



sharks

Activity Guide for Grades 3-5

by
Shedd Aquarium

Shedd Aquarium Activity Guide Series



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Acknowledgements

President/CEO: Ted A. Beattie

Writer: Fran Donovan

Editors: Katherine San Fratello and Dave Durette

Design: Rebecca Schneider

Illustration: Rebecca Joworski Cortez

Advisors: Debra Fassnacht, Karen Furnweger, Cheryl Mell, Bert Vescolani, Michelle Wildes, Information Services and Technology Department

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Sharks Activity Guide for Grades 3-5

Objectives

This Activity Guide is designed to provide teachers with a resource for incorporating the study of aquatic science, specifically sharks, into their existing curricula. Each activity will help meet specific learning objectives. If all of the activities in this Guide are completed, the following learning objectives will be met:

Illinois State Goals in Science: Goals 1 through 4

National Science Education Standards:

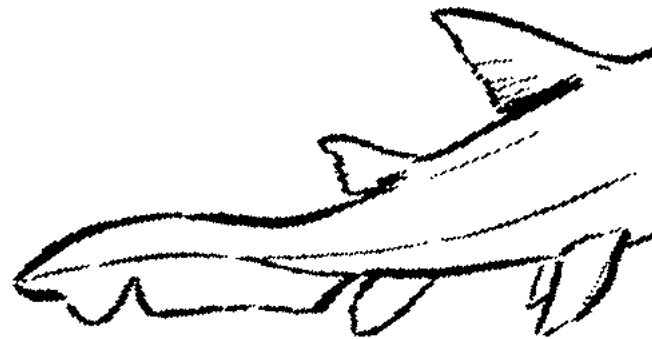
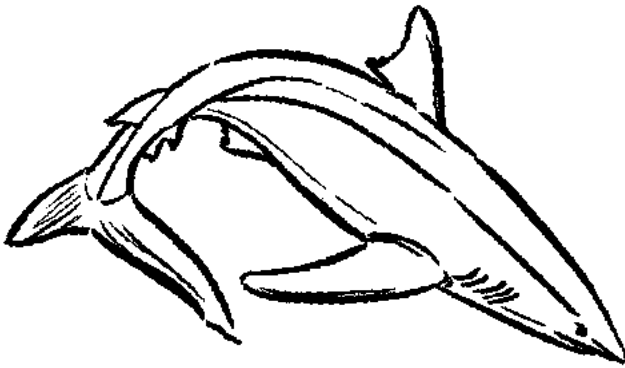
Unifying Concepts and Processes Standard

K-4 Content Standards A through G

5-8 Content Standards A through G

Goals

- to provide teachers with an interactive teaching tool and curriculum on sharks for grades 3-5
- to build students' critical thinking skills and scientific literacy
- to approach the study of science in an interdisciplinary way
- to offer students a fun, hands-on learning experience



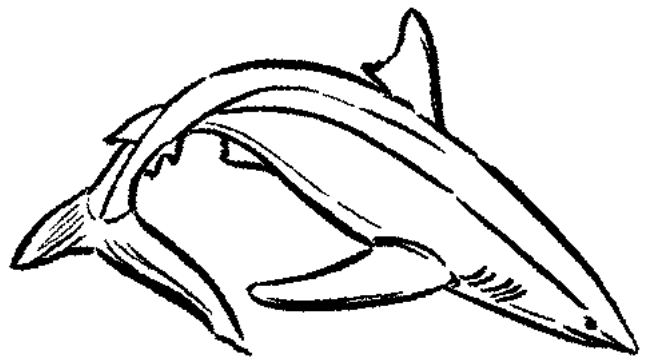
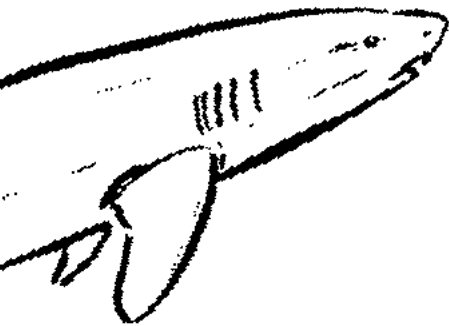
Using this Book: Guidelines for Teachers

Children are naturally intrigued by and curious about sharks. You can take advantage of this inherent interest and use it as a springboard to scientific inquiry. Get in the habit, with your students, of wondering about the world and then pursuing your questions by conducting research. For example, isn't it amazing that some sharks have a head shaped like a hammer? Why is that? You can make guesses, but without researching sharks, they will be made with very little context. Because sharks are fairly inaccessible as a topic of direct observation, research will need to occur largely through books and videotapes. Observing live sharks in an aquarium is very helpful but even that can be limiting because only a few species are represented.

General guidelines:

- Activities can stand alone but are designed to build on each other. It is most advantageous to complete all or most of the activities in the book.
- For continuity, the less time that passes between each activity the better.
- Throughout the experience, revisit major ideas to reinforce learning.
- Have students document their learning. Documentation can be in the form of writing they add to their Shark Diaries, drawings, paintings, 3-D models, etc.
- It is also helpful for you to document the learning process about sharks through photographs, videotapes and transcriptions of student dialogues. Documentation will provide a history of the project and the students' progress.

The activities provided will give you a good base from which to begin, but they are not meant to be a strict formula to follow. There are many sideroads upon which you can venture. Some will not be evident until you've already begun your journey. For example, you may find your study leads to an interest in other animals in the sea, or your students may be most interested in the way sharks glide through the water. This could lead to an exploration of hydrodynamics and the aerodynamics of airplanes. We encourage you to be open to these interests as they evolve. It is not so important exactly what subject matter is covered but what mysteries are uncovered based on the genuine interests of your students. You will find many ways to adapt these ideas, and we encourage you to do so.



Introduction to Sharks

Sharks ... evil, menacing creatures that attack humans indiscriminately, or majestic, masterful predators? Despite the fact that sharks can be deadly to humans, this tendency is greatly exaggerated. Of the approximately 370 species, only a very few pose any threat to humans, and when they do, it's probably because they have been provoked or have mistaken a person for another animal. All in all, sharks are more fascinating than fearsome.

Full of surprises

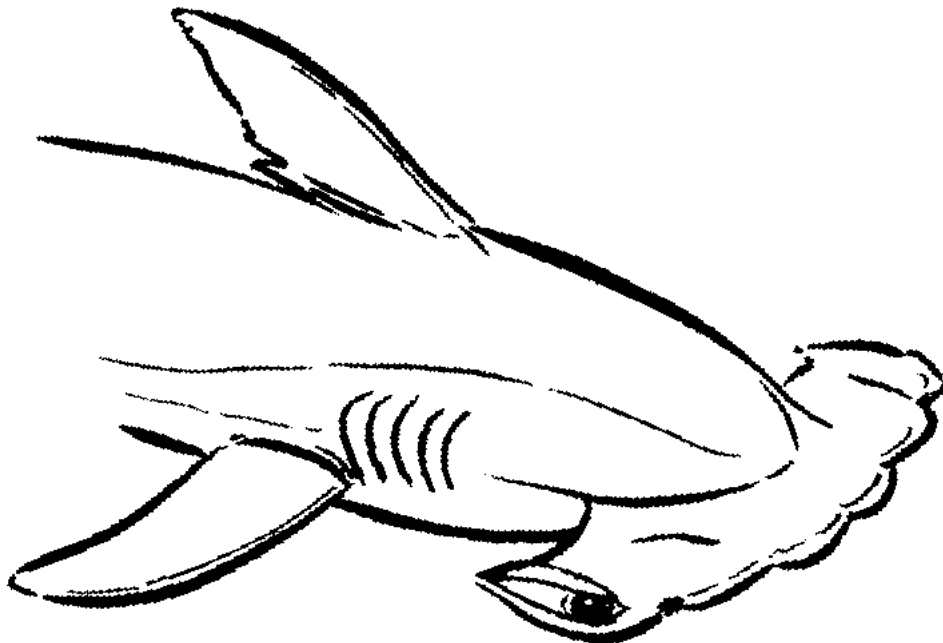
Sharks are amazing creatures! They can be as small as your hand or as large as a school bus. Some have heads shaped like hammers, while others look like flattened angels lying on the ocean floor. Sharks have developed extremely sharp senses. Some see well in very dark water. Others can hear their prey from great distances and smell the presence of only a few drops of blood. Sharks can even locate their prey by using electricity.

What is a shark?

All sharks are fishes, but they are different from other fishes. They have no bones, no gill covers and no scales. Instead of bones, sharks have skeletons made of cartilage, which is lighter and more elastic than bone, allowing for speed and flexibility. Along with skates and rays, sharks belong to the scientific class *Chondrichthyes*, which means "cartilage fishes." Instead of single gill covers, sharks have five to seven gill openings on each side. Instead of scales, sharks have toothlike growths called *dermal denticles* covering their skin.

The future of sharks

Perhaps more than any other animal on Earth today, sharks seem to embody successful evolution. Their extremely varied adaptations have helped them survive for hundreds of millions of years while many other species have gone extinct. Today, people are sharks' worst enemy, hunting millions each year. Sharks have been on Earth since long before the dinosaurs and yet, for some species, their existence is being threatened by overfishing and loss of habitat. By becoming knowledgeable about sharks, your students will become aware of the many threats to sharks and other aquatic animals and can become advocates for the future health of the world's oceans.



Activity 1

What Makes a Shark a Fish?

Sharks are fishes, but what makes them different from the fishes you're used to seeing in an aquarium? Begin your exploration of sharks to find out.

Objectives

Students will:

- brainstorm about sharks as a preassessment
- make comparisons between sharks and bony fishes
- learn basic characteristics of sharks

Goals and Standards

This activity meets:

Illinois State Goals in Science: Goals 1 and 4

National Science Education Standards:

Unifying Concepts and Processes Standard

K-4 Content Standards A and C

5-8 Content Standards A and C

Vocabulary

cartilage: an elastic connective tissue that makes up the skeleton of a shark

caudal fin: tail fin

dermal denticles: toothlike growths covering a shark's body

gill: an organ used to remove oxygen from the water

vertebrate: an animal with a backbone

Time

45 minutes

Materials

For each student:

- a copy of the Shark Diary cover on page 9
- pencil

For the class:

- overhead projector
- transparency of How Sharks Breathe overhead from page 8 and Shark Diary cover from page 9
- shark resource books

Background

Sharks belong to the same class of animals as bony fishes and share many of the same characteristics. Before distinguishing sharks from bony fishes, it is necessary to look at what makes a fish a fish. An animal must have the following three basic elements in order to be classified as a fish. All fishes:

- have a skeleton. In other words, they are vertebrates.
- possess *gills*, which are primarily used for breathing.
- have fins.

Sharks and bony fishes have the above three basic elements in common, but there are also a number of important differences:

- Although both sharks and bony fishes are *vertebrates*, the shark's skeleton is made of cartilage rather than the

many small, delicate bones that make up a fish skeleton. For this reason, sharks are known as cartilaginous fishes.

- Like bony fishes, sharks draw water into the body and extract oxygen as the water passes over the gills. However, sharks have five to seven uncovered gill slits on the sides of the head as compared to bony fishes with one gill opening protected by a bony flap.
- Sharks' fins are very stiff. This helps them remain stable in the water and allows some species to swim very quickly by depending mostly on their *caudal*, or tail fin. The fins of bony fishes, on the other hand, are very flexible. Bony fishes generally rely on all fins to propel themselves forward.
- Most sharks have mouths on the underside of the head with powerful jaws and many rows of teeth while the mouths of bony fishes are typically in front of the head, usually with the lower jaw protruding forward.
- Shark skin is covered with small toothlike scales called *dermal denticles*. Bony fishes have a thin skin covered by large, overlapping scales.
- While most fishes have a swim bladder filled with air to help keep afloat, sharks must always swim in a slightly upward direction in order to keep from sinking.

Procedure

1. Begin your study of sharks by asking your students what they know about sharks. Keep a record of their answers to be used as a preassessment.
2. To assist in the planning of your study of sharks, ask

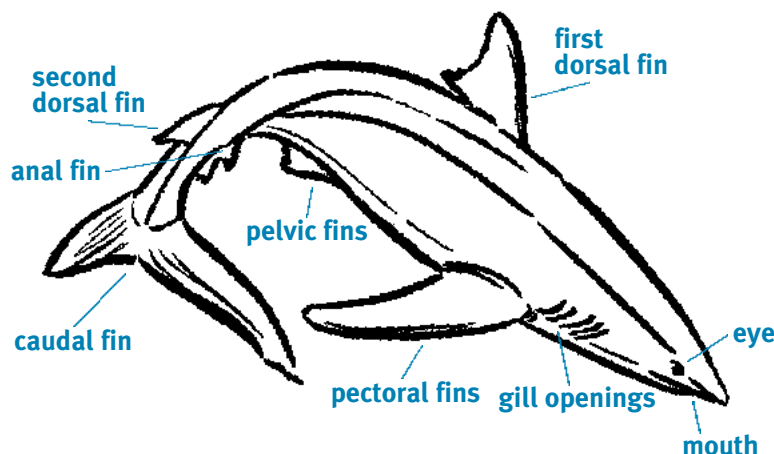
your students what it is they would like to learn about sharks. *What are they curious about? Are they afraid of sharks? Why?* Inform them that during your exploration of sharks over the next several weeks you will try to answer their questions as a group.

