

6th-8th Grade Whale Watching Adventure Packet

Teacher Information:

This packet is designed for sixth grade through the eighth grade and is based on the content standards adopted by the California State Board of Education. You will gain information about whales and other marine mammals as well as some fun facts. This packet's curriculum focuses on concepts of ecology relating to marine mammals, a more detailed look at marine food webs and energy flow, and the physiological adaptations for survival of marine mammals.

Marine Mammal Background:

Whales, dolphins, seals and sea lions are marine mammals. Whales and dolphins spend their entire life in the ocean while seals and sea lions spend a lot of time out of the water on land or on buoys catching some sun to warm up. These animals are mammals, which means they breathe air with lungs, have hair or fur, and give live birth to their young that they nurse with milk produced by the mother. They are also warm blooded which means they can maintain their body temperature no matter what the temperature is of the environment. This is unlike a cold blooded animal like a snake, lizard or fish that's body temperature is the same as the environment they live in and need to seek a warmer area to warm their body up or a colder area to cool down.

Marine Mammal Ecology:

Let's start with some terminology to help better understand the concepts of ecology that will be discussed.

- Organism- any individual form of life (ie: plant, animals, fungus, microbe...)
- Trophic Level- The position of an organism in a food chain or web.
- Food Web (chain)- A way to understand the connection that organisms have to in an ecosystem based on what they eat.

- **Ecosystem**- The interaction of all the living organisms (biotic factors) in an area as well as all the non-living components (abiotic factors) they depend on for survival.
- **Habitat**- The area naturally inhabited by an organism.
- **Biome**- An area of globally similar ecosystems that can be classified together based on their climate and geographical similarities. (ie: tundra, rainforest, ocean, desert...)
- **Niche**- The special role each species serves within its ecosystem. (ie: phytoplankton's niche is to photosynthesize and be eaten by zooplankton)
- **Population**- A group of individuals of the same species living in a particular area.
- **Species**- A group of similar organisms that reproduce amongst themselves and do not naturally reproduce with any other organisms. (ie: tiger, bald eagle, orca...)
- **Biodiversity**- A measure of the health of an ecosystem by looking at the variety of organisms living in it.

Marine biodiversity is the variety of organisms living in a marine environment. Here in Southern California we have a vast amount of organisms living in and around our coast. Even us as humans can be considered part of the diversity considering that we fish and eat some of the species living in our coastal waters. Biodiversity is defined as being a measure of the health of an ecosystem by the variety of organisms living in it. Do you think that our coastal environment is healthy?

- Discuss the reasons our coast is and isn't a healthy environment.
- Discuss why it is important to have biodiversity?

Loss of biodiversity could be from:

- Habitat loss or destruction
- Changes or alterations to an ecosystem (ie: changes in the food web)
- Introduction of non native species that may out compete native species.

- **Over-exploitation** such as hunting, fishing or harvesting too much of a species in one area.
- **Pollution or contamination** to a habitat or ecosystem.
- **Climate change** or changes to an ecosystem's conditions.

An example of a loss in biodiversity in a marine ecosystem is the near extinction of sea otters along the California coast. Sea otters were hunted for their furs in the 1800's and early 1900's and the population was so low that it had a huge affect on the biodiversity of the kelp forest ecosystem. Sea otters hunt and eat purple sea urchins but without enough otters the sea urchin population becomes uncontrollable. The sea urchins eat the kelp at such a fast rate without a predator to control them that they can actually destroy an entire kelp forest. This has a negative effect on other species that depend on that habitat for survival. Now you have a situation in which multiple species are being diminished and affected and the total biodiversity in that ecosystem is now threatened and out of balance. This particular example shows how by the loss of one species in a food chain can affect the biodiversity of the entire ecosystem.

Food Webs and Energy Flow:

Review:

A food web is a way of seeing how animals are connected through the things they eat. There are three kinds of organisms in a food web.

