12 Modeling the Introduction of a New Species

MODELING

1–2 CLASS SESSIONS

ACTIVITY OVERVIEW

NGSS CONNECTIONS

Students develop a new model for an ecosystem and then introduce a new species—either a new invasive species or a native species that had disappeared. Students use their models to demonstrate how this new component affects the flow of energy and cycling of matter throughout the ecosystem. The activity provides an opportunity to assess students' work related to Performance Expectation MS-LS2-3.

NGSS CORRELATIONS

Performance Expectations

MS-LS2-3: Develop a model to describe the cycling of matter and flow of energy among living and nonliving parts of an ecosystem.

Disciplinary Core Ideas

MS-LS2.B Cycle of Matter and Energy Transfer in Ecosystems: Food webs are models that demonstrate how matter and energy are transferred between producers, consumers, and decomposers as the three groups interact within an ecosystem. Transfers of matter into and out of the physical environment occur at every level. Decomposers recycle nutrients from dead plant or animal matter back to the soil in terrestrial environments or to the water in aquatic environments. The atoms that make up the organisms in an ecosystem are recycled repeatedly between the living and nonliving parts of the ecosystem.

MS-LS2.C Ecosystem Dynamics, Functioning, and Resilience: Ecosystems are dynamic in nature; their characteristics can vary over time. Disruptions to any physical or biological component of an ecosystem can lead to shifts in all its populations.

Science and Engineering Practices

Developing and Using Models: Develop a model to describe phenomena.

Crosscutting Concepts

Energy and Matter: The transfer of energy can be tracked as energy flows through a natural system.

Systems and System Models: Models can be used to represent systems and their interactions—such as inputs, processes, and outputs—and energy and matter flows within systems.

Stability and Change: Systems in dynamic equilibrium are stable due to a balance of feedback mechanisms.

Connections to Nature of Science: Scientific Knowledge Assumes an Order and Consistency in Natural Systems: Science assumes that objects and events in natural systems occur in consistent patterns that are understandable through measurement and observation.

Common Core State Standards—ELA/Literacy

WHST.6-8.1: Write arguments to support claims with clear reasons and relevant evidence.

INVESTIGATIVE PHENOMENA AND SENSEMAKING

A variety of species tend to be found together and linked through feeding relationships.

In this final activity in the third learning sequence, students demonstrate their understanding of food webs and their ability to make sense of what happens to a food web when a new species is introduced, or when a previously eliminated species is reintroduced.

WHAT STUDENTS DO

Using a set of Food Web Cards, each depicting an organism, students work in groups to model a food web for one of four ecosystems. Students are then given an additional card representing an introduced or reintroduced species. They must revise their models to explore and explain how the flow of energy and cycling of matter are disrupted by this new species.

MATERIALS AND ADVANCE PREPARATION

- *For the teacher*
  - 1 Scoring Guide: DEVELOPING AND USING MODELS (MOD)
  - all of the Introduced Species Cards from the Food Web Card sets (orange border)

■ *For each group of four students*

- 1 Scoring Guide: DEVELOPING AND USING MODELS (MOD) (optional)
- 1 set of Food Web Cards (teal border)
- * 1 large sheet of paper (optional)
- * ribbon or string (optional)
- * markers (optional)

* *not included in kit*

The DEVELOPING AND USING MODELS (MOD) Scoring Guide can be found in the Assessment tab in the back of this Teacher Edition.

Separate the the Food Web cards into sets and remove the Introduced Species cards. See step 2a for details.

TEACHING SUMMARY

GET STARTED

1. Students review what they know about food webs.
   a. Instruct students to turn and talk to their partners about the components of and interactions in a food web.
   b. Ask students, "How do you think the introduction of a new species affects a food web?"
   c. Have students read the introduction to the activity, and clarify the difference between introducing and reintroducing a species.

