Estuary Food Pyramid

Estuary Concept

Estuaries support an abundance of life, and a diversity of habitat types.

Learning Objectives

- Describe three basic trophic levels of an ecosystem: producers, consumers, and decomposer.
- Explain that food energy is lost as it flows through an ecosystem, using a food pyramid to model how there are fewer organisms at each trophic level, supported by larger numbers at the level just below.
- Recognize the potential for far-reaching impacts within marine food webs.

Activity Information

Grade Level

6-8, 9-12

Time Required

2 (45 minute class periods)

Topic

Ecosystem Interactions and Dependencies
Climate Extension

Overview

Students will apply knowledge of estuary organisms to explore food webs and energy flow in an estuary ecosystem using a food pyramid. Students will then read and discuss a scientific article about marine plankton food webs and climate change.

Teacher Background

There are three major categories of living organisms in an ecosystem and each has a special role. Together, producers (plants), consumers (animals), decomposers, and detritus feeders are the building blocks of the food pyramid.

The food energy produced by producers via photosynthesis is cycled through the ecosystem through food chains and complex food webs by way of a series of energy levels or feeding levels called trophic levels. Producers make up the first trophic level or

base of the food pyramid. Primary consumers rely on the producers for food energy and make up the second level. The secondary consumers make up the third trophic level and so on. Each level depends on the levels below it for food energy.

Climate Extension

In most coastal systems, primary production is a function of phytoplankton. Even in salt marsh estuaries, where grass and sedge biomass can greatly exceed algae, phytoplankton are a substantial contributor to overall primary production and the base of the food chain. Phytoplankton are highly sensitive to environmental variables and respond quickly to changes in the estuary. As climate shifts, it will likely change the species and abundance of phytoplankton present. Although scientists anticipate dramatic impacts due to climate, little is known about exactly how and what changes will occur.

For more, explore our interactive climate extension.

Teacher Preparation

1. Read the Teacher Background above to review food webs, trophic levels, and energy transfer within food pyramids.
2. Familiarize yourself with the interactive Estuary Food Pyramid. You will use this as an in-class demonstration for your students. Your students will then use the simulation themselves after they have completed the Student Master: *Estuary Food Pyramid*.
3. You may also want to have the food pyramid diagram available to project on a screen. Make a copy or transparency using the diagram found in the Student Master: *Estuary Food Pyramid.*
4. Make copies of Student Master: *Estuary Food Pyramid and Climate Extension: Estuary Food Webs and Climate Change.*

Materials Needed

- Teacher Master: Estuary Food Pyramid
- Teacher Master: Estuary Food Webs and Climate Change

Per student pair / team:

- Computer or tablet with internet access
- Student Master: Estuary Food Pyramid
- Climate Extension: Estuary Food Webs and Climate Change

Procedure or Activity Steps

1. Begin the lesson by reviewing the definitions of food web, food pyramid, and trophic levels with your students. Use the Teacher Master: Food Pyramid and material found in the Teacher Background to explain how the food pyramid shows the flow and concentration of food energy from one organism to the others at higher trophic levels.

2. Show your students the interactive Estuary Food Pyramid. Talk about how an estuary has many diverse habitats that support an equally diverse range of organisms. Demonstrate for students that hovering the curser on an image and then click and hold down to see a pop-up description of each organism. Read one together. You may want to use different animals than those selected for this activity (phytoplankton, oyster, horseshoe crab, shark, and osprey). You may show students that the organism images can be dragged to the pyramid, but do not complete a food pyramid at this time. Students will do that for themselves later.

3. Divide your students into pairs or small teams. Distribute copies of Student Master: *Estuary Food Pyramid.* Have students quickly scan the list of organisms found on the second page, to explore (phytoplankton, oyster, horseshoe crab, shark, or osprey). Tell students that their assignment for this exercise is to explore how and where these organisms get the energy they need to survive in the estuary.

4. Assign each student team one of the five organisms. Ask students to read the paragraph about their assigned organism and predict which trophic level their organism belongs on the food energy pyramid.

5. Next have students read the descriptions of the other four organisms and predict which organism belongs on the trophic level just above and just below their assigned organism.

6. Stop student work at this point and ask students to consider why their assigned organism belongs at a trophic level. Is it related to what they eat? Teams with the same assigned organism can compare their work at this time.

