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.

Teacher Resources

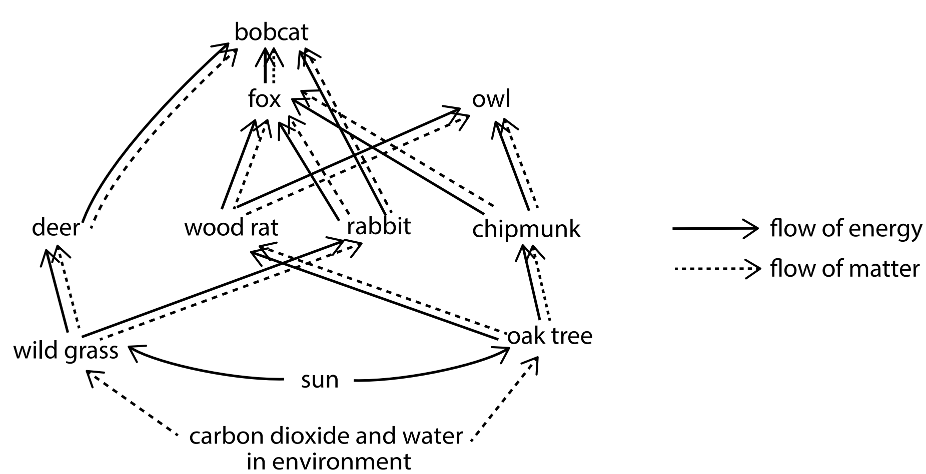
Learning Pathways

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

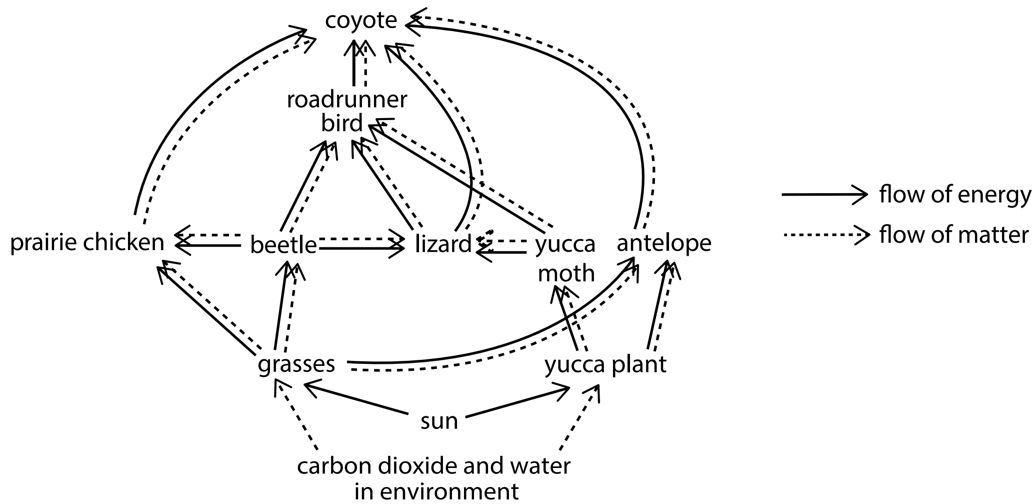
If groups are constructing their models on a large sheet of paper, they can show relationships by drawing arrows with pencils or markers. If they are constructing their model on a desk or table, they can use pieces of string or ribbon to show relationships.

Sample student responses for the four ecosystems follow.

