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.

UNIT OVERVIEW - NGSS

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.

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	Math: 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
3. **Investigation: Data Transects** In this activity, students engage in the practice of analyzing and interpreting data to look for patterns among living and non-living 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	Math: 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 Connections to Nature of Science: Science Knowledge Is Based on Empirical Evidence	Patterns Cause and Effect	Math: 6.SP.B.5 Literacy/ELA: RST.6-8.3
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	Math: 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	Math: MP.2 Literacy/ELA: RST.6-8.3

ECOLOGY (continued)

Activity Description	Disciplinary Core Ideas	Science and Engineering Practices	Crosscutting Concepts	Common Core State Standards
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	Math: 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	Math: MP.2 MP.4 6.RP.A.1 Literacy/ELA: RST.6-8.7 WHST.6-8.9
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	Math: 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	Math: 6.EE.C.9 Literacy/ELA: WHST.6-8.1

ECOLOGY (continued)

Activity Description	Disciplinary Core Ideas	Science and Engineering Practices	Crosscutting Concepts	Common Core State Standards
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 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
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

ECOLOGY (continued)

Activity Description	Disciplinary Core Ideas	Science and Engineering Practices	Crosscutting Concepts	Common Core State Standards
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 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	Math: 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	Stability and Change Connections to Nature of Science: Science Addresses Questions About the Natural and Material World	Literacy/ ELA: RI8.8 WHST.6-8.1
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

NGSS CORRELATIONS

ECOLOGY – TEACHER EDITION

Crosscutting Concepts		Activity number
Patterns	Patterns can be used to identify cause and effect relationships.	3, 4, 5, 6, 10, 14, 16
Energy and Matter	The transfer of energy can be tracked as energy flows through a designed or natural system.	7, 8, 9, 11, 12, 13
Stability and Change	Small changes in one part of a system might cause large changes in another part.	1, 2, 5, 6, 13, 14, 15, 16
Cause and Effect	Cause and effect relationships may be used to predict phenomena in natural or designed systems.	1, 2, 3, 4, 5, 6, 9, 10, 14, 16
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.	7, 8, 11, 12
Scale, Proportion, and Quantity	Proportional relationships (e.g. speed as the ratio of distance traveled to time taken) among different types of quantities provide information about the magnitude of properties and processes.	9
Connections to the Nature of Science	Scientific knowledge can describe the consequences of actions but does not necessarily prescribe the decisions that society takes.	1, 2, 15
Cause and Effect	Cause and effect relationships may be used to predict phenomena in natural or designed systems.	1, 2, 3, 4, 5, 6, 9, 10, 14, 16
	Science assumes that objects and events in natural systems occur in consistent patterns and are understandable through measurement and observation.	8, 11, 12
Science and Engineering Practices		**Activity number**
Analyzing and Interpreting Data	Analyze and interpret data to provide evidence for phenomena.	3, 4, 6, 7, 9, 14
Asking Questions and Defining Problems	Ask questions that can be investigated within the scope of the classroom, outdoor environment, and museums and other public facilities with available resources and, when appropriate, frame a hypothesis based on observations and scientific principles.	4
Constructing Explanations and Designing Solutions	Construct an explanation that includes qualitative or quantitative relationships between variables that predict or describe phenomena.	2, 7, 8, 10, 11, 13
Developing and Using Models	Develop a model to predict and/or describe phenomena.	7, 8, 11, 12

Science and Engineering Practices		Activity number
Engaging in Argument from Evidence	Construct and present oral and written arguments supported by empirical evidence and scientific reasoning to support or refute an explanation or a model for a phenomenon or a solution to a problem.	1, 5, 6
	Use an oral and written argument supported by evidence to support or refute an explanation or a model for a phenomenon.	14
	Evaluate competing design solutions based on jointly developed and agreed-upon design criteria.	15
Obtaining, Evaluating, and Communicating Information	Integrate qualitative scientific and technical information in written text with that contained in media and visual displays to clarify claims and findings.	16
	Gather, read, and synthesize information from multiple appropriate sources and assess the credibility, accuracy, and possible bias of each publication and methods used, and describe how they are supported or not supported by evidence.	2
Planning and Carrying Out Investigations	Conduct an investigation and evaluate the experimental design to produce data to serve as the basis for evidence that can meet the goals of the investigation.	4, 5, 7, 9
	Conduct an investigation to produce data to serve as the basis for evidence that meet the goals of an investigation.	11
Using Mathematics and Computational Thinking	Use digital tools (e.g., computers) to analyze very large data sets for patterns and trends.	14
Connections to the Nature of Science	Science disciplines share common rules of obtaining and evaluating empirical evidence.	3, 4, 5, 14
Performance Expectations		**Activity number**
Ecosystems: Interactions, Energy, and Dynamics (LS2)	Analyze and interpret data to provide evidence for the effects of resource availability on organisms and populations of organisms in an ecosystem. (MS-LS2-1)	9
	Construct an explanation that predicts patterns of interactions among organisms across multiple ecosystems. (MS-LS2-2)	10
	Develop a model to describe the cycling of matter and flow of energy among living and nonliving parts of an ecosystem. (MS-LS2-3)	12
	Construct an argument supported by empirical evidence that changes to physical or biological components of an ecosystem affect populations. (MS-LS2-4)	14
	Evaluate competing design solutions for maintaining biodiversity and ecosystem services.* (MS-LS2-5)	15

