Pre/Post Assessment

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

- Name as many kinds of whales as you can. What do they all have in common?
- How big are whales? Compare the size of whales to yourself, a car, a school bus, and your classroom.
- How do whales hear? Why is a sense of hearing important for a toothed whale?
- How are whales adapted to live in the ocean? Describe some adaptations for moving through water, for finding and eating food, and for avoiding predators.
- Why do scientists give animals scientific names? How do they choose a scientific name?

NATIONAL SCIENCE EDUCATION STANDARDS

SeaWorld and Busch Gardens education programs and publications support National Science Education Standards. The ***Whales*** Teacher's Guide for grades 4–8 includes connections to the following standards:

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

Personal and Social Perspectives Standards
- Population, resources, and environments
- Science and technology in society

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

Science as Inquiry
- Abilities necessary to do scientific inquiry
- Understanding about scientific inquiry

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

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

SeaWorld
ADVENTURE PARKS

Covers

Front *(from left):* beluga whales *(Delphinapterus leucas),* killer whale *(Orcinus orca),* gray whale *(Eschrichtius robustus).*

Back *(clockwise from upper left):* killer whale, bottlenose dolphins *(Tursiops truncatus),* false killer whale *(Pseudorca crassidens)*, gray whale.

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Whales

4–8 Teacher's Guide

A SEAWORLD PUBLICATION

CONTENTS

To the Teacher

The ***Whales*** Teacher's Guide for grades 4–8 was developed at SeaWorld to help you teach your students—in an active, hands-on way—about whales and the ecology of the ocean. Our goal is to integrate science, mathematics, language and literacy, geography, and art. 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@seaworld.com* or call 1-800-380-3202.

Goals of the Whales Unit

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

Objectives

After completing the SeaWorld Whales unit, students will be able to…

1. Discuss how whales are adapted for an aquatic environment.
2. Develop scale drawings that show how large various whales are.
3. Formulate a hypothesis, gather data, draw conclusions, and communicate—orally and in writing—about how to do science.
4. Investigate how air, water, bone, and soft tissue conduct sound.
5. Explore how scientists use Greek and Latin root words to create genus and species names and explain why scientific names for animals are important.
6. Use a map to locate countries and regions.
7. Explain how photo-identification helps scientists learn about whales and use observation skills to draw conclusions about a pod of killer whales.
8. Analyze and investigate the complexity of an environmental issue.
9. Express concern for how human activities may impact whales' survival.

Vocabulary

baleen (bay-LEEN) — parallel plates, composed of keratin, that grow from the upper jaw of a baleen whale for filtering food from the water.

blow — the visible exhalation of a whale.

blowhole — the nostril(s) at the top of the head in whales, dolphins, and porpoises through which they breathe.

blubber — a layer of fat cells and fibrous connective tissue, between the skin and the muscle of most marine mammals.

dorsal fin — the appendage on the back or top of an aquatic animal.

echolocate (eck-oh-LOW-kayt) — to locate objects by emitting sound waves and interpreting the resulting echo.

flipper — a broad, flat limb supported by bones and adapted for swimming.

flukes — the horizontal lobes of the tail of a whale, dolphin, or porpoise, made of connective tissue (not bone).

hemoglobin (HE-meh-glo-bin) — the oxygen-carrying molecule of a red blood cell.

melon — the rounded, fat-filled region of a toothed whale's forehead.

myoglobin (MY-eh-glo-bin) — the oxygen-storing molecule of muscle cells.

plankton (PLANK-tuhn) — tiny plants and animals that drift in oceans, lakes, ponds, and rivers.

pod — a social group of whales.

rostrum (RAH-strum) — a beaklike or snoutlike projection.

whale — any large aquatic mammal in the scientific order Cetacea. Whales have forelimbs modified into flippers, a horizontally flattened tail, a nostril at the top of the head for breathing, and no hind limbs.

What Is a Whale?

Whales are aquatic mammals.

Whales live in the water, but they aren't fish—they're mammals. All mammals are warm-blooded (maintain a high and constant body temperature), breathe air, give live birth, nurse their young, and have hair.

Whales have lungs and breathe air.

A whale breathes air through nostrils called a *blowhole*, located on top of its head. When it needs oxygen, a whale surfaces, thrusts its blowhole clear of the water, exhales (blows), and then inhales (takes in a deep breath of air).

Baby whales drink milk.

Like other mammal mothers, whales give birth to live young. A whale calf is born under water and can swim at birth. Soon after birth, the calf begins nursing. A mother whale's nipples are concealed in a pair of mammary slits.

Whale milk is rich in fat and protein, and baby whales grow quickly. A blue whale *(Balaenoptera musculus)* calf can gain as much as 90 kg (200 lb.) a day while nursing.

What?!
Whales have hair?

Yes, they do! But they usually shed their hair while they are very young. Adult whales rarely have hair. A young whale may be born with sparse hairs along its *rostrum*. Smooth skin makes a whale sleek and fast—an adaptation for living in water. What does a whale's skin feel like? Some people say it feels like a wet inner tube.

Whales are adapted for water.

Whales' bodies are streamlined. A streamlined shape glides easily through water and helps a whale conserve energy as it swims.

A whale's powerful tail is made up of a pair of *flukes*. The tail flukes move up and down for swimming. Forelimbs are called *flippers*. Whales use their flippers for steering and, with the help of the flukes, for stopping. Most whales have a *dorsal fin,* which helps regulate body heat and also helps stabilize a swimming whale.

Blankets of blubber keep whales warm.

Whales are warm-blooded, with a core body temperature about the same as ours. Because they live in cool water, they have adaptations for retaining body heat. A thick layer of fatty tissue—called *blubber*—lies just under the skin. Blubber insulates a whale's internal organs and muscles.

Killer whale calves nurse from nipples concealed in mammary slits.

Whale Works

A common dolphin *(Delphinus delphis)* is well adapted for its watery world.

There are two groups of living whales.

There are two different suborders of whales: mysticetes and odontocetes. They differ in a number of ways, including biology and behavior. (See pages 5–6.)

Are dolphins different from whales?

Dolphins and porpoises are odontocetes, (toothed whales). Oceanic dolphins belong to the family Delphinidae. Porpoises belong to the family Phocoenidae. In general, these two families of whales are different.

	dolphin	porpoise
teeth	*cone-shaped*	*spade-shaped*
dorsal fin	*curves toward the tail*	*triangular*
rostrum	*long, beaklike, pronounced*	*short, thick, blunt*

SOME GENERAL DIFFERENCES BETWEEN MOST DOLPHINS AND PORPOISES

How do we learn about whales?

Much of our knowledge about whales has come from the study of dead animals on beaches and from whaling expeditions. Today scientists study live whales to learn more about how they live.

Studying whales in the wild can be difficult because all we usually see is the *blow*, the back, or the tail flukes. Some scientists study whales under water or analyze whale photographs.

Much information has also come from whale studies in research facilities and marine zoological parks including SeaWorld. Zoological research and breeding efforts have generated a wealth of behavioral, genetic, nutritional, reproductive, and veterinary information. Recovered stranded whales also provide insight.

Mysticetes—the Baleen Whales

Baleen plates hang from the upper jaw.

Mysticeti means "mustached whale."

This nickname refers to the *baleen* that hangs from the gums along each side of a mysticete's upper jaw. Baleen is made mostly of keratin, a substance that also forms our fingernails and hair.

Baleen plates are somewhat triangular and arranged side by side, like teeth in a comb. The inner edge is frayed, and the fringes form a dense mat inside a whale's mouth.

Baleen plates work like a strainer.

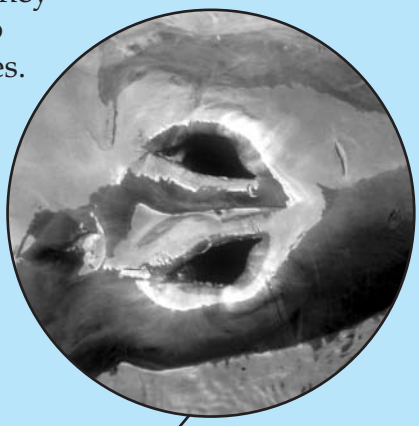
A mysticete's baleen strains food from the water. Some mysticetes feed by swimming with their mouths wide open. Others gulp in huge amounts of water. When they close their mouths, the water is forced out through the baleen, and food is trapped in the fringe. The whale swallows its meal.

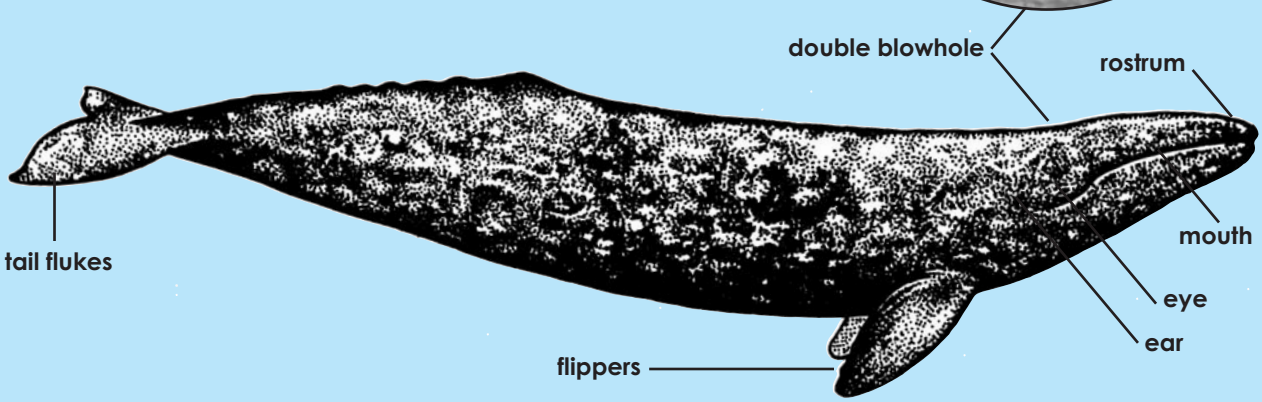
The largest eat the smallest.