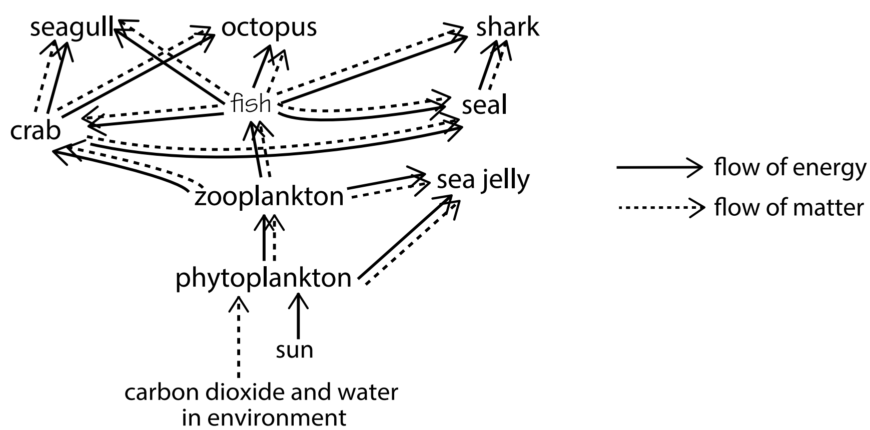
DECIDUOUS FOREST



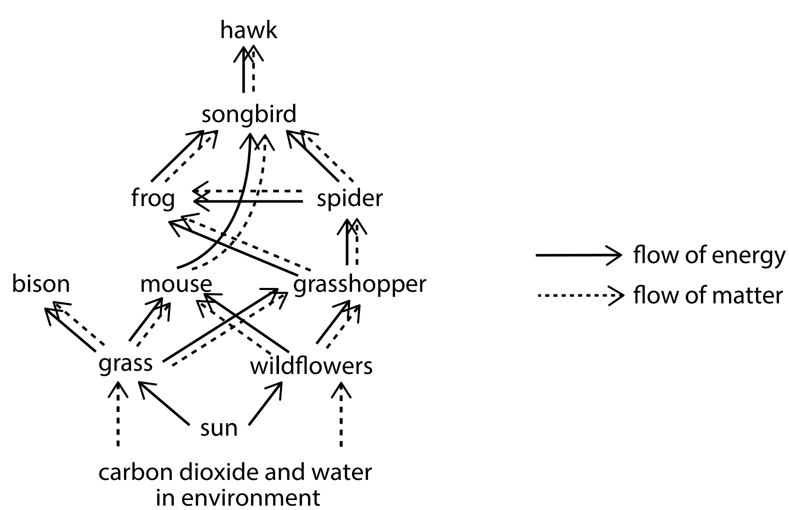
DESERT



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

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 disciplinary core ideas and crosscutting 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.

NGSS OVERVIEW

ECOLOGY

Performance Expectation MS-LS2-1: Analyze and interpret data to provide evidence for the effects of resource availability on organisms and populations of organisms in an ecosystem.

Performance Expectation MS-LS2-2: Construct an explanation that predicts patterns of interactions among organisms across multiple ecosystems.

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.

Performance Expectation MS-LS2-4: Construct an argument supported by empirical evidence that changes to physical or biological components of an ecosystem affect populations.

Performance Expectation MS-LS2-5: Evaluate competing design solutions for maintaining biodiversity and ecosystem services. .*

* *Performance expectations marked with an asterisk integrate traditional science content with engineering through a science and engineering practice or disciplinary core idea.*

Activity Description	Disciplinary Core Ideas	Science and Engineering Practices	Crosscutting Concepts	Common Core State Standards
1. **Talking It Over: The Miracle Fish?** This activity introduces students to the concept of ecology—the study of organisms and their interactions with other organisms and the environment —through a reading about the introduction of Nile perch into Lake Victoria in Africa. Students consider how this change to the biological component of the ecosystem has affected populations of other species of fish. After obtaining empirical evidence about past changes in the ecosystem, students construct arguments to predict what will happen in the future. Students then examine trade-offs and decide whether humans should have introduced Nile perch into Lake Victoria—a decision that is informed but not prescribed by science. This activity provides an opportunity to assess student work related to the crosscutting concept of connections to nature of science: Science addresses questions about the natural and material world, but while scientific knowledge can describe the consequences of actions, it does not necessarily prescribe the decisions that society takes.	MS-LS2.A MS-LS2.C MS-LS4.D	Engaging in Argument from Evidence	Cause and Effect Stability and Change Connections to Nature of Science: Science Addresses Questions About the Natural and Material World	Mathematics: 6.EE.C.9 Literacy/ELA: RST.6-8.1 WHST.6-8.1 WHST.6-8.9
2. **Project: Introduced Species** Students obtain information about a number of introduced species and use their growing knowledge and understanding about ecology to investigate the effects of one of these introduced species on an ecosystem. When communicating the results of their investigation, they explain how this species interacts with other species in the ecosystem, and how this introduced species affects (or could affect) the flow of energy in the ecosystem.	MS-LS2.A MS-LS2.C MS.LS4.D MS-ETS1.B	Obtaining, Evaluating, and Communicating Information Constructing Explanations	Cause and Effect Stability and Change Connections to Nature of Science: Science Addresses Questions About the Natural and Material World	Literacy/ELA: RST 6-8.1 RST 6-8.8 WHST.6-8.9 SL8.4 SL8.5