3. Your students are probably more familiar with bony fishes than they are with sharks. Lead a discussion with the aim of arriving at the three basic elements that define a fish as described in the Background. It would be helpful to have live bony fishes or photos of fishes for the children to observe during this part of your discussion. Ask the children to consider what it is that makes a fish a fish. They may answer that fishes live in water, which could result in a discussion of what it is that allows them to breathe underwater, i.e., the gills. They may suggest that all fishes swim, in which case you could lead them towards noting fins as a necessary element. Because the skeleton of a fish is not visible, it may not occur to them as an answer, but you may suggest it by comparing fishes to other creatures in the sea such as sea jellies (which have no skeleton) or crabs (which have external skeletons). Focusing on how these various animals move may help them envision the skeleton. If possible, show them a picture of a fish skeleton.

4. Now that your students have a sense of basic fish characteristics, ask, *“Are sharks fishes? What do sharks and other fishes have in common? In what ways are they different?”* Use the Background to guide your discussion.

5. Display the “How Sharks Breathe” diagram from page 8 on the overhead projector. Explain: *Like all fishes, sharks breathe by using their gills to get oxygen out of*

Answer key to Shark Diary cover



the water. First, a shark draws water into its mouth. As the water passes over the gills, oxygen that is dissolved in the water is transferred into the shark's blood by way of many small blood vessels. The water then exits out the gill slits. This process is similar to the way our lungs extract oxygen from the air to supply our blood.

6. Project the shark diagram from the Shark Diary cover on page 9. Discuss the various parts of the shark and their significance as you label the diagram on the overhead. Wherever possible, obtain input from the children. Give each student a copy of the Shark Diary cover page so students may label their own shark diagrams. Throughout your study of sharks, students can add pages to their Diary as they gain knowledge through their research. You may want to provide a folder for each student to keep all the shark information he or she gathers.

Extensions

Depending on what materials are available, ask students to draw, paint, or make a 3-D model of a shark with the parts labeled, which then can be displayed and/or shared with the class. Have children refer to a book about sharks for ideas.

Make a shark mural. Children can share the responsibility of creating the background as well as the variety of sharks you might like to include. Use this as an opportunity for your students to learn about shark habitats and prey, as well as underwater plant and animal life.

Make a class book about sharks. Each child chooses a favorite shark, illustrates it and includes the most salient facts such as habitat, size, prey, etc. Make the book part of your regular library of resources. Trade books with other classrooms in your school or share with your local library.

Additional Resources

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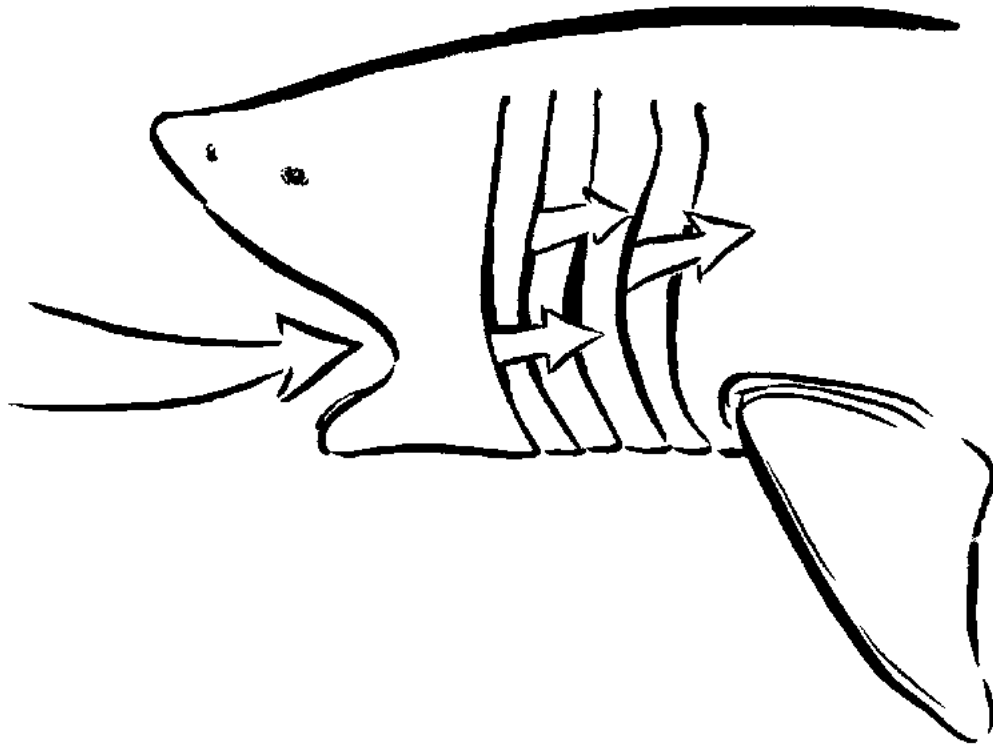
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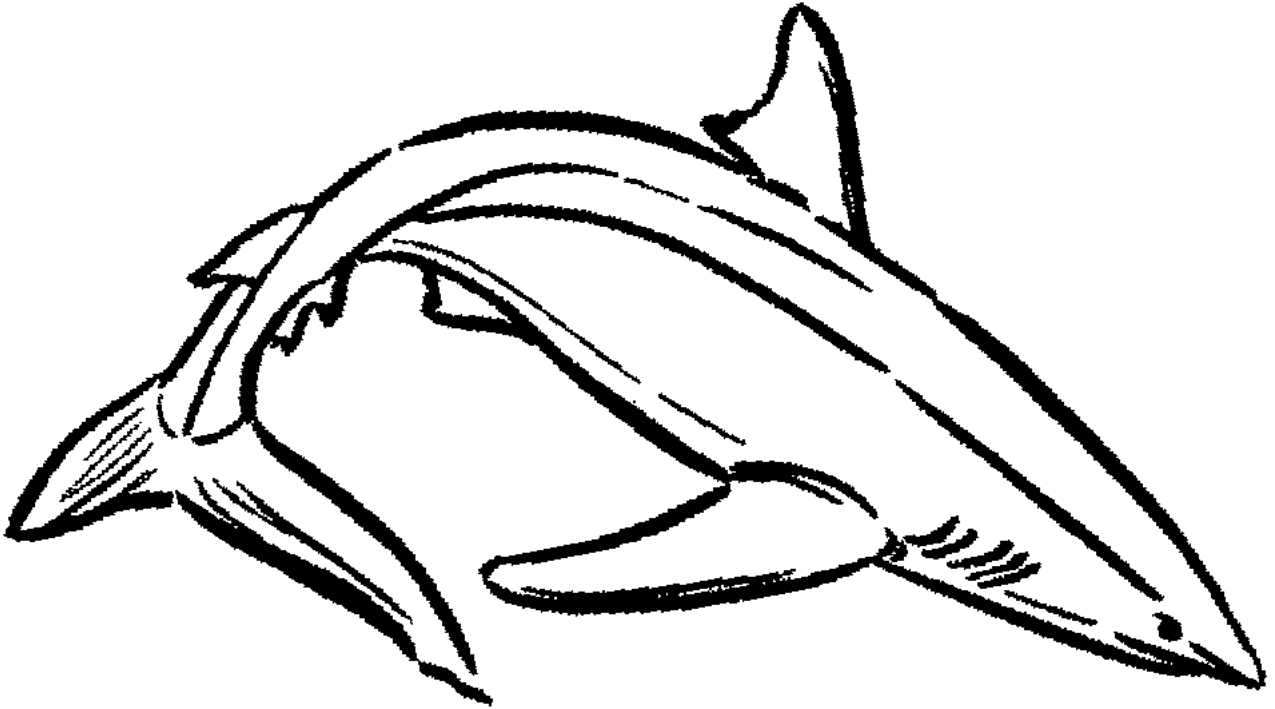
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How Sharks Breathe



Shark Diary



Name _____

Activity 2

What's in a Name?

What's so great about a great white shark? Does a cookie cutter shark make cookies? Find out as you explore the amazing diversity among shark species.

Objectives

Students will:

- investigate the diversity of sharks and make hypotheses about shark adaptations
- consider how a shark's structure affects its function
- become familiar with a number of shark species

Goals and Standards

This activity meets:

Illinois State Goals in Science: Goals 1 and 4

National Science Education Standards:

Unifying Concepts and Processes Standard

K-4 Content Standards A and C

5-8 Content Standards A and C

Vocabulary

barbels: fleshy “whiskers” used for feeling

gill rakers: comblike structures lining the inside of fish gills

plankton: drifting plants and animals found in all aquatic environments

Time

60 minutes (can be divided into two shorter time segments)

Materials

For each student:

- 11" x 17" photocopy of shark drawings on pages 14 and 15
- pencil
- one sheet 8¹/₂" x 11" paper
- ruler
- photocopy of Shark Parts on page 13
- bingo markers

For the class:

- shark resource books
- shark drawings on display

Background

The world's oceans are filled with approximately 370 species of sharks that represent a wide variety of characteristics. You and your students can get a good sense of the diversity of sharks by exploring a few unique shark species:

Whale sharks are not only the largest sharks, but also the largest living fish species, reaching a maximum of 18 meters (60 feet) and weighing as much as 20 tons. Despite their immense size, they feed on only the smallest prey and are not dangerous to humans. Whale sharks eat by filtering *plankton* out of the water through a sieve-like structure called *gill rakers*. In addition to its size, a whale shark can be identified by distinctive white spots and stripes on a background of brown skin, and a broad mouth filled with minute teeth.

Easily identifiable by the feature that gives **hammerheads** their name, these unusual-looking sharks range in size from 1 meter (3 feet) to 6 meters (20 feet). It is not known for certain the purpose of the hammer-shaped heads, but many scientists believe it gives these sharks a better field of vision. It has also been suggested that the location of the eyes protects the hammerheads from one of their favorite foods. Hammerheads prey on stingrays, which tend to lash out at attackers' heads with their spiny tails.

Nurse sharks* can be identified by their brown coloring and by the pair of *barbels* located at the corners of their mouths. They are able to suck up food such as crabs and shrimp from cracks in rocks and coral. As you can witness at Shedd Aquarium's coral reef exhibit, nurse sharks spend much of their day lying in a pile of up to several dozen individuals on the ocean floor. Nurse sharks can reach a maximum length of about 3.5 meters (15 feet).

A horn like spine located in front of each dorsal fin gives **horn sharks*** their name. Like the nurse sharks, they spend the day lying on the ocean floor protected by mottled green and muddy brown camouflage. Horn sharks feed on urchins, crabs and other shellfish and reach a maximum length of about 1 meter (3 feet). The distinctive blunt snout explains why they are also referred to as bullhead sharks.

Distinctive and striking dark-brown-to-black stripes on a silvery gray background make the **leopard sharks*** easy to spot. They live in shallow waters feeding on crustaceans, worms and fishes on the bottom of the ocean floor. These fast sharks swim along the bottom with their mouths wide open snapping up prey along the way. Leopard sharks grow to a maximum of 2 meters (7 feet).

Angel sharks differ from most other sharks with their unique flattened bodies and broad pectoral fins that are similar in shape to angel wings. Most of their day is spent half buried in the sand or mud camouflaged to blend into the ocean floor. They hunt at night, lying in ambush, waiting for small fishes to swim within striking distance. Angel sharks reach a maximum of 2 meters (7 feet).

Cookie cutter sharks, despite their small size (maximum 30 centimeters or about one foot) prey on very large animals—even whales. Their name derives from the fact that they feed by biting into their prey and then twisting with their razor-sharp teeth, leaving a perfectly round hole in the prey's flesh.

Thresher sharks are easily recognized by their enormously long tails—sometimes longer than their bodies. The long tail may be used to corral schools of small fish and then thrash at the group, stunning the fishes and making them easy to catch. These sharks swim mostly in the open ocean and reach a maximum length of 6 meters (20 feet).

