

Goals of the SeaWorld and Busch Gardens Education Departments

Based on a long-term commitment to education and conservation, SeaWorld and Busch Gardens strive to provide an enthusiastic, imaginative, and intellectually stimulating atmosphere to help students and guests develop a lifelong appreciation, understanding, and stewardship for our environment. Specifically, our goals are ...

- To instill in students and guests of all ages an appreciation for science and a respect for all living creatures and habitats.
- To conserve our valuable natural resources by increasing awareness of the interrelationships of humans and the environment.
- To increase students' and guests' basic competencies in science, math, and other disciplines.
- To be an educational resource to the world.

“For in the end we will conserve only what we love. We will love only what we understand. We will understand only what we are taught.” — B. Dioum

Shark!

4-8 Teacher's Guide

PART OF THE SEAWORLD EDUCATION SERIES

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Front: sandtiger shark (*Carcharias taurus*)

Back (clockwise from left): bonnethead shark (*Sphyrna tiburo*),
swell shark (*Cephaloscyllium ventriosum*), sandtiger shark (*Carcharias taurus*),
brown shark (*Carcharhinus plumbeus*)

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Shark!

4–8 Teacher’s Guide

A SEAWORLD EDUCATION DEPARTMENT PUBLICATION

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To the Teacher

The ***Shark!*** Teacher’s Guide for grades 4–8 was developed at SeaWorld to help you teach your students—in an active, hands-on way—about sharks and the ecology of the ocean. Our goal was to integrate science, mathematics, art, and language. SeaWorld curriculum supports the *National Science Education Standards*.

The brief background information in this Guide was written for you, the teacher. It will help you do these activities with your students. We suggest you also refer to some of the materials listed on page 24 for more in-depth information. SeaWorld strives to provide teachers with up-to-date information and activities that motivate students to appreciate and conserve wildlife, the oceans, and the natural world.

Do you have comments or suggestions regarding the activities in this Teacher’s Guide? We’d love to hear your opinion. Write the SeaWorld San Diego Education Department, email us at SWC.Education@Anheuser-Busch.com or call 1-800-380-3202.

Goal of the Shark! Unit

Students explore the natural history of sharks and recognize that humans are an interconnected part of sharks' ecosystems.

Objectives

After completing the SeaWorld Shark! Unit, the student will be able to...

1. Identify and describe various shark adaptations.
2. Compare and contrast sharks and bony fishes.
3. Use a dichotomous key to identify shark families.
4. Discuss what sharks eat.
5. Demonstrate the steps of the writing process.
6. Create an artistic impression of a fish.
7. Discuss why sharks need conservation and how people can help conserve sharks.
8. Share their learning experience with family and friends.

Vocabulary

anal fin — the median fin located on the underside of a fish, between the anus and the caudal fin. (Not all fishes have an anal fin.)

bony fish — any fish of the class Osteichthyes, characterized by a skeleton of bone.

bycatch — nontarget animals caught during a fishing operation.

cartilage (CAR-tih-lij) — a type of tough, flexible connective tissue. Cartilage composes the skeleton of sharks and all very young vertebrates.

caudal fin — the tail fin.

Chondrichthyes (kon-DRIK-theez) — a scientific class of fishes that have jaws, paired fins, paired nostrils, and a skeleton composed of cartilage.

conservation — taking care of our environment by wisely managing its resources.

dichotomous (die-KOT-uh-mus) **key** — a tool for identifying organisms, based

on answers to a sequence of questions. Each question offers two choices.

dorsal fin — a fin on the back of a whale or fish.

ecosystem — a unit of plants, animals, and nonliving components of an environment that interact.

finning — the practice of removing only a shark's fins, which are used in sharkfin soup.

gill slits — slitlike openings through which water leaves a shark's gills.

gyotaku (gyoh-TOCK-oo) - the art of fish printing, which originated in Japan or China in the early 1800s as a way for fishermen to record their catch.

pectoral fins — the pair of fins toward the front of a fish's body.

pelvic fins — the paired fins on the underside of a fish's body, behind the pectoral fins.

venomous — having venom-producing tissue and able to inflict a toxic wound.

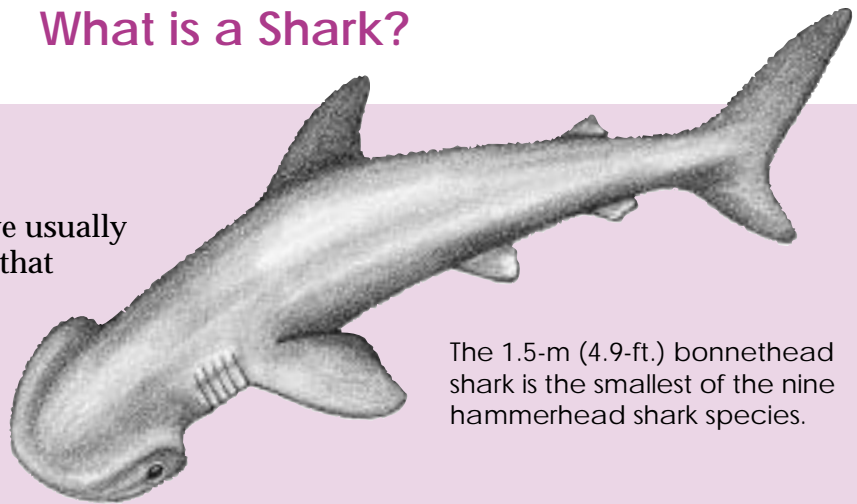
What is a Shark?

What do you picture?

When we think of sharks, we usually think of sleek, large species that stalk the seas for fishes and marine mammals. Some do just that. But not all. The huge basking shark feeds on plankton. And the small horn shark crushes and eats clams, lobsters, and crabs. Some sharks are giants—longer than a school bus. Some are tiny enough to hold in your hand. Some spend their entire lives in motion. And some rarely stir from the sea bottom. Yet they are all sharks.

A shark has five kinds of fins.

A shark's tail is called its *caudal fin*. The caudal fin propels the shark forward. The paired fins toward the front of a shark are its *pectoral fins*. Pectoral fins lift a shark as it swims. The fins on a shark's back are the *dorsal fins*. *Pelvic fins* are paired fins underneath the shark, and the *anal fin* is a single small fin near the tail. The dorsal, pelvic, and anal fins all stabilize the shark as it swims.



The 1.5-m (4.9-ft.) bonnethead shark is the smallest of the nine hammerhead shark species.

Sharks swam the seas long ago.