ECOLOGY (continued)

Activity Description	Disciplinary Core Ideas	Science and Engineering Practices	Crosscutting Concepts	Common Core State Standards
2. **Project: Introduced Species** Students obtain information about a number of introduced species and use their growing knowledge and understanding about ecology to investigate the effects of one of these introduced species on an ecosystem. When communicating the results of their investigation, they explain how this species interacts with other species in the ecosystem, and how this introduced species affects (or could affect) the flow of energy in the ecosystem.	MS-LS2.A MS-LS2.C MS.LS4.D MS-ETS1.B	Obtaining, Evaluating, and Communicating Information Constructing Explanations	Cause and Effect Stability and Change Connections to Nature of Science: Science Addresses Questions About the Natural and Material World	Literacy/ELA: RST 6-8.1 RST 6-8.8 WHST.6-8.9 SL8.4 SL8.5
3. **Investigation: Data Transects** In this activity, students engage in the practice of analyzing and interpreting data to look for patterns among living and nonliving components in ecosystems, and they hypothesize what might be causing those patterns. They explore how ecologists use the transect method to collect ecological data, which gives them an opportunity to become familiar with the nature of science concept that scientific disciplines share common rules of obtaining and evaluating empirical evidence. Students also explore the core idea of populations of organisms being dependent on their environmental interactions both with other living things and with nonliving factors.	MS-LS2.C MS-LS4.D MS-ETS1.B	Analyzing and Interpreting Data Connections to Nature of Science: Scientific Knowledge Is Based on Empirical Evidence	Patterns Cause and Effect	Mathematics: 6.SP.B.5 RST.6-8.3
4. **Field Study: Taking a Look Outside** Students explore patterns and relationships in their local environment by planning and carrying out an investigation using the transect method learned in the previous activity. Students must decide how to organize their data to allow them to look for patterns among biotic and abiotic components in the ecosystem. Students are encouraged to ask scientific questions about their local ecosystem and determine how they would test these questions.	MS-LS2.C MS-LS4.D	Planning and Carrying Out Investigations Analyzing and Interpreting Data Asking Questions and Defining Problems Connections to Nature of Science: Science Knowledge Is Based on Empirical Evidence	Patterns Cause and Effect	Mathematics: 6.SP.B.5 Literacy/ELA: RST.6-8.3

ECOLOGY (continued)

Activity Description	Disciplinary Core Ideas	Science and Engineering Practices	Crosscutting Concepts	Common Core State Standards
5. **Laboratory: A Suitable Habitat** Students plan and conduct an investigation to explore a species' habitat requirements by looking at how individuals respond to and interact with different physical components in the environment. Students construct an argument from evidence for the habitat requirements of the species and where it is likely to be in nature. They explore the behaviors and structures of individuals that help those organisms survive in their environment.	MS-LS2.A MS-LS2.C MS-LS4.C MS-LS1.D	Planning and Carrying Out Investigations Engaging in Argument from Evidence Connections to Nature of Science: Scientific Knowledge Is Based on Empirical Evidence	Patterns Cause and Effect Stability and Change	Mathematics: 6.SP.B.5 Literacy/ELA: WHST.6-8.1
6. **Investigation: Ups and Downs** Students analyze data on population size to detect patterns over periods of time, and discover that there can be periods of relative stability and periods of small and large changes in population size. They consider what might cause changes in population size, including both biotic and abiotic changes in the environment.	MS-LS2.A MS-LS2.C	Analyzing and Interpreting Data Engaging in Argument from Evidence	Patterns Cause and Effect Stability and Change	Mathematics: MP.2 Literacy/ELA: RST.6-8.3
7. **Laboratory: Coughing Up Clues** Students investigate and collect data on an owl's diet to determine the owl's place and role in a food web. They construct a simple model of a food web to begin understanding how matter and energy move in, through, and out of an ecosystem. In subsequent activities, students continue to develop their models.	MS-LS2.A MS-LS2.B	Constructing Explanations Planning and Carrying out Investigations Analyzing and Interpreting Data Developing and Using Models	Energy and Matter Systems and System Models	Mathematics: 6.RP.A.3 Literacy/ELA: RST.6-8.3
8. **Reading: Eating for Matter and Energy** Students deepen their understanding of food webs and the roles that different kinds of organisms play in an ecosystem. Students continue revising their owl food webs to model the flow of energy and to explain how disruptions to the ecosystem affect the food web. They also incorporate their initial understandings of the cycling of matter into their models. Student groups then create models to account for the fact that only 10% of the energy remains in an ecosystem from one level of the food web to the next.	MS-LS2.B MS-LS2.A	Developing and Using Models Constructing Explanations	Energy and Matter Systems and System Models Connections to Nature of Science: Scientific Knowledge Assumes an Order and Consistency in Natural Systems	Mathematics: MP.2 MP.4 6. RP.A.1 Literacy/ELA: RST.6-8.7 WHST.6-8.9