*Sharks that can be seen at Shedd Aquarium

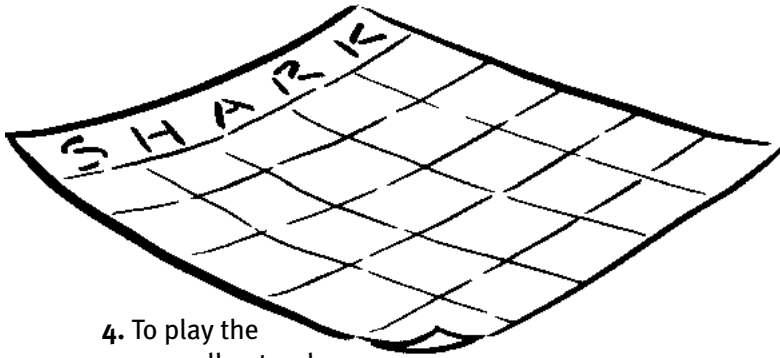
Procedure

1. In Activity 1, you focused on the similarities among sharks. During this activity you'll explore some of the diverse characteristics sharks have developed. Make a photocopy of the shark drawings on pages 14 and 15 for each student. Ask the children, "*If you were the scientist who first documented the existence of this species of shark, what would you name it?*" Discuss what others might have used to name sharks, i.e. color, where found, size, etc. Point out that the sharks in the drawing are made approximately to scale. For example, the largest shark (whale shark), is many times larger than the smallest (cookie cutter shark). If possible, show children photographs of the sharks to give them a more complete picture. Ask children to write their invented name on the top line beside each shark on their photocopy.

2. Reveal the actual name of the species shown and ask the children to write the names on the lower line beside each shark. Using the Background, lead a discussion as to the origins of the names. Many sharks are named after the traits and characteristics they possess. Ask the children to make hypotheses about why each shark developed these adaptations. Explain to the children that it is not so much the name that is important, but rather the differences among sharks and how those traits help each species adapt and therefore survive. Point out that even scientists who have studied sharks for years cannot answer all of these questions in part because sharks are difficult to study. Only a few species can be studied in aquariums, and those in nature often move very quickly or stay in such deep waters that they are not often observed directly by humans.

3. You can both assess and reinforce what the children have learned from this discussion by playing a game of Shark Bingo. Have each child construct their own Bingo game card by first creating a grid containing five squares down and five across each 4 centimeters square. Instruct the children to write S-H-A-R-K

across the top of the grid placing one letter above each column. Give each child a copy of the *Shark Parts* page to cut out individual squares and glue or tape the pictures onto the grid he or she created. Or, for a more challenging game, the names of the species can simply be written in each square. Children should not use any species more than once in a column or row. Encourage the children to place their sharks as randomly as possible so the chances for more than one child “winning” at a time are reduced.



4. To play the game, call out a clue about one of the sharks on their sheet. For example, “S—The shark that uses its tail to stun its prey,” or “H—the largest shark.” Use the Background for information on each species. Make the clues progressively more difficult. Note how well the children are identifying the various species as an assessment of their knowledge of these shark species.
5. As a variation, once the children become familiar with these sharks, you might allow the children to play in small groups and have one of the children call out the clues. You might create small groups named after types of sharks. Children could vote on their favorite shark or could be placed in a group in a more random way such as by drawing names. These groupings could then be used during all of your future shark explorations.

Answer key to shark species names on pages 14 and 15:

- | | |
|------------------|---------------|
| 1. whale shark | 18 meters |
| 2. hammerhead | 1 to 6 meters |
| 3. nurse | 3.5 meters |
| 4. horn | 1 meter |
| 5. leopard | 2 meters |
| 6. angel | 2 meters |
| 7. cookie cutter | .3 meter |
| 8. thresher | 6 meters |

Answer key to shark parts (from left to right):

whale shark, hammerhead, nurse, horn, leopard, angel, cookie cutter, thresher

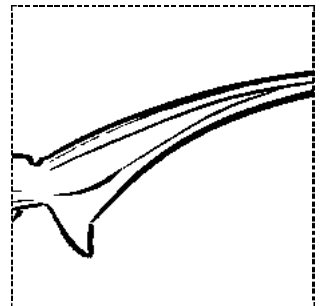
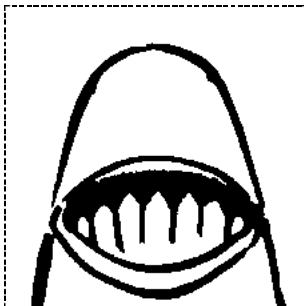
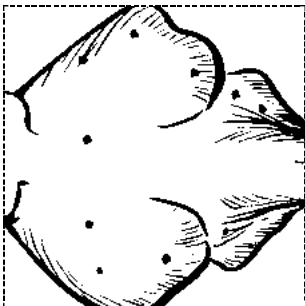
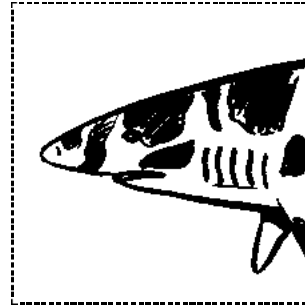
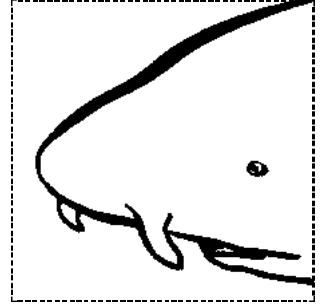
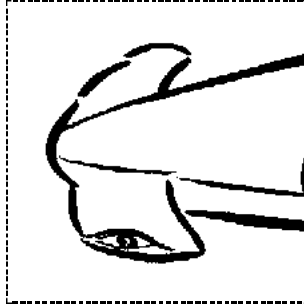
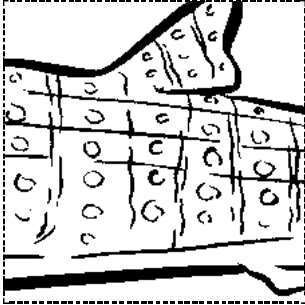
Extensions

Once the children have mastered these sharks, have them research other species and create new bingo boards.

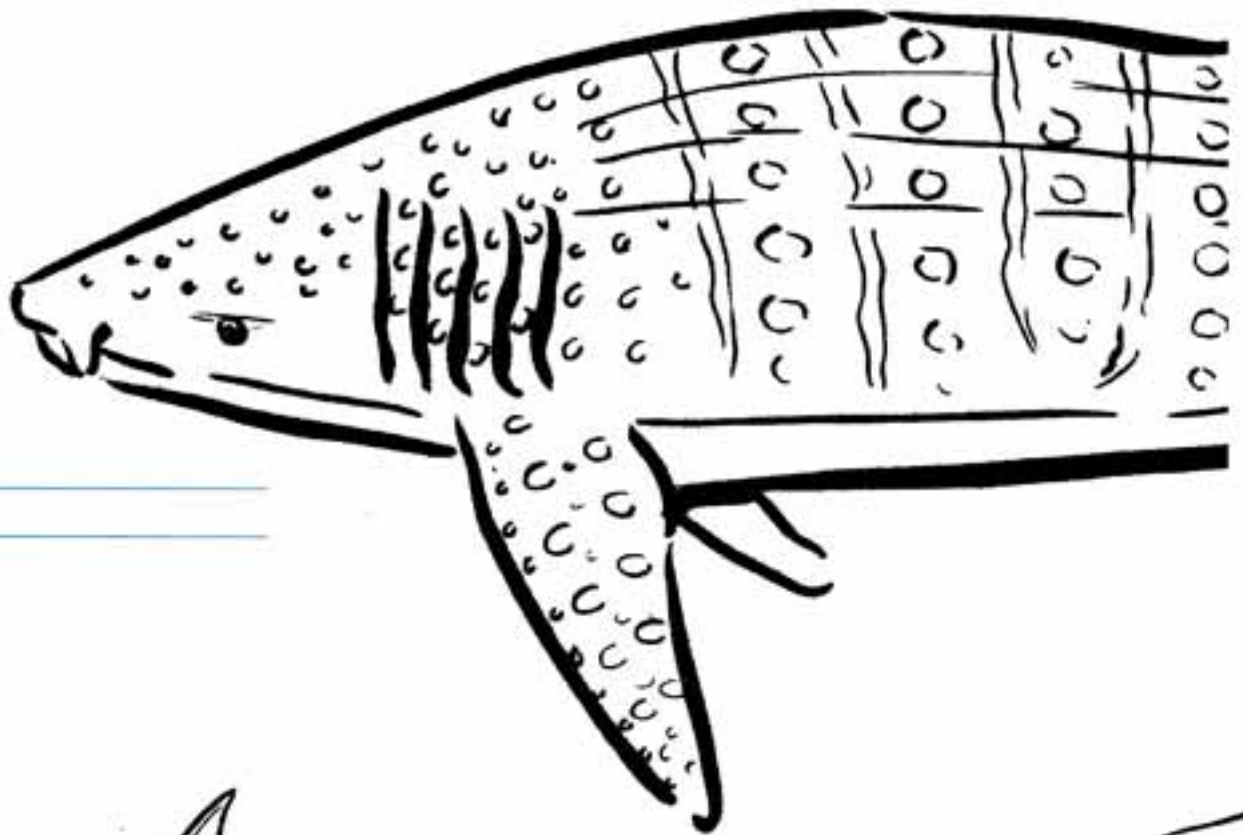
Additional Resources

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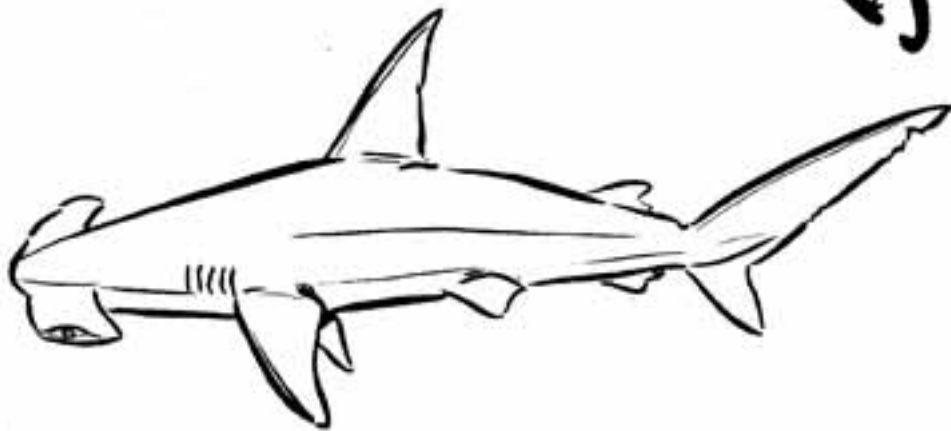
Shark Parts



Sharks



1.



2.

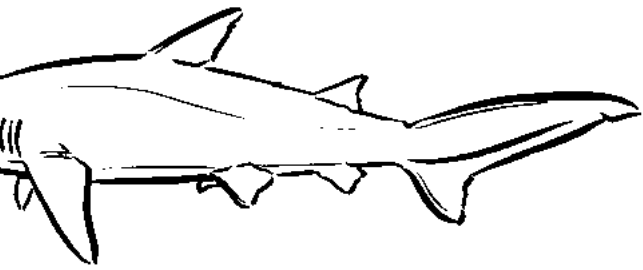
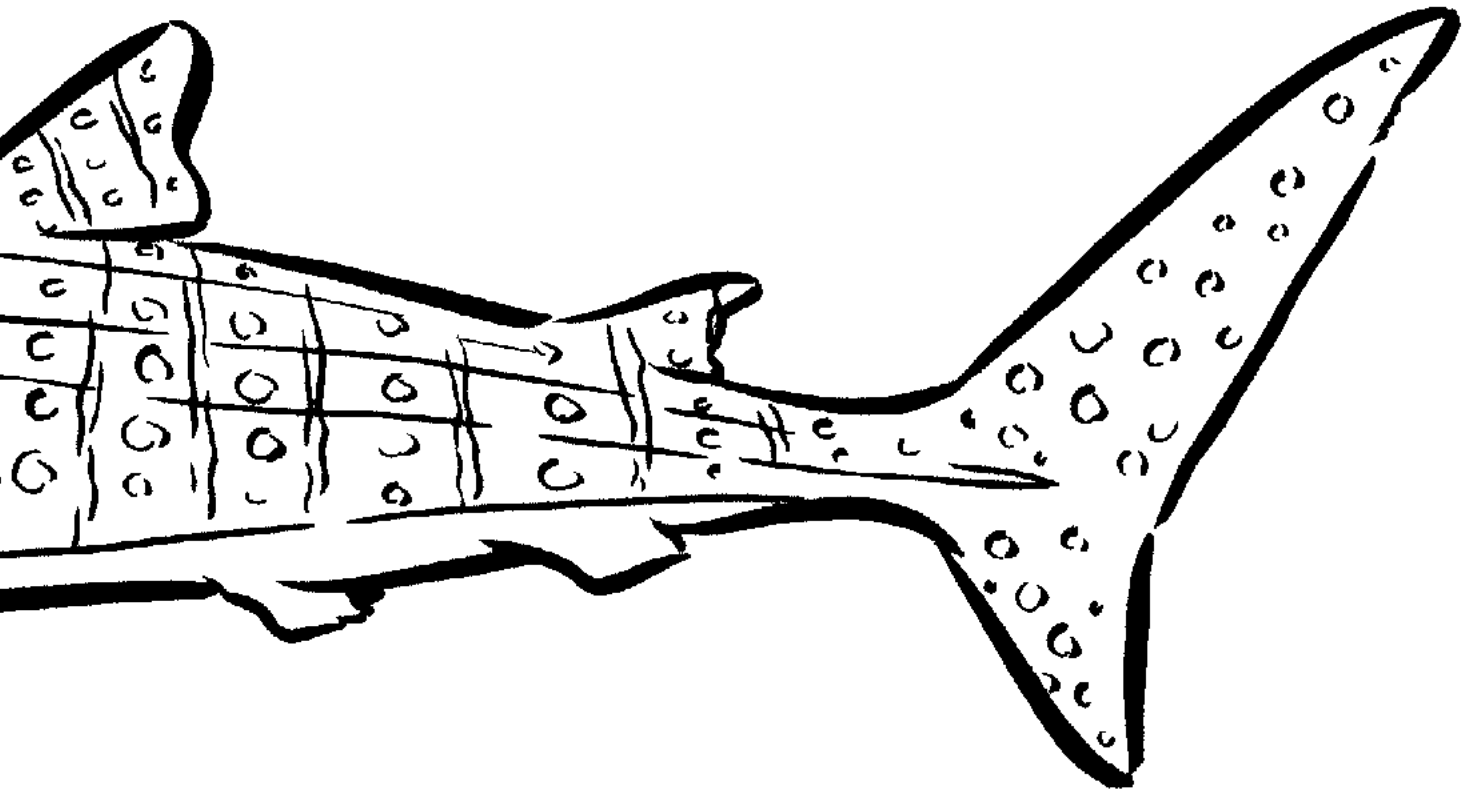
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5.