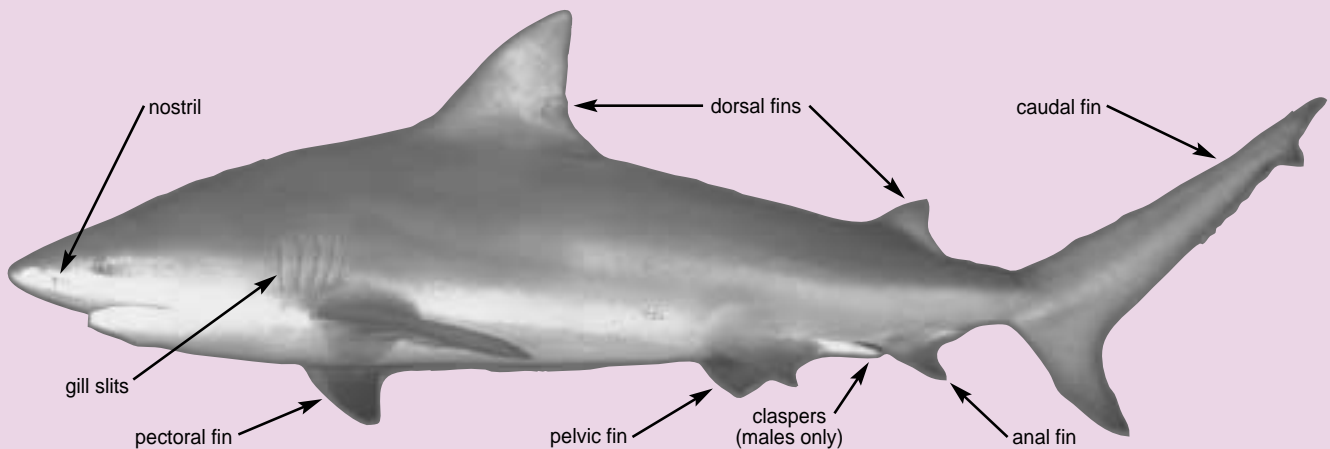
Sometimes people describe sharks as being “primitive” fishes. What does that mean? It means that most of the families of sharks alive now were swimming the seas when dinosaurs roamed the earth. Unlike other animals, sharks have changed very little since then.

You can tell males from females.

Only male sharks have claspers—a pair of organs attached to the pelvic fins. So it's easy to tell males from females.

Where do sharks live?

Sharks live all over the world, from tropical lagoons to polar seas. Some even inhabit freshwater lakes and rivers.



Fins lift, stabilize, and propel a shark as it swims.

A Shark is a Fish

Sharks have typical fish features.

Like other fishes, all sharks are cold-blooded. They have a skeleton and fins, live in the water, and breathe with gills. Most fish in the world are called *bony fishes*. Their skeletons are made of bone, as are ours. There are more than 23,500 different species of bony fishes in the world, but less than 400 different species of sharks.

So what's the difference?

One thing that makes sharks different from bony fishes is that a shark's skeleton is made of *cartilage*, not bone. Cartilage is a tough connective tissue. We have cartilage in parts of our bodies, too. Push on your nose or squeeze your ear to feel cartilage.

Another difference between sharks and bony fishes is their scales. Most bony fish scales are round, and as the fish grows, so do its scales. In fact, you can estimate how old some fish are by counting the rings in their scales, just like counting tree rings. Shark scales are different. Each one looks like a miniature tooth. And they have the same structure as a tooth: an outer layer of enamel, a layer of dentine, and a pulp cavity. Sharks' scales don't grow bigger as the shark ages. As a shark grows, it grows more scales. These toothlike scales make a shark's skin rough, like sandpaper.



Shark scales look like miniature teeth.

Sharks have lots of teeth.

A shark has several rows of teeth in its mouth. Sharks bite with the outer row of teeth, but eventually these teeth fall out. A tooth from the row behind moves up to take its place. Another difference between sharks and bony fishes is that sharks grow new teeth all the time. Some sharks may go through as many as 30,000 teeth in a lifetime.



A shark has several rows of teeth.

Think of a batoid as a flat shark.

The closest relatives of sharks are called batoids. Like sharks, they have toothlike scales and skeletons made of cartilage. What makes them different from sharks is that their bodies are flat, and the front fins are fused with the head. Some batoids, like stingrays, have one or more *venomous* spines on a whiplike tail. The sharp spine can deliver a painful sting.



A bat ray (*Myliobatis californica*) is a batoid.

Sharks are Predators



Most sharks would rather avoid you. But 32 kinds of sharks have been known to attack people.

What do sharks eat?

Some sharks are probably not very picky about what they eat. But certain kinds of sharks eat some foods more than others. Hammerhead sharks eat mostly stingrays. Smooth dogfish eat mostly crabs and lobsters. Tiger sharks eat mostly sea turtles. Blue sharks eat squids. And whale sharks eat plankton.

Many sharks prey most often on the weakest members of a population. Sharks eat weak, ill, or injured animals because they are the easiest to catch.

These predators have poor appetites.

Sharks eat far less than most people imagine. Remember that, like other fishes, sharks are cold-blooded. Cold-blooded animals have much lower metabolisms than warm-blooded animals such as mammals. So sharks don't need huge amounts of food. A shark probably eats between 1% and 10% of its body weight in a week, and

many sharks probably go several weeks between meals.

Who needs silverware?

Think of a shark's lower jaw teeth as a fork, and its upper jaw teeth as a knife. As a shark's jaws extend to bite its prey, teeth of the lower jaw puncture and hold prey. The upper jaw teeth slice. A shark's short jaws make the bite powerful.

Sharks don't eat people...very often.

Only 32 (of nearly 400) kinds of sharks have ever been known to attack people. Like other wild animals, most sharks would rather avoid you. Sharks that have attacked people probably mistook them for food or may have attacked to protect their territory.

Sharks have predators, too.

As a group, sharks and batoids have several predators, including other sharks, elephant seals, and killer whales.

Shark Conservation

People are predators too.

Over the years, people have used sharks for food, medicines, vitamins, weapons, jewelry—even sandpaper. But today some species are in trouble. Why? Shark meat has become a more popular food. Also each year, thousands of sharks are caught accidentally as *bycatch*, snagged in nets set out to catch other types of fish. The number of sharks taken this way can equal or exceed the number of sharks taken intentionally. A particularly wasteful practice is shark *finning*—removing only the fins and tossing back the rest of the shark to die at sea.

Sharks can't bounce back.

Sharks grow very slowly compared to other fishes. A female shark produces at most only a few hundred pups in her lifetime, compared with millions of offspring produced by other fishes. Depleted shark populations may take years to recover.



When we understand shark populations, we can better plan for the future of sharks.



A female shark produces at most only a few hundred pups in her lifetime. Depleted shark populations may take years to recover.

Go fish—wisely.

The United States is a world consumer and trader of shark meat. The National Marine Fisheries Service has developed management plans for 39 shark species in the Atlantic Ocean, Caribbean Sea, and Gulf of Mexico. While there is no federal management of sharks in Pacific waters, California and Alaska regulate shark fishing. Such plans and regulations address issues such as bycatch and include setting catch limits and closed seasons. Finning is prohibited in Alaska, California, and Atlantic waters.

