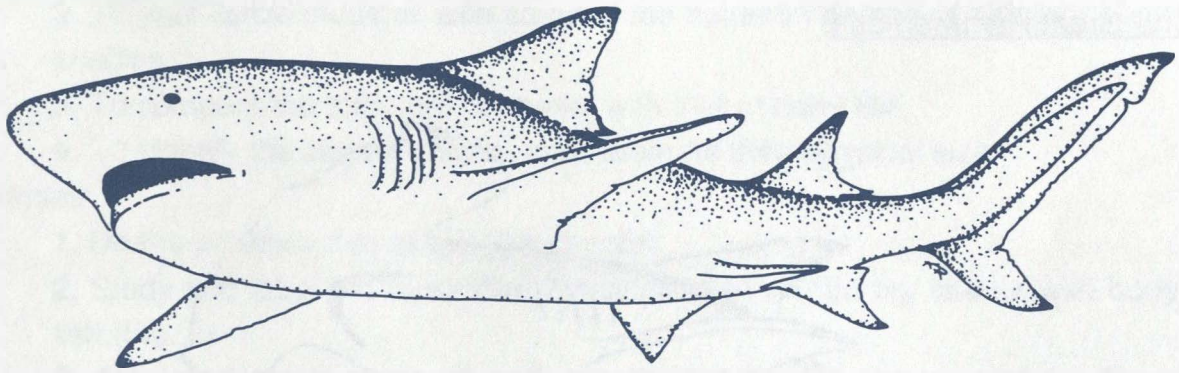
The Spiny Dogfish



The spiny dogfish is the most abundant and best known of the sharks found on the east coast of the United States. This small shark is frequently found travelling in large schools. Recognized by its two dorsal fins, each with spines, the spiny dogfish is a favorite shark for laboratory dissections. Its flesh is eaten by people and often used for cat and dog food. These sharks eat many kinds of small fish and also invertebrates such as squid and octopus.

The spiny dogfish only grows to around 3' to 4' in length. Males take eleven years to mature and females between eighteen and twenty-one years to mature. The gestation period of the spiny dogfish is the longest of any vertebrate animal. It takes from 20 to 24 months from fertilization until young spiny dogfish are born.

The Lemon Shark

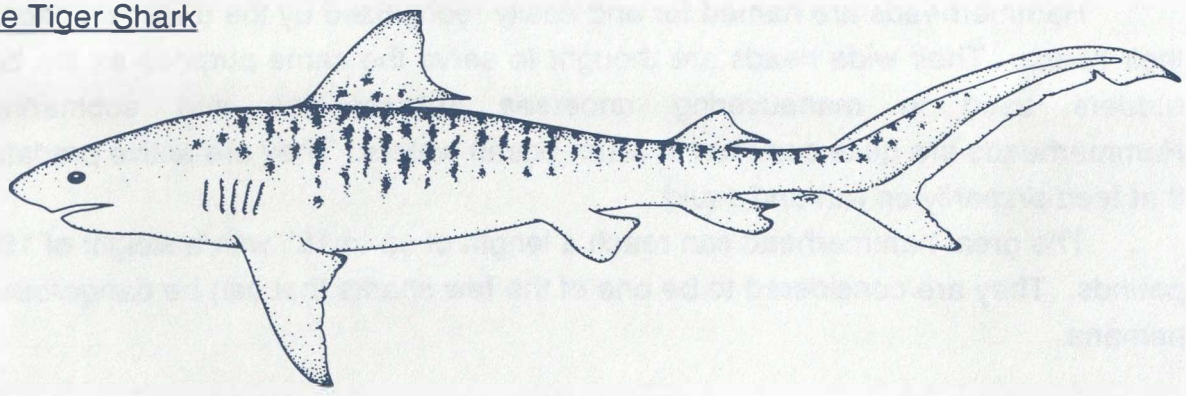


The Lemon shark belongs to one of the largest families of sharks -- the requiem sharks. This family includes many of the better known sharks including the tiger shark, the blacktip shark, the bull shark, sandbar shark and blue shark. It is interesting that a requiem is a hymn or mass for the dead. Several of these sharks are reported to be responsible for "shark attacks."

The yellowish color on its sides gives the lemon shark its name. It is a common shark along the southeast coast of the United States. It eats mainly bony fish but will also eat shrimp, crabs and other small sharks.

Lemon sharks grow 6' to 8' in length with a weight exceeding 200 pounds.

The Tiger Shark

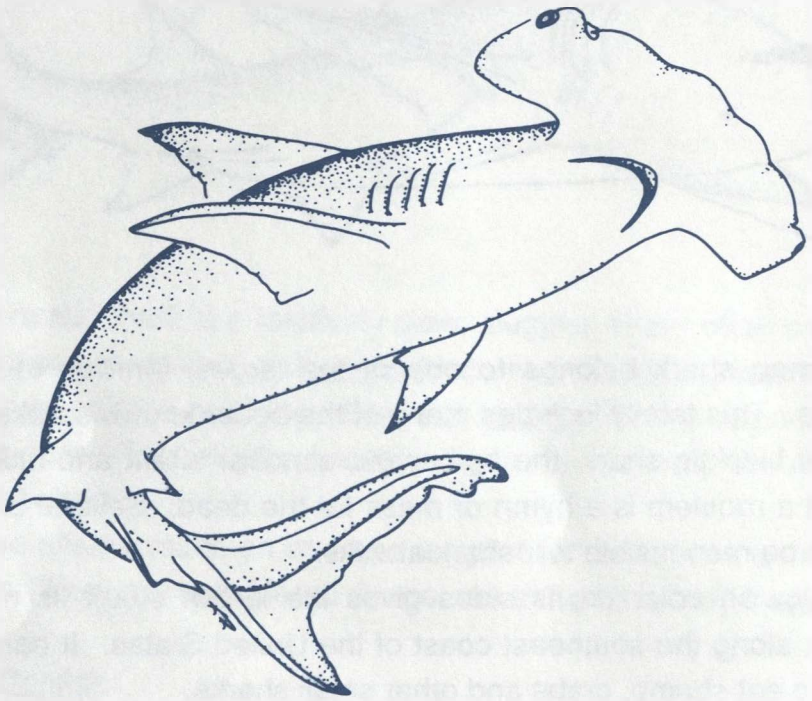


The tiger shark is one of the largest sharks in the ocean. The tiger gets its name from the vertical black stripes that commonly appear on its sides. Tiger sharks

will eat almost anything including conchs, skates, fish, sea turtles, birds, horseshoe crabs, and even human garbage.

This shark also is a requiem shark and may be responsible for human casualties. Tiger sharks are caught as a gamefish and can weigh as much as 2,000 pounds.

The Great Hammerhead



Hammerheads are named for and easily recognized by the unusual shape of their heads. Their wide heads are thought to serve the same purpose as the bow rudders used in maneuvering undersea submersibles and submarines. Hammerheads are quite common in warm ocean waters. They are active predators that feed primarily on fish and squid.

The great hammerhead can reach a length of up to 18', with a weight of 1500 pounds. They are considered to be one of the few sharks that can be dangerous to humans.

Shark Activities

Science

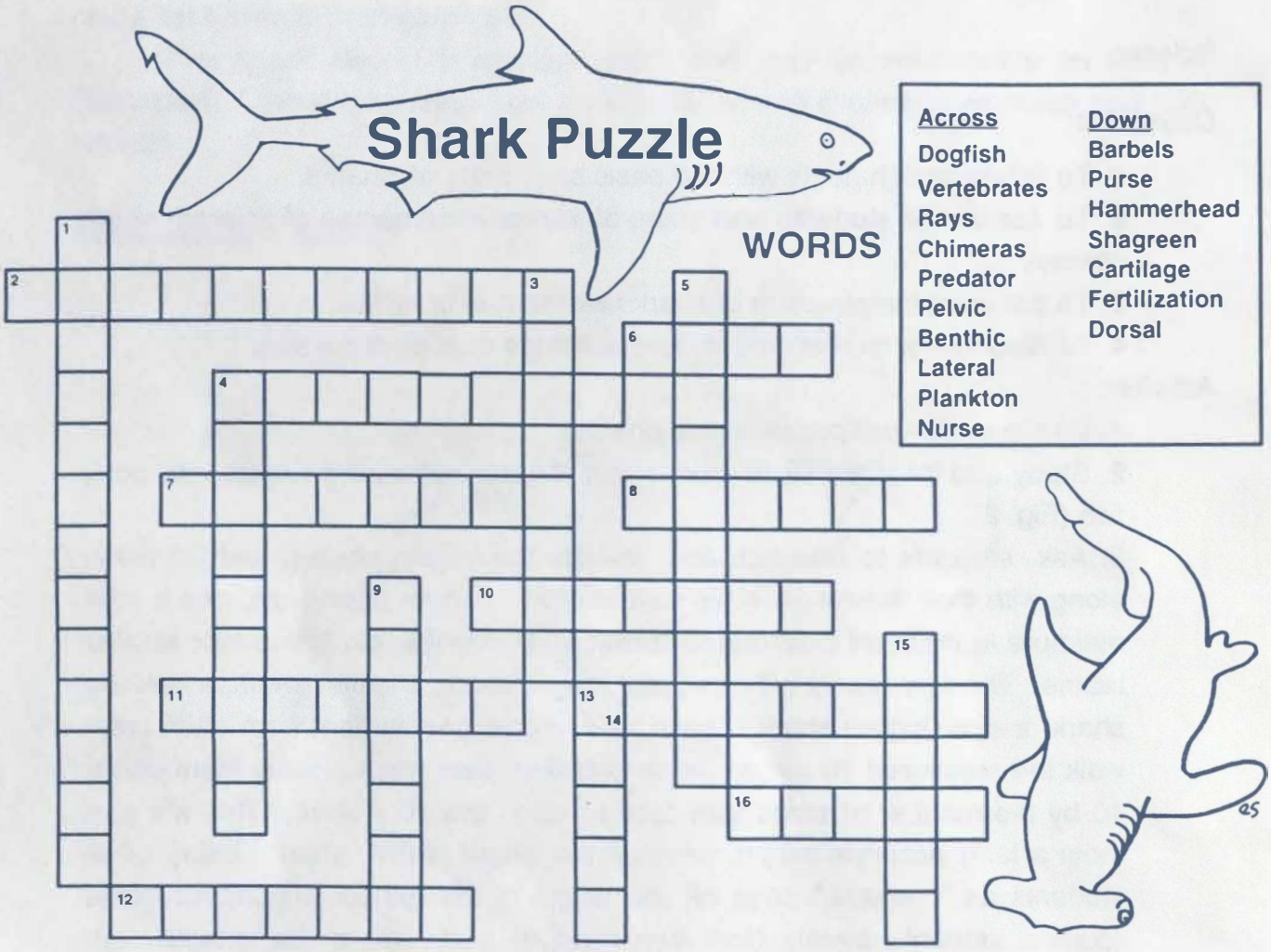
Objectives:

1. To familiarize students with the basic body parts of sharks.
2. To familiarize students with some of the common names of different shark species.
3. To compare the structure of sharks with that of bony fish.
4. To identify the largest sharks, and estimate their physical size.

Activities:

1. Do the crossword puzzle in this chapter.
2. Study and label the illustration in this chapter comparing sharks with bony fish (Fig. 2).
3. Ask students to research and identify the largest sharks, and list these along with their maximum sizes (use metric). In an open area, use a tape measure to mark off a 10-meter distance. Divide the class into four smaller teams. The four teams will represent a tiger shark, a lemon shark, a basking shark, and a dogfish shark respectively. Have one student from each team walk the measured 10 meters while counting their steps. Have them divide 10 by the number of steps they took to walk the 10 meters. This will give them a fairly accurate way to pace off the length of their shark. Using other students as "markers," pace off the length of the (particular) shark's body, spacing students evenly from beginning to end. Have the groups start parallel to one another to compare the actual sizes when they finish.