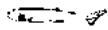


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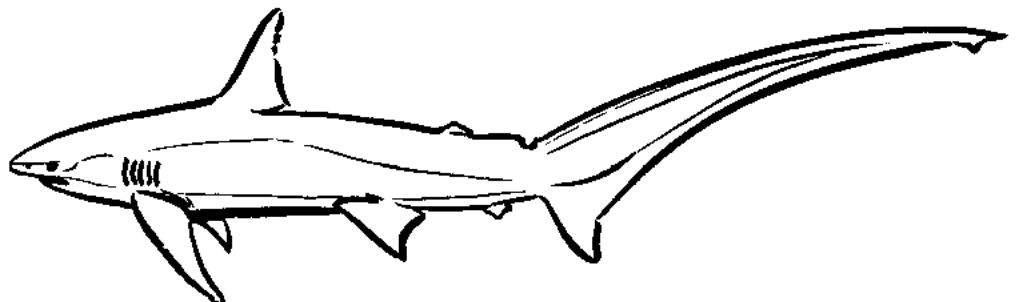




4.



7.



8.

Activity 3

Pretty Smart for a Hammerhead

Sharks are often viewed as primitive fishes. Yet, they have highly developed senses—even one that allows them to locate prey by sensing its electricity!

Objectives

Students will:

- model how sharks locate prey by sensing electrical charges
- learn the function of the ampullae of Lorenzini

Goals and Standards

This activity meets:

Illinois State Goals in Science: Goals 1 and 4

National Science Education Standards:

Unifying Concepts and Processes Standard

K-4 Content Standards A, B, C

5-8 Content Standards A, B, C

Vocabulary

ampullae of Lorenzini: system of tiny, jelly-filled capsules on the shark's snout that are sensitive to minute electrical discharges

Time

30 minutes

Materials

For each student:

- balloon
- dark colored marker
- clear tape

For each group (or for the class):

- small aluminum pie tin
- baby food jar or similar small clear glass jar

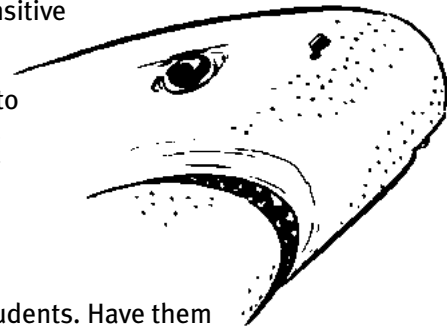
Background

All living creatures give off small electrical signals as they breathe or move. Sharks have a remarkable receptor system called the *ampullae of Lorenzini* which enables them to detect even the faintest electrical field generated by another animal. The ampullae are so sensitive that they can perceive an electrical charge as minute as one-millionth of a volt. They consist of a pattern of hundreds of dark, tiny holes on the shark's snout that almost look like the beginnings of a beard. Sharks use these extremely sensitive organs to locate predator or prey underwater at close range.

Studies have shown that the ampullae of Lorenzini can also be used by sharks to navigate and orient themselves with respect to the Earth's magnetic field. It is believed that this ability helps direct sharks to the same breeding grounds year after year.

Procedure

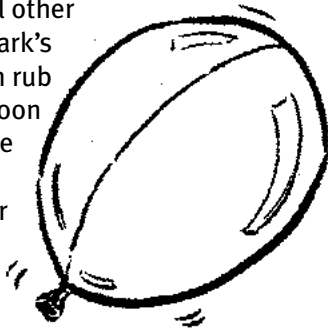
1. To prepare for this activity, make one or several electroreceptors with your students. Have them bend the paper clip open and hook it through the pie tin so that it hangs off the bottom. (See illustration.) Instruct



them to attach the small pieces of aluminum foil to the paper clip and set the pie tin over the jar making sure the foil hangs freely and does not touch the sides or bottom of the jar. Use a piece of clear tape on either side of the jar to secure the tin to the jar.

2. Ask each child to inflate a balloon and then draw a line around it with a marker as shown below.

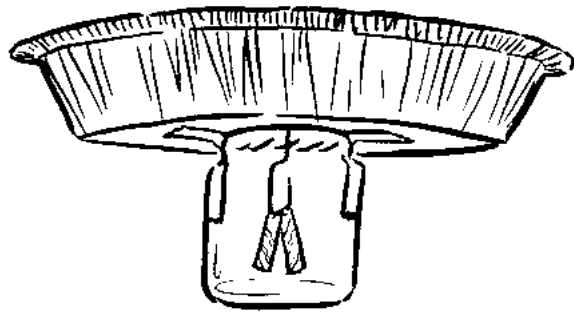
3. Designate one student as the shark and ask him or her to leave the room. While the “shark” is out of the room, choose several other children to be the shark’s “prey.” The prey then rub one side of their balloon (using the marker line as a boundary) back and forth across their hair to create static electricity. Only one side of the balloon should be used because the charge can only be held on one side. Children who are acting as prey should note which side they charged and offer that side to the shark.



4. Have the student playing the shark return to the classroom. Explain that the classroom has become a coral reef. Each balloon represents either a part of the reef or a camouflaged fish that is the shark’s prey. The shark is unable to see the difference between balloons and the prey fish so it must use its ampullae of Lorenzini to detect the electrical charges given off by the prey. (See Background.)

5. The shark then searches your simulated coral reef by placing the electroreceptor near but not touching each balloon to find out which balloons activate the aluminum foil. Explain to the children how the homemade electroreceptor works in a similar way to the shark’s ampullae of Lorenzini. In this activity the balloon initially has a neutral charge. Rubbing the balloon builds up the electrons (the negative charge) and creates static electricity. The aluminum pie tin also is neutral but when placed near the negatively charged balloon, its electrons are repelled. The electrons move as far away from the balloon as possible, which in this case is the hanging aluminum strips causing them to move apart.

6. This activity can be repeated as many times as you like. Simply deactivate the electrical charge in the balloons by wiping them with a damp cloth so that different children can become the prey.



Extensions

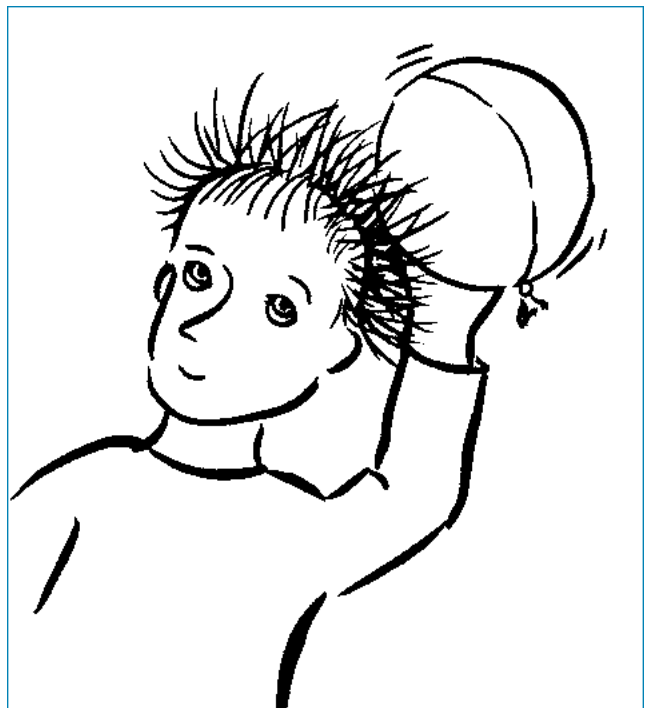
Research other animals that use electricity to avoid predators or to locate prey.

Additional Resources

Hall, Howard. *Sharks: The Perfect Predators*. San Luis Obispo, California: Blake Publishing, 1990.

Sattler, Helen Roney. *Sharks, the Super Fish*. New York: William Morrow & Company, 1986.

Welsbacher, Anne. *Hammerhead Sharks*. Minneapolis: Capstone Press, 1995.



Activity 4

Making Sense of Sharks

From dark, deep waters to shallow sandy beaches, sharks' incredibly sharp senses make them the ocean's most successful predators. Get a sense of how sharks use their senses.

Objectives

Students will:

- learn how sharks use an integrated system of senses to locate prey
- make comparisons between human and shark senses

Goals and Standards

This activity meets:

Illinois State Goals in Science: Goals 1 and 4

National Science Education Standards:

Unifying Concepts and Processes Standard

K-4 Content Standards A and C

5-8 Content Standards A and C

Vocabulary

lateral line: network of sensory cells interconnected by fluid-filled canals running the length of a shark; canals are attached to nerves that are very sensitive to sound or pressure waves

Time

30 minutes

Materials

For the class:

- overhead projector
- shallow glass or clear plastic dish with 1 inch of water
- “fishing pole” such as a broomstick
- small rag or towel
- strong-smelling solution such as vinegar, perfume, or extract

Background

In the ocean, sharks hold the same position as the lion on the African plains—the top of the food chain. Their only enemies are humans, larger sharks and killer whales. But what makes them such successful predators? Thanks to a highly developed system of senses, there is very little that escapes a shark's notice. Even in complete darkness or buried in the sand, prey is not safe from the shark.

In Activity 3, *Pretty Smart for a Hammerhead*, you introduced your students to the ampullae of Lorenzini, a sense unique to sharks but one that can only be used at close range. The shark's other senses are very effective at locating prey at a variety of distances.

Sharks' sense of smell is highly developed. In fact, two-thirds of their brain is devoted to smell, explaining why sharks are often referred to as “swimming noses.” Sharks use their nostrils to smell, but unlike us, they do not use them for breathing. Instead, water constantly passes through the nostrils, and even the slightest odors are detected. In fact, some sharks have the ability to smell one part of blood in 100 million parts of water. By turning its head from side to side, a shark can also tell from which direction the smell is coming.

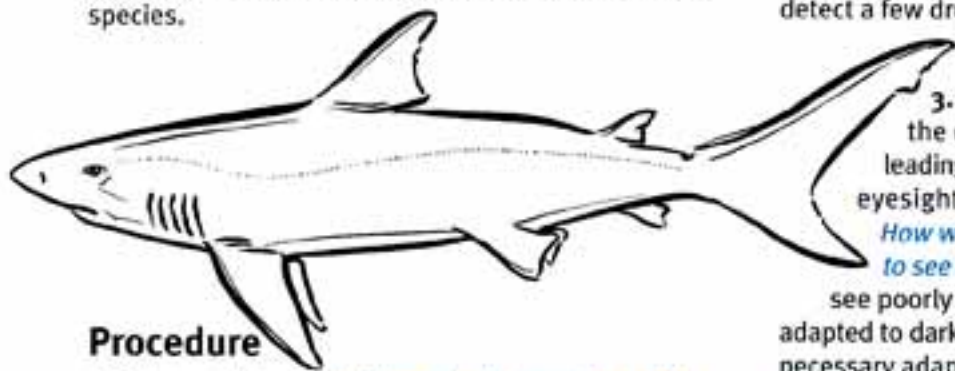
How well a shark sees depends upon several factors such as where it lives and what it eats. For example, sharks

that live in deep waters tend to have eyes adapted to seeing in the dark while species that don't rely on sight for catching prey may have poor eyesight. Many sharks, similar to cats, can see well in low light levels due to a series of mirrorlike surfaces inside the eye that reflect light back through the retina.

From even farther away (as much as 3,000 feet), sharks use their sense of hearing to locate prey. Sound travels through the water and enters a pore on top of the shark's head and travels to receptors in the inner ear. Experiments have shown that sharks are especially sensitive to low-frequency sounds such as those made by struggling or injured fish.