7. Allow student teams to use the Estuary Food Pyramid simulation to build a food pyramid based on the work they've done on the Student Master. Students should drag their assigned organism to the proper place on the pyramid, then drag the one or two other organisms they drew on their pyramid to the trophic levels above and below. Students should use any of the other available organisms in the simulation to fill in the remaining trophic levels. Students can click the "Check" button to check the work as they add organisms on the pyramid. The simulation will indicate how many organisms that have been placed at the correct trophic levels.

8. Students should answer the questions on the Student Master.

Climate Extension

1. Review and discuss responses from Student Master: Estuary Food Pyramid to ensure students grasp trophic levels and the flow of energy before introducing food webs.

2. Have students add organisms (clam worm, raccoon, mussel, Bald Eagle, striped bass, blue crab, shrimp, and diamondback terrapin,) to their Estuary Food Pyramid handout at the correct trophic levels. Ask students to draw a food web, reviewing with students that their arrows should show energy flow, pointing from the organism that is being eaten to the organism that is doing the eating.

3. Using their completed food web, have the students complete questions 2A and 2B on the Student Master: Estuary Food Webs and Climate Change. Ask the students to explain what kind of role they think phytoplankton plays in the estuary food web.

4. Provide students or groups of students with a copy of the white paper "Marine Plankton Food Webs and Climate Change" written by scientists at the Virginia Institute of Marine Science. This can be downloaded from estuary education website. Either in groups or individually have the students read and answer the questions 3A - 3C on the Student Master: Estuary Food Webs and Climate Change. Depending on time and class you can assign students different sections of the article and have a group discussion.

TEACHER MASTER

Estuary Food Pyramid

1. Is your assigned organism a producer or a consumer? Explain.

   POSSIBLE ANSWER: Student answers will vary depending on their assigned organism. The only producer is the phytoplankton. A producer creates food using energy from the sun. The other organisms are all consumers; they get their energy by consuming either a producer or other consumers.

2. Where does your organism get its energy?

   POSSIBLE ANSWER: Student answers will vary depending on their assigned organism. The producer gets its energy from the sun. The consumers get their energy by consuming either a producer or other consumers.

3. Do you think there are many or few organisms located in your assigned organism's trophic level? Why or why not?

   POSSIBLE ANSWER: Student answers will vary depending on their assigned organism. The higher on the pyramid their organism is found, the less biomass or food energy is available on the food pyramid. The student should realize that, in terms of numbers, the populations of organisms decrease going up the pyramid. It takes more of the prey to support fewer of the predators as energy flows through the system.

4. Write a paragraph describing the roles different organisms play in the estuary food pyramid.

   POSSIBLE ANSWER: Student paragraphs should include discussions of the ultimate source of energy in an ecosystem (the sun), the role of producers, and the flow of energy from producers to primary consumers, secondary consumers, and so on.

Estuary Food Webs and Climate Change

2A. How many organisms in your estuary food web rely directly on primary producers like phytoplankton as a food source?

ANSWER: There are two organisms – Eastern oyster and mussel.

2B. How many organisms in your estuary food web rely indirectly on phytoplankton?

ANSWER: There are ten organisms that rely indirectly on phytoplankton because they are a higher level consumer or an apex predator and phytoplankton is the driver of the food web –horseshoe crab, American oystercatcher, shrimp, clam worm, blue crab, diamondback terrapin, raccoon, striped bass, bull shark, and Bald Eagle.

3A. List three environmental variables, associated with climate change that are expected to have impacts on plankton?

POSSIBLE ANSWER: Students could have a variety of answers including: nutrients, temperature, salinity, precipitation, or CO_2 concentrations.

3B. How could climate change cause an increase in some jellyfish populations and what impact would the increase have on other organisms in a coastal food web?

ANSWER: Increase in temperature related to climate change could cause an increase in the jellyfish populations. For example sea nettle can become extremely abundant and grow rapidly when water temperatures exceed 25º C. Jellyfish species, like sea nettles and comb jellies, are significant consumers of copepods, an important species of zooplankton. Many fish and whale species also rely on copepods and could starve or be stressed if jellyfish consume a significant amount of the copepods.

3C. Why is it important for scientists to continue to study the impacts of climate change on estuarine and coastal plankton?