Shark Crossword Puzzle



Shark Puzzle Clues

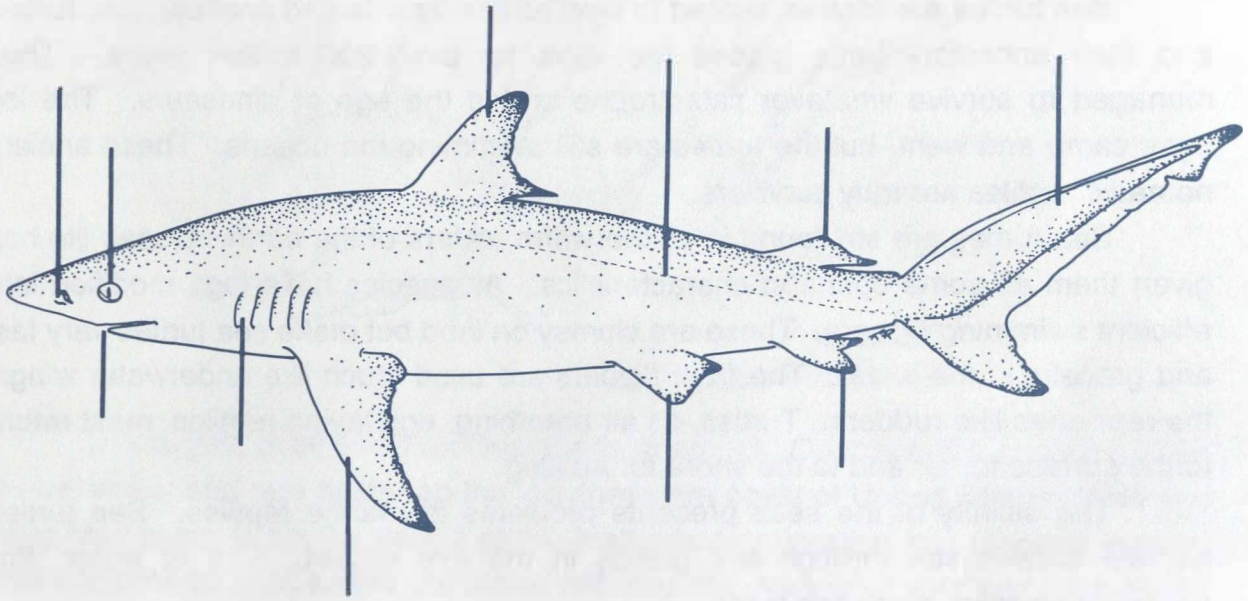
Down

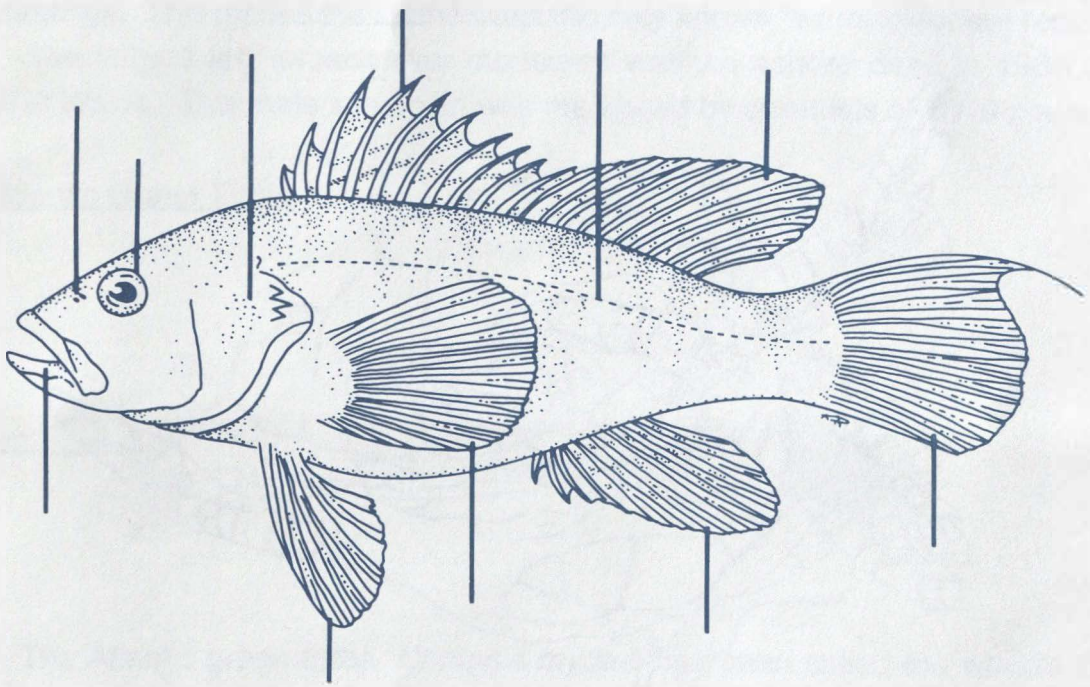
1. Combing male and female to make young.
3. Fine sandpaper made from shark skin.
4. Material in the skeletons of sharks.
5. Shark with an odd-shaped head.
9. Fleshy sensory appendages around fishes mouths.
13. The egg case of a skate.
15. The upper surface of animals.

Across

2. Animals with backbones
4. A relative of sharks, rays, and skates.
6. Shark relative that is flattened for bottom dwelling.
7. An animal that kills prey for food.
8. Fins found on sharks, modified for reproduction.
10. General community of animals that live on the ocean bottom.
11. A sensory line that runs down the side of fishes.
12. A small shark with spines on its dorsal fins.
14. Animals and plants at the mercy of the water's currents.
16. A sluggish shark with barbels under its mouth.

Comparative Anatomies of a Shark and a Bony Fish





SEA TURTLES

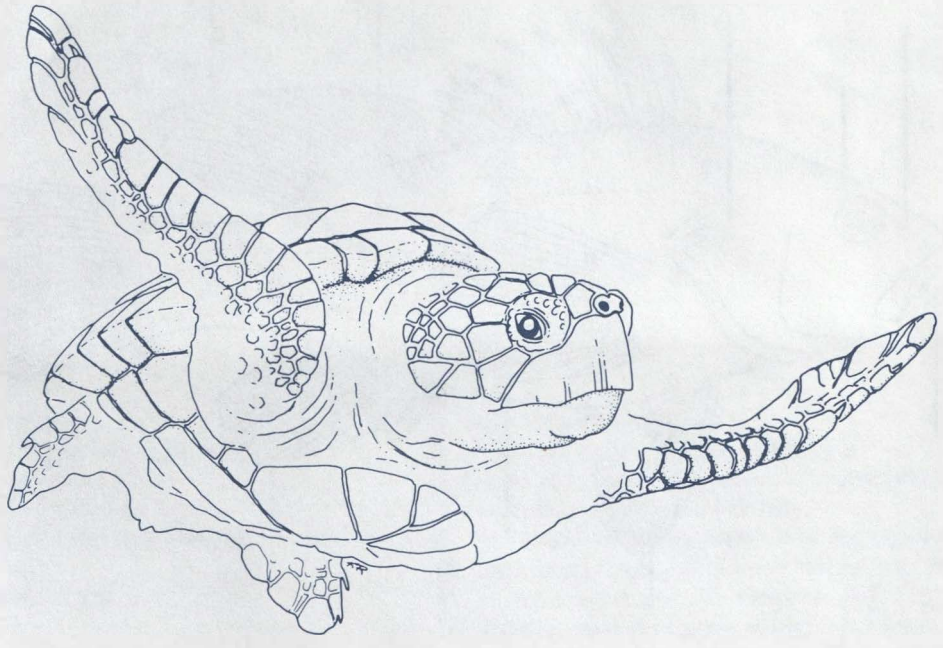
By John A. Crawford

Sea turtles are reptiles related to land turtles, lizards and snakes. Sea turtles and their ancestors have graced the seas for over 200 million years. They managed to survive whatever catastrophe ended the age of dinosaurs. The ice ages came and went, but the turtles are still swimming the oceans. These ancient nomadic reptiles are truly survivors.

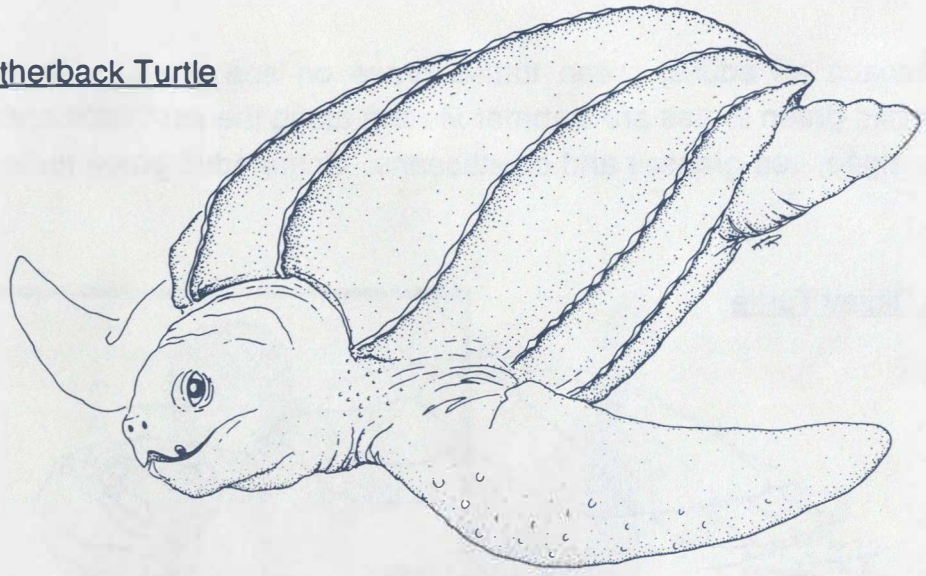
Sea turtles are still found in all the warm waters of the earth. Ocean life has given them all some common characteristics. All species have legs modified into efficient swimming flippers. These are clumsy on land but make sea turtles very fast and graceful in the water. The front flippers are used much like underwater wings, the rear ones like rudders. Turtles, as air breathing, egg laying reptiles, must return to the surface for air and to the shore for nesting.

The salinity of the seas presents problems to marine reptiles. Sea turtles excrete excess salt through salt glands in the eye socket. Out of water, this secretion appears much like tears.

The five species of sea turtles are found along the eastern and gulf coasts of North America are: the leatherback, green turtle, hawksbill, Kemp's ridley and loggerhead.



The Leatherback Turtle

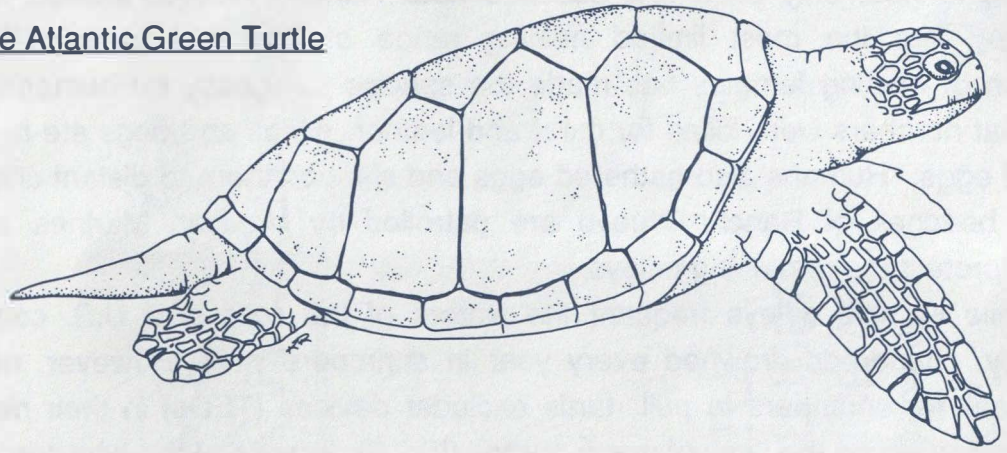


The largest of all living reptiles, the leatherback, *Dermochelys coriacea*, is an annual visitor and rare nester on the southeastern coast of United States. April and early May seem to be the period of the leatherback migration into Georgia waters. This concentration of turtles coincides with the occurrence of vast numbers of the cannonball jellyfish. The diet of these huge turtles is made up almost entirely of jellyfish.

Interestingly, the body temperature of this reptile is warmer than its surroundings. This makes the leatherback the only known "warm blooded" reptile.

The largest leatherback ever measured washed ashore dead in 1988 on a beach in Wales. This male specimen was measured by scientists at 2019 pounds.

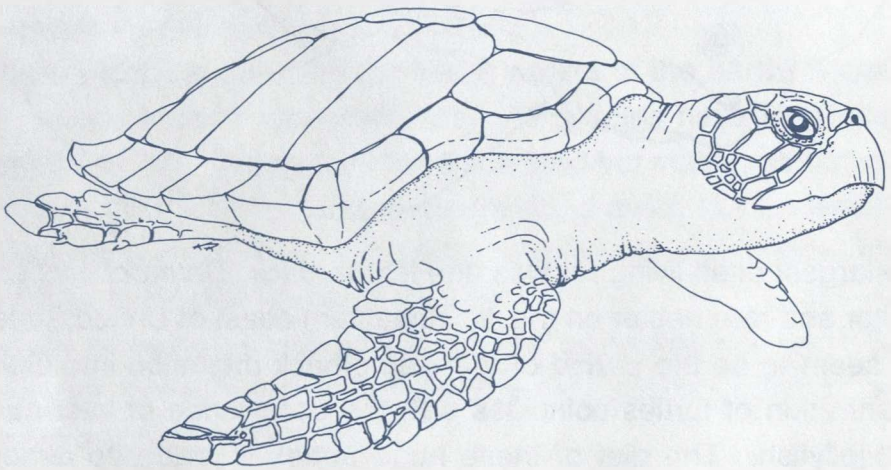
The Atlantic Green Turtle



The Atlantic green turtle, *Chelonia mydas*, has been called the world's most valuable reptile. This refers to its history as a food source. Unfortunately, millions of these animals have ended up in the soup pot. The very name green turtle refers to its greenish fat which is used to make the famous green turtle soup.

Vegetarians as adults, green turtles graze on sea grass pastures of the tropics. Juvenile green turtles are summer visitors along the southeast coast where they feed on algae, sea grasses and crustaceans. Some adult green turtles nest in Florida.

