ACTIVITY 3

Constructing a Model

FIELD TRIP

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Constructing a Model

ACTIVITY SUMMARY

Students draw on prior knowledge to construct a food web model of a local ecosystem. The class takes a field trip to a local nature area to make and record observations. Students revise their models based on their real-world observations. The class uses the models to make predictions about how feeding relationships affect population size. Students revise their models a final time based on additional researched information. The class discusses the role of data, including firsthand observations, to inform scientific models.

ACTIVITY TYPE
FIELD TRIP

NUMBER OF
40–50 MINUTE
CLASS PERIODS
2-3

KEY CONCEPTS & PROCESS SKILLS

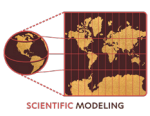
1 Models are developed based on observations of a system. When modeling a complex system, it is often useful to identify how a system's parts interact and to describe the limitations of the model based on the scientific question being investigated.

2 Models can be made more accurate through an iterative process that can involve testing it, refining it based on new evidence, adding or deleting relevant factors, or modifying the relationship between factors.

3 Scientific models are constructed to explain phenomena and make predictions. They represent aspects of the natural world that are too small, too large, too complex, or too difficult to observe or explain directly.

NEXT GENERATION SCIENCE STANDARDS (NGSS) CONNECTION:
Develop, revise, and/or use a model based on evidence to illustrate and/or predict the relationships between systems or between components of a system. (*Science and Engineering Practice: Developing and Using Models*)

CONCEPTUAL TOOLS



VOCABULARY DEVELOPMENT

system

a collection of parts that interact with each other to work together as a whole

TEACHER BACKGROUND INFORMATION

Population Dynamics

Population dynamics is the study of how and why the size, structure, and distribution of a population change over time. Mathematical models are used to understand the biological and environmental processes that drive these changes. The core factors studied are the four demographic events: birth, death, immigration, and emigration. By analyzing how these rates are influenced by factors such as resource availability, predation, disease, and climate, ecologists can predict future population trends, assess species health, and inform conservation and management strategies.

MATERIALS & ADVANCE PREPARATION

FOR THE TEACHER

- MAP OF THE FIELD TRIP AREA
- RESEARCH ON LOCAL FOOD SPECIES INTERACTIONS (OPTIONAL)
- VISUAL AID 3.1 "Scoring Guide: Developing and Using Models (MOD)"
- ITEM-SPECIFIC SCORING GUIDE: Activity 3, Build Understanding Item 4

FOR EACH STUDENT

- STUDENT SHEET 3.1 "Making Local Observations"
- STUDENT SHEET 3.2 "An Ecological Relationship Model" (OPTIONAL)
- STUDENT SHEET 1.3 "Unit Concepts and Skills" (OPTIONAL)
- SCORING GUIDE: Developing and Using Models (MOD) (OPTIONAL)
- SPECIES IDENTIFICATION PHONE APP (such as *Merlin* and/or *Seek by iNaturalist*)
- UNLINED PAPER
- CLIPBOARD (OPTIONAL)

Prior to the activity, you will need to identify one or more suitable sites in which to conduct the activity. The site(s) should have at least some biotic (living) components. Consider a school garden, a grassy median, or a playground.

It is helpful to be able to identify common species in the local area. Several apps exist for aiding species identification, although these often work best for organisms that move slowly or are stationary, such as plants or snails. You may wish to download one of these apps onto your own phone and learn to identify some of the most common plant and animal species in your area.

In Procedure Part C, students are asked to do research on their local ecosystem and use that information to revise their models for the final time. Depending on the time available and your student population, you may wish to do this research in advance and provide students with this information in Part C.

Safety Note

Prepare students with guidelines and expectations for participating in a field trip.

TEACHING NOTES

Suggestions for **discussion questions** are highlighted in gold.

Strategies for the **equitable inclusion of diverse students** are highlighted in pink.

GETTING STARTED (10 MIN)

1 **Explain that models represent systems.**

- Use the Introduction in the Student Book to connect the activity to the issue of changing animal distribution, modeling, and systems. If you have begun a word wall, add the term *system*.

