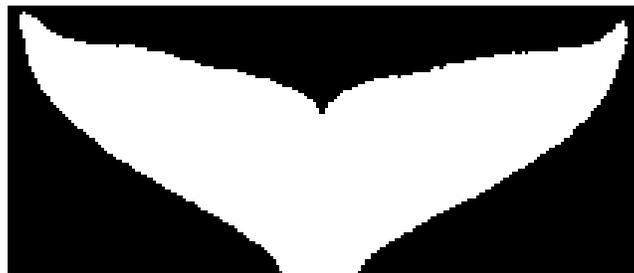


CETACEAN CURRICULUM

A TEACHER'S GUIDE TO INTRODUCING AND
USING WHALES, DOLPHINS AND PORPOISES IN
THE CLASSROOM.



AMERICAN CETACEAN SOCIETY

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Curriculum Outline

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HOW TO USE THIS CURRICULUM.

This curriculum is intended as a resource for teachers interested in teaching their students about whales and dolphins. It contains some basic background information on cetaceans and offers some ideas for activities to engage students. It is not intended to be either all encompassing or the ultimate resource. The hope is that this will serve as a springboard for teachers and their students to delve into the world of cetaceans, and the marine environment.



WHAT IS A CETACEAN?

At first glance, whales, dolphins and porpoises may appear to be similar but different types of animals. Whales tend to be very large animals that live way out at sea, while dolphins and porpoises seem to be much smaller and can be seen playing with boats, and often from the beach. However, all whales dolphins and porpoises share certain characteristics that put them together in the scientific order Cetacea (from the Greek word *ketos*, which means whale). They all have a fairly streamlined body, as well as other adaptations that allow them to live a completely aquatic life, without ever having to come onto land. Their front limbs have become paddle-like flippers, and, externally, they have lost their back limbs completely. While these features have caused them to become fish-like in appearance, they also all share a characteristic that strongly separates them from fishes, and links them to otters, cows, dogs, and people. They are all mammals.

What is a Mammal?

So, then, what is a mammal? Mammals share several characteristics with other types of animals. Certainly, mammals breathe air with lungs, which immediately separates them from the fishes. This does not make them a mammal, though, since birds and reptiles also breathe air with lungs. Like birds, mammals are endothermic, which means that they maintain a constant inner body temperature (often referred to as “warm blooded”). For the most part, mammals give birth to live young. However, 3 species of mammals do lay eggs, and several species of fish and reptiles give birth to live young. Hair, or fur, is useful as a determining feature, since no other animals have “true” hair (The “hair” on some arachnids and insects are actually sensory bristles, and are not similar to mammal hair in anything but casual appearance). But many cetaceans are hairless, and some other mammals, like rhinos, are not immediately recognized as having hair. The one characteristic that **all** species of mammals possess is that the mothers produce milk for their young. No other type of animal in the world does this. It is this feature, in combination with the other characteristics that serve to separate mammals from all the other groups of animals.

Cetaceans, therefore, are referred to as Marine Mammals – Mammals that live in the ocean. Cetaceans aren’t the only group of marine mammals, however. There are also pinnipeds (seal, sea lions, and walruses), sirenians (manatees and dugongs), sea otters, and even polar bears! However, from ancient Greek pottery to today’s advertisements and movies, cetaceans seem to have most completely captured the hearts and minds of people all over the world.



CETACEAN EVOLUTION

Evolution is the process by which all living things change gradually over long periods of time. This process usually occurs in response to changes in the environment. Whales and dolphins evolved over a period of 55 million years from an animal that looked very different from the cetaceans that live today. The exact ancestor of cetaceans is still unknown, but recent fossil findings indicate that one of the earliest cetaceans is an animal called a **pakicetid**. Pakicetids lived on land and resembled a short-legged wolf with hoof-like claws. It walked on four legs and was a meat eater. Some pakicetids may have hunted along the shore, probably to catch fish. They may have begun to find more food in deeper waters or may have begun to escape from predators by swimming. Over time, the pakicetids body began to change to gradually adapt to this new aquatic environment.

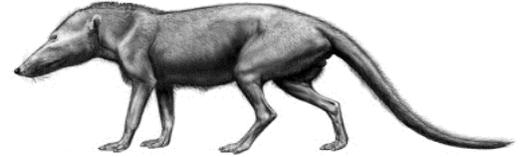
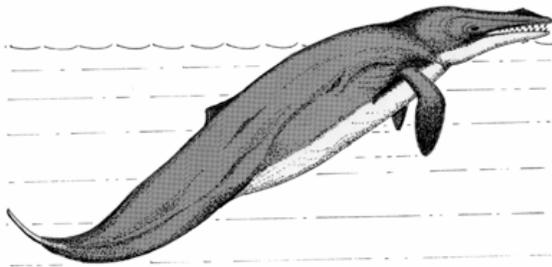


Illustration by Carl Buell and taken from <http://www.neoucom.edu/Depts/Anat/Pakicetid.html>

Over millions of years, pakicetids evolved into a primitive group of whales, called **archaeocetes**, which means "ancient whale." Initially, archaeocetes were small, seal-like animals, with four legs and few marine specializations. They may have spent some time on land at first. Gradually, the archaeocetes evolved into large, eel-like animals highly adapted for a marine life. Their limbs were replaced with paddle-like flippers to help them move in water. The archaeocetes ultimately evolved into two groups of whales, **mysticetes** and **odontocetes**, which are still alive today.



Fossils have helped scientists identify the ancient relatives of whales, such as mesonychids and archaeocetes. Fossils are the preserved remains of animals and plants in rocks. By identifying and comparing fossils, scientists can begin to see how different types of animals on earth are related. The fossilized wrist bones of pakicetids, for example, reveal that they most likely evolved from the same ancestor as the modern day artiodactyls (even toed hoofed animals). This is strongly supported by fossils of pakicetids that show a combination of features of both artiodactyls and cetaceans. So although they appear to be very different animals, the closest living relatives to whales and dolphins are cows, hippos, and giraffes!

Key Words:

Archaeocete (ark-ee -oh-seat)

Artiodactyl (arty-oh-dack-tul)

Fossil (foss-il)

Mysticete (miss-ta-seat)

Odontocete (oh-don't-oh-seat)

Pakicetid (pack-ee-seat-id)

GENERAL CETACEAN ANATOMY

Cetaceans come in all sizes, and have many adaptations to help them survive in the ocean. They are even broken up into two major groups (based in part on feeding strategies), the Mysticetes and Odontocetes. All cetaceans, however, have a common overall body plan. They have a streamlined, torpedo-like shape that allows them to swim efficiently through the water. It is no coincidence that humans have designed submarines and airplanes in a similar shape. For the most part, they also share a number of common body parts as well.

Cetacean Body Parts

Flukes:

The flukes are often referred to as the whale's tail. However, the flukes are large appendages at the end of the tail (also referred to as the caudal peduncle). The flukes are made up of fibrous connective tissue, without any bone or muscle inside. These paddle-like structures serve to help push the whale through the water, much like the swim fins of a human diver. Like a diver's fins, the flukes move up and down to push the whale through the water, as opposed to the side to side motion of fishes. When swimming near the surface, the water displaced by the flukes causes smooth circular patterns to appear on the surface, which observers often call "footprints" or "flukeprints". The whales can actually be tracked by these prints as long as they remain near the surface. (The same effect can be observed in a bathtub or pool by putting your hands under the water and moving them up and down near the surface.)

Dorsal Fin:

The dorsal fin is the fin on the back of most cetaceans. Like the flukes, it is made of fibrous connective tissue. Most polar species (beluga, narwhals, right and bowhead whales), as well as gray whales, lack dorsal fins. Many scientists believe it helps keep balance, aid in turning when chasing prey, and assist in thermoregulation (maintaining internal body temperature).

Pectoral Fins:

The pectoral fins, or flippers, are used mainly for balance and steering. The bones of a whale's flippers are similar to the bones found in a human hand. Differences in the size or shape of individual bones enhance the whale's ability to steer. Shortened wrist bones and longer finger bones provide added power, better balance, and help the whale to maneuver.

Blowholes:

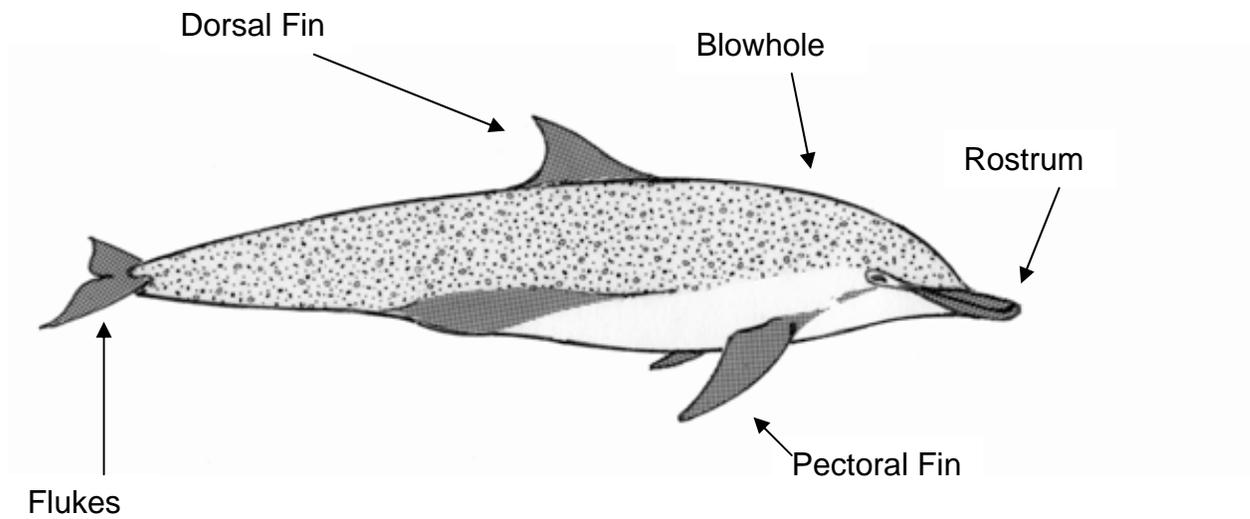
A cetacean's nostrils, or blowholes, are located at the top of its head. This facilitates the movement of the cetacean through the water since only the top of the head needs to break the surface of the water to allow the cetacean to breathe. Cetaceans are voluntary breathers; meaning that, unlike land mammals, their nostrils are sealed shut in



their relaxed state. The whale must open their blowholes to breathe. Mysticetes have two blowholes, and odontocetes have only one.

