

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.

- ◆ Find pictures of whales in books and magazines. Can you identify them?
- ◆ What do whales do? Pretend you're a whale. Using your whole body, act out some behaviors that whales do.
- ◆ Draw a picture of a whale. Identify and label the body parts that help the whale live in the ocean. Explain how the body parts work.
- ◆ On a map or globe, show where gray whales live. What other animals live in these areas?
- ◆ Use a tuning fork to help you explain how a toothed whale hears.
- ◆ Beluga whales can dive as deep as 300 meters. Pilot whales can dive as deep as 600 meters. Create a graph to help you communicate this information to a friend.

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

- ◆ Characteristics of organisms
- ◆ Life cycles of organisms
- ◆ Organisms and environments

Personal and Social Perspectives Standards

- ◆ Types of resources
- ◆ Changes in environments
- ◆ Science and technology in local challenges

History and Nature of Science Standards

- ◆ Science as a human endeavor

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.



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*), "J.J." the rescued gray whale calf, false killer whale (*Pseudorca crassidens*)

ISBN 1-893698-33-5

Printed in the United States of America

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Published by the SeaWorld Education Department
500 SeaWorld Drive, San Diego, California, 92109-7904

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Whales

K–3 Teacher’s Guide

A SEAWORLD PUBLICATION

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To the Teacher

The *Whales* Teacher’s Guide for grades K–3 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 Shamu@seaworld.com or call 1-800-23-SHAMU.

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. Describe similarities and differences between whales and other animals.
2. Read and write – both fiction and nonfiction – about whales.
3. Sketch a dolphin and label the external structures.
4. Trace the migration route of a gray whale.
5. Investigate how sound travels.
6. Infer and describe how some whales use echolocation to help them navigate and locate prey.
7. Graphically communicate mathematical ideas.

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).

mammal – a vertebrate animal that is warm-blooded, has hair, breathes air, bears live young, and has milk-producing glands in the female.

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

migration – the periodic mass movement of animal populations to and from feeding or reproductive areas.

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, nostrils 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 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.

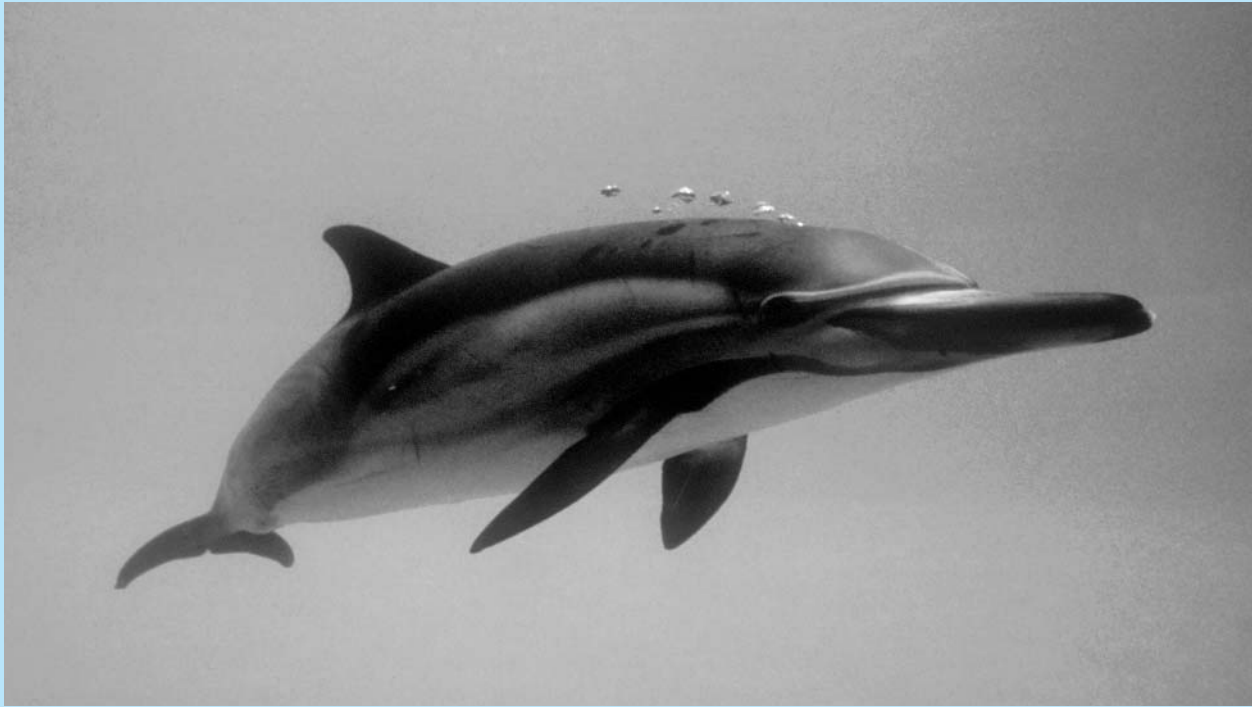
Blankets of blubber keep whales warm.

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.

SOME GENERAL DIFFERENCES BETWEEN MOST DOLPHINS AND PORPOISES

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

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

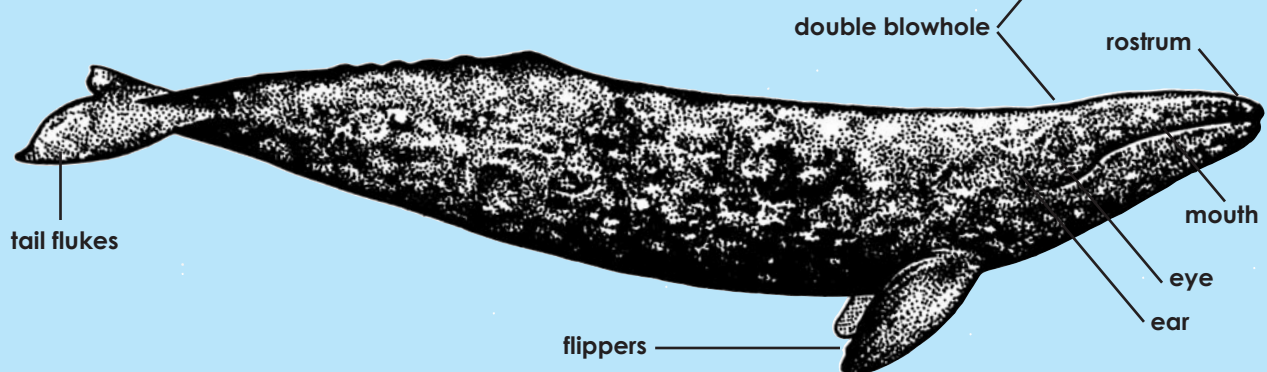
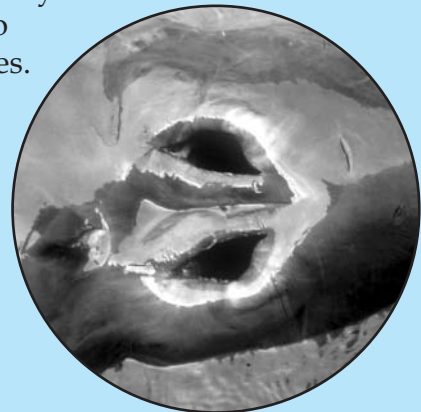
open. Others gulp in huge amounts of water. When they close their mouths, the water is forced out through the baleen, and food is trapped in the fringe. The whale swallows its meal.

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.