2 **Discuss organisms that students have seen in their area.**

- Have students brainstorm a list of common local organisms. Ask, What kinds of animals, birds, insects, and plants (including trees and bushes) have you seen in the area, around the school, or around your homes? What do they look like? Even in cities, there are many organisms such as pigeons, sparrows, crows, starlings, hawks, squirrels, rats, mice, ants, spiders, flies, etc. You may have some students who can identify organisms at a finer grain size, such as a white-crowned sparrow. Since most students will not be able to do this, list more specific species after the broader category—for example, Sparrow: house sparrow, white-crowned sparrow, etc.

- If students do not know names of species, encourage them to describe animals they've seen and help them identify those animals. You can invite the class to come up with shorthand descriptions for internal reference, such as fried-egg flowers. If students know very little about your area and have difficulty generating likely organisms, you may wish to prepare a set of pictures of common local organisms. Or you can use the Explore function in the *iNaturalist* app to find out what species have been observed recently in your area; this will pull up a map with observations tagged and color-coded by kingdom (animal, plant, fungus). Tapping on a tag will pull up the species, date of observation, and a photograph. You can use this information to highlight common local species.

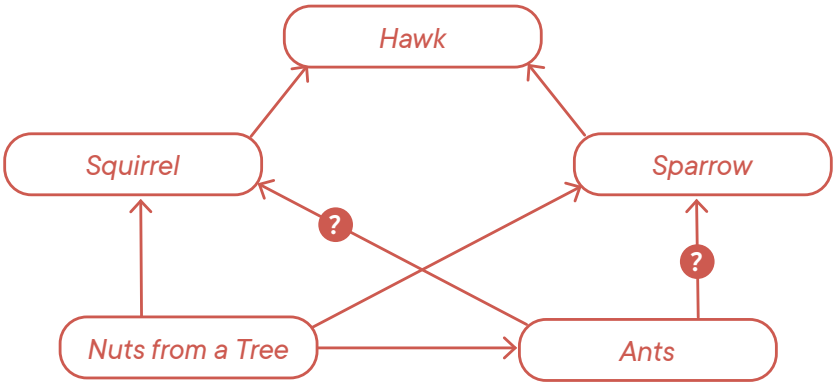
PROCEDURE SUPPORT (20 MIN)

3 In Part A, students construct food web models based on prior knowledge.

TEACHER'S NOTE: This activity has students iterate on a food web model. Depending on your student population and your content objectives, this activity can also be done using a model of ecological relationships. Optional Student Sheet 3.2,"An Ecological Relationship Model," describes these relationships and includes suggestions for constructing the model. If you use Student Sheet 3.2, you will need to use a different version of Build Understanding item 4. A different version of this question is provided at the end of this activity, along with a sample student response.

- This activity assumes that students have some prior knowledge of simple food web models and local organisms. A food web model is shown in Procedure Part A, and a brief Science Review on food webs can be found at the end of the activity in the Student Book.
- In Procedure Step 2, hand out a sheet of unlined paper to each student. Explain that models are constructed through a process of revision and that students are not expected to construct complete and correct models. They should construct models to the best of their knowledge and place a question mark on their models anywhere they are unsure of an organism or a relationship.
- If students are having difficulty with this task, you may want to have them work together in pairs or small groups to construct their models.
- A sample response is provided.

Sample Response to Procedure Step 2



4 The class participates in a field trip to a natural area to make observations.

- Explain that students will have the opportunity to make real-world observations to inform and, if need be, revise their food web models. Present a map of the outdoor area you are going to visit. As a class, discuss how well the field trip site represents (or differs from) common local ecosystems and/or the local organisms that students have been including in their food web models.
- Prior to visiting the site, communicate any safety considerations and behavioral expectations.
- At the site, hand out Student Sheet 3.1, "Making Local Observations," and ask students to arrange themselves as far apart as possible within your range. Remind them that the quieter they are, the more organisms they will see. Encourage students to observe not only in trees or on the grass but also under leaves or stones, in cracks in the pavement, in soil, and in the sky.
- Remind students to use the phone app to help identify any unfamiliar species.
- Have students make their observations in silence and record observations on Student Sheet 3.1. Remind them to:
  - include at least five different observed species.
  - describe any possible feeding relationships based on observations and prior knowledge.
  - add a drawing or a map to their observations and label parts of their drawing or map as needed. (This can be done on the back of Student Sheet 3.1). They may want to sketch the entire scene or mark a particular organism's place within the environment.
- After a minimum of 10 minutes of observation, invite students to share what they've seen with the class. Ask, In general, in which parts of the environment do you observe more animals? Which organisms did you observe in proximity to each other? Did you observe any organisms interacting (including animals and plants)? What observations could inform your ideas about the relationships among the organisms? Useful types of observations include noticing proximity between organisms; animals carrying or eating plants or seeds; organisms feeding on scraps of food discarded by people; cats and dogs in the area that play a role in the local ecology; animals pulling fruit or nuts off trees or the ground, digging in the ground, chasing insects, etc.
- After this initial sharing, you may want to provide students with a few more minutes to observe. Having their peers notice something that they didn't may guide students to enhance their observations, either by observing the same thing or by making additional observations.
- After students have completed their observations, provide them with time to use a phone app or other type of key to identify the organisms in the ecosystem. They can edit their observations on Student Sheet 3.1 as necessary.