Rostrum:

The rostrum is the very front end of the cetacean, often called the snout or beak. It is structurally comprised of the same bones humans have between the bottom of their nose and their upper jaw. On cetaceans, these bones have been elongated to the rostrum. This gives the cetacean a more streamlined shape, making it easier to move through the water.



CETACEAN BODY PARTS

Key Words:

Flukes (flukes)

Dorsal Fin (door-sal fin)

Pectoral Fin (peck-tor-al fin)

Blowhole (blow-hole)

Rostrum (raw-strum)

ANATOMY ACTIVITY

As Big As That?

Cetaceans come in all sizes, from the massive blue whale, all the way down to the Vaquita, a tiny porpoise that lives in the Sea of Cortez. However, students can have a hard time trying to visualize how big 30 feet actually is, let alone 100 feet. This activity gives students a chance to see how big (and how small) cetaceans can actually get.

Materials:

100 ft rope, (knotted or marked at the lengths given on Size Chart)

Cetacean Size Chart

Large open space (at least 100 feet long)

(Additionally, you may want to select certain species to focus on with the rope and add pictures, posters, models or stuffed animals of these cetaceans)

National Science Education Standards Correlations:

K-4: Strand B, Properties of Objects and Materials

Procedure:

1. Explain to the students that cetaceans come in all sizes and pass out the Size Chart.
2. Ask the students how big a whale they think you can fit in your classroom.
3. Have one student be the anchor point, and unroll the rope, stopping at the different lengths and having a student represent that cetacean.
4. When you have stretched the length of your classroom, take the rope to a larger space (if available) and continue to 100 feet. Explain that this is as long as blue whales can get and have them examine just how long that really is.

Discussion Questions:

- How long a whale could you fit in the classroom?
- Are all whales gigantic?
- Would it be easy for anything to catch and eat a large whale?

Extensions:

- Have the students join hands and see how long a whale the whole class can be.
- Working with student heights, calculate how many class members it would take to equal a blue whale (or other whale of interest).
- Add information from the “Notes” section of the chart to your class measurements so they can make some comparisons.
- Hang the rope on the wall and have your students find pictures and/or information about the different cetaceans.



CETACEAN SIZE CHART

SPECIES	LENGTH Feet / Meters	WEIGHT Pounds / Kg	NOTES
Vaquita	4-5 / 1.2-1.5	65-120 / 30-55	Smallest cetacean
Harbor Porpoise	6 / 1.8	125-145 / 55-65	
Commerson's Dolphin	5.5 / 1.7	75-130 / 35-60	
Dall's Porpoise	7.5 / 2.3	300-485 / 135-220	One of the fastest cetaceans
Common Dolphin	8 / 2.4	155-245 / 70-110	
Dwarf Sperm Whale	9 / 2.7	300-605 / 135-275	
Pygmy Sperm Whale	12 / 3.7	695-880 / 315-400	
Bottlenose Dolphin	12 / 3.7	330-1435 / 150-650	
Risso's Dolphin	13 / 3.9	660-1100 / 300-500	
Beluga	16.5 / 5	.4 – 1.5 tons	
Narwhal	16.5 / 5	.8 – 1.6 tons	
Short Fin Pilot Whale	20 / 6.1	1 – 4 tons	
Strap Tooth Whale	20 / 6.1	1 – 3 tons	
Pygmy Right Whale	21 / 6.5	3-3.5 tons	Smallest baleen whale
Northern Bottlenose Whale	29.5 / 9	5.8 – 7.5 tons	
Killer Whale	32 / 9.7	2.6 - 9 tons	Average male is 25 feet – about the same size as a newborn blue whale. Also the largest dolphin.
Minke Whale	33 / 10.1	10 tons	
Baird's Beaked Whale	42 / 12.8	11 – 15 tons	Largest beaked whale
Right Whale	45-50 / 13.7 – 15.2	100 tons	
Humpback Whale	45-50 / 13.7 – 15.2	25-40 tons	
Gray Whale	46-48 / 14 – 14.6	30-40 tons	
Sperm Whale	49-59 / 14.9 - 18	13-14 tons	Largest toothed whale
Bowhead Whale	50-55 / 15.2 – 16.8	60 tons	
Sei Whale	50-65 / 15.2 – 19.8	14-17 tons	One of the fastest baleen whales
Fin Whale	88 / 26.8	70-80 tons	
Blue Whale	100 / 30.5	110 tons	Largest animal ever

All sizes and weights are approximate maximums.
Tons are in English tons: 1 ton = 2000 pounds.

Numbers based on information found in Whales, Dolphins and Porpoises (Mark Carwardine, 1995), and Marine Mammals – Evolutionary Biology (Annalisa Berta & James L. Sumich, 1999)



ANATOMY ACTIVITY

Whale Parts

All cetaceans share a certain number of external body parts. The names of these body parts are useful in describing cetaceans, and are important to know.

Materials:

Laminated Body Part cards
Yarn or string

National Science Education Standards Correlations:

K-4: Strand C, Characteristics of Organisms

Procedure:

1. Discuss the different body parts of cetaceans.
2. Tell the students that they are going to help build a whale, using one of them (the students) as the base.
3. Ask questions regarding the use or placement of each of the body parts. The student who answers correctly gets to put the card on the appropriate part of the “whale body” by tying it on with yarn or string.
4. When the whale is built, review the different body parts.

Discussion Questions:

- Do all cetaceans have all the same body parts?
- What body parts do humans have that whales don't? Are there some that are similar?

Extensions:

- Divide the class into two groups and have a “game show” competition as to who can build their whale first. Ask questions about whales in general or about the specific body parts. If you desire, you can add features from the following section “Cetacean Adaptations” (such as baleen and melon).



BODY PART CARDS

FLUKES	DORSAL FIN
PECTORAL FIN	BLOWHOLE
ROSTRUM	MELON
BALEEN	TEETH



CETACEAN ADAPTATIONS

An **adaptation** is a change in an organism's body or behavior that helps it to survive. An organism adapts to an environment very slowly over thousands of generations. Those that are better suited for their environment have a greater chance of surviving and passing their adaptations on to offspring. A thin-furred animal living in a very cold environment is not as well adapted as a thick-furred animal, for example. Whales and dolphins have particular body and behavior modifications that have helped them successfully adapt to a marine life.

Melon:

The melon is a special organ located between the blowhole and rostrum of toothed whales. It is essentially an oil filled sack that most marine biologists agree serves as an "acoustical lens". The melon helps the whale to focus the produced sounds in a desired direction.

Baleen:

Baleen is an adaptation some whales developed that aids in capture of very small prey in large amounts. It grows from the roof of the mouth of the mysticetes and hangs down in structures called plates. Baleen is made out of **keratin**, just like our hair and fingernails, and works like a spaghetti strainer to filter small animals out of the water. The plates of baleen overlap a little and have a fringe to trap food on the inner side. There may be anywhere from 200 – 600 plates in their mouth. The frayed inner edge of the baleen looks like a moustache, from whence came the name mysticete (*mysti* from the Greek word for moustache).

Blubber:

Unlike most mammals, whales do not rely on hair or fur for warmth. Instead, they have a thick layer of fat, called **blubber**, that acts like insulation to keep them warm. Blubber can also help to provide energy as a food reserve when food is scarce. In addition, blubber is lighter than water and can help the whale remain buoyant, or stay afloat, in the water. This important fat layer beneath the skin can be up to one foot thick!

Vestigial Pelvic Bones:

Whales do not have hind legs like those of their terrestrial or land-dwelling ancestors. This improves their streamlining. Nevertheless, internally all whales have vestigial pelvic bones that are remnants of hind limbs that have gradually disappeared through evolution.

Breathing:

Whales, like all mammals, have lungs and breathe air. Whales have one or two nostrils, called **blowholes**, on top of their head that allow them to breathe easier while swimming. The holes close tightly underwater so the animal does not drown. When the whale surfaces, the blowhole opens quickly to allow the whale to exhale, and take a breath. Since cetaceans spend most of their lives underwater, another important aspect



of breathing is how long they can hold their breath. Some can only hold their breath for 3-5 minutes. But then there are the champion breath holders, the sperm whale and beaked whales, who can hold their breath for over an hour! The mechanisms allowing this incredible feat are not completely understood. It is known that these cetaceans have a higher affinity for oxygen in their tissues than land mammals. In some cases, it appears that the lungs completely collapse under the pressure of deep dives, indicating that the whale's lungs are empty when they dive! This would help reduce the amount of nitrogen that could be forced into their blood from the lungs by the pressure of a deep dive. It is nitrogen in the blood (or rather, the release of nitrogen dissolved in the blood) that causes the potentially lethal condition known as the bends.

Sound:

Sound production in cetaceans is a complex phenomenon not fully understood by scientists. All cetaceans produce sound when underwater. Baleen whales produce powerful low frequency sounds that can travel over vast distances (potentially over hundreds of miles.) These sounds seem to serve mostly for communication. Toothed whales produce high frequency sounds. These high frequency sounds don't travel nearly as far as low frequency sounds, but when they bounce, or echo off objects, these high frequency sounds can provide a lot of information regarding that object. Toothed whales seem to use these sounds for navigation as well as communication. The use of these high frequency sounds for navigation is a process known as echolocation. The whale uses its nasal air sacs to make distinctive clicking sounds that are then transmitted out through the **melon**. These high frequency sound waves bounce off objects in the water, creating echoes that help the whale to determine the distance and size of an animal or object. Returning signals may be received through the lower jawbones, called the mandibles, and conducted to the inner ear via a waxy material in the jawbone. The ability to echolocate is a great advantage to animals that live in an environment where visibility is limited.