What can we do to help?

Conservation begins with learning. Research into shark reproduction helps us understand shark population dynamics. And when we understand shark populations, we can better plan for the future of sharks. Keeping the ocean clean and adhering to fishing regulations are more ways we can help. *(Visit your local bait and tackle shop or contact your state's Fish and Game Department for information on fishing regulations in your state.)*

Sharks in Danger

While sharks are often feared as “man-eaters,” the truth is that humans pose a far greater danger to sharks than they pose to us. Threats to shark populations include overfishing, bycatch as a result of fishing operations, and habitat degradation. The negative public image of sharks can be a challenge to conservation efforts.

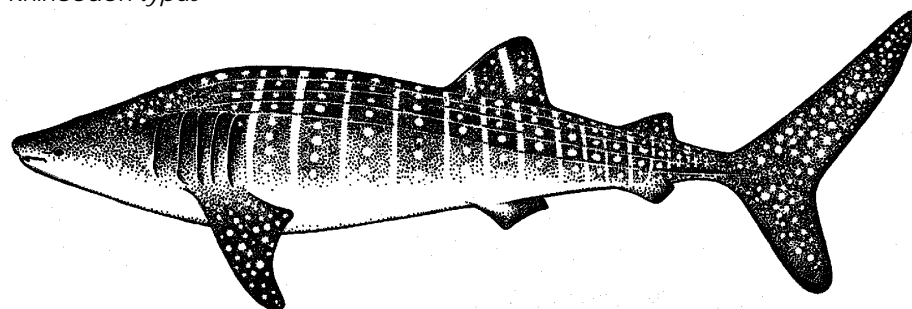
Slow-growing animals that reach maturity only after several years, sharks produce few young. When shark populations become depleted, they may take decades to recover. In fact, some species—like the rare Ganges shark (*Glyphis gangeticus*) may soon be extinct.

There are nearly 400 species of sharks. They inhabit virtually all ocean environments and range in size from about 22 centimeters (8 in.) to about 12 meters (nearly 40 ft.).

On the following pages you’ll find information on seven of the shark species that are most in need of conservation.

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whale shark
Rhincodon typus



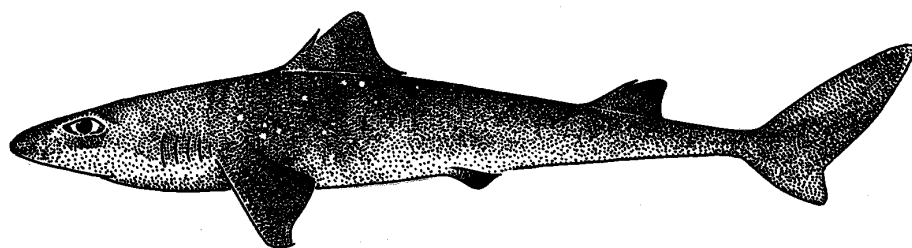
distribution: oceanic and coastal, generally close to or at the surface in tropical and temperate seas worldwide. They are often found offshore but also inshore, even in lagoons.

adult size: to about 12 m (39 ft.), the world’s largest fish

conservation concerns: Whale sharks have been fished by harpoon in some areas, to the point of depletion. Protected in U.S. waters of the Atlantic, Gulf of Mexico, and Caribbean.

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spiny dogfish
Squalus acanthias



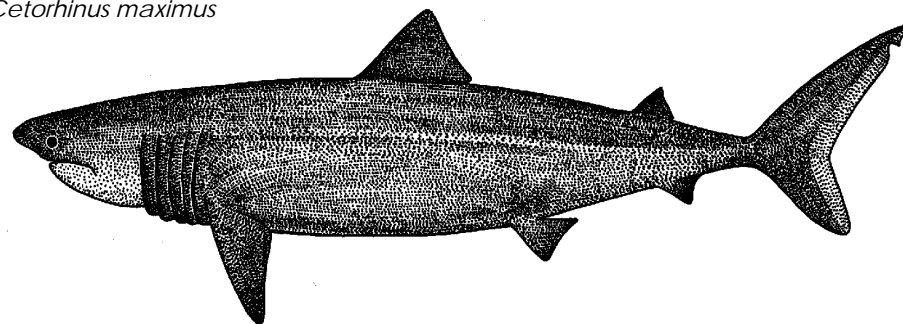
distribution: coastal and pelagic over the continental shelf in areas of temperate and subarctic waters worldwide

adult size: about 1 m (3.3 ft.)

conservation concerns: Spiny dogfish accounted for about 96% of U.S. exports of shark meat in 1995. In the 1990s, dogfish landings in the U.S. Atlantic increased six-fold, depleting the population. New legislation for the U.S. Atlantic severely reduces dogfish fishing.

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basking shark
Cetorhinus maximus



distribution: coastal and pelagic over continental shelves in temperate seas. They are found offshore as well as inshore, into the surf zone and enclosed bays.

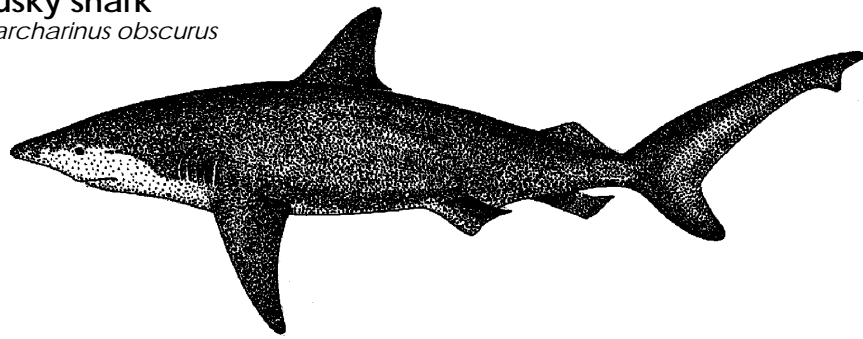
adult size: to about 9.8 m (32 ft.)

conservation concerns: Historically basking sharks have been fished by harpoon, sometimes until local stocks were depleted. They also become entangled in gillnets and trawls. Protected in U.S. waters of the Atlantic, Gulf of Mexico, and Caribbean.