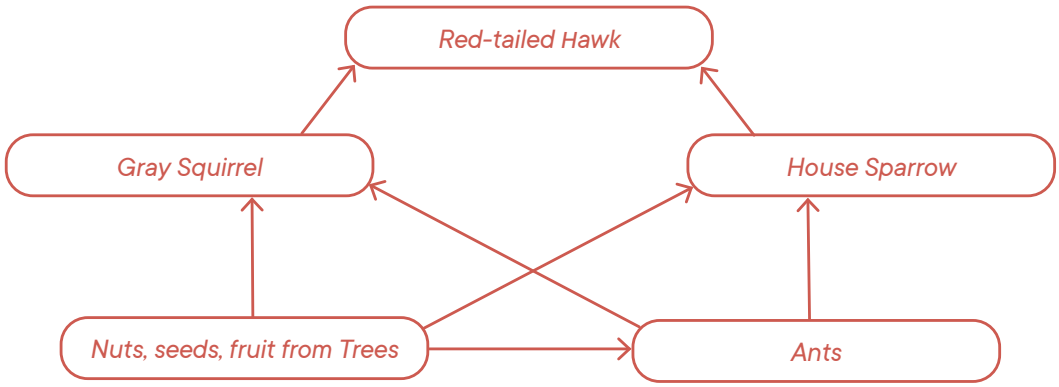
5 **Students make additional observations through the process of nature journaling (optional).**

- If you have more time and/or there are very few animals to be seen, invite students to nature journal—a process that is designed to engage students in closer observation of their environment. Have students respond to one or more of the following prompts:
  - *What do you notice? What does it remind you of? What do you wonder about?*
  - *Draw what you see. You may decide to draw an animal, a tree, sketch the scene as a whole, or draw animals in the scene.*
  - *Write five or more sentences describing what you see in as much detail as possible.*

6 **Students share their observations and revise their food web models.**

- After returning to the classroom, have students share their observations. In a food web model, organisms provide food to other organisms. As a class, discuss potential feeding relationships between the different organisms that students may have observed. Work together to brainstorm possible feeding relationships.
- Students should use the class' observations to revise their food web models as needed. Students are asked to label their food web models with a word or phrase that describes the system they are modeling. A sample response is provided here.

Sample Food Web: The Wooded Park at Town's Edge



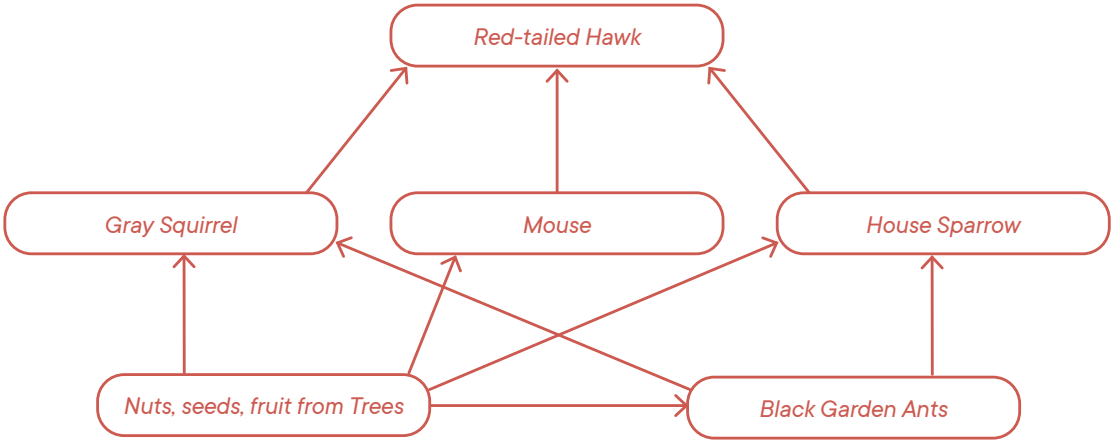
- As a class, discuss how to make predictions about the interactions among species. For example, ask, What would happen to the population of sparrows if herbicide was sprayed and most of the insects died? Students should be able to conclude that the sparrow population would likely decline without any other source of food. Provide additional examples as needed.
- Point out that the food web model is useful in explaining feeding relationships within an ecosystem and can be used to predict what might happen to other species when there is a change in the population of a particular species.