Sharks' hearing is integrated with another sensory organ called the *lateral line* (add to Shark Diary cover), which detects minor pressure changes in the water. On many sharks and other fish, the lateral line is visible as a canal that runs beneath the skin along the length of each side of the body. This organ also is used by sharks to establish their balance and orient themselves in the water. It even enables sharks to detect a fish at rest by its heartbeats reverberating in the water. (See illustration.)

In general, sharks are highly sensitive to chemical odors, mechanical movement and electrical fields, giving them a clear advantage over almost any other species.



Procedure

1. Tell your students, *"We've already investigated the ampullae of Lorenzini, a very helpful sense sharks have that distinguishes them from us. However, this sense can only be used by the shark at close range. How else might sharks detect prey? How do their senses compare to ours?"* Begin your discussion about shark senses by explaining the lateral line and hearing to your students. (See Background.) Both of these senses help the shark by detecting movement or vibrations in the water. To help them gain a better understanding of how water moves in a way that sharks can detect, try the following activity. Place a clear shallow container such as a glass baking pan filled with about 1 inch of

water on top of an overhead. Try dropping a variety of small objects such as a paper clip or piece of rice into the water. Or ask one of your students to lightly place a finger in the water. Your students will be able to observe that even the smallest objects create visible waves. Ask the students to imagine what it would be like to be able to detect that amount of movement without using your eyes from over 600 feet away as the shark can. Help them understand how far 600 feet is by comparing it to another location in your school such as the principal's office or the playground.

2. By comparing our sense of smell to that of sharks', your students will develop an idea of just how keenly sharks can smell. Tie string to the end of your "fishing pole" and attach a small towel or rag. Create your smell target (the prey) by soaking the towel in a strong smelling nontoxic solution such as vinegar, perfume, or an extract. Have one child hold the pole and blindfold another child instructing him or her to attempt to find the prey only by smell. (A variation of this activity is to soak cotton balls in the smell solution and hide them around the room. Depending on how difficult you would like to make it, children could be blindfolded.) Your students will probably find this difficult to do even when they are very close to the target. Compare the results of this experience with the sharks' ability to detect smell. (See Background.) In fact, sharks can detect a few drops of blood in the amount of water it takes to fill a swimming pool.

3. Discuss sharks' sense of sight with the children using the Background. Ask leading questions to get them to consider how eyesight is adapted in sharks. For example, *How well do you think sharks would be able to see above water?* (Most likely, sharks would see poorly above water because their eyes are adapted to darker environments and it would not be a necessary adaptation.) *Why might some sharks have bigger eyes than others?* (Some sharks that live in deep waters have larger eyes in order to take in more light.)

4. Challenge your students to hypothesize the order in which sharks might use their senses to find their prey. For example, *"Which sense might first alert the shark that prey is nearby?"* You might have the children role-play a scenario in which the shark finds food. For example, place a plastic fish or picture of a fish in a central location in your classroom to represent the shark's prey. Assign different children to take on the role of each of the senses—smell, hearing, sight, lateral line and the ampullae of Lorenzini. Ask them to stand

in order in comparison to the fish. (See illustration.) You may need to review some of the Background information. (Generally, a shark will first locate its prey through hearing or the lateral line, then will home in with smell, sight and, finally, the ampullae of Lorenzini.)

Extensions

Conduct Step 4 of the activity in a large, open space such as the school gymnasium or playground using the actual distances in which sharks may utilize their various senses. Ask children to mark off the distances using a tape measure.

Ask the children to conduct research to find examples of how the senses of various shark species have developed differently based on their habitat and prey.

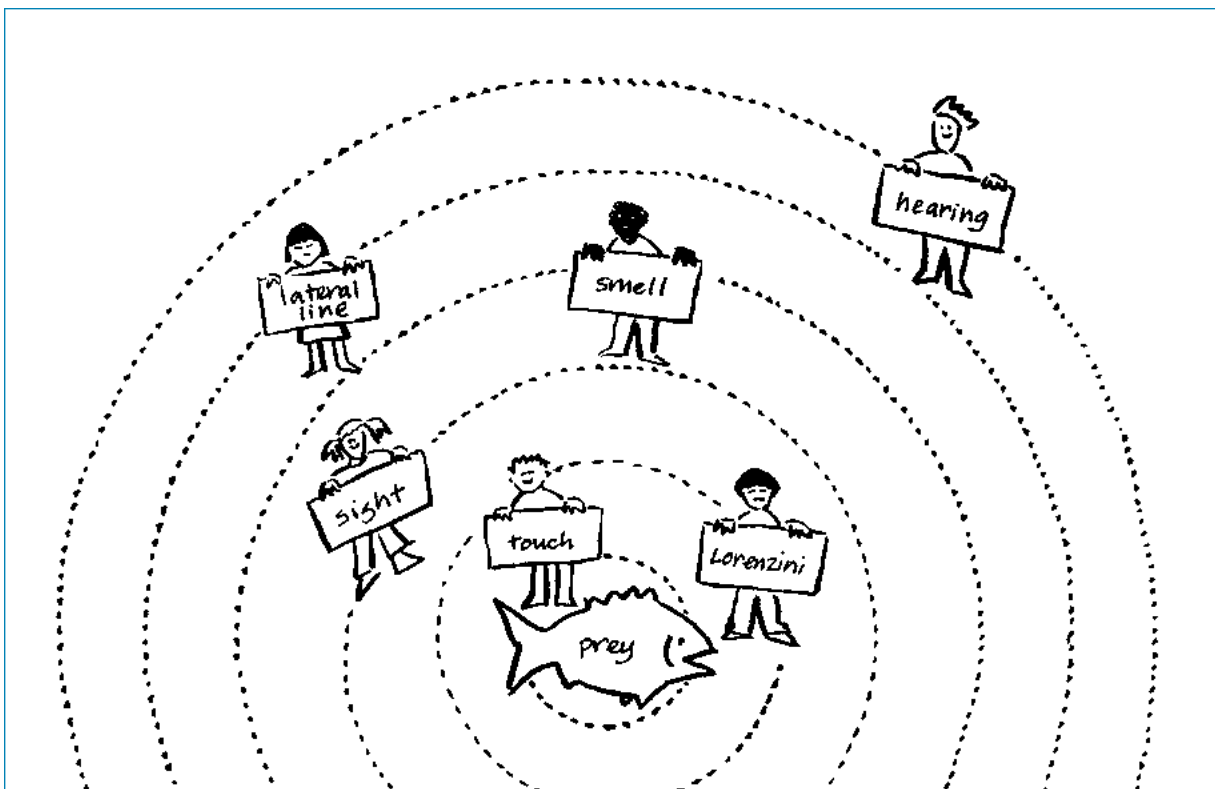
Additional Resources

Dingerkus, Guido. *The Shark Watchers' Guide*. New York: Julian Messner, 1985.

MacQuitty, Miranda. *Shark: Eyewitness Books*. New York: Alfred A. Knopf, 1992.

Maniguet, Xavier. *The Jaws of Death: Shark as Predator, Man as Prey*. New York: Sheridan House, 1991.

Wexo, John Bonnett. *Zoobooks 2: Sharks*. San Diego: Wildlife Education, Ltd., 1983.



Activity 5

This Old Shark

Sharks are sometimes called living fossils. But just how long have they been around? Make a time line to find out.

Objectives

Students will:

- gain an understanding of the evolution of sharks in relation to other species present on Earth today
- represent the passage of time on a time line

Goals and Standards

This activity meets:

Illinois State Goals in Science: Goals 1 and 4

National Science Education Standards:

Unifying Concepts and Processes Standard

K-4 Content Standards A and C

5-8 Content Standards A and C

Time

40 minutes

Materials

For each student:

- pencil and marker
- ruler or measuring tape

For the class:

- paper strip for time line (length and width will vary according to your space)

Background

Sharks' highly developed senses helped enable them to attain their position as top predators in the oceans, and to maintain it for millions of years. Most scientists agree that today's sharks originated from earlier species dating back about 400 million years. By comparison, dinosaurs did not appear until about 250 million years ago and experienced a mass extinction about 65 million years ago. There is no consensus as to what caused the dinosaurs' extinction, but many experts believe it was due to some sort of cataclysmic event. Humans, in relative terms, are the newcomers on Earth. Our earliest ancestors emerged only 5 million years ago.

Procedure

1. Determine the width and length of your time line (the wider and longer the better) according to your wall space:

Length—You will need to represent 400 million years on your time line, so you may want to use a scale of 1 centimeter or 1 inch equal to one million years. A larger scale would be better, but it may be impractical. Your time line could be placed around the perimeter of your classroom above the chalkboard, in the hallway, library, or wherever you have access to running wall space.

Width—Because the children will be adding events to the time line, the wider the paper, the better it can accommodate the children's ideas. If your vertical space is very limited, you might use a cash register tape roll or a roll of craft paper cut to the appropriate width. If you don't have access to a roll of paper, you may cut any size paper and tape it together to get the correct length.

2. Once you have determined the scale of your time line, you can have the children get started on marking off the years. Explain to your students that you will be making a time line to show how long sharks have been on Earth. Inform them of the unit of measurement you have chosen to mark off each one million years (i.e. one inch or one centimeter) for a total of 400 million years. Have them work in small groups on the time line, marking each line representing one million years in pencil. After you've checked their work, ask them to go over the pencil lines and add the written numbers (every 10 million years) in marker. (See below.) If you are using separate strips of paper, you may want to lay out each of the pieces in the correct order and tape them together before adding the marker lines and numbers. Hang the time line in the designated location.



3. Start your discussion by asking children to think of important dates in history as far back as possible, long before they were born. They may come up with answers such as the Civil War or Columbus' voyage to America. Ask them to mark the time line with these events. They should immediately notice how relatively recently these events occurred.

4. Encourage them to go even further back, for example, to when dinosaurs lived. Most scientists agree that dinosaurs originated about 250 million years ago and were all suddenly extinct by 65 million years ago. Mark the time line with these two dates. What about humans? Fossil evidence shows that our ancestors originated about 5 million years ago. Mark the time line. When did sharks appear? (See Background.) Ask the children to make comparisons in their Shark Diaries among sharks, dinosaurs and humans, and then share their thoughts. They could also respond to, "What does the time line tell us? Why have the sharks been on Earth so long? Why have sharks survived while dinosaurs have become extinct?"

If they list events for which you don't know the date, tell the students you will research the topic as a class the next time you visit the school library. (If this is not possible, tell them you will bring in reference books that will provide more information.)

4. To continue your exploration of evolution and time, assign the children to research the origin of other animals such as the alligator, cockroach, turtle, first birds, first mammals, etc. Or allow the children to choose an animal group to research. Ask the children to mark the time line with their findings. Again ask them to make comparisons between the animals.

Extensions

Ask the children to research the extinction of dinosaurs and devise a theory explaining both their disappearance and a reason why the sharks survived.

With the help of a librarian, encourage your students to research geological eras such as the Paleozoic when sharks first appeared, the Mesozoic when dinosaurs thrived and then became extinct, and the Cenozoic. Add this information to your time line.

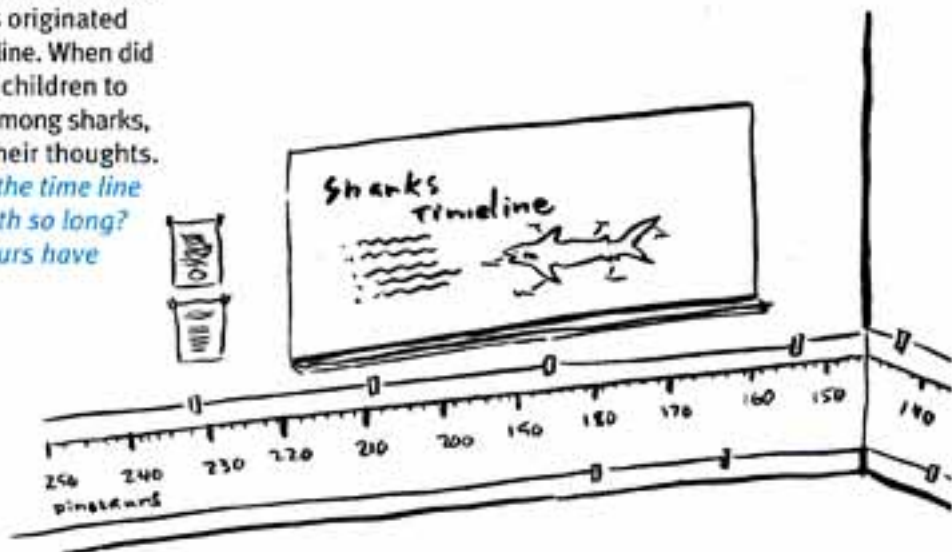
Additional Resources

Bridgewater, Peter. *Sharks: A Close-up Look at the Sea's Most Frightening Creatures*. Philadelphia: Running Press Book Publishers, 1993.

