Lesson 5 Echolocation and the Web of Life

Overview
Students engage in activities that demonstrate two of the many adaptations whales have for hunting. They will also participate in a demonstration of the delicate balance between species that exist in ocean ecosystems.

National Science Education Standards
Content Standards K-4
Science as Inquiry: Abilities necessary to do scientific inquiry, Understanding about scientific inquiry.
Life Science: The characteristics of organisms, Life cycles of organisms, Organisms and environments.
Science and Technology: Understanding about science and technology.
Science in Personal and Social Perspectives: Characteristics and changes in populations, Types of resources, Changes in environments.
History and Nature of Science: Science as a human endeavor.

Content Standards 5-8
Science as Inquiry: Understandings about scientific inquiry
Life Science: Regulation and behavior, Populations and ecosystems, Diversity and adaptations of organisms.
Science in Personal and Social Perspectives: Populations, resources, and environments, Science and technology in society.
History and Nature of Science: Science as a human endeavor.

Ocean Literacy Principles
Principle 3: The ocean is a major influence on weather and climate.
Principle 4: The ocean makes Earth habitable.
Principle 5: The ocean supports a great diversity of life and ecosystems.
Principle 6: The ocean and humans are inextricably interconnected.

Performance Objectives
Students will:
• Learn about echolocation and how toothed whales use it to find food as well as navigate their environment.
• Discover how important the web of life is to each member of the food chain.

Background
Lesson Four explained how whales utilize echolocation to hunt and locate prey, to choose the right direction in which to find a companion and to navigate their way across the open seas. Just as a ship steaming through a fog-covered sea uses radar to see other ships and islands through the mist, whales use sound and their acute sense of hearing to see the ocean world beyond their field of vision. Based on the returning echoes whales receive from the sounds they create, they can determine an abundance of information about their surroundings and about objects both near and far. One of the basic pieces of information that can be obtained using echolocation is the position of an object relative to the echolocator. The Dolphin-Fish activity in this lesson will help illustrate this idea.
Obtaining enough food and water is necessary for all life. Whales have unique food-related adaptations such as toothed whales using echolocation to locate prey, baleen or teeth to catch prey, and blubber to use as fuel for getting through long periods of fasting.

A fascinating and unexpected strategy for catching fish is employed by humpback whales. The behavior is called cooperative bubble-net feeding and only occurs in one location - Alaska. A group of whales start by forming a circle. The whales submerge and simultaneously create a ring of bubbles while swimming in a circle. One of them shrieks a unique sound (individual whales and even larger groups also employ this technique). The fish move close together and will not cross the bubbles net. The rising bubbles literally act as a corral to contain the fish. The whales, now in a vertical position, move up through the middle of the bubble-net and surface with their mouths wide open, taking in huge gulps of fish-filled water. Almost in unison, the entire group of whales surface in a synchronized upward lunge.

All of earth's creatures, including plants, rely on the delicate balance of nature to provide a secure habitat for growth, nutrition and survival. As the planet is mostly covered by water, it is critical that we learn to preserve aquatic ecosystems.

The food web or food chain is one way of demonstrating how groups of plants and animals are interconnected. Imagine a pyramid; at the bottom you have the smallest of creatures, the primary producers in the ocean. Marine microscopic plants, known as phytoplankton, are the primary producers, the basis of the food chain, and supply hundreds of millions of tons of food to animals. Phytoplankton also supplies the majority of oxygen to the earth’s atmosphere. The pyramid ascends with animal plankton called zooplankton. These tiny creatures, with krill as an example, provide tens of millions of tons of food to the larger animals above them such as fish and squid. Other species that feed on krill and zooplankton include baleen whales and some sharks. At the top of the pyramid, the secondary consumers, eat fish and squid and are toothed whales, like dolphins, as well as birds and even humans! There is a highest level that is called the apex predator which includes orcas and large sharks.

All levels of every food pyramid require that each level remain intact to support the level above. If you remove squid, there might not be enough alternate food sources for squid-eating animals like sperm whales or dolphins. If you remove all the fish, there will be an overabundance of plankton, yet not enough food for birds, seals, whales and for us seafood-loving humans.

The Web of Life Activity at the end of this lesson will show students the importance of this concept and will give them an understanding of the fragile ecological balance of nature. Lesson Six will offer solutions and actions that people can make to help take care of the environment.