Fast Facts

- Whale skin has no oil glands or pores.
- Although whales are not covered in fur or hair, some species have small amounts of hair on the snout, jaws, or chin.

Key Words:

Adaptation (a-dap-tay-shun)

Blubber (blub-er)

Echolocation (ecko-low-cay-shun)

Flipper (flip-er)

Fluke (fluke)

Keratin (care-a-tin)

Melon (melon)



ADAPTATION ACTIVITY

The Breath Test

Breath control is a very necessary adaptation for a cetacean. Since it breathes air, it has to get enough at the surface to allow it to swim and look for food, without having to surface too often. This activity will help illustrate how remarkable cetaceans are in this respect.

Materials:

Stopwatch or timer
Cetacean breath chart

National Science Education Standards Correlations:

K-4: Strand A, Abilities to do Scientific Inquiry
K-4: Strand C, Characteristics of Organisms
K-4: Strand G, Science as Human Endeavor
5-8: Strand C, Regulation and Behavior
5-8: Strand C, Diversity and Adaptations of Organisms

Procedure:

1. Explain to students that cetaceans, as mammals, have to hold their breath while underwater just like we do. Using the chart let them know how long different cetaceans can hold their breath.
2. Ask the students how long they think they can hold their breath. Tell them they will all have a chance to see if they can hold their breath as long as a cetacean.
3. Have the students take several long deep breaths to prepare them. Then have them take a deep breath and hold it. Time how long they can hold their breath (up to one minute).
4. Compare their time with the cetacean breath chart.

Discussion Questions:

- Do the students think they would get better at holding their breath if they tried it every day?
- Do they think they could hold their breath as long if they had to do things while holding their breath, like walking or playing?



Extensions:

- Explain to the students that whales have to swim and hunt and eat while holding their breath. Have the students stand and walk or run in place while holding their breath. Can they do it as long?
- Explain that scientists think that some whales empty their lungs before diving. Ask them if they think they could go without breathing as long as they did if they exhaled before “holding” their breath.



CETACEAN BREATH CHART

SPECIES	TIME	MAX DIVE DEPTH
Pacific White Sided Dolphin	5 minutes	210 m
Bottlenose Dolphin	10 minutes	535 m
Killer Whale	15 minutes	250 m
Narwhal	20 minutes	1000 m
Humpback Whale	20 minutes	150 m
Gray Whale	25 minutes	170 m
Fin Whale	30 minutes	500 m
Blue Whale	50 minutes	100 m
Bowhead Whale	80 minutes	300 m
Bottlenose Whale	120 minutes	1000 m
Sperm Whale	140 minutes	3000 m

All Times and depths approximate.

Numbers based on information found in Whales, Dolphins and Porpoises (Mark Carwardine, 1995), and Marine Mammals – Evolutionary Biology (Annalisa Berta & James L. Sumich, 1999)



ADAPTATION ACTIVITY

Beautiful Blubber

Blubber is an important adaptation for cetaceans living in cold ocean waters. The activity below will help you investigate how well blubber keeps a whale warm. By imitating this important insulation layer, students will discover the importance of this cetacean adaptation.

Materials:

- water
- surgical or tight-fitting latex gloves (one pair per student)
- stop watch
- buckets (one per group)
- bag of ice
- dishwashing gloves (one pair per group)
- masking tape
- vegetable shortening (such as Crisco™)

National Science Education Standards Correlations:

- K-4: Strand C, Characteristics of Organisms
- 5-8: Strand C, Regulation and Behavior
- 5-8: Strand C, Diversity and Adaptations of Organisms

Procedure:

1. Divide students into teams of three. Each student will have a specific task, which can be rotated depending on time.
2. Assign each student a role: researcher, technician, or recorder. The researcher will be the first to wear the glove and discover if the blubber (Crisco™) layer makes a difference in detecting the water's temperature. The technician will prepare the gloves for the researcher. The recorder will measure the time it takes the researcher to feel the cold water with each hand.
3. Fill the bucket with enough icy water to allow students to completely immerse their gloved hands. Ice can be added throughout the activity to maintain the chilly temperature.
4. Have the researcher slip on a latex surgical glove onto each hand. If necessary, have the technician use masking tape to secure the gloves at the wrist. Next, have the technician spread a generous layer of shortening (Crisco™) over **one** of the researcher's gloved hands. Then the technician should slip dishwashing gloves over both of the researcher's hands.
5. Next, ask the researcher to place both of his/her hands into the bucket of water. Have them keep each hand in the bucket until they can feel the cold. Which hand gets cold first? Have the researcher remove the hand from the bucket that feels cold first. The recorder should note after how many seconds the researcher feels the cold and which hand, with or without Crisco™, got cold first.
6. Have the students rotate roles as time permits.

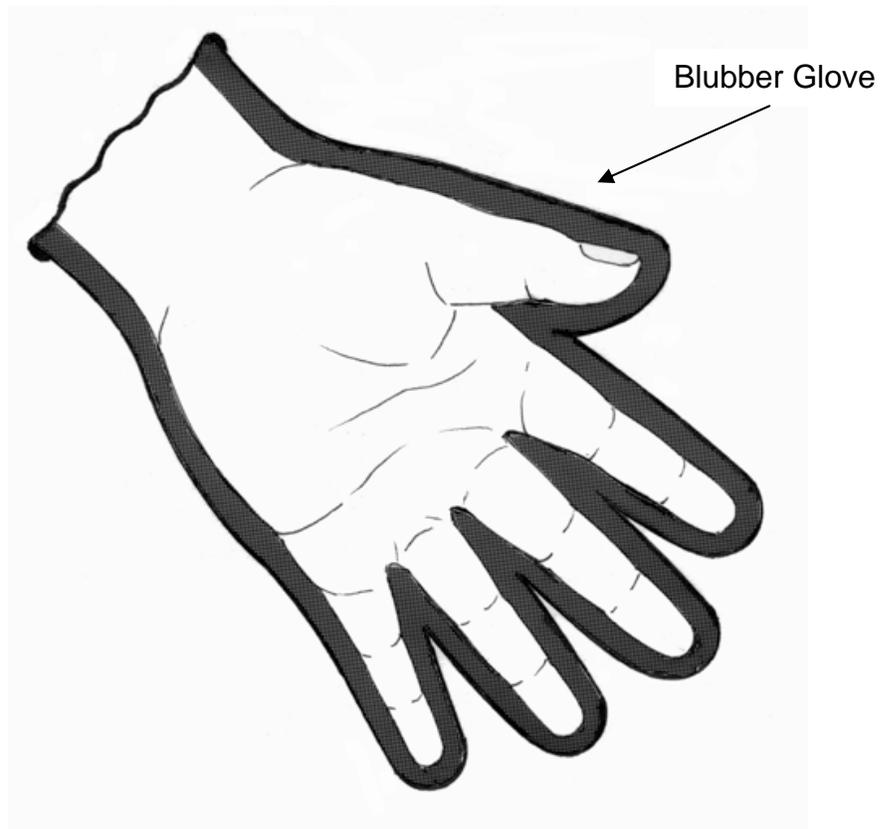


Discussion questions:

- Which hand got cold first?
- How does blubber protect a whale from the cold ocean water?
- What would happen if a whale did not have blubber?
- Can you name different ways other animals (land or marine) stay warm?

Extensions:

Test the blubber glove in different degrees of cold water and compare the lengths of time it takes to feel the cold. Create a time vs. blubber/ no blubber glove graph.



ADAPTATION ACTIVITY

Hearing is Believing

Echolocation is a very useful adaptation for animals that live in areas where sight is limited, such as murky water or in dark deep water. Toothed whales produce a series of sounds and listen for the echoes to help them communicate and navigate. The high frequency sounds that are sent out from the whale bounce off objects in their path and send back an echo. The whale can receive valuable information based on how loud the echo is and how long it takes to come back. If an echo is very loud, the object is large. The further away an object is, the longer it takes the echo to return.

Allow students to "see" with their ears by trying this activity below.

Materials:

- blindfolds (for half of class)
- noise makers, such as pots and pans, party whistles etc.
- large, open area

National Science Education Standards Correlations:

K-4: Strand C, Characteristics of Organisms

5-8: Strand C, Regulation and Behavior

5-8: Strand C, Diversity and Adaptations of Organisms

Procedure:

1. Divide the students into two teams. The first team will be blindfolded and will try to navigate around objects they encounter. The second team will stand in clusters of three around the open area and make various noises. If you are unsure of the safety of the area, divide the students into three groups and have the third group be responsible for carefully navigating the blindfolded students.
2. The blindfolded students should try to maneuver around the other students without hitting them. They should carefully listen to determine how close they are to them before turning away.
3. Have the students rotate roles.

Discussion Questions:

- Did students improve after playing awhile?
- What types of sounds were easier to hear and avoid?
- What other animals echolocate? In what type of environments do they live?

Extensions

- Increase or decrease the number of students making noise.
- Have students create noises that are at different levels volumes.



