Lesson 3: Who eats Whom in the Open Ocean?

Summary
Students learn about how different organisms interact with each other in the open ocean in terms of predator-prey relationships by using their organism cards. Students then learn how these relationships build food webs. Students are introduced to how we, as humans, represent the top predator in every food web.

Objectives
1. Describe how the organisms in the open ocean interact in terms of predators and prey.
2. Explore how these relationships add up to build food webs with many levels and pieces.
3. Introduce how humans fit into the open ocean dynamic of food webs.

Materials
- Organism Cards
- Sample Organism Distributions
- Sample Food web worksheet
- Food Web questions
(Also included: Additional materials for a lesson on plankton)

Making Connections
This session is meant to introduce the students to how what you feed on or what eats you is important. This concept feeds into the next session where we examine how squids are adapted to feed on or escape certain organisms. The session also builds the concept of food webs and inter-relationships, which is the basis of ecology and a keystone of fishery management.

Background
Open ocean organisms spend a lot of time searching for food or avoiding predation. This behavior is often the most well understood piece of an open ocean organism’s biology because much of what we know about those animals comes from catching them and examining their stomachs. Stomach contents can provide important clues about what that animal ate and where it may have found that food. This information coupled with direct observations of predation and organism distribution has allowed researchers to build oceanic food webs, which attempt to link the major predators and prey together, for different areas of the world. Often the food webs in tropical areas like Hawaii are very complex because the diversity of organisms is much greater.
This is not to say all the relationships in the open ocean are built off eating each other. Some animals group together for protection, for hunting, for cleaning, or for a free ride.

Commercial fisheries typically fit into the top of food webs because we prey on the top predators first in most systems. However, as many oceanic predators are heavily fished other fisheries may begin to exploit smaller organisms in a food web. This practice is called fishing down the food web and is best illustrated by the whale fishery of the early 1900s. This fishery decimated the large species of whales that fed primarily on krill. The krill population subsequently increased in size and was then exploited by a newly formed fishery in Japan. This example also demonstrates how fisheries may alter food webs by not only reducing the population of a target species but also decreasing predation for other species.

**Preparation**

1st Period

1. Print a few actual distributions from the provided examples.

2nd Period

1. Print food web worksheets for students (one per student).
2. Draw an outline of the food web on the board but do not fill in the organisms yet.

**Procedure**

1st Period

Review HW from lesson #2 (10 min)

**What is the actual distribution of your organism?**

Print out 4 or 5 actual distributions from the provided examples. These maps are from www.iovis.org or from the FAO website (see link below) for other maps. Once you have several of the actual distributions, show them to the students and compare to the students’ maps. Why do the distributions look different?

**REMEMBER:** These distributions are created using data collected from satellites. These satellites only “see” what is happening on the surface! We learned in the first lesson that the ocean is changing all the time through currents and seasons. This satellite data may not be accurate for all times of the year. Also there are other important factors in determining organism distribution. Just because an organism is capable of surviving the physical environment does not mean it will necessarily be in that environment. Factors such as where that organism originate, amount of prey or predators, reproduction, or migration patterns may all play important roles in determining distributions.

2nd Period

This week we are going to learn about how open ocean organisms interact with each other in the open ocean. This lesson deals with predators and prey. We are going to build food webs. FOOD WEBS SHOW HOW MANY ANIMALS ARE INTERCONNECTED BY DIFFERENT PATHS this is different from a food chain. FOOD CHAINS FOLLOW A SINGLE PATH AS ANIMALS EAT EACH OTHER. The basis of most ocean food webs is phytoplankton. Phytoplankton are just like plants on land in that they harness the energy of the sun and use
nutrients to grow in a process called photosynthesis. Because of this phytoplankton are limited to the photic zone, where light penetrates. These phytoplankton are preyed on by zooplankton that follow them around in the water. Both phyto and zoo-plankton can be large colonies or individual organisms or they can be microscopic. Take a look in a glass of seawater sometime and look at all the organisms in there (Optional activity). These two groups support almost all the other animals in the ocean.

Put organism cards in plain view and write down list of each organism to be put into the food web. Make sure to have two phytoplankton cards and a picture of a person for the top of the food web. Have handout with empty food web, no names or lines. (A sample food web is provided. You should draw out the blanks of your food web on the blackboard before so you have an idea where to generally put each organism).