Disciplinary Core Ideas		Activity number
Information Processing (LS1.D)	Each sense receptor responds to different inputs (electromagnetic, mechanical, chemical), transmitting them as signals that travel along nerve cells to the brain. The signals are then processed in the brain, resulting in immediate behaviors or memories.	5
nterdependent Relationships in Ecosystems (LS2.A)	Organisms, and populations of organisms, are dependent on their environmental interactions both with other living things and with nonliving factors.	1, 2, 5, 6, 7, 8, 9, 14, 16
	In any ecosystem, organisms and populations with similar requirements for food, water, oxygen, or other resources may compete with each other for limited resources, access to which consequently constrains their growth and reproduction.	1, 5, 6, 7, 9, 12, 14, 16
	Growth of organisms and population increases are limited by access to resources.	6, 7, 9, 16
	Similarly, predatory interactions may reduce the number of organisms or eliminate whole populations of organisms. Mutually beneficial interactions, in contrast, may become so interdependent that each organism requires the other for survival. Although the species involved in these competitive, predatory, and mutually beneficial interactions vary across ecosystems, the patterns of interactions of organisms with their environments, both living and nonliving, are shared.	2, 6, 7, 10, 12, 16
Cycle of Matter and Energy Transfer in Ecosystems (LS2.B)	Food webs are models that demonstrate how matter and energy is 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 cycled repeatedly between the living and nonliving parts of the ecosystem.	7, 8, 11, 12, 13
Ecosystem Dynamics, Functioning, and Resilience (LS2.C)	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.	1, 2, 3, 4, 6, 12, 13, 14, 16
	Biodiversity describes the variety of species found in Earth's terrestrial and oceanic ecosystems. The completeness or integrity of an ecosystem's biodiversity is often used as a measure of its health.	2, 3, 4, 5, 14, 15, 16

Disciplinary Core Ideas		Activity number
Adaptation (LS4.C)	Adaptation by natural selection acting over generations is one important process by which species change over time in response to changes in environmental conditions. Traits that support successful survival and reproduction in the new environment become more common; those that do not become less common. Thus, the distribution of traits in a population changes.	5
Biodiversity and Humans (LS4.D)	Changes in biodiversity can influence humans' resources, such as food, energy, and medicines, as well as ecosystem services that humans rely on—for example, water purification and recycling.	1, 2, 3, 4, 14, 15, 16
Human Impacts on Earth Systems (ESS3.C)	Human activities have significantly altered the biosphere, sometimes damaging or destroying natural habitats and causing the extinction of other species. But changes to Earth's environments can have different impacts (negative and positive) for different living things.	13, 14, 16
	Typically as human populations and per-capita consumption of natural resources increase, so do the negative impacts on Earth unless the activities and technologies involved are engineered otherwise.	15
Defining and Delimiting Engineering Problems (ETS1.A)	The more precisely a design task's criteria and constraints can be defined, the more likely it is that the designed solution will be successful. Specification of constraints includes consideration of scientific principles and other relevant knowledge that is likely to limit possible solutions.	15, 16
Developing Possible Solutions (ETS1.B)	There are systematic processes for evaluating solutions with respect to how well they meet the criteria and constraints of a problem.	2, 3, 15, 16

