CEREAL CITY SCIENCE by BCAMSC

Teacher Guide and Student Journal
Sample Activity and Planning Pages

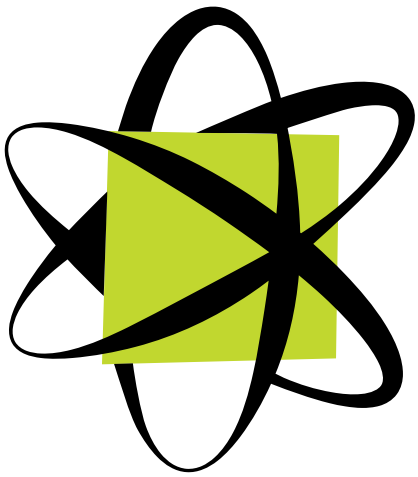
Stability and Change in an Ecosystem
MSLNG1

A Middle School Unit supporting Next Generation Science Standards and Michigan Science Standards

Stability and Change in an Ecosystem

MSLNG1

A middle school unit supporting **Next Generation Science Standards** and the **Michigan Science Standards** developed and written by the Battle Creek Area Mathematics and Science Center for



CEREAL CITY SCIENCE™

by BCAMSC

Stability and Change in an Ecosystem

Pre-Activity Information Pages

Activities

Appendix

NEXT GENERATION SCIENCE STANDARDS

DISCIPLINARY CORE IDEAS/PERFORMANCE ASSESSMENTS	Activity
LS2.A: Interdependent Relationships in Ecosystems • 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. (MS-LS2-2) • Organisms, and populations of organisms, are dependent on their environmental interactions both with other living things and with nonliving factors. (MS-LS2-1) • 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. (MS-LS2- 1) • Growth of organisms and population increases are limited by access to resources. (MS-LS2-1)	1,2,3,4,5,6
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.	1,2,3,4
MS-LS2-2. Construct an explanation that predicts patterns of interactions among organisms across multiple ecosystems.	2,3,4
LS2.C: Ecosystem Dynamics, Functioning, and Resilience • 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. (secondary to MS-LS2-5) • 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. (MS-LS2-4)	2,3,4
MS-LS2-4. Construct an argument supported by empirical evidence that changes to physical or biological components of an ecosystem affect populations.	2,3,4
MS-LS2-5. Evaluate competing design solutions for maintaining biodiversity and ecosystem services.	2,3,4

NEXT GENERATION SCIENCE STANDARDS

DISCIPLINARY CORE IDEAS/PERFORMANCE ASSESSMENTS	Activity
LS4.D: Biodiversity and Humans • 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. (secondary to MS-LS2-5)	2,3,4,6
MS-LS2-5. Evaluate competing design solutions for maintaining biodiversity and ecosystem services.	2,3,4,6
ETS1.B: Developing Possible Solutions • There are systematic processes for evaluating solutions with respect to how well they meet the criteria and constraints of a problem. (secondary to MS-LS2-5)	3
MS-LS2-5. Evaluate competing design solutions for maintaining biodiversity and ecosystem services.	3,4
LS2.B: Cycle of Matter and Energy Transfer in Ecosystems • 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. (MS-LS2-3)	2,3,4,5,6
MS-LS2-3. Develop a model to describe the cycling of matter and flow of energy among living and nonliving parts of an ecosystem.	2,3,4,5,6

NEXT GENERATION SCIENCE STANDARDS

SCIENCE AND ENGINEERING PRACTICES/PERFORMANCE ASSESSMENTS	Activity
Developing and Using Models Modeling in 6–8 builds on K–5 experiences and progresses to developing, using, and revising models to describe, test, and predict more abstract phenomena and design systems. • Develop and use a model to describe phenomena. • Develop a model to describe unobservable mechanisms.	1,2,3,4,5,6
MS-LS2-3. Develop a model to describe the cycling of matter and flow of energy among living and nonliving parts of an ecosystem.	2,3,4,5,6
Analyzing and Interpreting Data Analyzing data in 6–8 builds on K–5 experiences and progresses to extending quantitative analysis to investigations, distinguishing between correlation and causation, and basic statistical techniques of data and error analysis. • Analyze and interpret data to provide evidence for phenomena. (MS-LS2-1)	2,4
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.	2,4
Constructing Explanations and Designing Solutions Constructing explanations and designing solutions in 6–8 builds on K–5 experiences and progresses to include constructing explanations and designing solutions supported by multiple sources of evidence consistent with scientific ideas, principles, and theories. • Construct an explanation that includes qualitative or quantitative relationships between variables that predict phenomena. (MS-LS2-2)	2,3,4,5,6
MS-LS2-2. Construct an explanation that predicts patterns of interactions among organisms across multiple ecosystems.	2,3,4,5,6

NEXT GENERATION SCIENCE STANDARDS

SCIENCE AND ENGINEERING PRACTICES/PERFORMANCE ASSESSMENTS	Activity
Engaging in Argument from Evidence Engaging in argument from evidence in 6–8 builds on K–5 experiences and progresses to constructing a convincing argument that supports or refutes claims for either explanations or solutions about the natural and designed world(s). • Evaluate competing design solutions based on jointly developed and agreed-upon design criteria. (MS-LS2-5) • Construct an oral and written argument 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. (MS-LS2-4)	3,4,6
MS-LS2-4. Construct an argument supported by empirical evidence that changes to physical or biological components of an ecosystem affect populations.	3,4,6
MS-LS2-5. Evaluate competing design solutions for maintaining biodiversity and ecosystem services.	3,4,6

NEXT GENERATION SCIENCE STANDARDS

CROSSCUTTING CONCEPTS/PERFORMANCE ASSESSMENTS	Activity
Cause and Effect • Cause-and-effect relationships may be used to predict phenomena in natural or designed systems. (MS-LS2-1)	1,2,3,4,5,6
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.	2,3,4,5,6
Energy and Matter • The transfer of energy can be tracked as energy flows through a natural system. (MS-LS2-3)	4,5,6
MS-LS2-3. Develop a model to describe the cycling of matter and flow of energy among living and nonliving parts of an ecosystem.	4,5,6
Stability and Change • Small changes in one part of a system might cause large changes in another part. (MSLS2-4)	2,3,4,6
MS-LS2-4. Construct an argument supported by empirical evidence that changes to physical or biological components of an ecosystem affect populations.	2,3,4,6
MS-LS2-5. Evaluate competing design solutions for maintaining biodiversity and ecosystem services.	2,3,4,6
Patterns • Patterns can be used to identify cause-and-effect relationships. (MS-LS2-2)	2,3,4,6
MS-LS2-2. Construct an explanation that predicts patterns of interactions among organisms across multiple ecosystems.	2,3,4,6

NEXT GENERATION SCIENCE STANDARDS—GUIDING QUESTIONS

DISCIPLINARY CORE IDEAS

LS2.A: Interdependent Relationships in Ecosystems

- 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. (MS-LS2-2)
- Organisms, and populations of organisms, are dependent on their environmental interactions both with other living things and with nonliving factors. (MS-LS2-1)
- 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. (MS-LS2- 1)
- Growth of organisms and population increases are limited by access to resources. (MS-LS2-1)
  - How can we use patterns to construct an explanation to predict interactions among organisms in ecosystems?
  - How can we evaluate patterns in data to explain how populations will change when resources change within an ecosystem?

LS2.C: Ecosystem Dynamics, Functioning, and Resilience

- 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. (secondary to MS-LS2-5)
- 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. (MS-LS2-4)
  - How can we determine how humans affect changes in biodiversity and how those changes affect human resources?
  - How can we use patterns in shifts in one population to explain the shifts in all its populations?

LS4.D: Biodiversity and Humans

- 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. (secondary to MS-LS2-5)
  - How can we determine how humans affect changes in biodiversity and how those changes affect human resources?
  - How can we use patterns in shifts in one population to explain the shifts in all its populations?

NEXT GENERATION SCIENCE STANDARDS—GUIDING QUESTIONS

DISCIPLINARY CORE IDEAS

ETS1.B: Developing Possible Solutions

- There are systematic processes for evaluating solutions with respect to how well they meet the criteria and constraints of a problem. (secondary to MS-LS2-5)
  - How can we figure out how to solve the problem of human impact on top predators in an ecosystem?

LS2.B: Cycle of Matter and Energy Transfer in Ecosystems

- 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. (MS-LS2-3)
  - How can we develop a model of a food web that explains how matter and energy is transferred within the components of the system?

NEXT GENERATION SCIENCE STANDARDS—GUIDING QUESTIONS

SCIENCE AND ENGINEERING PRACTICES

Developing and Using Models

- Develop and use a model to describe phenomena.
  - How can we develop and use a model to explain changes in populations of organisms?
  - How can we develop and use a model to demonstrate the flow of energy and matter within an ecosystem?
  - How can we develop and use a model to explain the interdependent relationships in ecosystems?

Analyzing and Interpreting Data

Analyzing data in 6–8 builds on K–5 experiences and progresses to extending quantitative analysis to investigations, distinguishing between correlation and causation, and basic statistical techniques of data and error analysis.

- Analyze and interpret data to provide evidence for phenomena. (MS-LS2-1)
  - How can we use data to provide evidence to explain how human activity that limits or eliminates the number of top predators in an ecosystem has an effect on all living things in an ecosystem and available resources?

Constructing Explanations and Designing Solutions

Constructing explanations and designing solutions in 6–8 builds on K–5 experiences and progresses to include constructing explanations and designing solutions supported by multiple sources of evidence consistent with scientific ideas, principles, and theories.

- Construct an explanation that includes qualitative or quantitative relationships between variables that predict phenomena. (MS-LS2-2)
  - How can we use patterns to construct an explanation to predict interactions among organisms in ecosystems?
  - How can we evaluate patterns in data to explain how populations will change when resources change within an ecosystem?