**Key Words for Whale Wall**
Bubble-net feeding, Food web, Primary producers, Consumers, Secondary consumers, Apex predator, Zooplankton
Materials

- 4 Blindfolds
- Small ball of yarn or string
- Student Journals

Procedure

During Class:
This activity demonstrates how some whales use echolocation to locate and capture their food. It can be played in a large open room or outside. If you have a large class, you may want to break into two groups.

Activity: Dolphin-Fish

1. Have your class form a circle. The circle represents the ocean boundaries and is responsible for keeping all ocean life in the circle during this activity.
2. Choose two students, blindfold them and place in the middle of the circle.
3. Place four or five other students throughout the center of the circle and give them names like rock, seaweed, boat, surface and sea floor. Tell these students to stay in their assigned places.
4. One student is the dolphin and the other is a fish. The dolphin calls in a high voice, "dolphin," and the fish must answer in its tiniest, highest voice, "fish." (This is played like Marco Polo, but out of water.)
5. The students forming the ocean boundary circle put their hands up, palms inward, to stop the dolphin and fish from going out of the circle if necessary. They should not push.
6. The students in the circle with names other than fish also call out every time the dolphin calls out but they should all call back in the same or softer tones than the whale is using.
7. The dolphin tries to tag the fish. When tagged, two more students come into the center to be blindfolded and become the dolphin and fish.

Discuss

1. How is this similar to the way toothed whales (like dolphins) find their food? Echoes come from many things in their environment, not just food. Whales must pick out different types of objects without being able to see them.
2. How is it different? Whales receive MANY echoes back at one time, plus all of the noise in the ocean, wind, waves, other animals, boats, geologic sounds, surf and much more. They can filter through all of this extraneous sound to 'see' their prey in enough detail to catch it.
3. When toothed whales navigate underwater do you think they listen only to the echoes of their own echolocation or do they make use of other sounds too? Whales process sounds in their environment continuously. They process the echoes of sounds that they themselves have produced, the sounds of other whales, or many other natural and manmade sounds in the ocean. To a whale, sound and not light is the energy that illuminates its world.

Activity: Web of Life

1. Ask students to form a circle and discuss that they are going to be creating a food web. Begin by discussing and asking students to give examples of a land based food
web.
2. Select a student to begin the ocean food web. Take a ball of string and hand the start of the ball to the first person.
3. Ask the first student to name the first level of the food web starting with producers (plants).
4. Explain to the students that the producers, at the start of the web, are in turn eaten by another animal higher up on the food chain known as a consumer and so on to secondary consumers, until the top is reached at an apex predator. (e.g., orcas, great white sharks, and sperm whales are examples of apex predators which are the animals at the top of the food web).
5. Repeat the question to each student of naming something in the food web from the ocean that might have a relationship or connection with the previous answer.
6. Unravel the ball as each student provides an example, handing an equal portion to each successive student until all students form a web, interconnected with the string.

**Discuss**
1. While the students continue to hold the web, ask them if any parts of the circle are more important than any other parts?
2. If something happens to one part of the web, how does it affect the web as a whole? What if large amounts of krill were killed due to a chemical or oil spill?
3. Go to one person in the web and give the string a gentle tug. How many students could feel it? Have each student who felt the tug gently pull on his or her segment of string. When a student feels a gentle tug, have them give a gentle tug in return. This example of a food web represents the interconnection of all creatures.
   - Is there any part of the web that doesn’t eventually feel the effects of the krill die-off?
   - Should humans be represented in the web? Why or why not? Where would humans be in a web like this?

**Extension**
Instruct students to illustrate an ocean food chain starting with marine plants (producers), moving up through herbivores (consumers), carnivores (secondary consumers), and top carnivores (predators and apex predators). Challenge them to see how long they can make their food chain. The longest food chains on earth are in the ocean. A food web enables us to see who eats whom in an ecosystem. A food chain provides this same information and should also illustrate necessary quantities. How many producers are needed to support consumers? What consumers and in what quantities are necessary to support secondary consumers?

**Teacher Wrap Up**
As we’ve learned, whales possess high level abilities to communicate with each other and assess their surroundings. Discovering these traits in whales, scientists are led to believe that these animals also possess an intelligence. When we think of reasons to study and protect whales, one of the most compelling is to understand this intelligence in the ocean.

When we stretched the Web of Life across this classroom we saw a model for the larger cycles that bring our planet to life. The most important idea to take from this activity is a sense of how fragile the balance of life is and how the decisions we make everyday can pull the cords of this web.