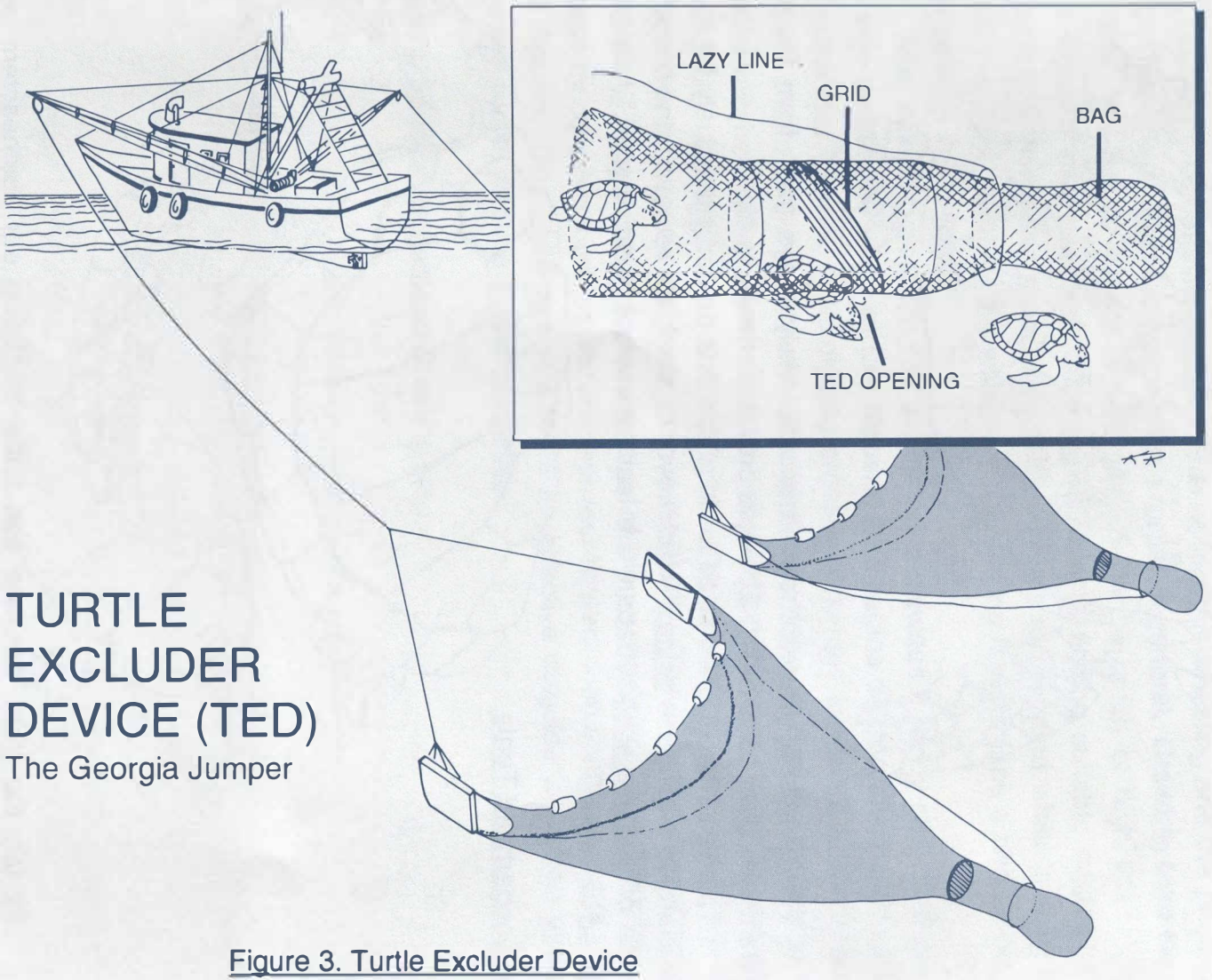
The Kemp's Ridley Turtle



The smallest of the sea turtles, the Kemp's ridley, *Lepidochelys kempi*, is also the most endangered. In the past 40 years, the mass nestings or arribadas of this turtle have dropped from tens of thousands of individuals to less than 400 females per year.

Known to nest only on a few beaches near Rancho Nuevo, Mexico, the Kemp's ridley has the most limited nesting range of any sea turtle. This concentration of nesting females has made the species very easy for humans to exploit. Great numbers were killed for meat and leather. Hogs and dogs ate huge quantities of eggs. Humans also gathered eggs and shipped them to distant cities. Today, the beaches of Rancho Nuevo are patrolled by Mexican Marines and scientists to protect the remaining ridleys.

Juvenile Kemp's ridleys frequent the waters of the southeast U.S. coast. Until recently, hundreds drowned every year in shrimpers' nets. However, new regulations call for shrimpers to pull turtle excluder devices (TEDs) in their nets, which have since saved the lives of many turtles (Fig. 3). In spite of the introduction of TEDs, many scientists fear that the Kemp's ridley is doomed to extinction.

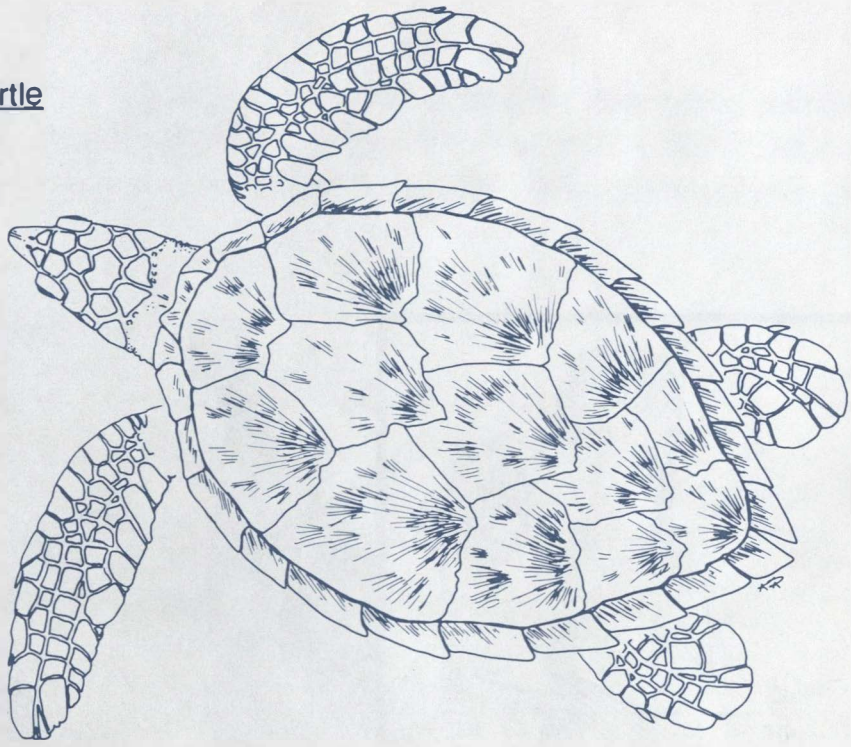


TURTLE EXCLUDER DEVICE (TED)

The Georgia Jumper

Figure 3. Turtle Excluder Device

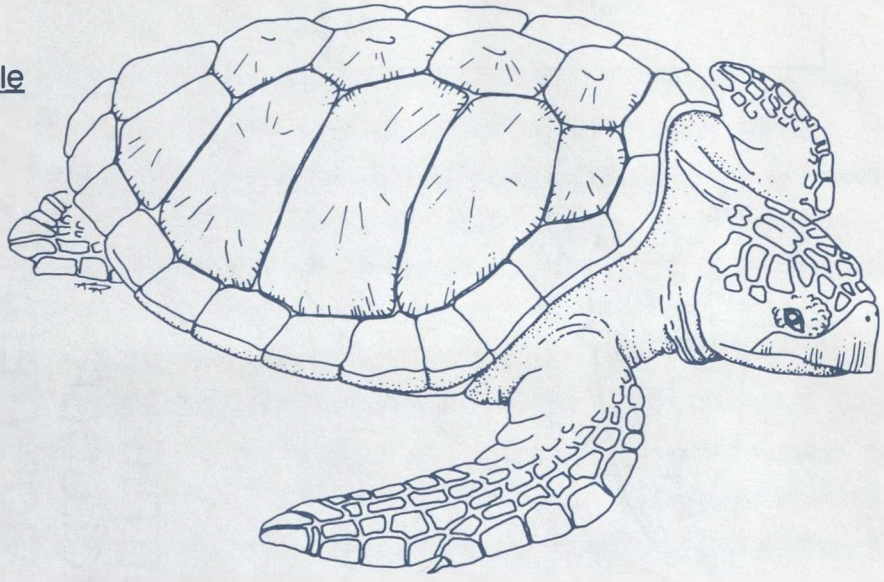
The Hawksbill Turtle



The hawksbill, *Eretmochelys imbricata*, rarely strays north from the tropics where it lives near coral reefs. Sponges provide some of its diet.

This turtle is not often killed for food, but it is hunted extensively for its shell. The marbled plastic-like scutes, which cover its shell, are removed and become the source of "tortoise shell." Japan, the leading user of "tortoise shell," has recently banned its import.

The Loggerhead Turtle



By far, the most common sea turtle inhabiting our southeastern coastal waters is the loggerhead, *Caretta caretta*. Thousands of nesting females crawl ashore each year on the beaches of Florida, Georgia, and the Carolinas.

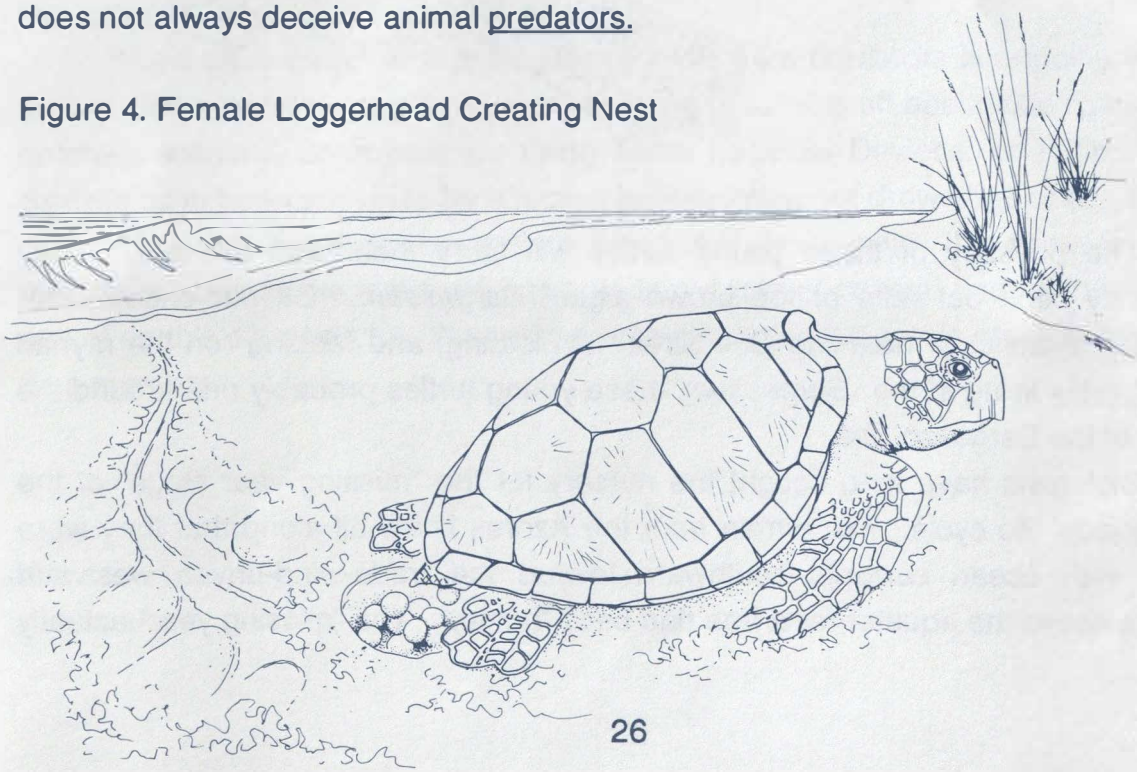
The loggerhead is primarily a carnivore. Its diet includes crabs, shrimp, whelks, conches, fish, clams, jellyfish, sea urchins and even sponges.

Probably reaching a maximum weight of over 600 lbs., the normal mature specimen is between 200 and 350 lbs. The largest shell size on record is 45 inches long.

Loggerhead behavior patterns such as nighttime nesting and the production of large numbers of eggs are typical of sea turtles in general. Crawling from the surf after dark, the female selects a nest site above the reach of high tides (Fig.4). Some females make several "false crawls" before finding suitable nesting sites. Loggerheads have been seen pushing their noses to the sand while looking for a nesting place. It is not known what they are looking for--perhaps a certain odor or moisture level in the sand.

After selecting her nest site the female excavates a "body pit." She creates this large depression using all four flippers, then begins digging alternately with her scoop-like rear flippers. This digging process continues for about 20 minutes and results in a light bulb-shaped hole 20 to 25 inches deep. When the mother turtle is satisfied with her nest cavity she places her rear flippers on each side of the narrow opening and lays eggs for about 20 minutes. The average number of eggs is about 120 but one nest under observation contained 198. The eggs have flexible shells and are the shape and approximate size of ping-pong balls. She completes the process by covering the nest first with her rear flippers then scattering sand with her front flippers. The nest appears to be an effective disguise to human eyes, but does not always deceive animal predators.