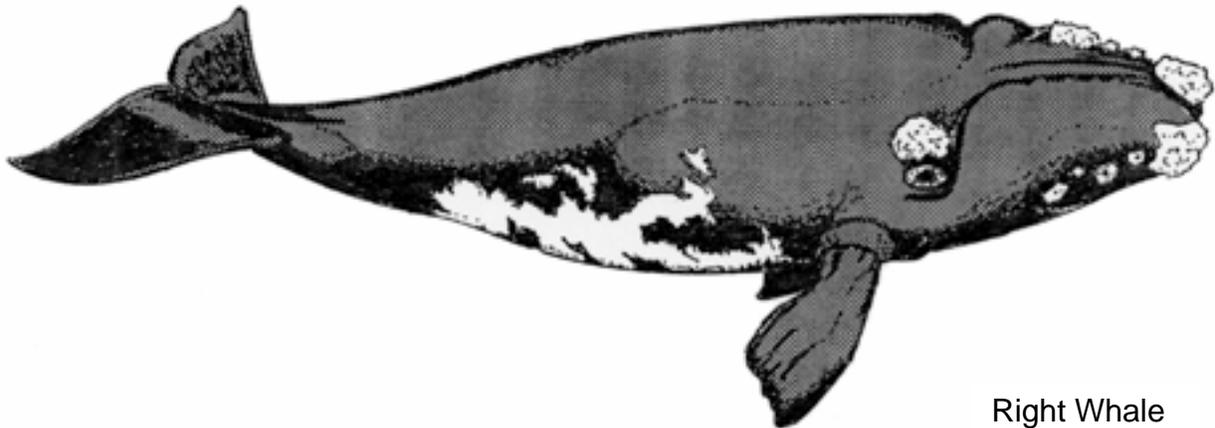
BALEEN WHALES

Whales are classified into two major groups, toothed or baleen, based partially on feeding strategies. **Mysticetes**, or baleen, whales have specialized structures in their mouth called baleen instead of teeth to help them catch food.

Amazingly, the largest animals on earth, baleen whales, survive by eating some of the smallest animals, called **zooplankton**. Imagine how much zooplankton a 100-foot blue whale must eat! A large Blue whale can eat more than 9,000 pounds (4,100 kilograms) in one day. Every time the whale swallows, over 100 pounds (50 kilograms) can go down its throat.

Different ways of feeding:

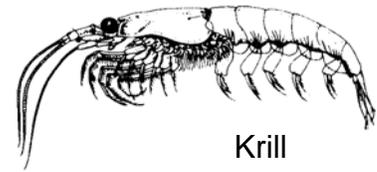
Skimmers: Some baleen whales feed by sifting plankton directly out of the water. They swim close to the surface with their mouths open. Zooplankton, like copepods, float into



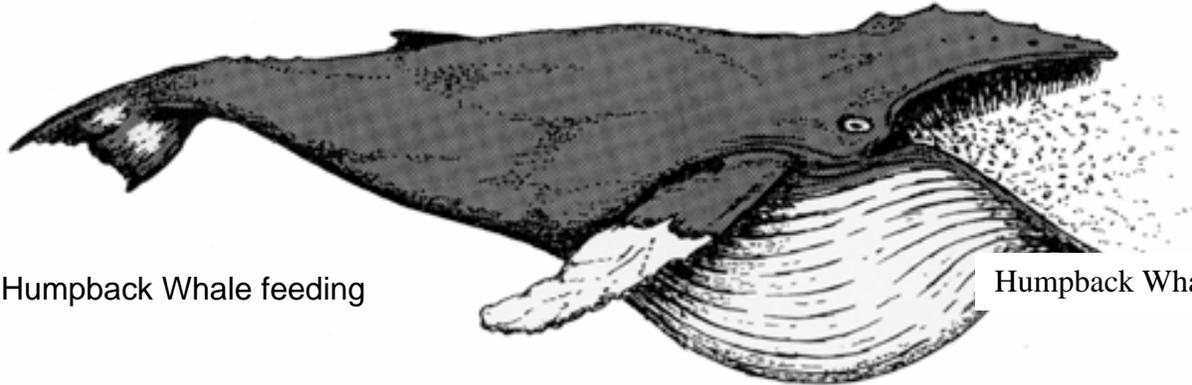
Right Whale

the mouth and are caught in the baleen. This type of feeding is best for capturing slow, surface-dwelling zooplankton that cannot swim away from the whale. Right whales and bowhead whales are skimmers.

Gulpers: These whales have specialized pleats, or folds, in their throats that expand out like a huge bag. They feed by taking huge amounts of water into their mouths, trapping the prey inside. The pleated throat balloons out to hold the water and food. The whale forces the water out past the baleen and the food gets trapped in the baleen. Gulpers are very good at catching fast swimming food, such as **krill** or small schooling fish.



Krill



Humpback Whale feeding

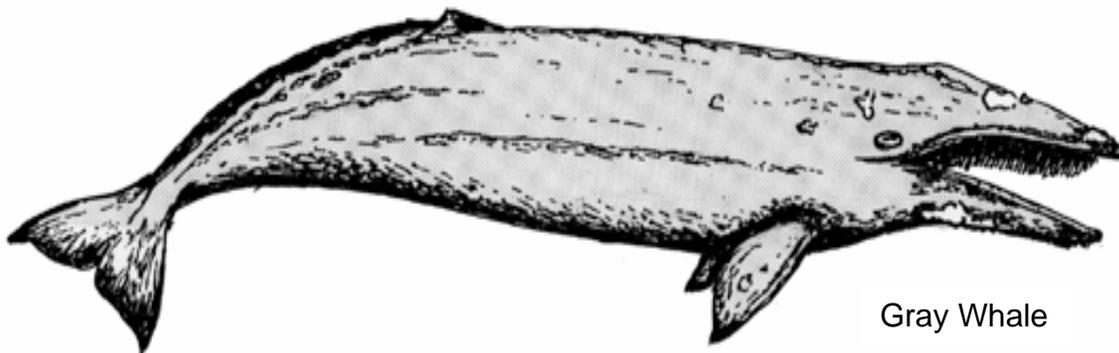
Humpback Whale feeding

Blue whales and humpback whales are gulpers.

Suckers: Bottom-feeding whales travel down to the ocean bottom to feed on small shrimp-like crustaceans, called **amphipods**. They roll over on one side of their bodies and suck up large mouthfuls of mud. As they travel back to the surface, they squeeze out the mud and water through the baleen to trap the amphipods. They use their large, 2,500-pound tongue to lick the amphipods off the baleen and push it down their throats. These whales often leave large craters along the bottom where they vacuumed up their dinner. Gray whales are bottom-feeders.



Amphipod



Gray Whale

Natural History:

Mysticetes do not appear to form large tightly knit social groups. Some do form groups, especially around breeding and feeding seasons. Occasionally they do form cooperative feeding groups, most notably in humpback whales. The closest bonds are those between mothers and calves.

Baleen whales exhibit sexual dimorphism. This means that there are obvious physical differences between males and females. Mysticetes are rather unusual compared to other mammals in that female baleen whales are larger than males. Admittedly, this is extremely difficult to determine while at sea on a boat. This has come from many years of research, including the records of whaling ships, which routinely measured the size of their catches.

Fast Facts:

- Baleen grows throughout a whale's lifetime. The inner edge and tip continually wears down.
- Baleen whales have tooth buds during the embryonic stage. The tooth buds disappear before birth.
- Baleen is sometimes referred to as "whalebone".
- Baleen ranges in color from black to yellow to white, depending on the species.
- The longest baleen belongs to the bowhead whale. Their baleen grows to over 14 feet long.

Key Words:

Amphipod (am-fee-pod)

Baleen (bay-leen)

Gulper (gulp-er)

Keratin (care-a-tin)

Krill (krill)

Mysticete (miss-tah-seat)

Plankton (plank-ton)

Skimmer (skim-er)

Sucker (suck-er)



WHALE ACTIVITY

A Mouthful

Because baleen whales eat such relatively small prey items, they need an effective way to gather large numbers of these prey. Baleen is a very efficient feeding adaptation, working like a sieve or spaghetti strainer. This activity gives students an idea of how the baleen actually works.

Materials:

- large plastic bin (at least 4 inches deep)
- plastic ants
- plastic combs

National Science Education Standards Correlations:

K-4: Strand C, Characteristics of Organisms

5-8: Strand C, Regulation and Behavior

5-8: Strand C, Diversity and Adaptations of Organisms

Procedure:

1. Fill the bin with water to about 3 inches.
2. Pour in the ants, explaining to the students that they represent the plankton and small fish that mysticetes eat.
3. Explain that mysticetes have many pieces of baleen hanging from the roof of their mouth. The tines on the comb will represent these baleen plates. Ask the students what they think will happen when you (or they) put the comb in the water and lift it up under the ants. Demonstrate, or have the students try it themselves.

Discussion Questions:

Can mysticetes decide which small animals they want to eat once they are in their mouth?

Does this feeding method allow the whales to eat things not good for them, like pieces of floating trash?

How long did the activity take?



Extensions:

- Use different size combs, or make combs with different amounts of tines or spacing. Do you think the number of “baleen plates” (tines) or the spacing affect what the whale can catch?
- Using the modified combs from above, put different size items in the bin as prey items. Explain that different kinds of whales have different size fringe on their baleen. Show how this affects the prey a whale will look for.



TOOTHED WHALES

The second major group of whales is the toothed whales or **odontocetes** (*odont* from the Greek work for tooth) and includes dolphins and porpoises. Odontocetes are usually smaller than baleen whales and have one blowhole.

Unlike baleen whales, toothed whales are selective eaters. They often hunt down individual animals, such as fish, squid, seals or sea lions, and even birds. Toothed whales have the ability to locate and identify objects by listening for echoes. They **echolocate** by producing clicking sounds and then interpret the echo that comes back. Echolocation allows odontocetes to determine size, shape, speed, distance, and direction of potential prey and other objects.

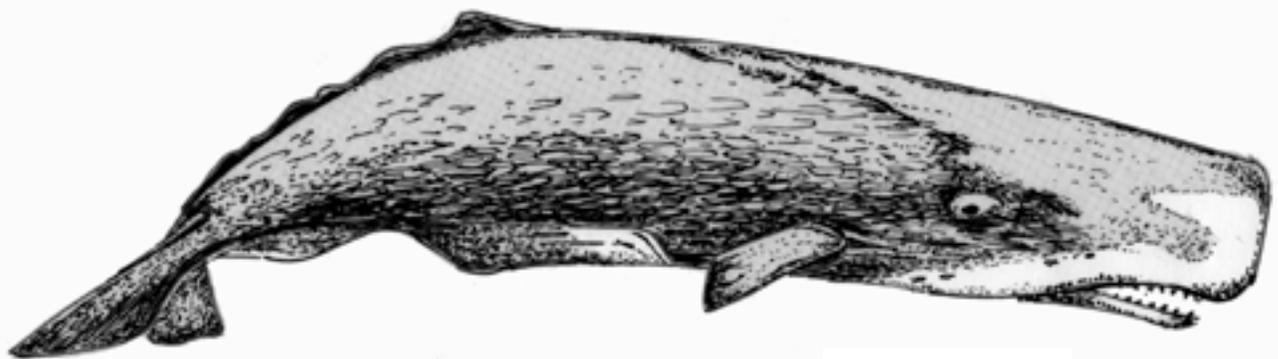
Unlike many other animals with teeth, odontocetes do not use their teeth to chew their food. Odontocetes' sharp teeth help them to grab onto their prey. The food is swallowed whole or in large chunks. The number and placement of teeth a toothed whale has affects what it eats and how it captures its food.