- **Producer**- Usually a plant or organism that gets its food from the sun by a process called photosynthesis. In the ocean the producer is going to be either kelp (seaweed) or phytoplankton.
 - **Phytoplankton**- Microscopic plants that live in the ocean.
- **Consumer**- There are three kinds of consumers.
 - **Herbivore**- An animal that only eats plants (or producers). In the ocean this is an animal that eats only seaweed or phytoplankton. This would be a Zooplankton and some fish.
 - **Zooplankton**- an animal that floats through the ocean. Usually microscopic but not always. Could be baby (larval) fish, crabs, or other animals or even jellyfish.
 - **Carnivore**- An animal that only eats other animals. In the ocean this is a whale, dolphin, shark, pelican etc.

- **Omnivore**- An animal that eats both plants and animals. Some fish are omnivores and eat whatever is available.
- **Decomposer**- An animal that eats dead plants and animals. Sea cucumbers, crabs, and sea stars are great decomposers in the ocean.

In Detail:

The main source of all energy in a food web comes from the sun. The producers which are photosynthetic harvest the sun's energy by combining the energy from the light with carbon dioxide to produce sugars. However only 10% of the energy from the sun is harvested by the producer and the other 90% is lost to the environment as heat. In each trophic level only 10% of the energy from the previous level in the food web is obtained and 90% is lost to heat and respiration. So the energy level decreases farther up the food web. A **primary consumer** is an organism that eats producers (an herbivore/vegetarian) and will gain 1% of the original energy harvested from the sun. A **secondary consumer** eats primary consumers (carnivore that eats an herbivore) and will gain 0.1% of the energy. A **tertiary consumer** eats secondary consumers (carnivore that eats carnivore) and only gains .01% of the energy. With this flow of energy through the food web you can see how the organisms higher on the food chain would have to consume more to get the energy they need to survive.