- Ask, What scientific questions could this model be used to investigate? Possible responses include: *What happens to the hawk population when the grass dies due to drought? What effect do large spider populations have on sparrow populations? What effect do outdoor house cats have on bird populations?*

7 Students research their local ecosystem and revise their food web models.

- Have students research or provide information to them about the species and feeding relationships common in the type of local ecosystem they visited. Students should use this information to revise their food web models as needed. A sample response is provided.

Revision of Sample Food Web: The Wooded Park at Town's Edge



- Have students share their final food web models with the class. You may want to create a gallery wall for students to observe one another's work.

SYNTHESIS OF IDEAS (20 MIN)

8 **Discuss how observations of a system inform scientific models and model revisions.**

- A scientific model can represent a system and can be used to help understand and predict its structure, behavior, and interactions. By breaking down complex phenomena into manageable parts and illustrating their connections, scientific models of systems enable people to understand, analyze, and predict how systems function. Review the idea that scientific models are developed based on observations of a system and the relationship between its components. Point out that this is exactly what students did by drawing from their prior knowledge (often based on previous observations), field trip observations, and research (based on observations and studies produced by others).
- Ask, What additional observations could you make to inform your model and how? Students could spend more time making observations, make observations under more varied conditions (i.e., different times of the day, different weather conditions), and make observations in different areas with similar ecosystems.
- Ask, How do you think additional observations would cause you to revise your model? Possible responses include adding additional organisms to the model and revising interactions between organisms.
- Highlight the process of revision that goes into model making and the role that real-world data plays in making those revisions.

9 **Use optional Student Sheet 1.3, "Unit Concepts and Skills," to help track important concepts of the unit.**

- You may wish to have students revisit optional Student Sheet 1.3, "Unit Concepts and Skills," and add information about models representing systems, as well as the use of new information to revise models.

10 **Introduce the assessment for Build Understanding item 4.**

- Build Understanding item 4 is a modeling assessment item. This first opportunity should be used to introduce your students to the Scoring Guide: Developing and Using Models (MOD). As this is the first opportunity for students to review the Scoring Guide, you may wish to have them work in pairs or small groups to discuss and/or write their responses, using the Scoring Guide to help develop their responses. See Appendix 2, Assessment Resource at the end of the Teacher's Guide for more guidance and information on using the Scoring Guides and assessment system with your students.
- Do not share the item-specific version of the Scoring Guide (Item-Specific Scoring Guide: Activity 3, Build Understanding Item 4) with students as it provides specific information on how to respond to the item prompt. Review the Item-Specific Scoring Guide to support scoring this specific item.
- Visual Aid 3.1, "Scoring Guide: Developing and Using Models (MOD)," can be used to assess Build Understanding item 4. Point out the scoring levels (0–4) and review the criteria for each score.

Explain that the scores are based on the quality of students' responses and reflect student growth over time. The scores do not correspond to letter grades. A Level 4 response is complete and correct. A Level 3 response is almost complete and mostly correct, but possibly missing minor details or containing small errors. At first, many students will write Level 2 responses, and they should strive to achieve Level 3 or Level 4 responses. Let students know that you would like them to improve by at least one level as they progress through the unit. As a class, discuss what a Level 4 response to Build Understanding item 4 would include. You may develop a Level 4 exemplar as a class or share with students the Level 4 response from the provided sample responses. To help students better understand the three levels, discuss how they are different and ask students for ideas about how to improve from Level 2 to Level 3 and from Level 3 to Level 4.