Ellis, Richard, and John E. McCosker. *Great White Shark*. Stanford, California: Stanford University Press, 1991.

Eyewitness Visual Dictionaries. *The Visual Dictionary of Prehistoric Life*. London, Dorling Kindersley, 1995.

Hall, Howard. *Sharks: The Perfect Predators*. San Luis Obispo, California: Blake Publishing, 1990.



Activity 6

My, What Sharp Teeth You Have

What can we learn about a shark by looking at its teeth? Sharks' teeth give us many clues about its diet and size, even for a species that are extinct.

Objectives

Students will:

- make comparisons between a great white shark and the extinct *Carcharodon megalodon*
- infer relationships between the form and function of the teeth of various species
- make puppets to simulate the attack mode of sharks

Goals and Standards

This activity meets:

Illinois State Goals in Science: Goals 1 and 4

National Science Education Standards:

Unifying Concepts and Processes Standard

K-4 Content Standards A and C

5-8 Content Standards A and C

Vocabulary

dermal denticles: toothlike growths covering a shark's body

Carcharodon carcharias: scientific name for the great white shark

Carcharodon megalodon: extinct species of shark related to the great white

genus: a taxonomic category ranking below a family and above a species

Time

40 minutes

Materials

For each student:

photocopy of Shark's Teeth on page 26

pencil

small paper bag

white paper

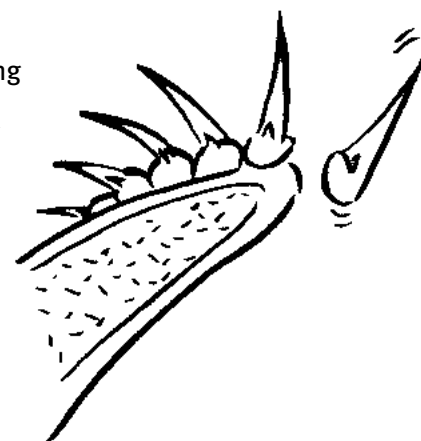
glue

For the class:

shark resource books

Background

Often when we envision sharks, our mental image includes razor-sharp, menacing teeth. Most sharks do have very sharp teeth but, mostly as a result of diverse diets, there is an amazing variety of teeth among shark species. No matter what kind of teeth a shark has, it continuously grows new ones on a system similar to a conveyor belt. As teeth fall out or are worn out, they are replaced by a tooth from the row behind. When a shark is growing, it may replace its teeth as often as every seven days resulting in thousands of teeth over the shark's life. The shark's entire body is also covered with tiny teeth called *dermal denticles* that act as both a weapon and defensive armor.



Because sharks have skeletons of cartilage that does not preserve well, the only fossil evidence we have of extinct species are the teeth. Many teeth samples of *Carcharodon megalodon*, an extinct relative of the great white, or *Carcharodon carcharias*, have been found. Because we have no other evidence of their existence, scientists estimate its size by comparing its teeth to that of the modern great white. Your students can participate in a similar process of scientific inquiry by making this same comparison.

Procedure

1. This activity allows you to continue your study of shark evolution begun in Activity 5 by making comparisons between the teeth of modern-day sharks and those of the extinct species *Carcharodon megalodon*. Begin by giving each child a photocopy of the Shark's Teeth on page 26. Tell the children, *Pretend you are an archaeologist who has discovered a giant shark's fossilized tooth.* (Refer to the large tooth on the page.) Because you know that you are not likely to find any other fossil evidence (see Background) you will need to figure out as much as you can using just this tooth. *What do you think you can learn about the shark from which this tooth came? What does the size of the tooth tell you about the shark? What might this shark have eaten? Because of its enormous size, you might be able to hypothesize that it is from an extinct species. To which of today's species do you think it is most closely related?* Scientists have named this species *Carcharodon megalodon*, putting it in the same *genus* as the great white shark. This means they believe the ancient shark was not a direct ancestor of the great white but as closely related as, for example, a lion and a tiger.
2. Ask your students if they can think of a way to determine the approximate size of the extinct shark. They may suggest measuring the teeth of both the *Carcharodon megalodon* and the modern great white. The children should determine that the *Carcharodon megalodon* tooth is approximately 14 centimeters (5 1/2 inches) long and the great white tooth is 6 centimeters (2 1/3 inches). We know that a modern great white can grow as long as 6 meters (20 feet). Challenge them to devise an equation that will help them make comparisons between the length of the two species. If they are unable to come up with their own method, provide them with the following equation, explaining how it could give them an estimation of the extinct shark's size.

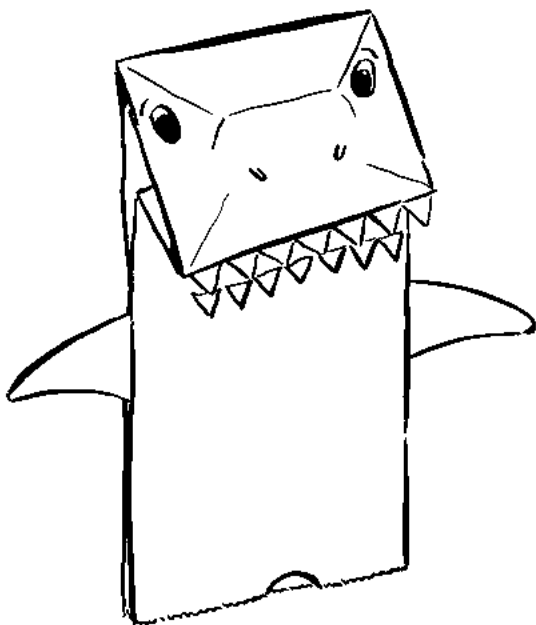
<u>great white tooth</u>	x	<u>megalodon tooth</u>
length of great white	or	length of megalodon
6 cm	x	14 cm
6 meters		x meters

There are several ways to solve this equation. One is to multiply the length of the great white (6 meters or 600 centimeters) by the size of the megalodon tooth (14 centimeters) for a total of 8400 meters. Then divide by the size of the great white tooth for an answer of 1400 centimeters or 14 meters (50 feet) as the approximate length of the megalodon. Another simpler way to arrive at the same answer is to note that the length of the great white is 100 times as long as the length of its tooth. Apply this to the megalodon by multiplying 14 centimeters by 100 to arrive at 1400 centimeters or 14 meters.

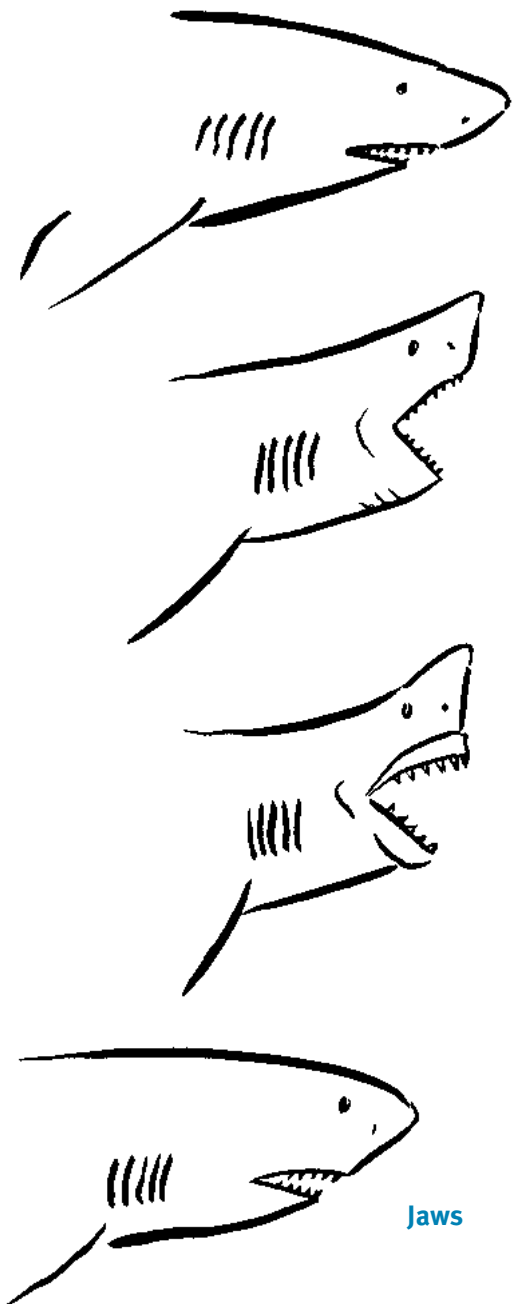
3. To help the children get a better sense of the megalodon's size, have them measure 14 meters (50 feet) in the hallway or other long space. Ask, *What would a shark that size eat?* Remind students that this is just an approximate guess and that we can never know the actual size of an extinct species of shark unless a fossil is found. Instruct students to write the length of the megalodon on the line provided on the Shark's Teeth sheet including a written or mathematical explanation.
4. Ask the children to refer to the other teeth on their handout and to hypothesize why different species of sharks have different sized and shaped teeth. Provide them with resource books so they can see photographs of shark teeth and gain more information about their form and function. In general, the size and shape of teeth are related to the type of food the shark eats and the way it hunts. A great white shark's triangular teeth are perfect for biting large chunks out of prey. The serrated edges then work like steak knives to tear apart the prey. The world's largest shark has some of the smallest teeth. Whale sharks have rows of tiny teeth that act like a sieve to filter plankton as they cruise along at a slow pace. Tiger sharks have multi-purpose teeth with both a sharp tip to impale and hold prey, and a serrated edge for cutting. When a tiger shark feeds upon larger prey, it shakes its head from side to side to tear off chunks. Using small, pointed front teeth to grab prey, Port Jackson sharks then utilize their flat back teeth to crush their hard-shelled

prey. The cookie cutter shark attaches itself to prey with strong lips and uses many sharp, even teeth to bite out a plug of flesh. Instruct students to include information about the sharks' prey on their Shark's Teeth page and then add it to their Shark Diary.

5. With sharp teeth and powerful jaws, most sharks are dangerous predators. They also have the further advantage of the ability to change the whole shape of their jaws when taking a bite of their prey. (See illustration.) You can simulate this amazing adaptation by making a shark puppet out of a small paper bag. Give each child a bag and ask them to cut out a number of white teeth to glue along the bottom of the folded edge of the bag to represent the top layer of teeth and a second corresponding row underneath. (See illustration.) If desired, you can have them add other shark features such as eyes and fins. Have them strive for accuracy by referring to posters or books. Keeping their hands folded inside and moving horizontally will imitate how the shark moves when it is simply cruising.



To simulate the attack mode, the children can open their hand, pushing their "jaw" forward, thereby changing the whole shape of the head. (See illustration.) Ask, *What happens to the eyes when the shark is attacking?* They should notice that they slide back and are protected.



Additional Resources

MacQuitty, Miranda. *Shark*: Eyewitness Books. New York: Alfred A. Knopf, 1992.

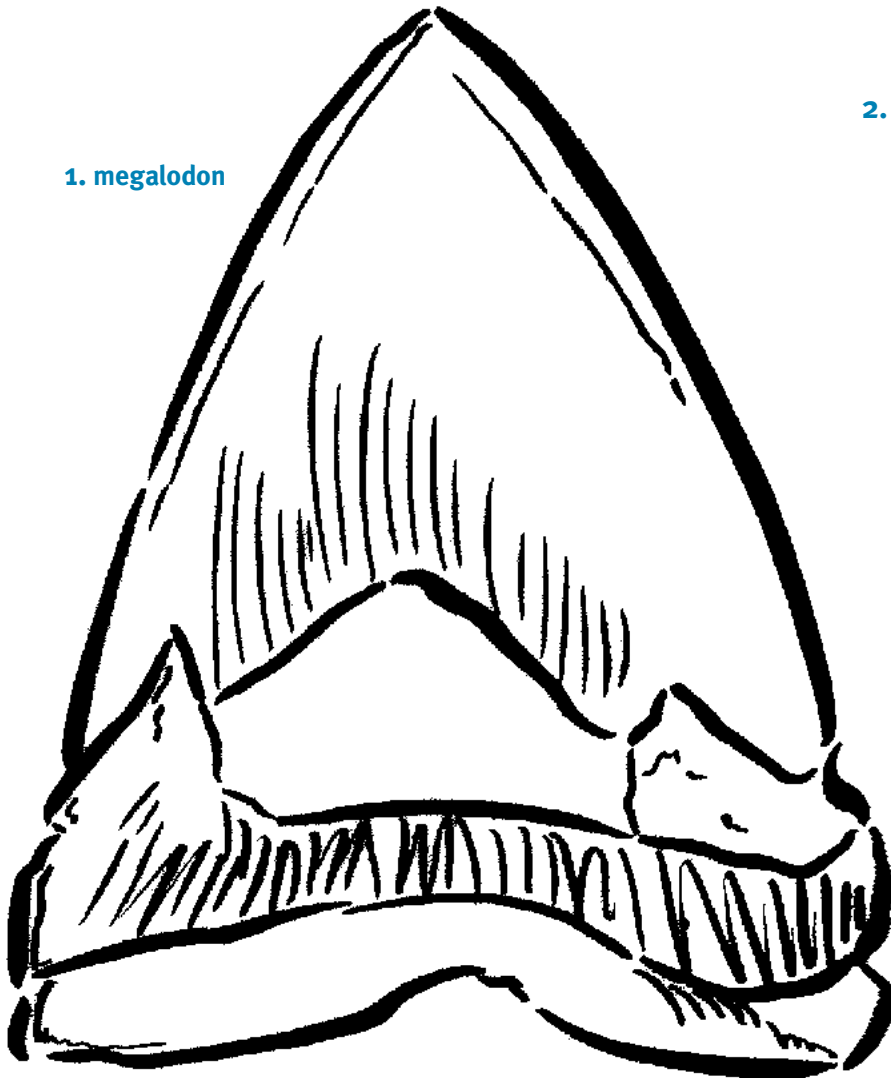
Springer, Victor G., and Joy P. Gold. *Sharks In Question*. Washington, D.C.: Smithsonian Institution Press, 1989.