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dusky shark

Carcharinus obscurus



distribution: from the surf zone to well out to sea in temperate and tropical areas of the Pacific, Western Atlantic, and Western Indian Oceans

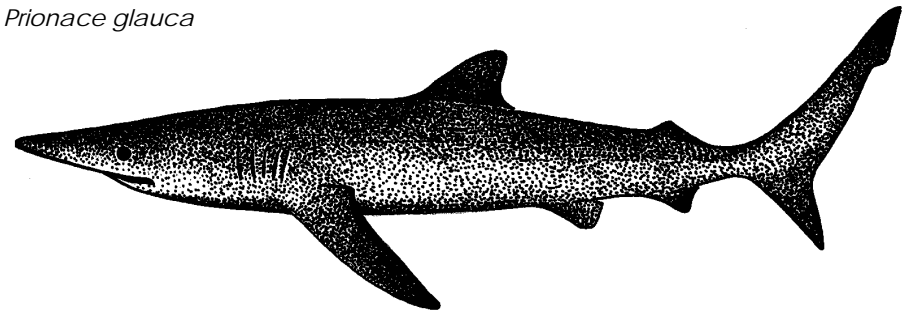
adult size: about 3.4–3.7 m (11.2–12.0 ft.)

conservation concerns: Dusky sharks were once abundant but now are in decline due to overfishing. Their fins are considered the highest quality for soup. In 1998 the American Elasmobranch Society issued a resolution urging the National Marine Fisheries Service to prohibit fishing for this species.

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blue shark

Prionace glauca



distribution: oceanic in tropical and temperate seas worldwide. They are usually found offshore but may venture inshore, especially at night.

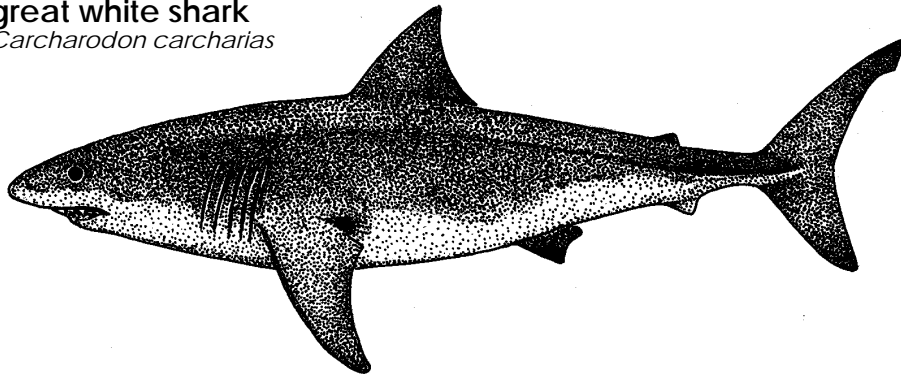
adult size: about 1.8–3.2 m (6.0–10.6 ft.)

conservation concerns: Blue sharks are among the predominant species fished in the U.S. Pacific. More than 60,000 are killed each year for their fins (for soup) in the Hawaiian longline fishery—one of the few fisheries left where finning is allowed. Finning is prohibited in Atlantic, Alaska, and California waters.

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great white shark

Carcharodon carcharias



distribution: coastal and offshore over continental shelves and around continental islands in most temperate oceans of the world

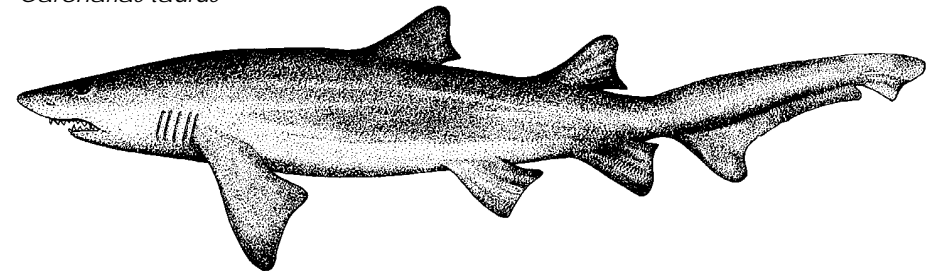
adult size: about 3.7–6.0 m (12.0–19.7 ft.)

conservation concerns: Great white sharks are often a bycatch of other shark fisheries such as longlines, hook-and-line, gillnets, purse seines, and others. They are also fished for their teeth and jaws, which are used as decorations. Protected in U.S. waters of the Atlantic, Gulf of Mexico, and Caribbean.

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sandtiger shark

Carcharias taurus



distribution: shallow waters of the surf zone, bays, and reefs to about 191 m (627 ft.) in areas of the temperate and tropical Atlantic, Indian, and Western Pacific Oceans

adult size: about 2.2–3.2 m (7.2–10.5 ft.)

conservation concerns: Sandtigers are fished primarily with line gear, also gillnets and trawls. Like other coastal sharks, they depend on nearshore habitats, which are vulnerable to destruction and degradation. Protected in U.S. waters of the Atlantic, Gulf of Mexico, and Caribbean.

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Name That Fish

OBJECTIVE

The student will be able to use a *dichotomous key* to identify shark and batoid families.

MATERIALS

- copies of ***Name That Fish*** funsheet on page 10
- copies of ***Key to Families*** on page 11
- pens or pencils

BACKGROUND

All sharks and batoids belong to a group of fishes called the *Chondrichthyes*. To help learn about them, scientists divide them into groups called families. All the sharks in one family usually will look more like each other than sharks in other families.

To find out which family a shark is in, you would examine the shark carefully. You would count the gill slits on the sides of the shark's head. You would look at the shark's paired pectoral fins and paired pelvic fins, its one or two dorsal fins, and its anal fin (if it has one—not all sharks do). And you would look at the shark's tail, called a caudal fin.

A useful tool for listing characteristics and identifying a shark's family is a dichotomous key. The key presents a sequence of questions. Each question offers two choices.



ACTION

1. Distribute copies of the ***Name That Fish*** funsheet and ***Key to Families*** to the students. For this activity, students may work individually or in learning groups.
2. Instruct students to always begin at number one of the ***Key to Families*** for each shark on the ***Name That Fish*** funsheet.

Students read sentences 1A and 1B of the key. They study Shark 1 for the characteristics referred to in 1A and 1B. For each shark, they choose either 1A or 1B, and then follow the directions given in that letter. When they can identify the shark family, they write the family name on the line below each animal. Lead them through one or two examples.

