7 Energy Flow Through an Ecosystem

Now that you are familiar with producers and consumers, you are going to learn about how these organisms interact within an ecosystem. Picture a seal swimming in the Pacific Ocean just off the coast of California. Chances are this seal is among a forest of seaweed including a species called giant kelp. Giant kelp *(Macrocystis pyrifera)* is a type of algae that grows up to two-thirds of a meter a day, and over 45 m (about 148 feet) in height. At its base is a woven knot of rootlike branches called a holdfast that attaches to rocks on the ocean floor. The kelp grows in clusters with each plant shooting upward to the surface, then spreading out and sheltering thousands of organisms in a complex ecosystem.

The kelp forest ecosystem is often compared to an underwater tropical rainforest, in part because of its high levels of biodiversity. The kelp are tall, with long leaf-like structures that create a canopy that blocks the light at lower ocean depths, providing habitat and nourishment for organisms that thrive in limited light conditions. Many species of aquatic organisms, such as sea urchins and anchovies, live and reproduce on and among the long strands.

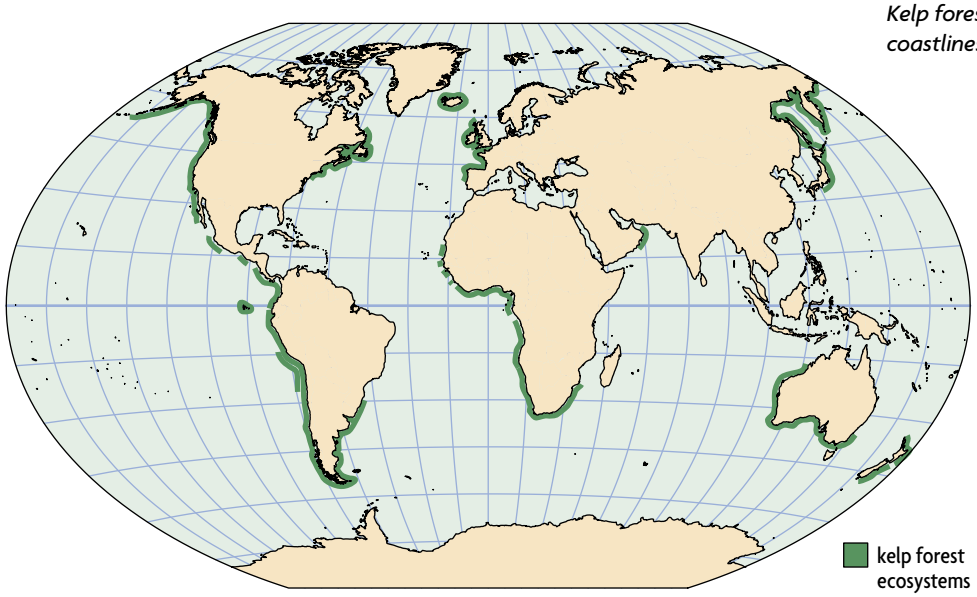
When organisms in the kelp ecosystem die, other organisms, including specialized bacteria, consume their remains, keeping the nutrients flowing through the ecosystem. These essential organisms are called **decomposers.**

This harbor seal (Phoca vitulina) *is swimming in a forest of giant kelp.*

One way to show these interrelationships between the organisms in an ecosystem is by creating a **food web,** mapping what each organism eats and how the energy flows through an ecosystem. In the last activity the food web included plankton, herring, and whales. In this activity you will construct a food web for a kelp forest ecosystem and from it predict what will happen to the ecosystem in various circumstances.

Challenge

- How can we use food webs to predict the short- and long-term effects of particular events on an ecosystem?



Kelp forests are found off coastlines around the world.