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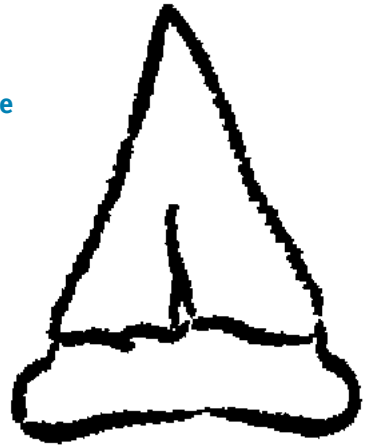
Wexo, John Bonnett. *Zoobooks 2: Sharks*. San Diego: Wildlife Education, Ltd., 1983.

Shark's Teeth

1. megalodon



2. great white



3. cookie cutter



4. tiger



5. Port Jackson



6. whale shark



Activity 7

In Shape to Swim

How well would a shark swim if it were shaped like a box? Conduct an experiment to learn how the shape of a shark's body affects the way it moves through the water.

Objectives

Students will:

- use the Scientific Method to determine how the shark's body shape affects the way it moves through the water

Goals and Standards

This activity meets:

Illinois State Goals in Science: Goals 1, 3 and 4

National Science Education Standards:

Unifying Concepts and Processes Standard

K-4 Content Standards A, B, C, E

5-8 Content Standards A, B, C, E

Vocabulary

aerodynamics: the study of air and other gases in motion and the forces acting on objects in motion relative to such gases

hydrodynamics: the study of fluids in motion and the forces acting on objects in motion relative to such fluids

Time

40 minutes

Materials

For each student:

flat Styrofoam container such as a meat tray

scissors

hot glue gun

coffee stirrers

For the class:

large shallow, tray of water such as a preschool sand/water table

small electric fan

Background

Some sharks are among the fastest creatures in the sea while others spend much of their time barely moving. Despite these differences, most sharks have a similar body shape that results in efficient *hydrodynamics*. Their cone-shaped snout allows them to cut through the water easily. As we discovered in Activity 6, even the mouth is tucked under the shark's body in order to reduce drag. Their muscular, streamlined bodies are propelled almost effortlessly through the water by their powerful tails. In other words, the shark's sleek, torpedo-shaped body is perfectly adapted to its predatory life.

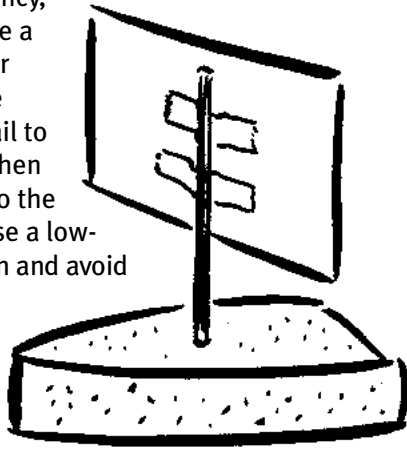
The Scientific Method

This activity utilizes the Scientific Method to help your students determine the relationship between the shape of a shark's body and how well it moves through water. Like any scientific inquiry, it begins with a question— which shape moves the most quickly through the water? The children are then asked to make an hypothesis, a prediction. Through directly testing their ideas and observing the results, they should be able to generate enough information to make a reasonable conclusion.

Procedure

1. Begin by asking your students to make a prediction about which shape will move the fastest in the water. Make sure the students have a clear reason for their prediction and that it is not just a random guess. You may want to avoid specifically discussing the shape of a shark's body at this point in order to encourage the children to think more broadly about hydrodynamics. Explain to them that they will be conducting an experiment in order to test their hypothesis. In this experiment, they will be testing only one variable—how the shape of an object affects how quickly it moves through the water. To find out, they will create shapes using Styrofoam and then “sail” them in a tray of water using a small fan to provide wind.

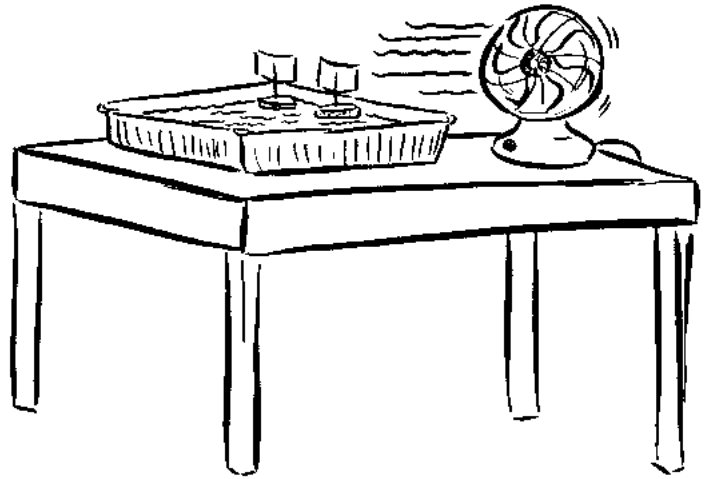
2. Have the children cut shapes from the Styrofoam meat trays to test their hypotheses. Encourage them to try a variety of designs such as geometric or random shapes. For consistency, have the children use a pattern to make their Styrofoam sail. Have them hot glue the sail to a coffee stirrer and then hot glue the stirrer to the Styrofoam shape. Use a low-temperature glue gun and avoid touching the tip of the gun to the Styrofoam, as it may melt. Make sure all the sails are the same height.



3. In order to be sure that nothing else is affecting the movement of the shape through the water, it is important to keep all other variables in the experiment constant:

- The fan must always be on the same speed and in the same location. Position the fan so that it is aimed vertically across the surface of the water.
- All sails must be the same size and shape and be placed in the same position on the Styrofoam shape.
- During each test race, the shapes must be started from the same position. You might mark a starting point with a piece of masking tape on the edge of your water tray.

4. Race two shapes at a time, instructing the children to hold their shapes against the start mark and release on the count of “three.” Notice which reaches the opposite side first. Ask them to observe the paths



their shapes take through the water. (Keep shapes as far away from the sides and each other as possible, as contact with another object will cause them to stick together.) Each shape should be tested at least 5 times on each side of the water tray for a total of 10 tests to insure that the results are valid.

5. Ask your students, “*Which shape moves faster? Why?*” After a number of races, children will probably notice a pattern. The shapes that are the most streamlined, like a shark's body, produce less drag in the water and therefore move the fastest. Ask the children to consider other objects or animals that resemble the way a shark is shaped. They may think of surf boards, submarines, boats, canoes, torpedoes, airplanes, seals, dolphins, etc. They should conclude that the shark's shape is very efficient for moving through water quickly.

6. You may also want to consider other sea animal shapes such as octopus, sea stars, sea jellies, squid, etc. Ask children to cut these shapes from the Styrofoam and repeat the above experiment. Discuss the results.

7. Ask your students to record all aspects of this experiment—from their hypothesis, to test results, to the conclusion—in their Shark Diary.

Extensions

For more precise results in the above experiment, repeat the tests using stopwatches to record the time it takes the shark to get from one side of the water tray to the other. Ask the children to record in a table or graph and then find the average time for each shape.

Ask your students to consider the relationship between the shape of various species of sharks and how it affects their swimming. Have them research such

species as the hammerhead, the basking shark, horn shark, angel shark, etc.

To continue your investigation of the shark's body shape and hydrodynamics, conduct a second experiment starting with the question, "*How do the shark's fins affect the way it moves through the water?*" Add Styrofoam fins to their shark shapes to see how they may affect a shark's movement. Provide resource books for the children to study for a better understanding of the various types of shark fins and their functions.

Challenge your students to design a shape that will move even faster than a shark!

Encourage your students to further research hydrodynamics and aerodynamics, focusing on concepts such as drag and lift. Have the children design and make paper airplanes imitating the shape of the shark's

body. Ask, "*Which types of designs are the most successful? Why?*" Refer to a book about paper airplanes for design ideas. You might also make comparisons between vehicle designs. For example, "*Why are sports cars designed differently than school buses? Which is more like a shark?*" Ask the children to think about which Olympic sports use hydrodynamics or aerodynamics to help the athlete move faster. Consider swimmers, cyclists, bobsledders, skiers, etc.

Additional Resources

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Maniguet, Xavier. *The Jaws of Death: Shark as Predator, Man as Prey*. New York: Sheridan House, 1991.

Springer, Victor G., and Joy P. Gold. *Sharks In Question*. Washington, D.C.: Smithsonian Institution Press, 1989.

Activity 8

Sharks to Scale

Sharks range in size from 15 centimeters to 18 centimeters.
Size up a shark as you create a life-size image.

Objectives

Students will:

- explore the diversity of sharks with an emphasis on the wide range of shapes and sizes
- research a particular shark species and present their findings
- review what they have learned about sharks

Goals and Standards

This activity meets:

Illinois State Goals in Science: Goals 1 and 4

National Science Education Standards:

Unifying Concepts and Processes Standard

K-4 Content Standards A and C

5-8 Content Standards A and C

Time

2-3 hours (can be divided into several shorter time segments)

Materials

For each small group:

- large piece of white butcher paper or newsprint
- pencils
- watercolor or tempera paints

For the class:

- tape
- overhead projector
- resource books and posters

Background

Review the Background in Activity 2 regarding specific shark species. If you choose to have students study species not covered in Activity 2 use resource books to familiarize yourself with these sharks.

Procedure

1. Organize students into the shark groups you formed in Activity 2 or create small groups of four to six children. Assign each group to research the shark species for which their group is named and prepare a report. With input from students, create a format for their reports and then photocopy it for each group. You might suggest focusing on such areas as prey, habitat, speed, weight, or other ideas solicited from the class. Provide resources for their research and/or send them to the school or public library to gather information. Let them know that part of their research will involve making a life-size drawing of the shark they are studying.
2. After completing their research, students will be ready to make their life-size reproductions. Create a transparency from the line drawings on pages 14 and 15. Have students measure and cut a piece of paper large enough to accommodate the length of their shark, tape the paper to the wall and measure to determine exactly where their drawing will begin and end. They can then attain the desired length by carefully moving the projector backward or forward. Once the transparency is in place, it is helpful to tape it down to keep the image consistent.

3. As students are tracing the shark, encourage them to make the results as accurate and as detailed as possible. For the most realistic looking sharks, provide students watercolor or tempera paint and color photographs so they can reproduce the shark more accurately. Using resource books as a guide, instruct students to label the parts of their shark.

4. After the research and life-size drawings are complete, each small group should present their findings to the class. Encourage them to find creative and interesting ways to share what they have learned rather than simply relaying factual information. For example, students might present a “talk show” skit and interview a shark or create a fictional book such as “A Day in the Life of a Thresher Shark.” No matter what format students use, the emphasis should be on considering why each species has developed particular adaptations. You might prompt them with such questions as, “*Why is the cookie cutter shark so small? Why is the angel shark flat? What purpose does the coloring of a leopard shark serve?*”

5. Display the finished drawings with the reports nearby and photocopy the report for students to include in their Shark Diary. As a review and culmination of the activity, lead a discussion about the various sharks, making note of the ways they are alike and different.

