12 Modeling the Introduction of a New Species

MODELING

1–2 CLASS SESSIONS

ACTIVITY OVERVIEW

NGSS CONNECTIONS

Students develop a model for an ecosystem and then introduce a new species to explain how this new component in the system affects the flow of energy and cycling of matter throughout the ecosystem. The activity provides an opportunity to assess student work related to Performance Expectation MS-LS2-3.

NGSS CORRELATION

Performance Expectation

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.

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.

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 species. They must revise their models to explore and explain how the flow of energy and cycling of matter are disrupted by this introduced species.

MATERIALS AND ADVANCE PREPARATION

- *For the teacher*
  - 1 set of Introduced Species cards
  - 1 Scoring Guide: DEVELOPING AND USING MODELS (MOD)

- *For each group of four students*
  - 1 set of 9 Food Web cards
  - 1 Scoring Guide: DEVELOPING AND USING MODELS (MOD) (optional)
  - *1 large sheet of paper (optional)
  - * ribbon or string (optional)
  - * markers (optional)

**not included in kit*

TEACHING SUMMARY

GET STARTED

1. Students review what they know about food webs.
    a. Instruct students to return to their owl food webs and turn and talk to their partners about the components and interactions in a food web.
    b. Ask students, "How do you think the introduction of a new species affects a food web?" Have them discuss briefly with their partners.

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, being sure to withhold the Introduced Species cards.
    b. (MOD ASSESSMENT) Let students know they will be assessed on the ecosystem models they develop in the next step, and explain the criteria for their models.
    c. Instruct groups to create food webs 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 models to show how the introduced species impacts the flow of energy and cycling of matter.

BUILD UNDERSTANDING

4. Students extend their understanding by considering what would happen to their ecosystems 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 return to their owl food webs and turn and talk to their partner about the components 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 that 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 them discuss briefly with their partners.

    The point of asking this question and having students answer to their partners is to have them start thinking about effects of an introduced species as they create their models.

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, being sure to withhold the Introduced Species cards.

    The Food Web cards have a teal border, while the Introduced Species cards have an orange border. Separate the Introduced Species cards from the set and distribute these in Step 3 below. There are two identical sets of cards for four different ecosystems. Each card has a brief description of an organism and enough information for the students to be able to determine whether the organism is a producer or a consumer, and if the consumer eats plants, animals, or both.

    b. (MOD ASSESSMENT) Let students know they will be assessed on the ecosystem models they develop in the next step, and explain the criteria for their models.

    Students' models must show the food web's biotic components (organisms) and interactions (feeding relationships). They must indicate how energy is flowing and 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 by drawing arrows or placing pieces of ribbon or string between organisms, 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.

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

   If groups are constructing their models on a large sheet of paper, they can show relationships with arrows drawn 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.

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 models to show how the introduced 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 string) if relationships will be eliminated.

BUILD UNDERSTANDING

4. Students extend their understanding by considering what would happen to their ecosystems 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 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.

SAMPLE RESPONSES TO ANALYSIS

1. Explain how the introduction of your new species affected your ecosystem. Be sure to address which interactions were affected.

   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. Below are just a few 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 wildflower outcompetes the other producers and the animals aren't able to eat the flowers.

   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.

   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 of the interactions could be affected.

   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 predator that feeds on these other animals could decline.

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. Introduced Species Research Project: Explain how the introduction of the species you are investigating impacts the flow of energy and cycling of matter in the ecosystem.

   Student responses will vary. One 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.

ACTIVITY RESOURCES

KEY VOCABULARY

consumer

food web

producer

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 scientific phenomena.

What to look for:

- Response accurately represents the phenomenon
- 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	Description
Level 4 Complete and correct	The student's model completely and accurately represents the components, relationships, and mechanisms of the phenomenon 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 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 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 BUT provides little or no evidence of the relationships or mechanisms associated with the phenomenon.
Level 0	The student's response is missing, illegible, or irrelevant.
x	The student had no opportunity to respond.

⋆ 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.