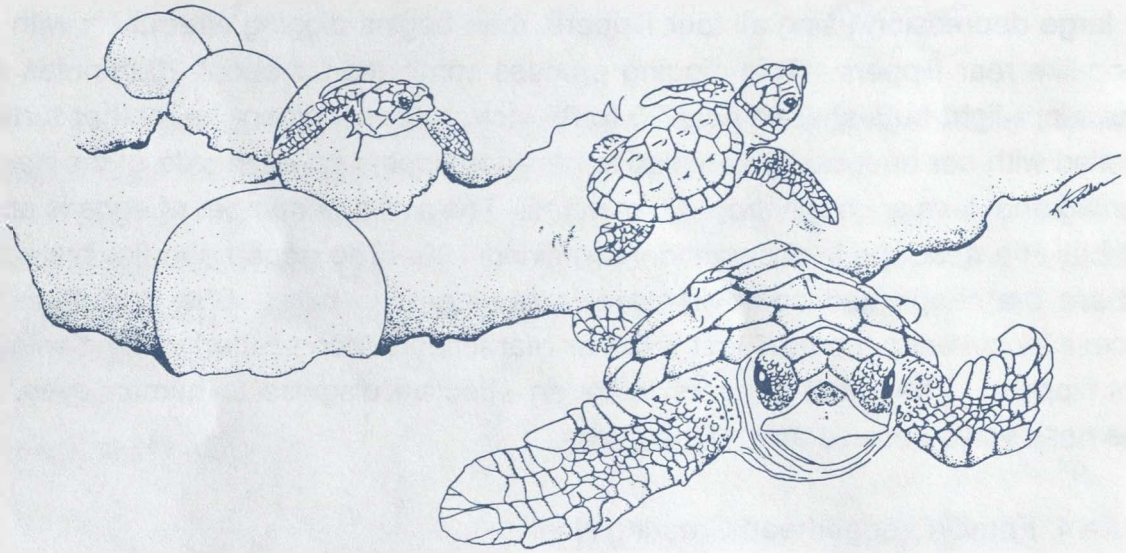
Figure 4. Female Loggerhead Creating Nest



Disguise and location alone do not insure a successful nest. Predators with a taste for turtle eggs include raccoons, ghost crabs, dogs, wild hogs and humans. Birds, commonly thought to be major predators, are little or no threat to the nest. Storm tides, rain and even plant roots can destroy the nest.

Eggs that survive in the nest take approximately two months to hatch. It takes several days of concerted effort for the hatchlings to dig through the sand covering the egg chamber (Fig.5). They almost always wait for the top layers of sand to cool before making their nighttime break for the sea. Emerging from the nest at night protects the hatchlings from most bird predators.

Figure 5. Hatchlings Emerging From Their Eggs



The odyssey of these young turtles will carry them well offshore. They apparently seek out rafts of the brown algae, *Sargassum*. Off our shores, that would put them in or near the Gulf Stream. Floating, and feeding on the myriad invertebrates living in the *Sargassum*, these young turtles probably ride around the fringes of the Sargasso Sea.

Biologists have long sought the nursery for the "missing year stage" of the loggerheads' life cycle. Fishermen from the Azores knew all along that they were drifting with ocean currents southward toward the trade-wind-driven westward currents above the equator for a free ride back "home." The "missing year" actually

seems to be three or four years. This is when we first see them again off our eastern seaboard.

Unfortunately, most of the juvenile sea turtles we see are dead, the victims of human activities and natural mortality. It takes many thousands of eggs to produce just one sexually mature adult.

If a young female loggerhead survives all the hazards of her early pelagic life, she returns to the waters off nesting beaches. It is thought that loggerheads reach sexual maturity after twenty years of age. The males never return to shore but gather with the mature females to mate.

Some scientists believe that loggerheads return to the beach of their birth for nesting, but this has never been proven. However, it is known that the Kemp's ridley does, due to the limited nesting sites of this species.

The nesting time for sea turtles is usually on a two-or three- year cycle. They may nest five or more times, on a thirteen day rotation, in one season. Individual turtles may return to the same region to make their nests, but we don't know if they return to the same nesting beaches.

Adult sea turtles have few natural enemies. Large sharks have been found with turtles and turtle parts in their stomachs, but man is the greatest enemy. The killing of adults and taking of eggs for food has all but stopped on our coast, but trawl fishing and habitat destruction take a great toll. Lights on beachfront buildings and parking lots have lured countless hatchlings to their deaths under the wheels of cars. Normally attracted to the brighter horizon of the open sea, the hatchling babies are confused by the artificial lighting.

Hope does exist. The protection of nests from predators is ongoing in many areas. Some coastal communities are shading or turning off beachside lights during hatching season. Shrimpers are using Turtle Excluder Devices, or TEDs. These devices have been shown to be effective in preventing net drownings of sea turtles.

Time will tell if these ancient creatures can survive the present age of mammals. Unless we make adjustments in our use of coastal and offshore areas, one of earth's oldest rituals, the nesting of these huge and gentle reptiles, may soon be a memory.

Turtle Activities

Science

Activities:

1. Have the students complete the turtle hatchling maze, which appears in this chapter.
2. Obtain a description of the "Turtle Hurdles" activity from Project Aquatic Wild, for the students to participate in. Write to Project Wild, P.O. Box 18060, Boulder, Colorado 80308. This is a fun outdoor activity.
3. Using information from the readings in this workbook, have the students estimate the total number of eggs laid by one female loggerhead during her lifetime. Take into account the average life span (50 years) minus the years before sexual maturity (20), the size of each clutch of eggs, the average number of nests per season, and the frequency of their reproductive cycle (biennial). Considering the number of eggs laid over a lifetime (more than 7,000), ask the students to account for why loggerheads (and other sea turtles) are considered to be an endangered species.

Geography

Objective:

1. To enable the students to identify and map the ranges of loggerhead nesting areas, and to locate the Sargasso Sea where the hatchlings spend the first few years of their lives.

Activity:

1. Using information from the readings, an atlas, and blank copies of maps of the Atlantic Ocean, have the students label the regions where loggerhead sea turtles are known to nest.
2. On the same map have students identify the region in the Atlantic Ocean known as the Sargasso Sea. Currents in the Atlantic Ocean carry young turtles born in Georgia all the way around the Sargasso Sea. Have students locate the British Isles, the Azores, the Canary Islands, Puerto Rico, Cuba and the Virgin Islands. Mark these islands on a map of the North Atlantic Ocean.

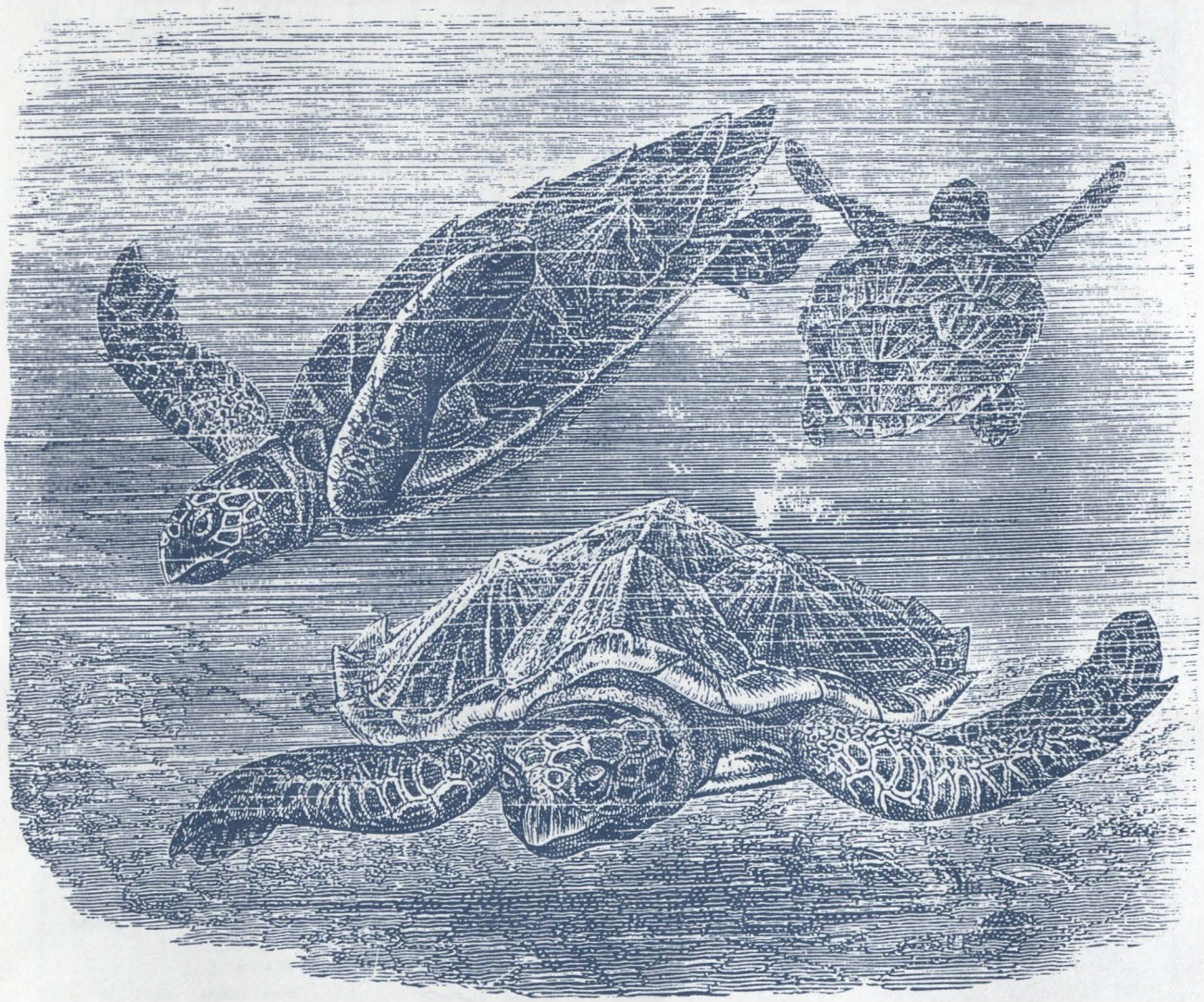
Math

Objective:

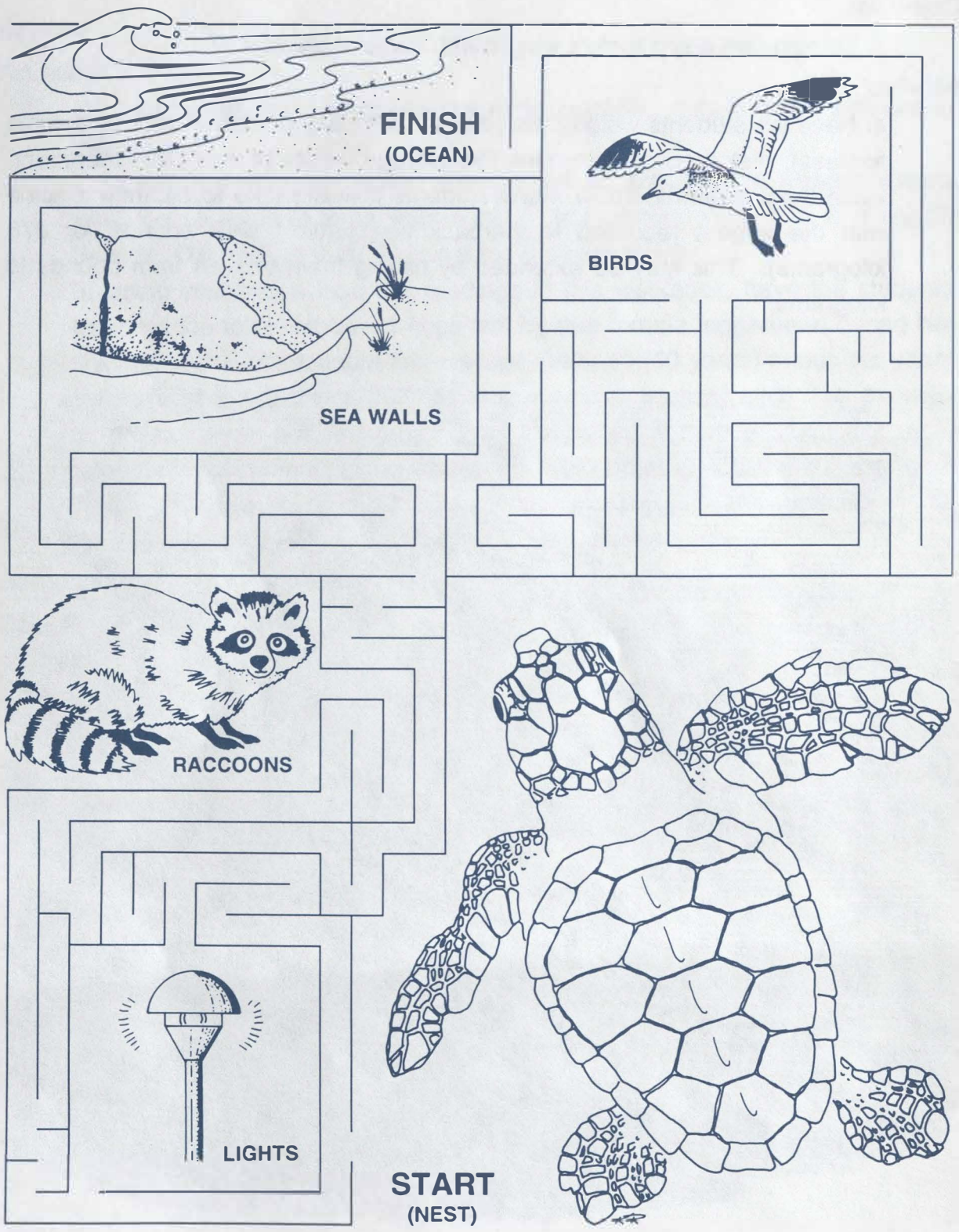
1. To compare a sea turtle's weight with that of a student.

Activity:

1. Have the students weigh themselves individually (at home or bring a scale to class). Ask them to determine the average weight of their class members. Have them determine how many students it would take to balance a scale with the largest recorded leatherback sea turtle (2,019 pounds, or 878 kilograms). This may be extended by having them convert from pounds to kilograms.