Engaging in Argument from Evidence

Engaging in argument from evidence in 6–8 builds on K–5 experiences and progresses to constructing a convincing argument that supports or refutes claims for either explanations or solutions about the natural and designed world(s).

- Evaluate competing design solutions based on jointly developed and agreed-upon design criteria. (MS-LS2-5)
- Construct an oral and written argument 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. (MS-LS2-4)
  - How can we figure out how to solve the problem of human impact on top predators in an ecosystem?

NEXT GENERATION SCIENCE STANDARDS—GUIDING QUESTIONS

CROSSCUTTING CONCEPTS

Cause and Effect

- Cause-and-effect relationships may be used to predict phenomena in natural or designed systems. (MS-LS2-1)
  - How can we use evidence to explain the cause-and-effect relationship between human activity and change in an ecosystem?
  - How can we use evidence to explain the cause-and-effect relationship between the loss of the top predator and changes in the ecosystem?

Energy and Matter

- The transfer of energy can be tracked as energy flows through a natural system. (MS-LS2-3)
  - How can we use a model to explain how energy and matter cycle through an ecosystem?

Stability and Change

- Small changes in one part of a system might cause large changes in another part. (MSLS2-4)
  - How can we use a model to explain how a change in the population of one species in an ecosystem changes the population of other species within the system?

Patterns

- Patterns can be used to identify cause-and-effect relationships. (MS-LS2-2)
  - How can we use patterns to explain the cause-and-effect relationship between human activity and change in an ecosystem?
  - How can we use patterns to explain fluctuations in populations over time?

COMMON CORE STATE STANDARDS—READING

READING SCIENCE AND TECHNICAL SUBJECTS—GRADES 6–8	Activity
Key Ideas and Details	
RST.6–8.1: Cite specific textual evidence to support analysis of science and technical texts.	2,5,6
RST.6–8.2: Determine the central ideas or conclusions of a text; provide an accurate summary of the text distinct from prior knowledge or opinions.	2,5,6
RST.6–8.3: Follow precisely a multi-step procedure when carrying out experiments, taking measurements, or performing technical tasks.	5
Craft and Structure	
RST.6–8.4: Determine the meaning of symbols, key terms, and other domain-specific words and phrases as they are used in a specific scientific or technical context relevant to grades 6–8 texts and topics.	2,5,6
RST.6–8.5: Analyze the structure an author uses to organize a text, including how the major sections contribute to the whole and to an understanding of the topic.	
RST.6–8.6: Analyze the author's purpose in providing an explanation, describing a procedure, or discussing an experiment in a text.	
Integration of Knowledge and Ideas	
RST.6–8.7: 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).	2,5,6
RST.6–8.8: Distinguish among facts, reasoned judgment based on research findings, and speculation in a text.	6
RST.6–8.9: Compare and contrast the information gained from experiments, simulations, video, or multimedia sources with that gained from reading a text on the same topic.	2,5,6
Range of Reading and Level of Text Complexity	
RST.6–8.10: By the end of grade 8, read and comprehend science/technical texts in the grades 6–8 text complexity band independently and proficiently.	2,5,6

COMMON CORE STATE STANDARDS—WRITING

HISTORY/SOCIAL STUDIES, SCIENCE, AND TECHNICAL SUBJECTS WRITING STANDARDS—GRADES 6–8	Activity
Text Types and Purposes	
WHST.6–8.1: Write arguments focused on discipline-specific content.	2,5,6
WHST.6–8.1.A: Introduce claim(s) about a topic or issue, acknowledge and distinguish the claim(s) from alternate or opposing claims, and organize the reasons and evidence logically.	1,2,3,4,5,6
WHST.6–8.1.B: Support claim(s) with logical reasoning and relevant, accurate data and evidence that demonstrate an understanding of the topic or text, using credible sources.	1,2,3,4,5,6
WHST.6–8.1.C: Use words, phrases, and clauses to create cohesion and clarify the relationships among claim(s), counterclaims, reasons, and evidence.	1,2,3,4,5,6
WHST.6–8.1.D: Establish and maintain a formal style.	2,5,6
WHST.6–8.1.E: Provide a concluding statement or section that follows from and supports the argument presented.	1,2,3,4,5,6
WHST.6–8.2: Write informative/explanatory texts, including the narration of historical events, scientific procedures/ experiments, or technical processes.	1,2,3,4,5,6
WHST.6–8.2.A: Introduce a topic clearly, previewing what is to follow; organize ideas, concepts, and information into broader categories as appropriate to achieving purpose; include formatting (e.g., headings), graphics (e.g., charts, tables), and multimedia when useful to aiding comprehension.	2,3,4,5,6
WHST.6–8.2.B: Develop the topic with relevant, well-chosen facts, definitions, concrete details, quotations, or other information and examples.	1,2,3,4,5,6
WHST.6–8.2.C: Use appropriate and varied transitions to create cohesion and clarify the relationships among ideas and concepts.	2,3,4,5,6
WHST.6–8.2.D: Use precise language and domain-specific vocabulary to inform about or explain the topic.	1,2,3,4,5,6
WHST.6–8.2.E: Establish and maintain a formal style and objective tone.	2,4,5,6
WHST.6–8.2.F: Provide a concluding statement or section that follows from and supports the information or explanation presented.	1,2,3,4,5,6

COMMON CORE STATE STANDARDS—WRITING

HISTORY/SOCIAL STUDIES, SCIENCE, AND TECHNICAL SUBJECTS WRITING STANDARDS—GRADES 6–8	Activity
Production and Distribution of Writing	
WHST.6–8.4: Produce clear and coherent writing in which the development, organization, and style are appropriate to task, purpose, and audience.	1,2,3,4,5,6
WHST.6–8.5: With some guidance and support from peers and adults, develop and strengthen writing as needed by planning, revising, editing, rewriting, or trying a new approach, focusing on how well purpose and audience have been addressed.	4,5,6
WHST.6–8.6: Use technology, including the Internet, to produce and publish writing and present the relationships between information and ideas clearly and efficiently.	1,2,3,4,5,6
Research to Build and Present Knowledge	
WHST.6–8.7: Conduct short research projects to answer a question (including a self-generated question), drawing on several sources and generating additional related, focused questions that allow for multiple avenues of exploration.	1,2,3,4,5,6
WHST.6–8.8: Gather relevant information from multiple print and digital sources, using search terms effectively; assess the credibility and accuracy of each source; and quote or paraphrase the data and conclusions of others while avoiding plagiarism and following a standard format for citation.	1,2,3,4,5,6
WHST.6–8.9: Draw evidence from informational texts to support analysis, reflection, and research.	1,2,3,4,5,6
Range of Writing	
WHST.6–8.10: Write routinely over extended time frames (time for reflection and revision) and shorter time frames (a single sitting or a day or two) for a range of discipline-specific tasks, purposes, and audiences.	1,2,3,4,5,6

COMMON CORE STATE STANDARDS—MATHEMATICS

MATHEMATICS—GRADES 6–8	Activity
Mathematical Practices	
1. Make sense of problems and persevere in solving them.	1,2,3,4,5,6
2. Reason abstractly and quantitatively.	1,2,3,4,5,6
3. Construct viable arguments and critique the reasoning of others.	1,2,3,4,5,6
4. Model with mathematics.	3,4
5. Use appropriate tools strategically.	1,2,3,4,5,6
6. Attend to precision.	1,2,3,4,5,6
7. Look for and make use of structure.	1,2,3,4,5,6
8. Look for and express regularity in repeated reasoning.	1,2,3,4,5,6
Ratios and Proportional Relationships	
6. Understand ratio concepts and use ratio reasoning to solve problems.	2,3,4
7. Analyze proportional relationships and use them to solve real-world and mathematical problems.	2,3,4
8. Know that there are numbers that are not rational, and approximate them by rational numbers.	4
The Number System	
5. Multiply and divide multi-digit numbers and find common factors and multiples.	3
7. Apply and extend previous understandings of operations with fractions to add, subtract, multiply, and divide rational numbers.	3
Expressions and Equations	
1. Apply and extend previous understanding of arithmetic to algebraic expressions.	4
2. Reason about and solve one-variable equations and inequalities.	
3. Represent and analyze quantitative relationships between dependent and independent variables.	2
Statistics and Probability	
1. Develop understanding of statistical variability.	2
2. Summarize and describe distributions.	2,4

UNIT AT A GLANCE

Activity	Time to Complete	Lesson-Level Learning Goals	Phenomena/ Challenge	Summary: Students will…
1. Models of Ecosystems	Preparation: 30 minutes Activity: 2 classes Lesson 1A: 55–60 min. Lesson 1B: 55–60 min.	Develop a classroom model of an ecosystem. Ask questions about how ecosystems sustain themselves and are balanced.	Challenge: Make observations of diverse organisms to develop a classroom model woodland ecosystem.	• Make observations of organisms and share their findings. • Develop a model of their ideas of how to design a habitat to support their organisms. • Read and interpret informational text about their organism. • Write a procedure to assemble a classroom habitat.
2. Interactions on Isle Royale	Preparation: 20 minutes Activity: 8–11 classes Lesson 2A: 55–60 min., 2–3 classes Lesson 2B: 55–60 min. Lesson 2C: 55–60 min. Lesson 2D: 55–60 min., 3–5 classes with time for presentations	Develop an initial model to explain predator/prey relationships between populations. Analyze and interpret data to find patterns in populations of organisms in an ecosystem.	Relationship between wolf and moose populations. Fluctuations in wolf and moose populations.	• Obtain information from multiple sources about the wolf and moose populations on Isle Royale. • Develop models of a classroom habitat.
3. Expanding beyond Isle Royale	Preparation: 20 minutes Activity: 4 classes Lesson 3A: 55–60 min., 2 classes Lesson 3B: 55–60 min., 2 classes	Obtain and analyze information about biodiversity and human impact to engage in argument about the importance of biodiversity and the different roles each organism plays.	Relationship between wolf and moose populations. Fluctuations in wolf and moose populations.	• Communicate initial ideas about and reactions to wolves and top predators. • Analyze and critique the models of others. • Ask questions about the wolf and moose populations on Isle Royale. • Research a question and present findings.