ECOLOGY (continued)

Activity Description	Disciplinary Core Ideas	Science and Engineering Practices	Crosscutting Concepts	Common Core State Standards
9. **Laboratory: Population Growth** Students plan and carry out an investigation to determine the effect of resource availability on population growth in *Paramecium*. They collect, analyze, and interpret data to provide evidence that greater food availability results in greater population growth. The activity provides an opportunity to assess student work related to Performance Expectation MS- LS2-1	MS-LS2.A	Analyzing and Interpreting Data Planning and Carrying Out Investigations	Cause and Effect Energy and Matter Scale, Proportion, and Quantity	Mathematics: MP.2 6. RP.A.1 Literacy/ELA: WHST.6-8.1
10. **Investigation: Interactions in Ecosystems** Students explore and explain the types of interactions among biotic and abiotic components in ecosystems. They consider the causes and effects of these interactions and learn that these types of interactions occur as patterns across all ecosystems. The activity provides an opportunity to assess student work related to Performance Expectation MS-LS2-2.	MS-LS2.A	Constructing Explanations	Patterns Cause and Effect	Mathematics: 6.EE.C.9 Literacy/ELA: WHST.6-8.1
11. **Laboratory: Cycling of Matter** Students carry out an investigation on decomposers to explore how matter cycles in an ecosystem. They add to their understanding of how the biotic and abiotic components of an ecosystem interact. They revise and expand their food web models, which already capture how energy flows through an ecosystem, to explain how matter cycles from the abiotic components of an ecosystem, through the biotic components, and back to the abiotic components.	MS-LS2.B MS-LS2.A	Developing and Using Models Planning and Carrying Out Investigations Constructing Explanations	Energy and Matter Systems and System Models Connections to Nature of Science: Scientific Knowledge Assumes an Order and Consistency in Natural Systems	Literacy/ELA: RST.6-8.3
12. **Modeling: Modeling the Introduction of a New Species** 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.	MS-LS2.B MS-LS2.C	Developing and Using Models	Energy and Matter Stability and Change Systems and System Models Connections to nature of science: Scientific Knowledge Assumes an Order and Consistency in Natural Systems	Literacy/ELA: WHST.6-8.1

ECOLOGY (continued)

Activity Description	Disciplinary Core Ideas	Science and Engineering Practices	Crosscutting Concepts	Common Core State Standards
13. **Investigation: Abiotic Impacts on Ecosystems** Students explore how abiotic changes in the environment can impact ecosystems. They explain how these abiotic disruptions affect the flow of energy and cycling of matter in ecosystems. These disruptions can lead to cycles of stability and change over time and at different scales. Students are assessed on their abilities to construct an explanation for why a top predator is the last organism to arrive in a disrupted ecosystem.	MS-LS2.C MS-LS2.B	Constructing Explanations	Stability and Change Energy and Matter	Literacy/ELA: WHST.6-8.1
14. **Investigation: Effects of an Introduced Species** Students use computers to analyze a large data set on the effects of the zebra mussel on the Hudson River ecosystem. They analyze and interpret data to argue how the introduction of the zebra mussel affected populations of other organisms as well as the abiotic environment. Students are assessed on how well they use empirical evidence to construct an argument for how a change to the biological component of an ecosystem affects other populations. The activity provides an opportunity to assess student work related to Performance Expectation MS-LS2-4.	MS-LS2.A MS-LS2.C MS-LS4.D MS-ESS3.C	Engaging in Argument from Evidence Asking Questions and Defining Problems Using Mathematics and Computational Thinking Analyzing and Interpreting Data Connections to Nature of Science: Scientific Knowledge Is Based on Empirical Evidence	Cause and Effect Patterns Stability and Change	Mathematics: 6.SP.B.5 Literacy/ELA: WHST.6-8.1
15. **Talking It Over: Too Many Mussels** Students explore potential solutions to the invasive zebra mussel problem. Students engage in the design process by developing initial criteria and constraints by which to evaluate solutions. After reading about several actual solutions, they revise their criteria and constraints, and then argue for the best solution(s) to maintain the natural ecosystem. The activity provides an opportunity to assess student work related to Performance Expectation MS-LS2-5.	MS-LS4.D MS-ETS1.A MS-ETS1.B MS-ESS3.C	Engaging in Argument from Evidence Using Mathematics and Computaional Thinking	Stability and Change Connections to Nature of Science: Science Addresses Questions About the Natural and Material World	Literacy/ELA: RI.8.8 WHST.6-8.1

