Food Webs

Background:

(excerpted/adapted from http://cetus.ucsd.edu/voicesinthesea_org/education.html lesson 2)

This lesson focuses on marine mammal food webs. It is important for the students to understand the definition of a marine mammal. All mammals, including marine mammals, have five key traits in common. These are:

- Breathe air
- Give birth to live young
- Nurse their young
- Warm-blooded
- Have hair (baby whales and dolphins actually have small hairs on their rostrums (nose) when born and it eventually sheds away leaving behind small follicles)

In addition to these traits, marine mammals are mammals that are adapted to life in the marine environment. Mammalian traits are a large contrast to fish. Bony fish, like rockfish, and cartilaginous fish, like sharks and rays, obtain oxygen directly from the water through their gills. Fish are cold blooded and have protective layers of scales.

The local marine mammals fall into two categories: cetaceans (whales, porpoises, and dolphins) and pinnipeds (seals, sea lions, and walrus). There are more than 70 species of cetaceans and more than 30 species of pinnipeds worldwide. In general, you might find the following species off of Cape Cod:

Cetaceans

- North Atlantic right whale
- Humpback whale
- Fin whale
- Minke whale
- Blue whale
- Sei whale

Mysticetes (see below)

- Atlantic white-sided dolphin
- Atlantic pilot whale
- Harbor porpoise

Odontocetes (see below)

Pinnipeds

- Gray seal
- Harbor seal

All the pinnipeds have teeth but the cetaceans are broken up into two suborders based on whether they have teeth or not:

1) **Odontocetes** (toothed whales) are whales, dolphins and porpoises with teeth. Odontocetes use their teeth to grasp prey and swallow fish or squid whole. Some toothed whales, like killer whales, dismember their prey by shaking it violently. Most toothed whales, with a few exceptions like the sperm whale and killer whales, are relatively small compared to baleen whales.

2) **Mysticetes** (baleen whales), like the right whale, don't have teeth at all. They have unique structures in their mouths called baleen. Baleen is made of a protein called keratin, which is the same substance that makes up our hair and fingernails. Mysticetes have hundreds of long, flat plates of baleen suspended from the top of their mouths. These plates are stacked next to each other, where teeth would have been, with a small space between each plate. The inside edge of each baleen plate is hairy or fringed, like a broom, and these baleen hairs crisscross to form a net. This makes them experts at filter feeding. All the local species of whales mentioned above are baleen whales.

   There are three methods that different types of baleen whales employ for catching their food:

   • *Skim feeding:* Right and bowhead whales swim along the surface and trap slow-moving plankton (tiny, free-floating organisms) against the hairy linings of their baleen while water flows out of the sides.

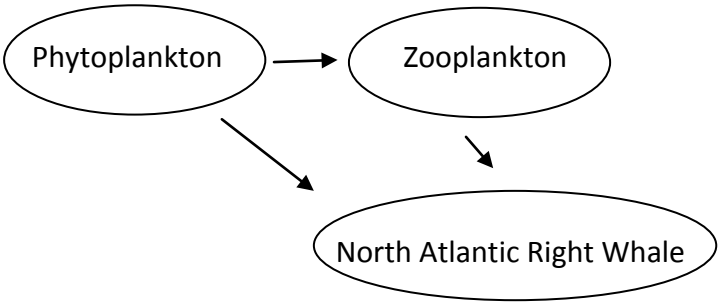
   • *Bottom or Pit Feeding:* Gray whales move along the muddy bottom on one side of their body, scooping up mud. They also will position themselves vertical in the water with their head burrowing into the mud. These techniques allow them to strain their crustacean prey out with their baleen. Gray whales are the only baleen whale that feeds using this method.

   • *Lunge Feeding:* Humpback whales (and other baleen whales with throat pleats like the blue, fin, sei, Bryde's, minke, and rorqual whales), lunge forward quickly, taking hundreds of gallons of water into their mouths along with a school of small fish. The pleats expand making room for the large volume of water. The whales close their mouths partway and force the water out through the baleen. The baleen hairs trap small fish and plankton inside.