Teeth in both jaws

Some toothed whales have teeth in their upper and lower jaws, like humans. Whales with small rows of teeth, such as the Bottlenose Dolphin, eat small, schooling fish. Other toothed whales, such as killer whales, have larger teeth and can hunt down larger fish and marine mammals.

Teeth in lower jaw

Some toothed whales, like the sperm whale, have fully developed teeth on the lower jaw only. Through time, the upper teeth gradually became modified. Sperm whales often feed on squid.



Sperm Whale

Unusual teeth:

American Cetacean Society

www.ACSONline.org



Some toothed whales are very unusual in their dental patterns. Most female beaked whales have no teeth at all, and most males only have two teeth on the lower jaw. And some of these teeth may be so modified as to be useless for feeding. The two teeth on an older male Strap-toothed whale may grow so large as to curve over the mouth and prevent it from opening completely! Fortunately, the whale can still suck squid into its mouth, using its beak and tongue like a vacuum cleaner.

Then there is the male narwhal, with its large (up to 9 feet) tusk. (It only has two teeth, too, but in their case they are in the upper jaw only). The tusk is actually the one of its teeth (usually the left one)! It is obvious that these teeth cannot be used for eating. Scientist believe that these teeth are used in dominance battles, where males use non-lethal fighting to establish their place in their social order. The female narwhal also has two teeth in the upper jaw, but these rarely erupt into tusks.

Natural History:

Toothed whales tend to form tight social groups. Some dolphins form groups, or pods, of over 1,000. Sometimes, the groups are divided by sex, with females and calves in so called “nursery pods” separate from the smaller male, or “bachelor” pods.

Sexual dimorphism is common in odontocetes, with the males being larger than the females. This is carried to extremes in the case of the sperm whale. The males may be 10-20 feet larger than the female!



WHALE ACTIVITY

What's for Dinner?

All plants and animals on the earth are connected to each other in a food pyramid. Plants are at the bottom of the food pyramid because they produce energy from the sun and are called producers. Animals that eat plants, called herbivores, are on the next level of the pyramid. At the very top of the pyramid is a carnivore, which gets its energy by eating the animals below it. Whales, dolphins, and porpoises are at the top of the food pyramid. They are carnivores that capture their food in different ways.

Before you begin:

Divide the class into two groups. One group will be small fish that eat zooplankton, represented by popcorn. The small fish will try to pick up as much zooplankton (popcorn) to put into their stomach (paper bag) before they get eaten. The second group will represent killer whales that eat the small fish. They will both try to get enough food to survive and the small fish will try to avoid being eaten!

Materials:

- paper bags
- popped popcorn (won't create litter because birds will eat the leftovers!)
- four or five students (or more!)

National Science Education Standards Correlations:

K-4: Strand C, Organisms and Their Environment

5-8: Strand C, Populations and Ecosystems

9-12: Strand C, The Interdependence of Organisms

Procedure:

1. Spread the popcorn on a grassy area outside.
2. Give each team member a paper bag. The paper bag will represent either the fish's or the whale's stomach.
3. At the same time, the small fish will try to pick up zooplankton, while the killer whales tag (eat) them and capture their stomachs full of food. Each whale should combine all of their captured popcorn to see which whale survived the best.

Discussion Questions:

Who won?

How long did the activity take?

Extensions:

- Let the fish run and the whales walk to represent faster swimming fish.
- Give the fish hiding places, such as time-out zones.

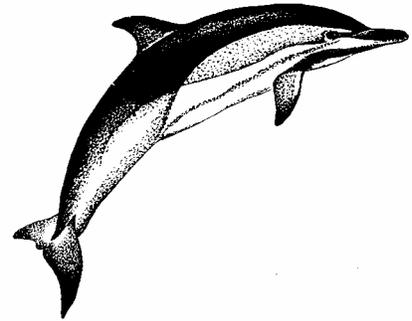


DOLPHINS AND PORPOISES

Dolphins and porpoises are toothed cetaceans. They are the smaller members of the suborder **Odontoceti** and have one blowhole like larger toothed whales. They are found in all the world's oceans, except for the coldest polar seas. A few species of dolphins live in large freshwater rivers in South America and Asia. Dolphins and porpoises are very closely related; they are often confused with each other because they have similar behaviors and live in similar environments. Dolphins and porpoises, however, are divided into different classification groups, called families, based on physical differences.

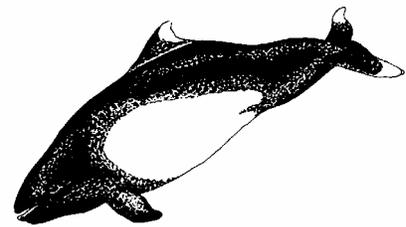
Family Delphinidae

There are over 30 species of ocean dolphins. Dolphins usually have a beak, cone-shaped teeth, and a curved or hooked dorsal fin. A few larger species of dolphins are often called whales because of their size. The killer whale is actually the largest member of the dolphin family.



Family Phocoenidae

They are smaller than dolphins and usually have small, triangular-shaped dorsal fins. Porpoises do not have a beak and have small spade-shaped teeth. They usually travel in smaller groups than most dolphins. There are six species of porpoises.



Dolphins and porpoises are social animals that often travel in groups, called pods. They are very efficient hunters and work together with members of their pods to round up large schools of fish. The pod herds the fish into a tight ball, and then each animal takes a turn swimming through the group of fish to feed on them while the others keep the fish trapped. Some species of dolphins and porpoises can dive down to more than 300 m (900 ft) to search for schooling animals, such as squid or mackerel. Traveling in pods may also provide protection from predators, as well as helping with rearing young dolphins, called calves. Often while the mother is feeding, other members of the pod keep an eye on the calf.

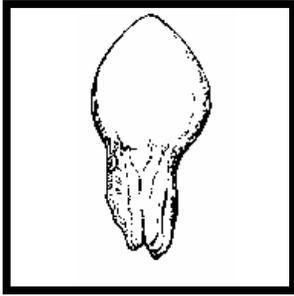
Key Words:

Delphinidae (dell-fin-a-day)

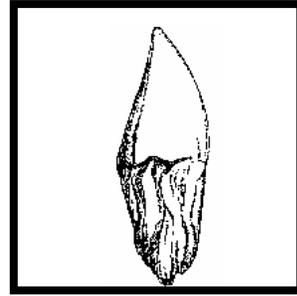
Phocoenidae (fo-sin-a-day)

Pod (pod)

PORPOISES VS. DOLPHINS



Spade shaped



Cone shaped



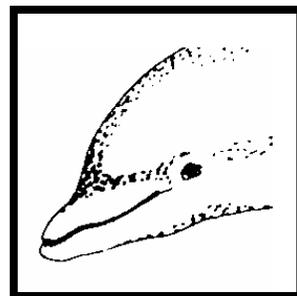
Triangular dorsal
Fin



Curved or hooked
dorsal fin



No beak



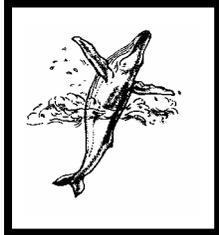
Often prominent
beak

Porpoise Features

Dolphin Features

CETACEAN BEHAVIOR

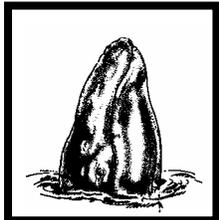
Very little is known about cetacean behavior because much of it occurs beneath the water. We do see a variety of whale and dolphin behaviors above the water. Scientists can only guess why cetaceans perform certain types of behavior. Using careful observations and different technology to listen to and track cetaceans, we are beginning to unlock the mysteries of the whale's world.



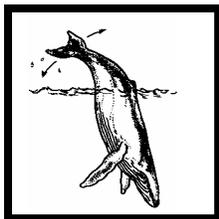
Breaching: This behavior occurs when a whale or dolphin leaps out of the water and splashes back down. There are a variety of explanations about why different whales and dolphins perform this artful leap. Some researchers have proposed it may be a behavior to dislodge parasites off of the whale's back, while others have interpreted it as a form of communication. Some believe the whale is just having fun!



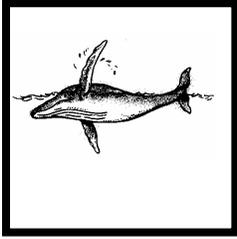
Bowriding: Boats create powerful pressure waves as the front of the boat, or bow, moves forward through the water. Smaller cetaceans, especially dolphins, often swim playfully in this bow wave, often just being pushed along. Dolphins may also "bowride" in the large waves created by larger whales. Perhaps the best explanation for this behavior is that the cetaceans are playing just for the fun of it!



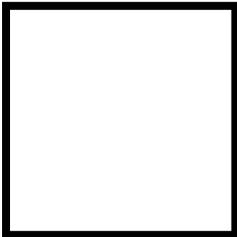
Spyhopping: The whale slowly rises straight out of the water, until its eye is above the water surface. After a few moments, the whale sinks back down. Again, we cannot be sure why whales spyhop, but they may be coming up to take a look around.



Lobtailing: Cetaceans can often be observed lifting up their powerful flukes and slapping them down hard on the ocean surface. This behavior may indicate aggression or irritation, especially in humpback whales, killer whales, bottlenose and Risso's dolphins.



Flippering: The whale lifts one or both flippers out of the water and slaps them down against the surface of the water. This creates a loud sound that can be heard over large distances both above and below the water. It is also known as a pectoral slap.