- For some students, you may wish to support a specific level of growth—this can be particularly helpful if students have an Individualized Educational Plan (IEP), a 504 plan, or other specific educational goals. Growth from a Level 1 to a Level 2 may indicate significant progress for a student and should be recognized as such. Additionally, assessments can be a good opportunity to have students evaluate one another's work and provide initial feedback for revisions prior to submitting their responses to you. You may wish to project a copy of the Scoring Guide for your students to review each level and clarify your expectations.

- Sample responses for Levels 1–4 are provided in the Build Understanding section. Review these responses to get an idea of what is expected for each level, alongside the Item-Specific Scoring Guide. See Appendix 2, Assessment Resource at the end of the Teacher's Edition for more guidance and information on using the Scoring Guides and assessment system with your students.

EXTENSION (50+ MIN)

11 **Use the Extension as an opportunity for advanced learning.**

- **Extension 1:** Have students collect observations over time and record them on a map of your school district. Compare the results of the data collection with the observations from the field trip. Discuss whether the new data support the design of the food web model and what new scientific questions are raised.

- **Extension 2:** You may wish to have students construct a physical model of an ecosystem by establishing an ecosystem in a bottle, often referred to as "bottle biology." 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. The first step in establishing such a system is deciding on what ecosystem to model and what question to investigate.

TEACHER'S NOTE: The use of vertebrates (such as fish or lizards) in the classroom is often governed by local or state guidelines and laws and may not be allowed or may require additional authorizations or approvals.

SAMPLE STUDENT RESPONSES

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?

Living (biotic) parts.

b What are three examples of nonliving parts that are not included in a food web model?

Rainfall, temperature, and population density.

c If you wanted to construct a more complete and accurate model of an ecosystem, what would you do differently?

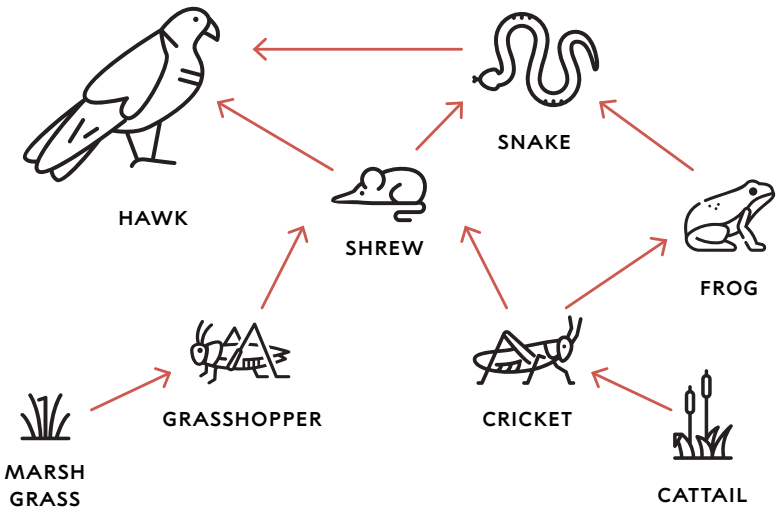
I could add lines connecting nonliving factors to the organisms and use +/– signs to indicate positive or negative relationships. For example, I could add a line pointing to the grass that says "rainfall" and mark it with a "+" sign.

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.**

I would choose a time when there were fewer people, observe for a longer period of time, and go back on different days. I would record the time of year and the weather (since that might affect my observations).

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.

I predict that the frog species would decline significantly because it only eats crickets. The shrew and the snake would only decline a bit because they have other sources of food. The hawk would also decline because it eats snakes and shrews. The grasshopper population might go up because it would have less competition.

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?

The snake, frog, and grasshopper populations would decline, possibly causing the shrew and hawk populations to decline as well.

