ACTIVITY 3

Constructing a Model

FIELD TRIP

There are many interactions among local species that can be observed and modeled.

3 : CONSTRUCTING A MODEL

GUIDING QUESTION

How are firsthand observations used in scientific modeling?

INTRODUCTION

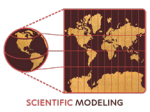
Around the world, organisms are expanding into ecosystems beyond their native range. For example, the nine-banded armadillo, which cannot tolerate extremely hot or cold temperatures, was historically limited to the southern United States. Milder winters are allowing it to spread hundreds of kilometers north. Imagine wanting to model the effect that this species might have on your local ecosystem.

If you need to review the concept of food webs, you will find a Science Review at the end of this activity.

A system is a collection of parts that interact with each other to work together as a whole. You are probably familiar with examples of systems in and around you, such as your digestive system, a coral reef ecosystem, and the Solar System. Scientists represent systems with different types of models to explain phenomena and make predictions. In this activity, you will use your observations of a local ecosystem to construct a food web model.

The nine-banded armadillo has been observed in the northern U.S. states of Nebraska, Iowa, and Illinois.

CONCEPTUAL TOOLS



MATERIALS LIST

FOR THE CLASS

- MAP OF FIELD TRIP AREA

FOR EACH STUDENT

- STUDENT SHEET 3.1 "Making Local Observations"
- UNLINED PAPER
- SPECIES IDENTIFICATION PHONE APP

PROCEDURE

PART A: MODELING FROM PRIOR KNOWLEDGE

1 You will be going outdoors to make ecological observations. Consider what you know about the ecosystem you will be visiting. In particular, think about:

- species that you have observed or that you know live in your area such as birds; insects; reptiles; amphibians; spiders; mammals; and plants, including trees.
- the feeding relationships that you have observed or that you have knowledge of.

2 Use your prior knowledge about local species and feeding relationships to construct a food web model of the ecosystem you will observe. A sample food web model is shown in Figure 3.1.

a Record the names of two local species that you think are likely to have a feeding relationship, each in its own circle or box.

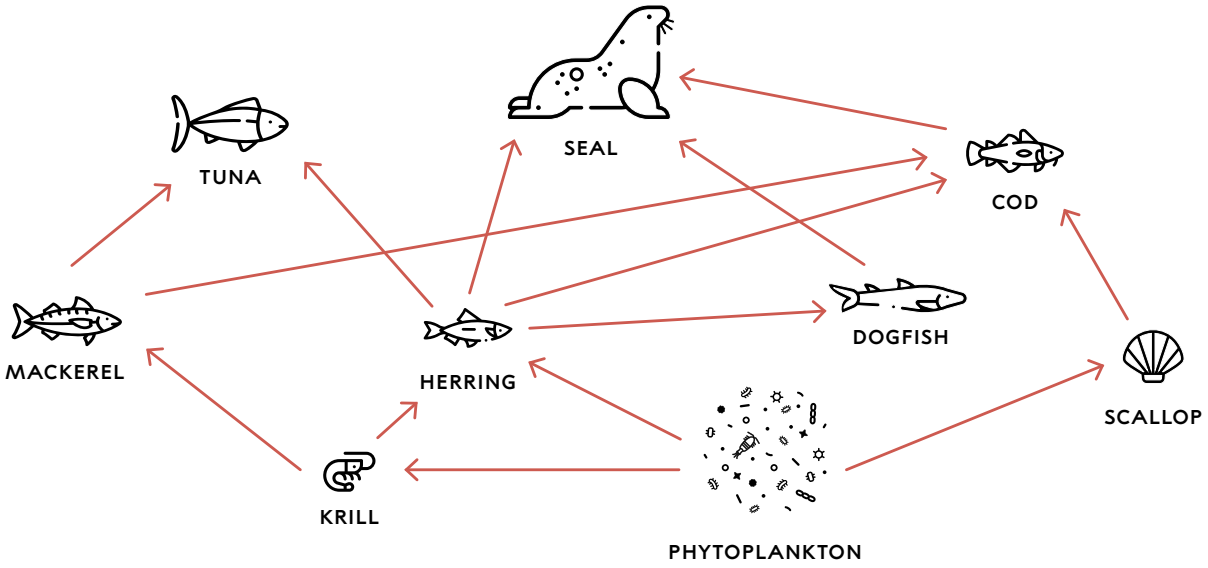
b In a food web model, arrows indicate the transfer of energy and matter from one organism to another. For example, an arrow begins at a prey species, such as a mouse, and points to a predator species, such as a hawk. On your model, draw an arrow from the species that is being eaten to the species that eats it.

c Add additional species to your model until you have at least five species.

