

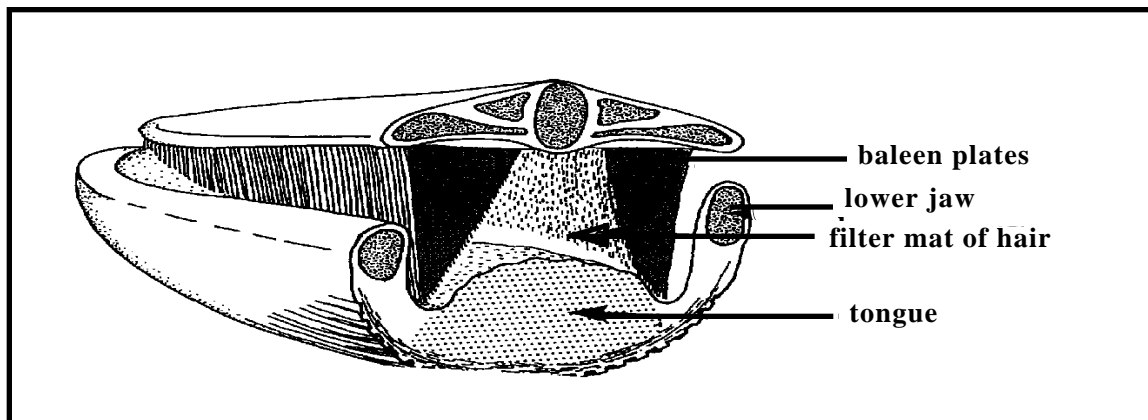
Biodiversity: The Food Chain, Including Food Capture, of the Blue Whale

Student Activity Sheet

Name _____ Date _____ Class _____

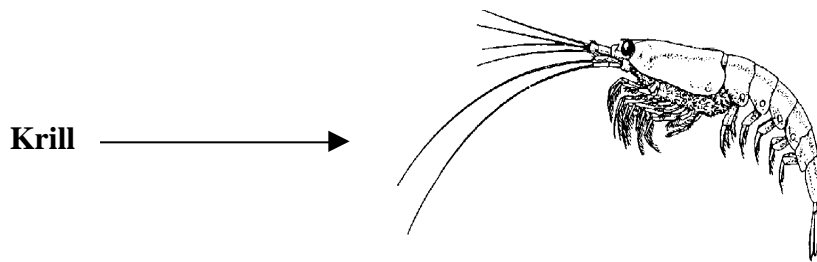


Do you know what is the largest animal in the world? The *blue whale* is probably the largest animal that has ever lived on Earth. It weighs up to 150 tons and can grow as long as 103 feet. The blue whale is not a fish but a mammal and belongs to a group of marine animals called *cetaceans*. There are two types of cetaceans: those that have teeth and those that have *baleen* instead of teeth. The blue whale is a baleen (or whalebone) whale. All baleen whales have hundreds of pieces of baleen hanging from their upper jaw. Each piece of baleen is called a plate and is made out of keratin, the same material that human fingernails are made of. Just like our fingernails, baleen is hard but it can also bend. The illustration below shows what the inside of a blue whale's mouth would look like if we were able to look inside its head.



You may not realize it, but the ocean is full of microscopic animals. These tiny animals, or **zooplankton**, are what baleen whales eat. The blue whale eats by gulping up huge mouthfuls of water. Once its mouth full of water, the blue whale closes its jaws and pushes the water out through the baleen plates. The food or zooplankton is left behind on the baleen. The food gets caught in the tiny hairs that line the inside edge of the baleen. The whale uses its tongue to scoop the zooplankton off the hairy mat and then swallows its meal. There are about 800 pieces of baleen in a blue whale's mouth and the plates are very close together. The blue whale's baleen is dark brown to black and about 3 1/2 feet long.

The blue whale's favorite food is **krill**. Krill are a type of zooplankton that look like little baby shrimp. The largest species of krill is only 2 inches long and most are smaller than an inch. You can imagine how many thousands of these animals a blue whale has to eat. In fact, an average baleen whale can eat up to two tons of krill a day during the feeding season.