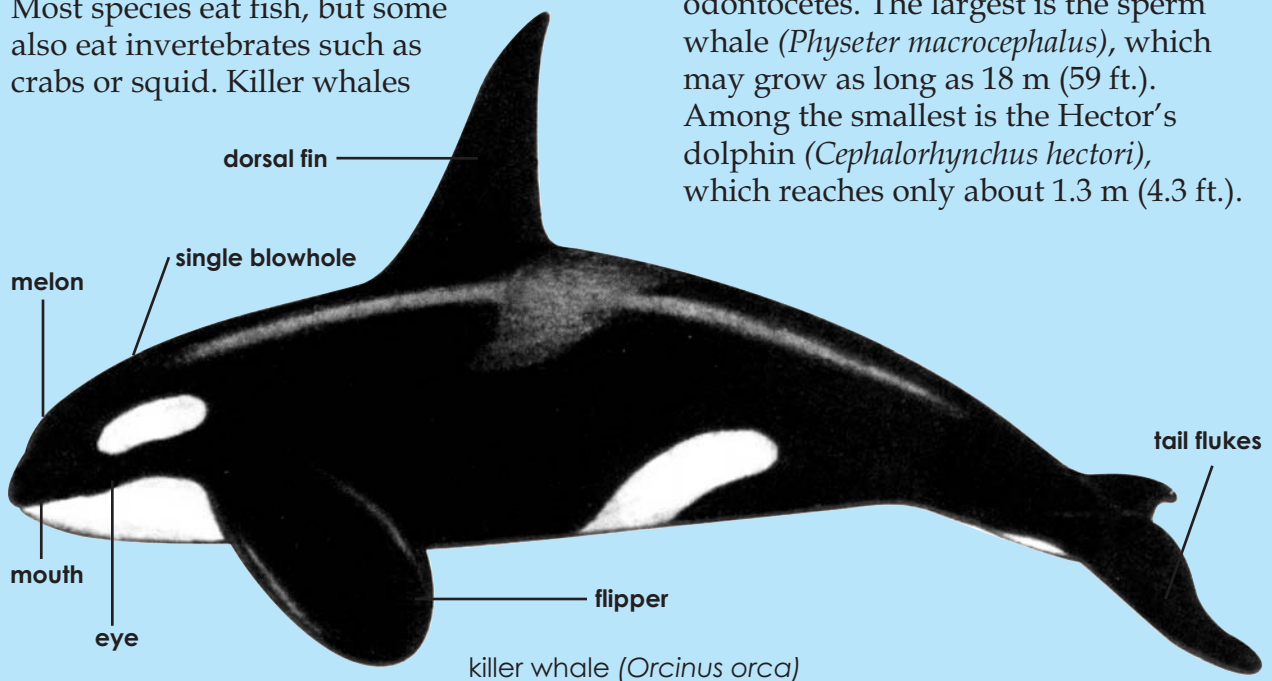
The size, shape, and number of teeth vary with species. Bottlenose dolphins (*Tursiops truncatus*) have about 88 teeth; killer whales have about 48. Narwhals (*Monodon monoceros*) have only two teeth. In males, one spirals forward through the gum. This "tusk" can extend more than 3 m (10 ft.) in front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



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.

Is It a Whale?

OBJECTIVES

Students observe and describe similarities and differences in appearance of animals. They compare and sort pictures of animals.

MATERIALS

- Is It a Whale?* funsheet on page 9
- crayons

BACKGROUND

Whales are *mammals*. All mammals share the following characteristics.

- ◆ Mammals are *warm-blooded*: they maintain a high and constant body temperature independent of their surroundings.
- ◆ Mammals give *live birth*. Baby whales, called calves, are born in the water.
- ◆ Mammals *nurse* their young. A mother whale's *milk* is rich in fat, so the calves develop a thick layer of blubber.
- ◆ Mammals have *hair*. Although adult whales rarely have hair, young whales may have sparse hairs along the rostrum.
- ◆ Mammals *breathe air*. A whale breathes air through nostrils called a *blowhole*, located on top of the

whale's head. When it needs oxygen, a whale surfaces, thrusts its blowhole clear of the water, exhales, and takes a deep breath of air into its lungs.

Although whales live in the sea and have a body shape similar to fish, whales are not fish. Here's why not:

- ◆ Fish are *cold-blooded*. That is, a fish's temperature is usually about the same temperature as that of the water it swims in.
- ◆ Most fish have *scales*.
- ◆ Fish take oxygen from the water with *gills*.
- ◆ Fish generally move their tails *side to side* to swim. Whales move their tails *up and down*.