④ MOD Scoring Guide

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

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:

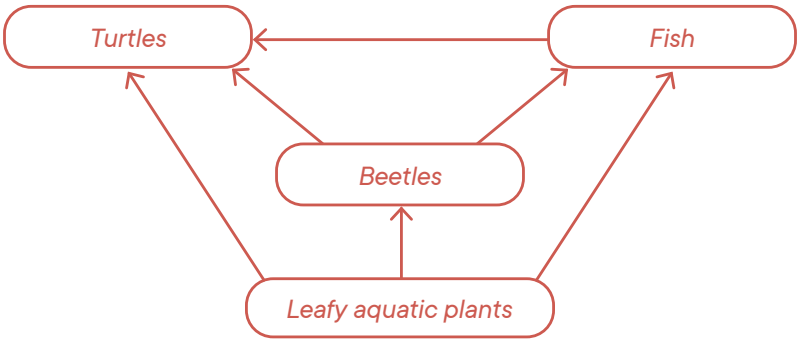
- label each organism in your model,
- show the interactions between organisms in your model,
- identify the system your model represents, and
- describe the feeding relationships shown in your model by explaining at least three species interactions.

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.

NOTE: The interactions students show may vary.

Level 4 response

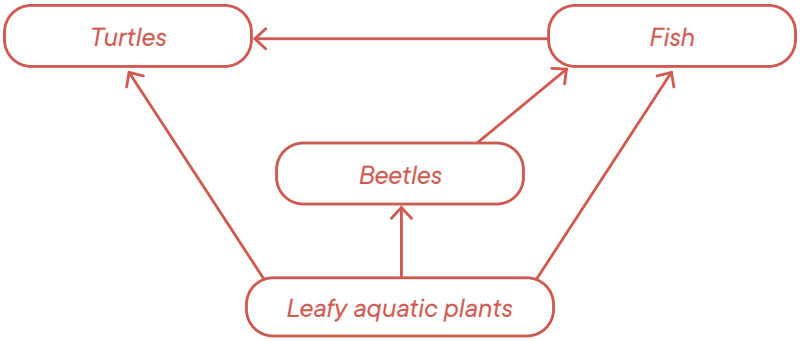


a *My model represents a food web of a pond. Turtles eat fish, beetles, and fish. Fish eat beetles and plants. Beetles eat aquatic plants.*

b *If all the beetles died, the populations of fish and turtles might also go down because they would lose a food source.*

c *If an armadillo ate the beetles, it would compete with the turtles and fish for this food source. This could first result in a decline in the beetle population and then maybe also reduce the population of turtles and fish over time.*

Level 3 response

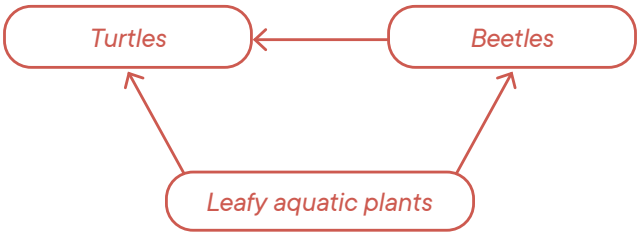


a *This is a pond ecosystem model. It shows which species eat each other. Fish, beetles, and turtles eat leafy plants, fish also eat beetles, and turtles also eat fish.*

b *Without beetles, fish would have one less food source.*

c *If armadillos came and ate beetles, fish would eat more plants. There would be less plants.*

Level 2 response

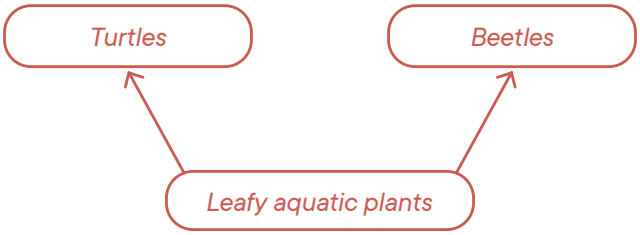


a *In the pond, the turtles and beetles eat the plants.*

b *Without beetles, turtles would only have plants to eat.*

c *With armadillos, turtles would have less food. There might be less turtles.*

Level 1 response



a *Leafy plants provide food for turtles and beetles.*

b *If there were no beetles, turtles would have lots more plant food.*

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?**

   Seeing the school layout as I walked around helped develop my mental model.

   b **Does your mental model include any elements 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?**

   Yes, I know where some closets are because I've seen the doors, but they're locked. I was able to include them because of my prior knowledge of similar spaces.

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?**

   An accident happened on my route around the time I left home. The app did not update that quickly.

   b **Could the model be revised to address this type of situation? Why or why not?**

   It could be revised if there were millions of sensors everywhere to relay this data in real time.