UNIT AT A GLANCE

Students Figure Out How to:	Practices/Crosscutting Concepts	Assessment
• Use information from text to design and develop a classroom habitat for their class organisms. • Use information to explain the interactions among the different organisms. • Analyze patterns in comparing needs of different organisms. • Communicate an understanding of a balanced ecosystem.	**Developing and Using Models** **Obtaining, Evaluating, and Communicating Information** **Asking Questions and Defining Problems** **Systems and System Models** **Patterns**	**Formative: Assessment** Initial models Activity Page Science Talk Class Concept Map
• Develop initial models of the food web on Isle Royale. • Raise questions about interactions among the organisms on Isle Royale. • Determine how to investigate their ideas.	**Developing and Using Models** **Obtaining, Evaluating, and Communicating Information** **Asking Questions and Defining Problems** **Analyzing and Interpreting Data** **Cause and Effect** **Systems and System Models** **Matter and Energy** **Patterns** **Stability and Change**	**Assessment: Formative** Initial models Group models Science Talk Activity Page **Assessment: Summative** Activity Page Graphs Science Talk Presentations (written and oral)
• Develop initial models of Isle Royale ecosystem. • Recognize common components in models. • Determine relationships and interactions among components in the models. • Categorize questions. • Develop a survey to obtain information about perceptions of wolves and the relationship between humans and the natural world. • Conduct research to answer their questions. • Recognize patterns in the class research findings.	**Developing and Using Models** **Obtaining, Evaluating, and Communicating Information** **Asking Questions and Defining Problems** **Analyzing and Interpreting Data** **Cause and Effect** **Systems and System Models** **Matter and Energy** **Patterns** **Stability and Change**	**Assessment: Summative** Consensus model Journal Entry Trophic Cascades Science Talk

UNIT AT A GLANCE

Activity	Time to Complete	Lesson-Level Learning Goals	Phenomena/ Challenge	Summary: Students will…
4. Ecosystems Great and Small	Preparation: 30 minutes Activity: 5-6 classes Lesson 4A: 55–60 min. Lesson 4B: 55–60 min., 2–3 classes Lesson 4C: 55–60 min., 2 classes	Develop model ecosystems to determine relationships and interactions among organisms and availability of resources for populations to survive. Determine why there are fewer carnivores than herbivores in an ecosystem and where the energy is transferring within the system and into and out of the system.	Challenge: Conduct a field study of the populations of the schoolyard or a nearby park to determine interactions that balance the system. Populations in an ecosystem interact to balance the system.	• Make observations of the organisms and populations in the schoolyard or park. • Ask questions about their observations. • Collect specimens of plants and animals in their field study.
5. Exploring Producers	Preparation: 30 minutes Activity: 3 classes Lesson 5A: 55–60 min., 2 classes Lesson 5B: 55–60 min.	Obtain information through observation, text, and analysis to figure out how plants get their energy (food source).	Challenge: Conduct a field study of the populations of the schoolyard or a nearby park to determine interactions that balance the system. Populations in an ecosystem interact to balance the system.	• Use the microscope to make observations of plant and animal cells. • Read informational text to obtain information about plant cells and how plants make and store their own food.
6. Reading All About It!	Preparation: 30 minutes Activity: 5 classes Lesson 6A: 55–60 min., 2 classes Lesson 6B: 55–60 min., 2 classes Lesson 6C: 55–60 min.	Obtain information through text and compare new information to the field study ecosystem, Isle Royale, and classroom habitat.	Challenge: Conduct a field study of the populations of the schoolyard or a nearby park to determine interactions that balance the system. Populations in an ecosystem interact to balance the system.	• Read and compare two texts explaining the balance in ecosystems. • Present information. • Make adjustments to initial models.

UNIT AT A GLANCE

Students Figure Out How to:	Practices/Crosscutting Concepts	Assessment
• Determine the flow of energy within their field study. • Develop a model ecosystem to collect data over time. • Develop a model that explains the flow of energy in the field study. • Collect information and data to answer the question of how the system balances itself and the plants are not all consumed. • Develop a model to explain why there are fewer carnivores than herbivores in an ecosystem and where the energy is transferring within the system and into and out of the system.	**Asking Questions and Defining Problems** **Developing and Using Models** **Analyzing and Interpreting Data** **Energy and Matter** **Systems and System Models** **Stability and Change**	**Formative Assessment** Individual and group questions Activity Page **Assessment: Summative** Organization charts Science Talk Revised models Journal Entry Science Talk
• Construct explanations about how plants use energy from the sun to make and store their food. • Develop models to explain that plants use energy from the sun to make food and how it relates to the transfer of energy within and into and out of the system.	**Developing and Using Models** **Constructing Explanation and Designing Solutions** **Obtaining, Evaluating, and Communicating Information** **Energy and Matter** **Systems and System Models**	**Assessment: Formative** Activity Pages Science Talk **Assessment: Summative** Revised models Science Talk Journal Entry
• Make connections among information from text and information from previous lessons. • Use information from text to make revisions to models.	**Developing and Using Models** **Obtaining, Evaluating, and Communicating Information** **Cause and Effect** **Energy and Matter** **Systems and System Models** **Stability and Change**	**Assessment: Summative** Activity Pages Group charts Group presentations Journal Entry

PARENT LETTER

Dear Parent,

Your student is beginning a science unit created by the Battle Creek Area Mathematics and Science Center. This unit was designed to promote science and engineering literacy and integrate reading and writing skills into high-interest science content. During the next twelve weeks, your student will be actively involved with *Stability and Change in an Ecosystem* unit. This unit is geared for middle school students and focuses on ecosystems and the roles plants and animals play in an ecosystem to maintain its balance. The unit includes the following areas of study:

- Biotic (living) and abiotic (nonliving) factors contribute to the balance in an ecosystem.
- Organisms can be categorized by the way they obtain their energy (producer, consumer, decomposer).
- Organisms interact and form relationships that have a fragile balance in an ecosystem.
- All organisms cause change in the environment where they live. Some changes are harmful and some are beneficial to the balance in the ecosystem.

In this unit of study, students will explore a variety of ecosystems that range from the ecosystem on Isle Royale in Lake Superior to a coastal ecosystem, forest ecosystems, and wetland ecosystems. They will conduct long-term observations of a classroom model of a woodland ecosystem to determine the role different organisms play in the ecosystem, the food web that exists in an ecosystem, and the delicate balance of populations of species that make up the community within the area.

This unit concludes with an in-depth research and exploration into the factors that upset the balance in different ecosystems across the globe, which leads to species endangerment and extinction, such as resource depletion, pollution, climate change, and habitat destruction. This unit relies heavily on current research and studies that are being conducted by environmentalists, biologists, ecologists, and naturalists. Students will gain an understanding of how human beings are part of the ecosystem of Earth and how humans can purposefully, or accidentally, alter the balance in ecosystems. The final activity of the unit challenges your student to design a plan to help reduce the adverse effect of human activity at home, school, and within the community.

Suggestions for activities to do at home are included with this letter. These activities will reinforce the concepts taught during this unit of instruction.

We hope you enjoy discussing the concepts involved in *Stability and Change in an Ecosystem* with your student. Let us know if we may be of assistance.

The Outreach Staff
Cereal City Science by the Battle Creek Area Mathematics and Science Center
(269) 213-3907 or (269) 213-3908

ACTIVITIES TO DO AT HOME

1. Take a walk through a local park or neighborhood and discuss the populations and communities or organisms that live there. Keep a log of the different populations in the park or neighborhood over the seasons.
2. Conduct a family observation and data collection investigation of your backyard. Have your student draw a map of the yard, including the biotic and abiotic components of the yard. Design an observations log to record the backyard temperature, precipitation, plant growth, and animal activity.
3. Plan and plant a family garden of Michigan native plants. Have your student keep a log of the different animals that visit the garden.
4. Make a family recycling, reduce, and reuse plan. Challenge family members to reduce the amount of waste produced each week.
5. As a family, discuss the different steps each member can take to make your home a "greener" home. Discuss the thermostat setting for winter and summer, the use of electronics and unplugging items not in use, turning off lights, switching to energy-saving light bulbs, and switching to organic and Earth-friendly cleaners and detergents.
6. The unit includes student research projects into a variety of ecosystems. If you have resources that you would like to share with the class (magazines, books, articles), please send them with your child.

Models of Ecosystems

Teacher Background Information
The unit begins with purposeful observations of diverse organisms and brainstorming ideas of the different elements in an ecosystem that would be necessary for the animals and plants to survive. The class develops a model ecosystem for the organisms and determines what to provide so that all the organisms have food, water, air, and shelter.

In following activities, students learn the importance of different populations of species that help to balance an ecosystem and ask:

- What is needed to balance the classroom ecosystem?
- Can we develop a model of an ecosystem that will sustain all organisms, becoming a balanced system?

Engage the Learner
The initial phase of the Learning Cycle is intended to introduce and activate prior knowledge about interdependent relationships among organisms. The unit begins with the challenge to develop a classroom model ecosystem and continues with the study of the predatory interactions between wolves and moose on Isle Royale. Students develop initial models, raise questions, and determine how to investigate their ideas.

Lesson 1A: Organisms in the Classroom

Advance Preparation
Make copies of the Parent Letter and Activities to Do at Home to be sent home.