MATERIALS

FOR EACH GROUP OF STUDENTS

- sheet of chart paper
- set of colored pencils

FOR EACH PAIR OF STUDENTS

- set of 12 Kelp Forest Organism cards
- set of 4 Ecosystem Event cards

Procedure

Part A: Construct a Food Web

1. With your group, read each Kelp Forest Organism card, noting the similarities and the differences in what substances are going into and coming out of each organism.
2. Sort the organism cards into at least two sets of cards based on similarities in the information about the organisms.
3. As a group, develop a system for further sorting the organisms within each set of cards. When your group comes to agreement, record in your science notebook the organisms in each set of cards and the feature(s) they have in common.
4. Construct an ecosystem food web to show the direction of energy transfer from one organism to another. Begin by laying the giant kelp card on the table in front of your group.

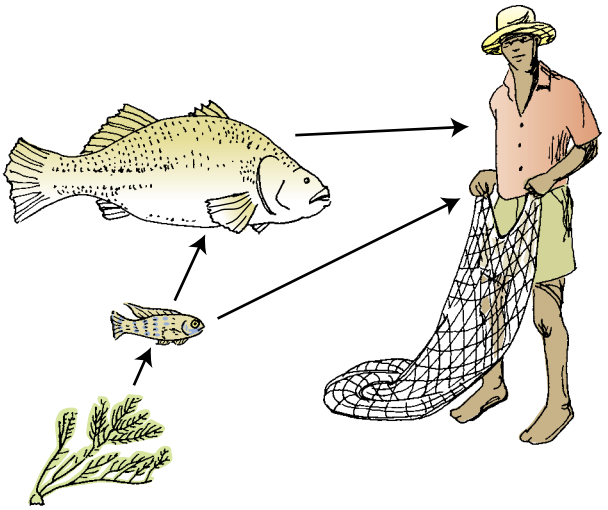
5. Look through the cards and identify all of the organisms that feed on giant kelp. Place these above the giant kelp card.

6. Continue placing cards on the table based on the organisms they feed on, forming a food web. When you have placed all of the cards, show your teacher your work.

7. With your group, record the food web on a piece of chart paper.

8. Draw arrows from one organism to the next to show how energy passes from one organism to another.

   Hint: Remember that arrows in a food web point in the direction of energy flow—*toward* the organism that is doing the "eating," as shown in the food web below.



9. One way scientists classify organisms in an ecosystem is by describing how the organisms obtain energy. This is known as the organism's trophic role in the food web. Read about these trophic roles in the table below.

Trophic Roles of Organisms in an Ecosystem

TYPE OF ORGANISM	HOW ORGANISM GETS ENERGY TO SUSTAIN LIFE
Producer	Transforms light energy or other energy sources into chemical energy The chemical energy is stored in carbon-containing molecules, such as simple sugars or starch.
Consumer	Feeds on other organisms to obtain energy
Decomposer	Feeds on other organisms and dead and decaying biological material and wastes to obtain energy

10. Select a colored pencil to represent each of the trophic roles shown in the table above. Make a key on the side of your chart paper to indicate which color indicates which role.

11. With your group, color-code each of the organisms in the food web to indicate its role in the ecosystem.

Part B: Use a Food Web to Predict the Impact of Actions and Events on an Ecosystem

12. Obtain a set of Ecosystem Event Cards from your teacher. With a partner, select and read one of the cards.

13. Using the information provided by your kelp forest food web, discuss how the event described on the card affects the ecosystem.

    Hint: Choose one organism or factor in the web that is affected, and think of the chain of events that will then occur throughout the ecosystem. Scientists call this type of chain of events a trophic cascade.

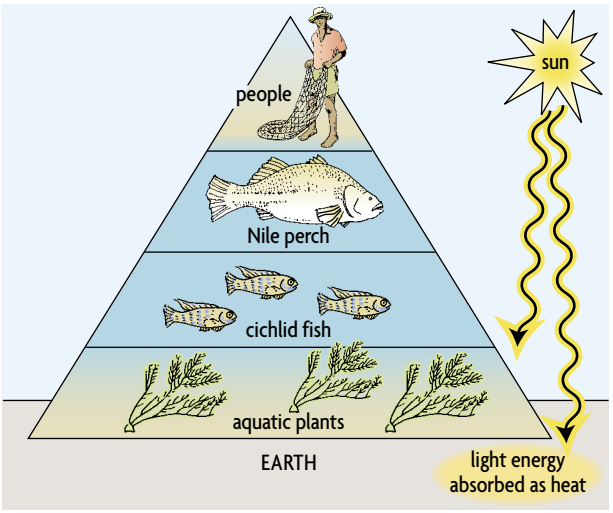
14. Record the following for each event card in your science notebook:
    a. summary of the event
    b. what effect the event will have on the ecosystem in the
       i. short term
       ii. long term
    c. what effect the event will have on the flow of energy through the kelp forest ecosystem