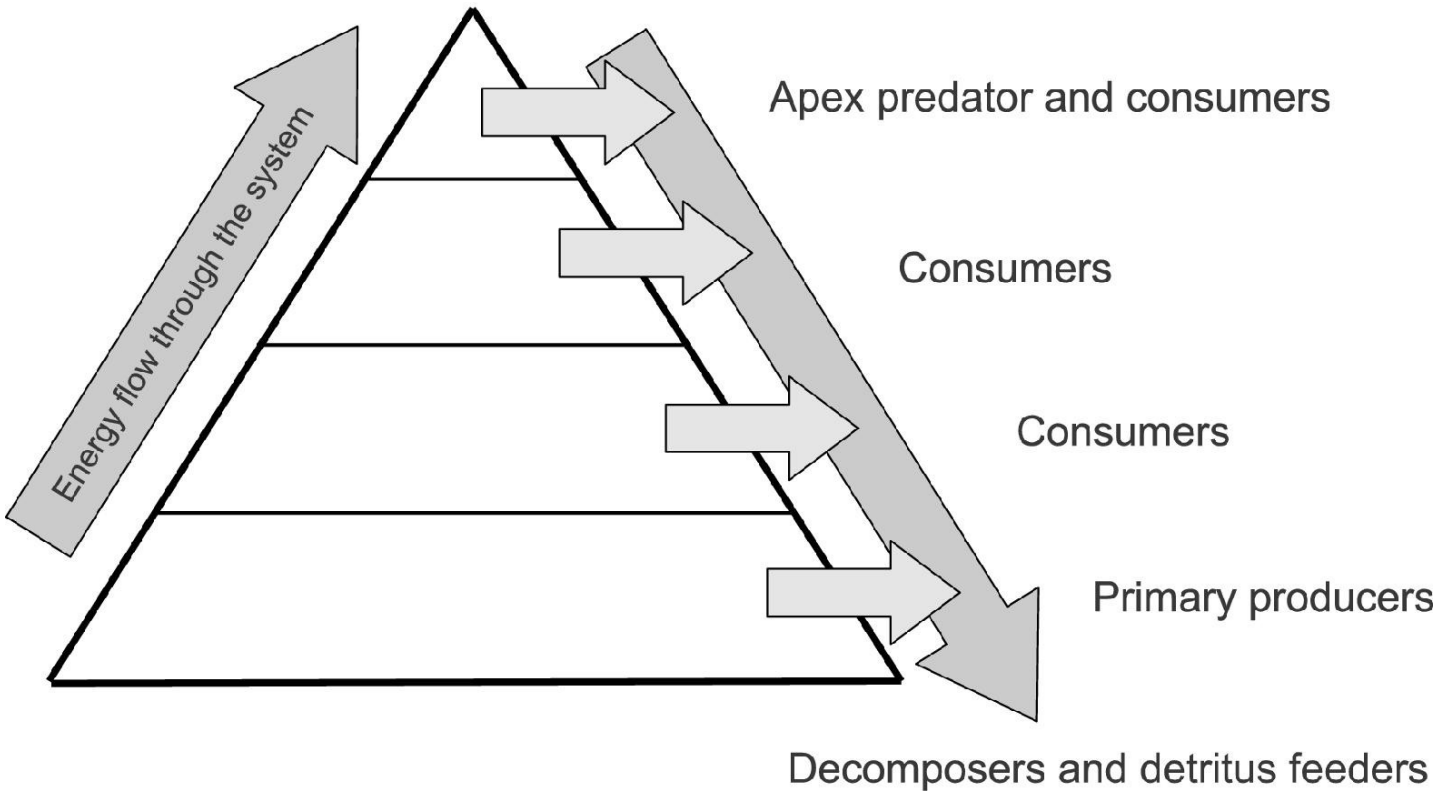
ANSWER: While scientists acknowledge that climate change will have impacts on plankton communities and estuary food webs, much more research is needed to understand the specific mechanisms of how these changes will occur. Scientists need more information to understand how climate change impact on plankton's abundance, growth rates and diversity of species

will specifically play out in the estuaries. More research is needed on this topic to understand how impacts to food webs will affect coastal economies like the fishing and tourism industry that many human life styles are dependent on. The Virginia Institute of Marine Science included four major research questions that their researchers think should be addressed to help Virginia be able to understand, mitigate, and adapt to some of the impacts of climate change.