Krill eat **phytoplankton**, which are microscopic plants that live near the surface of oceans and lakes. Phytoplankton are mainly one-celled organisms and are **autotrophic**. This means that they depend on the sun for the energy they need to produce their food. The microscopic phytoplankton are very important to all living organisms in the sea. They are one of the first links in the food chain of most ocean animals. Here are the three parts of the blue whale's food chain:

Phytoplankton ⇒ Zooplankton ⇒ Blue Whale
(Plant/Producer) ⇒ (Consumer/Carnivore) ⇒ (Consumer/Carnivore)

It's amazing, isn't it, that the largest organism in the oceans depends upon the smallest to survive. The blue whale feeds throughout the summer on krill that are abundant in the cold, **polar** water of both the northern and southern hemisphere. In the late fall, the blue whale **migrates** to the warmer waters of the **tropics** where the water is warmer. There are no krill in tropical areas of the ocean so the blue whale must live off its blubber for the entire time it spends there. The blue whale is able to survive the time it spends in the tropics only by eating thousands and thousands of krill and storing this food in their bodies as fat or **blubber**.

Blue whales are now an *endangered species*. There are not many of these animals left. The people of the world need to protect the whales and their habitat if any blue whales are to survive. One way people can help protect the blue whale is by protecting the blue whale's *food chain* that includes not only krill but also the phytoplankton on which krill feed. We need to keep the oceans clean and unpolluted.

ACTIVITY A: BALEEN-WHAT'S IT GOOD FOR?

Objectives:

- Understand the physical features and adaptations used by the blue whale in capturing and ingesting food.
- Appreciate the importance of food webs, especially the fragile web of the blue whale.

Materials:

1 Aluminum pan	Small plastic, toothed combs
Paper towels	Water (Teacher supplied)
Newspaper	
1 Krill vial (about 2 tablespoons of dried herbs)	

Procedures:

1. Work with at least one other partner to form your work team. Your teacher will have set up all the equipment you need for your group. There should be about 1-2 inches of water in your pan. This is your ocean. What's the name of your ocean?
2. Each person in your group should have a comb. This is your baleen. The teeth in the comb represent individual plates of baleen. Your team also has a plastic container of dried herbs. This is the zooplankton that your whale is going to eat. Remove the cover from the container and slowly sprinkle the herbs over the surface of your ocean (tin). Don't dump all the herbs into the water at once- you don't want a clump of them but a layer on the surface.
3. Each student in your group should take a turn moving the comb through the water just like a blue whale does in search of krill. Make long passes across the surface of the water. See how many zooplankton you can capture.
4. Wipe the herbs that you have captured onto the newspaper or a paper towel. Pretend the whale has just digested the krill found on the comb. Keep feeding until all the zooplankton (herbs) are gone. Where you a hungry blue whale?

5. If you have more herbs left, pour them onto the water's surface and continue feeding until everyone in your group has had a chance to eat zooplankton.
6. When all your team members have eaten, clean up your area. Throw your paper towels away and make sure your work area is dry. Hand in your combs and herb containers to your teacher.
7. Answer the discussion questions and review the vocabulary words.

Discussion Questions for Activity A:

1. What did it feel like to be a blue whale feeding on krill?
2. How did your baleen (comb) help you to catch the krill?
3. What would it be like if you tried to capture krill in the ocean using your mouth and your teeth? Would your mouth and teeth be much good to you in this environment?
4. How is the whale's mouth designed to help it catch and digest the largest amount of krill?
5. How is the whale's mouth different from yours?
6. About how many krill do you think you caught when you were the whale?
7. About how many krill do you think the blue whale needs to eat each day to keep its stomach full?
8. What would happen to the blue whale if there were not many krill in the ocean one year?
9. What things could man do which might harm the supply of krill? What about an oil spill?
10. Did you notice that some of the krill sank to the bottom of the pan? What would happen to these krill? How would this help the food web?

ACTIVITY B : FEEDING A BLUE WHALE

Objective:

- Understand the parts of the blue whale's food chain and the general amounts needed to feed each level.
- Use math to figure out how many krill and phytoplankton are eaten.