Kickfeeding: Some whales use this interesting behavior to aid them in hunting by splashing the flukes down to surprise nearby fish.



Logging: This behavior occurs when a whale rests at the water's surface without swimming. The still whale resembles a giant floating log! Sperm whales are the most prone to logging. They must spend quite a bit of time on the surface after their extremely long deep dives, which can last over an hour!

Key Words:

Bowriding (bow-riding)
Breaching (bree-ching)
Flippering (flip-er-ing)
Kickfeeding (kick-feed-ing)
Lobtailing (lob-tail-ing)
Logging (log-ing)
Spyhopping (spy-hop-ing)



BEHAVIOR ACTIVITY

Do it! Do it! *

In this activity, students will learn about specific whale behaviors by trying the behaviors themselves. Make sure all students have room to move! The darker text is what you will instruct the students to do. The information in parentheses describes the action that goes with each direction.

Materials:

Eager students!

National Science Education Standards Correlations:

K-4: Strand C, Characteristics of Organisms

K-4: Strand G, Science of Human Endeavor

5-8: Strand C, Regulation and Behavior

Procedure:

1. Become a Whale

We are going to make ourselves into a whale.

Everyone grab your jaw. We are going to pull it forward to make it like a whale's jaw. (Pull forward with a "Whoop!")

Touch your nose. The whale has his nose on top of his head so he can breathe easier in the water. Move your nose to the top of your head. (Touch your nose with your finger and around to the top of your head. "Bloop, bloop, bloop!")

Now do this. (Close both fists and place it on top of your head.) Now we are going to breathe like a whale. Everybody go "Whoosh!" (Raise fists while opening your fingers with a loud "Whoosh!")

Now that you are a whale, let's try some whale behaviors!

2. Spyhopping

Everyone say "Spyhopping!"

Make a whale. (Place arms up vertically with hand extended.)

Give me some water. (Place the other arm horizontally.)

A whale goes up, up, up. (Bump the vertically raised arm up.)

Looks around. (Twist the arm.)



Then it comes right back down. (Lower the hand.)

What was that called? ("Spyhopping!")

3. Breaching

Everyone say, "Breaching!"

Let me see your whale again. (Place arm up vertically with hand extended.)

A whale will come out of the water (arm up), turn to his side or back (Have your arm do a free-falling motion), and make a big splash. "Splash!" (Both arms do a vertical breaststroke motion with a vocal splash.)

Let's do it one more time. (Repeat the above.)

Now what was that called? ("Breaching!")

Extensions:

Break students into groups. Assign each group another behavior to create movements for. Bowriding, lobtailing, and kickfeeding are just a few to choose from.

Have student pantomime different cetacean behaviors using their whole bodies. Can the other students guess what behavior they see?

***"Do it! Do it!" is courtesy of John Olguin of the Cabrillo Marine Aquarium**



CETACEAN MIGRATIONS

A **migration** is the seasonal movement of animals from one area to another. Many whales migrate to different areas of the world during the year. The general pattern of migration is from cooler feeding grounds to warmer breeding grounds. The gray whale makes one of the longest migrations of any mammal. Each year, gray whales travel south along the coast of North America on a round trip that averages between 10,000 and 14,000 miles!

During the warm summer, gray whales feed in the colder waters of the **Bering** and **Chukchi** Seas along the coasts of Alaska and Siberia. They can spend up to 20 hours a day feeding on small shrimp-like crustaceans, called **amphipods**. The gray whales spend most of the summer fattening up for the long winter ahead. There is usually plenty of food during the summer for the whales.

As fall approaches the amphipods begin to disappear, and the cold waters begin to get covered in ice. The gray whales begin their migration to warmer waters in **Baja California**, Mexico. The journey is about 6,000 miles long, and takes about two to three months. When they arrive in the warm, sheltered lagoons, pregnant females give birth. Other whales may mate so **calves** will be born the next year. The mothers spend most of the winter caring for the newborn calves. The calves prepare for their long journey ahead by feeding on their mother's rich milk (as thick as yogurt), and improving their swimming ability. Places where whales mate and give birth are called **breeding grounds**.

Adult gray whales do not feed as such while migrating and living in the lagoons. However, they will “snack” should the opportunity arise. Fortunately, living in warmer water does not take as much energy, and the gray whales can survive for a long time without food. A nursing gray whale mother may have lost up to 25 percent of her body weight before returning north! As spring approaches and the waters in the north begin to warm, the gray whales begin their journey back up north to their summer **feeding grounds**.

Key Words:

Amphipods (am-fee-pods)
Baja California (bah-hah california)
Bering Sea (bearing sea)
Breeding grounds (breed-ing grounds)
Calves (calves)
Chukchi Sea (chuck-chee sea)
Feeding grounds (feed-ing grounds)
Migration (my-gray-shun)



MIGRATION ACTIVITY

Migratory Math

Whales travel great distances to get to other parts of the world. Try to solve the questions below to figure out how long it takes them and how their bodies change along the way.

Materials:

Map of the west coast of North America (including Alaska)

National Science Education Standards Correlations:

K-4: Strand G, Science as Human Endeavor

5-8: Strand C, Populations and Ecosystems

5-8: Strand G, Science as Human Endeavor

Try these questions:

1. Gray whales can swim at about four miles an hour while migrating south. How many miles can they travel in one day?
2. Gray whales travel about 6,000 miles one way to get to Baja California, Mexico. If they swim 100 miles per day, how many days does it take to arrive at their destination?
3. If a gray whale calf is 1,500 pounds when it is born and gains 50 pounds a day, how much will it weigh in 30 days?
4. An adult gray whale may weigh 80,000 pounds when it arrives in Baja California. If it lost 25% of its weight while in the lagoons, how much would it weigh?

(Answers: 1. 96 miles; 2. 60 days; 3. 3,000 pounds; 4. 60,000 pounds.)

Try to find each of these areas on a map of the west coast of North America:

Baja Mexico (Breeding grounds)

Laguna Guerrero Negro

Laguna Ojo de Liebre (Scammon's Lagoon)

Laguna San Ignacio

Bahia Magdalena

Bering Sea (Feeding ground)

Chukchi Sea (Feeding ground)



HUMANS AND CETACEANS

People seem to have always been fascinated by cetaceans. Over 4,000 years ago, the Minoan civilization on the island of Crete decorated their coins, vases, and walls with pictures of dolphins. (Interestingly, the ancient Minoan and Greek depictions of cetaceans are fairly accurate in terms of how they looked. Later medieval artwork portrayed them as fish-like creatures, with scales and gills.) Any number of coastal peoples include cetaceans in their society with carvings, paintings, clothing, and even ceremonies.

Many different cultures throughout the world contain stories and legends about marine mammals. These stories reflect their cultural beliefs and traditions regarding cetaceans. In many of the stories that concern the origin of dolphins, several cultures (such as Greeks, Romans, and Chumash indians) tell of humans being turned into dolphins, thus creating a very strong cultural bond with them. Others, such as the Tlingit indians of the northwestern coast of North America, tell stories of humans being directly involved in the formation of dolphins and whales and their behaviors, again creating a sense of responsibility towards them.

Cetaceans have also been important as sources of food and materials for various cultures of the world. Some tribes of Aborigines in Australia, while not known to hunt whales, would take advantage of the carcasses of stranded cetaceans for meat and bones to craft tools. Other people, such as the Inuit, would actively hunt whales. This was a very dangerous proposition for them. The whales they hunted were usually 40-50 feet long and quite capable of diving under the water for prolonged periods of time to escape their pursuers; who were often hunting them from small seal-skin boats. The rewards, however, were well worth the risk. A whale provided an enormous amount of meat, intestine, and blubber to eat, as well as blubber for fuel, and bones and baleen for tools and building material. Every part of the whale was used. Some tribes believed that the whale would allow itself to be killed to feed the people, and that its skull must be returned to the ocean so that it's soul would be immortal. The whale could then be reincarnated to feed the people again.

There are also many reports of cooperative associations between humans and dolphins. There are numerous accounts of coastal fisherman being aided by dolphins chasing fish into their nets, with the dolphins eating the ones that escape the nets, or being fed the fish the fishermen throw back. There are many reports of dolphins helping swimmers, as well, or simply freely interacting with humans in the water, such as at Monkey Mia in Australia.

There is also the story of a Risso's dolphin known as Pelorus Jack who, from 1888 to 1912, allegedly guided steamboats through a dangerous straits area in New Zealand. The story goes that he did this until he was shot at from one of the boats, the *Penguin*. He disappeared for several weeks, and when he returned continued to guide ships through the straits, except for the *Penguin*, which reportedly later wrecked in those same waters. Whether or not the entire story is true, Pelorus Jack was officially protected by an Order from the Governor of New Zealand. This protection demonstrates the strong feelings people have for dolphins and other cetaceans.



CULTURE ACTIVITY

Rainbow Bridge

Dolphins are an important part of the creation story of the Chumash, a coastal tribe of Native Americans in southern California. The Chumash have passed stories down from generation to generation for hundreds of years. Older tribal members told the stories to younger people. Many cultures did not have a written language, so stories are important tools in understanding different beliefs and values.

Materials:

Rainbow Bridge story (on following page)

Procedure:

1. Tell or read the Chumash story, *Rainbow Bridge*.
2. Discuss with your class what this story tells us about the Chumash culture.

Discussion Questions:

What was important to the Chumash?
How did they live?
What values are shown in their story?

Extensions:

Younger grades:

Draw a picture of the world in which the story took place. Discuss with the students what the land might have looked like during the time of the story. Do you think the land looked different than it does today?

Older grades:

Have students research other legends of the origins of dolphins. What kinds of similarities are there? What do these stories tell you about the cultures that told them?

Have cooperative learning groups of three students create a fictional story that could be used to pass cultural information to future generations. For example, they could write about where they live.

Demonstrate the interesting ways different people tell similar stories by having each group use the same three components in their story (for example, a toothbrush, rain, and a porcupine). Have the students share their stories when completed.