DO THE ACTIVITY

2. Students construct a food web model using their set of Food Web Cards.
   a. Give each group a set of Food Web Cards.
   b. (MOD ASSESSMENT) Explain the criteria for the ecosystem models, and let students know that they will be assessed on their models.
   c. Instruct groups to create food web models for their set of organisms.
3. Students introduce a species to their food web models.
   a. Give each group the Introduced Species Card that corresponds with their ecosystem.
   b. Explain to groups that they need to revise their model to show how the new species impacts the flow of energy and cycling of matter.
   c. Consider using Analysis item 1 to further assess student' understanding.

BUILD UNDERSTANDING

4. Students extend their understanding of ecosystems by considering what would happen if species were removed.

a. Direct students to Analysis item 2a, which asks them to consider what would happen in their ecosystems if a top predator were removed.

b. Direct students to Analysis item 2b, which asks them to consider what would happen if a producer were removed.

TEACHING STEPS

GET STARTED

1. Students review what they know about food webs.

   a. Instruct students to turn and talk to their partner about the components of and interactions in a food web.

      By this point, students should have a clear understanding that the components in the food web are the different organisms, and the interactions are the flow of energy and matter from one organism to another.

   b. Ask, "How do you think the introduction of a new species affects a food web?"

      Have students briefly discuss this with their partners. This will get them thinking about the effects of an introduced species as they create their models.

   c. Have students read the introduction to the activity, and clarify the difference between introducing and reintroducing a species.

      The introduction in the Student Book includes two scenarios. The first scenario describes how the introduction of zebra mussels has created problems for other species in the environment. The second scenario is about wolves in Yellowstone National Park. Wolves are native to North America, and they were exterminated from Yellowstone for decades. They were eventually reintroduced, so they are not really a "new" species.

DO THE ACTIVITY

2. Students construct a food web using their set of Food Web Cards.

   a. Give each group a set of Food Web Cards.

      There four different ecosystems represented on the Food Web Cards: grassland, deciduous forest, desert, and marine. There are two identical sets of cards for each ecosystem, so in a class with eight groups of students, there will be two groups examining each ecosystem. Each card has a brief description of an organism and enough information for students to be able to determine whether the organism is a producer or

a consumer, and if the consumer eats plants, animals, or both. For now, be sure to withhold the Introduced Species Cards, which have an orange border. (The Food Web Cards have a teal border.)

b. (MOD ASSESSMENT) Explain the criteria for the ecosystem models, and let students know that they will be assessed on their models.

Students' models must show the food web's biotic components (organisms) and interactions (feeding relationships). Their food web must indicate how energy is flowing and how matter is cycling in the ecosystem. The models must also incorporate abiotic components in the environment to indicate the original source of energy for the ecosystem and the matter that exists outside of the organisms. This should be done either by drawing arrows or by placing pieces of ribbon or string between organisms, then tying a knot at the end of the string or ribbon suggesting the point of the arrow. Students should use different colors of arrows to distinguish energy from matter. This part of the Procedure corresponds to Performance Expectation MS-LS2-3.