Materials:

Each group receives:

- 1 Game board
- 1 Tally sheet
- 1 Pencil (student supplied)
- 1 Game packet

Each game packet contains:

- 15 Phytoplankton
- 10 Krill
- 4 Blue whales
- 1 Die

Procedure:

1. Each group of students receives one game card, one tally sheet, and one game packet.
2. The objective of the game is to see who can feed the most blue whales after 30 minutes of playing the game or until one person feeds all 4 whales. Your teacher will let you know when the time is up. Remember that a blue whale eats zooplankton and its favorite is krill. Krill eat phyto- or plant- plankton. These are the three parts to the blue whale's food chain. You'll start out the game accumulating phytoplankton until you have enough to feed a krill. You keep playing until you eventually have enough krill pieces to feed a blue whale.
3. You'll be trading in one type of game pieces for another in this game. You trade or exchange 10 phytoplankton for 1 krill and 10 krill can be traded in for 1 whale.
4. Take turns rolling the dice, writing the numbers on your sheet, and adding the game pieces to the board.
5. Every turn you roll the dice twice. Each time you roll the dice a number of dots will be face up. Add together the number of dots for your two rolls. (Example: first roll= 4, second roll= 2. Sum of these two numbers is 6.) The sum of two rolls of the dice is the number of phyto- or plant plankton that you will put onto your board. Place the phytoplankton pieces in the column of your game board labeled PHYTOPLANKTON.
6. You can write the numbers that were on the dice on the tally sheet. There is also a space for you add the numbers together. Keep rolling the dice twice for every turn. When you have 10 phytoplankton on your board, trade them in for one krill. That means that you take the 10

phytoplankton pieces off your board and add one krill game piece to the center section of the game board. That's the section labeled KRILL on the game board. (For example, if a student has 13 phytoplankton, 10 are traded in for 1 krill game piece and 3 phytoplankton remain on the board.)

7. Use your tally sheet to help you keep track of how many phytoplankton you have on the board. When you exchange phytoplankton pieces for krill, subtract 10 plant plankton from your total. If you are good enough at math to do the addition and subtraction in your head, then you don't have to write down the numbers on the tally sheet.
8. Continue playing in this manner, adding phytoplankton and trading them in for krill, until you collect 10 krill. When you have 10 krill or zooplankton, you can trade or exchange 10 krill for 1 blue whale.
9. Each group should continue to roll, tally, sum, and trade until the time limit has been reached or until a group has fed four whales. See which team can feed all four blue whales the fastest.
10. Answer the discussion questions.

Discussion Questions for Activity B:

1. What do krill need to feed on to stay alive?
2. What do phytoplankton need to grow and survive?
3. Why does krill not grow well in tropical regions?
4. Why do you think that there are lots of krill in the polar regions?
5. What could happen to the blue whale if phytoplankton did not grow well one year?
6. Estimate how many krill a blue whale needs to eat each day to keep from going hungry. Why did you select that number?

7. Estimate how many phytoplankton a krill eats each day? Why?
8. Which organisms are in the food web of the blue whale?
9. The blue whale depends on phytoplankton even though it does not eat them. Explain why phytoplankton are important to the blue whale.
10. What can we do to keep the blue whale from becoming extinct?
11. What things can people do to help protect the food web of the blue whale?

Vocabulary

Blue Whale: The largest whale and animal to ever to have lived on Earth. It is a baleen whale with long grooves or pleats on its throat. The blue whale can grow up to 100 feet long, but most mature blue whales are between 74-77 ft. long.

Cetaceans: A water dwelling mammal group. The biological order that includes whales, dolphins, and porpoises.

Baleen: Long thick plates that hang from the upper jaws of baleen whales. Baleen is used to trap food from the ocean water that the baleen whale eats. Baleen is made out of keratin, the same protein material our fingernails are made of. The blue whale has baleen plates that are between 3 1/2 ft. long. The filtering area of the blue whale is about 152 sq. feet.

Zooplankton: Very small animals that drift in the sea and feed on phytoplankton or other zooplankton.