Whether a marine mammal has teeth or not can provide information on where that animal is located in a food chain or food web. A food chain is a linear system starting with a primary producer and ending with an apex predator. A primary producer is a living thing that takes non-organic energy, such as sunlight, and converts that energy into sugars. An example of a primary producer on land is a plant. Examples of marine primary producers are microscopic phytoplankton, kelp, or seaweed. Each successive trophic level, or feeding level, uses the sugar produced by the primary producers. Animal consumes animal until the energy reaches the apex predator. An apex predator is one that sits at the

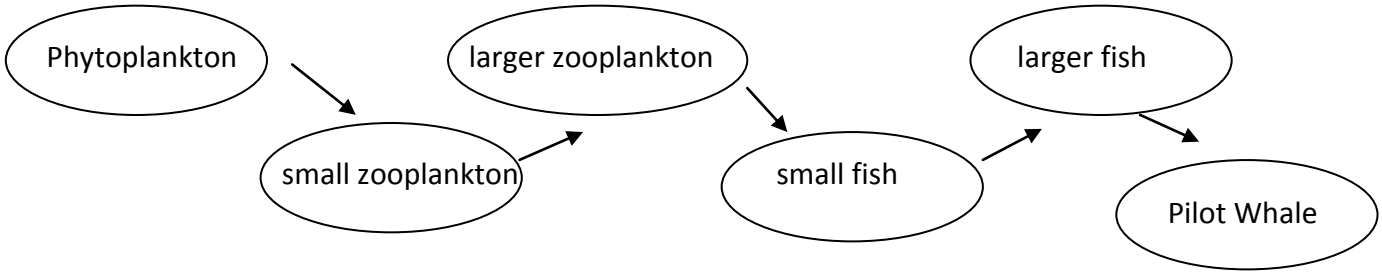
top of the food chain and has no predator. Those animals that need to eat other animals or plants for their energy are consumers. A food web is a complex web consisting of many interconnected food chains within an ecosystem.

In the ocean the food web often starts with phytoplankton. Phytoplankton are microscopic, drifting organisms that use photosynthesis to meet their energy needs. They live in the sunlit surface waters of the ocean. Phytoplankton are responsible for much of the carbon dioxide usage and oxygen production in the world. Examples of phytoplankton are diatoms, dinoflagellates, radiolarians, and forams. Phytoplankton are in turn consumed by zooplankton (microscopic, drifting animals). Examples of zooplankton are tiny crustaceans called krill (which look like tiny shrimp), copepods, and amphipods. Many of the baleen whales enter the food web here by consuming large quantities of zooplankton and phytoplankton. This can be a short food web. A sample might look like this:



The arrows flow from prey (what is being eaten) to predator (the eater). In this food web, both zooplankton and right whales are eating phytoplankton. Zooplankton are only being consumed by right whales. In general, as you get higher on the food chain, the size of the animal gets larger as well. However, baleen whales are generally larger than toothed whales. Baleen whales are very large and must consume a LOT of zooplankton to meet their daily energy needs.

Toothed whales and seals may be on a longer strand of the food web that looks more like this:



Lesson:

Introduce yourself as a representative of NOAA and PSB. Show students (**slide 1**) where we are located in Woods Hole.

Introduction (5 minutes):

Questions to ask while showing the slideshow intro (***Always ask the questions, generate answers on the board, and THEN show the slide with information****):

(a) What is a mammal? (**slide 2**) **For younger children you can use props and call students up to represent each characteristic. Have one student hold a snorkel to represent lungs (even marine mammals need to go to the surface to breath as they have lungs designed to get oxygen out of air and not water), one student holds a stuffed seal with pup (demonstrates live young), one holds an empty carton of milk (demonstrates mammary glands), one holds something with hair or fur like a jacket ruff (demonstrates all mammals have fur or hair), and the last students holds a thermometer (demonstrates warm blooded).

(b) We'll be talking about marine mammals today. (**slide 3)** Tell them that you wish you could bring in a real marine mammal but you can't so you brought some artifacts from real marine mammals. You can show them the sperm whale vertebrate, harbor seal pelt, harbor seal skull, and sperm whale rib. For perspective, have one student hold the human rib and have 5 hold the sperm whale rib (this is a great photo-op for the classroom).

(c) We'll be talking about marine mammals and food webs. What is a food web? If this is kindergarten, read the book Food Chain by M. P. Robertson before going any further.

(d) What do you eat? Use **slide 4-7** to demonstrate a simple food web. Point out that the arrows follow the energy, they go from the food being eaten to the consumer, and in general animals get larger as you move up the food web. See a food web in action. Click on the link to the interactive food web: http://www.sheppardsoftware.com/content/animals/kidscorner/games/foodchaingame.htm. Have the class help you decide which component belongs in each square.