COMMON CORE STATE STANDARDS CORRELATIONS

ECOLOGY – TEACHER EDITION

Common Core State Standards – English Language Arts		Activity number
Reading Informational Text (RI)	Trace and evaluate the argument and specific claims in a text, assessing whether the reasoning is sound and the evidence is relevant and sufficient to support the claims. (RI. 8.8)	15, 16
Reading in Science and Technical Subjects (RST)	Cite specific textual evidence to support analysis of science and technical texts, attending to the precise details of explanations or descriptions. (RST.6-8.1)	1, 2
	Follow precisely a multi-step procedure when carrying out experiments, taking measurements, or performing technical tasks. (RST.6-8.3)	3, 4, 6, 7, 11
	Integrate quantitative or technical information expressed in words in a text with a version of that information expressed visually (e.g., in a flowchart, diagram, model, graph, or table). (RST.6-8.7)	8
	Distinguish among facts, reasoned judgment based on research findings, and speculation in a text. (RST.6-8.8)	2, 16
Speaking and Listening (SL)	Present claims and findings, emphasizing salient points in a focused, coherent manner with relevant evidence, sound and valid reasoning, and well-chosen details: use appropriate eye contact, adequate volume, and clear pronunciation. (SL.8.4)	2, 16
	Integrate multimedia and visual displays into presentations to clarify information, strengthen claims and evidence, and add interest. (SL.8.5)	2, 16
Writing in History/ Social Studies, Science, and Technological Subjects (WHST)	Write arguments focused on discipline-specific content. (WHST.6-8.1)	1, 5, 9, 10, 12, 13, 14, 15
	Write informative/explanatory texts to examine and convey ideas, concepts, and information through the selection, organization, and analysis of relevant content. (WHST.6-8.2)	16
	Draw evidence from informational texts to support analysis, reflection, and research. (WHST.6-8.9)	1, 2, 8

Common Core State Standards – Mathematics		Activity number
Mathematical Practice (MP)	Reason abstractly and quantitatively. (MP.2)	6, 8, 9
	Model with mathematics. (MP.4)	8
Ratios and Proportional Reasoning (RP)	Understand the concept of a ratio, and use ratio language to describe a ratio between two quantities. (6.RP.A.1)	8, 9
	Use ratio and rate reasoning to solve real-world and mathematical problems. (6.RP.A.3)	7
Expressions and Equations (EE)	Use variables to represent two quantities in a real-world problem that change in relationship to one another; write an equation to express one quantity, thought of as the independent variable. Analyze the relationship between the dependent and independent variables using graphs and tables, and relate these to the equation. (6.EE.C.9)	1, 10
Statistics and Probability (SP)	Summarize numerical data sets in relation to their context. (6.SP.B.5)	3, 4, 5, 14

PHENOMENA, DRIVING QUESTIONS AND STORYLINE

ECOLOGY

How and why do organisms interact with their environment and what are the effects of these interactions?

Phenomenon	Driving Questions	Guiding Questions	Activities	PE	Storyline/Flow
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 ETS1.A ETS1.B	Does this happen elsewhere? GO TO ACTIVITY 2
		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. GO TO ACTIVITY 3
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 environments, and how might the information in these patterns be helpful 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. GO TO ACTIVITY 4
		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. GO TO ACTIVITY 5
		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. GO TO ACTIVITY 6
		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. GO TO ACTIVITY 7

Phenomenon	Driving Questions	Guiding Questions	Activities	PE	Storyline/Flow
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. GO TO ACTIVITY 8
		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. GO TO ACTIVITY 9
		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. GO TO ACTIVITY 10
		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. GO TO ACTIVITY 11
		How does a new species affect the flow of energy and movement of matter through an ecosystem? (Activity 11)			Decomposers break down dead organisms and return the matter to the environment. GO TO ACTIVITY 12
		What is the role of decomposers in the cycling of matter in an ecosystem? (Activity 12)			Ecologists can use models to try to predict the impact of an introduced species. GO TO ACTIVITY 13

PHENOMENA, DRIVING QUESTIONS AND STORYLINE

ECOLOGY (continued)

How and why do organisms interact with their environment and what are the effects of these interactions?

Phenomenon	Driving Questions	Guiding Questions	Activities	PE	Storyline/Flow
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. GO TO ACTIVITY 14
		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. GO TO ACTIVITY 15
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 an invasive species be controlled or eliminated? (Activity 15)	(1, 2) 15, 16	MS-LS2-5 MS-LS2-4 ETS1.A ETS1.B	How can we look for and detect patterns in the living environment? Transects are one method. GO TO ACTIVITY 16
		What effect can certain introduced species have on an environment? What, if anything, can or should be done 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. GO TO ACTIVITY 1