Mysticetes, some of the largest animals ever to live on earth, eat some of the smallest, most abundant life in the oceans: *plankton*. Depending on the species, mysticetes also eat small schooling fishes and a variety of tiny crustaceans such as krill, copepods, and amphipods.

More about mysticetes.

Mysticetes tend to be solitary animals, traveling alone or in small groups. Unlike toothed whales, they have two blowholes.





gray whale *(Eschrichtius robustus)*

Odontocetes—the Toothed Whales

A killer whale's conical teeth are adapted for grasping and tearing food.

Odontocetes don't chew their food.

An odontocete's teeth are adapted for grasping, gripping, and tearing food—not for chewing it. Toothed whales swallow their food whole or in very large pieces. They eat a variety of prey. Most species eat fish, but some also eat invertebrates such as crabs or squid. Killer whales *(Orcinus orca)* are top predators. They eat fishes, seabirds, and marine mammals—including other whales.

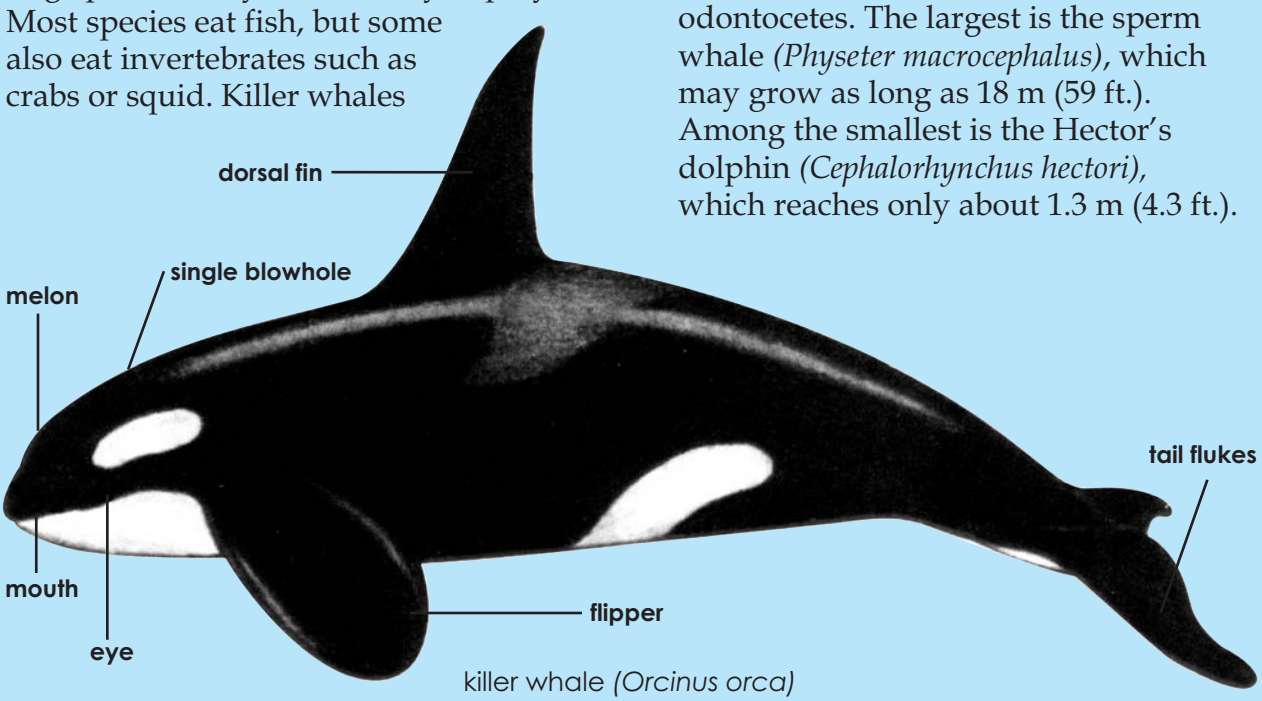
The size, shape, and number of teeth vary with species. Bottlenose dolphins *(Tursiops truncatus)* have about 88 teeth; killer whales have about 48. Narwhals *(Monodon monoceros)* have only two teeth. In males, one spirals forward through the gum. This "tusk" can extend more than 3 m (10 ft.) in front of the whale.

More about odontocetes.

Most odontocetes are smaller than baleen whales. They are more social than mysticetes, and live together in family groups called *pods*. Males are generally larger than females.

Although all whales have two nostrils, an odontocete's nostrils are covered with a muscular flap, so an odontocete has a single blowhole.

There are at least 65 species of living odontocetes. The largest is the sperm whale *(Physeter macrocephalus)*, which may grow as long as 18 m (59 ft.). Among the smallest is the Hector's dolphin *(Cephalorhynchus hectori)*, which reaches only about 1.3 m (4.3 ft.).



killer whale *(Orcinus orca)*

Save the Whales!

Some whales are endangered.

Throughout history, people have hunted whales. In recent years groups all over the world have rallied support to "save the whales."

Some whale populations have recovered. Gray whales *(Eschrichtius robustus)*—hunted to near extinction in the 1800s and again in the 1930s—have been removed from the Endangered Species List. Today, more than 24,000 gray whales inhabit the North Pacific, a population estimate that most experts consider at least as high as pre-whaling numbers.

Other whales are still endangered. The northern right whale *(Eubalaena glacialis)* is the most endangered baleen whale: only about 300 remain. The baiji *(Lipotes vexillifer)* of China is one of the most endangered toothed whales. Probably less than 100 baiji live in China today.

Why are whales in danger?

Hunting whales is only part of the problem. Other threats include—

- entanglement in fishing gear
- habitat destruction
- increased boat traffic in areas where whales migrate, feed, or breed
- ocean pollution (Scientists have found traces of toxic chemicals in the tissues of some river dolphins, bottlenose dolphins, and beluga whales. They are studying the effects of these toxins and ways to reduce pollution.)

What laws protect whales?

The United States manages native whale populations under the 1972 Marine Mammal Protection Act and the 1973 Endangered Species Act.

There are also international agreements to conserve whales.

- The International Whaling Commission (IWC) is responsible for managing whale populations worldwide. The U.S. is a member.
- The Cetacean Specialist Group of the IUCN/The World Conservation Union identifies threatened whale populations in their Action Plan for the Conservation of Cetaceans. The IUCN publishes the Red List of Threatened Animals.
- The Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES) regulates international trade of plants and animals. CITES prohibits trade of all whale products.

Here's how you can help.

- Reduce, reuse, or recycle your trash so it doesn't end up in the ocean.
- Participate in a beach cleanup.
- Read and learn about whales and keep up on current events involving them.
- Support marinelife parks and conservation organizations that conduct whale research programs.
- Share what you know with your family and friends.

The results of research done in the wild and at marine zoological parks enhance our understanding of whales and how they interrelate with humans and the marine environment. This knowledge, together with education and increased public awareness, helps conserve wild populations of whales.

How Big Is a Blue?

OBJECTIVES

Students compare the lengths of several species of whales. They recreate whale illustrations, exploring proportional relationships and changes in scale.

MATERIALS

- ❑ one 30-m (about 100-ft.) rope
- ❑ measuring tape
- ❑ ten different colors of tape or felt pens
- ❑ butcher paper
- ❑ pencils
- ❑ protractors
- ❑ whale illustrations and lengths from the Whale Cards in this Guide.
- ❑ *optional: additional whale photos or illustrations. See the bibliography on page 24.*

BACKGROUND

More than 70 species of whales inhabit our planet. The smallest is just 1.2 m (4 ft.) long. Extremely large blue whales have reached lengths of 27.5 m (90 ft.).

(Top) At just 1.5 m (5 ft.), Commerson's dolphins *(Cephalorhynchus commersoni)* are among the smallest of whales.

(Center) A humpback whale's *(Megaptera novaeangliae)* tail flukes can measure 4 m (13 ft.) from tip to tip.

(At left) A large female gray whale can reach lengths of 14 m (46 ft.)—but that's only about half as long as a giant blue whale!