Turtle Maze



WHALES AND DOLPHINS

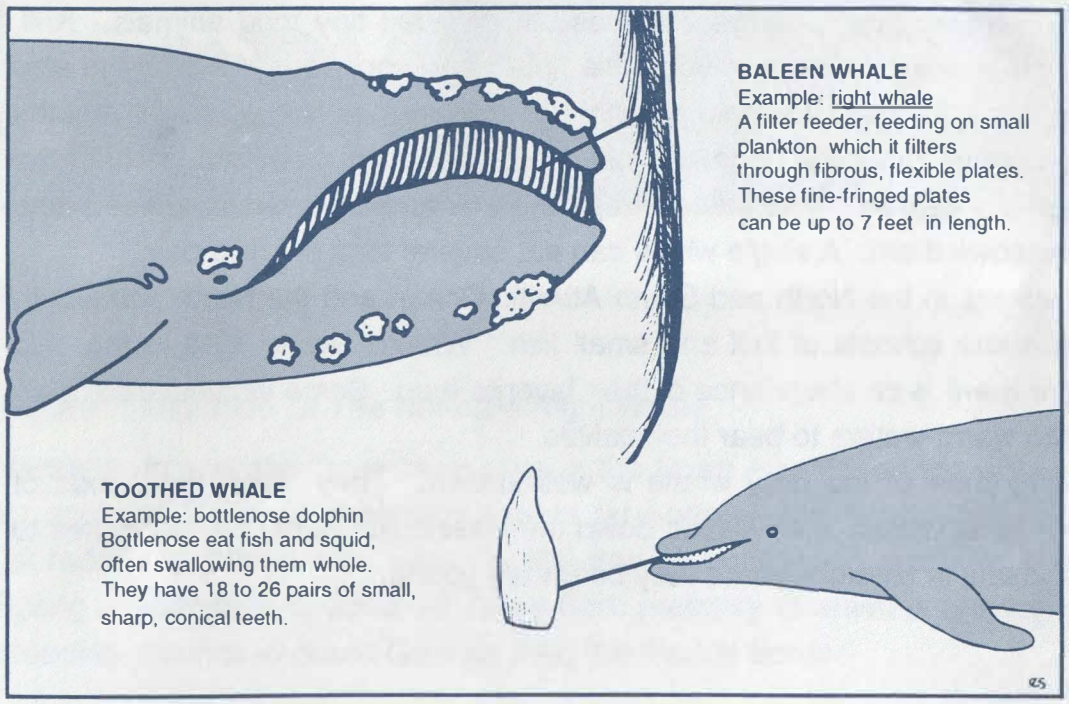
By Jay R. Calkins

Seventy-five species of whales, dolphins and porpoises in the ocean all belong to the order *Cetacea*. They are the only mammals, other than manatees, that live their entire lives in the water. Some whales are huge. The blue whale, for example, grows to 100 feet in length and over 200 tons in weight. It is the largest animal that has ever lived on earth. Some whales, such as the dolphins, grow only three feet long.

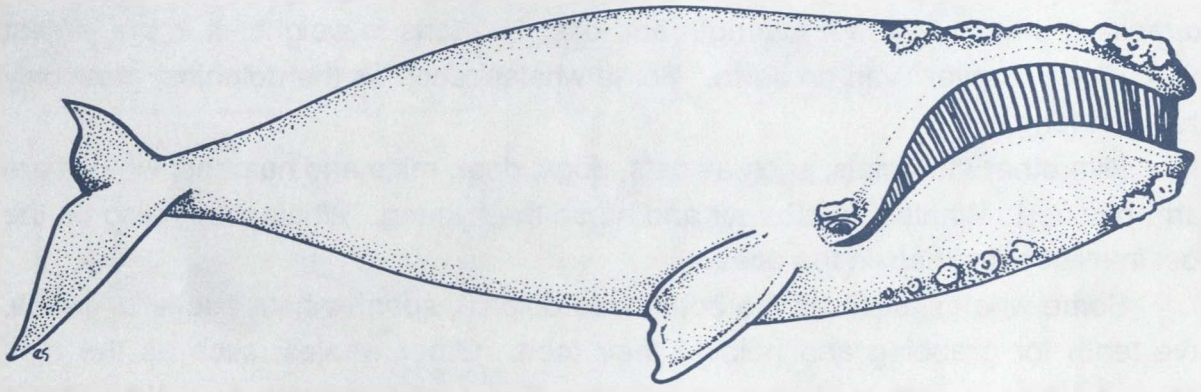
Like other mammals, such as cats, dogs, deer, mice and humans, whales are warm-blooded. Whales breathe air and nurse their young. Whales may also be the most intelligent animals in the ocean.

Some whales, such as the bottlenose dolphin, sperm whale and killer whale, have teeth for grabbing and holding their food. Other whales, such as the right whale and the blue whale, do not have teeth. These whales have rows of baleen in their mouths for catching food (Fig.6). Baleen has many bristles like a broom used to trap small animals in the whale's mouth. Baleen whales eat mostly shrimp-like animals called krill, copepods, and small fish. Toothed whales catch larger prey including fish, squid and octopi. Killer whales even eat other large mammals such as seals and sea lions.

Figure 6. Differences Between Toothed and Baleen Whales



BALEEN WHALES



The Right Whale

Examples of baleen whales are the right whale, blue whale, humpback whale, fin whale, and gray whale. These gentle giants were nearly hunted to extinction for meat and oil. The bones, too, were prized for carving decorative items, and the baleen was used for garment stays.

Baleen whales are the largest whales but they eat tiny food animals. Krill, related to shrimp, are smaller than your little finger and copepods are only the size of a grain of rice. Whales swim into a school of krill or small fish with their mouths open. They take in hundreds of gallons of water, close their mouths and squirt the water through the baleen. The baleen traps the krill and other small animals and the whale swallows them. A single whale can eat several tons of krill a day.

Cold waters in the North and South Atlantic Ocean and the North and South Pacific have many schools of krill and small fish. Whales like to feed in the cold oceans where there is an abundance of their favorite food. Some whales are known to migrate into warm waters to bear their calves.

The migration of the gray whale is well known. They travel thousands of miles in the Pacific Ocean from Alaska down the west coast of the United States to the Baja Peninsula in Mexico, where they bear their young.

RIGHT WHALE

The right whale also migrates from cool waters to warm waters (Fig.7). In the summer, right whales are found in the Gulf of Maine and Bay of Fundy. In the winter, right whales are found with calves near the Georgia and Florida coasts.

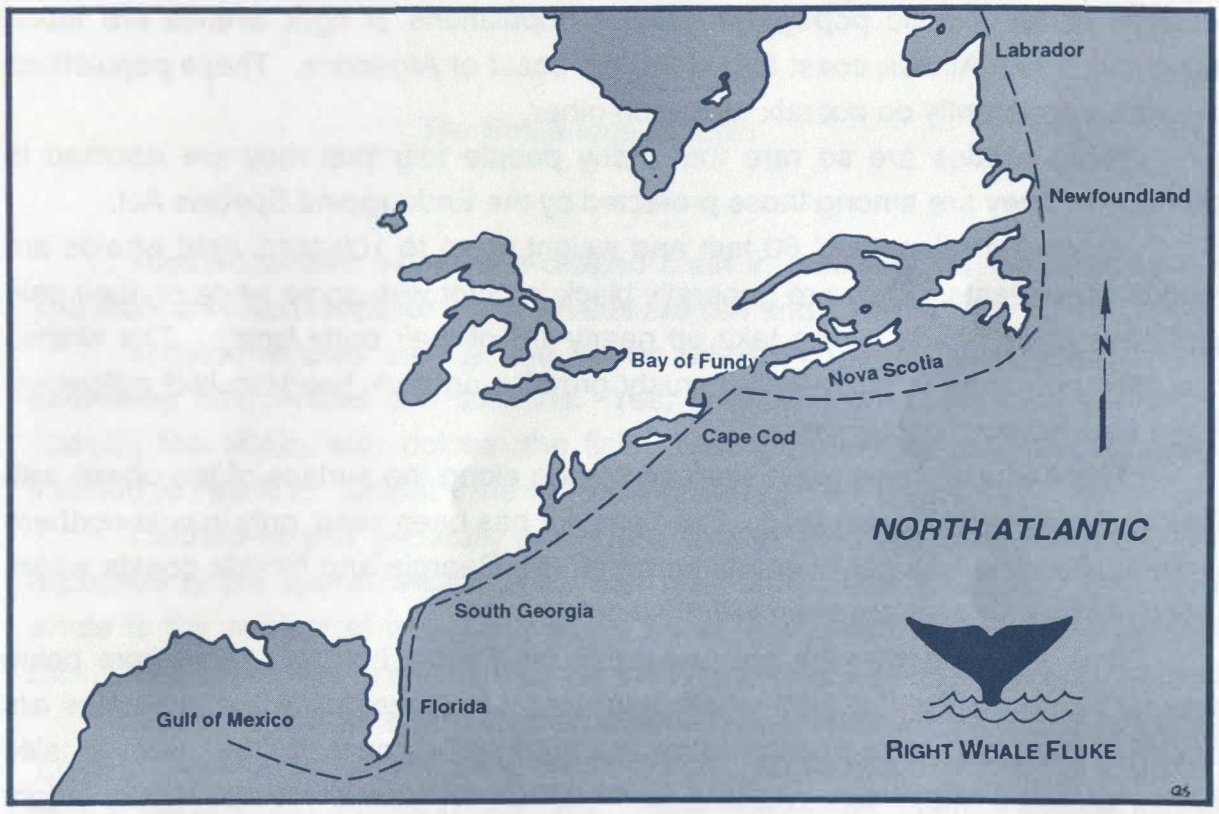


Figure 7. Migration Of The Northern Right Whale

Northern right whales have been seen in the North Atlantic, on the western side, as far south as the Gulf of Mexico and as far north as the Newfoundland coast and Labrador. Sightings also occur in the Bay of Fundy and southern Nova Scotia. Spring concentrations occur off Cape Cod, probably of animals moving north from breeding grounds in South Georgia near the Florida border.

Right whales are the only large baleen whales regularly seen along the southeastern coast of the United States. They have been adopted as the official marine mammal for the State of Georgia. The right whale was heavily hunted by commercial whalers until the 1950s. The right whale got its name because it was the "right" whale to kill. It was a slow swimmer, produced large amounts of oil and baleen, and it floated after it was harpooned. These characteristics made the right whale a favorite target for whalers.

Scientists estimate that between 200 to 300 right whales may be left in the western North Atlantic population. Other populations of right whales are found along the South African coast and along the coast of Argentina. These populations of whales apparently do not mix with each other.

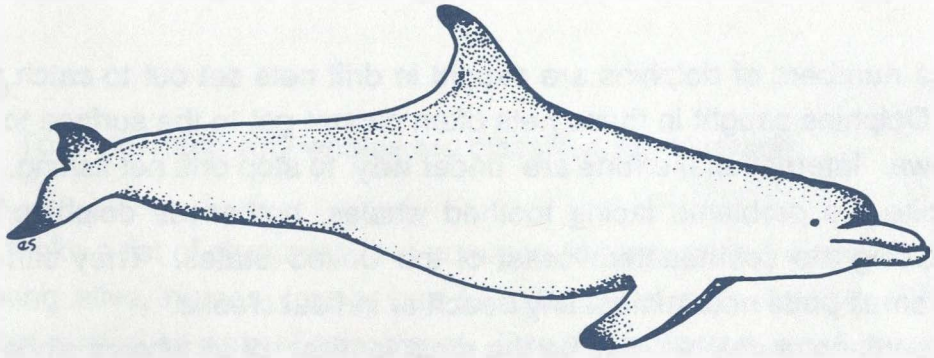
Right whales are so rare that many people fear that they are doomed to extinction. They are among those protected by the Endangered Species Act.

Achieving a length of 60 feet and weight of up to 100 tons, right whales are magnificent beasts. They are generally black in color with some white on their chin and have large heads, which take up nearly 1/3 of their body length. The whales can also be recognized by white, crusty growths on their heads called callosities. They also have no dorsal fin.

Right whales have been seen swimming along the surface of the ocean with their mouths open to catch food. This behavior has been seen only in cold northern waters. Feeding has not been observed off the Georgia and Florida coasts where mostly female whales are seen with their calves.

It is a puzzle why the gray whale of the Pacific has recovered from being heavily hunted while the right whale has not. Laws protecting these whales are equally strong and have been enforced for an equal amount of time. Gray whales have increased from near extinction to 16,000 individuals since the 1950s. Right whale populations have not increased during the same time period. This leads scientists to believe that other environmental problems such as water pollution and collisions with and sounds from ships may affect the right whales more than the gray whale. One concern is that the right whale may disappear entirely before we can learn enough about it to help it recover.

TOOTHED WHALES



The Bottlenose Dolphin

Toothed whales have cone-shaped teeth in their mouths for catching food. The most common foods for these whales are fish and squid.

Toothed whales include the sperm whale, narwhal, pilot whale, beluga, porpoises, killer whales and dolphins. Yes, dolphins are whales! Do not confuse dolphin, the whale, with dolphin the fish. Dolphin, the fish, is a favorite dish in seafood restaurants. Dolphin, the whale, is not caught for food.

Toothed whales generally are much smaller than the baleen whales. One exception is the sperm whale, which can grow to 60 feet in length. The sperm whale is the subject of a whaling ship's quest in Herman Melville's novel "Moby Dick." The sperm whale can dive to a mile in depth and stay down an hour or more.

A notable feature of the toothed whales is a great rounded forehead called a "melon." The melon is used as a "second-sight" sense much like sonar is used by navy ships to locate objects underwater. Even blindfolded, toothed whales can find objects around them.

Some toothed whales are capable of great bursts of speed up to 30 miles per hour. Dolphins can jump over 15 feet out of the water. This is quite amazing considering they weigh 300 to 400 pounds. The sperm whale was seriously hunted, but most toothed whale populations were not as devastated by whalers as the baleen whale populations. Since most whaling ceased in the 1950s, sperm whale populations have increased in number.