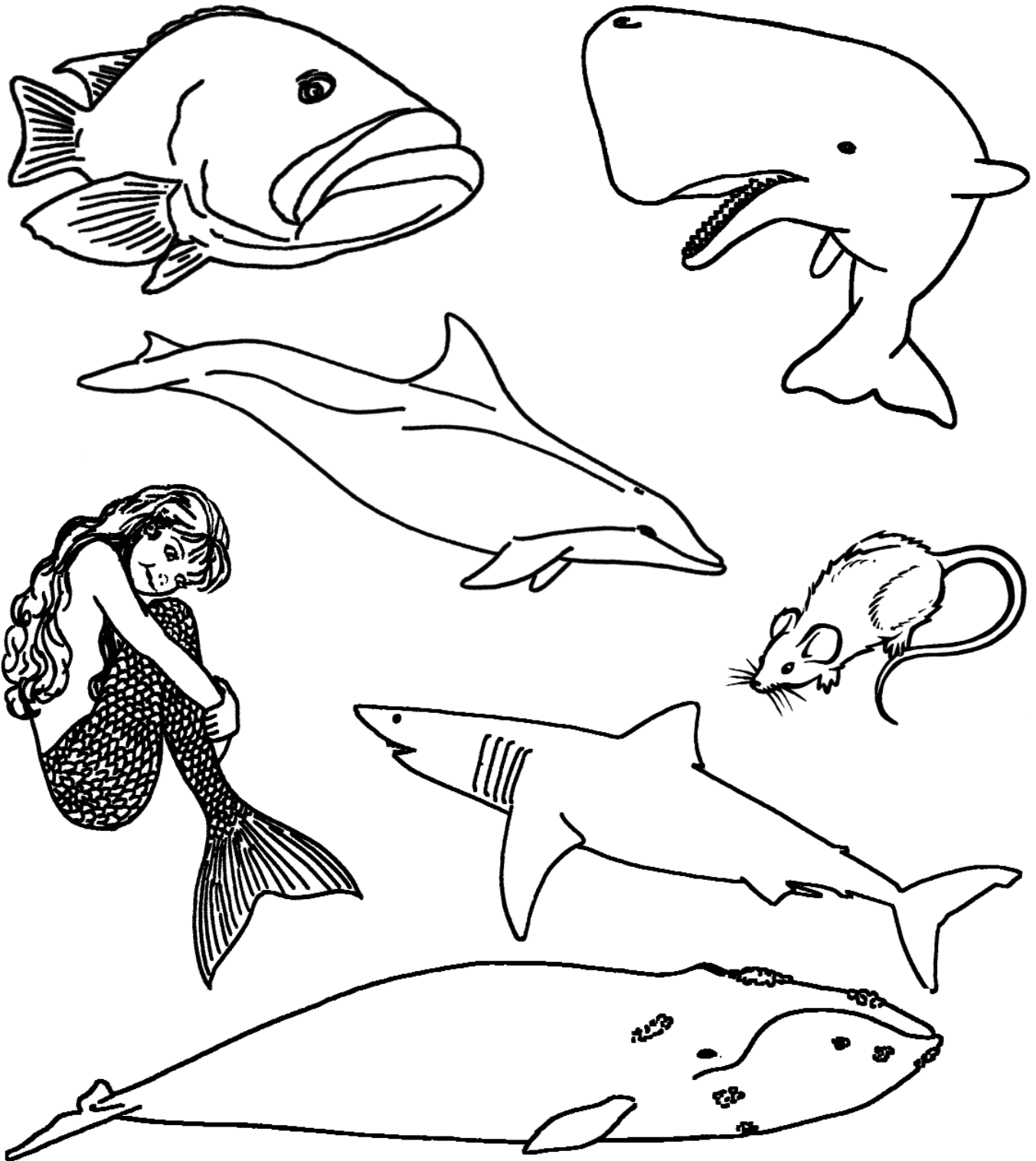
ACTION

1. Whales are mammals that live in the sea. Define mammal characteristics for your students, using the BACKGROUND information above. Help students make a list of words that describe whales. Make a second list of words that describe fish. Circle words that appear on both lists.
2. Copy and distribute the *Is It a Whale?* funsheet (on page 9).
3. Students color the animals that are mammals and circle the animals that are whales. Remind students to look for blowholes and tail orientation (a fish tail or whale flukes) to help them decide what is a whale and what is a fish.
4. When students are finished, discuss why each animal is or isn't a mammal and which mammals are whales.

Name _____

Is It a Whale?

Color the animals that are mammals. Circle the animals that are whales. Can you find the imaginary sea creature?



Something's Missing!

OBJECTIVES

Students identify the major structures of a whale's body and practice illustration.



MATERIALS

- chalkboard and chalk or writing surface and dry-erase markers
 - photos or illustrations of dolphins (Use *Whale Cards* in this Guide and also see reference materials suggested on page 24.)
 - Draw a Dolphin* instructions on page 12
 - crayons, markers, pencils or pens
 - blank paper
- one per student:
- copy of the *Something's Missing* funsheet on page 11

Not all whales have a dorsal fin. (At left, beluga whales at SeaWorld San Diego.)



ACTION

1. Using the illustrations on pages 5 and 6, the *Whale Cards* in this Guide, and other reference materials as available, help your students to identify the major external structures of a whale's body:
 - ◆ tail flukes
 - ◆ flippers
 - ◆ rostrum
 - ◆ eye
 - ◆ single blowhole (toothed whales)
 - ◆ double blowhole (baleen whales)
 - ◆ baleen
 - ◆ teeth
2. Distribute funsheets. Students identify the missing structure on each dolphin and draw a line from that dolphin to the correct structure.
3. Students draw the missing part on each dolphin and label it.
4. Distribute blank paper and pencils, markers, or crayons.

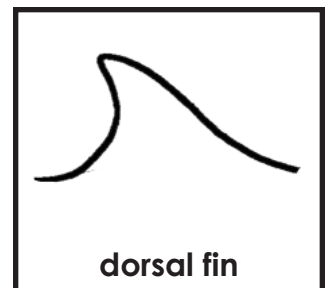
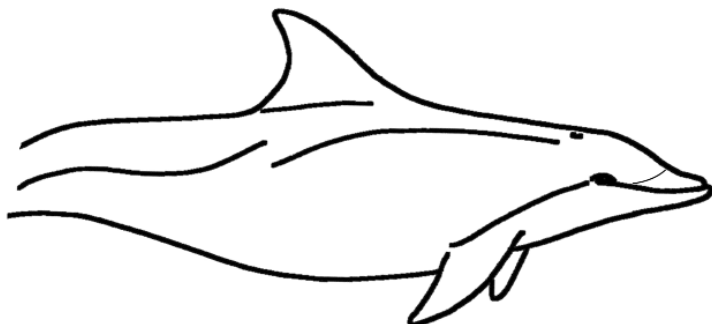
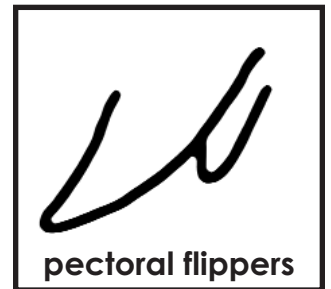
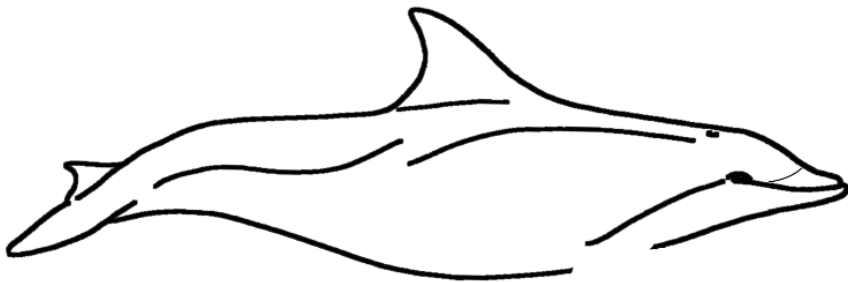
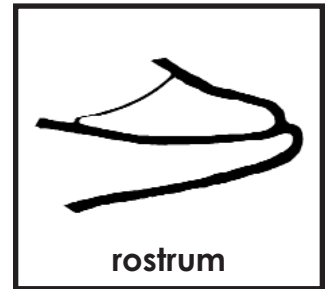
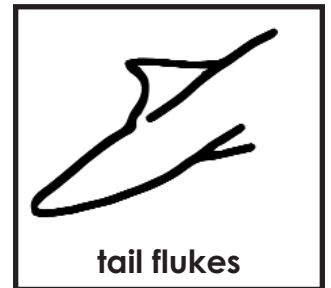
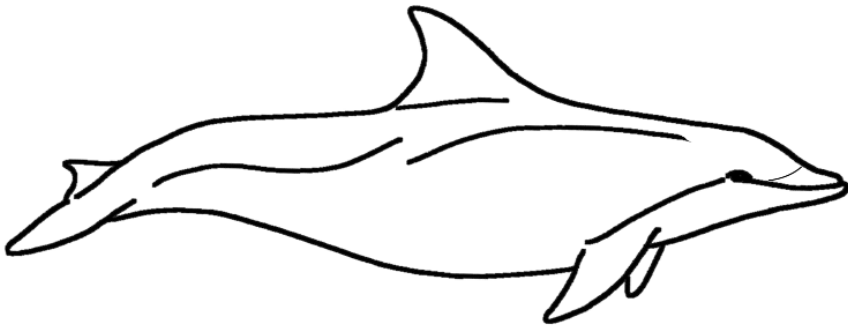
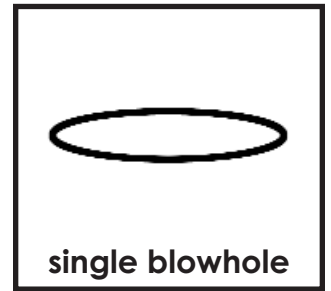
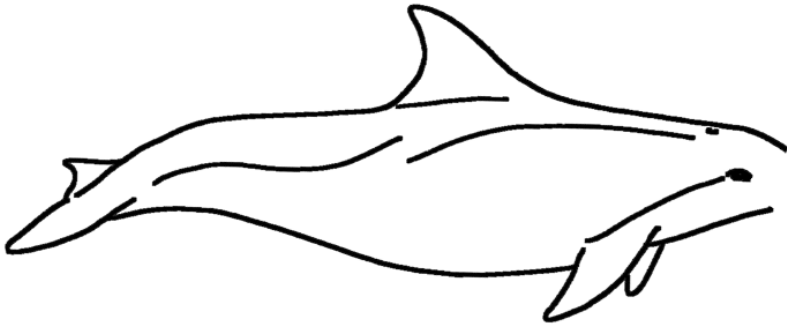
On the chalkboard or writing surface, demonstrate, step-by-step, how to draw a dolphin using the *Draw a Dolphin* instructions on page 12.