Estuary Food Pyramid

When animals eat plants or other animals in order to survive, there is a flow of food energy through the ecosystem. What starts out as energy from the sun becomes food energy created by the green plants that use photosynthesis to grow and reproduce. These plants are the producers and the base of food chains and complex food webs.

As one thing eats another, the layers of the food pyramid narrow. These layers, called trophic levels, represent available energy. Animals at each trophic level depend on animals living in the levels below them for food energy. The largest amount of available food energy is found on the first trophic level, the base of the pyramid. Less than 10% of the amount of food energy from one level is available to the animals in the next trophic level above. This means each higher level has energy to support fewer and fewer organisms.



Procedure

1. Your teacher will assign you one of the organisms below. Read the description of your assigned organism.

Oyster

Oysters and other bivalves are filter feeders. As they filter water over their gills, the oysters take in and eat algae, a kind of phytoplankton. The oyster spat or larvae are eaten by a wide variety of fish and invertebrates. Larger, mature oysters may be eaten by crabs, fish, starfish, worms, or birds.

Bull shark

Immature sharks may be prey to larger fish. However, adult sharks almost always find themselves at the top of the food web and the food pyramid. In an estuary, the shark is the apex (top) predator. Some sharks, such as leopard sharks, may feed on worms, clams, and crabs. Other sharks, such as the bull shark, may hunt for other sharks, turtles, and birds, among other prey.

Phytoplankton

Plankton are floating or drifting plants and animals and are found in bodies of water ranging from fresh to salty. Phytoplankton, the plant plankton that use the sun's energy to make food, are the base of the estuary food web and food pyramid. Plankton are critical in maintaining the health and productivity of the estuary ecosystem.