Toothed whales have been found stranded on beaches, sometimes in large numbers. Whales travel in groups or "pods." Pilot whale pods have been known to follow a sick leader into shallow water where they often die. Dolphins have also

been found stranded in large numbers on the east coast of the United States. Some scientists blame diseases induced by human pollution for this stranding behavior.

Large numbers of dolphins are caught in drift nets set out to catch tuna and other fish. Dolphins caught in these nets often cannot get to the surface to breathe, so they drown. International efforts are under way to stop drift net fishing.

Despite the problems facing toothed whales, bottlenose dolphins are very numerous along the southeastern coast of the United States. They can be seen traveling in small pods near almost any beach or in tidal creeks.

The bottlenose dolphin may be the most familiar of all whales since they are common performers at large marine aquariums. Bottlenose dolphins were also filmed for the popular television show "Flipper."

Dolphins feed mostly on fish. They can be seen herding fish in teams much like cowboys herding cattle. Dolphin pods "talk" to each other with a large vocabulary of sounds including squeals and clicks. Some scientists are trying to learn the language of whales in order to understand their behavior better. Think what we could learn about the ocean if we could talk to a dolphin!

Dolphins and other whales usually have only one calf every other year. The calves are born tail-first and then quickly boosted to the surface by the mother for their first breath of air. Other females in a pod will often care for the newborn calf. Whale mothers nurse their calves underwater. Milk is forcibly squirted through the mother's nipples to feed the calf. Some whale calves will double their weight in only a week.

Whale populations that produce so few young in a season can be quickly brought to the brink of extinction by heavy hunting pressure. Conservation groups have convinced the International Whaling Commission to stop most whaling. Native American hunters, such as the Eskimos, who rely on whale meat and other wild game to feed their communities, are still allowed to hunt a limited number of whales. We must all work together to make sure that conservation measures continue to protect whales and keep these wonderful animals from disappearing forever.

Whales and Dolphins Activities

Science

Objective:

1. To understand why whales are classified as mammals.

Activities:

1. Make a list of characteristics common to mammals (warm-blooded, bears young alive, nurses young, has hair, breathes air). Lead a discussion on what makes an animal a mammal. Direct the class in small groups to list all the mammals they can name. Ask one member of each group to read their list as you write them on the board. Put the mammals in one list. If other animals are named, make a separate list (e.g. reptiles, fish, amphibians, invertebrates, birds are not mammals). Have your students collect pictures of all kinds of mammals and combine them into a collage.

2. Have the class make lists of all the animals they can name that are not mammals. Make a collection of pictures of animals that are not mammals including invertebrates (sponges, worms, snails, insects, crabs, starfishes) and members of the other vertebrates (fish, amphibians, reptiles, birds). Ask the class to organize these pictures into groups showing the greatest similarities.

Discussion Questions:

A. How are fish similar to whales? How are they different?

B. How are whales similar to humans? How are they different?

3. Ask students to study and label the illustration in this chapter comparing toothed and baleen whales (Fig.8).

Math

Objective:

1. To measure people and whales and develop the concept of proportions.

Activities:

1. In small groups direct your students to use rulers, or meter sticks to measure their height and the length of their walking pace. On the playground have each team estimate the length of a 60-foot right whale by pacing off the distance. Next, have them compare their estimates to a true measurement using their rulers or a tape measure.

2. Have each team outline a team member with chalk on the playground. Using a picture of a right whale as a guide, ask each team draw a full-size outline of a right whale superimposed on the drawing of a person. Challenge the team to estimate how many students it would take lying head to foot to match the length of the whale. Test their estimates with real measurements. Approximately how many times longer is the whale than a student?

$$\frac{\text{Whale Length}}{\text{Human Length}} = \underline{\qquad} \text{ times longer.}$$

Geography

Objective:

1. To locate geographical landmarks along the migration route of the right whale.

Activities:

1. On a map of North America (or a globe), locate the following places: Newfoundland, Canada; Nova Scotia, Canada; the Gulf of Maine; Cape Cod, Massachusetts; Cape Hatteras, North Carolina and Cape Canaveral, Florida. Ask individual students to mark the location of each of these places in the United States and Canada on a blank map of North America.

2. Locate on a map ten large cities of the east coast of the United States which might have large ports with shipping activities. Mark these cities on your blank maps. An almanac will help students discover how active each coastal state is in ocean transport. Ask students to write a short story of a whale migrating from Nova Scotia to Florida.

Discussion Questions:

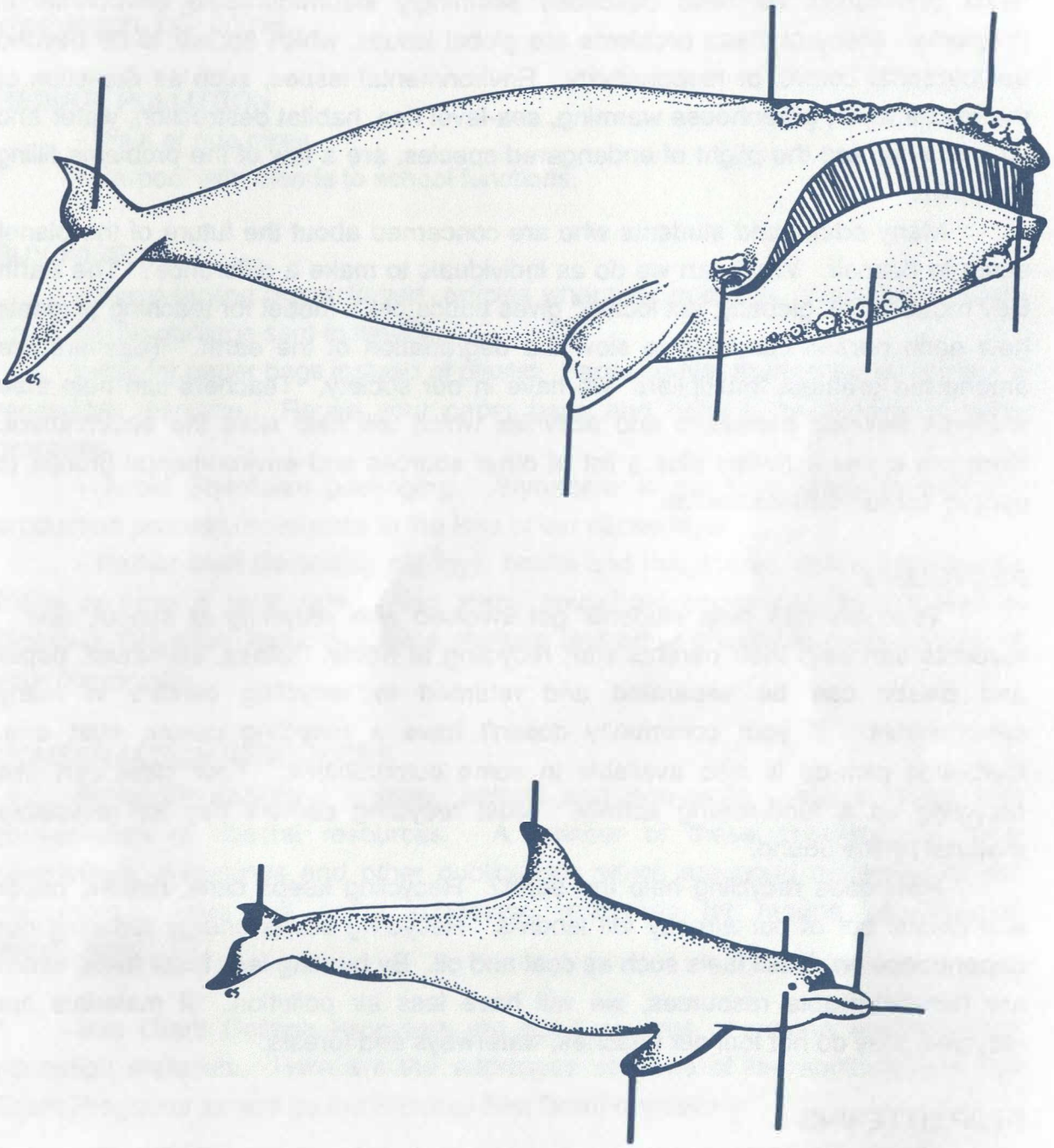
A. How might coastal shipping be a hazard to right whales on their migration?

B. What other human activities might be a problem for the right whale and other whale species?

3. Order The Right Whale Program 1992 Activities Guide from the Ocean Society, 441 Ridgewater Drive, Marietta, Georgia 30068, for more about right whales.

4. Obtain a copy of one/or both of the following National Geographic videos:
Dolphins (#51052)
Portrait of a Whale (#51178)

Comparative Anatomies of a Baleen and a Toothed Whale (Figure 8.)



CONSERVATION OF RESOURCES

By Jay R. Calkins

The earth's resources are being stressed by human activities. Nearly every news publication we read describes seemingly insurmountable environmental problems. Many of these problems are global issues, which appear to be beyond our personal control or responsibility. Environmental issues, such as depletion of the ozone layer, greenhouse warming, sea-level rise, habitat destruction, water and air pollution, and the plight of endangered species, are a few of the problems filling the news.

Many adults and students who are concerned about the future of the planet seem to despair. What can we do as individuals to make a difference? The Earth Day motto "think globally; act locally" gives educators a model for teaching students how each person can help to slow the degradation of the earth. Teachers are among the greatest "multipliers" we have in our society. Teachers can help their students develop behaviors and activities which will help save the environment. Here are a few activities plus a list of other sources and environmental groups to contact for further information.

RECYCLING

Teachers can help students get involved with recycling at school, and students can help their parents start recycling at home. Glass, aluminum, paper and plastic can be separated and returned to recycling centers in many communities. If your community doesn't have a recycling center, start one. Curb-side pick-up is also available in some communities. Your class can use recycling as a fund-raising activity. Most recycling centers pay for recyclable material by the pound.

How does recycling help the earth? Recycling keeps cans, bottles, paper and plastic out of our already full landfills. Recycling saves energy reducing our dependence on fossil fuels such as coal and oil. By burning less fossil fuels, which are non-renewable resources, we will have less air pollution. If materials are recycled, they do not foul our beaches, waterways and forests.

STOP LITTERING

Many kinds of litter are not only eyesores but dangers to wildlife. Discarded plastics end up in the water and are responsible for the deaths of fish, sea birds, sea turtles and marine mammals.

- Sponsor an art contest depicting the hazards of litter to marine life.

- Organize a trip to the coast to help with Beachsweep, a national program to clean litter from coastal beaches. For information on Beachsweep in your state contact: The Center for Marine Conservation, 1725 DeSales Street N.W., Washington, DC 20036.

REDUCE POLLUTION

- Walk or ride bikes.
- Carpool with friends to school functions.

BUY WISELY

- Avoid buying prepackaged articles whenever possible. Packaging makes up 1/3 of the garbage sent to landfills.

- Ask for paper bags instead of plastic. Paper comes from trees, which are a renewable resource. Reuse your paper bags and bring canvas bags to carry groceries.

- Avoid Styrofoam packaging. Styrofoam is not biodegradable and the production process contributes to the loss of our ozone layer.

- Rather than discarding old toys, books and magazines, share them with a friend or have a yard sale. Also many household goods can be donated to Goodwill, Salvation Army, homeless shelters and other charitable organizations in your community.

CONSERVATION RESOURCES

Many organizations - state, federal and non-profit - are involved with conservation of coastal resources. A number of these organizations have newsletters, magazines and other publications which are good materials for the classroom. Here are some suggested resources for marine conservation information:

* Sea Grant College Programs are good sources of marine environmental education materials. Here are the addresses of some of the southeastern Sea Grant Programs as well as the National Sea Grant depository:

National Sea Grant Depository
Pell Library Bldg/Bay Campus
University of Rhode Island
Narraganset, RI 02882

Georgia Sea Grant College Program
Ecology Building University of GA
Athens, GA 30602

Florida Sea Grant College Program
University of Florida Building 803
Gainesville, FL 32611

South Carolina Sea Grant College
287 Meeting Street
Charleston, SC 29401

North Carolina Sea Grant College
Box 8605 NC State University
Raleigh, NC 27695-8605

Mississippi/Alabama Sea Grant College
P.O. Box 7000
Ocean Springs, MS 39564

* The National Marine Educators Association publishes CURRENT a quarterly education journal. CURRENT, Vol. 10 No.4, 1991, pp 25-28 lists the names and addresses of twenty environmental groups, their areas of interest and their publications. NMEA, Kure Beach, NC 28449.

* Here are the addresses of five environmental organizations which emphasize coastal protection:

Clear Water Action
1320 18th Street, N.W.
Washington, DC 20036

Natural Resources Defense Council
40 W. 20th Street
New York, NY 10168

National Wildlife Federation
1400 16th Street, N.W.
Washington, DC 20036-2266

Defenders of Wildlife
1244 11th Street, N.W.
Washington, DC 20036

Center for Marine Conservation
1725 DeSales St. NW
Washington, DC 20036

* Federal Agencies have many publications about the environment:

The National Marine Sanctuary Programs &
The National Estuarine Research Reserves
Sanctuaries & Reserves Division, NOAA
1825 Connecticut Ave. N. W.
Washington, DC 20235

U.S. Geological Survey
Federal Center, Box 25425
Denver, CO 80225

Publications Requests
Office of Policy, Planning & Evaluation
U.S. Environmental Protection Agency
401 M Street S. W.
Washington, D C 20460

National Agricultural Library
U.S. Department of Agriculture
Beltsville, MD 20705

Be as specific as possible when requesting information from large federal agencies.