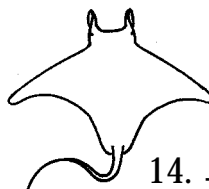
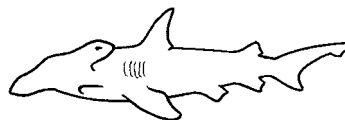
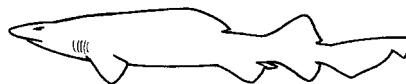
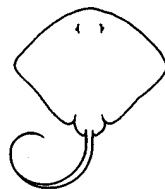
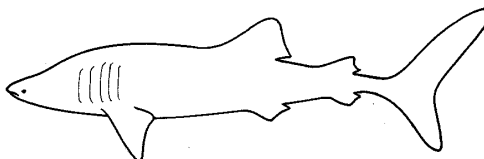
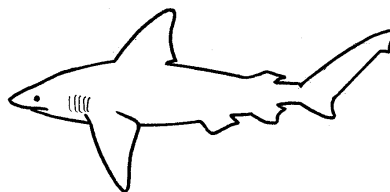
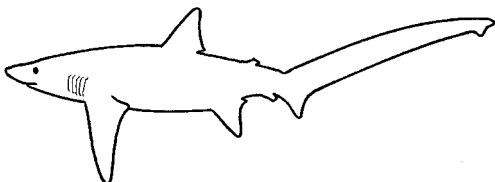
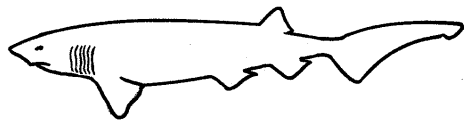
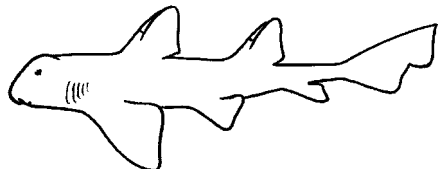
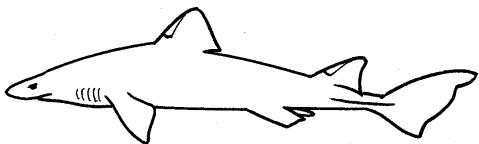
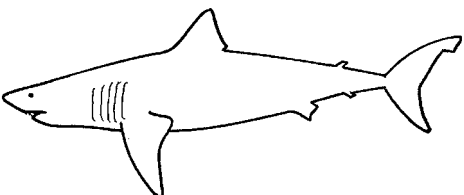
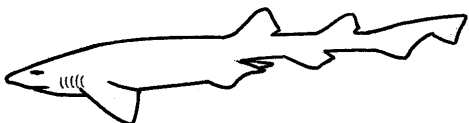
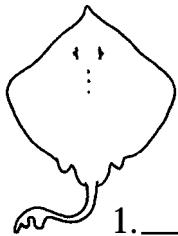
ANSWERS

1. Rajidae
2. Scyliorhinidae
3. Lamnidae
4. Squalidae
5. Heterodontidae
6. Hexanchidae
7. Alopiidae
8. Pristiophoridae
9. Carcharhinidae
10. Rhincodontidae
11. Dasyatidae
12. Pseudotriakidae
13. Sphyrnidae
14. Mobulidae

Name _____

Name That Fish

Use "**Key to Families**" to help you identify the family of each shark or batoid on this page.



Key to Families

1. A. body kitelike if viewed from the top go to 12
B. body not kitelike if viewed from the top go to 2
2. A. anal fin absent go to 11
B. anal fin present go to 3
3. A. six gill slits present Family Hexanchidae
B. five gill slits present go to 4
4. A. dorsal fin with spines Family Heterodontidae
B. no spines on dorsal fins go to 5
5. A. mouth at front of snout (rather than
on underside of head) Family Rhincodontidae
B. mouth on underside of head go to 6
6. A. head expanded with eyes at ends of expansion Family Sphyrnidae
B. head not expanded go to 7
7. A. top half of caudal fin about the
same size as bottom half Family Lamnidae
B. top half of caudal fin different
in size than bottom half go to 8
8. A. first dorsal fin very long, almost
half the total length of the body Family Pseudotriakidae
B. first dorsal fin regular length go to 9
9. A. caudal fin very long, almost as long as entire body .. Family Alopiidae
B. caudal fin “regular” length go to 10
- 10 A. base of first dorsal fin behind pelvic fins Family Scyliorhinidae
B. base of first dorsal fin in front of pelvic fins Family Carcharhinidae
11. A. long point on the end of snout Family Pristiophoridae
B. snout without long point Family Squalidae
12. A. front of animal has two hornlike appendages Family Mobulidae
B. no hornlike appendages go to 13
13. A. small dorsal fin present near tip of tail Family Rajidae
B. no dorsal fin present near tip of tail Family Dasyatidae

Catch of the Day

OBJECTIVES

Students conduct experiments that simulate fishing techniques and explore processes that result in bycatch.



Each year, thousands of sharks are snagged in nets set out to catch other types of fish.

MATERIALS

- leaf rake
- four 10" wooden dowels (or use craft sticks, large pencils, or rulers)
- 2' of string or yarn, cut into four 6" lengths
- small craft or similar magnets (magnetic tape will not work well)
- about 75 large-size paper clips
- about 35 2" squares of white construction paper*
- about 35 2" squares of blue construction paper*
- about 35 2" squares of red construction paper*

* *or—if possible—use small, fish-shaped pieces of construction paper.*

BACKGROUND

Fishing nets like purse seines and driftnets make it easy to catch lots of fish. But they've also introduced new problems: the nets catch everything that can't swim through the mesh, regardless of species. When the nets are hauled in, fishers try to toss back non-target species (the bycatch), but most of these animals die anyway. According to the Center for Marine Conservation, the number of sharks killed incidentally in fishing operations equals or exceeds those taken intentionally.

For this activity, students work in small learning groups to see how two different fishing methods result in bycatch. (*Note: this activity can be done indoors or outdoors.*)

ACTION

1. Prepare materials before class:
 - Use pieces of construction paper to simulate three different species of sharks. Attach a large paper clip to each red and white "shark." Do not attach paper clips to blue "sharks."
 - To simulate fishing poles, tie one end of a 6" string to a dowel (*or ruler, stick, or pencil*). Tie a paper clip on the other end of the string, and place a magnet on the paper clip.

2. Discuss how people use sharks for food and other materials. Sharks (and other fishes) can be caught in a variety of ways, including hook-and-line, longline (one long fishing line with hundreds of hooks), and nets. Also discuss bycatch. Ask students to predict which fishing method results in a larger catch and which results in the most bycatch.
3. Divide your class into groups of five students. Work with one group at a time. In each group, four students fish for sharks with fishing poles, and the fifth student is the boat captain.
4. With the first group of students, distribute “fishing poles” to the four pole fishers and demonstrate how to use them: Students will “hook” a shark with the magnet on their fishing line. (The magnet attracts a paper clip.) The boat captain’s job is to assist the pole fishers by removing the shark from their line and by counting the day’s catch.
5. Explain to students that their goal is to catch as many red sharks as possible. Blue papers and white papers represent two species of sharks that share habitat with the red sharks. If caught, they represent bycatch.
6. Create a playing field that represents the ocean. Scatter all three colors of paper squares over the playing field.
7. Time the group for one minute. Students catch as many red sharks as they can. The boat captain should record the catch.
8. Next the group will try net fishing. To simulate a net that scoops in a lot of animals at once, they will use a leaf rake to scoop sharks. Again, scatter all three colors of paper squares over the playing field. The boat captain gets one chance to run the rake across the playing field to catch as many red sharks as possible. This time the other fishers on the boat sort and count the day’s catch.
9. Discuss this experiment with your students:
 - Which fishing method resulted in the highest red shark catch? Which method resulted in more bycatch?
 - What are the advantages of each fishing method? What are the disadvantages?
 - Which method might work well for schooling fishes? Which method might work best for a species that doesn’t school?
10. Repeat this experiment with the following variations, and ask students how these situations affect their fishing operation.
 - Blue sharks are not reproducing fast enough to replace numbers taken as bycatch. They are placed on the Endangered Species List, and a fishing boat will be fined for catching more than two blue sharks.
 - The blue shark population continues to decline, and it is now illegal to catch *any* blue sharks.
 - White sharks are suddenly in demand because a famous restaurant chef has created a fabulous new white shark recipe.