Prepare for a space for Science Talk so all students are standing or sitting in a circle and can make eye contact with one another. (See Science Talk and Developing Effective Questions in the appendix.)

Become familiar with the Woodland Ecosystem Setup below. Your class will complete the setup in lesson 1B.

Demonstration videos of the Woodland Ecosystem Setup, anole feeding, and cricket care can be found at: https://cerealcityscience.org/curriculum-updates. (See Planning p. 6 for more information.)

Woodland Ecosystem Setup

A video demonstration of the Woodland Ecosystem Setup can be found at https://cerealcityscience.org/curriculum-updates.

1. Be sure the 10-gallon tank is clean and free of debris. (Do not use soap or other chemicals to clean the tank.)

ESTIMATED TIME
Lesson 1A: 55–60 minutes
Lesson 1B: 55–60 minutes

LESSON-LEVEL LEARNING GOALS
Develop a classroom model of an ecosystem.

Ask questions about how ecosystems sustain themselves and are balanced.

MATERIALS NEEDED
For each student:
student pages
1 hand lens
For the class:
1 classroom ecosystem (10-gallon tank with lid)
10–12 cups peat
1 temperature strip
2 millipedes
2 bess beetles
2 anoles
1 container crickets
1 container mealworms
1 container freeze-dried crickets
wood substrate
2 ferns
2 moss mats
grass seed
1 spray bottle
8 cups, 9 oz., with lids
1 flex tank, 1 gallon, with lid
plastic wrap, 1 box
1 cricket keeper
Teacher provides:
water
2–3 climbing branches
2–3 rocks
whiteboards
markers
scrap paper
sticky notes
additional crickets as needed (food for anoles)

LS2.A: INTERDEPENDENT RELATIONSHIPS IN ECOSYSTEMS

- 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.** (MS-LS2-2)
- **Organisms, and populations of organisms, are dependent on their environmental interactions both with other living things and with nonliving factors. (MS-LS2-1)**
- 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. (MS-LS2- 1)
- **Growth of organisms and population increases are limited by access to resources. (MS-LS2-1)**

TEACHING TIP

Adding a UV dome light to the Woodland Ecosystem Habitat will greatly benefit your anole. Look for a bulb that provides both UV-A and UV-B.

2. Spread the bag of peat on the bottom of the tank. Add water to make a moist substrate. Spread the wood substrate on top of the peat leaving some areas of open soil for planting grass seed.
3. Plant the fern and moss in the peat and wood substrate. Use the spray bottle to soak the bottom of the moss mat and place it on top of the peat and wood. Dig a small opening in the peat and wood and place the fern in the soil. Make sure the fern is firmly planted in the soil.
4. Sprinkle grass seed over the damp soil and spray with the spray bottle.
5. Place a few rocks and sticks in the ecosystem. (See Materials Needed.) The anoles will climb on the sticks and sunbathe on the rocks. Thoroughly mist the entire ecosystem with the spray bottle.
6. Place the temperature strip on the side of the tank. Make sure the temperature is visible from the outside of the tank.
7. Only after the students have made their animal observations, carefully place the animals in their new ecosystem. Have the students place the millipedes in the ecosystem first and note their initial activity, followed by the bess beetles, 5 or 6 crickets (food for anoles), and finally anoles. Crickets and mealworms are provided as food for your anoles. Plan on purchasing feeder crickets from your local pet store as needed.
8. Place the screen lid on the ecosystem. Cover the screen with plastic wrap to help keep moisture in the tank. Vent the plastic in opposing corners for airflow.
9. The ecosystem should be misted at least twice daily.
10. Note: The anoles are very lively. The lid should remain on the ecosystem and observation tanks at all times.

Prepare a space for a What We Think chart that includes the Driving Question and an activity summary table. Plan to have the chart visible throughout the activities.

Example:

What We Think About Interdependent Relationships in Ecosystems

What We Think	Questions We Have	What We Did	What We Figured Out	How Does That Help Us to Understand the Phenomenon?

Procedure

Engage the learner.

Inform the class that they are going to work together to make purposeful observations of different animals and plants and brainstorm ideas of the different elements in an ecosystem that would be necessary for the plants and animals to survive. They will be using the information that they collect in this lesson to design a classroom ecosystem for the animals and plants that they will be observing. Ask:

- Who knows what a terrarium is?
- Does anyone have a terrarium at home? What kinds of things are in your terrarium?
- How do we take care of animals? Plants?
- What do animals and plants need to survive?

Divide the class into eight groups (2 anole groups, 2 giant millipede groups, 2 bess beetle groups, 2 brown cricket groups). Have the fern and moss mat available for groups that have completed observations to observe a second organism.

Show the groups the different animals and plants for observations. Explain that the anoles are not to be handled or taken out of the observation tank. Assure the students that the animals are not a threat and demonstrate the safe handling of the bess beetle and the giant millipede.

Explore the concept.

Distribute hand lenses, a damp paper towel, and an observation cup with an organism to each group. Give the groups sufficient time to make observations of the organisms and brainstorm ideas of the type of ecosystem the animal would need to survive.

Have the students refer to the activity page in the Student Journal to record their observations of their animal.

1. *Draw and label a picture of your observation animal.*
2. *Write about your observations of your animal. Tell what physical characteristics and behaviors you observed.*
3. *Record at least three questions you have about your observation animal.*
4. *Record your observations of the fern plant.*
5. *Record your observations of the moss mat.*

SCIENCE TALK

Science Talk is a discussion between students that is an essential part of making meaning from observations and the processing of information. Actively engage your students in collaboration about ideas in a clear, concise form in a nonthreatening environment. Remind students that all ideas are valid and appreciated. Conduct the Science Talk in a circle where students can see one another and no one has his or her back to another student. Science Talk is conducted among students, and the role of the teacher is to facilitate and record ideas that may lead to further discussion. (See Science Talk in the appendix, p. 126.)

SYSTEMS AND SYSTEM MODELS

- **A system can be described in terms of its components and their interactions.**

PATTERNS

- **Patterns can be used to identify cause-and-effect relationships.**

CLASSROOM SAFETY

Instruct students to always wash hands after handling materials and organisms from the Woodland Habitat.

ASKING QUESTIONS AND DEFINING PROBLEMS

Asking questions and defining problems in 6–8 builds on K–5 experiences and progresses to specifying relationships between variables, and clarifying arguments and models.

- **Ask questions:**
  - **that arise from careful observation of phenomena, models, or unexpected results, to clarify and/or seek additional information.**
  - to identify and/or clarify evidence and/or the premise(s) of an argument.
  - **to determine relationships between independent and dependent variables and relationships in models.**
  - to clarify and/or refine a model, an explanation, or an engineering problem.
- **Ask questions that require sufficient and appropriate empirical evidence to answer.**
- 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.
- **Ask questions that challenge the premise(s) of an argument or the interpretation of a data set.**

Facilitate the observations by circulating among the groups, listening to their ideas and checking for observation skills. To check students' progress and help students make connections, ask:

- What have you observed about your organism so far?
- What do you think its specific needs are to survive?
- Where in nature might you find this animal? What makes you think that?
- Can someone add to that idea?
- What role do you think it plays in an ecosystem? Is it a predator? Prey? Producer? Consumer? Decomposer? What makes you think that?
- How would you build a suitable ecosystem for your animal?

After the groups have had sufficient time to make and record observations, have them join another group to compare and contrast the organisms and discuss if they think the animals would survive in the same system. If time permits, allow each group the opportunity to get acquainted with each organism.

Explain the concept and define the terms.

Science Talk

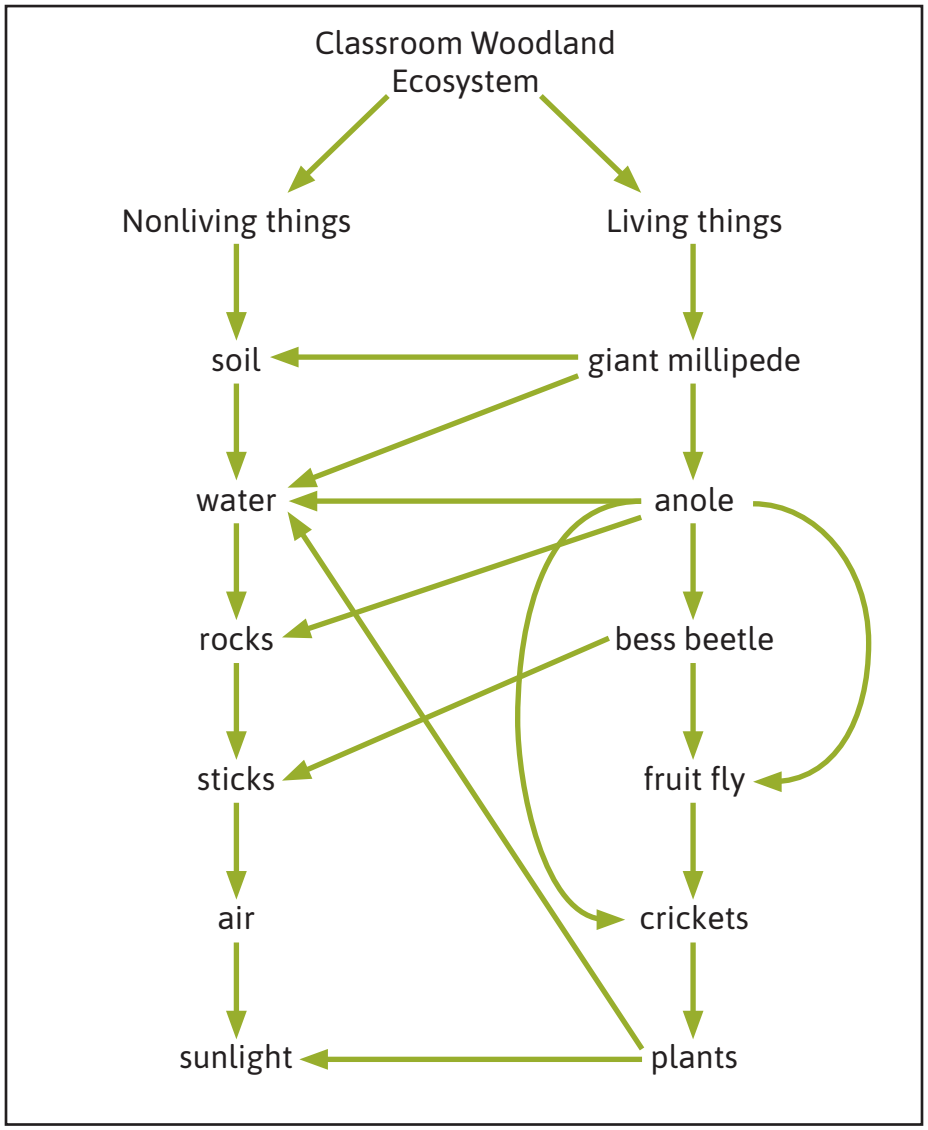
After the groups have completed their observations, ask them to bring their Student Journals and form a circle for discussion and sharing. Ask:

- Who would like to start us off by sharing their observation of their animal or plant?
- Can someone from that group add to that idea?
- What would you do to make a suitable habitat for that animal or plant?
- What components will we need to help the animal or plant survive?
- How might the animal or plant interact with its surroundings?
- Who has another observation to share?
- What do you think about what _____said?
- Do you think the animals could survive together? Why or why not?
- How might they interact with each other?
- Are there any patterns emerging in figuring out the needs to survive for the animals and plants?

Continue the discussion until all groups have had the opportunity to share their observations and thinking about a suitable habitat. At the conclusion of the Science Talk, develop a habitat concept map using the organisms the students observed (see example on next page). Show the class the materials table to help them think beyond their observation animal.

Ask students to make connections among the living things and between the living and nonliving things. Listen for ideas of what the organisms need for food and if all the living things will survive in the habitat. Help students organize their ideas by making a chart and asking them to make connections.

Example:



DEVELOPING AND USING MODELS

Modeling in 6–8 builds on K–5 experiences and progresses to developing, using, and revising models to describe, test, and predict more abstract phenomena and design systems.

- ~~Evaluate limitations of a model for a proposed object or tool.~~
- ~~Develop or modify a model—based on evidence—to match what happens if a variable or component of a system is changed.~~
- **Use and/or develop a model of simple systems with uncertain and less predictable factors.**
- Develop and/or revise a model to show the relationships among variables, including those that are not observable but predict observable phenomena.
- **Develop and/or use a model to predict and/or describe phenomena.**
- Develop a model to describe unobservable mechanisms.
- ~~Develop and/or use a model to generate data to test ideas about phenomena in natural or designed systems, including those representing inputs and outputs, and those at unobservable scales.~~

TEACHING TIP
The What We Think chart will serve as an area where students can place questions that will build the driving questions for the remainder of the unit. As questions are answered, they can be removed from the Questions column and added to the What We Figured Out column.

Ask students to share their questions in the Student Journal. Introduce the What We Think chart and have students record and post their initial ideas about interactions in ecosystems, roles different organisms play, and questions they have about the classroom ecosystem and how to balance the system.

Explain that the chart will be used to keep a record of their thinking, questions, and what they figured out throughout the unit.

Assessment: Formative
Use the Activity Page, Science Talk, initial models and class concept map to assess the students' current ideas about the needs for survival and the interactions among the living and nonliving components in an ecosystem.

Lesson 1B: Putting Our Habitat Together

Teacher Background Information

This lesson continues to engage the learner in their initial ideas about the challenge to develop a classroom ecosystem and how they will provide the components necessary to keep the organisms alive. Students do a quick research on the animals they have questions about and then assemble the habitat.

Advance Preparation

Prepare a materials table to assemble the classroom ecosystem. (See Materials Needed.)

Be sure students have computers and Internet available to conduct short research on the animals in the classroom habitat.

Make copies of the *Fun Facts* handouts. Each group should receive the page(s) for the organisms that they observed in Lesson 1A.

Make copies of the *Classroom Ecosystem Observation Log*.

Demonstration videos of the Woodland Ecosystem Setup, anole feeding, and cricket care can be found at: https://cerealcityscience.org/curriculum-updates. (See Planning p. 6 for more information.)

Be prepared to assemble the Woodland Ecosystem:

Woodland Ecosystem Setup

1. Be sure the 10-gallon tank is clean and free of debris. (Do not use soap or other chemicals to clean the tank.)
2. Spread the bag of peat on the bottom of the tank. Add water to make a moist substrate. Spread the wood substrate on top of the peat leaving some areas of open soil for planting grass seed.
3. Plant the fern and moss in the peat and wood substrate. Use the spray bottle to soak the bottom of the moss mat and place it on top of the peat and wood. Dig a small opening in the peat and wood and place the fern in the soil. Make sure the fern is firmly planted in the soil.
4. Sprinkle grass seed over the damp soil and spray with the spray bottle.
5. Place a few rocks and sticks in the ecosystem. (See Advance Preparation/Materials Needed in Lesson 1A.) The anoles will climb on the sticks and sunbathe on the rocks. Thoroughly mist the entire ecosystem with the spray bottle.
6. Place the temperature strip on the side of the tank. Make sure the temperature is visible from the outside of the tank.

MATERIALS NEEDED

For each student:
- student pages

For each group of 4:
- handout: *Fun Facts*
- handout: *Classroom Ecosystem Observation Log*

For the class:
- 1 classroom ecosystem (10-gallon tank with lid)
- 10–12 cups peat
- 1 temperature strip
- 2 millipedes
- 2 bess beetles
- 2 anoles
- 1 container crickets
- 1 container mealworms
- 1 container freeze-dried crickets
- wood substrate
- 2 ferns
- 2 moss mats
- grass seed
- 1 spray bottle
- 4 cups, 9 oz., with lids
- 1 flex tank, 1 gallon, with lid
- plastic wrap, 1 box
- 1 cricket keeper

Teacher provides:
- water
- 2–3 climbing branches
- 2–3 rocks
- whiteboards
- markers
- scrap paper
- sticky notes
- additional crickets as needed (food for anoles)

SYSTEMS AND SYSTEM MODELS

- **A system can be described in terms of its components and their interactions.**

OBTAINING, EVALUATING, AND COMMUNICATING INFORMATION

Obtaining, evaluating, and communicating information in 6–8 builds on K–5 experiences and progresses to evaluating the merit and validity of ideas and methods.

- **Critically read scientific texts adapted for classroom use to determine the central ideas and/or obtain scientific and/or technical information to describe patterns in and/or evidence about the natural and designed world(s).**
- 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.
- **Communicate scientific and/or technical information (e.g., about a proposed object, tool, process, system) in writing and/or through oral presentations.**

READING SCIENCE AND TECHNICAL SUBJECTS—GRADES 6–8

Key Ideas and Details

RST.6–8.1: Cite specific textual evidence to support analysis of science and technical texts.

RST.6–8.2: Determine the central ideas or conclusions of a text; provide an accurate summary of the text distinct from prior knowledge or opinions.

Craft and Structure

RST.6–8.4: Determine the meaning of symbols, key terms, and other domain-specific words and phrases as they are used in a specific scientific or technical context relevant to grades 6–8 texts and topics.

7. Only after the students have made their animal observations, carefully place the animals in their new ecosystem. Have the students place the millipedes in the ecosystem first and note their initial activity, followed by the bess beetles, 5 or 6 crickets (food for anoles), and finally anoles. Crickets and mealworms are provided as food for your anoles.
8. Place the screen lid on the ecosystem. Cover the screen with plastic wrap to help keep moisture in the tank. Vent the plastic in opposing corners for airflow.
9. The ecosystem should be misted at least twice daily.
10. Note: The anoles are very lively. The lid should remain on the ecosystem and observation tanks at all times.

Procedure

Explain the concept and define the terms.

Divide the class into their groups from the previous lesson. Distribute the *Fun Facts* handout that describes the organism the group observed in Lesson 1A. Allow sufficient time for each group to read and discuss the information on the handout and complete the questions in the Student Journal.

1. *All living things need air, water, and food, and plants also need sunlight. What special needs does your organism need to survive?*
2. *With your group, develop and draw a model of a classroom habitat that will support the needs of your organism.*
3. *Write a procedure (in order) for the habitat assembly.*

Available materials: 10-gallon tank (habitat), soil, sticks, stones, water, spray bottle, grass seed.

When the groups have completed their reading and Student Journal entries, have them find another group and share the information. Allow time for all groups to discuss their findings with each other and bring the class back together for a sharing of ideas for the habitat setup. Ask:

- Can someone share what you discovered about the components in the habitat necessary for the organisms to survive?
- Who can add to _____'s idea?
- Would it be helpful to figure out the diet of each organism first? Who eats what, and how will we sustain their diets?
- What patterns are we discovering from our research?

Take this opportunity to develop a food web for the habitat. As students dictate their ideas, draw the food web on the board or chart paper.

- What common components did you recognize in the models and procedures?
- Do we have a common starting point for building the habitat? What do you mean when you say _____?
- _____, I heard you say that the anole will eat the crickets and mealworms. What are your ideas about that?
- Let me see if I understand what you are saying. Are you saying…?
- What do people think about what _____said?

With classroom participation, build the habitat. (See Advance Preparation for an example of the assembly instructions.) As each step is completed, ask students for their ideas of what should happen next.