Students follow your dolphin-drawing instructions and example. Step-by-step, they draw a dolphin on their paper.
5. Students complete their illustration by adding background and color. Then they label the external structures of the dolphin.

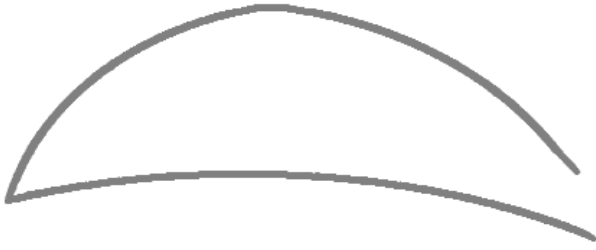
Name _____

Something's Missing!

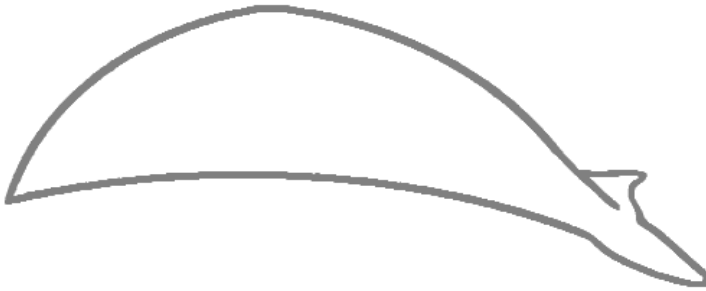
Each of these dolphins is missing something. Can you fix the drawings?



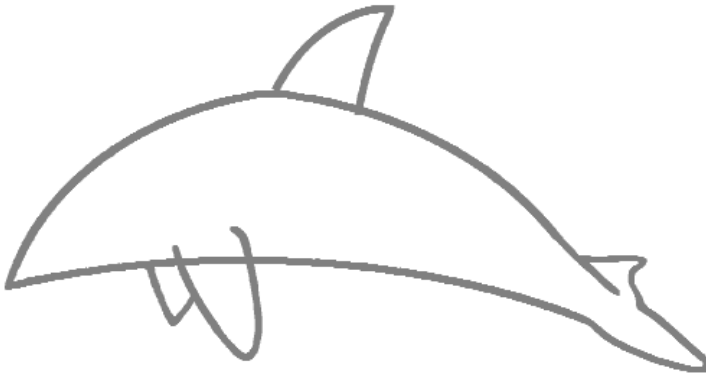
Draw a Dolphin



Draw two curved lines that connect at one end. The top curve will be the dolphin's back and the bottom curve will be the dolphin's tummy.

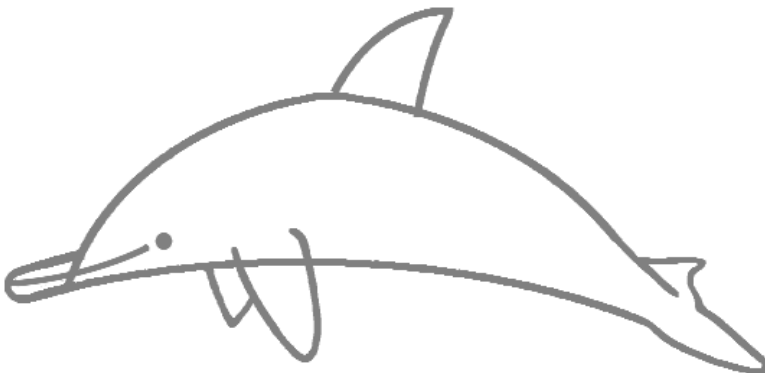


At the open end, draw your dolphin's **tail flukes**. A dolphin's tail flukes move up and down when the dolphin swims. (A dolphin tail looks different than a fish tail, which moves side-to-side as a fish swims.)



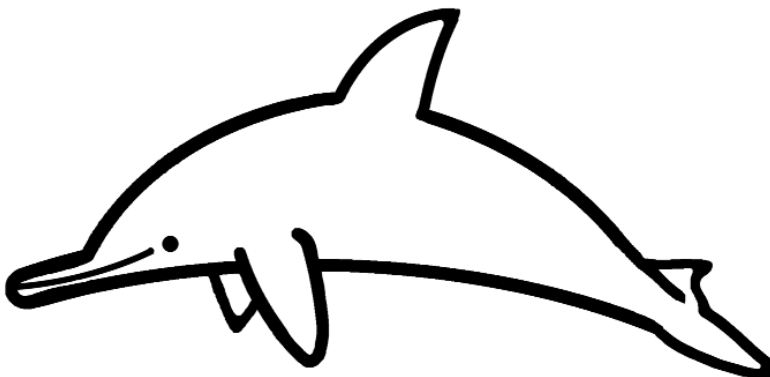
Dolphins don't have arms; they have a pair of **pectoral flippers** that help them steer. Add two pectoral flippers near the front of the dolphin.

Many species of dolphins have a **dorsal fin**: a fin on the back. Add a dorsal fin to your dolphin's back.



Draw a beaklike projection onto your dolphin's head. It's called a **rostrum**. Then draw the mouth.

A dolphin's eyes are near the corners of its mouth. Draw an eye on your dolphin.



If you want to make your picture neater, you can darken the outside lines and erase the lines under the dorsal fin, above the pectoral flippers, and where the rostrum meets the head.

Now color your dolphin and the background of your picture.

Whale Cards

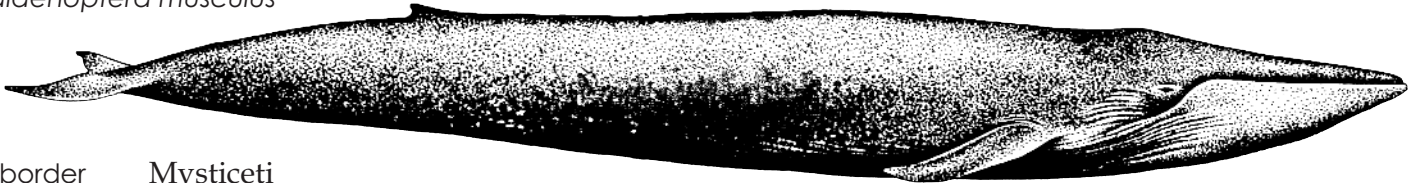
Use the cards on this insert to get started exploring whales. Each of the nine families of whales are represented by one or more of the following species. Each card includes a scale for reference; note that not each illustration is drawn to the same scale.

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



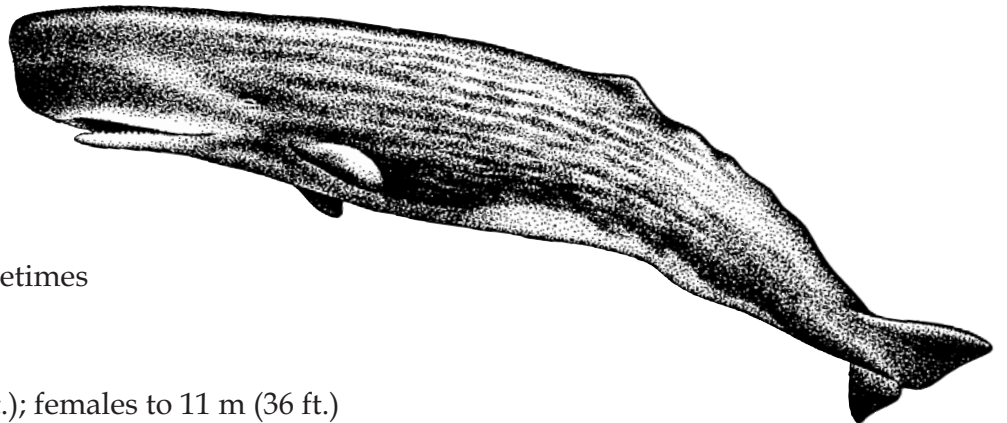
suborder	Mysticeti
family	Balaenopteridae, the rorqual whales
distribution	worldwide
prey	krill (A single blue whale may eat as much as 8 tons in one day.)
predators	killer whales
adult length	to about 26 m (85 ft.), although the largest recorded blue whale measured 34 m (112 ft.). Blue whales are the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

1 in. = 4 m

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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.)