ECOLOGY (continued)

Activity Description	Disciplinary Core Ideas	Science and Engineering Practices	Crosscutting Concepts	Common Core State Standards
16. **Projects: Presenting the Facts** Students explore how abiotic changes in the environment can impact ecosystems. They explain how these abiotic disruptions affect the flow of energy and cycling of matter in ecosystems. These disruptions can lead to cycles of stability and change over time and at different scales. Students are assessed on their abilities to construct an explanation for why a top predator is the last organism to arrive in a disrupted ecosystem.	MS-LS2.A MS-LS2.C MS-LS4.D MS-ETS1.A MS-ETS1.B MS-ESS3.C	Obtaining, Evaluating, and Communicating Information	Cause and Effect Patterns Stability and Change	Literacy/ELA: RST.6-8.8 RI8.8 WHST.6-8.2 SL.8.5

PHENOMENA, DRIVING QUESTIONS AND SEPUP STORYLINE

ECOLOGY

ECOLOGY

Unit Issue: The environmental impacts of introduced species.

Anchoring Phenomenon: Introduced species are changing environments all around us. They can cause problems for people and affect biodiversity. Examples explored include Nile perch, zebra mussels, and local examples, such as starlings, kudzu, and others identified by students and teachers. Students generate and answer questions such as: How do introduced organisms interact with their environments, what are the effects of these interactions, and what can be done to prevent harmful interactions?

Investigative Phenomena	Driving Questions	Guiding Questions	Activities	PE	Storyline
People have introduced many kinds of species into new ecosystems either on purpose or accidentally, and they can cause problems for both people and the environment.	What are the effects of introduced species, and what can be done about them?	How have introduced Nile perch changed Lake Victoria? What are the trade-offs of introducing Nile perch into this environment? (Activity 1)	1, 2 (15, 16)	MS-LS2-4 MS-LS2-5 MS- ETS1.A MS- ETS1.B	Does this happen elsewhere?
		What effect can an introduced species have on an environment? What, if anything, can or should be done to control introduced species? (Activity 2)			Students research such a species, but in order to understand that research, they need to learn about Ecology.
There are different organisms and different numbers of organisms in different places.	Why are certain species more common than others, and why do some species become more common over time?	What patterns do you detect in the two locations, and how might the information in these patterns be useful to scientists? (Activity 3)	3, 4, 5, 6	MS-LS2-1 MS-LS2-2 MS-LS2-4	How can we look for and detect patterns in the living environment? Transects are one method.
		What patterns do you observe when you investigate your own environment, and what might be causing these patterns? (Activity 4)			These differences occur everywhere, including one's own backyard/school grounds, and we can use the transect method, too.
		How do the habitat requirements of individual organisms determine where a species will be found in nature? (Activity 5)			Populations are found in places that have the right kind of features in the environment.
		Do zebra mussel populations change or stay the same in their native range? (Activity 6)			Populations fluctuate in size, and determining the causes for those changes is an important question in ecology.