DEEPER DEPTHS

- (1) Students create graphs that show the volume of their catch and bycatch and the percent bycatch of each species.
- (2) Assign one group of students the role of fishermen and another group the role of shark population biologists. The two groups debate net fishing.

Calculating Sharks

OBJECTIVES

- (1) Given data about sharks and the amount of food they eat, the student will be able to solve for the unknown in percentage problems.
- (2) Given information about a shark's growth, the student will be able to graph coordinates and interpret a linear graph.
- (3) Given the conversion factor, the student will be able to convert from metric to English units.

MATERIALS

- copies of *Calculating Sharks* funsheet on pages 15–16
- pencils
- graph paper
- calculators (optional)

ACTION

1. Distribute *Calculating Sharks* funsheets to students. Students may work individually or in cooperative learning groups.
2. After the students complete their calculations, review the problems together. How did students go about solving the problems?

ANSWERS

1. $650 \text{ lb.} \times 0.25 = \mathbf{162.5 \text{ lb.}}$
2. nurse shark $350 \text{ lb.} \times 0.10 = 35 \text{ lb.} = \mathbf{15.9 \text{ kg}}$
 sandtiger shark $250 \text{ lb.} \times 0.10 = 25 \text{ lb.} = \mathbf{11.3 \text{ kg}}$
 lemon shark $300 \text{ lb.} \times 0.10 = 30 \text{ lb.} = \mathbf{13.6 \text{ kg}}$
 brown shark $150 \text{ lb.} \times 0.10 = 15 \text{ lb.} = \mathbf{6.8 \text{ kg}}$
3. $7 \text{ lb. bluefish} + 2 \text{ lb. mackerel} + 5 \text{ lb. herring} = \mathbf{14 \text{ lb.}}$ total food fish
 bluefish $7 \text{ lb.} \div 14 \text{ lb.} = 0.50$ or $\mathbf{50\%}$
 mackerel $2 \text{ lb.} \div 14 \text{ lb.} = 0.143$ or $\mathbf{14.3\%}$
 herring $5 \text{ lb.} \div 14 \text{ lb.} = 0.357$ or $\mathbf{35.7\%}$
 weight of shark = n
 $n \times 0.10 = 14 \text{ lb.}$
 $n = 14 \div 0.10 \text{ lb.}$
 $n = \mathbf{140 \text{ lb.}}$
4. shrimp $8 \text{ lb.} \div 129 \text{ lb.} = 0.062$ or $\mathbf{6.2\%}$
 clams $8 \text{ lb.} \div 129 \text{ lb.} = 0.062$ or $\mathbf{6.2\%}$
 brine shrimp $42 \text{ lb.} \div 129 \text{ lb.} = 0.326$ or $\mathbf{32.6\%}$
 whitebait $12 \text{ lb.} \div 129 \text{ lb.} = 0.093$ or $\mathbf{9.3\%}$
 mackerel $8 \text{ lb.} \div 129 \text{ lb.} = 0.062$ or $\mathbf{6.2\%}$
 squid $16 \text{ lb.} \div 129 \text{ lb.} = 0.124$ or $\mathbf{12.4\%}$
 lettuce $35 \text{ lb.} \div 129 \text{ lb.} = 0.271$ or $\mathbf{27.1\%}$

5. a. about $\mathbf{48 \text{ kg}}$
 b. $\mathbf{60 \text{ kg}}$
 c. about $\mathbf{132 \text{ lb.}}$



Calculating Sharks

1. A shark's liver is extremely large. It makes up as much as 25% of the shark's total body weight. If a bull shark (*Carcharhinus leucas*) weighs 650 pounds, what is the maximum weight its liver might be?
2. The sharks of SeaWorld eat approximately 10% of their body weight in food per week. SeaWorld aquarists (people who take care of fishes) weigh the food fish before they feed it to the sharks. They record the amount and total weight of food fish each shark eats during a feeding. Here are estimated weights of some SeaWorld sharks. Calculate how many pounds of fish each of the following sharks eats in one week. There are 2.2046 pounds in one kilogram. How many kilograms of fish does each shark eat in one week?

<i>shark</i>	<i>weight</i>	<i>weekly food amount</i>	
		<i>in pounds</i>	<i>in kilograms</i>
nurse shark	350 lb.	_____	_____
sandtiger shark	250 lb.	_____	_____
lemon shark	300 lb.	_____	_____
brown shark	150 lb.	_____	_____

3. A shark eats 7 pounds of bluefish, 2 pounds of mackerel, and 5 pounds of herring in one week.
 - a. What percent of the weekly total is each type of fish?
 - b. Estimate how much this shark weighs if its weekly food consumption is about 10% of its body weight.

4. As a group, 2,000 fish in the Coral Reef Aquarium at SeaWorld eat the following amounts of food per week:

8 lb. shrimp
8 lb. clams
42 lb. brine shrimp
12 lb. whitebait
8 lb. mackerel
16 lb. squid
35 lb. lettuce

What percent (by weight) of the weekly total is each food type?

5. As sharks grow, their weight increases in proportion to the amount of food they eat. A brown shark (*Carcharhinus plumbeus*) weighs 40 kilograms in April and 55 kilograms in January. Graph these two measurements on graph paper. Plot weight on vertical axis and months on the horizontal axis. Then use your graph to answer the questions below.

- a. Estimate the brown shark's weight in September.

- b. If the brown shark's weight increases at the same rate, what will its weight be next April (in kg)?

- c. There are 2.2046 lb. in one kilogram. What will the brown shark's weight be next April in pounds?

Print a Fish (You Can Gyotaku, Too!)

OBJECTIVES

The student will identify fish body parts and create an impression of a fish.

BACKGROUND

Sometime in the early 1800s fish printing, or *gyotaku*, originated in Japan or China. Fishermen in Japan used fish printing to keep records of their catches. Fish printing has been practiced as an art in the U.S. for about 40 years.