(e) Who are your producers (they make their own food), or the base of a food chain on land? In other words, what gets eaten first? Who are your producers in the ocean? **(slide 8)**

(f) In the ocean, what do you think eats the phytoplankton? What consumers (they have to eat food) would you expect to see? **(slide 9)**

(g) In general, are larger animals like marine mammals higher or lower on the food chain?

Optional Activity 1

YARN FOOD WEB

Goals:

- To learn how a food web is interconnected on many levels.

Concepts

- Food webs are full of complex and dynamic interactions

Materials:

- Ball of yarn

1. Have the students stand in a circle with one person in the center of the circle.

2. Tell the student in the middle that they are the sun. The ball of yarn represents sunbeams or energy from the sun. They should think about who they can give their energy to or who would eat them.

3. Have the students in the circle call out if they can think of an organism that could use the sunlight. When the students call out a plant or phytoplankton walk the ball of yarn over to one student that called out a correct name (if they are older you may have them toss the ball of yarn).

4. Instruct them to remember what plant/animal they are as we will make multiple chains and they may be involved again.

5. Continue to pass the yarn around until the first food chain is completed. For example, the yarn may go from the sun to grass to a rabbit to a fox. Cut the yarn.

6. Return the yarn to the sun and make another food chain. Repeat this until everyone has been involved in at least one food chain.

Discussion:

1. Have we made food chains?

2. What do all the food chains together look like? Why do we call it a food web?

3. Who is holding the most pieces of the yarn? Why?

4. What would happen if all the green plants die?

5. Pick one of the plants and ask what would happen if that plant dies. Have them release their strings and sit down. What happened to our food web? What could cause some plants to die?

Activity 2

WHAT BIG TEETH OR BALEEN YOU HAVE…

Goals:
- To learn about the different feeding strategies between toothed and baleen whales.
- To understand the mechanics of teeth versus baleen

Concepts:
- Odontocetes are toothed whales that use their teeth for catching macro animals. They tear and grind their food.
- Mysticetes are baleen whales that sieve their microscopic food out of the water column (other than gray whales).

Materials:
- 15 lidded plastic dishes full of "food"
  - Plastic rectangular take out containers can be filled with sand (our "ocean")
  - Use 3 types of large seeds to represent plankton. We use pea, corn and pumpkin
  - Use a variety of small plastic marine animals including three species of prey and an assortment that are not.
- 15 hair picks
- 15 toothed whale grabbers (we use dolphin and orca grabbers)
- 15 data sheets
- 15 dry erase markers

1. Today we are talking about mysticetes and odontocetes. What do those words mean? Explain. Use the sperm whale teeth, fin whale and minke whale baleen as props.

2. They will each get an opportunity to be both North Atlantic right whales (NARW) and pilot whales today. As a NARW they will be skim feeding mysticetes and use their baleen (comb) to collect food. As pilot whales they will be odontocetes using their teeth (grabber toy) to collect food.

3. Place ½ the materials in one area of the room and ½ the materials in another area.

4. Split the students into groups of two assigning each partner a 1 or a 2.

5. Ask the ones to get materials from one pile and the twos to get materials from the other pile. Each group should end up with a grabber, a pick, a data sheet, an "ocean" tub, and a dry erase marker.

6. Person number one will start as an odontocete (toothed whale). They will have 30 seconds to eat as much food as they can. However, they do not just eat anything in their path. They are selective. There are pictures of what the odontocetes may eat on slide 11. They will record their data on a sheet (**use slide 10 to demonstrate)**. When everyone is ready you will start a 30 second timer. (**Keep slide 11 up so they know what they may eat)** They need to use their 30 seconds to grab as many food items as they see and put them in the lid. Caution them that if they eat something they shouldn't you will put it back in the ocean and penalize them by putting another food item back as well. This will encourage them to be selective rather than eating anything in sight.

7. When they are done they should sort their prey (food) into piles and count them.

8. They then record their results on their data sheet. They should count how many organisms they caught and what type of organisms they caught. When they have recorded their data they should hand the grabber to person 2 and ask person 2 to turn away. Person 1 will then rebury all the animals in the "ocean".

9. Repeat steps 6 and 7 with person 2 doing the eating. When they have recorded their data they should remove all the plastic animals from the "ocean". This simulates the animals in the tub that are able to move out of the way so the baleen whales are only collecting the plankton.