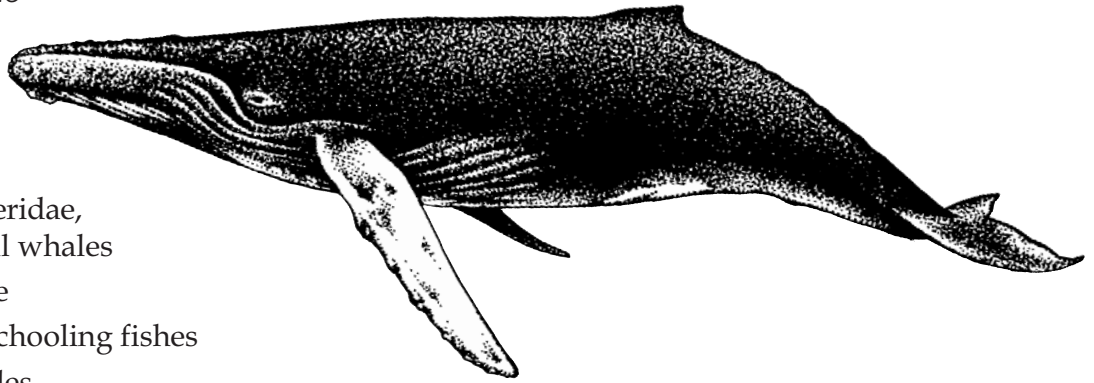
1 in. = 3 m

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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.)



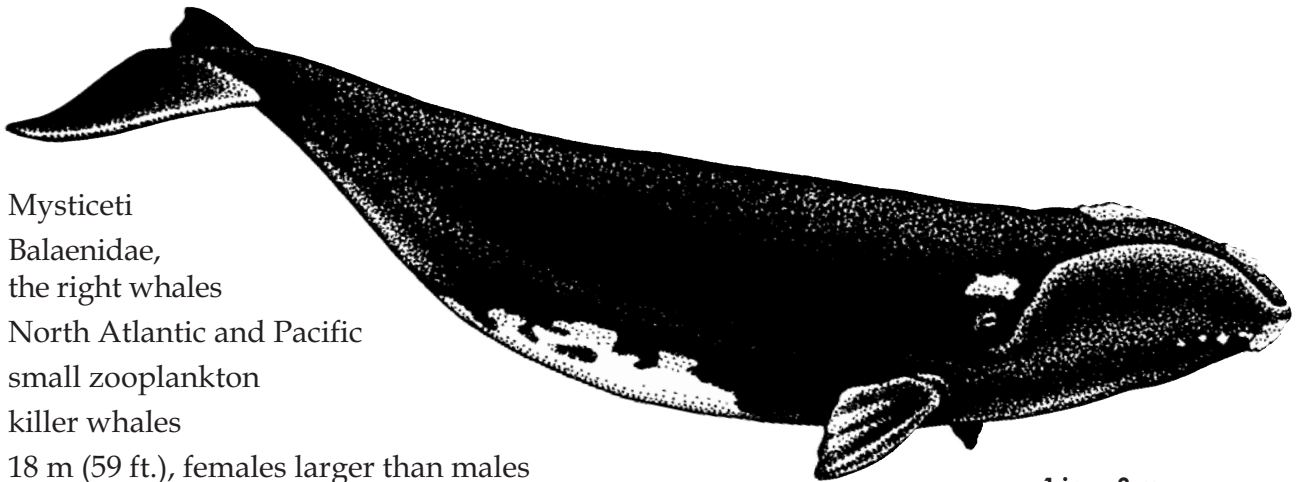
1 in. = 3 m

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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



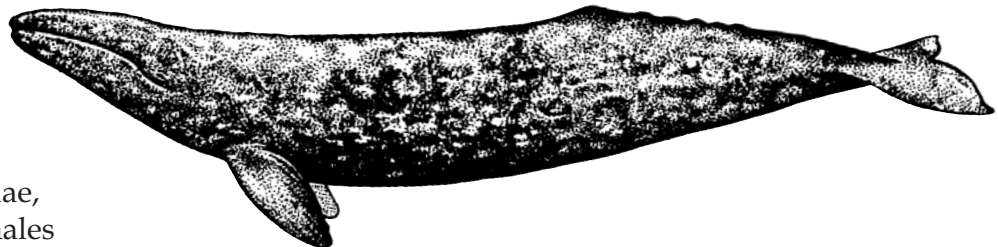
1 in. = 3 m

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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.)

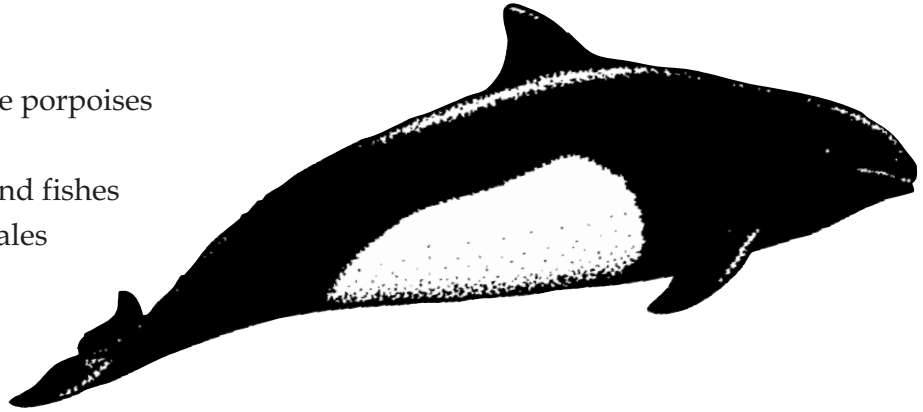


1 in. = 3 m

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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)

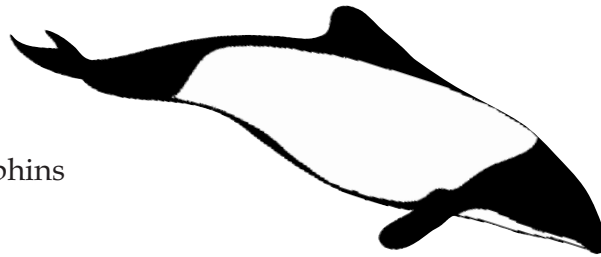


1 in. = 500 cm

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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.)