After the nonliving components are in place, take this opportunity to introduce the term *abiotic components*. Ask students for their idea of the meaning of the term and reach a consensus before entering it in the Key Terms of the Student Journal.

Introduce the term *biotic components*. As a class, define the term and have students write their definitions in the Key Terms of the Student Journal.

Ask students what biotic components should go into the ecosystem. Plant the ferns and moss mat, and have the groups gently place the other organisms in the tank. Discuss the addition of the crickets and mealworms as a food source for the anole.

DEVELOPING AND USING MODELS

Modeling in 6–8 builds on K–5 experiences and progresses to developing, using, and revising models to describe, test, and predict more abstract phenomena and design systems.

- Evaluate limitations of a model for a proposed object or tool.
- ~~Develop or modify a model—based on evidence—to match what happens if a variable or component of a system is changed.~~
- **Use and/or develop a model of simple systems with uncertain and less predictable factors.**
- Develop and/or revise a model to show the relationships among variables, including those that are not observable but predict observable phenomena.
- **Develop and/or use a model to predict and/or describe phenomena.**
- ~~Develop a model to describe unobservable mechanisms.~~
- Develop and/or use a model to generate data to test ideas about phenomena in natural or designed systems, including those representing inputs and outputs, and those at unobservable scales.

PATTERNS

- **Patterns can be used to identify cause-and-effect relationships.**

HISTORY/SOCIAL STUDIES, SCIENCE, AND TECHNICAL SUBJECTS WRITING STANDARDS—GRADES 6–8

Text Types and Purposes
WHST.6–8.2: Write informative/explanatory texts, including the narration of historical events, scientific procedures/experiments, or technical processes.
Range of Writing
WHST.6–8.10: Write routinely over extended time frames (time for reflection and revision) and shorter time frames (a single sitting or a day or two) for a range of discipline-specific tasks, purposes, and audiences.

CONSTRUCTING EXPLANATIONS AND DESIGNING SOLUTIONS
Constructing explanations and designing solutions in 6–8 builds on K–5 experiences and progresses to include constructing explanations and designing solutions supported by multiple sources of evidence consistent with scientific knowledge, principles, and theories.

- Construct an explanation that includes qualitative or quantitative relationships between variables that predict(s) and/or describe(s) phenomena.
- Construct an explanation using models or representations.
- Apply scientific ideas, principles, and/or evidence to construct, revise and/or use an explanation for real-world phenomena, examples, or events.
- Apply scientific reasoning to show why the data or evidence is adequate for the explanation or conclusion.

Discuss the necessity of providing a food source for the anoles. Ask:

- Is the classroom ecosystem balanced? Why or why not?
- What other component(s) need to exist to have the classroom ecosystem sustain itself? How will they interact?

If time allows, have students conduct an initial observation of the classroom ecosystem and enter their observations into the *Classroom Ecosystem Observation Log*.

Set up an observation schedule for students to maintain the habitat and make observations of changes and interactions within the system. Post the schedule.

Have the students work in their groups to complete the Journal Entry.

Pre-Writing Strategy: Science Talk
Have the students work in their groups and discuss their ideas prior to completing the Journal Entry. Give students the opportunity to orally describe how they are going to respond and listen to the ideas of others.

Journal Entry

4. *Draw and label a model of the classroom ecosystem. Include the role of each organism.*
5. *Develop a model of a food web that explains the interactions among the organisms.*
6. *Write if you think the ecosystem is balanced or unbalanced. Explain why.*

Assessment: Formative
Use the Activity Page, Science Talk, and Journal Entry to assess the students' initial ideas of interactions among plants and animals and the roles organisms play in an ecosystem.

The Student Journal responses and Science Talk serve as a formative assessment of your students' initial understanding of the interaction among organisms within an ecosystem. In following lessons, students dig deeper into interactions and roles different organisms play in ecosystems.

Interactions on Isle Royale

Teacher Background Information

The initial lessons, after setting up the classroom habitat, introduce students to the relationships and fluctuations in the moose and wolf populations on Isle Royale, Michigan. Students use real data to construct graphs that demonstrate moose and wolf population fluctuations for a span of over fifty years. The research about the wolf and moose predator-prey system represents the longest continuous study in the world. Through their reading and data analysis, students raise questions about the moose/wolf relationship, the conditions on Isle Royale, and other factors that affect the wolf and moose populations.

Less than one hundred years ago the timber wolf lived throughout North America, but now it is gone from forty-five of the forty-eight contiguous states. The remaining population is estimated at less than five hundred wolves in Minnesota, Wisconsin, and Michigan. The decline of the wolf population is due to habitat destruction and the persecution of wolves by humans. Wolves have been long misunderstood, and an anti-wolf prejudice continues to exist today. The wolf is a predator and must hunt for food. The habits of howling, hunting, and traveling in packs have contributed to the public's fear and perception of danger when wolves are near. Throughout history humans and wolves have competed for some of the same food; deer, elk, antelope, moose, buffalo, and livestock are prey for both. Therefore, humans set out to eliminate the competition for food and trapped, hunted, and poisoned wolves to near extinction.

Wolves are currently protected under the federal Endangered Species Act. Wolves can only be killed if they are a direct and immediate threat to human life. If an animal is killed, the incident must be reported to the Department of Natural Resources (DNR).

Study of the wolf population and its relationship with the moose on Isle Royale in Michigan's Lake Superior is ideal for learning more about the behavior and possible rescue of the diminishing wolf population. The objective is to explore the dynamics of the wolf/moose relationships.

The moose first arrived on Isle Royale around the year 1900, when they swam across Lake Superior from Minnesota. Their population fluctuated with weather conditions and the availability of food, but overall the moose thrived, having no predator to slow the population growth. A pair of wolves arrived on Isle Royale in the late 1940s by crossing an ice bridge that connected the island to Canada. The population of moose was greatly affected by the introduction of a predator.

ESTIMATED TIME

Lesson 2A: 55–60 minutes, 2–3 classes
Lesson 2B: 55–60 minutes
Lesson 2C: 55–60 minutes
Lesson 2D: 55–60 minutes, 3–5 classes with time for presentations

LESSON-LEVEL LEARNING GOALS

Develop an initial model to explain predator/prey relationships between populations.

Analyze and interpret data to find patterns in populations of organisms in an ecosystem.

MATERIALS NEEDED

For each student:
student pages

For each group of 4:
Wolf/Moose Card Set (wolf, moose, map)

Teacher provides:
Michigan map
chart paper or whiteboards
markers
scrap paper
sticky notes

STABILITY AND CHANGE

- **Small changes in one part of a system might cause large changes in another part.**

LS2.A: INTERDEPENDENT RELATIONSHIPS IN ECOSYSTEMS

- 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.** (MS-LS2-2)
- **Organisms, and populations of organisms, are dependent on their environmental interactions both with other living things and with nonliving factors. (MS-LS2-1)**
- 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. (MS-LS2- 1)
- **Growth of organisms and population increases are limited by access to resources. (MS-LS2-1)**

In following lessons, students are given real data on the numbers of moose and wolves on the island that has been collected since 1958. Students make graphs from the data, raise questions, and draw conclusions about the moose and wolf populations that will be applied to the study of communities, populations, ecosystems, and the relationships between organisms.

The students conclude their exploration into the moose/wolf relationship with a research project based on their questions. This introduction to population research serves as a precursor or point of reference for application and comparison to populations and relationships in a variety of ecosystems.

Engage the Learner

The initial phase of the Learning Cycle is intended to introduce and activate prior knowledge about interdependent relationships among organisms. The unit begins the study with the predatory interactions between wolves and moose on Isle Royale. Students develop initial models, raise questions, and determine how to investigate their ideas.

Lesson 2A: The Moose/Wolf Population

Advance Preparation

Preview the chart on page 2 in the Ecological Studies of Wolves on Isle Royale 2019 Annual Report from the Isle Royale Wolf website:

https://bit.ly/3UdW4Mv

Prepare four charts with the following titles:

Respectfully Disagreeing

Asking a Clarifying Question

Asking a Probing Question

Adding to an Idea

Allow time for the students to carry out their observation, care and feeding of the classroom habitat. If changes or interactions have occured, be sure to discuss as a class.

Prepare a *Wolf/Moose Card Set* for each group of four students (see Materials Needed).

Procedure

Engage the learner.

The activity begins with an audio segment and then a video of wolves on Isle Royale discussing the fluctuations of wolf and moose populations until 2018, when the population of wolves was down to two. Begin the introduction by showing the video of the wolf howling:

https://youtu.be/fUpQFMEb9po (howling)

Ask students to turn to a partner or discuss at their table their reactions to the audio of the howling. Encourage students to discuss the range of images and reactions that come to mind.

Continue the introduction with the beginning segment of the video "Wolves of Isle Royale: The Quest for Survival".

https://youtu.be/DS-4IsDg7mA (0:00–1:24)

Ask students to turn to a partner or discuss at their table their reactions to the video and the project on Isle Royale.

Have the students work individually at first and develop a model in their Student Journals of their initial thinking about the wolf/moose population. Give students sufficient time to think about their ideas about the animals, make lists, and develop an initial model.

1. *Use the space below to develop a model of your initial ideas about the wolf and moose populations on Isle Royale. Include how they might interact and your ideas about their habitat.*
2. *Write a list of questions you have about the wolves, the moose, and the Isle Royale ecosystem.*

Explore the concept.
After the students have had the opportunity to think about and develop their initial models, divide the class into groups of four students and have them share their initial models and develop a group model based on their collective thinking and understanding.

To help inspire their thinking and discussion, distribute a *Wolf/Moose Card Set* to each group.

After the groups have shared information and concluded their brainstorming, ask them to read the prompt in the Student Journal. Discuss the use of a model to describe unobservable mechanisms that work together and have an effect on the wolf and moose populations.