<table>
<thead>
<tr>
<th>Marlin</th>
<th>Loggerhead Turtle</th>
<th>Squid</th>
<th>Amphipod</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mako Shark</td>
<td>Man-O-War Slug</td>
<td>Flying Fish</td>
<td>Phytoplankton</td>
</tr>
<tr>
<td>Albatross</td>
<td>Man-O-War Jelly</td>
<td>Anchovy</td>
<td>Phytoplankton</td>
</tr>
<tr>
<td>Opah</td>
<td>Sunfish</td>
<td>Copepod</td>
<td>People</td>
</tr>
<tr>
<td>Mahi Mahi</td>
<td>Whaleshark</td>
<td>Krill</td>
<td></td>
</tr>
</tbody>
</table>

Give the students 15 – 20 minutes to fill out their food webs on the first side of the handout. They should fill in the names of all the organisms, including phytoplankton and people, in each of the blanks. Then have the students draw a one way arrow to indicate who eats who. A good way to start is to begin with the top of the food web and fill out the major predators, then fill out the bottom of the food web, and then try to fill in the middle. Pass around the organism cards using the predators and prey information on each on to help complete your food web.

Once the students have finished their food webs you should fill out the master copy on the blackboard. You may write the name of the organism or you may want to tape the organism card onto the board if there is enough space. The students may follow along by filling out the second side of their handout. The point here is to demonstrate the complexity of the food web not to have every student’s food web look the same. Start with the plankton and ask who eats it. Draw lines to indicate who eats who. Try to keep the connections to two predators and two prey for each animal. At the end make sure to put PEOPLE on the top.

Remove the phytoplankton from the web. Ask the students what the zooplankton will eat. (Nothing). Then remove zooplankton and on and on to demonstrate that the food web is based on phytos. It is important to discuss how the food web is affected if we remove the base of the food web (phytoplankton) or we remove a top predator (such as is happening with the millions of sharks being killed for shark products. See link www.bite-back.com). Work on the questions at the end of the worksheet.

Assessment
HW: Answer the food web questions.

Key Concepts (what the students should know!)
1. The four major physical ranges (you mapped them already) that make up habitats and determine organism’s distribution in the open ocean.
2. Some other reasons why organisms live in certain habitats (food, reproduction, etc.)
3. Who is always at the top of the ocean food web and who is always at the bottom.
4. What the difference is between a food web and food chain.

**OPTIONAL ACTIVITY:** Plankton Tow Lesson. Students may conduct their own plankton tows to catch zooplankton and phytoplankton. Students then examine these interesting animals and plants to gain a firsthand look at how these animals live in the open ocean. See additional materials for instructions on plankton tow lesson.

**Links**
This is the FAO website link to look at more fish distributions. Input the common or scientific name from the organism card into the search engine for both websites. The FAO website works well for food-fish such as marlin, mahimahi, mako shark, and opah. Use iobis for other species. 

**Notes**
Lesson 3: Who eats Whom?

NAME ___________________________

OPEN OCEAN FOOD CHAIN AND FOOD WEB

1. All the lines on the food web eventually lead back to where? (Hint: Who is on the bottom?)

2. Who has the most energy, the organisms at the bottom of the food chain or the top?

3. What did you notice is different between the food chain and the food web?

4. What would happen if somehow all the phytoplankton in the ocean suddenly died?

5. How do phytoplankton support all of the animals in the whole ocean when they are so small?

6. Define the following words:
   Predator – ________________________________________________________________
   Prey – _________________________________________________________________
   Photic Zone – __________________________________________________________
   Organism – ____________________________________________________________
   Abiotic – ______________________________________________________________
   Biotic - ________________________________________________________________

Lesson 3: Who eats Whom?
FOOD WEB WORKSHEET

1. Predict where you think the organism goes. (Hint: top of the web = predators)
2. Draw arrows from Predator → to Prey

Name __________________________

Diagram of a food web with boxes representing organisms and arrows indicating predator-prey relationships.
Draw where organisms actually are
FOOD WEB OF THE PACIFIC OCEAN

PEOPLE

MAKO SHARK

MARLIN

ALBATROSS

OPAH

MAHIMAHI

SQUID

ANCHOVY

COPEPOD

PHYTOPLANKTON

LOGGERHEAD TURTLE

MAN-O-WAR SLUG

SUNFISH

FLYING FISH

WHALESHARK

MAN-O-WAR JELLY

AMPHIPOD

PHYTOPLANKTON
Questions:

1. Does your predicted foodweb compare to the foodweb drawn on the board? Be specific (for instance were any animals way out of place?).