* Your State Department of Natural Resources may be a good source of information and materials. (See your telephone book under State of...)

* The Cooperative Extension Service in your state, including 4-H clubs, is a good source of environmental education materials.

* Newspaper and news magazines are loaded with environmental issues and articles. Ask your class to collect these articles for several weeks and make a file of them.

* An interesting book is 50 Simple Things Kids Can Do To Save The Earth, written by the Earthworks Group, Andrews and McNeal publishers, 4900 Main Street, Kansas City, MO 64112 with many activities designed for elementary students.

* Most large public aquariums have education departments, which produce good educational materials about marine animals. Here are some aquarium addresses:

Education Department
National Aquarium in Baltimore
Pier 3, 501 E. Pratt Street
Baltimore, MD 21202

Education Department
New England Aquarium
Central Wharf
Boston, MA 02110-3309

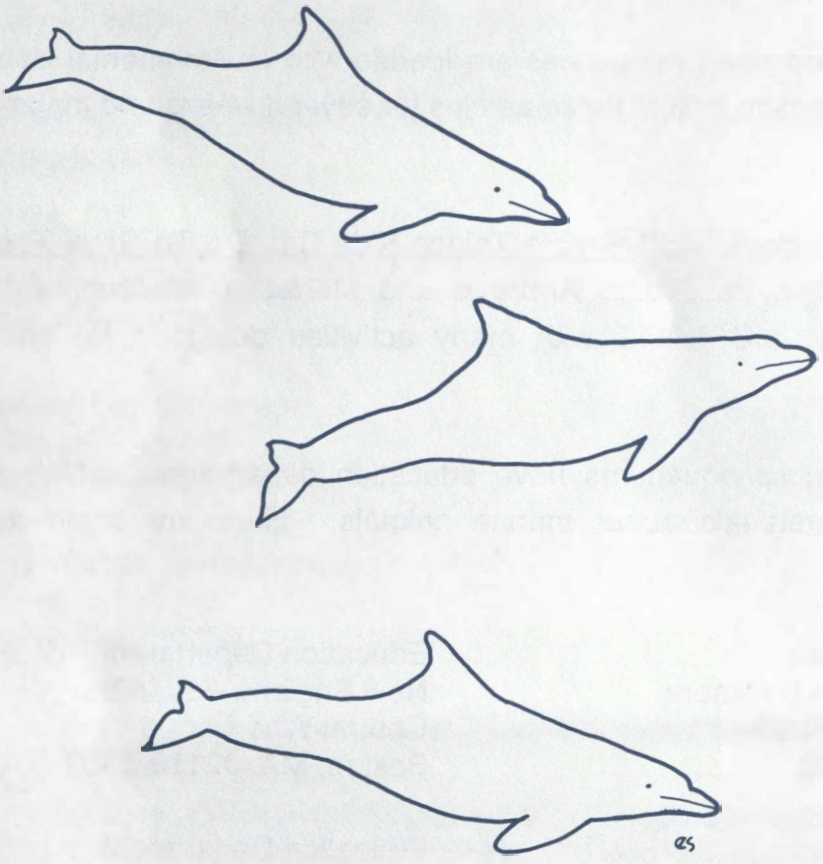
Education Department
Sea World of Florida
7007 Sea World Drive
Orlando, FL 32819

Education Department
Monterey Bay Aquarium
886 Cannery Row
Monterey, CA 93940

* A collection of marine educational materials is kept on microfiche that can be searched by subject areas. Marine Education Materials System (MEMS) is located at two addresses:

Librarian
Skidaway Institute of Oceanography
P.O. Box 13687
Savannah, GA 31416

MEMS
Virginia Institute of Marine Science
The College of William & Mary
Gloucester Point, VA 23062



APPENDIX I

Glossary of Terms

ANNELIDA - phylum of animals that includes marine polychaete worms

ANTENNAE - appendages used as a sensory organs by many invertebrates

BALEEN - whalebone, the material in the mouths of some whales, which is used to strain food from the water

BARBELS - fleshy sensory appendages around the mouth of fishes such as nurse sharks, catfish and hake

BENTHIC - denoting animals and plants that live on the bottom of the ocean

BIVALVES - molluscan animals with two shells attached by a hinge, including clams, oysters and scallops

CALLOSITIES - white, crusty growths found on the heads of right whales

CALVES - young, immature whales

CARNIVORES - animals that only eat other animals

CARTILAGE - material that makes up the skeleton of sharks and their relatives

CEPHALOPODS - animals in the molluscan phylum that include squid and octopus

COPEPODS - tiny crustaceans, which make up a significant portion of the zooplankton community

CRUSTACEANS - the class of arthropods, which includes shrimp, lobsters and crabs

DECAPOD - crustacean animals with ten legs such as the shrimp

DEPOSIT FEEDER - animals that feed on decaying organic matter found on the bottom.

DETRITUS - decomposing plant and animal matter; an important food source for many animals

DORSAL - the upper surface of an animal or the surface where the spinal chord is located

ENDANGERED - designating plants and animals that are on the brink of extinction

EXOSKELETON - the outside skeleton or shell found on arthropods such as shrimp, crabs and lobsters

EXTINCTION - the total disappearance of a species of animal or plant

FILTER FEEDERS - animals, which eat by filtering small food particles from the water

FLIPPERS - modified legs of sea turtles used for swimming

FOOD CHAIN - the natural feeding sequence within a community from lower to higher trophic levels

GASTROPODS - molluscan animals with single-coiled shells such as conchs, whelks and snails

GILL SLITS - openings in the sides of sharks, which allow water to pass over their gills

HABITAT - the type of environment in which a particular group of animals or plants lives

HATCHLINGS - young, newly hatched sea turtles

HERBIVORES - animals that eat only plants

INVERTEBRATES - animals with no backbone or dorsal notochord.

JUVENILE - the immature phase of an animal

KRILL - small shrimp-like crustaceans often found in large schools in cool ocean waters

LATERAL LINE - a curved line of fluid-filled sacs located on the sides of fishes and used to sense vibrations in the water

MAMMALS - the class of vertebrate animals, including humans, that have hair, are warm-blooded and nurse young with mammary glands

MATRIX - the jelly-like substance containing the spicules and skeletal parts of a sponge

MELON - enlarged forehead of the toothed whales; which is used to detect underwater objects

ORGAN - a differentiated part of an organism that performs a specific function

PARAPODIA - fleshy leg-like appendages of marine worms

PELAGIC - living in the open ocean

PHYLUM - a large group of animals or plants related by a few common characteristics

PLANKTON - animals and plants, which drift with ocean currents - many are microscopic

POD - a group of whales traveling together

POLYP - a cnidarian such as a hydra or anemone with a cylindrical body and tentacles for feeding

PORPOISES- toothed whales related to dolphins and killer whales

PREDATOR - an animal, which kills other animals for food

PREY - animals caught and eaten by other animals

PROTOZOANS - simple, single-celled organisms such as amebas and euglenas

RAYS - relatives of sharks that are flattened dorso-ventrally for bottom-dwelling

SCAVENGERS - animals that eat dead, decaying animals

SCUTES - bony plates on the back of a turtle

SESSILE - plants or animals that permanently attach themselves to an object or surface

SKATES - relatives of sharks that are flattened dorso-ventrally for bottom-dwelling

SONAR - sound waves used to detect underwater objects

SPECIES - animals or plants that are the most alike in the classification system

SWIM BLADDER - an air-filled sack inside most bony fish that helps keep them afloat

TENTACLES - elongated appendages used for feeding by squid, anemones and jellyfishes

TISSUE - an aggregation of specialized cells with a similar function (e.g. brain tissue)

TORTOISE SHELL - material taken from the shell of hawksbill sea turtles used for making jewelry

VERTEBRATES - animals with backbones made of bone or cartilage

APPENDIX II

BIBLIOGRAPHY OF CHILDREN'S BOOKS

Below is a list of recent, recommended books in the categories which are covered by this workbook. All the books were included in "The Children's Catalog" published by H.W. Wilson, a collection development aid used by librarians in ordering children's books. They are listed by recommended grade levels.

Abbot, R. Tucker. Seashells of the World. Rev. ed. New York: Golden Press, 1985. (gr. 5 and up)

Anacona, George. Turtle Watch. New York: Macmillan, 1987. (gr. 2-4)

Blassingame, Wyatt. Wonders of Sharks. New York: Putnam, 1984. (gr. 4 and up)

Blumberg, Rhoda. Sharks. New York: Watts, 1976. (gr. 4 and up)

Boschung, Herbert T. et al. Audubon Society Field Guide to North American Fishes, Whales and Dolphins. New York: Knoph, 1983. (gr. 5 and up)

Bulholzer, Theres. Life of the Snail. Minneapolis: Carolrhoda Books, 1987. .3-6)

Coupe, Sheena and Robert Coupe. Sharks. New York: Facts on File, 1990. (gr. 5 and up)

Crump, Donald J., ed. Amazing Animals of the Sea: Marine Mammals. Washington, D.C.: National Geographic Society, 1981. (gr. 5 and up)

Dow, Lesley. Whales. New York: Facts on File, 1990. (gr. 5 and up)

Freedman, Russell. Killer Fish. New York: Holiday House, 1982. (gr. 3-5)

Johnson, Sylvia A. Hermit Crabs. Minneapolis: Lerner Publications, 1989. (gr. 4 and up)

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Mallory, Ken. Rescue of the Stranded Whales. New York: Simon and Schuster, 1989. (gr. 5 and up)

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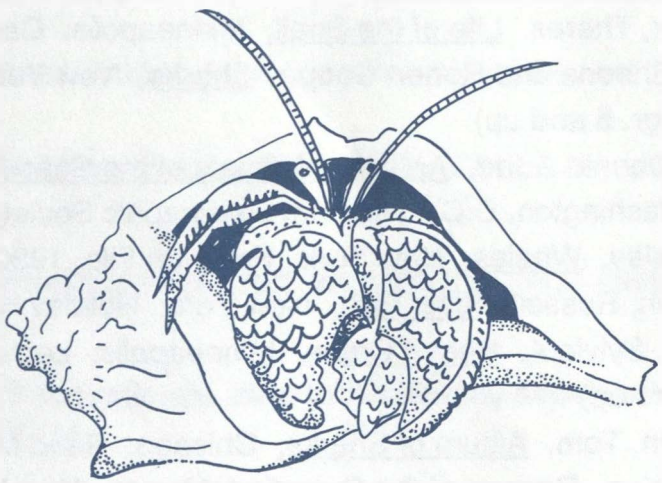
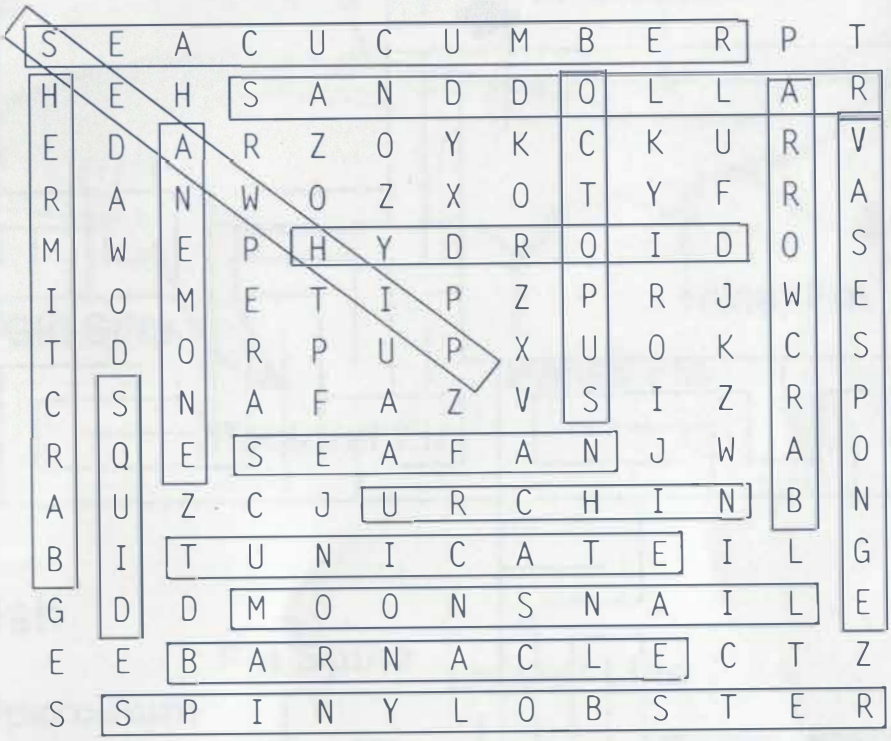