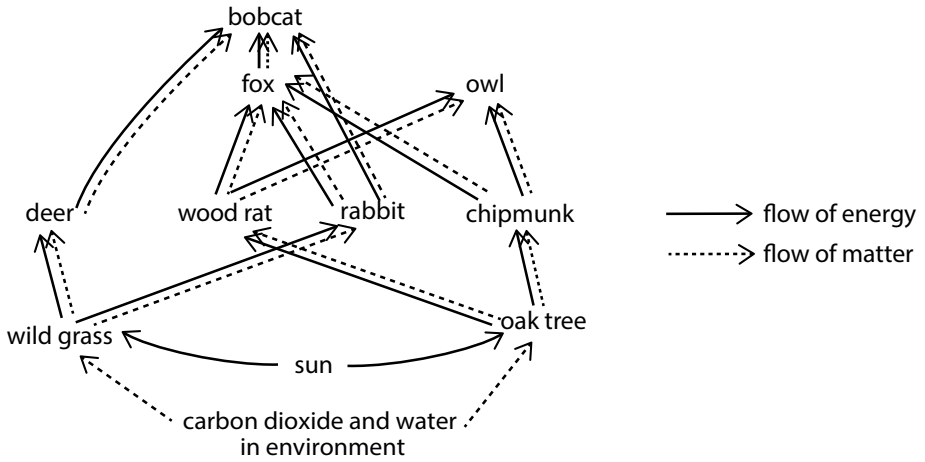
Learning Pathways

c. Instruct groups to create food web models for their set of organisms.

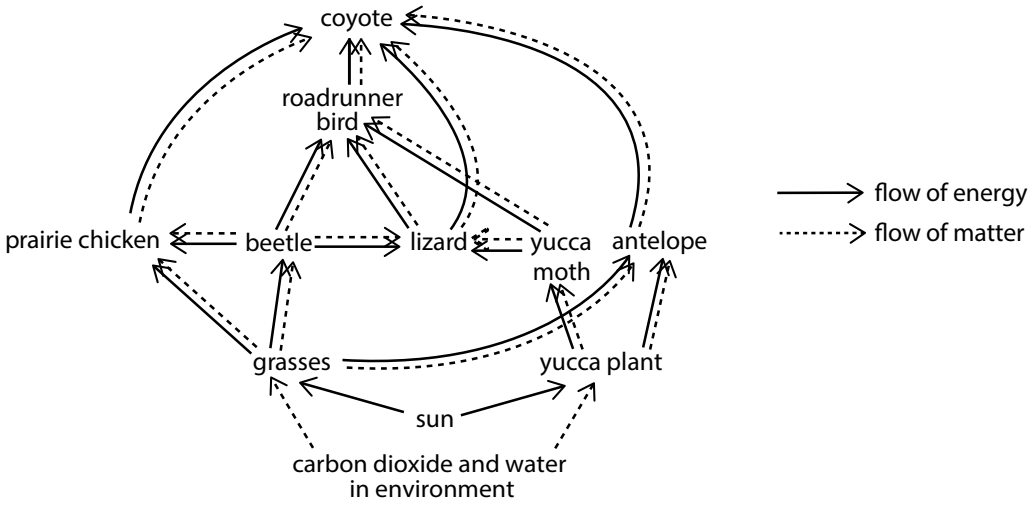
If groups are constructing their models on a large sheet of paper, they can show relationships by drawing arrows with pencils or markers. If they are constructing their model on a desk or table, they can use pieces of string or ribbon to show relationships.

Sample student responses for the four ecosystems follow.