Krill: Small shrimplike, translucent animals that live in the ocean. The average baleen whale can eat up to three times its weight in krill during a feeding season.

Phytoplankton: Microscopic plants that drift in the sea or in lakes. The single celled types are usually called algae.

Autotrophic: A type of organism that makes its own food or organic material from inorganic sources, such as carbon dioxide and water. All green plants are autotrophic.

Polar: The areas of the world near the north and south poles, from about 60 to 90° latitude. These are very cold areas, with winter's of continuous darkness and summers of continuous light.

Migrate: When an animal physically moving from one area to another, usually to go to a different geographical area to feed, mate, or give birth. These moves happen due to changes in the surrounding water temperature or food sources.

Tropics: The area bordering the equator, at or near 0° of latitude. These areas have very warm climates and a lot of sunshine, but the water usually doesn't have many nutrients.

Blubber: The fat of whales and some other sea animals. Blubber lies under the skin and over the muscles.

Endangered species: Animal groups which are threatened with extinction due to changes in their environment and/or the food webs upon which they depend. They may also be threatened by excessive hunting from their predators (such as man).

Food Chain: A series of organisms along different food levels that feed on one another. The food chain of the blue whale starts out with plants- phytoplankton. Krill eat phytoplankton and blue whales eat krill. These are the three different food levels or links in the food chain of the blue whale.

Teacher Strategies for Activity A

Materials and Preparation:

1. The teacher may want to fill pans and distribute materials to workstations prior to the start of the lesson. This lesson might be best scheduled right after recess or lunch
2. Students should place something that is flat and hard, such as a cookie pan or tray, under the pan when emptying the water. These trays can buckle under the weight of the water when being moved.
3. Students should be instructed to wipe any water on the trays after draining them and to wash and clean their combs using paper towels.
4. If your class is too large and you anticipate problems with students and water, etc., then a teacher demonstration would work just as well.

Approximate Time Required for Activity A: One class period.

Target Audience: Science Class

Answers to Discussion Questions for Activity A:

1. Accept any answer, such as busy, heavy, or wet.
2. The krill (herbs) got caught between the teeth of the comb.
3. I might suck some in and I might be able to bite a few with my teeth, but my teeth and mouth wouldn't be very useful.
4. The whale has a huge body, a large mouth, a large stomach, and a powerful ability to suck in large amounts of water. The baleen are long and strong. The stiff hairs on the inside edges of the baleen traps large quantities of krill.
5. Accept any answers which describe the baleen/mouth apparatus versus teeth/mouth apparatus.
6. Accept any answer which specifies a large amount, such as, hundreds or thousands.
7. The average baleen whale can eat up to 3 times its' total weight in krill in one feeding session. Accept reasonable estimates.
8. The blue whale wouldn't make enough blubber to help it survive the summer season. Many of the whales would die or become very ill.
9. Accept any answer that describes how oil clings to things and how it effects the phytoplankton and zooplankton (krill) as well as the feeding process of the blue whale.

10. There may be too few krill left for the blue whale to survive on and if it could not find another type of zooplankton to eat, it would probably die of starvation.
11. These krill might be eaten by other animals, such as fishes, that live on the bottom. What krill are not eaten by bottom dwellers will decompose. This will add nutrients and minerals to the sediments and water.

Extensions for Activity A:

Grades 4-6

1. Cooking oil could be added to the water after the herbs have been added. Students could then conduct the same activity and discuss the effects on the water, whale, krill, and food web. Students could offer ways to prevent an oil spill from taking place. This extension might work better as a teacher demonstration.
2. Create a story about what it feels like to be a blue whale moving through the water and eating krill. Students could investigate the dominant senses used by the whale and include these in their story.
3. Draw the physical adaptations (size and shape of mouth and body, design of lips and shape and proximity of baleen) which make the whale proficient in the gathering and ingesting of krill.
4. Create a story based on the feeding procedure of the whale from the krill's point of view.
5. Create a poster which lists things which would be harmful to the whale if dropped in the ocean and show what we as humans could do to help keep the oceans clean for the whale.