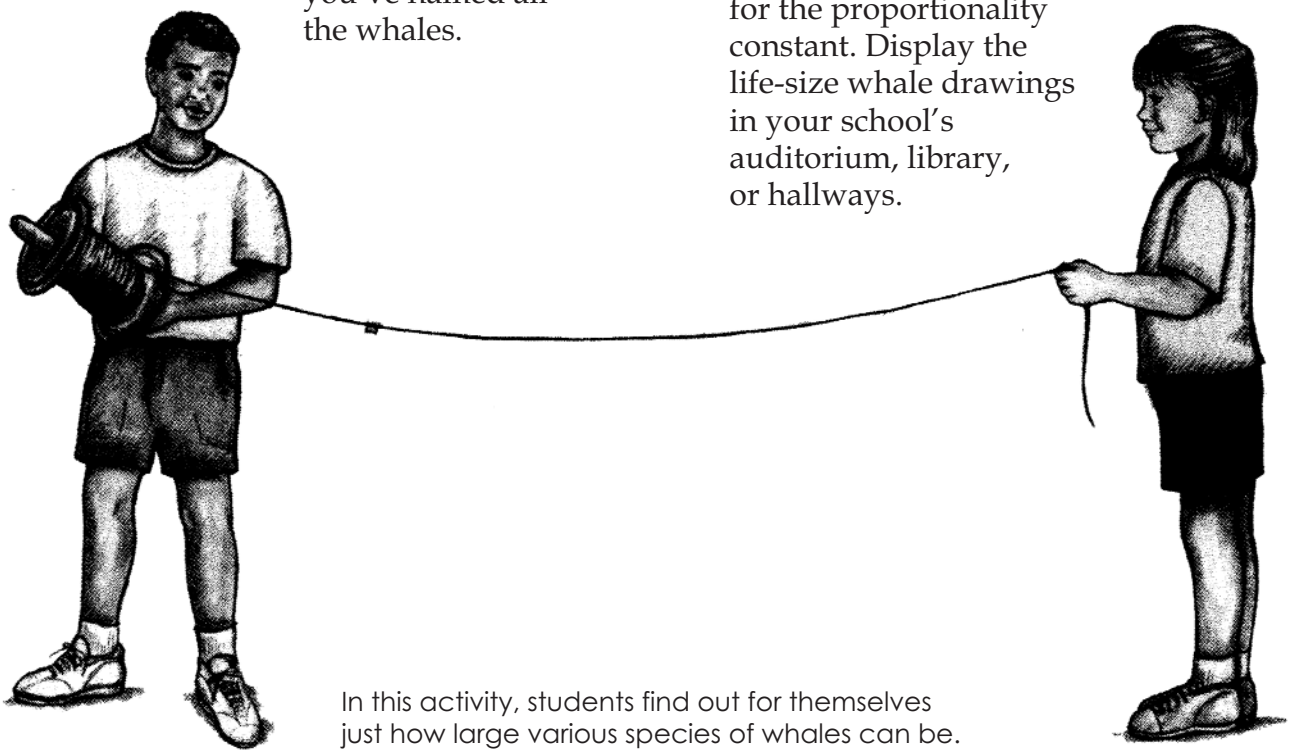
ACTION

PART ONE: MEASURING

1. Make a "whale rope" to estimate, make, and use measurements. Using a different color of tape or a different color felt pen for each whale you've chosen, students mark the lengths of various whales on the rope. (Use the whale lengths given on the Whale Cards in this Guide.)
2. On a piece of paper or cardboard, students make a color key to go along with the rope.
3. *(Do this part of the activity outside or in the school auditorium.)* Select two students to slowly unroll the whale rope. Have them stop unrolling each time they reach a colored marker. At each marker, ask students to guess which whale is as long as the unrolled rope. Tell the name of the correct whale and continue to unroll the rope until you've named all the whales.

PART TWO: SCALE DRAWINGS

4. Photocopy the pictures, names, and lengths of the whales you've chosen from the miniposter.
5. Divide the class into cooperative learning groups and distribute one whale illustration to each group. Also give each group pencils and enough butcher paper to create a life-size drawing of their whale. (Option: students can use chalk to create drawings on the sidewalk or blacktop.)
6. Students measure lengths, areas, and angles of their whale illustration so that they will be able to create a life-size drawing.
7. Students create life-size drawings of whales on the butcher paper or blacktop. They refer to the scale printed on the whale cards in the center of this guide for the proportionality constant. Display the life-size whale drawings in your school's auditorium, library, or hallways.



In this activity, students find out for themselves just how large various species of whales can be.

Good Vibrations

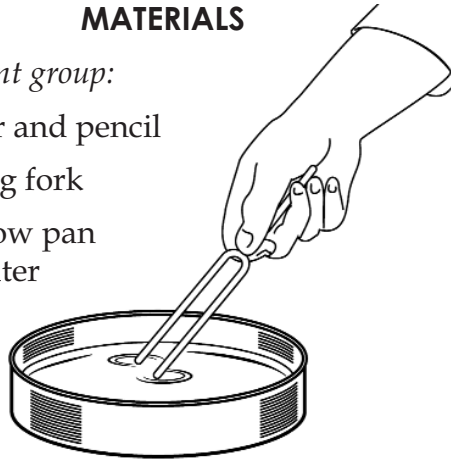
OBJECTIVES

Students investigate how sound travels through air, solids, and water. They will formulate a hypothesis and draw conclusions based on data they gather. They will be able to infer why sound is an effective means of communication and navigation for whales.

MATERIALS

per student group:

- ❑ paper and pencil
- ❑ tuning fork
- ❑ shallow pan of water



BACKGROUND

Sound is the vibration of molecules. These vibrations travel in waves, and they travel at different speeds depending on what they are traveling through. Sound travels slowest through gases, faster through liquids, and fastest through solids. That's because the molecules of a liquid are more densely packed than the molecules of a gas, and the molecules of a solid are even closer together than the molecules of gases or liquids.

Sound travels through air at a speed of about 340 meters per second (0.2 mile/sec). But under the sea, sound travels at approximately 1,600 meters per second (1 mile/sec).

Some toothed whales (and other animals, such as bats) use sound to navigate and to locate prey. A whale produces sounds that travel through its *melon* and out into the water in front of the whale. The whale listens for the echoes that bounce back. This process of sound navigation is called *echolocation*. Even in dark or murky water, echolocating whales can interpret the echoes they hear to tell the shape, size, speed, and distance of objects in the water.

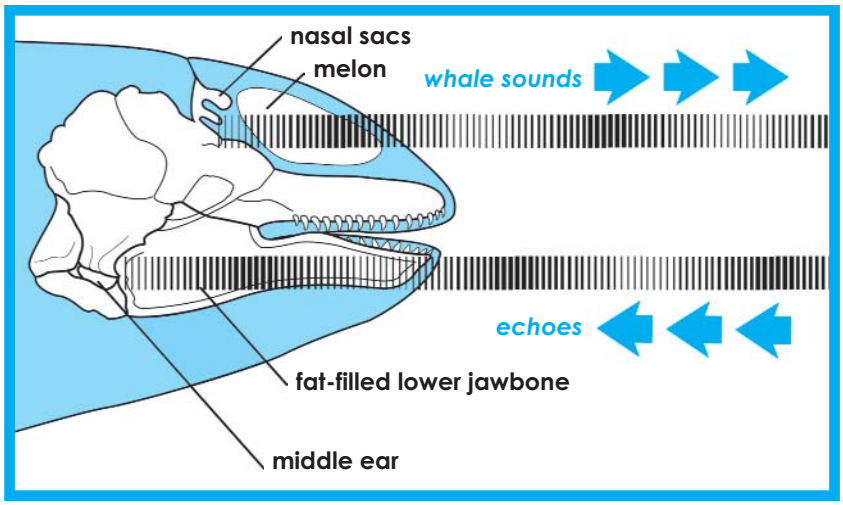
The soft tissue and bone that surrounds a whale's ear conducts sound to the ear. In toothed whales, the fat-filled lower jawbone is a good conductor of sound.

ACTION

1. Divide students into learning groups. Give each group a tuning fork and a shallow pan of water. Ask students to submerge the tines of the tuning fork in the water and to describe what they see.
2. Holding the handle of a tuning fork, show students how to strike it on a hard solid surface and then gently move the two tines of the fork under water. Now ask students to describe what they see. *(The vibrating tuning fork tines produce ripples in the water.)* Allow each student to try it.
3. Explain that the ripples they see are evidence of sound waves produced from vibrations of the tuning fork. Describe how sound is the vibration of molecules. As sound waves travel through a substance, each molecule of the substance hits another and then returns to its original position.

4. On the board, write the rate of sound travel through air and through water. (See BACKGROUND, page 10.) Ask your students the following questions:
   - In which medium does sound travel faster, air or sea water? *(sea water)*
   - About how much faster does sound travel through sea water than it does through air? *(4.7 times faster in sea water)*
   - Which is a better conductor of sound: sea water or air? *(sea water)*
   - What are some possible explanations? *(Water molecules are closer together than the molecules in air.)*
5. Explain that students will have the opportunity to hear the sound made by a tuning fork. They will hear the sound conducted through air and then they will hear the sound conducted through bone and soft tissue (their chin). Which do they think will be a better conductor of sound? Ask them to formulate a hypothesis (a testable question) about whether there will be a difference in the way they perceive the vibrations. On a sheet of paper, each student group writes down its hypothesis.
6. One student in each group strikes a tuning fork on a hard solid surface and holds it a few inches from his or her ear. Ask them to describe what they hear. *(They may hear a faint hum.)* Repeat for each student. Students record their observations.
7. Again, one student in each group strikes the tuning fork on a hard solid surface. This time the student holds the tip of the handle to his or her lower jaw. Ask students to describe what they hear or feel. *(The vibration is more audible.)* Repeat for each student in the group. Students record their observations of how bone and soft tissue conduct vibrations to the middle ear.
8. Student groups record their conclusions. Was their hypothesis correct?
9. Describe how whales echolocate. (See BACKGROUND information on page 10.) Using the evidence they've gathered from this investigation, students discuss why sound is an effective way for whales to communicate and navigate.

Students may be surprised to learn that the bone and soft tissue of their lower jaws conduct sound waves to their middle ears.



A killer whale's fat-filled lower jawbone conducts sound to its ears.

Dive Like a Dolphin

OBJECTIVES

Students make predictions, then plan and conduct an investigation. They discuss whether their evidence is consistent with a proposed explanation and communicate the steps and results from their investigation.

MATERIALS

- ❑ stopwatches or watches with a second hand
- ❑ pens or pencils

BACKGROUND

Hemoglobin is a protein molecule in blood. It transports oxygen from the lungs throughout the body. *Myoglobin* is a similar protein molecule in muscles. Myoglobin stores oxygen.

When you exercise vigorously, your heart pumps blood very fast, and you breathe rapidly to increase your intake of oxygen. But at some point, you may not be able to transport oxygen fast enough to meet the needs of your muscles. When blood isn't bringing sufficient oxygen to the muscles, myoglobin molecules release oxygen.

The muscles of diving mammals—such as whales, dolphins, and seals—have much higher concentrations of myoglobin than our muscles do. Why? This "emergency supply" of oxygen is an adaptation for breath-holding and deep diving. It allows these mammals to remain under water for long periods.

ACTION

1. Ask students to predict how long they would be able to flex their index finger repeatedly before they could no longer make it move.
2. Working in groups, students plan and conduct investigations to test their predictions. (If they need help, guide students to record their methods and their data, and to perform multiple trials.)
3. Read the BACKGROUND information (above) aloud (or make copies for students to read). Discuss the role of oxygen, hemoglobin, and myoglobin. Explain that muscles need oxygen to work.
4. Use these questions to guide a discussion with your students:
   - How long (minutes and seconds) could students flex their fingers?
   - Why did their fingers stop "working"?
   - What can they infer about myoglobin in their fingers? Is their data consistent with this explanation?
   - Why do marine mammals require more myoglobin than humans do?
   - Humans have one muscle that has an extremely high level of myoglobin. Can they guess which muscle it is? *(the heart)* How does a high myoglobin level in the heart adapt us for survival? *(The heart can work even when blood oxygen levels are low.)*
5. Students prepare a written report of their methods, data, and conclusions.