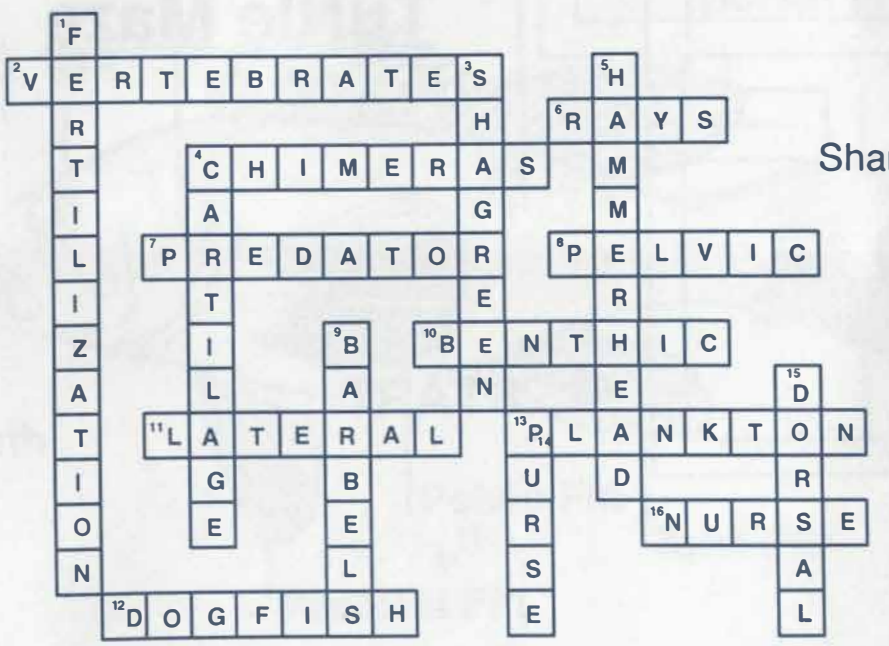
APPENDIX III

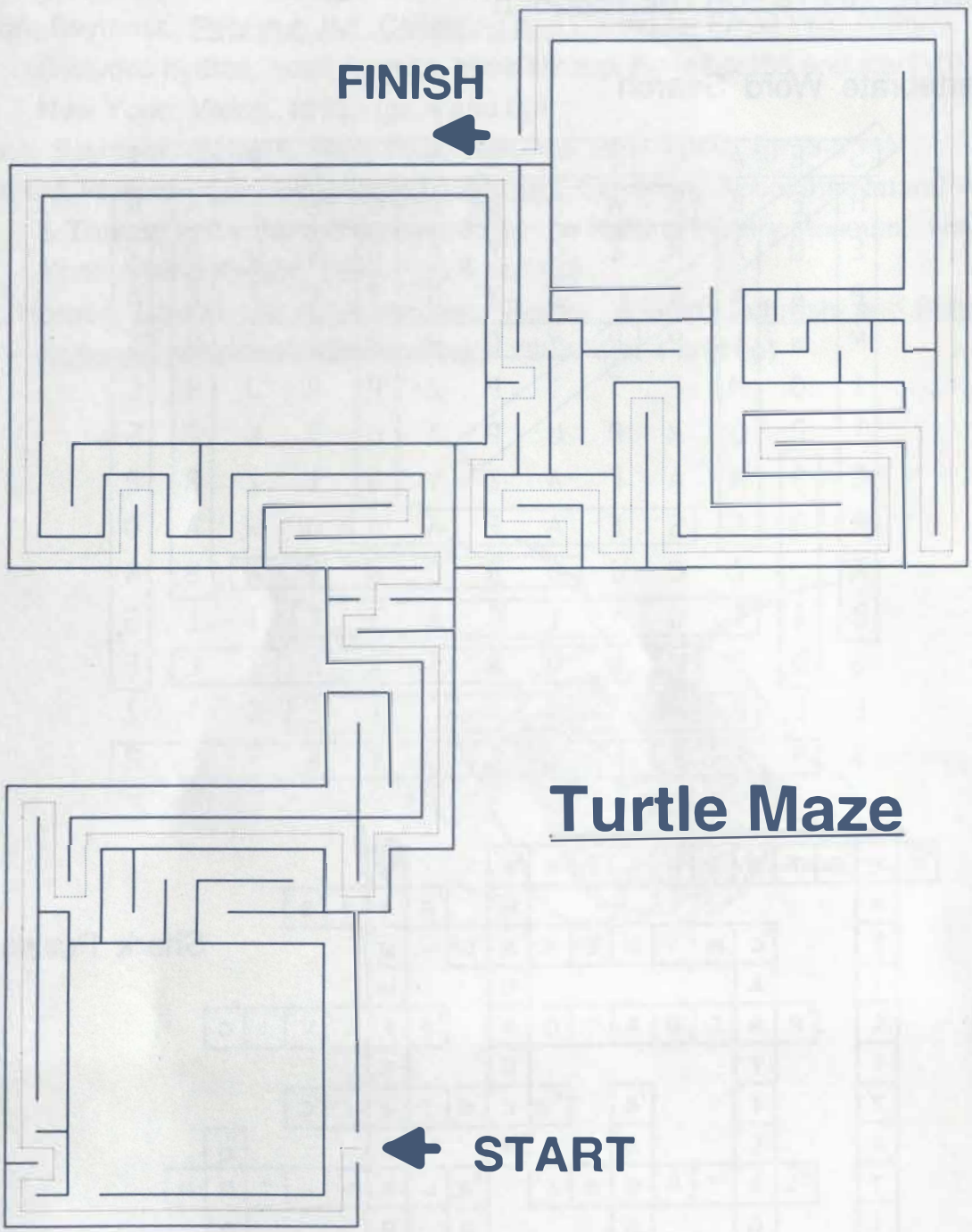
ANSWER SHEETS FOR THE TEACHER

Invertebrate Word Search



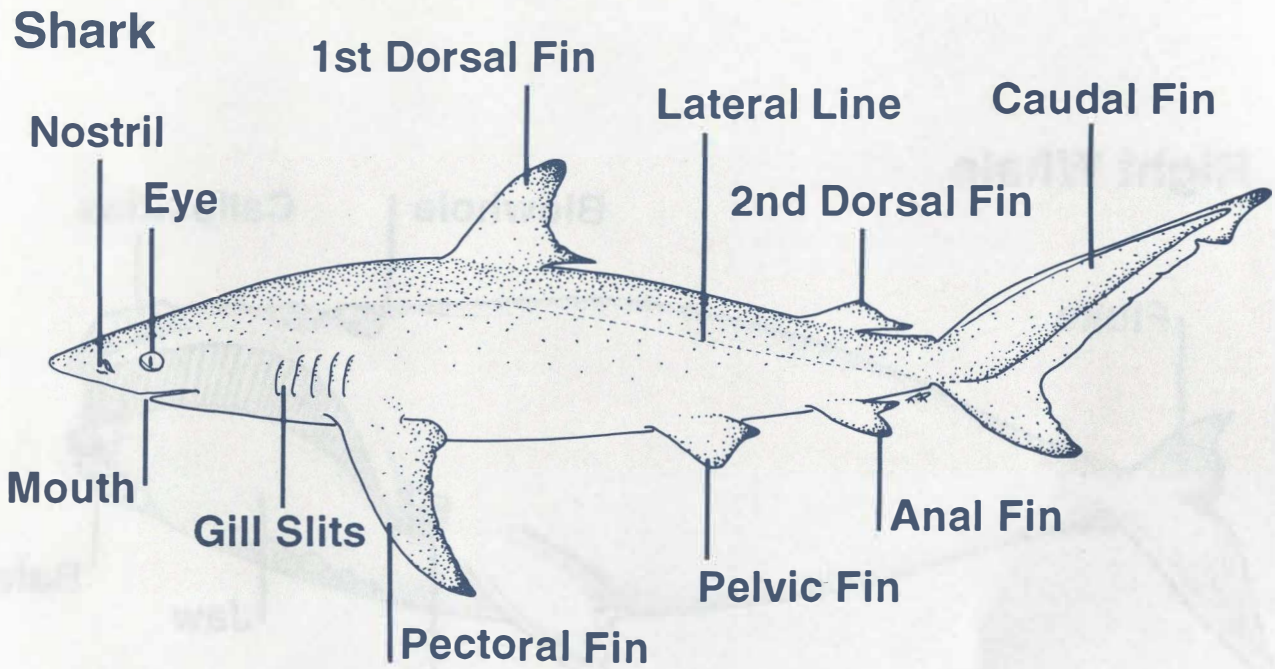
Shark Puzzle

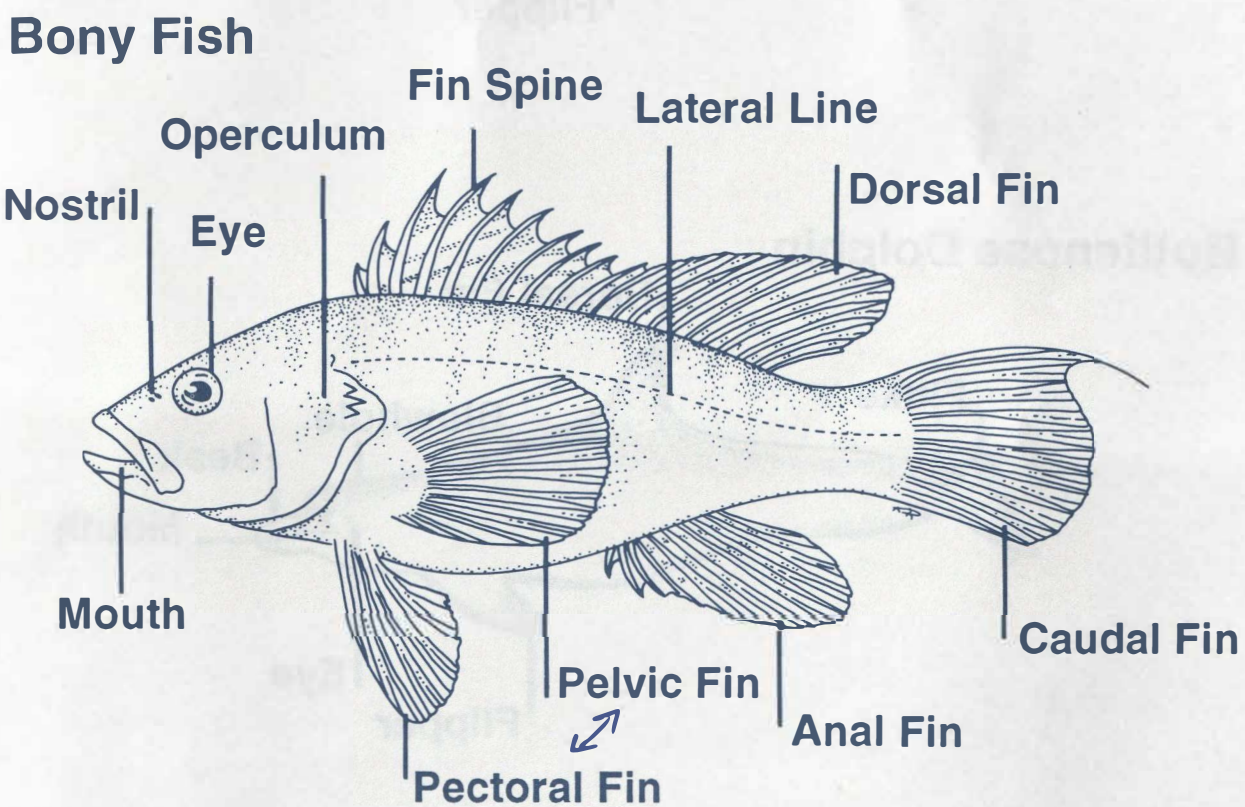




Turtle Maze

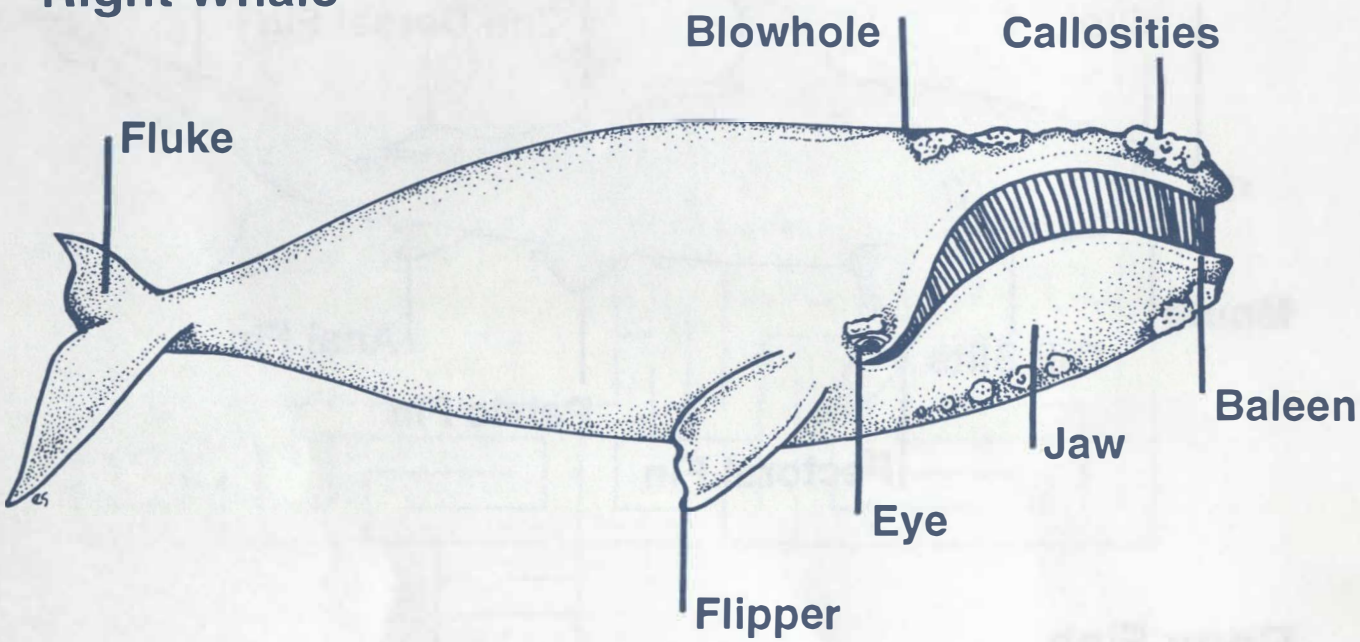
Comparative Anatomies of a Shark and a Bony Fish





Comparative Anatomies of a Baleen and a Toothed Whale

Right Whale



Bottlenose Dolphin