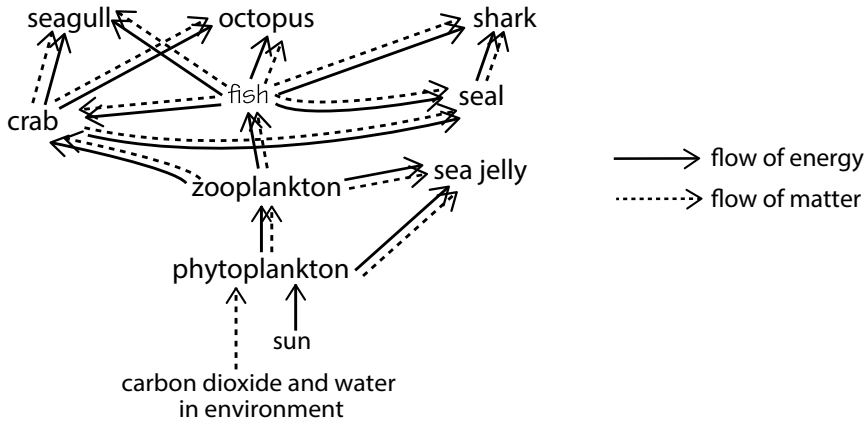
DECIDUOUS FOREST



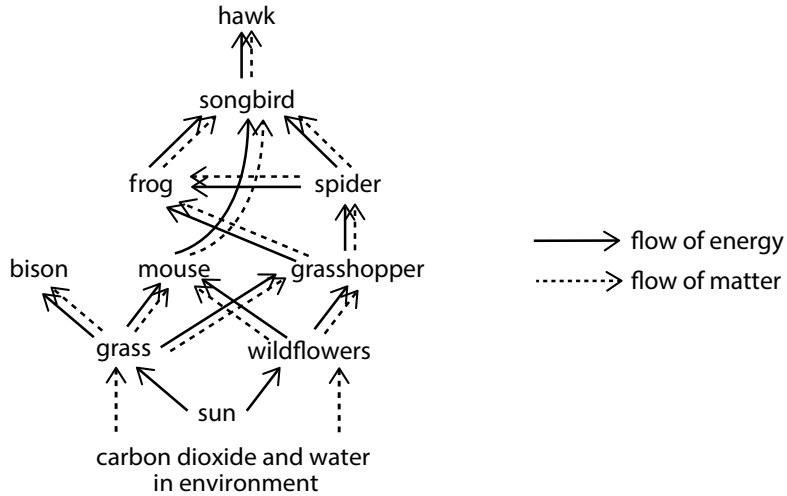
DESERT



MARINE



GRASSLAND



3. Students introduce a species to their food web models.

   a. Give each group the Introduced Species card that corresponds with their ecosystem.

      Note that students are intentionally not yet told whether their "new" species is an invasive species or a native species that is being reintroduced. Do not let them know that the wild pig in the grassland ecosystem (Set D) is the invasive species and that the wildflowers in the deciduous forest ecosystem (Set A), the rattlesnake in the desert ecosystem (Set B), and the shrimp in the marine ecosystem (Set C) are all species that are being "reintroduced" into their models.

   b. Explain to groups that they need to revise their models to show how the new species impacts the flow of energy and cycling of matter.

      Students will need to develop a way to depict if feeding relationships are disrupted. If groups are struggling, suggest that they make their arrows thicker (or add string) if more energy and/or matter will flow. They can add dashes to their arrows (or make marks on the string) if less energy and/or matter will flow. They can put an "x" on arrows (or remove the string) if relationships will be eliminated.

      Note that any introduction has consequences for the entire ecosystem because all organisms are connected either directly or indirectly through feeding relationships. Any time a feeding relationship is added to an ecosystem, the flow of energy and cycling of matter are affected. Note also that there is no way for students to know for certain if their "new" species is native or invasive, but they should be able to offer a logical answer.

   c. Consider using Analysis item 1 to further assess students' understanding.

      Analysis item 1 asks students to explain what happened to their food web when a new species was introduced. A student's ability to explain the effects provides further evidence of their understanding of the flow of matter and energy in ecosystems.

BUILD UNDERSTANDING

4. Students extend their understanding of ecosystems by considering what would happen if species were removed.

   a. Direct students to Analysis item 2a, which asks them to consider what would happen in their ecosystems if a top predator were removed.

      This scenario represents the problem in conservation biology when a native species, like a tiger or bald eagle, is removed due to hunting or habitat destruction; the entire ecosystem can collapse because all feeding interactions are disrupted.

b. Direct students to Analysis item 2b, which asks them to consider what would happen if a producer were removed.

   This scenario replicates the harvesting of plants for agricultural use. The rest of the food web is disrupted if the plant being removed is the primary producer in the ecosystem.

STRATEGIES FOR TEACHING DIVERSE LEARNERS

Below are suggestions for differentiating instruction and assessment in this activity for diverse learners in your classroom:

- Academically gifted students: Have students compare and contrast their food web models before and after the introduction of the new species.