Whale Cards

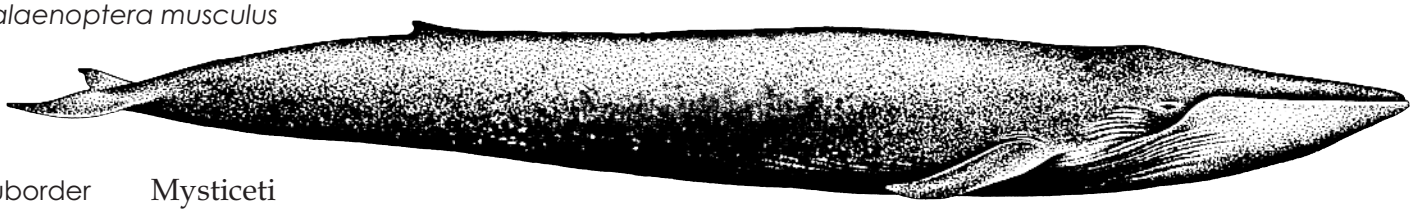
Use the cards on this insert to get started exploring whales. Each of the nine families of whales are represented by one or more of the following species. Each card includes a scale for reference; note that not each illustration is drawn to the same scale.

Here are some ideas for ways to use these cards in your classroom:

- Use the facts on the cards to help you prepare lessons and lead discussions in class.
- Copy and cut apart the cards. Distribute a different card to each cooperative learning group. Visit the school library to learn more about the whales. Groups may even adopt that species as their "mascot" while working on the Whales unit.
- Copy and cut apart the cards. Distribute a complete set to each student or group of students. Students compare similarities and differences among species.

blue whale

Balaenoptera musculus

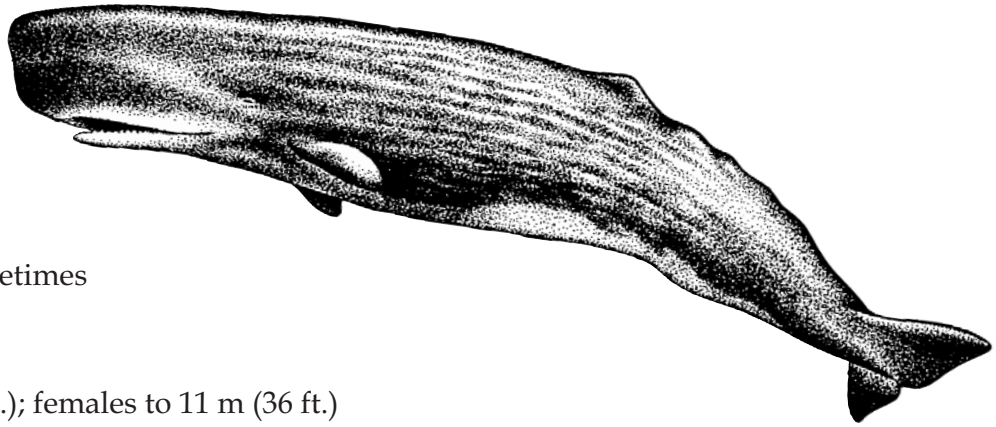


Suborder	Mysticeti
Family	Balaenopteridae, the rorqual whales
distribution	worldwide
prey	krill (A single blue whale may eat as much as 8 tons in one day.)
predators	killer whales
adult length	to about 26 m (85 ft.), although the largest recorded blue whale measured 34 m (112 ft.). Blue whales are the largest animal in the world. Females grow larger than males.

1 in. = 4 m

sperm whale

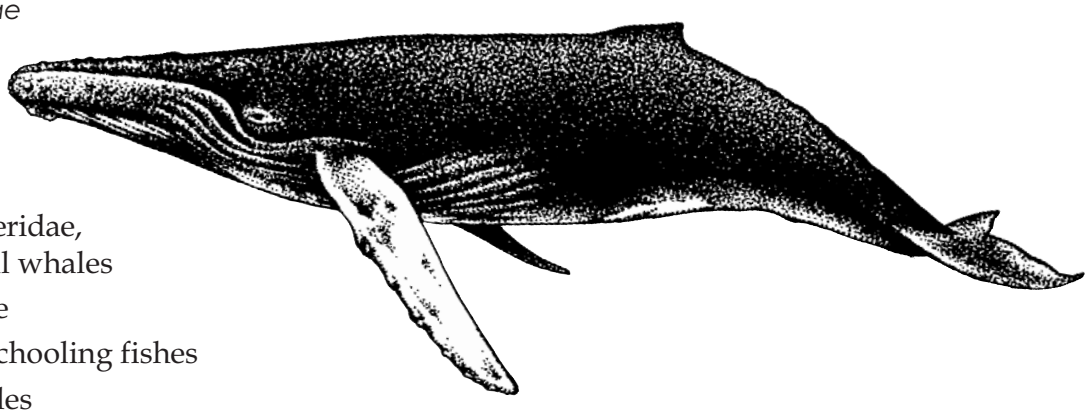
Physeter macrocephalus



Suborder	Odontoceti
Family	Physeteridae, the sperm whales
distribution	worldwide
prey	mostly squids, sometimes octopus and fishes
predators	killer whales
adult length	males to 15 m (49 ft.); females to 11 m (36 ft.)

1 in. = 3 m

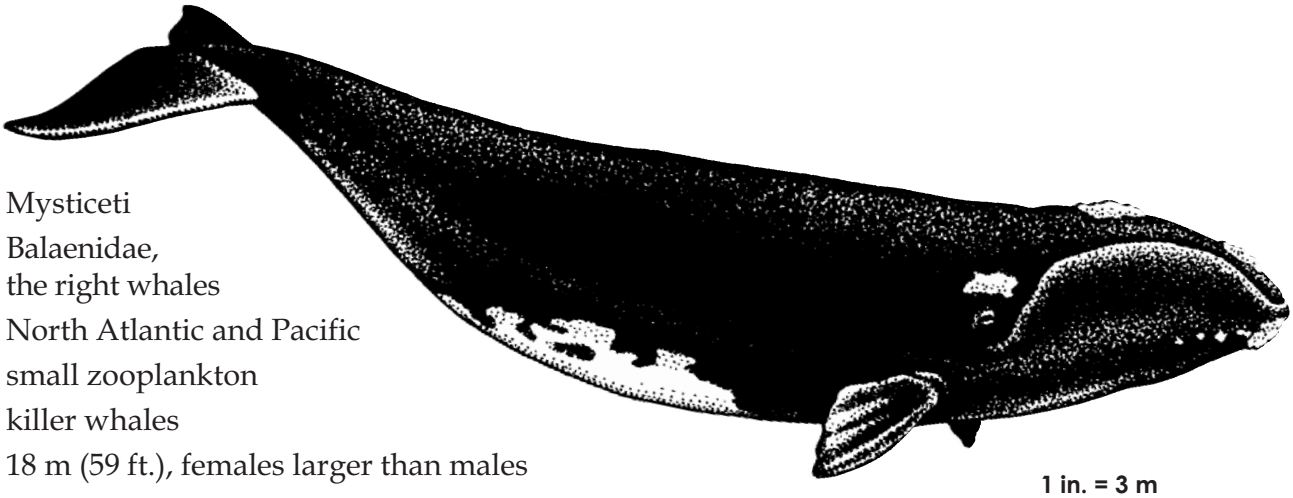
humpback whale
Megaptera novaeangliae



Suborder	Mysticeti
Family	Balaenopteridae, the rorqual whales
distribution	worldwide
prey	krill and schooling fishes
predators	killer whales
adult length	to about 16 m (52 ft.)

1 in. = 3 m

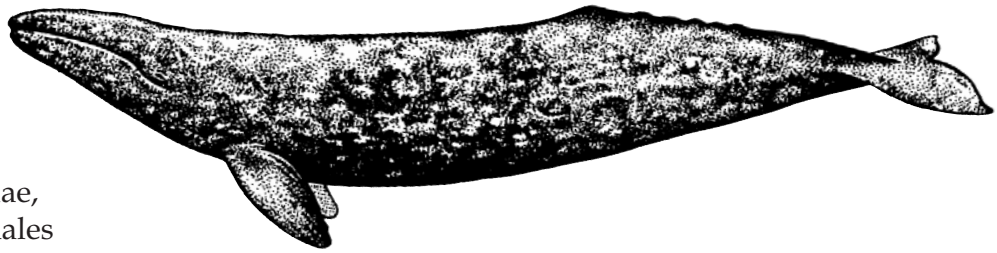
Northern right whale
Eubalaena glacialis



Suborder	Mysticeti
Family	Balaenidae, the right whales
distribution	North Atlantic and Pacific
prey	small zooplankton
predators	killer whales
adult length	18 m (59 ft.), females larger than males

1 in. = 3 m

gray whale
Eschrichtius robustus



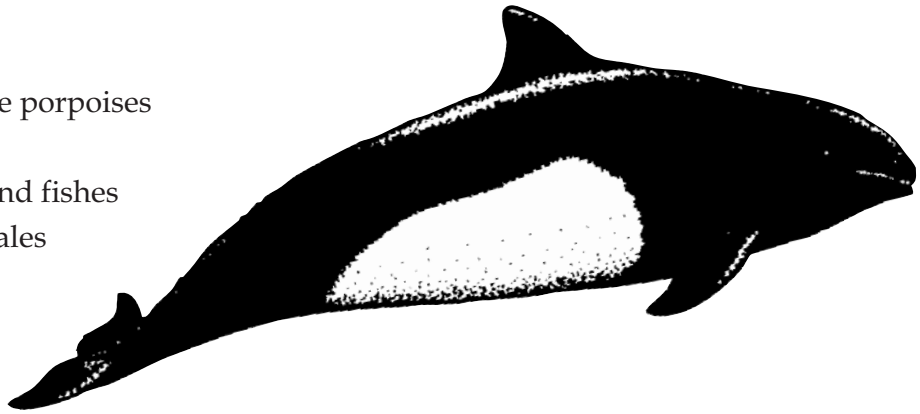
Suborder	Mysticeti
Family	Eschrichtiidae, the gray whales
distribution	Eastern North Pacific
prey	mostly benthic amphipods
predators	killer whales
adult length	14 m (46 ft.)