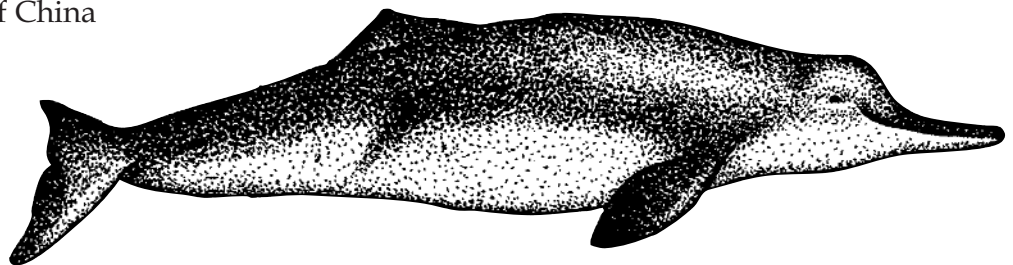


1 in. = 500 cm

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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.)



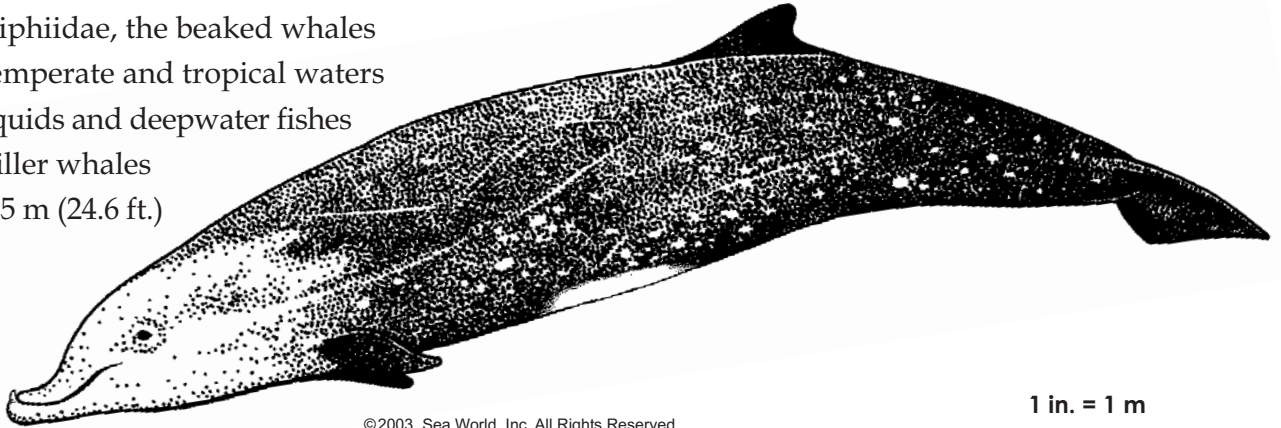
1 in. = 500 cm

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Cuvier's beaked whale

Ziphius cavirostris

suborder	Odontoceti
family	Ziphiidae, the beaked whales
distribution	temperate and tropical waters
prey	squids and deepwater fishes
predators	killer whales
adult length	7.5 m (24.6 ft.)



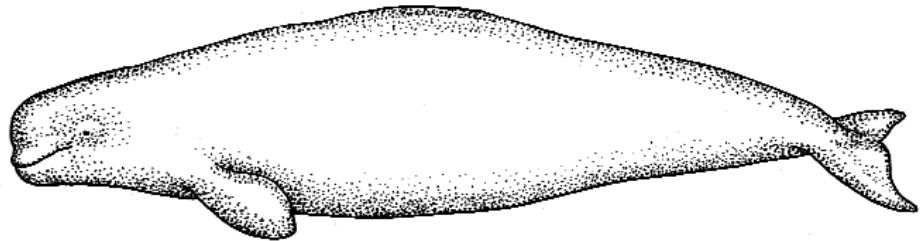
1 in. = 1 m

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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.)



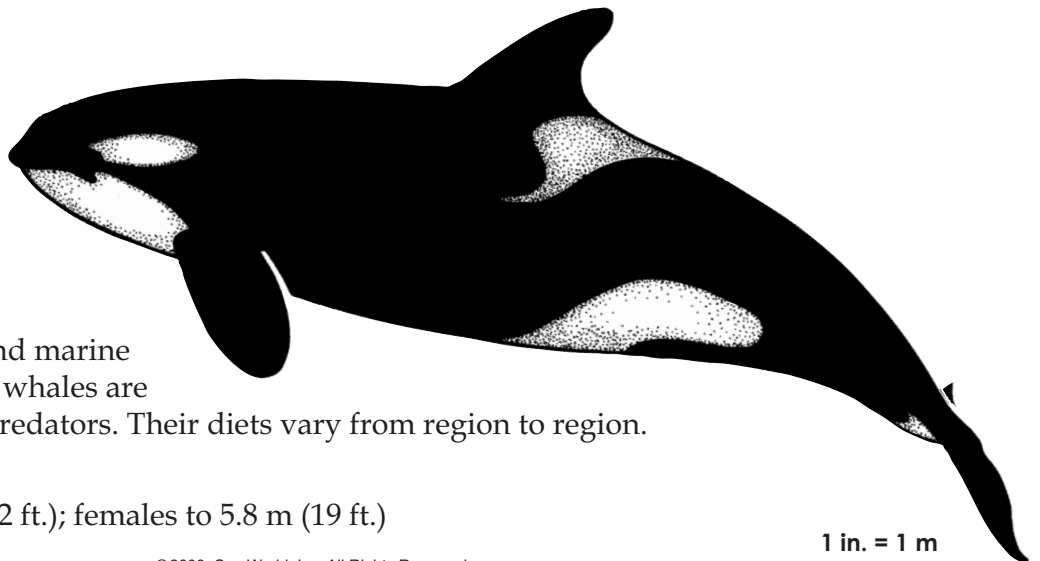
1 in. = 1 m

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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

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On the Road Again

OBJECTIVES

Students trace the *migration* route of a gray whale and discover a gray whale's natural history.

MATERIALS

- ❑ copies of the *On the Road Again* cut-outs on page 15
- ❑ map of western North America, big enough for a classroom bulletin board (or enlarge map at right onto butcher paper)
- ❑ markers, crayons, tempera paint, and/or various other art materials
- ❑ illustrations, photos, videos, and other resource materials on gray whales as available (see page 24)
- ❑ tacks or tape

BACKGROUND

Gray whales inhabit the eastern North Pacific Ocean. They spend summers in the icy waters of the Bering and Chukchi seas, off Alaska — their feeding grounds. As the ice pack advances in the fall, gray whales embark on one of the longest known migrations of any mammal.

Hugging the North America coastline, gray whales swim south more than 9,000 km (5,600 miles) to the warm-water lagoons of Baja California, Mexico. The trip takes two or three months each way. The migrating whales can be seen from shore or whale-watching boats.



As it begins a deep dive, a gray whale lifts its tail flukes.



ACTION

1. Enlarge the map of western North America so that it's big enough for a bulletin board display. Have students help color and label the map, then mount it on the wall in your classroom.
2. Photocopy the animal illustrations on page 15 (enlarge if you like) and cut them out.
3. Secure the adult gray whale cut-out to your map so that it can be moved and re-attached once each week with tape or tacks. Begin with your adult gray whale in the arctic feeding grounds. (Choose the Bering Sea or the Chukchi Sea.)
4. Explain to your students that the gray whale is going to be making a long trip (migration) all the way to the lagoons of Baja California, Mexico. Have the class choose which lagoon will be their destination. A gray whale takes two to three months to reach its destination – try this activity for ten weeks. (*If you measure the migration route and divide this measurement by 10, you'll know how far to move your whale each week.*)
5. Each week on the same day, move your whale a little farther down the migration route. Along the way, focus on the geography, animal life, and culture of the area.

Attach the photocopied cut-outs (from page 15) to your map when you're near the appropriate area.
6. Mother whales give birth to calves on their southward migration. Surprise students by placing the gray whale calf next to the adult as the adult nears the lagoons. Celebrate with a baby whale birthday party!