MATERIALS

- one or more fresh or thawed fish
(*Use a fish with large, visible scales.*)
- fabric paints
- small and medium fairly stiff brushes
- modeling clay
- newspaper
- prewashed T-shirts (*for paper printing use newsprint or rice paper*)

ACTION

1. Wash the fish carefully but thoroughly with soap and water to remove the mucus. Pat dry the fish taking care not to rub off the scales. Clip any sharp spines with pliers.
2. Place the fish on several layers of newspaper. Plug the anus of the fish (the opening just in front of the anal fin) with a small wad of newspaper.
3. Students adjust the fish so that it lies the way they want it to look in their fish prints. They identify the fins and spread fins out into lifelike positions. Students support fins with modeling clay to hold them in place.
4. Brushing head to tail, students apply a light coat of paint to the fish, avoiding the fish's eye and the modeling clay. After the fish is covered with paint, students brush from tail to head.
5. Students place their hands inside the T-shirts as if they were going to put them on. They grasp the inside of the T-shirt to create a flat surface for printing. Students place T-shirts carefully on top of the painted fish and press firmly, head to tail. Warn them not to move the T-shirt around too much once they've set it in place.
6. Students carefully peel their printed T-shirts off the fish from head to tail.
7. Students use fabric paints to fill in the fish's eyes and to outline or add detail to their prints.



A fish print is a lifelike rendition of a real fish.

The Tooth Will Tell

OBJECTIVES

Students will be able to relate shark tooth shapes to shark prey selection. They will identify the distributions of various shark species.

MATERIALS

- copies of tooth illustrations on page 19
- copies of a world map
- paper
- colored pencils, crayons, or markers
- glue or tape
- scissors
- reference materials on sharks (*see page 24; also see periodicals and videos*)

BACKGROUND

The characteristic teeth of each shark species are adapted to that particular species' diet. The teeth may be serrated or smooth. Most are used for seizing prey, cutting, or crushing. For sharks, platelike, triangular teeth are the most common shape.

Many types of sharks are adapted for bottom feeding. For example, horn sharks (*Heterodontus francisci*) eat bottom-dwelling crabs and clams. The horn shark's pointed front teeth grasp, and its flat, molarlike back teeth crush. Another mechanism some sharks use for collecting food is filter feeding. The basking shark strains plankton from the water. Its teeth are reduced and nonfunctional.



ACTION

1. Ask students if they think that the size or shape of a shark's teeth is related to its diet. Students work individually or in cooperative learning groups to investigate this question.
2. Distribute copies of the shark tooth illustrations on page 19 and copies of a world map. Students use references to gather information on the listed sharks:
 - leopard shark (*Triakis semifasciata*)
 - Pacific angel shark (*Squatina californica*)
 - sandtiger shark (*Carcharias taurus*)

Students find information on each shark species' diet, methods of collecting and eating food, habitat (including temperature, topography, depth, other animals and plants), and distribution.
3. Students create presentations of their findings. Instruct them to cut out tooth shapes (as many as needed) and glue or tape them to the world map to graphically represent the

distribution of each shark species. Students can enhance distributions through shading or other means. Have students create map legends explaining their distribution maps.

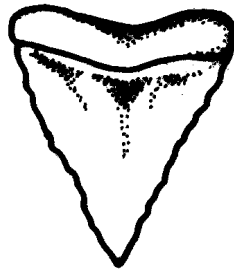
- On separate sheets of paper, students list each shark, its diet, feeding habits, habitat, and distribution.
- As a class, discuss conclusions. Is the size and/or shape of a shark's teeth related to its diet? What else did students discover? For example, is habitat related to what a shark eats?

DEEPER DEPTHS

During their investigations, have students explore what kinds, if any, of interactions these sharks have with humans. (*For example: fisheries, conservation issues, shark attacks.*)

Use world maps to identify geographic locations where these issues are critical. Students follow up their investigations with a brief report or class presentation.

Shark Teeth



great white shark
(*Carcharodon carcharias*)



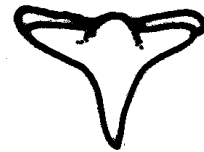
sandtiger shark
(*Carcharias taurus*)



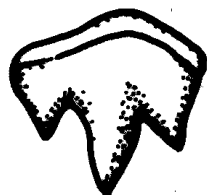
blue shark
(*Prionace glauca*)



basking shark
(*Cetorhinus maximus*)



Pacific angel shark
(*Squatina californica*)



leopard shark
(*Triakis semifasciata*)



horn shark
(*Heterodontus francisci*)

Shark Storytellers

OBJECTIVES

Students demonstrate all the steps in the writing process: prewriting, writing, responding, revising, and editing.

MATERIALS

- reference materials on sharks (*see page 24*)
- writing paper
- pens or pencils

ACTION

1. Each student will create and write a short story based on “a day in the life of a shark.” As a prewriting activity, discuss shark behavior, senses, conservation, and other topics. Use the information gathered from ***The Tooth Will Tell*** on page 18 and resources listed on page 24. Encourage students to use books and videos to get more ideas on what sharks do. Brainstorm a few possible outlines students might use to write their shark story. Can students think of more than one outline for telling the same story?
2. Students write their own short stories about a day in the life of a shark.
3. Divide the class into small response groups of two to five students. Students read their stories aloud or exchange papers. They give each other feedback on their work.
4. Next, students revise their stories. In this process they can rethink and reorganize their stories, changing as much as they want.
5. Explain to students that authors edit their writing before they submit it to a publisher. As student authors, they now have the chance to edit their own stories. Make dictionaries and other reference books available. You may wish to help students develop a checklist for editing their stories. (*Examples of checklist items: spelling, page numbers, name on report, etc.*)
6. Make a book out of the stories. Read the stories to the class.



Can students imagine a day in the life of a great white shark?

DEEPER DEPTHS

Check the Internet and collect cartoons, books, and newspaper and magazine articles about sharks. Students use their knowledge of sharks to analyze and critique the way the information is presented.

Robo Shark

OBJECTIVES

Students brainstorm ideas to create a fictional shark and a futuristic habitat in which the shark lives. They build an artistic representation of this imaginary shark and describe its adaptations.

MATERIALS

- paper
- glue
- scissors
- plastic bottles
- cans
- scraps of wood
- other nonfood “garbage” items

BACKGROUND

Humans use the ocean for transportation, harvesting food and minerals, and recreation. And because all water eventually reaches the ocean, the things we do on land also affect the oceans. Some of our actions can be harmful: in the past, humans have destroyed habitats, dumped various pollutants into the ocean, and overharvested certain animals.

Human activities can speed up environmental changes. By changing the environment quickly and radically, we have the ability to completely destroy a habitat for which an animal is adapted. The environment we leave behind may be so different from the animal’s habitat that the animal lacks the adaptations necessary to survive there. If there are no members of the population that can survive the environmental change, the entire population will become extinct. We have the responsibility to study our *ecosystem* and learn how it works so we can predict how our actions might affect it.