REFERENCES

Blackwood, J. S., Dresner, M. Luh, H.-K. (April 2006, posting date). Using student generated qualitative ecological models. *Teaching Issues and Experiments in Ecology, Vol. 4:* Experiment #4. https://www.esa.org/tiee/vol/v4/experiments/ecological_models/synopsis.html

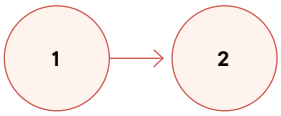
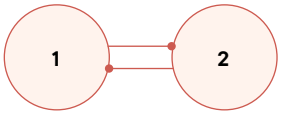
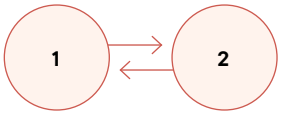
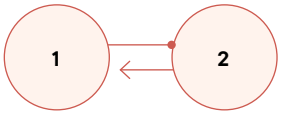
Organism What is it?	**Observations** How many? Where is it? What is it doing? You can add sketches.	**Possible feeding relationships within the ecosystem**	**Questions you have about organisms and their interactions**

Organism What is it?	**Observations** How many? Where is it? What is it doing? You can add sketches.	**Possible feeding relationships within the ecosystem**	**Questions you have about organisms and their interactions**
Crows	*Two crows on different tree branches making sounds, bobbing heads*	*Eating insects, scavenging food from people/dead animals*	*What do crows eat?* *How many crows in an average flock?*
Small bird	*One flying overhead*	*Eating insects*	*What bird is it?* *Where do these small birds nest?*
Black ants	*Four ants along the path near the grass border, moving around in different ways*	*May gather nectar from flowers, may be food for other organisms*	*What do ants eat?* *Do birds eat ants?* *Where is the ant hill?*
Marigold flowers	*Patch of seven yellow-orange flowers that smell a little lemony*	*May be food for other animals or insects*	*Do bees pollinate marigolds?* *Are these flowers native to our area?*
Trees	*Three large trees*	*Makes its own food using sunlight, provides food to other organisms such as squirrels*	*What type of tree is it?* *Is it native, or has it been planted?*

Table 1: Common Ecological Relationships

Commensalism	An interaction where one organism or species benefits while the other is unaffected. For example, birds benefit from nesting in trees, but most trees are unaffected by the presence of nests.
Competition	An interaction between organisms or species in which both require a resource that is in limited supply. For example, two different bird species may compete for the same food source.
Mutualism	An interaction where both organisms or species benefit. For example, bees gather food (nectar or pollen) from flowering plants, and flowering plants disperse pollen to other plants of the same species to aid in reproduction.
Parasitism	An animal or plant that gets nutrients by living on or in an organism of another species. For example, black-legged ticks are common parasites of deer, and they live on their skin while feeding on their blood.
Predation	An interaction where one organism (the predator) eats another organism (the prey). For example, predators such as wolves eat prey such as caribou. (Herbivory is a type of predation where an animal eats parts of plants.)

Table 2: Representing Ecological Relationships in a Model

Commensalism	Organism 1 has a positive effect on Organism 2 without any effect on itself.	
Competition	Two organisms negatively affect each other.	
Mutualism	Two organisms positively affect each other.	
Parasitism, Predation	Organism 1 has a negative effect on Organism 2, while Organism 2 has a positive effect on Organism 1.	

CONTINUED

BUILD UNDERSTANDING ITEM 4 ALTERNATIVE:

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

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.
Algae	Lots	Algae is growing at the edges of the pond and on the sides of the log in the pond.
Leafy aquatic plants	Lots	The plants are growing under water in the shallow area of the pond.
Fish	At least 50	There are different-sized fish, but they all look similar. The smaller fish are eating the algae, and the larger fish are eating the leafy aquatic plants.

a Develop an ecosystem 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, and
- label your model with a title.

b Describe the ecological processes shown in your model by identifying at least three ecological interactions and explaining how the organisms interact.

CONTINUED

BUILD UNDERSTANDING ITEM 4 ALTERNATIVE:

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

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.
Algae	Lots	Algae is growing at the edges of the pond and on the sides of the log in the pond.
Leafy aquatic plants	Lots	The plants are growing under water in the shallow area of the pond.
Fish	At least 50	There are different-sized fish, but they all look similar. The smaller fish are eating the algae, and the larger fish are eating the leafy aquatic plants.

a Develop an ecosystem 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, and
- label your model with a title.

b Describe the ecological processes shown in your model by identifying at least three ecological interactions and explaining how the organisms interact.