2. Were the results surprising?

3. Where do all the lines on the food web eventually lead back too? (who is on the bottom)?

4. What would happen if somehow all the phytoplankton in the ocean suddenly died?

5. How do phytoplankton support all of the animals in the whole ocean when they are so small?
Plankton - Who are You??

These plankton to the left are mostly phytoplankton, which means they use the sun to make energy just like plants. Number 1 and 2 plankton are Radiolarians because they have “radiating” spines. Number 3 is a Foraminiferan. These plankton have shells with chambers in them. Numbers 4, 5, & 6 are Ciliates, not because they are silly, but because they have little hairs all over them called cilia. These hairs help them move around.

These plankton are a mix of phytoplankton, “plant plankton” and zooplankton, which are animal plankton and mostly eat other plankton in the ocean. Numbers 1,2,3, & 4 are all Dinoflagellates. These plankton have one or two long hairs, called “flagella”, which help them move around quickly. Sometimes dinoflagellates can reproduce so fast that they may turn the water red and create a “red tide”. Numbers 5-9 are all Diatoms. Diatoms are one of the most important kinds of plankton. They usually have clear shells with spines on them. They have a droplet of oil inside them that they use for food and also to help them float around. Diatoms may form long chains that may be several feet long (see 7 & 8).

These plankton are all zooplankton. Numbers 1,2, & 3 are small Snail plankton. They sometimes use mucas nets to catch their prey. Numbers 4 & 5 are Shrimp and Crab plankton. There plankton may be small their whole lives or grow into bigger crabs and shrimp. Many kinds of fish love to eat these plankton. Number 6 is a Copepod. These plankton have two antenna and one single eye in the middle of their head. Number 7 plankton is a Chaetognath. These plankton are like small worms. They may attach themselves to larger fish and suck their blood!

Drawings courtesy of www.answers.com
Plankton Tow Lesson

Materials:
Plankton Id sheet (one per student)
Plankton worksheet (one per student)
Plankton net with tow rope
3 to 4 jars filled with seawater
3 to 4 petridishes. Jar lids also work well.
3 to 4 Digital microscopes and accompanying computers or dissecting microscopes or a
good hand lens may also be used.

1. Plankton nets should be towed at the surface for appx. 10 minutes between
recapturing. Tow rates should not exceed 2-3 knots.
2. Retrieve net and rinse or dunk with seawater to flush the plankton to the bottom
of the net. Rinse plankton into jars with seawater. Store jars out of the sun put 2
tbs of alchohol per quart of seawater into each jar. This will help preserve the
plankton.
3. Repeat steps 1 & 2 until all your jars are teeming with plankton. Then return to
classroom. These steps may be done 1 to 2 days ahead of time.
4. Classroom should be arranged in 3 to 4 stations depending on how many
microscopes are available. Group students into corresponding stations.
5. Pour some of your plankton into each petridish and arrange on microscope.
Students may also accomplish this.
6. Instruct students to fill out their worksheets by identifying plankton, drawing each
identified plankton, and labeling their adaptations (eg. how they move, how they
eat or prevent being eaten, etc.). Students may have to take turns on the
microscopes or reach a consensus on which plankton they want to draw.

You may also choose to focus in on particular groups of plankton and rotate the students
from station to station.

Visit this link to make your own plankton net
http://www.biosci.ohiou.edu/faculty/currie/ocean/makeanet.htm
There are also many other links with different designs and materials on the web. You
may capture plankton at the beach, from the shore, in a tidepool, from a kayak, or from a
boat.
Your Name____________________ Your Teachers Name__________________

What Kind of Plankton Do You Have??

Try to name and draw four different kinds of plankton from your plankton tow. Describe any adaptations your plankton has and why you think it may be useful to survive in the open ocean!! Use the back of this sheet as well.

Plankton Name
Draw your plankton below↓↓↓

Plankton Name
Lesson 3: Who eats Whom?
Albatross (Ka’upu)
Diomedea immutabilis

This map uses a tool based on the reported occurrences of an animal and the values of temperature, salinity, depth, and nutrients that that animal prefers. The purple dots are reported occurrences and the orange areas show the potential distribution. This map does not show the actual distribution of the animal, only the potential range!
Ocean Anchovy
*Encrasicholina punctifer*

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Loggerhead Turtle
*Caretta Caretta*

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Dolphinfish (Mahimahi)
*Coryphaena hippurus*

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Shortfin Mako Shark

*Isurus oxyrhincus*

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Moonfish (Opah)

*Lampris guttatus*

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