1 in. = 3 m

Dall's porpoise

Phocoenoides dalli

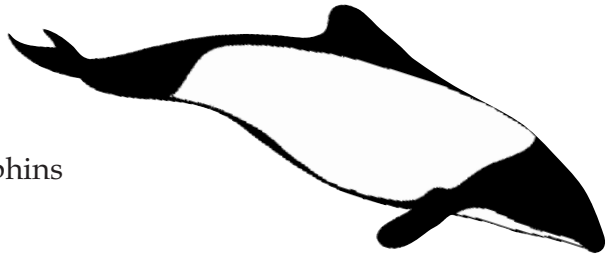
Suborder	Odontoceti
Family	Phocoenidae, the true porpoises
distribution	North Pacific
prey	squid, crustaceans, and fishes
predators	sharks and killer whales
adult length	2.2 m (7.2 m)



2 in. = 1 m

Commerson's dolphin

Cephalorhynchus commersoni



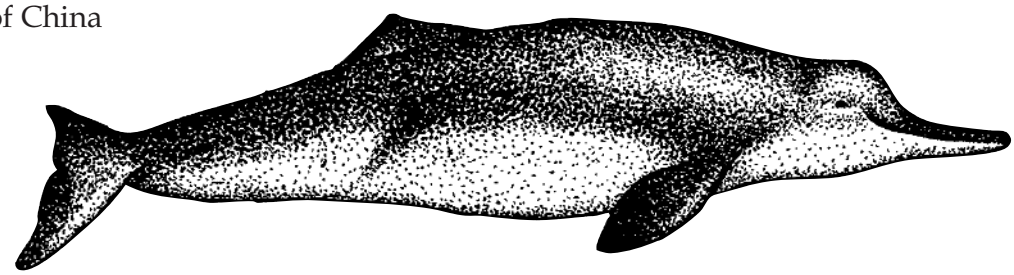
Suborder	Odontoceti
Family	Delphinidae, the oceanic dolphins
distribution	southern Pacific, Atlantic, and Indian Oceans
prey	invertebrates including krill and small fishes
predators	killer whales and sharks
adult length	1.5 m (5 ft.)

2 in. = 1 m

baiji (Chinese river dolphin)

Lipotes vexillifer

Suborder	Odontoceti
Family	Platanistidae, the river dolphins
distribution	Yangtze River of China (fresh water)
prey	fishes
predators	unknown
adult length	2.5 m (8.2 ft.)

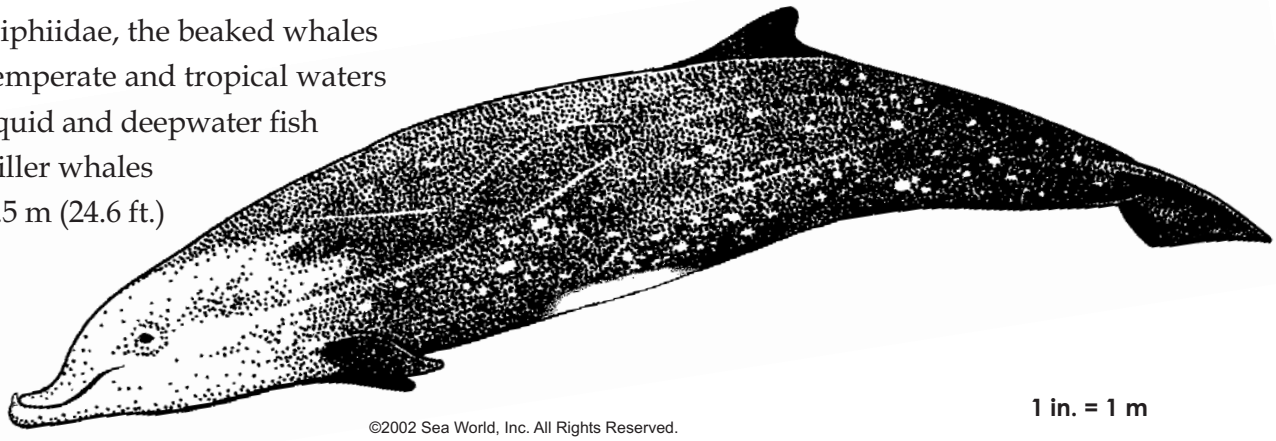


2 in. = 1 m

Cuvier's beaked whale

Ziphius cavirostris

Suborder	Odontoceti
Family	Ziphiidae, the beaked whales
distribution	temperate and tropical waters
prey	squid and deepwater fish
predators	killer whales
adult length	7.5 m (24.6 ft.)

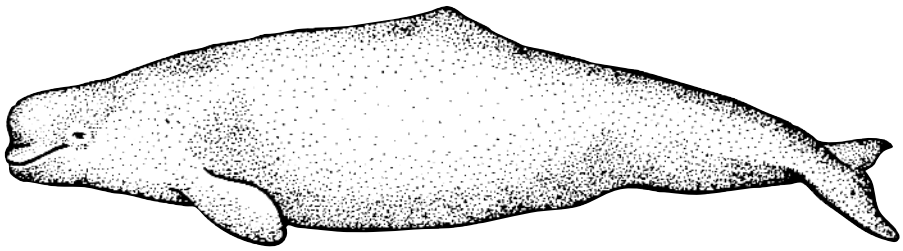


1 in. = 1 m

beluga whale

Delphinapterus leucas

Suborder	Odontoceti
Family	Monodontidae, the narwhal and beluga
distribution	arctic and subarctic seas
prey	bottom-dwelling invertebrates and fishes
predators	killer whales and polar bears
adult length	males to 4.6 m (15.1 ft.); females to 4 m (13.1 ft.)

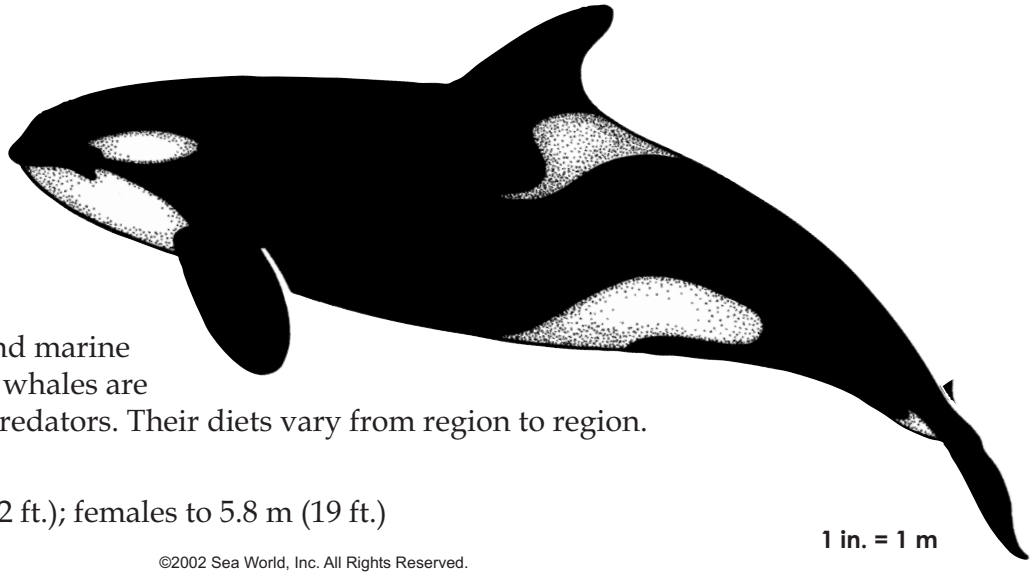


1 in. = 1 m

killer whale

Orcinus orca

Suborder	Odontoceti
Family	Delphinidae, the oceanic dolphins
distribution	worldwide
prey	Fishes, squids, and marine mammals. Killer whales are the oceans' top predators. Their diets vary from region to region.
predators	none
adult length	males to 6.7 m (22 ft.); females to 5.8 m (19 ft.)



1 in. = 1 m

Name Game

OBJECTIVES

Students investigate what killer whales are called in other countries. They increase their awareness of geography by mapping the names. Finally, students explore Greek and Latin root words to develop a scientific vocabulary.

BACKGROUND

Most animals can be identified two ways —by a common name and by a scientific name. Common names can be confusing. For instance, killer whales live in all oceans of the world. Many of the people around the world have a name for killer whales in their own language. At right is a list of some of those names.

How do scientists know when they're talking about the same whale? Their system for naming animals gives each living thing a genus name and a species name. Throughout the world, killer whales are known to scientists as *Orcinus orca. Orcinus* is the genus, and *orca* is the species. Most scientific names are derived from Latin and Greek, and they often describe physical features of an animal. Some names are derived from the names of scientists.

