# WHALE FOOD PYRAMID ACTIVITY

SEATTLE AQUARIUM

**GRADES:**

9–12

**DURATION:**

30–60 minutes

**MATERIALS:**

- Student worksheet

**STANDARDS:**

WA state:

- Systems: SYSB & SYSC
- Life Sciences: LS1A

Ocean Literacy Principles:

5. The ocean supports a great diversity of life and ecosystems.

## OVERVIEW:

*How can the largest animal on the planet, the blue whale, sustain itself on plankton? Students will dive deep into a marine-themed food pyramid and learn all about energy transfer via fun math exercises.*

## GOALS AND OBJECTIVES:

Students will:

- Learn how much salmon it takes to sustain an adult orca and how much phytoplankton, zooplankton and small fish are required to support the salmon.
- Uncover the reasons why the largest animal on the planet, the blue whale, is able to support itself on plankton.
- Understand how to interpret a food pyramid.
- Be able to calculate how much phytoplankton, zooplankton, small fish and salmon it takes to support an adult orca.
- Be able to calculate how much phytoplankton and zooplankton it takes to support an adult blue whale.

## VOCABULARY:

**Baleen whale:** Baleen whales belong to the suborder Mysticiti. These whales lack teeth and instead have hundreds of rows of baleen plates that hang down from their upper jaws like the teeth of a comb. The baleen is used to strain food from the water.

**Primary producer:** Primary producers are organisms take energy from abiotic, or non-living, sources and turn it into usable energy.

**First-order consumer:** A first-order consumer is a consumer that eats a producer.

**Second-order consumer:** Second-order consumers, also known as secondary consumers, are organisms that occupy a position in a food chain. They are often referred to simply as predators, as they get their food by eating first-order consumers, or herbivores.

**Third-order consumer:** A third-order consumer is an animal that eats the second-order consumer.

**Fourth-order consumer:** A fourth-order consumer is an animal that eats a third-order consumer.

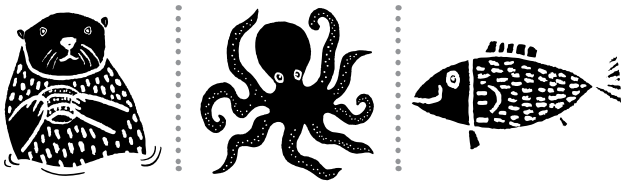
**Food chain:** A series of organisms interrelated in their feeding habits, the smallest being fed upon by a larger one, which in turn feeds a still larger one, etc.

**Food web:** A series of organisms related by predator-prey and consumer-resource interactions; the entirety of interrelated food chains in an ecological community.

## BACKGROUND:

### Food chains

Food chains in themselves are usually fairly simple and may include no more than two or three links. Interlocking food chains form food webs. Food webs are a part of every



ecosystem because few animals rely on a single source of food, and seldom is any food source consumed by just one kind of animal.

The bottom of the food chain is dominated by a great number of very small animals, such as copepods. As the chain grows in length, the size of the animals at each level increases. Link by link, each successive level tends to be made up of larger types of animals.

The flow of energy through such chains is best visualized as a pyramid. The base of the pyramid is formed by vast numbers of microscopic organisms. The top of the pyramid has a few large, predatory animals. From base to top, each succeeding level tends to be dominated by larger organisms which are preying on animals smaller than themselves.

Large size is advantageous in that it is often more difficult to catch and eat a large animal than a small one. However, large animals require large amounts of food to support their size. Special demands are placed on warm-blooded animals which live in cold seas, since they must maintain a body temperature well above ambient temperatures. They often must also expend considerable amounts of energy in pursuit of their prey. Such animals devote a great deal of energy to maintaining life. Only a little energy is available for growth and reproduction. These limitations help explain why there are a few large animals at the top of the pyramid which depend upon billions of minute organisms at the base.

Transfer of energy from the base to peak of the pyramid is governed by the "10 percent rule." Simply put, nine-tenths of the food value is lost as energy and heat to the environment at each level of the pyramid. Only about one-tenth of the available energy transfers from one level to the next.

In the pyramid below, we see that 10,000 pounds of phytoplankton are needed to produce 1,000 pounds of zooplankton which produces 100 pounds of small fish. The 10 pounds of salmon produced by feeding on small fish will yield only one pound of killer whale. Each pound of whale is supported by 10,000 pounds of phytoplankton. The inefficient transfer of energy limits the number of killer whales which can live and reproduce. It also means killer whales must work hard to obtain the amount of food they need.

Obviously, it is energetically advantageous to feed on organisms close to the base of the pyramid. Baleen whales (the whale at the third level of the pyramid) exemplify this strategy since they feed directly on zooplankton (krill). The 10,000 pounds of diatoms necessary to support one pound of killer whale will produce 100 pounds of baleen whale. This helps to explain why blue whales, the largest animals that ever lived, are plankton-feeding whales. Baleen whales can afford to be both large and numerous, since they can obtain a large amount of krill with relatively little expenditure of energy.