VISUAL AID 3.1 | SCORING GUIDE: DEVELOPING AND USING MODELS (MOD)

WHEN TO USE THIS SCORING GUIDE:

This Scoring Guide is used when students develop their own models or use established models to describe relationships and/or make predictions about phenomena and/or systems.

WHAT TO LOOK FOR:

- Response accurately represents the phenomenon and/or system.
- Response includes an explanation of relevant ideas and concepts represented by the model or a prediction based on the relationships between ideas and concepts represented by the model.

LEVEL	GENERAL DESCRIPTION
Level 4 **Complete and correct**	The student's model* completely and accurately represents the components, relationships, and mechanisms of the phenomenon/system, AND the student uses it to develop a complete and correct explanation or prediction.
Level 3 **Almost there**	The student's model* completely and accurately represents the components, relationships, and mechanisms of the phenomenon/system AND includes a mostly correct use of the model to create an explanation or prediction.
Level 2 **On the way**	The student's model* represents components of the phenomenon/system AND includes a partially correct representation of the relationships or mechanisms associated with the phenomenon.
Level 1 **Getting started**	The student's model* represents components of the phenomenon/system BUT provides little or no evidence of the relationships or mechanisms associated with the phenomenon/system.

* A model can be a diagram, drawing, physical replica, diorama, dramatization, storyboard, or any other graphical, verbal, or mathematical representation. It may include labels or other written text as required by the prompt.

LEVEL	GENERAL DESCRIPTION
Level 0 **Missing or off task**	The student's response is missing, illegible, or irrelevant.
X	The student had no opportunity to respond.

WHEN TO USE THIS SCORING GUIDE:

This Scoring Guide is used when students develop their own models or use established models to describe relationships and/or make predictions about phenomena and/or systems.

WHAT TO LOOK FOR:

- Response accurately represents the phenomenon and/or system.
- Response includes an explanation of relevant ideas and concepts represented by the model or a prediction based on the relationships between ideas and concepts represented by the model.

LEVEL	GENERAL DESCRIPTION	ITEM-SPECIFIC DESCRIPTION
Level 4 **Complete and correct**	The student's model* completely and accurately represents the components, relationships, and mechanisms of the phenomenon/system, AND the student uses it to develop a complete and correct explanation or prediction.	The student response: • includes all four organisms. • correctly shows and explains at least one interaction between all four organisms. • correctly and thoroughly predicts what would happen to other species in two different scenarios.
Level 3 **Almost there**	The student's model* completely and accurately represents the components, relationships, and mechanisms of the phenomenon/system AND includes a mostly correct use of the model to create an explanation or prediction.	The student response: • includes all four organisms. • correctly shows at least one type of interaction between all four organisms. • correctly predicts what would happen to other species in two different scenarios, BUT explanations are minimal.

* A model can be a diagram, drawing, physical replica, diorama, dramatization, storyboard, or any other graphical, verbal, or mathematical representation. It may include labels or other written text as required by the prompt.

LEVEL	GENERAL DESCRIPTION	ITEM-SPECIFIC DESCRIPTION
Level 2 **On the way**	The student's model* represents components of the phenomenon/ system AND includes a partially correct representation of the relationships or mechanisms associated with the phenomenon.	The student response: • includes at least three organisms. • correctly shows interactions between some organisms BUT does not include all organisms. • predicts what would happen to other species in different scenarios, BUT predictions are partially incorrect or incomplete.
Level 1 **Getting started**	The student's model* represents components of the phenomenon/system BUT provides little or no evidence of the relationships or mechanisms associated with the phenomenon/system.	The student response: • may not include all four organisms. • shows interactions between a few organisms, BUT the model is mostly incorrect or incomplete. • includes predictions that are vague, incomplete, or incorrect.

* A model can be a diagram, drawing, physical replica, diorama, dramatization, storyboard, or any other graphical, verbal, or mathematical representation. It may include labels or other written text as required by the prompt.

LEVEL	GENERAL DESCRIPTION	ITEM-SPECIFIC DESCRIPTION
Level 0 **Missing or off task**	The student's response is missing, illegible, or irrelevant.	
X	The student had no opportunity to respond.	