MATERIALS

- ❑ world maps, atlases, or globes
- ❑ double-sided copies of the ***Name Game*** funsheet on pages 14–15.
- ❑ photos or illustrations of the whales listed on Side Two of the Funsheet. *(Use the Whale Cards in this Guide, reference materials listed on page 24, or the Internet.)*
- ❑ extra paper and pens or pencils

Alaska Tlingit	***keet*** (KEET)
Aleutian Islands	***agluk*** (ug-ul-OOK)
France	***orque gladiateur*** (ORK glad-e-ah-TOOR)
Germany	***schwertval*** (SHVAIRT-vahl)
Greenland Eskimo	***aardusak*** (AAH-ur-duh-sok)
Iceland	***háhyrningar*** (how-HIT-nuh-guh)
Japan	***shyachi*** (SHAW-chee)
Korea	***pomkore*** (POM-ko-RAY)
Mexico, Spain	***orca*** (OR-kuh)
Norway	***spekkhogger*** (spek-HOHG-ed)
Russia	***kasatka*** (kah-SAHT-kah)

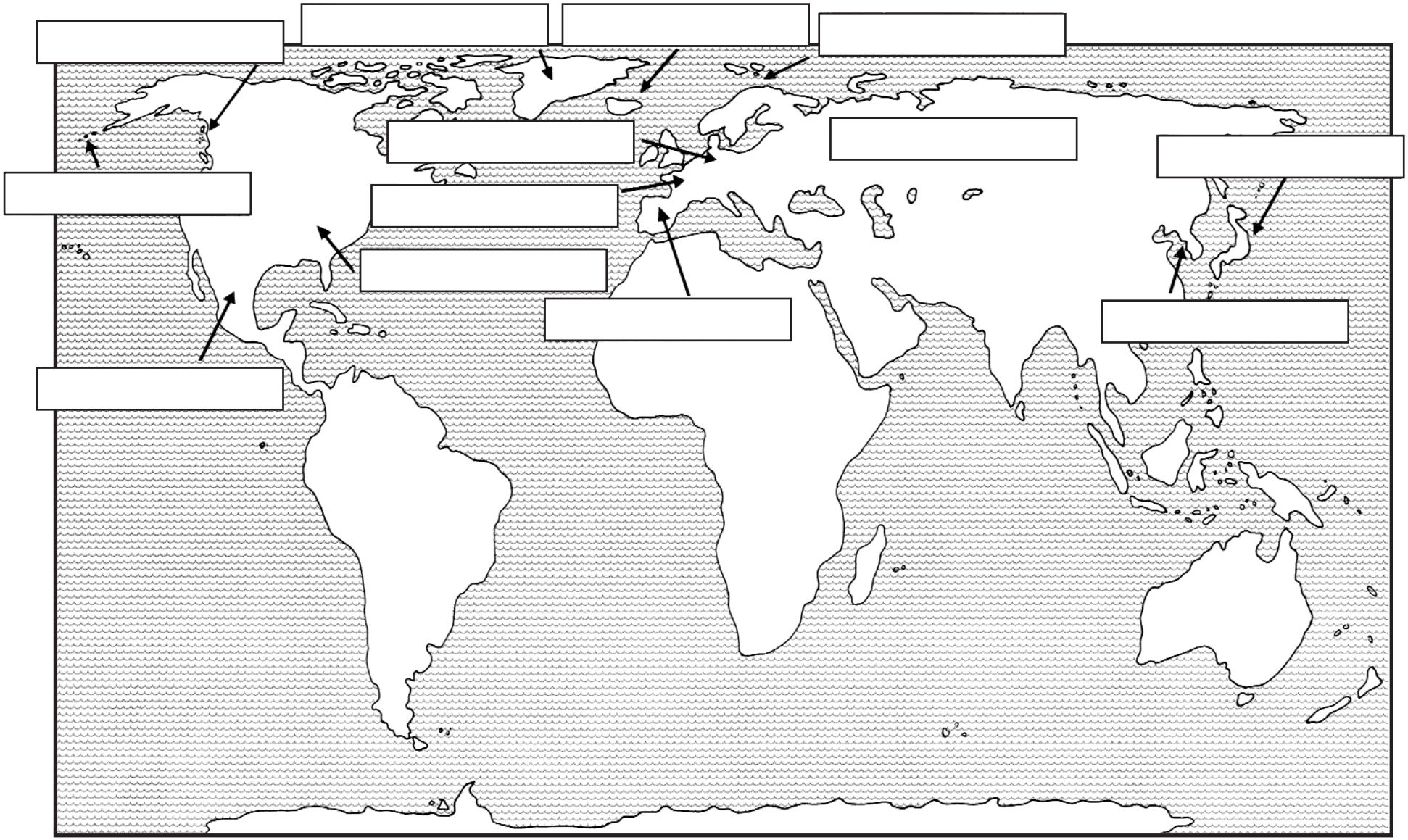
ACTION

1. On the board, write the locations and names for killer whales given here. Discuss how people who speak different languages have different names for the same animal. Help students pronounce the names.
2. Distribute ***Name Game*** funsheets and maps or globes.
3. Students locate and label oceans and the countries listed above. They write the native words for killer whales in the appropriate boxes.
4. Students "decode" whale scientific names. They use books or the Internet to see how each genus and species name describes the animal.

Name _____

Name Game—Part One

Many languages have a name for killer whales. Write the names in or near the appropriate country on this map. Use a globe or atlas to help you.



Name _____

Name Game—Part Two

Scientists use Greek and Latin words to form an animal's scientific name. Use the word fragments below to help you decode whale names.

alb — white *(Latin)*
anglic — English *(Latin)*
-atus — provided with *(Latin)*
balaena — whale *(Latin)*
cavus — hollow *(Latin)*
cephal — head *(Greek)*
cer — horn *(Greek)*
cet — whale, sea monster *(Greek)*
crass — thick, heavy *(Latin)*
delphin — dolphin *(Greek)*
dens — tooth *(Latin)*
-ella — suffix added to noun stem to indicate "small" *(Latin)*
eu — true (*Greek)*
fero — to bear *(Latin)*
glacialis — frozen *(Latin)*
glob — globe, ball *(Latin)*
-inus — like (*Greek)*
-is — daughter of *(Greek)*
lagen — flask *(Greek)*
leuc — white *(Greek)*
lip — (1) fat, lard. (2) to quit or fall. (3) perseverance *(Greek)*
long — long *(Latin)*
macro — long or large *(Greek)*
meg — great *(Greek)*
mon — single *(Greek)*
musculus — muscle *(Latin)*
myst — (1) mystic. (2) mustache *(Greek)*
nov — new *(Latin)*
obliqu — slanting sideways *(Latin)*
odon — tooth (*Greek)*
-oides — like *(Greek)*
orca — great killer *(Latin)*
orcinus — belonging to the underworld *(Latin)*
-ops — appearance *(Greek)*
phocaen — porpoise *(Greek)*
physeter — blower *(Greek)*
pseud — false *(Greek)*
pter — wing or fin *(Greek)*
robustus — strong, robust *(Latin)*
rostr — beak, snout *(Latin)*
rhynch — beak, snout *(Greek)*
sten — narrow, straight *(Greek)*
-tes — having to do with *(Greek)*
trunc — trunk, stem *(Latin)*
tursi — porpoise *(Latin)*
vexill — banner, flag *(Latin)*
ziph (from **xiph**) — sword *(Greek)*

1. *Balaena mysticetus*
2. *Balaenoptera musculus*
3. *Cephalorhynchus commersoni* (Commerson was an 18th-century French medical doctor and botanist.)
4. *Delphinapterus leucas*
5. *Delphinus delphis*
6. *Eschrichtius robustus* (Eschricht was a 9th-century Danish Zoology professor.)
7. *Eubalaena glacialis*
8. *Globicephala macrorhynchus*
9. *Lagenorhynchus albirostris*
10. *Lipotes vexillifer*
11. *Megaptera novaeangliae*
12. *Orcinus orca*
13. *Phocoenoides dalli* (Dall was an American zoologist.)
14. *Physeter macrocephalus*
15. *Pseudorca crassidens*
16. *Stenella longirostris*
17. *Tursiops truncatus*
18. *Ziphius cavirostris*

Then and Now

OBJECTIVES

Students use observation skills to draw conclusions about a pod of killer whales.

MATERIALS

- ❑ copies of ***Then and Now*** funsheets on pages 17–18 (one per student)
- ❑ pencils

BACKGROUND

In male killer whales, the dorsal fin is tall and triangular. In females, it is smaller and curves slightly toward the tail flukes. Researchers have learned to recognize many individual killer whales from photos. They take photographs when the whale rises highest out of the water as it breathes normally and exposes its dorsal fin and saddle region. These researchers must be skilled at recognizing subtle differences in the whale's body appearance as they study the pictures. Photo-identification is an important research tool for studying various aspects of cetacean biology, including distribution, habitat, and population changes.

A good book about identifying killer whales is *Killer Whales. A Study of Their Identification, Genealogy & Natural History in British Columbia and Washington State* (Michael A. Bigg, Graeme M. Ellis, John K.B. Ford, and Kenneth C. Balcomb, Phantom Press & Publishers Inc., 1987).

Even subtle characteristics of a killer whale's dorsal fin and saddle region help researchers identify individual whales.

ACTION

Some killer whales have irregular-shaped dorsal fins, sometimes leaning to one side.

1. Give each student a copy of the ***Then and Now*** funsheets on pages 17–18.
2. Share the background information on this page with your students.
3. Students study the pictures on the activity sheet to answer the questions.

DEEPER DEPTHS

Students write a brief description of each whale's dorsal fin, making note of what differences they use to identify the whales.

Name _____

Then and Now

A field biologist has asked you to help with a study of a pod of killer whales. Picture Set A was taken five years ago. Picture Set B was taken last month.

1. Which whales from Picture Set A and Picture Set B do you think are the same? Write the numbers of the matching whales.

2. The biologist suspects that Whale A3 and Whale B5 might be the same individual. What do you think? If it is the same whale, what might have caused the change in appearance?