PHENOMENA, DRIVING QUESTIONS AND SEPUP STORYLINE

ECOLOGY (continued)

Investigative Phenomena	Driving Questions	Guiding Questions	Activities	PE	Storyline
A variety of species tend to be found together and linked through feeding relationships.	How do different species in the same ecosystem interact with each other and with the physical environment?	What is an owl's place and role in a food web? (Activity 7)	7, 8, 9, 10, 11, 12	MS-LS2-3 MS-LS2-1 MS-LS2-2	What an organism eats helps ecologists understand their role in an ecosystem.
		How do matter and energy move in an ecosystem? (Activity 8)			We can look at what all the organisms in an ecosystem eat and connect them through energy and matter relationships.
		How does the availability of food affect a population? (Activity 9)			When a population's prey increases in abundance, its size may grow; when its prey is scarce, its size may decrease.
		How do interactions with living or non- living factors in ecosystems affect populations? (Activity 10)			There are patterns to the ways organisms interact in an ecosystem, and these patterns occur in all ecosystems.
		What is the role of decomposers in the cycling of matter in an ecosystem? (Activity 11)			Decomposers break down dead organisms and return the matter to the environment.
		How does a new species affect the flow of energy and cycling of matter through an ecosystem? (Activity 12)			Ecologists can use models to try to predict the impact of an introduced species.

PHENOMENA, DRIVING QUESTIONS AND SEPUP STORYLINE

ECOLOGY (continued)

Investigative Phenomena	Driving Questions	Guiding Questions	Activities	PE	Storyline
Physical and biological factors can disrupt an ecosystem to a small or large degree.	What happens to organisms and relationships among them when an ecosystem is disrupted?	How can an abiotic disruption such as fire affect the flow of energy and cycling of matter in an ecosystem? (Activity 13)	13, 14	MS-LS2-4	Physical disruption can impact the flow of energy and cycling of matter in an ecosystem.
		What do the scientific data tell you about how the Hudson River changed after introduction of the zebra mussel? (Activity 14)			Ecologists have a large amount of data to examine the effects of Zebra Mussels; students will examine these same data.
People have introduced many kinds of species into new ecosystems either on purpose or accidentally, and they can cause problems for both people and the environment.	What are the effects of introduced species, and what can be done about them?	How can humans control or eliminate an invasive species? (Activity 15)	(1, 2) 15, 16	MS-LS2-5 MS-LS2-4 MS- ETS1.A MS- ETS1.B	How can we look for and detect patterns in the living environment? Transects are one method.
		What effect can certain introduced species have on an environment? What, if anything, can or should humans do to control these species? (Activity 16)			These differences occur everywhere, including one's own backyard/school grounds, and we can use the transect method, too.

UNIT OVERVIEW

ECOLOGY

Unit Issue: The environmental impacts of introduced species.

Anchoring Phenomenon: Introduced species are changing environments all around us.

Listed below is a summary of the activities in this unit. Note that the total teaching time is listed as 29–34 periods of approximately 45–50 minutes (approximately 6–7 weeks). If you find you cannot finish in this time frame, consider skipping activities 5 and/or 13.

Activity Description	Topics	Advance Preparation	Assessment	Teaching Periods
1. **Talking it Over: The Miracle Fish?** Students read and discuss what happened after the Nile perch was introduced into Lake Victoria.	ecology, evidence, trade-offs, introduced species SENSEMAKING	Send drop card for blackworms (need by Activity 5) and *Paramecium* (Activity 9); prepare Student Sheet.	ARG QUICK CHECK A6 E&T A7	2
2. **Project: Introduced Species** After learning about eight species that have been introduced into the United States; students begin research to be presented later in the unit (Activity 16).	ecology, introduced species, ecosystem, biodiversity	Gather research resources; decide logistics, schedule, and timeline for research projects; prepare Student Sheet.	To be assessed at a later date: EXP: Introduced Species Research, and COM: Introduced Species Reports	2
3. **Investigation: Data Transects** Students use a model of a transect to compare organisms found in two different physical environments located in a prairie.	ecology, transects, ecological relationships, ecosystem components, restoration	Prepare Student Sheet.	3 AID QUICK CHECK A3	2
4. **Investigation: Taking a Look Outside** Students explore patterns in their local environment by using the transect method learned in the previous activity.	ecology, transects, abiotic and biotic ecosystem components, ecological relationships	Identify one or more suitable field sites; obtain hygrometer or sling psychrometer (optional).	PCI Proc. ODA Proc. QUICK CHECK	2–3
5. **Laboratory: A Suitable Habitat** Students plan and conduct a laboratory investigation to explore blackworms' responses to different habitats.	ecology, habitat, habitat requirements, adaptation LITERACY	Request blackworm shipment 2–3 weeks in advance; obtain spring water or de-chlorinated tap water, aquatic leaf litter, fish food.	PCI Proc. ARG A2	2
6. **Investigation: Ups and Downs** Students graph and interpret population data over time.	population size, population fluctuation, MATHEMATICS	Obtain transparent tape (optional); obtain visual aid; prepare Student Sheet.	ARG A1 AID A3	2
7. **Laboratory: Coughing Up Clues** Students gather information on owl diets and the owl's place in a food web as students dissect owl pellets.	food web, predator, prey, competition, energy flow	Obtain glue and cardboard (optional); prepare visual aid; prepare Student Sheet.	EXP A1 QUICK CHECK A2	1–2