10. They are now mysticetes (baleen whales). Demonstrate how they will record their data on the data sheet (**slide 12**). When they are done they will sort their prey (food) into piles and count it. With third grade and older you can use this as a chance to explain estimation (**slide 13-15**). **Explain this before they get to eat their "plankton".

    a. Demonstrate them dividing their seeds (unsorted) into 4 even sized piles. Explain that in science we often use estimation to gauge numbers as there may be too many to count or we may only be able to collect a sample. They would pick one pile to count. They must

multiply their numbers by 4 because they only counted 1 pile out of the 4 total piles they collected. These numbers are their estimates. For comparison, they can then see the actual numbers to see how accurate their calculations where.

11. Person 1 will start by using the pick as baleen. They will have 30 seconds (**slide 16**) to eat as much plankton as they can. They should put their plankton in the lid of their container. When the time is up they should estimate the number of organisms they ate and what type of organisms they caught. They can then record that data on their data sheet. **While they are using their baleen you should walk around and collect the grabbers.

12. They should put all their "plankton" back in the plastic container. Person 2 now gets a chance to be a mysticete. Person 2 repeats step 11.

Discussion

1. Which was it harder to do, use your teeth or baleen?

2. Did you catch larger or smaller animals as a baleen whale? Would you expect to see baleen whales closer or farther away from the producers then toothed whales?

3. Did you catch the same **number** of organisms as a baleen whale? Which animal caught more organisms?

Activity 3

BUILD YOUR OWN FOOD WEB

Goals:
- To learn how a food web works.
- To learn how where a marine mammals in on the food web and what it eats.

Concepts:
- Food webs are made up of complex interactions between many organisms.
- Marine mammals are an important part of the marine food web and are at the top or close to the top of the food web.

Materials:
- 15 bags of magnetic organisms.
- 15 dry erase magnetic boards.
- 30 dry erase markers

1. Explain that today we will be building our own marine food webs (**slide 17**). They will be working in pairs. Walk around the room and assign partners.

2. To demonstrate the activity, use a sample bag and have the class help you assemble the animals in the food web. Only do a few to give them the idea.

3. Give each group a bag of magnetic organisms, 1 magnetic board and 2 markers. Instruct them to make a food web using their organisms. They should have arrows to show which animal is consuming another. Caution them that their food web may look different from their neighbors and that is okay.

4. When the students are done call on a few pairs to share one chain on their food webs.

5. **Grades 3-5**, Ask them to remove one of their animals from the middle of their food web or give them one to add. Ask them how this changes their food web.

Discussion

1. Where are your marine mammals on the food web?

2. Does your food web look like a web? Why?

3. Does your food web look like your neighbors? Why or why not?

4. If you added an animal or removed one from your food web how did that impact your food web?

5. In general, were your larger animals like marine mammals higher or lower on the food chain? Are your baleen whales lower or higher on the food chain than your toothed whales?

Scientist Spotlight

Fred Wenzel is a PSB scientist (**slide 18**). Fred studies marine mammal feeding behavior. He looks at the contents of marine mammal stomachs (of dead animals) to see what and how much they are eating. This information can be used in protecting marine mammal food sources and assessing whether their prey base is changing over time. This can provide important information on population health and ecosystem interactions.

Conclusion:

1. What do marine mammals eat?

2. How can each student help protect marine mammals? (**slide 19**) Click on any of the yellow words to show a quick conservation video clip.

Lesson Links to Next Generation Science Standards

*All of the lessons reinforce the scientific method by asking students to observe, predict, hypothesize, participate in an experiment or activity, sort/classify, and make conclusions.

K-2nd grade

1. K-LS1-1 - Use observations to describe patterns of what plants and animals (including humans) need to survive. In this lesson students are asked to compare plant and animal needs and where their energy requirements place them in the food web.
2. K-ESS3-1 - Use a model to represent the relationship between the needs of different plants and animals (including humans) and the places they live. In this lesson students build both a terrestrial and ocean food web and explore the different feeding strategies employed by marine mammals as their habitat affects the location of "plants".
3. 2-LS4-1 - Make observations of plants and animals to compare the diversity of life in different habitats. Students compare and contrast what they know of terrestrial plants and animals with plankton and marine mammal samples and relate that to habitat information.

3-5th grade

1. 5-LS2-1 - Develop a model to describe the movement of matter among plants, animals, decomposers, and the environment. In this lesson students make a model, marine food web.
2. 5-PS3-1 - Use models to describe that energy in animals' food (used for body repair, growth, motion, and to maintain body warmth) was once energy from the sun. Students construct a food web and investigate how the suns energy travel's through that web.