I. SUN

II. Producer

- a. Plant or photosynthetic protozoan= 10% energy

III. Primary Consumer

- a. Herbivore= 1% energy

IV. Secondary Consumer

- a. Carnivore eats herbivore= 0.1% energy

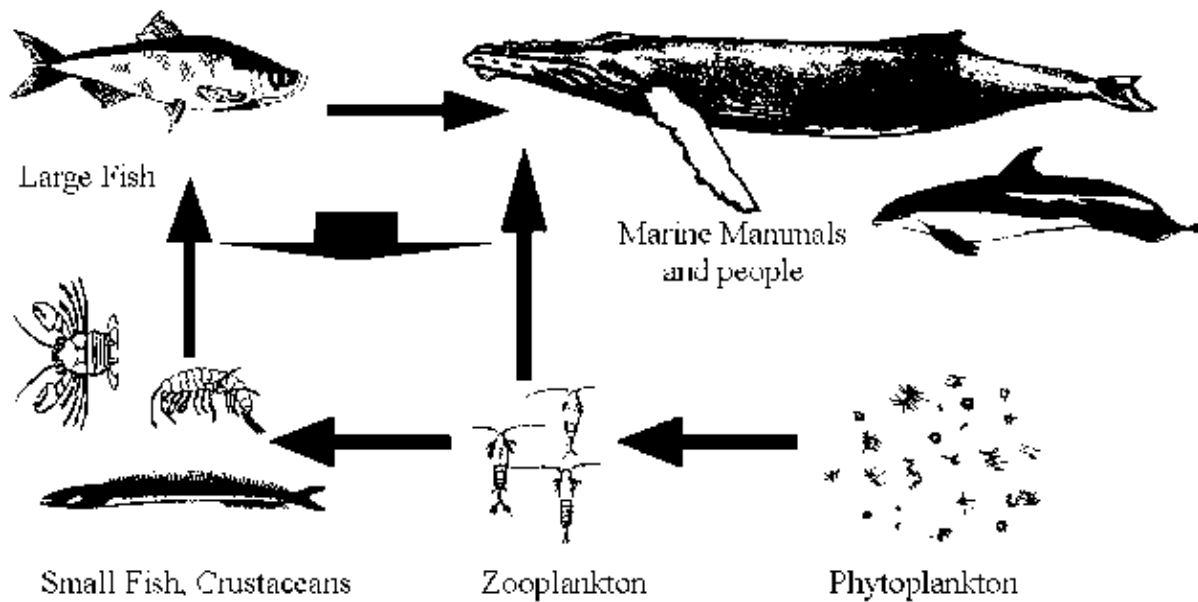
V. Tertiary Consumer

- a. Carnivore eats Carnivore= 0.01% energy

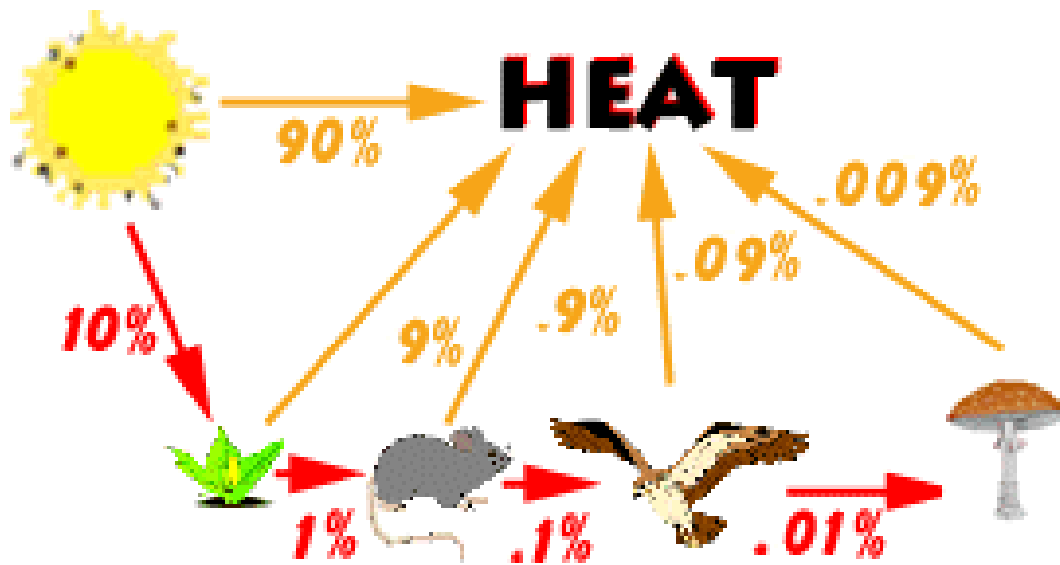
Discuss:

How can the Blue whale be the largest whale and the largest animal on earth when it eats only tiny krill and an Orca (killer whale) is a third of the size of a blue whale and eats sea lions? Why wouldn't it be the other way around with the biggest animal eating the biggest prey?

***Hint: krill is a zooplankton. Think about the energy flow in a food web.**



<http://www.yankeefleet.com/boston-goucester/information-on-whales.php>



<http://www.schools.utah.gov>

Whale Anatomy and Adaptations:

Marine mammals have some incredible adaptations to allow them to live in the ocean. If you were to spend an entire day in the water what are some things you would need to stay comfortable and survive?

- **Wetsuit to stay warm**
- **Food**
- **Air to breathe**
- **Strength to swim or ability to float**

Marine mammals have adapted to their environment in many ways not only in their physical form but also in their internal physiology. This section will raise questions about how marine mammals cope with different situations in their environment and the answers that scientists have discovered.

✓ How do marine mammals stay warm?

There are two ways to stay warm, blubber or thick fur. Seals and sea lions have a little bit of both, some fur but mostly blubber. Blubber is an extra layer of fat under their skin. Whales and dolphins (or cetaceans- se-tay-shuns) have a few sparse hairs but no fur and completely rely on blubber for warmth. The blubber also helps to give them buoyancy and smoothes out their skin making them more streamlined in the water. In addition to blubber, whales and dolphins are also assisted by the higher pressure when diving to colder depths. The pressure reduces the circulation to the extremities and keeps the warm blood circulating around their internal organs. An interesting mystery about cetacean anatomy is how the brain maintains normal function even when exposed to depth and low temperatures when the other extremities are reduced under the same conditions.

✓ How can whales dive so deep?