NOTE: You can place a question mark on any relationships you are unsure of.

d As you add each species, think about all the different possible feeding relationships that may exist among the species in your model. To demonstrate these relationships, add additional arrows from the species being eaten to the species that eats it.

FIGURE 3.1
Gulf of Maine Food Web Model



PART B: MODELING FROM FIRSTHAND OBSERVATIONS

3 Your teacher will take you to a local outdoor area to make ecological observations.

4 Find an area a few feet away from others in your class where you can quietly make observations of this local system.

5 Stand or sit silently in this area for 10 minutes and use your senses to observe the system around you. Make sure to look in all directions, including up and down. You may hear some organisms before you can see them.

6 Use a phone app such as *iNaturalist* to help you identify unfamiliar species.

7 Record your observations on Student Sheet 3.1, "Making Local Observations." Make sure to include at least five different observed species and describe any possible feeding relationships, based on your observations and your prior knowledge. (You will record questions you have about organisms and their interactions in Step 13.)

8 On the back of Student Sheet 3.1, add a drawing or a map to your observations. You may want to sketch the entire scene or mark a particular organism's place within the environment. Label parts of your drawing or map as needed.

9 When you return to the classroom, share your observations with your class and discuss the possible feeding relationships among the different species you observed. For example, one person may have observed a dead beetle, and another person may have observed a living ant. A possible feeding relationship you may discuss is *Are ants likely to eat the remains of the beetle? Is a living beetle likely to eat an ant?*

10 Use the firsthand observations made by you and your classmates to revise your food web model. Label your food web model with a word or phrase that describes the system you are modeling.

11 Explain your food web model to your group. Respond to any questions, comments, or suggestions they have and modify your model as needed.

12 Use your revised model to make predictions about the interactions among species. As a class, discuss what would happen to the population of a particular species if the population of another species changed. For example, how could you use your model to predict what might happen to a grasshopper population if a large amount of grass began to grow in this area, or to a lizard population if a large number of owls migrated to this area?

PART C: MODELING FROM RESEARCH

13 Identify at least two questions you have about species or feeding relationships in your model.

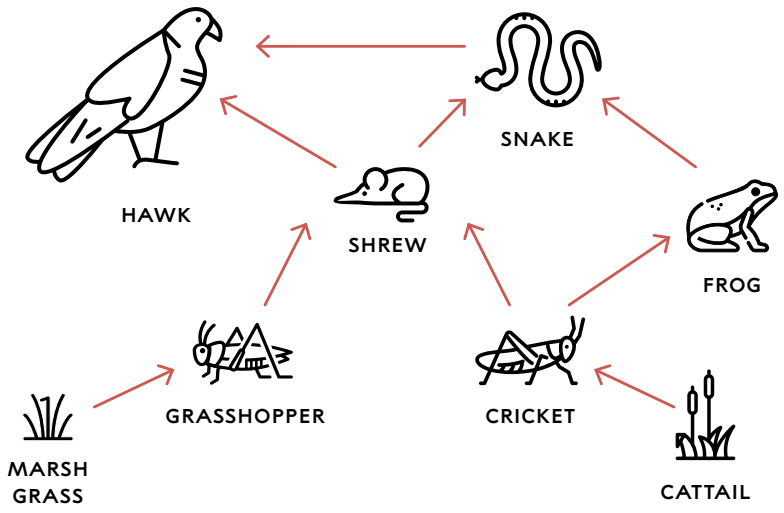
14 Research your local environment and use this new information to revise your model.

15 Share your revised model with your class and discuss how this information that was used to revise your model improves your predictions about local species.

BUILD UNDERSTANDING

1. An ecosystem consists of both living (biotic) parts, such as wildlife, and nonliving (abiotic) parts, such as water.
   - a Which parts are included in a food web model?
   - b What are three examples of nonliving parts that are not included in a food web model?
   - c If you wanted to construct a more complete and accurate model of an ecosystem, what would you do differently?
2. Reflect on the ways in which your initial food web model changed to incorporate new information. Design a more scientific approach to gathering firsthand observations to inform your food web model.
3. Scientific models are constructed to explain phenomena and make predictions. Look at the following food web model.