Chumash Creation Story: Rainbow Bridge

The first Chumash people were created on Santa Cruz Island by the Earth Goddess, Hutash. They were made from seeds of a magic plant. Hutash was married to Sky Snake, also known as the Milky Way. Sky Snake could make lightning bolts with his forked tongue. One day he decided to make a gift to the Chumash people. He sent down a bolt of lightning and started a fire. The Chumash people were very happy to have fire to keep warm and cook and kept it burning

After the Sky Snake gave the Chumash fire, their lives became easier and more comfortable. More people were born each year and soon the villages got bigger and bigger. The noise from all the people began to keep Hutash awake at night. She decided that the island was too crowded and some people should move off the island. They would move across the ocean to the mainland where there were no people yet.

The next day, Hutash created a large rainbow bridge that stretched from the highest mountain on Santa Cruz Island to the tall mountains on the mainland in California. Hutash told the people to cross the bridge, and fill the whole world with people. She warned them to be very careful on their journey across the bridge, and to not look down into the swirling fog below. Most of the Chumash crossed safely, but a few could not resist looking down and got very dizzy, and fell off the bridge into the deep, dark ocean. Hutash felt very badly about this because she had asked them to cross the bridge, and did not want them to be harmed. So, as the people were falling down, Hutash turned them into dolphins. This is why, to this day, the Chumash people believe that dolphins are their brothers and sisters.



CETACEAN RESEARCH

Have you ever wondered how dolphins communicate? Maybe you would like to know what the blue whale eats. This information can be found in a book or on the Internet because a cetacean researcher once had the same question. A way for scientists to learn more about a topic is by doing **research**, or a carefully planned study. Cetacean researchers are scientists who want to learn more about these marine mammals.

Research begins with a question that a scientist would like answered, or a problem that needs to be solved. Next, the researcher makes a plan for collecting information. This usually includes making observations and taking into account many variables. Many studies have been done on whales in captivity. More and more researchers are working in the field, or whales' natural habitat. Field studies can give a more accurate picture of natural behavior.

Researchers record, or write down all their observations. This collected information is called **data**. Back in their laboratory or office, researchers analyze, or carefully organize the data to help draw conclusions about what they observed. Researchers may then have an answer to their question, or may need to return to the field for more data collection.

Scientists can learn more about a species by studying individuals. Being able to identify individual whales from members of the same species can be difficult. Scientists use natural markings or tagging to identify individuals. This involves noticing slight differences in coloring, scarring, callosity patterns, or fin shape of individual animals. Researchers keep careful records of these differences in photo identification logs.

It is important that research studies continue to be supported because there is still much to discover about cetaceans and their behavior. The more we learn about whales and dolphins, the more effectively we can protect them and their habitat.

Key Words:

Research (ree-search)

Data (day-ta)

Callosity (cal-os-ity)



CETACEAN CONSERVATION

By practicing conservation, individuals preserve and protect not only animal and plant populations for a healthy environment now, but for generations to come.

Habitat destruction is a major threat to cetacean populations. Lagoons where they breed and give birth are being **developed**, or modified for human use, resulting in destruction of their natural, coastal habitat. Pollution is turning the ocean homes of whales such as the beluga and the killer whale into toxic areas. **Non-point pollution**, or pollution from sources difficult to trace such as storm drain runoff, greatly affects ocean health. Commercial fishing continues to be a major problem in many areas. Incidental kills (or death due to being caught in nets or other fishing apparatus) results in 3000 dolphin deaths per year in the tuna industry alone. Also being monitored is potential overfishing of ocean waters. Overfishing of an area can have a catastrophic affect on that area's foodchain, or productivity. As productivity declines, there is less plant matter and fewer animals for cetaceans to feed upon.

Through education and research, efforts have been and are being taken to protect whales and the oceans of the world. In 1972, the United Nations and the United States placed a moratorium, or stop on the commercial hunting of whales and other marine mammals. In 1986, the International Whaling Commission, IWC, also agreed to a ban on commercial whaling. A variety of environmental organizations, such as ACS, work to protect whales and prevent commercial whaling worldwide. Several small aboriginal (native) cultures around the world (including the U.S.) are still allowed to hunt for subsistence purposes only. They are not allowed to sell or trade the whale meat, however, since that would make it a commercial hunt.

Additional protection and conservation of whales is included in the Convention on International Trade in Endangered Species of Wild Flora and Fauna (CITES). CITES is an international agreement between over 150 governments regulating the trade in specimens of wild animals and plants to ensure that their survival is not threatened. Whales are listed on Appendix I, the most threatened level. This level includes species such as whales that are threatened with extinction. Trade in specimens of these species is permitted only in exceptional circumstances. Some countries, such as Japan, are working to down list whales to Appendix II, which includes species not necessarily threatened with extinction, but in which trade must be controlled in order to avoid utilization incompatible with their survival. So far, Japan has not been successful in this effort. Anti-whaling nations and conservation organizations, including ACS, around the world vigorously oppose down listing whales.

Key Words:

Developed (de-vell-upped)

Non-point Pollution (non point pollution)



CONSERVATION ACTIVITY

Let's Talk it Over

Whale conservation is just one issue that is highly debated. When students participate in a debate, they learn to research a subject, document their side's statements, organize their thoughts and communicate in an effective manner. Debating helps develop public speaking skills as well as respect for others opinions. Students may find it easy to argue in favor of whale conservation, but in order to help students see different sides of an issue, they should be encouraged to argue a side that may not be their own personal belief.

Materials:

History of Whaling sheets for each student

National Science Education Standards Correlations:

5-8: Strand F, Populations, Resources, and Environment

5-8: Strand F, Risks and Benefits

5-8: Strand F, Science and Technology in Society

5-8: Strand G, Nature of Science

9-12: Strand C, The Interdependence of Organisms

9-12: Strand F, Population Growth

9-12: Strand F, Science and Technology in Local, National, and Global Challenges

Procedure:

1. Provide students with the definition of a debate. Providing examples of highly debated topics or even a video of a debate will help students to prepare for the activity. Most importantly, students should be reminded that in a debate, each side has an equal opportunity to share their opinions.
2. As a class, choose the specific topic to debate. You may choose to debate the legalization of limited commercial whaling. Allowing Native American cultures to hunt whales is another potential topic. Once the students have decided, divide the class into two groups. Assign each group a stand on the issue and inform them that they will need to defend this opinion, whether they personally believe it or not. Hand out the sheets outlining the history of whaling to students and provide them time to prepare their arguments.
3. After students have had ample time to prepare, the instructor will lead the debate. If the students would like a "ruling" on who gave a more convincing argument, the instructor may choose to invite three impartial "judges", such as parents or other teachers, to determine which group more effectively defended their stand.



Extensions:

Debate the same topic, switching sides. To make it more difficult, set a rule that both groups must form new arguments.

This activity can be easily integrated into different areas of the curriculum by selecting different topics to debate.



Debate Background Information: A Brief History of Whaling

Whaling can be traced back over 2000 years through ancient stone carvings. Native Americans and Eskimos were among the first whalers. Hunting only a small number of whales, they had great respect for these creatures, and used every part of the animal's body. Not only was the meat a source of food, but other parts of the whale could be used to make tools or clothing. The whale was a great provider; much like the bison was to the Native Americans of the plains.

Commercial whaling, or whaling for profit, began in Europe 1000 years ago. Whale blubber was in demand because it could be boiled down into oil, and used for lanterns. Using small boats and hand-held harpoons, these hunters focused on the slower moving whales readily found offshore. They eventually crossed the Atlantic to hunt off the coast of what is now the United States. When colonists came to the New World, they too began hunting whales. By the 1700's, a decline in certain whale populations occurred. Rather than limiting hunting, whalers turned to more efficient hunting methods to get the few that remained.

The right whale was one of the first species to be threatened with extinction. Its name came from its reputation as the "right whale" to hunt. Not only did the right whale have a great amount of blubber and long baleen, it was slow moving, and did not sink after being killed. But it was not the only species that was threatened. Sperm, bowhead, and blue whales were just a few of the species whalers turned to as right whale populations declined. Powerful and more accurate harpoons, together with faster and specially designed boats allowed whalers to kill more, and a bigger variety of whales. Many species were threatened with extinction, but whaling continued.

The first whale protection law was passed in 1929 to outlaw the hunting of right whales. Laws to protect the gray whales quickly followed. The International Whaling Commission, or IWC, was created to manage whale populations by restricting the numbers and species that should be hunted. Its first resolution was in 1965 to eliminate hunting of the endangered blue whale.

In 1972, the United States became the first country to pass laws designed to protect all whales and dolphins. The International Whaling Commission later passed a worldwide ban or moratorium on whaling in 1986. While two countries, Japan, and Norway, continue to hunt certain species of whales, other countries may have occurrences of "pirate" whaling, since several whale populations are not recovering as quickly as they should. Organizations such as the American Cetacean Society, and individuals like you, continue to work hard to protect whales and their environment. While some whale populations seem to be on the road to recovery, they all need continued support to insure their survival.



RESOURCES

The Internet

The Internet is a wonderful source for information on whales. It is especially useful in its diversity of views that can be acquired. In searching the internet, you may not only find organizations dedicated to protecting whales, but viewpoints from places like Japan and Alaska where whaling has been a way of life for many years.

All of the sites listed below were found by using a search engine usually supplied by the internet provider. Yahoo! or Google are just a couple of examples of engines you may have access to. Yahoo!igans! is a search engine specially designed for use by children. On search engines, you simply type in one or two descriptive words, such as "whales" or "whale conservation", and different sites are suggested. Check out some of the sites below, or do your own search!