The champion diver is the sperm whale which can dive to nearly 10,000 feet and can hold its breath for over 2 hours! Even though other whales can't compete with this they are all capable of diving to depths of at least 300 feet. Other than coping with the lower temperatures of the depths these animals must also face extreme pressure. Pressure increases by one atmosphere (15 lbs per square inch) for every 33 feet of depth. The

equation to figure out what the pressure will be at depth is the depth times 15 and divided by 33. The adaptations that whales have for diving to these depths are mostly physiological. Cetaceans have more myoglobin which is the oxygen binding protein in their muscles which allows them to store more oxygen in their muscles that isn't being provided by the lungs. They also have a high tolerance for the build up of lactic acid and carbon dioxide which are the waste byproducts of muscles doing work without sufficient oxygen levels.

✓ Why don't whales get the bends?

In addition to the other adaptations for diving, cetaceans also have very flexible chests with stretchy lungs that are able to compress down while diving. The bends is caused by nitrogen gas that enters the blood stream from the gas exchange during breathing and gets stored in the tissues of the body. As a diver surfaces the trapped nitrogen gas in the body expands causing severe pain and even death. Divers have to surface slowly to allow the gas to exchange out of the tissues as the pressure decreases. Because cetaceans have such stretchy lungs they compress their lungs down so small that the alveoli (pouches that collect air in the lungs) close off and air exchange ceases so no nitrogen gas is exchanged into the body and they don't get the bends.

✓ What do whales eat and do they drink sea water?

There are two different kinds of whales determined by the differences in the things they eat. There are toothed whales and baleen whales. But all marine mammals are adapted to get the water they need from the food they eat. They do not have to drink fresh water, and are also adapted with specialized kidneys that help to excrete extra salt out of their body.

Teeth/Baleen-

- Toothed Whales- These are whales like orcas (killer whales), dolphins, porpoises, and sperm whales. Toothed whales tend to be smaller and hunt other animals and eat meat. They have sharp pointed teeth for grabbing fish, octopus, squid, or even other marine mammals. Toothed whales and dolphins will usually live in a group called a pod so they can hunt together similar to wolves on land. Dolphins will work together to herd fish into big groups and then take turns swimming into the ball of fish catching as many fish as they can eat each time. Orcas will hunt for

large fish like tuna or salmon but also eat seals and sea lions. They will stalk their prey like a lion and attack them quickly using their sharp teeth to grab them and kill them. You can relate dolphins and orcas to other predatory packs like lions or wolves.

- **Baleen Whales**- These whales have very special teeth called baleen. Whales that have baleen are gray whales, blue whales, humpback whales, and fin whales amongst others. Baleen is made out of the same material as our fingernails called keratin and looks like a brush or comb growing in the front of their mouth. Instead of using their teeth to grab fish or to chew, they use their baleen to sift through the water and capture tiny shrimp like animals called krill, small fish or crustaceans. Most baleen whales are filter feeders, eating krill or fish in the water but Gray whales will use their baleen to scoop huge mouthfuls of mud and sand and sift out small worms and crustaceans on the bottom of the ocean. They also have pleated grooves along their throat to help expand their mouth for such huge gulps of food. You can think of how a baleen whale eats like if you ate a huge spoon of cereal and squished all the milk out through your teeth to collect the cereal behind them.

✓ **How do cetaceans hear under water?**

Hearing is the most important sense for whales and dolphins and helps them locate food in some cases and communicate with others. Sound travels much farther and faster in water than it does on land however it does not necessarily mean it can be heard easier. Whales and dolphins have very specialized ears which are very small holes on the side of their head that help them to hear in the ocean. Some whales like blue whales make sounds that are very low and travel all the way across oceans to communicate with others. Other whales like humpback will sing songs to each other to communicate. Dolphins and toothed whales also use sound for echolocation which is a way to “see” with sound. They will emit sounds from an organ in the front of their head called a melon and listen to the echo as it bounces back off of objects including fish. It is thought that some dolphins will use their teeth as a sort of antennae to pick up the sound as it echoes back to them. Bats use this same technique to locate insects when hunting in the dark.