3. *Work with your group and use the space below to draw and label a model that explains the relationship between the moose and wolves and the changes in their populations. Include the unobservable mechanisms that help explain the phenomenon. Share your individual ideas with your group to develop a group model that includes ideas from all members.*

Ask students to be prepared to share their individual models and work as a group to develop one model that reflects the thinking of the group. Remind students that this is their initial thinking and that there are no wrong ideas at this time. Explain that if

DEVELOPING AND USING MODELS

Modeling in 6–8 builds on K–5 experiences and progresses to developing, using, and revising models to describe, test, and predict more abstract phenomena and design systems.

- ~~Evaluate limitations of a model for a proposed object or tool.~~
- ~~Develop or modify a model—based on evidence—to match what happens if a variable or component of a system is changed.~~
- Use and/or develop a model of simple systems with uncertain and less predictable factors.
- **Develop and/or revise a model to show the relationships among variables, including those that are not observable but predict observable phenomena.**
- **Develop and/or use a model to predict and/or describe phenomena.**
- ~~Develop a model to describe unobservable mechanisms.~~
- ~~Develop and/or use a model to generate data to test ideas about phenomena in natural or designed systems, including those representing inputs and outputs, and those at unobservable scales.~~

SYSTEMS AND SYSTEM MODELS

- **A system can be described in terms of its components and their interactions.**

CAUSE AND EFFECT

- Cause-and-effect relationships may be used to predict phenomena in natural and designed systems. (MS-ESS2-5), (MS-ESS3-4)
- Relationships can be classified as causal or correlational, and correlation does not necessarily imply causation. (S-ESS3-3)

LS2.C: ECOSYSTEM DYNAMICS, FUNCTIONING, AND RESILIENCE

- 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. (secondary to MS-LS2-5)
- 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. (MS-LS2-4)

the group has different ideas, they should add the different ideas to their model, and that it is not necessary for a complete consensus to be reached at this time.

When the groups have decided how they want their models to represent their collective thinking, distribute chart paper or whiteboards and markers for them to develop a model to share with the class. Encourage groups to write questions that come up during the model development. Distribute sticky notes to each group and encourage students to write questions about the moose/wolf relationship and populations on them (one question per note). Have the students attach the questions to their model.

Circulate among the groups to monitor their progress and listen to their exchange of ideas. Do not offer suggestions or information at this time. Make a note of key ideas and questions to revisit during Science Talk.

Facilitate the group brainstorming activity by circulating among the students, listening to their ideas and exchanges. To check group progress and help students raise questions and hypothesize, ask:

- Can someone explain what you have discussed regarding the moose and wolves so far?
- Can someone add to that idea?
- What do you mean when you say…?
- Is that true for all cases? Can you give me an example?
- What would happen if…?
- What do you know about the habitat of the moose? Wolf?
- What do you think they need to survive?
- How are the animals similar? How are they different?
- What is the relationship between moose and wolves?
- What further information would you like to learn about the moose? Wolf?
- What are your initial ideas about the cause of the decrease in wolf population? How can you show that on your model?

After the groups have had the opportunity to complete their initial models, ask them to display their models around the room.

In order to conduct friendly, nonthreatening critiques, as a class establish some guidelines and rules for critiquing methods.

As a class, create four anchor posters that will guide the class throughout the unit when sharing ideas. Display the four charts with the questioning and critiquing categories. Have students suggest how they might start a question that asks a group to

clarify, probes or digs deeper, disagrees, or adds to an idea. It is important for success in student-to-student interactions for the anchor charts to be developed by the students. (See Example Charts - next page.)

After the completion of the anchor questioning charts, conduct a gallery walk. Allow time for each group to make observations of the different models. Encourage students to look for common components that appear in each of the models.

Explain the concept and define the terms.

Science Talk

After the groups have completed the gallery walk, ask them to bring the models and form a circle for discussion and sharing. Ask each group to explain their model, and as a class, look for common ideas, unique ideas, and questions. To help the students elaborate on their explanation of their models, ask:

- _____, I heard you use the term _____. Can you tell us more about that?
- What does _____ represent in your model? What makes you think that is an important component to include in your model?
- Tell us more about what you mean by _____.
- What questions do you have about wolves, moose, and interdependent relationships in ecosystems?
- What do you mean when you say _____?
- How might where you live have an effect on your ideas and attitudes toward wolves and moose?

Allow time for all groups to share their models and comment on the ideas of others. Ask:

- What common component(s) do we see among all or most of the models?
- Are there any components that other groups used that you would like to add to your model?
- What makes you think that would be a useful addition?
- What questions do you have about the wolf and moose populations and their relationship?

Encourage groups to revisit their models and take time to make adjustments based on the class sharing experience.

Revisit the What We Think chart. Explain that the class has modeled and discussed their initial ideas about moose, wolves, and populations on Isle Royale and that the class will be using the What We Think chart to keep a record of their initial ideas

Example charts:

RESPECTFULLY DISAGREEING

- I agree with…but…
- I disagree with…because…
- I agree with part of your model but disagree with this part…
- I respectfully disagree because…
- I understand where you are coming from but have a different idea.
- I agree with you but also think…
- I see your reasoning but disagree with some of the ideas because…

ASKING A CLARIFYING QUESTION

- What do you mean by…?
- Can you be more specific about…?
- What makes you think that?
- What evidence do you have the supports that?
- How do you know?
- Can you say more about…?
- What do you mean by…?
- So are you saying…?

ASKING A PROBING QUESTION

- What do you mean by…?
- What makes you think that?
- If that were true, then wouldn't _____ be true?
- Where did you get this idea?
- How did you come up with…?
- What is your evidence?
- Why is _____ important in your model?
- Can you say more about…?

ADDING TO AN IDEA

- I agree with you, but also…
- I would like to add…
- I agree, but I also think…
- I agree with this part, but would it be helpful to add…?
- Do you think adding _____ would make it more clear?
- I agree but have an idea that might add more clarity or information.
- Would it be more clear if you added…?

SCIENCE TALK

Science Talk is a discussion between students that is an essential part of making meaning from observations and the processing of information. Actively engage your students in collaboration about ideas in a clear, concise form in a nonthreatening environment. Remind students that all ideas are valid and appreciated. Conduct the Science Talk in a circle where students can see one another and no one has his or her back to another student. Science Talk is conducted among students, and the role of the teacher is to facilitate and record ideas that may lead to further discussion. (See Science Talk in the appendix, p. 126.)

and new understandings as the lessons progress. Take this time to have students use their ideas from their notes in the Student Journals and models to make a list in the What We Think column.

Continue with the Questions We Have column and explain that the class has questions that need to be answered about wolves, moose, interdependent relationships, and how they occur. The chart will help the class keep track of their questions and when and how they have answered their questions. Ask students to relate the interactions in their classroom habitat to the interactions on Isle Royale.

Develop the Driving Questions for following lessons by building on student ideas. Help students turn their wonderings and ideas into questions that can be answered through investigation and research in the following lessons.

To help students collectively raise questions about wolves, moose, relationships, and population changes, ask:

- What questions do we need to answer to figure out the relationship between the moose and wolf?
- What do you think about what _____said?
- Does anyone have a questions that relate to _____'s question?

To help the students collaborate to form questions, ask them to return to their groups and use their Activity Page and models as references to develop as many questions as they can think of about wolves, moose, their interdependency, and roles in ecosystems.

Distribute sticky notes to each group. Ask students to use scrap paper or Student Journals and write as many questions as they can think of about the moose/wolf relationship and how and why the population numbers change. Then collaborate to find four or five of the most pressing questions to write on the sticky notes (one question per sticky note).

Categories for the student questions about the phenomenon may include:

- Roles in ecosystems
- Interactions among organisms
- Food source
- Population changes
- Stability
- Hunting
- Weather and climate
- Wolves
- Moose
- Isle Royale

To facilitate the categorizing of questions, ask a group to read one of their questions and place it in the Questions We Have column. Ask if anyone has the same or similar questions. Ask the groups to read similar questions and decide on a category for them, and then invite all similar questions to be posted on the column in proximity to one another. Write the category on the chart. Continue until all questions are acknowledged and categorized. (See sample Questions We Have chart next page.)

Your students may have questions similar to and different from those on the example chart. Raising and categorizing questions as a class is an important process for students to undertake to gain the sense that they are investigating what is real and relevant to them. The chart is merely a sample. Your students' questions may include many more questions and questions that relate to your location and the classroom habitat.

Remind the class that the chart is going to remain visible for the remainder of the unit and that as new questions and categories develop, they will be added to the chart. Explain that as the lessons progress, the class will periodically review their initial questions, add new questions, and decide which questions have been answered and what questions remain to be investigated.

Take this opportunity to develop with the class the overarching Driving Question that will drive the following lessons. The Driving Question should be broad enough that individual questions can be incorporated into the bigger question. The Driving Questions may include questions similar to the following:

- How do moose and wolves interact in an ecosystem?
- What causes the wolf and moose populations to fluctuate over time?
- What caused the wolf population to reduce to two wolves?
- What is the role of the wolf in maintaining biodiversity in an ecosystem?

At the conclusion of the lesson, allow time for students to conduct observations of the classroom ecosystem habitat and enter their observations into the *Classroom Ecosystem Observation Log*.

Assessment: Formative
Use the students' initial models, group models, activity page, and Science Talk to assess their initial ideas about the relationship between moose and wolves and the fluctuations in population numbers on Isle Royale.