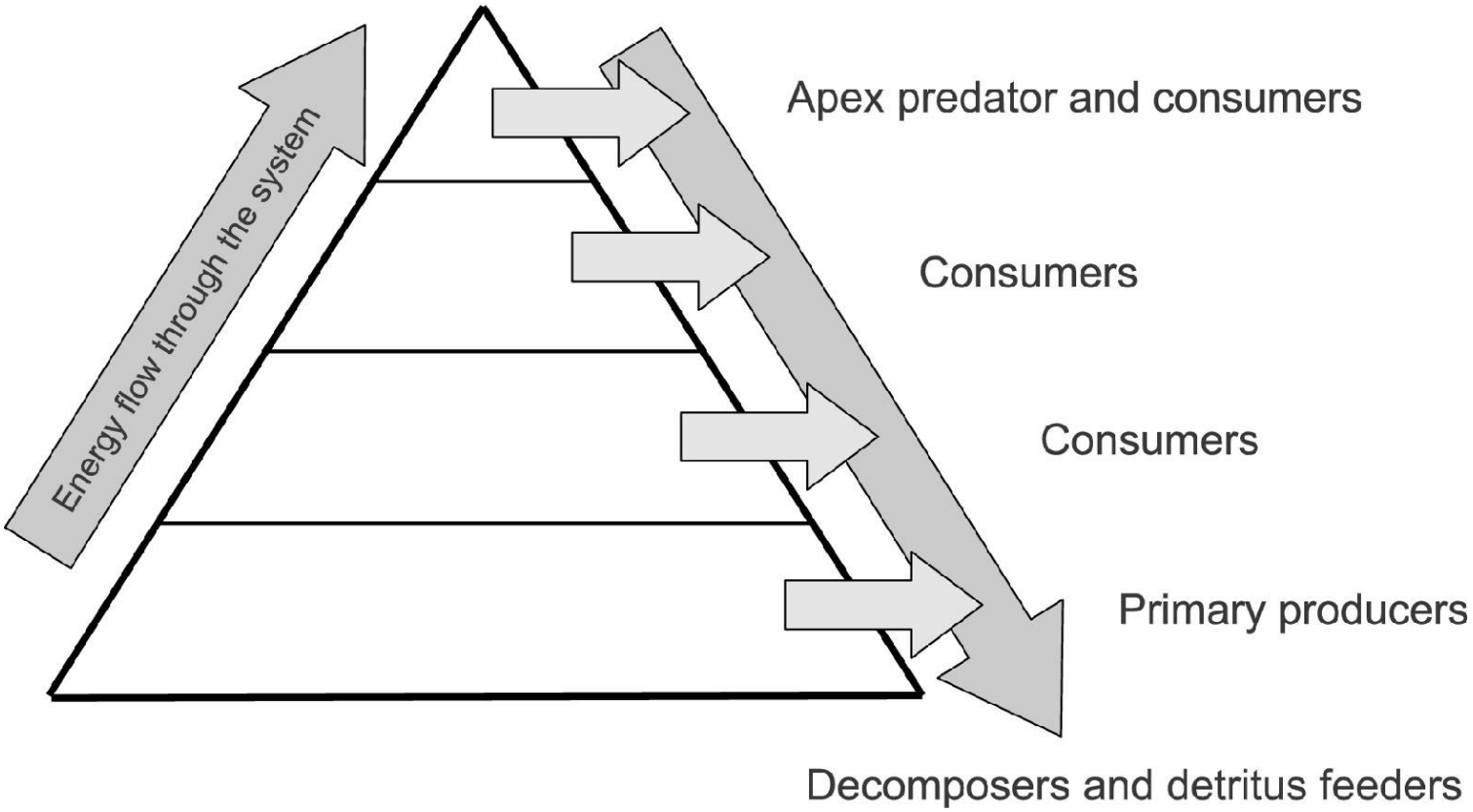
Horseshoe crab

Horseshoe crabs are bottom dwellers. Their diet usually consists of mollusks (various species of clams), gastropods (snails), and marine worms which are abundant on the bottom of estuaries. Horseshoe crab eggs and larvae are also a great food source for other animals, including birds such as the red knot sandpiper. Although juvenile and mature horseshoe crabs have a hard shell for protection, even they can be eaten. Mature horseshoe crabs are a food source for sea turtles and larger marine animals.

American Oystercatcher

The American Oystercatcher is a dark-colored, wading shorebird. Oystercatchers have long, large, heavy beaks that they use for smashing or prying open mollusks, including bivalves such as oysters, as well as mussels, barnacles, etc. Like other shorebirds, the main predatory threat to the oystercatcher occurs when their eggs are still in the nest, where the eggs can be eaten by other birds or small mammals or even some types of crabs

2. Draw a picture of your assigned organism on the food pyramid at the trophic level where you think it exists and/or feeds. Write your organism's name beneath your drawing.



3. Now read the descriptions of the other four organisms on the previous page. Based on the descriptions, draw and label an organism that exists on the trophic level just above your assigned organism and an organism that exists on the trophic level just below your assigned organism. (Of course, this is no level above if your assigned organism is an apex predator. And there's no level below if the organism is the producer, except the decomposers and detritus feeders!)

4. Next, go to the Interactive Food Pyramid simulation. Duplicate your food pyramid from this Student Master by dragging the onscreen image of your assigned organism to its proper trophic level. Drag to add the organisms you have selected for the adjacent trophic levels. Now fill in other trophic levels with other available organisms in the simulation. Click the "Check" button to check your work as you add organisms to see the food web.

5. Answer the questions on the next page.

Estuary Food Pyramid Questions

1. Is your assigned organism a producer or a consumer? Explain.

2. Where does your organism get its energy?

3. Do you think there are many or few organisms located in your assigned organism's trophic level?

Why or why not?

4. Write a paragraph describing the roles different organisms play in the estuary food pyramid.

Climate Extension

Estuary Food Webs and Climate Change

In this activity extension you will consider ways that the estuary food web could be impacted by climate change.

Procedure

1. Take your Estuary Food Pyramid created in the previous lesson and add the following organisms at the correct trophic level: clam worm, raccoon, mussel, bald eagle, striped bass, blue crab, shrimp, and diamondback terrapin.
2. Create a food web with the organisms on your Estuary Food Pyramid by drawing arrows that start at the organism being eaten and going to the organism eating it. Next use your completed estuary food web to answer the following questions:

    2A. How many organisms in your estuary food web rely directly on phytoplankton as a food source?

    2B. How many organisms in your estuary food web rely indirectly on phytoplankton?

3. Read the document titled “Marine Plankton Food Webs and Climate Change” and answer the following questions:

    3A. List three environmental variables, associated with climate change that are expected to have impacts on plankton.

3B. How could climate change cause an increase in some jellyfish populations and what impact would the increase have on other organisms in a coastal food web?

3C. Why is it important for scientists to continue to study the impacts of climate change on estuarine and coastal plankton?