**Orcas (killer whales)**

The following information is excerpted from the NOAA Fisheries: Office of Protected Resources website (accessed 12/30/2011).
http://www.nmfs.noaa.gov/pr/species/mammals/cetaceans/killerwhale.htm

**Blue whales**

The following information is excerpted from the NOAA Fisheries: Office of Protected Resources website (accessed 12/30/2011).

http://www.nmfs.noaa.gov/pr/species/mammals/cetaceans/bluewhale.htm

## ACTIVITY:

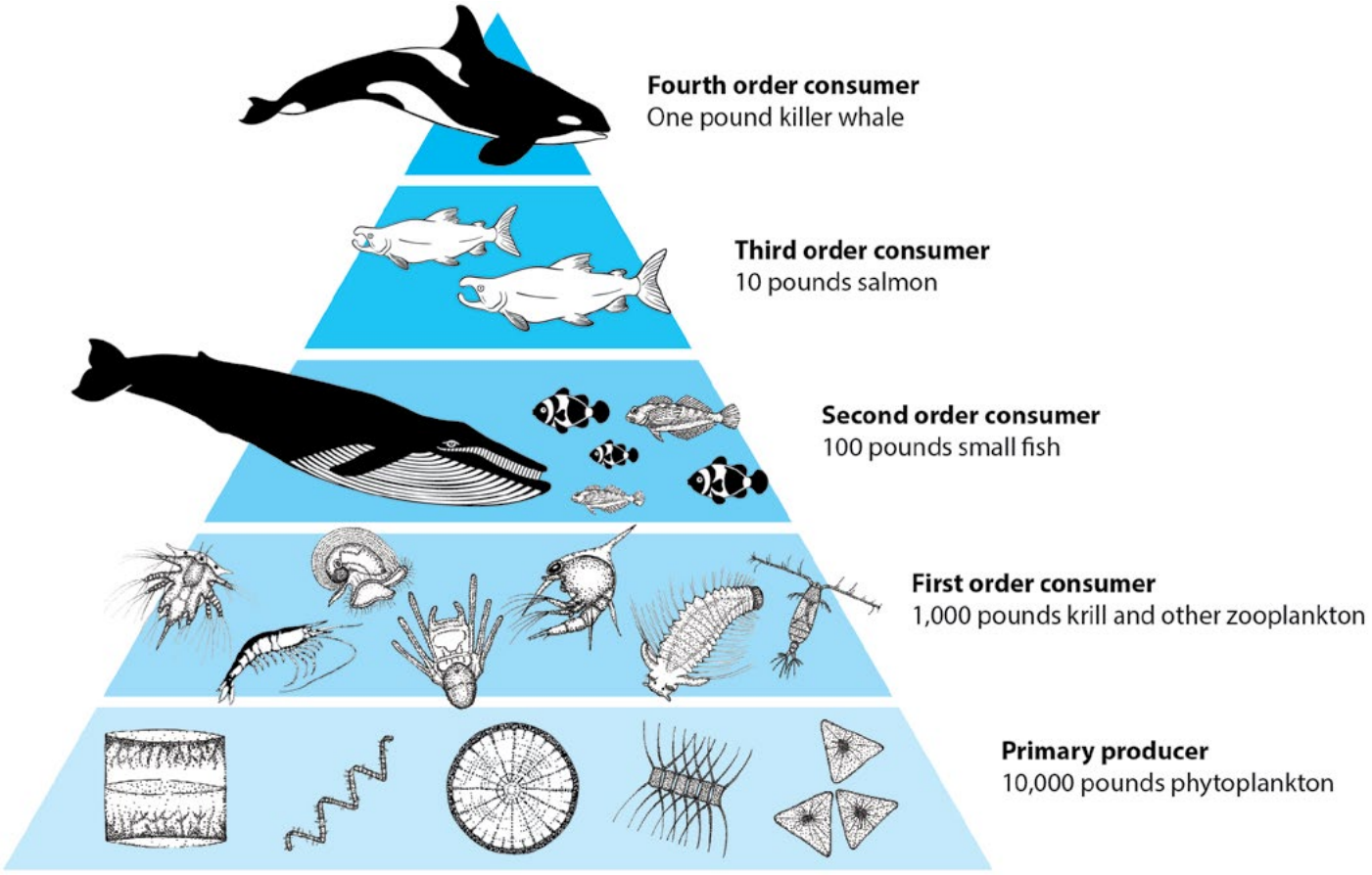
Students will use a food pyramid to determine how much food is required to support orcas and blue whales.

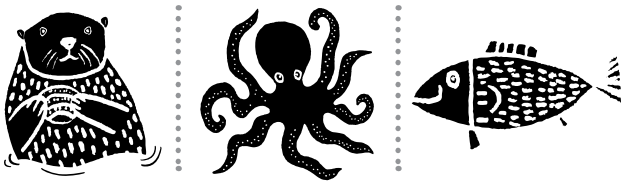
# ORCA AND BALEEN WHALE FOOD PYRAMID

SEATTLE AQUARIUM

Use the food pyramid to answer the following questions. For each question, show how you got your answer!