Grades 9-12

1. Have students investigate the blue whale in cooperative groups. Include such things as life cycle, habitat, range, breeding habits, population numbers, predators, and response to pollution.
2. Students could also research whaling policy 1800 to today and investigate the effects of the whaling industry on the blue whale. Posters and oral presentations can be made and shared with the class.

Questions:

- a. How many blue whales are believed to exist today? Is this species endangered?
- b. What are factors that contribute to blue whale numbers?
- c. Are any countries still hunting the blue whale today? If so, why are blue whales economically valuable?

3. Students may be able to observe whales on a whale watch. Once the whale species has been identified (or a species assigned by the teacher has been designated), the steps outlined and questions given in Extension #1 may be applied to the species observed.
4. Students can write letters of protest to the governments of countries still engaged in whaling, suggesting alternative sources of industrial materials obtained from whales, other sources of income.

Teacher Strategies for Activity B

Materials and Preparation:

1. Choose how many students to have in each group. This will largely depend upon the size of your class. You may want students in some groups to use one pair of dice because they are able to add more quickly. Students can share the die found in each packet and use a pair of dice to play the game.
2. The teacher may want the students to add more whales than the kit provides. In this case, photocopy the pieces and make more whale game pieces for each group.
3. You may also want to change the grouping rules or the number of dice used in the game once students become proficient in playing the game and in computing sums. The teacher may choose whatever ratios support the scientific concept.

Approximate Time Required for Activity B: One class period.

Target Audience: Science.

Answers to Discussion Questions for Activity B:

1. Krill need enough phytoplankton to eat and water which is clean and not polluted.
2. They need sunlight, clean water, and minerals in the water to help them grow.
3. They may not get enough of the nutrients or minerals that they need to help them grow and reproduce quickly.
4. There must be enough sunlight, clean water, and minerals for them to grow.
5. There would not be as many krill. The blue whale would not be able to eat as many krill as are needed to make blubber for the summer season.
6. Accept reasonable answers that represent large quantities based on the size and the feeding capacity of the blue whale.
7. Because phytoplankton are very small, the krill need to eat a great many. Accept reasonable answers.

8. Phytoplankton, krill, and the blue whale.
9. Although the blue whale does not eat the phytoplankton, the krill do. Small numbers of phytoplankton mean even smaller numbers of krill. This affects the amount of krill the whale gets to eat.
10. Keep the water clean and do not collect the krill that the blue whale needs.
11. Create laws which protect the blue whale and keep the water clean. Stop countries from developing food industries based on gathering the krill from the top of the water.

Extensions for Activity B:

Grades 4-6

1. Create new web characters to use in the game based on the food webs of other animals.
2. Create posters which illustrate the members and the sequence of the food web.
3. Research the eating habits of other baleen whales and develop a food web for these types of whales.
4. Research the food webs of toothed whales and compare these to the webs of the baleen whales on the basis of similarities and differences of animal selected.
5. Create a 100 ft. long line on the playground and see how many children it takes to fill the line from end to end. The maximum length an adult male blue whale has so far been estimated at 100 ft.
6. Create a square grid with masking tape on the gymnasium floor measuring 12 x 12 ft. and see how many students it takes to fill the area. The filtering area of the average adult whale is about 152 sq. ft. This area will fill 144 sq. ft.
7. Create a 40 ft. line on the playground and see how many students it takes to fill the line. The maximum length of a baleen plate of a blue whale is 41 ft.

References

Angel, H., *Life in the Oceans*, Cathay Books, London, WI, 1979.

Bunting, E. *The sea World Book of Whales*, Harcourt, Brace, & Jovanovitch Inc., New York, NY, 1980.

Curtis, H., *Biology*, Worth Publishers Inc., New York, NY, 1978.

Watson, J., *Whales*, Western Publishing Co. Inc., Racine, WI, 1978.

World Book Encyclopedia, Vol. 21 - Whales, World Book Inc., Chicago, IL. 1989.

World Book Encyclopedia of Science, *The Animal World*, Vol. VI, World Book Inc., Chicago, L, 1989.

World Book Encyclopedia of Science, *The Plant World*, Vol. V, World Book Inc., Chicago, IL, 1989.