Part C: Construct an Energy Pyramid

An energy pyramid is a diagram of the amount of the sun's energy that is stored in each level of organisms in a food web. The organisms use part of this energy, part of it is lost as heat, and part of it is stored and therefore available to other organisms.

15. With your group use the information from the kelp forest food web to place the name of each organism on the energy pyramid on Student Sheet 7.1, "Kelp Forest Energy Pyramid."

16. With the class discuss what the energy pyramid shows.



This energy pyramid shows how much energy is stored at each level of the food web.

Analysis

1. Name one organism from the kelp forest ecosystem that is:

   a producer
   a consumer
   a decomposer

2. What is the difference between the role of an organism that is a producer and one that is a consumer? How is a decomposer different from other consumers?

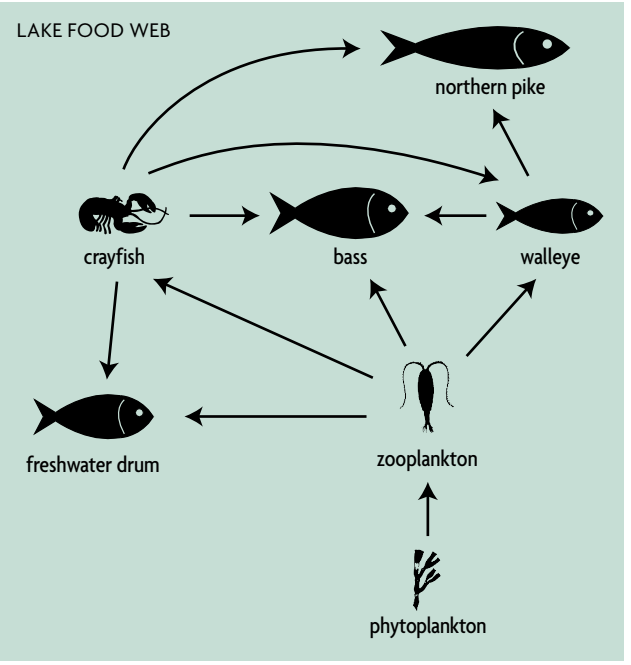
3. Explain the role of the sun in the kelp forest ecosystem.

4. Describe the flow of energy in the kelp forest ecosystem.

5. From the lake food web at right:

   a. predict what would happen if all of the walleye were fished out of the lake

   b. choose an organism other than the walleye, and predict what would happen if it disappeared from the lake



6. Explain why a pyramid is helpful for describing the amount of energy available in a food web.

7. Imagine you are an ecologist who studies kelp forest ecosystems. You have been asked by the federal government to evaluate two plans for managing the California sheephead fishery, which relies on kelp forests. A summary of two proposals follows. Read the proposals and determine:

   a. how the two proposals differ

   b. which proposal you think the government should implement

   In your recommendation include a discussion of the trade-offs you considered.

Proposals for Managing the California Sheephead Fishery

PROPOSAL A

Take population counts of California sheepheads once every three months.

If the fish population is below sustainable levels, decrease the size of the allowed sheephead catch. If the sheephead population is at or above sustainable levels, keep the catch limit at current levels.

Cost to implement this proposal: $750,000

PROPOSAL B

Take population counts of California sheepheads and sea urchins once every three months. Measure the density of the giant kelp population once every three months.

If the size of any population is below sustainable levels, decrease the size of the sheephead catch allowed. If the size of each population is at or above sustainable levels, keep the sheephead catch limit at current levels.

Cost to implement this proposal: $1,250,000

KEY VOCABULARY

biodiversity	energy pyramid
consumers	**food web**
decomposers	producers