American Cetacean Society (contains links to all regional chapters, as well as other whale links)

<http://www.acsonline.org>

MARINE MAMMALS:

Marine Mammal Protection Act (with full text)

<http://www4.law.cornell.edu/uscode/16/ch31.html>

Marine Mammal Resource List

<http://whale.wheelock.edu/whalenet-stuff/interwhale.html>

National Marine Fisheries Service

http://www.nmfs.noaa.gov/mar_mammals.htm

National Marine Mammal Laboratory

<http://nmml01.afsc.noaa.gov/>

Protected Marine Species Research and Information

<http://www.rtis.com/nat/user/elsberry/marspec.html>

Strategies for Pursuing a Career in Marine Mammal Science (from the Society for Marine Mammalogy)

<http://pegasus.cc.ucf.edu/~smm/strat.htm>

CETACEANS:

Baleen Whales (from Sea World)

<http://www.seaworld.org/infobooks/Baleen/home.html>

American Cetacean Society

www.ACSONline.org



Cascadia Research Collective
<http://www.CascadiaResearch.org/>

Center for Whale Research
<http://www.rockisland.com/~orcasurv/>

Cetacea (with information about 81 cetacean species)
<http://www.cetacea.org/>

Cetacean Bibliography
<http://www.physics.helsinki.fi/whale/literature/nfiction.html>

Cetacean Society International
<http://csiwhalesalive.org/>

Cetacean Videography
<http://www.physics.helsinki.fi/whale/literature/video/videogra.html>

Dolphin Research Institute
<http://www.dolphinresearch.org.au/>

The Hebridean Whale and Dolphin Trust
<http://whales.gn.apc.org/>

Intersea Foundation
<http://www.intersea.org/>

Ocean Alliance
www.oceanalliance.org

Whale and Dolphin Conservation Society
<http://www.wdcs.org/>

Whale Center of New England (formerly the Cetacean Research Unit)
<http://www.whalecenter.org/>

Whale Information Network
<http://www.webmedia.com.au/whales/whales6.html>

Whale Museum (Friday Harbor, WA)
<http://www.whale-museum.org/>

WhaleNet
<http://whale.wheelock.edu/>



Whales: A Thematic Web Unit
<http://curry.edschool.Virginia.EDU/go/Whales//>

Whale-Watching-Web (Helsinki, Finland)
<http://www.physics.helsinki.fi/whale/>

Wild Whales (a project of Vancouver Aquarium Marine Science Centre)
<http://www.wildwhales.org/>

Cetacean Evolution

Introduction to the Cetacea -- Whales and Dolphins (University of California, Berkeley, Museum of Paleontology)
<http://www.ucmp.berkeley.edu/mammal/cetacea/cetacean.html>

Origin of Whales (Thewissen Lab, Kent State University)
<http://www.neoucom.edu/Depts/ANAT/Thewissen.html>

Cetacean Evolution - Mark D. Uhen, Cetacean Research
<http://www-personal.umich.edu/%7Euhlen/CetRes.html>

Whale fossil showcase, Univ of Oslo
http://www.toyen.uio.no/palmus/galleri/montre/english/m_hval_liste_e.htm

Charlotte, the Vermont Whale (an electronic museum)
<http://www.uvm.edu/whale/whalehome.html>

OTHER WEB SITES:

The Endangered Species Chocolate Company
<http://www.chocolatebar.com/>

Humane Society of the United States
<http://www.hsus.org/ace/8313>

U.S. Coast Guard Sea Partners
<http://www.uscg.mil/hq/g-m/nmc/seapart.htm>

Greenpeace
<http://greenpeace.org/>

The information and opinions presented on these external web sites are not necessarily endorsed by the American Cetacean Society.



SUGGESTED MARINE MAMMAL REFERENCE BOOKS

The following is a short list of books that may be helpful in researching cetaceans, or simply books to have in your classroom. New books on marine mammals are always being released, so it is a good idea to periodically check your source of books for new material.

GENERAL MARINE MAMMALS:

- The Audubon Society Pocket Guides: Familiar Marine Mammals.* Audubon Society, Alfred A. Knopf, Inc., New York, NY, 1990.
- Biology of Marine Mammals.* J. E. Reynolds III and S. A. Rommel (eds.), Smithsonian Institution Press; Washington, DC; 1999.
- Guide to Marine Mammals of Alaska.* K. Wynne, University of Alaska, Fairbanks, AK, 1993.
- Marine Mammals Evolutionary Biology.* A. Berta and J. Sumich, Academic Press; New York, NY; 1999.
- Marine Mammals of California.* R. Orr and R. Helm; Univ. of California Press; Berkeley, CA; 1989.
- Marine Mammals of Eastern North Pacific and Arctic Waters.* (2d ed.) D. Haley (ed.), Pacific Search Press; Seattle, WA; 1986. NOTE: This is out of print and may be hard to find.

CETACEANS:

- American Cetacean Society Field Guide to the Orca.* D. Gordon and C. Flaherty; Sasquatch Books; Seattle, WA; 1990.
- DK Handbook: Whales Dolphins and Porpoises.* M. Carwardine, DK Publishing, NY, 1995
- Gray Whales.* D. Gordon and A. Baldrige, Monterey Bay Aquarium; Monterey, CA; 1991.
- Oceanic Society Field Guide to the Humpback Whale.* H. Bernard and M. Morris; Sasquatch Books; Seattle, WA; 1993.
- Oceanic Society Field Guide to the Gray Whale.* B. Bennett; Sasquatch Books; Seattle, WA; 1983.
- The Sierra Club Handbook of Whales and Dolphins.* S. Leatherwood and R. Reeves; Sierra Club Books; San Francisco, CA; 1983.
- Whales, Dolphins, and Porpoises of the Eastern North Pacific and Adjacent Waters--A Guide to Their Identification.* S. Leatherwood, R. Reeves, W. Perrin, and W. Evans; Dover Publications, New York; 1988.



MARINE MAMMAL EDUCATION AND CHILDREN'S BOOKS:

- Animals Close-Up*. Charlesbridge Publ.; Watertown, MA;
The Whale. Valerie Tracqui; 1995.
- Baby Whales Drink Milk*, B.J. Esbensen, Library Binding, 1999
- Dear Mr. Blueberry*, Simon James, School and Library Binding, 1991
- Discovering Marine Mammals*. N. Field and S. Machlis; Dog-Eared Publ.; Corvallis, OR; 1987.
- Dolphins First Day*, Kathleen Weidner Zoehfeld, Soundprints Corp. Audio, 1997
- Dolphins for Kids*, Parccia Corrigan
- Gentle Giants of the Sea*. The Whale Museum; Friday Harbor, WA; 1986.
- How Big is a Blue Whale?*, Jinny Johnson, Rand McNally & Co., 1995
- Humpback Goes North*, Darice Bailer, Soundprints Corp Audio, 1998
- Humphrey the Lost Whale*. W. Tokuda and R. Hall; Heian International Press; Union City, CA; 1986.
- Is a Blue Whale the Biggest Thing There Is?*, Robert Wells, School & Library Binding, 1993
- Ocean Mammals*, Elaine Landau, Children's Press, 1997
- The Plight of the Whales*, J.J. McCoy, Franklin Watts, NY, 1989
- Sea Searcher's Handbook*, Monterey Bay Aquarium, Monterey, CA, 1996
- Whales*, Cindy Barden, Teacher Created Materials, 1997
- Whales*, Gail Gibbons, School & Library Binding, 1991
- Whales And Dolphins*, Robin Kerrod, Lorenz Books, London, 1998
- Whales And Dolphins in Action*, Early Reader Pop-Ups, Aladdin Books, McMillian Pub. Co., NY, 1991
- Whales, The Nomads of the Sea*, Helen Roney Sattler, Lothrop, Lee, & Shepard Books, NY, 1987
- What is a Marine Mammal?* B. Kalman; Crabtree Publishing Co.; Ontario, Canada; 2000.
- Zoobooks*. Wildlife Education Limited; San Diego, CA.

The information and opinions presented in these resources are not necessarily endorsed by the American Cetacean Society.



CREDITS AND ACKNOWLEDGEMENTS

ILLUSTRATION CREDITS:

Carl Buell: Pakicetid (from <http://www.neoucom.edu/Depts/Anat/Pakicetid.html>) (page 3)

Charles Gretz: Archeocete (page 3), Dolphin (page 5), Blubber Glove (page 15), Right Whale (page 17), Humpback Whale Feeding, Amphipod, Gray Whale (page 18), Sperm Whale (page 21), Porpoise Tooth, Dolphin Tooth (page 25), Bowriding (page 26)

Linda Ayers: Breaching, Spyhopping, Lobtailing (page 26), Flippering, Kickfeeding, Logging (page 27)

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ACKNOWLEDGEMENTS:

The American Cetacean Society would like to thank the current and former members of their Board of Directors, and all members (past and present) of the Education Committee, for their help, ideas, support, patience, and most of all commitment in the creation of this Curriculum. We would also like to thank the many members of Cabrillo Marine Aquarium, the Natural History Museum of Los Angeles County, and all the Regional Chapters of the American Cetacean Society for their help, support, and dedication to this project.



Appendix A: National Science Education Standards Correlations

National Science Education Standards K-4

Strand	Activity Unifying Concepts	As Big as That!	Whale Parts	The Breath Test	Beautiful Blubber	Hearing is Believing	A Mouthful	What's for Dinner?	Do It! Do It!	Migratory Math
A	Abilities to do Scientific Inquiry			X						
C	Characteristics of Organisms		X	X	X	X	X		X	
	Organisms and Their Environment							X		
G	Science as a Human Endeavor			X					X	X

National Science Education Standards 5-8

Strand	Activity Unifying Concepts	The Breath Test	Beautiful Blubber	Hearing is Believing	A Mouthful	What's for Dinner?	Do It! Do It!	Migratory Math	Let's Talk it Over
C	Populations and Ecosystems					X		X	
	Regulation and Behavior	X	X	X	X		X		
	Diversity and Adaptations of Organisms	X	X	X	X				
F	Nature of Science								X
	Populations, resources, and Environment								X
	Risks and Benefits								X
	Science and Technology in Society								X
G	Science as a Human Endeavor							X	



National Science Education Standards 9-12

Strand	Unifying Concepts	Activity	What's for Dinner?	Let's Talk it Over
C	The Interdependence of Organisms		X	X
F	Population Growth			X
	Science and Technology in Local, National, and Global Challenges			X
	Environmental Quality		X	