Wildlife enthusiasts observe a gray whale in the warm-water lagoons of Baja California, Mexico.

On the Road Again

cut-outs



amphipod (food for gray whales)
Alaskan feeding grounds



Alaska sea otter
Alaska



walrus
Alaska



salmon
northwestern United States



Steller's sea lion
northwestern United States



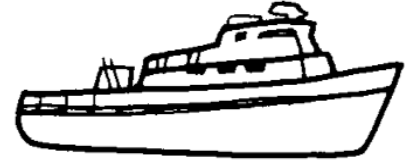
harbor seal
Alaska to Baja California



Douglas fir tree
northwestern United States



bottlenose dolphin
Southern California



fishing boat
(anywhere along the coast)



killer whale
throughout Pacific Ocean



California sea otter
central California coast



California sea lion
California coast to Baja California



surfer
Southern California



cactus
Baja California



coyote
Baja California



gray whale calf



adult gray whale

Good Vibrations

OBJECTIVES

Students investigate how sound travels. They observe, feel, and hear vibrations and communicate their observations. They infer and discuss why sound is an effective means of communication and navigation for whales.

MATERIALS

- tuning fork(s)
- shallow pan(s) of water
- blindfold(s)

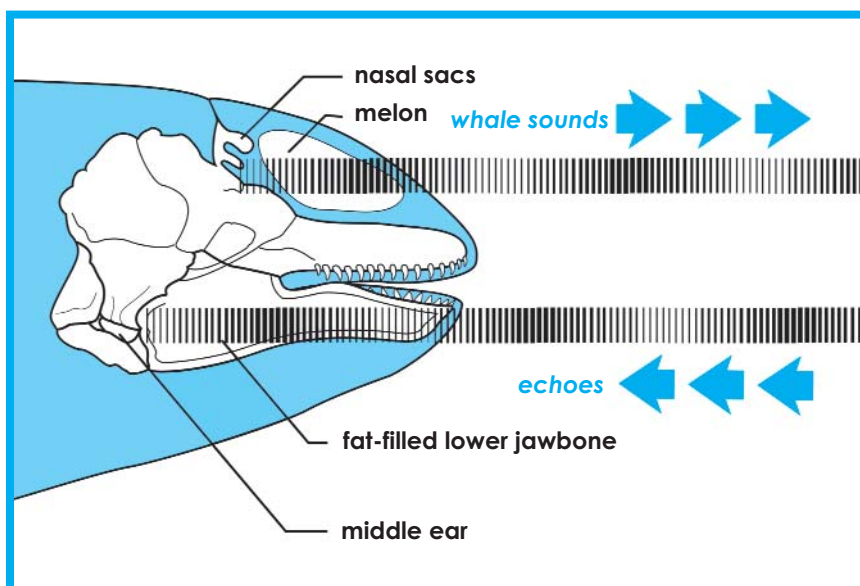
BACKGROUND

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 closer together than the molecules of a gas, and the molecules of a solid are even more densely packed 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 navigating 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.



A killer whale's fat-filled jawbone conducts sound through the jaw to bones in the middle ears.



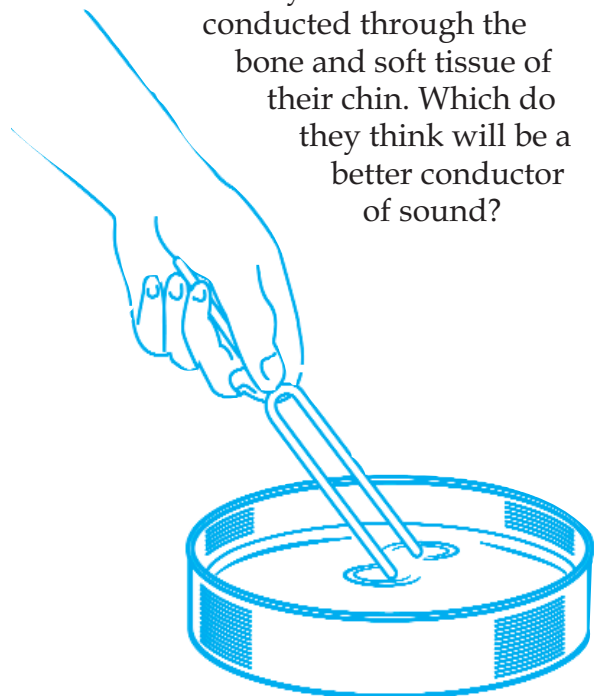
ACTION

Demonstrate the following activities, then divide the class into groups so each student can participate.

1. Holding the handle of the tuning fork, strike it on a hard solid surface. Gently move the fork towards the shallow pan of water and submerge the two tines under the water. Ask students to describe what they see. *(The sound vibrations create ripples in the water.)*

Explain that the ripples they see are evidence of sound waves that are moving outward from the source (the tuning fork). Describe how sound is the vibration of molecules. As sound waves travel through the water, each water molecule hits another and then returns to its original position.

2. Explain that students will have the opportunity to hear the sound made by the tuning fork. They will hear the sound conducted through air and then they will hear the sound conducted through the bone and soft tissue of their chin. Which do they think will be a better conductor of sound?



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

Ask them to predict if there will be a difference in the way they perceive the vibrations. Record their various predictions on the board.

3. Strike the tuning fork on a hard solid surface and hold it a few inches from a student's ear. Ask that student to describe what he or she hears. *(Students may hear a faint hum.)*
4. Strike the tuning fork again and hold the tip of the handle to the student's lower jaw. Ask the student to describe what he or she hears or feels. *(The hum is more audible because the vibration is traveling through the bone and tissues of the lower jaw. Because the molecules comprising these structures are more densely packed than the molecules in air, sounds travel faster and farther.)*

5. When all students have experienced the vibration in water, air, and through their chin, help them to communicate what they observed and experienced. Students write three sentences that describe their observations of the vibrations (1) through air, (2) through water, and (3) through their chin.
6. Review the students' predictions. Did anyone predict that they would be able to hear the sound best through their chin?
7. Write the word *echolocate* on the board and draw a circle around the "echo" and another circle around the "locate." Ask students if they know what each word means. Define the word *echolocate*.

Describe how whales echolocate. (See BACKGROUND information on page 16.) Explain how some toothed whales (and other animals) find food and each other by listening for echoes.

8. Students discuss why sound is an effective way for whales to communicate and navigate. (*Suggestion: ask the following questions to spur discussion.*)



- ◆ What does it look like when you open your eyes under water?
 - ◆ Is ocean water clear or murky? Bright or dark?
 - ◆ How do we see when it gets dark at night? (We turn on a light; by moonlight; by firelight).
 - ◆ Are there lights in the sea?
 - ◆ How would you find your way around if you couldn't see where you were going?
 - ◆ How do you think toothed whales find their way around a dark ocean?
9. Play a game that helps students better understand how whales navigate by sound. (This game is similar to the swimming pool game, "Marco Polo.")
 - ◆ Students hold hands and form a circle.
 - ◆ Blindfold a volunteer "dolphin" and steer him or her to the center of the circle.
 - ◆ Choose five students to be "fish." "Fish" stand inside the circle.
 - ◆ When dolphin calls out "dolphin!" the fish respond by calling out "fish!" (They are representing a dolphin making sounds and the echoes returning to the dolphin.) The dolphin moves around the circle trying to find and tag the fish by following the sounds of their voices. When the dolphin tags a fish, that fish sits outside the circle.
 - ◆ After a few minutes, call a time-out. In the ocean, dolphins sometimes hunt together in pods. Add a few more blindfolded dolphins to the center of the circle and see if the hunting gets easier.