3. Has the pod grown or shrunk?

4. How many whales have joined the pod in the last five years?

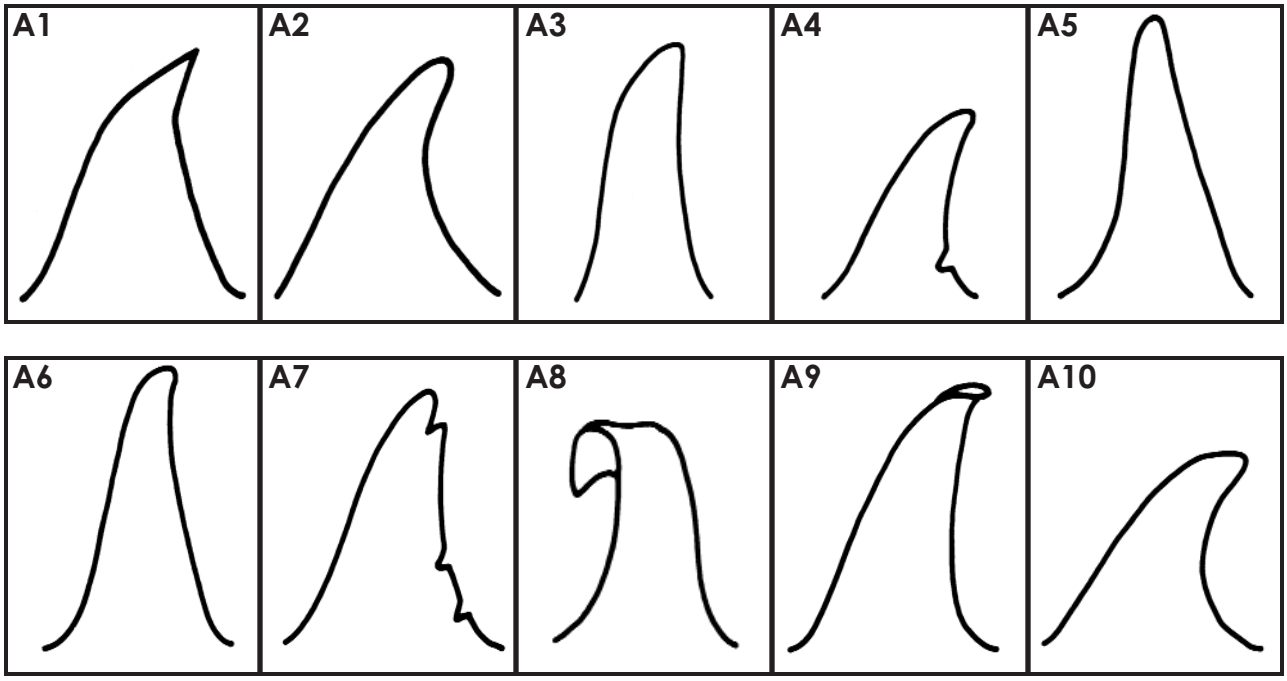
5. How many whales have left the pod in the last five years?

6. How many males were in the pod five years ago?

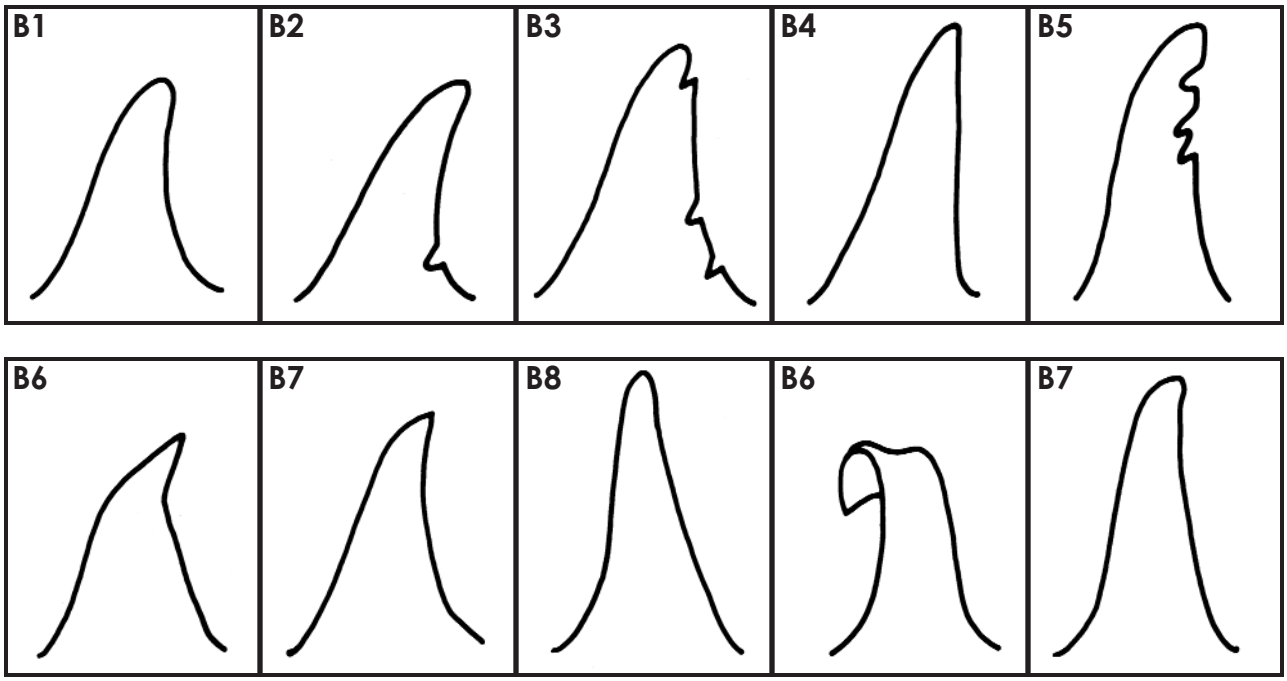
7. How many males are in the pod in the most recent photo set?

Then and Now

Picture Set A



Picture Set B



Whose Fish Is It?

OBJECTIVES

Students research literature and other resources for information and logically argue a viewpoint. They demonstrate a real-life decision-making process and evaluate its outcome.

MATERIALS

- ❑ *Whose Fish Is It?* Player Cards on page 21
- ❑ resource materials from the library
- ❑ Internet access

BACKGROUND

Fishermen and killer whales compete for blackcod, a type of fish. In Prince William Sound, Alaska, killer whales can determine when a fishing boat is backhauling (retrieving) the longline used to catch blackcod. When fishermen haul in their longlines, killer whales congregate near the boat and feed on the hooked fish.

Killer whales feeding on the catch of fisherman is a growing problem in fisheries worldwide.

Scientists from the Hubbs-SeaWorld Research Institute studied this conflict. They watched to see when killer whales approached a blackcod boat, and they recorded the boats' noises in all phases of the fishing operation. When they analyzed their recordings, they identified several sounds that are unique to the backhauling process. It seems that the equipment fishermen use to backhaul their longlines makes sounds that are different from other boat noises. It is likely that killer whales recognize these sounds and associate them with blackcod. In fact, the sound of backhauling equipment may be like a "dinner bell" that alerts the whale to a free meal!

The scientists investigated several methods to reduce the conflict between killer whales and blackcod fishermen. Their goal was to identify ways to reduce the fishermen's losses while at the same time not harming the killer whales.

ACTION

1. Familiarize yourself with the environmental situation by reading all three Player Cards and the synopsis.
2. Divide your class into three groups. Each student group represents a different faction of this issue.
   - Group One is comprised of the local fishermen.
   - Group Two is a team of biologists who have been brought in to study the conflict.
   - Group Three is a coalition of environmentalists.
3. Copy and distribute Player Cards to student groups.
4. Give students a chance to familiarize themselves with the situation and to gather additional resources about this or similar fisheries interactions. They research the killer whale population and the longline fishing industry in Prince William Sound, Alaska. They can use library resources such as scientific journals, books, and newspapers; the Internet; and information from special interest groups and other sources.
5. Stage a "Town Meeting" with all three groups to discuss the issue. Mediate between the groups.
6. At the end of the meeting, develop a plan that will be acceptable to all factions. Try to develop a plan by group consensus if possible. If consensus isn't possible, vote on a plan.
7. After the activity, discuss how environmental issues are complex problems of society that affect people as well as animals. Ask the following questions to prompt students to discuss the decision-making process:
   - Were all three groups satisfied with the outcome of the meeting and the new policy?
   - Is it always possible to come up with a solution acceptable to all concerned? Is it easy? It is worthwhile?
   - Would it ever be beneficial to compromise your point of view? If so, when and why? If not, why not?
   - What role does science play in policy-making?
   - What role does public education play in awareness and action?

Whose Fish Is It? Player Cards

LOCAL FISHERMEN

You live in a small fishing community. Since the first settlers, your family has made a living by fishing. In fact, it's the only trade you've ever known. Like your parents, you fish to survive. Blackcod and other fish provide food and money for your family. You sell or trade the fish to get other materials you need.

Fishing is also part of your culture. You used to think killer whales were signs of luck. But in the last few years they have become an expensive nuisance. They take blackcod directly off your lines and destroy your equipment in the process.

You have lost money—as much as $2 million in one year. Your life's savings are invested in your fishing boat. You fear that governmental interference to protect killer whales would disrupt your way of life and result in financial devastation.

Fishing is the basis of your economy, and right now unemployment in your area is very high. Some fishermen in your community will go to any extreme to get rid of the killer whales. Certain desperate fishermen have even shot the whales.

Whose Fish Is It? Player Cards

BIOLOGISTS

Your job is to manage the populations of local marine species and to develop plans to keep healthy populations abundant and to restore depleted species. You fear the killer whales are hunting blackcod from longlines because their other prey items have been overfished.

You have been assigned to find ways to deter killer whales from hunting off the fishermen's longlines. You realize that the local fishing community is totally dependent on the blackcod for its economy. The blackcod provides food and income for other necessities. The blackcod is not only economically important but culturally important to these people.

Your team has come up with a proposal to study the killer whales and investigate methods to reduce losses to the fishermen—methods that won't harm the killer whales. You and your team have already come across opposition from several organizations as well as some of the members of the fishing community who claim that the blackcod is theirs.

Whose Fish Is It? Player Cards

ENVIRONMENTAL ALLIANCE

Your organization is a group of "take action" individuals dedicated to protecting wildlife and the environment. You identify conservation needs, design conservation actions, and lobby decision-makers.

You and your organization are concerned about the killer whale population. If fishermen continue to shoot the whales and harvest the ocean's fisheries resources, the blackcod stock will be depleted and the killer whale population will suffer.