SAMPLE RESPONSES TO ANALYSIS

1. Explain how the introduction of your new species affected your ecosystem.

   a. Be sure to address which interactions were affected.

   b. Describe whether the introduction was harmful or helpful to the ecosystem.

   c. Do you think the species you "introduced" is native or non-native? Describe your reasoning.

      Students' responses will vary. Below are some examples of relationships that could be directly or indirectly affected.

      In Set A, the introduced species are wildflowers, which are producers. All interactions could be affected if the wildflowers outcompete the other producers and the animals aren't able to eat the flowers. This seems like a native species because if animals like chipmunks don't eat grass, there would be nothing for them to eat. And if there are no chipmunks, there can be no predators. It seems like the introduction of the wildflowers benefits the ecosystem.

      In Set B, the introduced species is the rattlesnake, a predator of small mammals and birds. All interactions could be affected if the snake consumes many of the mammals and birds. Populations of any organisms eaten by those mammals and birds might then increase. This seems like a native species because otherwise there are no predators of the small mammals and birds. The introduction of the snake seems like it benefits the food web because it keeps the mammals and birds that feed on insects and plants in check.

      In Set C, the introduced species is a shrimp, which eats tiny plants and animals. If the shrimp outcompetes other animals that feed on the same organisms, these other animals may disappear. If so, all the interactions could be affected. On the other hand, if there are no shrimp, there is less for the octopus and seals to eat. For this reason, I think the shrimp might be native and beneficial for the food web.

In Set D, the introduced species is a wild pig, which eats plants. If the pig eats most of the plants, there may not be enough food left for other plant-eating animals. Any population of predators that feed on these other animals could decline. It seems like the pig is competing with the bison for grass. I know from the "Data Transects" activity that bison aren't that common. So, this makes me think that the pigs are introduced and harmful to the food web.

2. What would happen if …

   a. the top predators disappeared from your ecosystem? This might happen if the predators were overhunted. How does this affect the flow of energy through your ecosystem?

      The entire ecosystem can collapse because all feeding interactions are disrupted. Removing a top predator allows the population of other predators to increase. If this happens, their prey items may decrease. Eventually, the only component left in the ecosystem may be the plants, because there is nothing left to eat them.

   b. the producers disappeared from your ecosystem? This might happen if a disease caused the producers to die off. How does this affect the flow of energy through your ecosystem?

      The source of energy for all of the other organisms would cause the collapse of the ecosystem. The animals that eat plants would have no source of energy, so the predators that eat those plant-eating animals would also lose their source of energy.

3. **Revisit the issue:** Return to your introduced species research project, and explain how the introduction of the species you are investigating impacts the flow of energy and cycling of matter in the ecosystem.

   Students' responses will vary, depending on their chosen species. A sample response is shown here:

   Asian carp consume a lot of the food that other native species would eat, and prevent the flow of energy and cycling of matter to those species. Because the carp have no predators, the energy gained from items lower on the food chain is released into the abiotic parts of the environment. After the carp die, their matter is taken in by decomposers before being returned to the abiotic components of the environment.

REVISIT THE GUIDING QUESTION

How does a new species affect the flow of energy and cycling of matter through an ecosystem?

A new species affects the entire ecosystem because all components are directly or indirectly connected through energy and matter interactions. A new plant species may outcompete other plants for sunlight or matter. A new predator may have a

domino effect on the entire ecosystem if it is at the top of the food web. All new species have the potential to rearrange the manner in which energy flows through and matter cycles in an ecosystem. But if the "new" species is a reintroduced species that had been eliminated, it could actually benefit the ecosystem by restoring feeding relationships.

This is a good time to revisit the driving question for this sequence of learning: How do different species in the same ecosystem interact with one another and with the physical environment? Revisit the Driving Questions Board, and identify the questions that have been answered and what questions still remain. Have students add to or revise their questions as needed.

ACTIVITY RESOURCES

KEY VOCABULARY

consumer

food web

producer