Bottlenose dolphins can echolocate to find prey and each other under water.

How Deep Do They Dive?

OBJECTIVES

Student relate pictures to mathematical ideas and create a graph.

MATERIALS

- scissors
- glue, gluesticks, or tape
- chalkboard or other writing surface
- MAXIMUM DIVING DEPTHS** table (at right)

one set per student:

- copies of the two *How Deep Do They Dive?* funsheets on pages 20-21

BACKGROUND

Most whales find their food within 100 m (330 ft.) of the ocean surface. But many whales are capable of diving to great depths. The sperm whale is one of the deepest-diving mammals. It can dive down to at least 1,000 meters!

MAXIMUM DIVING DEPTHS (APPROXIMATE)

Dall's porpoise	100 meters
Pacific white-sided dolphin	200 meters
beluga whale	300 meters
bottlenose dolphin	500 meters
pilot whale	600 meters



ACTION

1. Distribute the *How Deep Do They Dive?* funsheets.
2. Explain to students that they will graph the maximum diving depths of five whales. Copy the names of

the whales and their diving depths on the board.

3. Each whale illustration represents 100 meters. Students determine how many of each whale they need to cut. (*There will be extra whales on the funsheet.*)
4. Students glue the whales on their graphs. They begin at the ocean surface and work down.

DEEPER DEPTHS

Working in groups, students determine other ways to display this data. Let them try some of their ideas. Then ask students to list some advantages and disadvantages of each method.




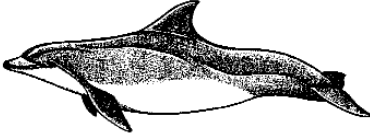























Look for examples of how people use graphs to communicate, and share these examples with your students. (*Hint: newspapers and periodicals often use graphs to communicate mathematical information.*)

ANSWERS

Students glue the following whales to their graphing funsheet:

- ◆ six pilot whales
- ◆ five bottlenose dolphins
- ◆ three beluga whales
- ◆ two Pacific white-sided dolphins
- ◆ one Dall's porpoise

How Deep Do They Dive?

 bottlenose dolphin	 beluga whale	 pilot whale
 bottlenose dolphin	 beluga whale	 pilot whale
 bottlenose dolphin	 beluga whale	 pilot whale
 bottlenose dolphin	 beluga whale	 pilot whale
 bottlenose dolphin	 beluga whale	 pilot whale
 Pacific white-sided dolphin	 Dall's porpoise	 pilot whale
 Pacific white-sided dolphin	 Dall's porpoise	 pilot whale
 Pacific white-sided dolphin	 Dall's porpoise	 pilot whale
 Pacific white-sided dolphin	 Dall's porpoise	 pilot whale

Name _____

How Deep Do They Dive?

A large gray rectangular area with a decorative white wavy border on the left side. The area is divided into four vertical columns by three vertical dashed lines, intended for writing answers.

Fiction or Nonfiction?

OBJECTIVES

Students read a variety of books about whales. They differentiate between fiction and nonfiction writing and compare whale natural behavior to the kinds of things that whales can do in fiction stories. They write their own fiction and nonfiction about whales.

MATERIALS

- ❑ a variety of fiction and nonfiction books that feature whales or whale characters. (See the Bibliography on page 24 for some recommendations.)



Nonfiction books are popular with students.

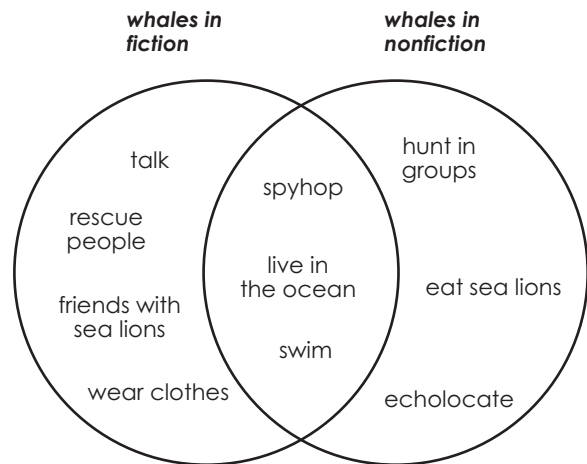


ACTION

1. Use independent and teacher-led reading techniques to introduce your students to books about whales. Include both fiction and nonfiction.
2. Discuss the whales you have read about. Ask students to compare the real and imaginary whales. What are the characteristics of the whales you've read about in nonfiction books? What are the characteristics of imaginary whales? Are some characteristics common to both? On the

board, generate a list of words that describe the real and imaginary whales in your books.

3. Help students create a Venn diagram showing the characteristics of real whales and imaginary whales. Use the word list you generated in step 2. Here's an example:



It's not fiction! Killer whales leap high in the air.

4. Ask students to write about whales. They write examples of nonfiction and fiction.

Whale Word Puzzles

OBJECTIVES

Students practice sounding and spelling new words.

MATERIALS

- paper and pencils
- chalkboard or writing surface



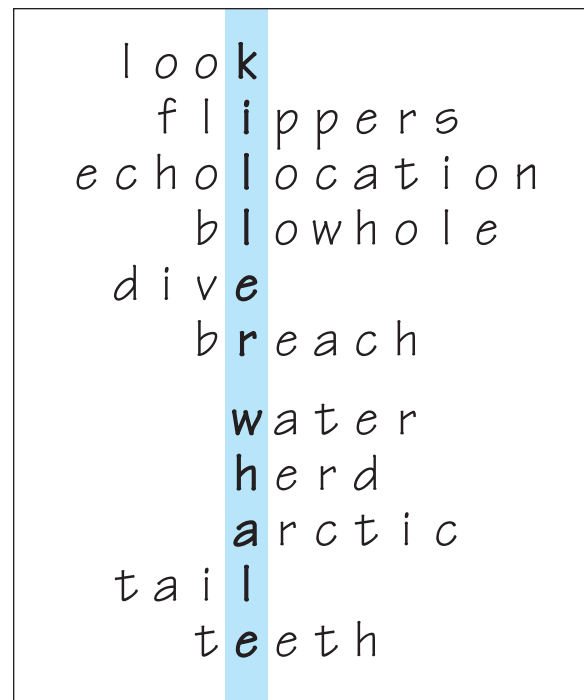
ACTION

1. Ask students to name words and terms they have learned while studying whales. Write these words on the board. Here are some suggestions:

Antarctic	gulp	melon
Arctic	herd	ocean
baleen	hunt	plankton
big	ice	pod
blow	jump	predator
blowhole	krill	prey
blubber	leap	rostrum
breach	length	skin
breathe	lice	smooth
dive	listen	swim
dorsal fin	long	tail
echolocate	look	teeth
endangered	lunge	underwater
flipper	mammal	water
flukes	marine	whale

in it. Write that word horizontally (so that the letter “k” in “killer whale” is also the k in the word chosen.) Repeat for each letter in the name “killer whale.” Below is an example:

3. Try again using another whale name.



2. Next, write the name “killer whale” vertically on the board. Ask a student to choose a word with the letter “k”

DEEPER DEPTHS

Each student chooses a whale species. Using the letters of the whale’s name, the student creates a series of descriptive words about the whale. For example, “baleen,” “long,” “underwater,” and “endangered” describe a blue whale. As students take turns reading their words aloud, the class listens and identifies the first letters of each descriptive word. Then students guess the name of the whale.

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* These books available through SeaWorld. Call 1-800-23-SHAMU for order information.

Whales K–3 Teacher’s Guide

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