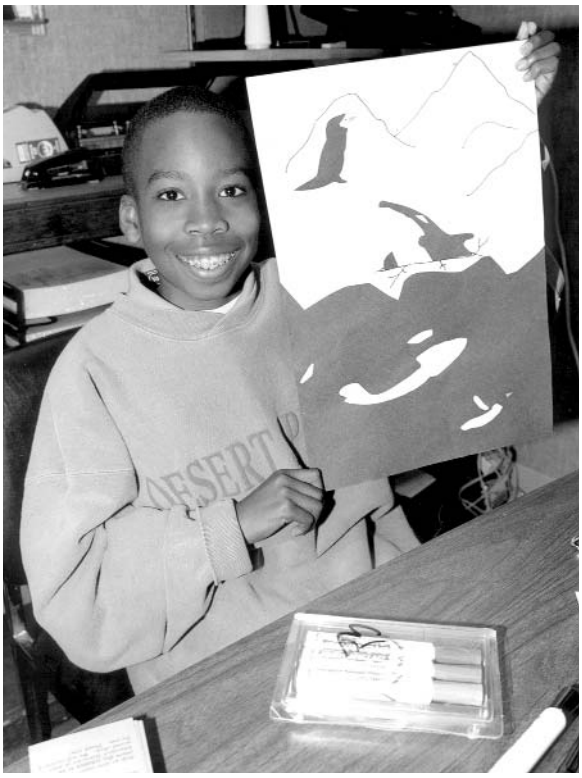
As you understand it, the Marine Mammal Protection Act states that marine mammals may not be harmed or harassed. Your goal is to protect killer whales from harm and harassment.

Whose Fish Is It? Player Cards

Black and White

OBJECTIVES

Students explore how disruptive coloration helps an animal hide.



Students find out how disruptive coloration helps conceal ocean animals.

MATERIALS

- ❑ glue or gluesticks
- ❑ black markers
- ❑ copy of page 23 for each student
- ❑ 12″ by 9″ white construction paper
- ❑ 6″ by 9″ black construction paper

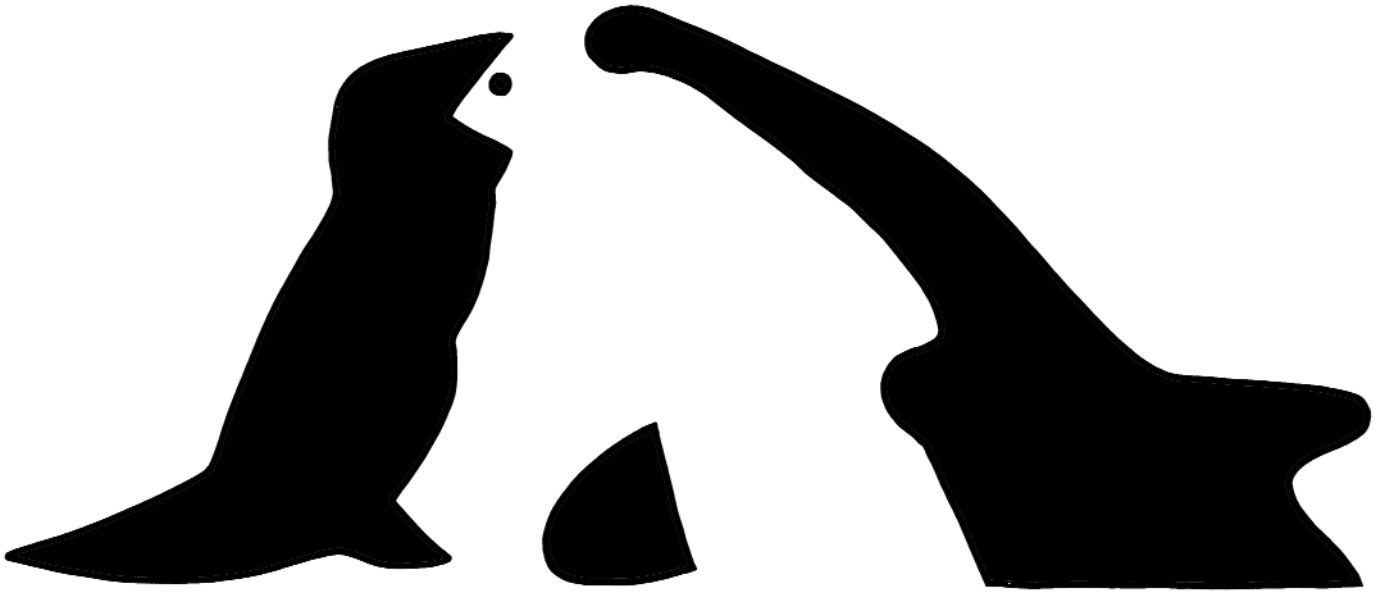
BACKGROUND

It's easy for us to recognize a killer whale. But by the flickering, filtered sunlight in the sea, ocean animals may not recognize a killer whale as a predator. That's because its color pattern is a type of disruptive coloration; a killer whale's distinctive black and white color pattern contradicts its body shape. Giraffes, zebras, tigers, and many tropical reef fishes also have disruptive coloration.

ACTION

1. Discuss disruptive coloration with your students. Can they name animals with this kind of coloration?
2. Distribute copies of page 23.
3. Students cut out both of their killer whales and penguins.
4. Give each student a sheet of white construction paper and a smaller sheet of black construction paper. They place the white paper vertically on the work area and glue the black sheet of paper to the bottom half of the white paper. (The black paper will be the ocean; the white paper will be the land.). With markers, they can add landscape such as icebergs, etc.
5. Where the black sea meets the white land, students glue killer whale #1 so that the whale appears to be poking its head above water. They glue penguin #1 on land. They glue whale #2 and penguin #2 in the ocean.
6. Ask students to describe the effect of their art. How well are the animals concealed in the ocean? How well are they concealed on land?

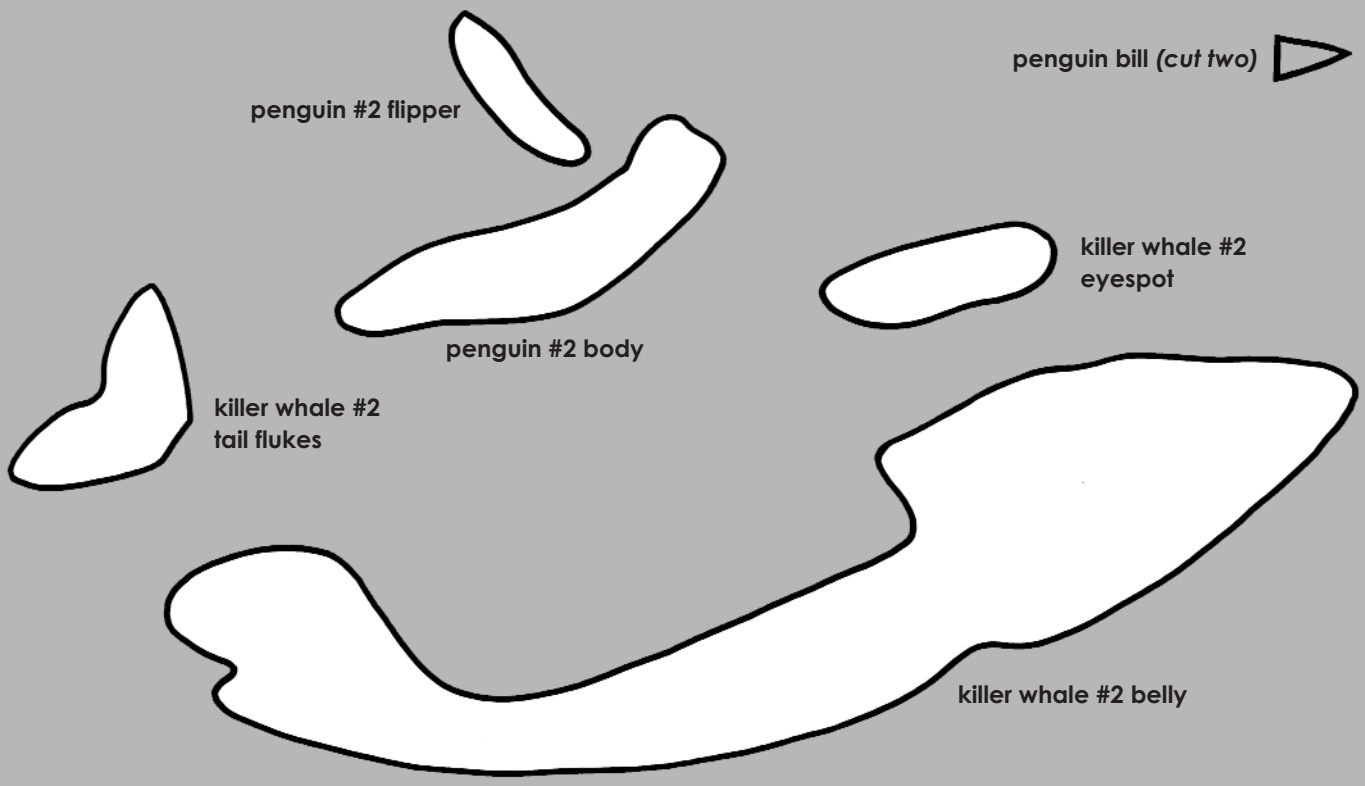
Black and White



penguin #1 body

killer whale #1 flipper

killer whale #1 body



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- To instill in students and guests of all ages an appreciation for science and a respect for all living creatures and habitats.
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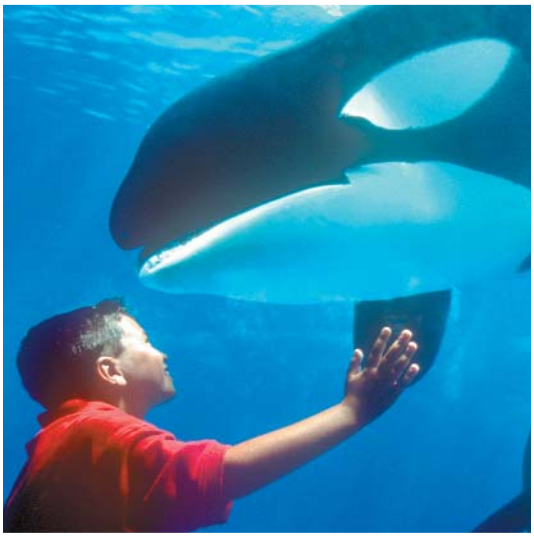

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