ACTION

1. Lead your students in a discussion about environmental problems in the oceans. Species that can’t adapt to environmental changes go extinct. Other species do adapt to environmental changes. What kind of adaptations might they develop?
2. Invite students to use their imaginations to artistically create their own futuristic shark out of scrap materials, working alone or in cooperative groups. Have each student or work group write a brief description of their shark’s habitat, adaptations,

prey, etc. How do these adaptations enable the shark to survive in its futuristic habitat? Allow each student (or group) a chance to share their creation with the class.

DEEPER DEPTHS

Use only recyclable materials to create the “Robo Sharks.” Then, have your students take their creations to a recycling center and recycle them.

The Closer You Get ...

OBJECTIVES

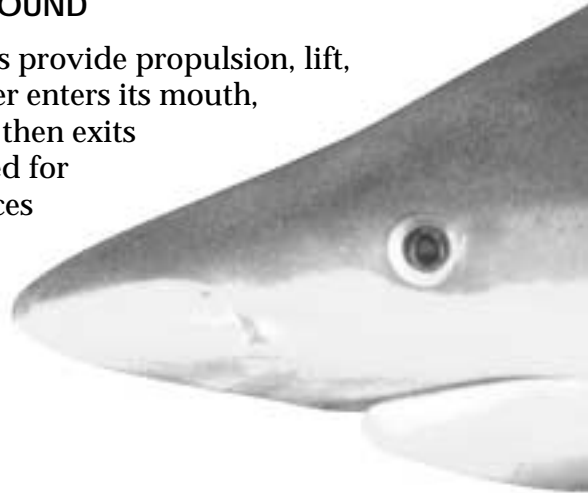
Given close-up photos of shark body parts and information about sharks, the student will be able to identify and describe the body parts and explain their functions.

MATERIALS

- copies of *The Closer You Get...* funsheet on page 23
- pencils or pens

BACKGROUND

Sharks are well adapted for life in the sea. Fins provide propulsion, lift, steering, and stability. As a shark swims, water enters its mouth, passes over gill filaments that absorb oxygen, then exits through gill slits. A shark's eyes are well suited for seeing in dim light. Its nostrils detect substances in the water that guide a shark to prey. A shark has several rows of teeth in its mouth. Toothlike scales make a shark's skin rough, like sandpaper. Some batoids, like stingrays, have one or more venomous spines on a whiplike tail.



ACTION

1. Discuss shark senses and other adaptations as discussed in this Guide. Photocopy and distribute *The Closer You Get...* funsheet to students or groups of students.
2. Students guess what each photo illustrates and write a sentence explaining what that body part does.

ANSWERS

1. gill slits (*where water exits after passing over gills*)
2. scales (*protective outer covering*)
3. eye (*for seeing*)
4. teeth (*for tearing or crushing food*)
5. nostril (*for smelling*)
6. stingray spine (*venomous spine for defense against predators*)

DEEPER DEPTHS

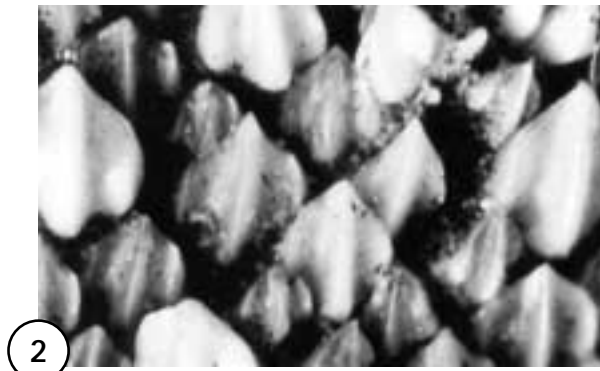
Working in groups, students look through old magazines for pictures of sharks. They cut out parts of photos and make their own funsheets for other groups of students to do. Have the students write out a hint that goes with each of their photos (example: this body part helps a shark swim fast).

The Closer You Get...

Can you identify the part of a shark or batoid in each of these photos?
What does each body part do?













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Books for Young Readers

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Shamu TV® on Video*

Shark! 1999; *Predator Alert*, 1999; *Myth, Monster or Misunderstood?* 1999.

SeaWorld Posters*

Inside Sharks, 1989; *Sharks and Other Cartilaginous Creatures*, 1994; *Great White Shark*, 1999.

Web Sites

- Marine life information from SeaWorld. <www.seaworld.org>
- American Elasmobranch Society. <www.elasmo.org>
- Center For Marine Conservation, Shark Fact Sheet. <www.cmc-ocean.org/2_bp/sharkfact.html>

*Available through SeaWorld San Diego. Call for prices.

Shark! Pre/Post Assessment

Use this assessment to discover how much your students already know about sharks before you begin this unit, and later as a conclusion to your study.

- Describe two different kinds of sharks. How are they different? How are they the same?
- How can you tell different kinds of sharks apart?
- Use a dichotomous key to identify a shark species.
- Create a picture or model of a shark. Show its adaptations for surviving in the sea.
- Describe “a day in the life of a shark.”
- Use a map or globe to show where various kinds of sharks can be found.
- Use math skills to calculate how much food a 350-lb. shark might eat in one week.
- Why are some shark populations in danger?
- How can people help conserve sharks?

National Science Education Standards Connections in this Guide

*Connections to National Science Education **Life Sciences** Standards include:*

- Structure and function of living systems
- Reproduction and heredity
- Regulation and behavior
- Populations and ecosystems
- Diversity and adaptations of organisms

*Connections to National Science Education in **Personal and Social Perspectives** Standards include:*

- Population, resources, and environments
- Science and technology in society

*Connections to National Science Education **History and Nature of Science** Standards include:*

- Science as a human endeavor
- Nature of science
- History of science

*Connections to National Science Education **Science as Inquiry** Standards include:*

- Abilities necessary to do scientific inquiry
- Understanding about scientific inquiry

Unifying Concepts and Processes to help students understand the natural world include:

- Systems, order, and organization
- Evidence, models, and explanation
- Change, constancy, and measurement
- Evolution and equilibrium
- Form and function

National Research Council. *National Science Education Standards*. Washington, D.C.: National Academy Press, 1996.

Want more information?

If you have a question about aquatic animals, call **1-800-23-SHAMU** (1-800-237-4268). TDD users call **1-800-TD-SHAMU** (1-800-837-4268). These toll-free phone numbers are answered by the SeaWorld Education Department.

The SeaWorld Education Department has information booklets, teacher’s guides, posters, and videos available on a variety of marine animals and topics. Call or write to request an Education Department Publications brochure.

Visit the SeaWorld/Busch Gardens Animal Information Database at www.seaworld.org

SeaWorld San Diego

(800) 380-3202
500 Sea World Drive
San Diego, CA 92109-7904

SeaWorld Orlando

(800) 406-2244
7007 Sea World Drive
Orlando, FL 32821-8097

SeaWorld San Antonio

(210) 523-3606
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San Antonio, TX 78251-3001

Discovery Cove

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