## FOOD PYRAMID





**1. How many pounds of salmon are required to support...**

a. One pound of killer whale?

b. 20 pounds of killer whale?

c. One ton (2,000 pounds) of killer whale?

**2. How many pounds of phytoplankton are required to support...**

a. One pound of killer whale?

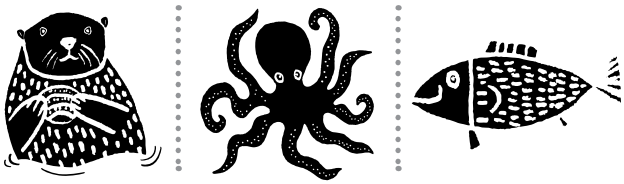
b. 20 pounds of killer whale?

**3. An adult female killer whale weighs about one ton (2,000 pounds). An adult male weighs about three tons (6,000 pounds).**

**How many pounds of phytoplankton are required to support...**

a. One full-grown female killer whale?

b. One full-grown male killer whale?



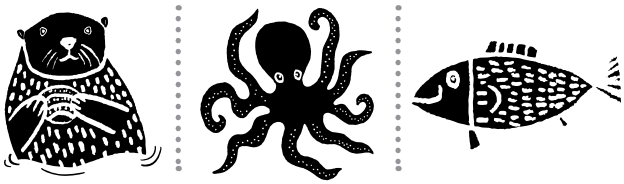
**4. Blue whales, the largest animals in the world, are baleen whales. They feed on zooplankton called krill. An adult blue whale weighs as much as 152 tons (304,000 pounds). They feed at the same level in the pyramid that the fish do. It takes 1,000 pounds of krill to support 100 pounds of blue whale.**

**How many pounds of krill are needed to support a 152-ton (304,000-pound) blue whale?**

**5. If a blue whale could eat salmon instead of krill, how many pounds of salmon would it take to support a 152-ton (304,000-pound) blue whale?**

**6. Blue whales do not eat salmon, but if they did, how many pounds of krill would it take to support a salmon-eating blue whale that weighs 200 tons (400,000 pounds)?**

# ANSWER KEY




**1. How many pounds of salmon are required to support...**

a. One pound of killer whale?

10 lbs. salmon x 1 lb. killer whale = 10 lbs. salmon required to support 20 lbs. killer whale.

b. 20 pounds of killer whale?

10 lbs. salmon x 20 lbs. killer whale = 200 lbs. salmon required to support 20 lbs. killer whale

c. One ton (2,000 pounds) of killer whale?

10 lbs. salmon x 2000 lbs. killer whale = 20,000 lbs. salmon required to support 2000 lbs. killer whale

**2. How many pounds of phytoplankton are required to support...**

a. One pound of killer whale?

10,000 lbs. phytoplankton x 1 lb. killer whale = 10,000 lbs. phytoplankton to support 1 lb. killer whale

b. 20 pounds of killer whale?

10,000 lbs. phytoplankton x 20 lbs. killer whale = 200,000 lbs. phytoplankton to support 20 lbs. killer whale

**3. An adult female killer whale weighs about one ton (2,000 pounds). An adult male weighs about three tons (6,000 pounds).**

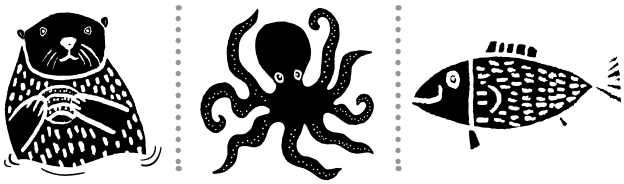
**How many pounds of phytoplankton are required to support...**

a. One full-grown female killer whale?

10,000 lbs. phytoplankton x 2000 lbs. female killer whale = 20,000,000 lbs. phytoplankton to support the whale

b. One full-grown male killer whale?

10,000 lbs. phytoplankton x 6000 lbs. male killer whale = 60,000,000 lbs. phytoplankton to support the whale



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**How many pounds of krill are needed to support a 152-ton (304,000-pound) blue whale?**

Ratio is 10 to 1.

304,000 divided by 100 = 3040
3040 x 1000 lbs. krill = 3,040,000 lbs. krill necessary to support a 152-ton blue whale

**5. If a blue whale could eat salmon instead of krill, how many pounds of salmon would it take to support a 152-ton (304,000-pound) blue whale?**

Ratio is 10 to 1.

304,000 divided by 10 = 30,400
30,400 x 100 lbs. salmon = 3,040,000 lbs. salmon necessary to support a 152-ton blue whale which could eat salmon

**6. Blue whales do not eat salmon, but if they did, how many pounds of krill would it take to support a salmon-eating blue whale that weighs 200 tons (400,000 pounds)?**

4,000,000 divided by 10 = 400,000
400,000 x 1000 lbs. krill = 400,000,000 lbs. krill or 100 times as much krill as necessary to support a whale which eats krill, not salmon.

Now use the food pyramid and your imagination to answer this question.

If there was an oil spill in Puget Sound and half of the plankton was destroyed, what do you think would happen to the small fish in the sound? What about the salmon and whales? How do you think the people living near Puget Sound might be affected?