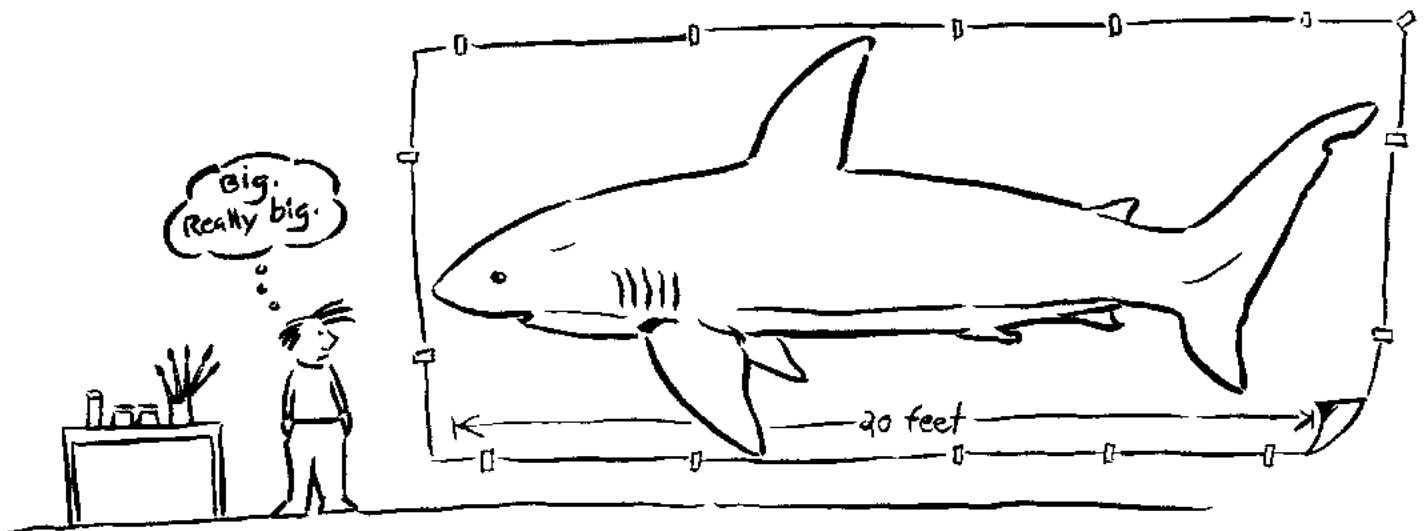
Extensions

Have a Shark Fair. Create a larger event surrounding the presentations by inviting other classes or parents. Have the children design invitations using their shark knowledge.

Make the drawings into 3-D models by creating a second image, stapling it together and stuffing it with crumpled newspaper. The sharks could then be displayed or hung where appropriate.

Additional Resources

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- Ferguson, Ava, and Gregor Cailliet. *Sharks and Rays of the Pacific Coast*. Monterey, California: Monterey Bay Aquarium, 1990.
- Michael, Scott W. *Reef Sharks and Rays of the World: A Guide to Their Identification, Behavior and Ecology*. Monterey, California: Sea Challengers, 1993.
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Activity 9

Save the Sharks? Yes!

Because sharks are feared creatures, we don't often consider them to be vulnerable. However, they do need protection, and you can help save them.

Objectives

Students will:

- recognize how sharks fit into the ocean's food web
- consider issues related to conservation vs. hunting of sharks

Goals and Standards

This activity meets:

Illinois State Goals in Science: Goals 1 and 2

National Science Education Standards:

Unifying Concepts and Processes Standard

K-4 Content Standards A, C, E, F

5-8 Content Standards A, C, E, F

Vocabulary

dermal denticles: toothlike growths covering a shark's body

plankton: drifting plants and animals found in all aquatic environments

Time

45 minutes

Materials

For each small group:

photocopy of shark puzzle

scissors

For the class:

Post-Its® and large poster or paper (optional)

shark resource books

Background

Following are some of the ways sharks are utilized by people:

- Sharks are an important source of food and their popularity seems to be growing. In Britain, much of the fish used in fish-and-chips dishes is actually spiny dogfish shark. In this country, it's possible that you may have had shark without knowing it because it is often marketed under different names. Shark flesh is also used to feed livestock or is ground up as fertilizer.
- Shark fins are highly prized in some Asian countries for making soup. Because the fin is so much more valuable than the rest of the body, sometimes sharks are hunted just for their fins. The fin is sliced off and the shark, injured and unable to swim, is thrown back into the water where it soon dies.
- Sharks' eyes have been successfully used in human cornea transplants. Also, the lenses are sometimes cut out of sharks' eyes to create "shark pearls."
- Sharks' livers are rich with oil, which is used in lubricants and cosmetics such as skin cream. Shark liver oil also was widely used as a source of vitamin A until a synthetic substitute was invented.
- Until sandpaper was invented, the rough skin of sharks was used to smooth wood. Now, the *dermal denticles* can be removed from the skin to create very durable leather used in making such items as shoes and belts.

- Shark teeth are often used in making jewelry, ornaments and weapons. Unfortunately, the tourist industry has greatly increased the demand for such items. Sometimes teeth are taken from sharks that are killed, but teeth are also relatively easy to find since sharks develop so many new teeth during a lifetime. The jaws of sharks, especially large ones such as the great white, are considered valuable trophies and souvenirs.

There are many questions to consider when discussing whether or how sharks or particular shark species should be protected. The children could reflect and respond to these questions in their Shark Diaries.

For example, is it legitimate to kill a shark to save a human's eyesight? What about to make a pair of shoes? Should we pass laws restricting the killing of sharks? Should all shark fishing be banned? If not, how do we draw the line? What would happen in the ocean if sharks were to become extinct? Are sharks more valuable to us dead or alive? Do humans have a right to kill off a species? Why does it appear that very few people seem concerned about sharks becoming endangered species?

No one has answers to all of these questions, but it is important to address them. Part of the difficulty lies in the fact that we know so little about sharks. We do know that some species have been obliterated from certain areas and that the population of many species has declined. Another factor to consider is that sharks, unlike most aquatic animals, take many years to reach reproductive maturity, have long gestation periods and very few offspring. The potential loss of shark species should be taken as seriously as any other endangered species such as whales or eagles. We need to be responsible in using resources so that there will continue to be a full range of species to maintain the Earth's diversity.

Procedure

1. With students, create a food web. This can be accomplished on the blackboard, or for a less temporary result, use Post-Its® on a large poster or paper so that elements can be re-arranged. Begin by asking students to name as many animals that live in the ocean as possible. As students provide suggestions, write them randomly on the board or place notes on paper. If they need prompting, remind them of all the sharks' prey about which they have learned, including *plankton*, an important staple for many marine animals.
2. After a wide variety of animals have been listed, ask students to name the prey for each animal. Draw arrows from each predator to its prey. Keep in mind that many animals feed on more than one other animal. If you are unsure about the diet of some animals, you might assign children to research it and continue the activity at a later time or have resource books on hand for reference. Also, if your school has a specialist who is knowledgeable about marine animals you might invite him or her to be present. Students should begin to notice the complex system that makes up the food web of the ocean.
3. In order to analyze the information in the web, ask the children what happens when one type of animal or one species is removed from the equation. Students might easily notice that if fishes were removed from the web, there would be no food for many other species. The impact of removing sharks from the web might be less clear since sharks are at the top of the food chain. However, the result could be just as devastating to the balance of life in the ocean. Sharks tend to feed on the weakest animals of a species and therefore help to keep the species strong. In effect, they are the scavengers of the sea. Also, without sharks, other species might propagate out of control. Each type of animal, no matter where it falls on the food chain or food web, is essential to help maintain the healthy natural balance of the world's oceans.
4. Organize students into small groups to play the shark puzzle game. Provide each group with a copy of the puzzle and instruct them to cut on the lines. Each resulting game piece represents a part of a shark and lists some of the ways humans use it. (See Background.) The object of the game is to assemble the puzzle, but the challenge for students is to come up with alternative materials to substitute for the shark parts. In other words, the group can only place a puzzle piece with the others when they have come up with a satisfactory substitute. Students must agree within their group and should be able to defend their answers.
5. When the puzzles are assembled, lead a discussion in which small groups share their answers with the class. Explain to students that there is no right or wrong answer and encourage debate. For example, one group might suggest cows as an alternative meat source. *Is this a reasonable choice? Is it less problematic to eat cows since they are domesticated animals and not in any danger of extinction?* The goal of this discussion should be for students to think carefully about these difficult questions and in the end have a good reason for their opinions.

Extensions

As a class, join a conservation organization that works to protect marine life.

Watch for informative articles in wildlife magazines and for television specials about sharks. Look for books and videos about sharks at the local library.

Have students write persuasive papers explaining and defending their position on any of the issues that evolved during the discussion portions of this activity.

Additional Resources

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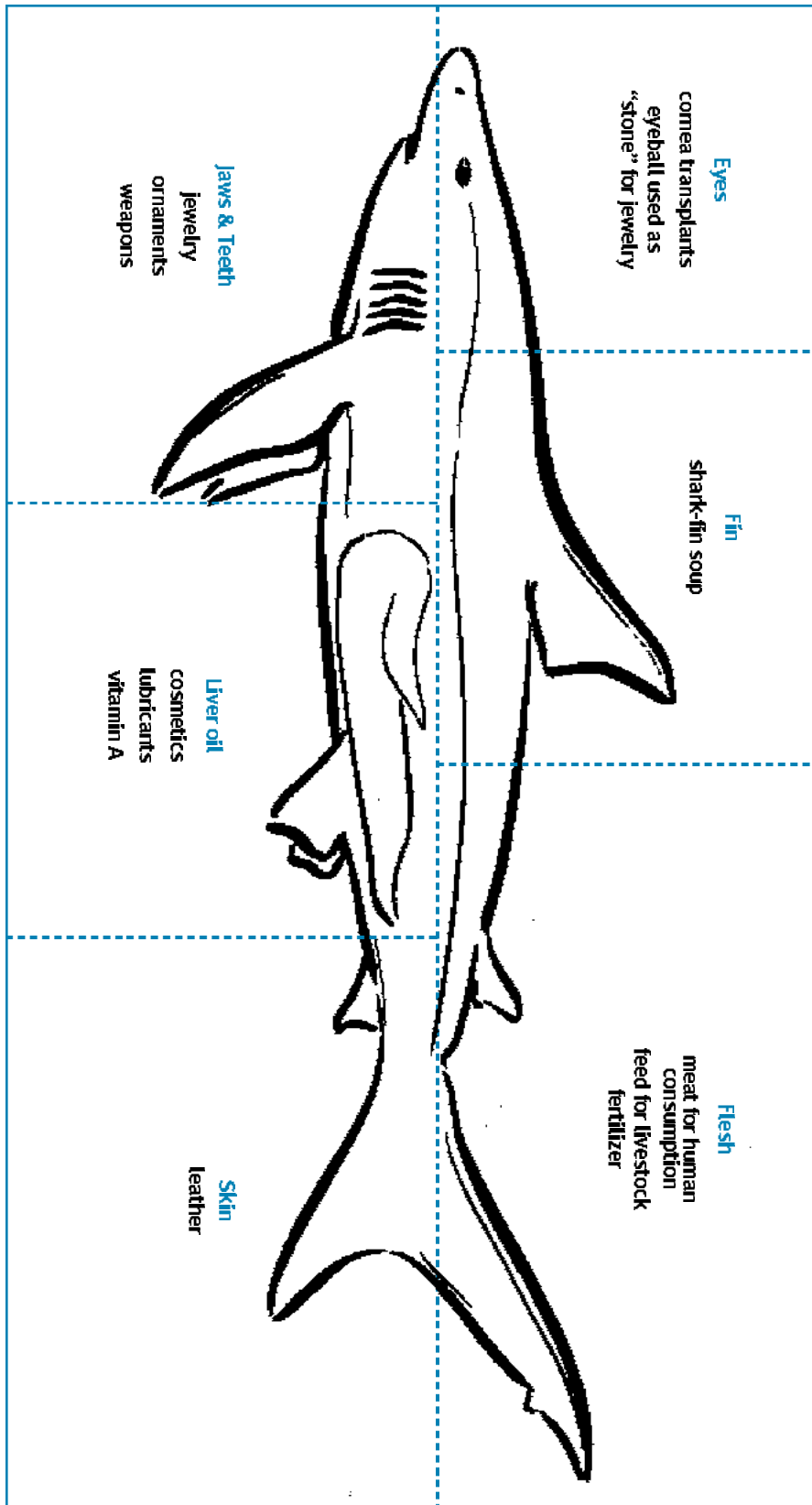
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Shark Puzzle



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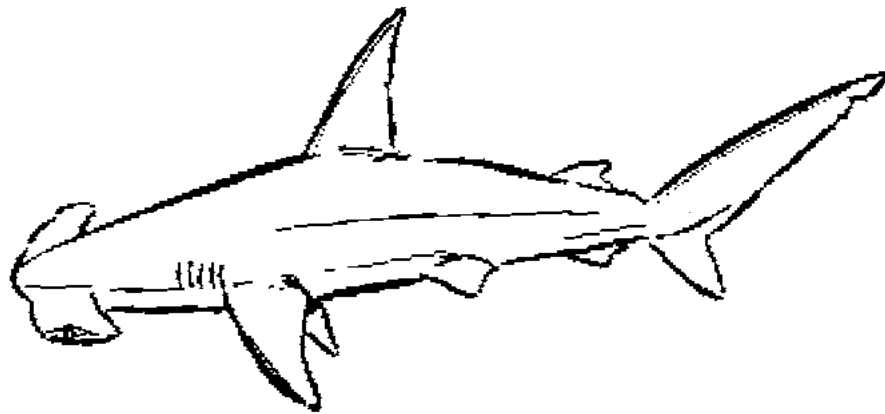
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