FIGURE 3.2
Food Web Model



   - a What do you predict would happen to the population of other species if the cricket population declined? Explain your reasoning.
   - b An owl species that eats snakes, frogs, and grasshoppers moves into the area. What do you predict will happen to the populations of the different species?

④ Imagine you visited a park with a small pond and recorded the following observations about the organisms there.

TABLE 3.1
Observations at a Local Pond

ORGANISM	NUMBER	OBSERVATIONS
Turtles	3	One turtle sat on a log in the sun. The other two were eating plants and beetles, and one of them caught a small fish and ate it.
Aquatic beetles	Lots	Beetle larvae eat aquatic plant roots, and adult beetles eat leaves of aquatic plants.
Leafy aquatic plants	Lots	The plants are growing under water in the shallow area of the pond.
Aquatic beetles	At least 50	There are different-sized fish, but they all look similar. The smaller fish are eating the leafy aquatic plants, and the larger fish are eating aquatic beetles.

a Develop a food web model that shows the pond organisms and their interactions. Be sure to do the following:

- label each organism in your model,
- show the interactions between organisms in your model,
- identify the system your model represents, and
- describe the feeding relationships shown in your model by explaining at least three species interactions.

b Use your model to predict what would happen to the population of other species if all the beetles died. Explain your reasoning.

c Imagine wanting to investigate the possible effect that the arrival of the nine-banded armadillo, which eats insects found in or near the water, could have on your local ecosystem. Use your food web model to predict what might happen. Be as specific as possible.

CONNECTIONS TO EVERYDAY LIFE

5. Think about the physical layout of the building and grounds of your school. You have a mental model of the size, shape, and location of classrooms, offices, and other facilities.
   - **a** What observations helped you to develop this model?
   - **b** Does your mental model include any parts of the buildings that you have not observed (for example, a room that you have not been inside)? If so, how were you able to include them in your mental model?

6. A GPS navigation app uses a model to predict the fastest route and arrival time. Think about your own experience with such apps and their relative accuracy.
   - **a** Think about a situation from your own experience where the model did not correctly predict the fastest route and/or correct arrival time. What happened to affect the model's accuracy?
   - **b** Could the model be revised to address this type of situation? Why or why not?

EXTENSION 1

Begin to observe species (animals, plants, and fungi) as you move through your community. As a class, record these observations on a map of your school district. This map will provide data on your collective observations about the species in your community over time. Compare the results of your data collection with the observations you made for your food web model. Does the new data support the design of your food web model? If not, what new scientific questions does it raise?

EXTENSION 2

Construct a physical model of an ecosystem using a "bottle biology" model (Figure 3.3). In this sample model, two plastic bottles are cut into two, and the ecosystem is established in the first bottle. The top half of the second bottle is used to seal the system. Many such models utilize soil; water; plants; and, in some cases, invertebrates. Gather more information and design your system. Before building the model, describe the ecosystem the model represents and identify the scientific question that is being investigated.

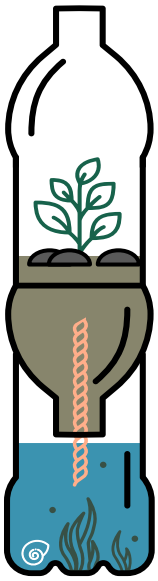


FIGURE 3.3
Model of a pond ecosystem in a bottle

KEY SCIENTIFIC TERM

system

SCIENCE REVIEW: FOOD WEBS

One way scientists classify organisms in an ecosystem is by describing how they obtain energy. An organism's position in a food web, representing a step in the flow of energy, is known as its *trophic level*. Read about these trophic levels in the following table.

TABLE 3.2
Trophic Levels of Organisms in an Ecosystem

TYPE OF ORGANISM	HOW ORGANISMS GET 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.

One way to show these interrelationships between the organisms in an ecosystem is by creating a food web. A food web models the feeding relationships among different species. The arrows show the direction that energy and matter are moving within the ecosystem.

FIGURE 3.4
Trophic Levels in a Food Web