ECOLOGY (continued)

Activity Description	Topics	Advance Preparation	Assessment	Teaching Periods
8. **Reading: Eating for Matter and Energy** Students read the text on food webs and the flow of energy through them. They create a model to explain the dissipation of energy from one level to the next.	food web, energy flow, matter, producers, consumers, predator, prey LITERACY	Obtain materials for student models, such as stickers, colored markers, paper, graduated cylinders, and beakers.	EXP A2 MOD QUICK CHECK A3	2–3
9. **Laboratory: Population Growth** Students use microscopes to compare populations of *Paramecium* that have been growing in environments with different amounts of food.	population growth, resource availability, competition	Request *Paramecium* shipment 2–3 weeks in advance; obtain visual aid; obtain spring water or de-chlorinated tap water, paper towels, milk and toothpicks (optional); need microscopes.	AID A3 (Assessment of PE MS-LS2-1)	2
10. **Investigation: Interactions in Ecosystems** Students interpret data from graphs and match them to ecological scenarios describing patterns of interaction that affect population sizes.	interactions, predator, prey, competition, symbiosis, mutualism, commensalism, parasitism LITERACY	Prepare Student Sheets.	EXP Proc. (Assessment of PE MS-LS2-2) QUICK CHECK A1	1
11. **Laboratory: Cycling of Matter** Students investigate the role of decomposers while isolating and examining nematodes in soil samples. Students study decomposition in a small classroom compost container.	decomposers, decomposition, cycling of matter, producers, consumers, food web	Obtain soil samples; need microscopes.	MOD QUICK CHECK A1	2
12. **Modeling: Modeling the Introduction of a New Species** Students work in groups to model a food web using a set of organism cards. They are then given an additional card representing an introduced species and must revise their models.	cycling of matter, flow of energy, ecosystem, food web	Obtain materials for student ecosystem models, such as string, stickers, and paper.	MOD Proc. (Assessment of PE MS-LS2-3)	2
13. **Investigation: Abiotic Impacts on Ecosystems** Students investigate a model of large- scale ecosystem disruption by arranging cards showing the effects of a large forest fire.	disruptions, dynamics, resilience, ecosystem, succession	Prepare Student Sheet.	EXP A3	1–2
14. **Investigation: Effects of an Introduced Species** Students use a Web-based graphing tool to graph and analyze a large data set on zebra mussels and their effects on several ecosystem components.	introduced species, ecosystem, dynamics, disturbance, disruption, biodiversity	Arrange access to multiple computers with Internet access.	ARG A1, A2 (Assessment of PE MS-LS2-4)	2

ECOLOGY (continued)

Activity Description	Topics	Advance Preparation	Assessment	Teaching Periods
15. **Talking it Over: Too Many Mussels** Students evaluate control options to address the problems caused by zebra mussels for humans and ecosystems.	engineering, design, solution, criteria, constraints, ecosystem services, biodiversity	Prepare Student Sheets.	ARG A1a (Assessment of PE MS-LS2-5) E&T A1b ENG QUICK CHECK SS 15.2	2
16. **Project: Introduced Species** Student groups present their introduced species research. The class discusses the characteristics of an introduced species that make it likely to proliferate in a given ecosystem.	ecosystem, ecology, food web, introduced species, competition, predator, prey, engineering, solution, biodiversity, ecosystem services	Prepare Student Sheet.	COM Presentations EXP Written Report	2–3