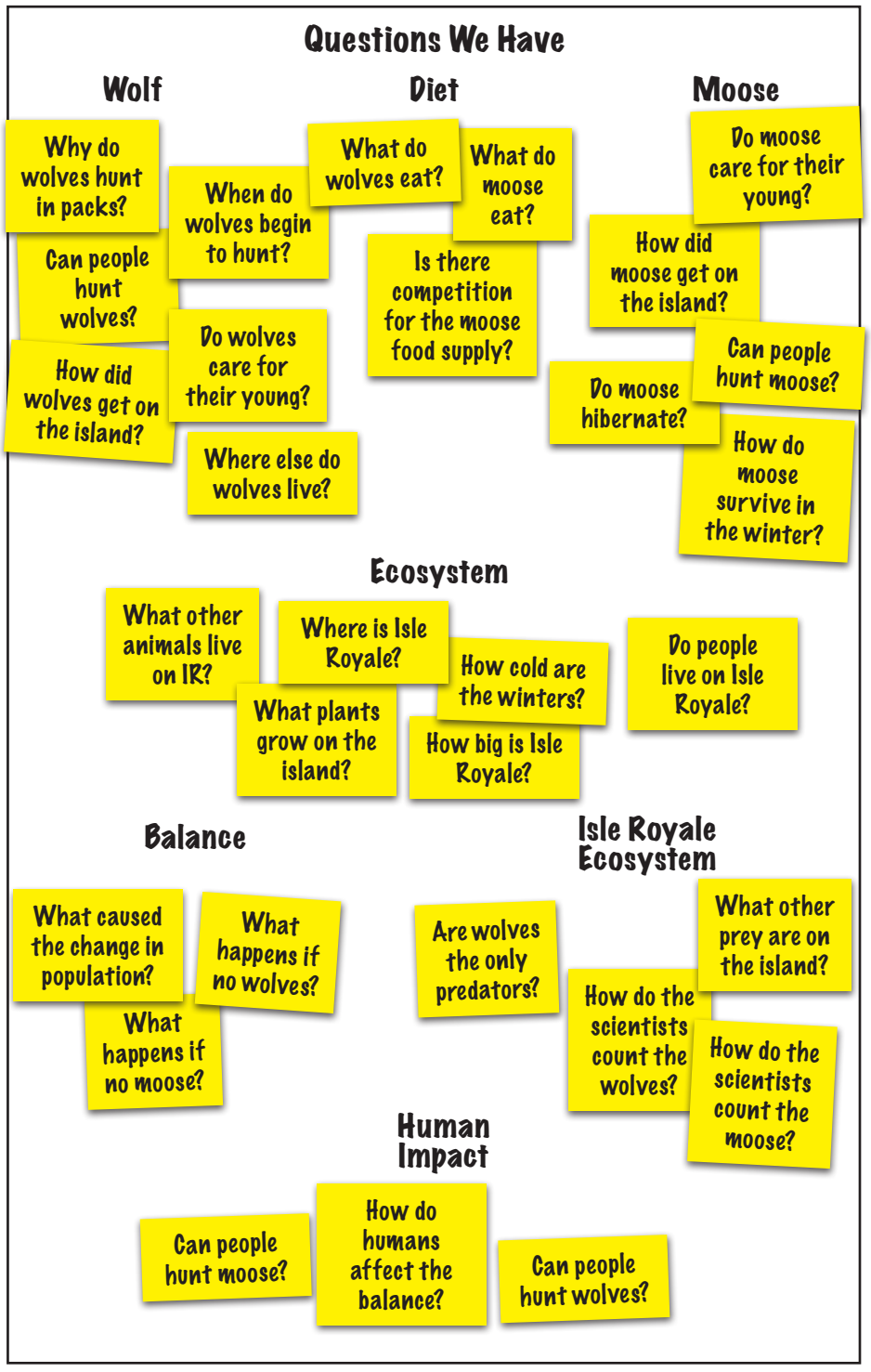
ASKING QUESTIONS AND DEFINING PROBLEMS
Asking questions and defining problems in 6–8 builds on K–5 experiences and progresses to specifying relationships between variables, and clarifying arguments and models.

- **Ask questions:**
  - **that arise from careful observation of phenomena, models, or unexpected results, to clarify and/or seek additional information.**
  - to identify and/or clarify evidence and/or the premise(s) of an argument.
  - **to determine relationships between independent and dependent variables and relationships in models.**
  - to clarify and/or refine a model, an explanation, or an engineering problem.
- **Ask questions that require sufficient and appropriate empirical evidence to answer.**
- 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.
- **Ask questions that challenge the premise(s) of an argument or the interpretation of a data set.**

LESSON 2A

TEACHING TIP

The Driving Question for following lessons should be broad enough that more specific questions get answered in the process of obtaining information to answer the Driving Question.



Lesson 2B: Surveying Perceptions about Wolves and the Relationship between Humans and the Natural World

Teacher Background Information

This lesson continues to engage the learner in their initial ideas about wolves, moose, and interdependency among organisms, and includes how students perceive wolves, their opinions about wolves, and attitudes about their role in an ecosystem.

This lesson includes a survey designed to obtain data about knowledge and attitudes about biodiversity in ecosystems. The survey can be limited to student knowledge and attitudes or expanded to include parents, grandparents, and school staff members to compare attitudes and knowledge across generations.

The lesson begins with an audio clip of a section in Jack London's book *White Fang*. In the fourth-grade unit *4LNG Structure, Function, and Information Processing*, students explored the structural characteristic of animal eyeshine and how it helps nocturnal animals to see in the dark. In this lesson, the audio clip from *White Fang* helps students to imagine themselves around the campfire, hearing the howling of wolves and seeing pairs of eyes appearing in the darkness. Take this opportunity to engage the class in a fictional reading about wilderness survival and check for copies of the book in the school or local library. Encourage students to read the book on their own or engage in a whole-class reading through a teacher read.

Advance Preparation

Keep the What We Think chart visible and active throughout the unit.

Make copies of the *Biodiversity Survey* handout for each group of four students.

Preview the NPR story *Why Do Animals' Eyes Glow in the Dark?*

https://n.pr/3BLH80G

Play the first part (0:00–0:52) of the story that includes narration of Jack London's book *White Fang*. Stop the narration with the question "Why do animals' eyes glow at night?"

Make a copy and review the Biodiversity Survey Google Form:

https://bit.ly/3QQSl4D

Allow time for the students to carry out their observation, care and feeding of the classroom habitat. If changes or interactions have occured, be sure to discuss as a class.

MATERIALS NEEDED

For each student:
- student pages
- handout: *Biodiversity Survey*

Teacher provides:
- Michigan map
- chart paper
- markers
- scrap paper
- sticky notes
- book: *White Fang* (optional)

LS4.D: BIODIVERSITY AND HUMANS

- 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. (secondary to MS-LS2-5)

TEACHING TIP

White Fang is available to read for free online from the Library of Congress at:
https://bit.ly/3DrLxY9.

TEACHING TIP

It is important for students to help develop the survey questions to obtain data about knowledge of and attitudes toward biodiversity in ecosystems within the classroom and school and at home. The *Biodiversity Survey* gives example questions and is a way to get the students thinking about their own questions, knowledge, and attitudes.

Example student questions might include:

- How important are wolves in an ecosystem?
- How important are moose in an ecosystem?
- How much does wolf activity interact with humans?
- How much does human activity interact with wolves?

Do not be concerned if students conclude that the survey fits their needs and they would like to use it as written.

Procedure

Explore the concept.

Review the What We Think chart and students' initial ideas and questions about the wolf/moose phenomenon. Check for disparities in students' thinking and feelings about wolves.

To help the class make connections between their ideas and perceptions about wolves, play the first part of the NPR story "Why Do Animals' Eyes Glow in the Dark" that includes narration of Jack London's book *White Fang* (0:00–0:52). Stop the narration with the question "Why do animals' eyes glow at night?"

https://n.pr/3BLH80G

Discuss the students' initial reaction to the narration and sounds of the audio clip. Invite students to share their mental images of the scene and what animals' eyes were glowing in the dark around the campfire. Ask:

- What images did the audio from *White Fang* bring to mind?
- What feeling were you experiencing?

Explain that different people have different attitudes about the wolf and the importance of biodiversity in an ecosystem. It might be helpful as we try to figure out the wolf/moose relationship and population changes to take a classroom survey about wolves and roles different animals play in ecosystems and the importance of biodiversity in ecosystems.

Divide the class into groups of four students and distribute the *Biodiversity Survey* handout to each group. Allow time for the groups to read the questions on the survey and discuss questions they would like to add or revise. Encourage students to write notes on the handout for additional questions and revisions. Ask:

- How can we use this survey and include attitudes and knowledge about the wolf? Moose?
- How can we frame those questions for the survey?
- Who has another or different idea?
- What questions could we ask to find out our collective knowledge of biodiversity and how it affects balance in an ecosystem?

After the class is satisfied with additions and revisions to the survey, add their questions and revisions to the survey document, publish the revised survey for each student, and ask them to take the survey individually and to try not to be influenced by ideas from the group or friends in the classroom.

If your class is not equipped with one-to-one devices, print the survey and have the students enter their responses using paper and pencil. Create a Biodiversity Survey Data chart to collect the students responses to the survey.

Science Talk
After all students have taken the survey, go to **Responses** and select **Summary** to see the results of the survey, or compile the class's written surveys. Discuss what the whole class might agree on. Select some of the responses and ask students if they would like to justify their ideas or discuss further what is meant by "loss of biodiversity" and what effect that has on different ecosystems and the environment. Ask:

- Would anyone like to discuss their response to _____? Why do you think some of the class chose _____ and others chose _____?
- Can someone add to that idea?
- Do the rest of you agree? Why or why not?
- How might knowing our current understandings and ideas help us to answer our questions?

Review the What We Think chart and add new ideas and questions that were prompted by the survey. Explain that as the lessons progress the class will return to the survey and be given the opportunity to revisit their answers.

Discuss the possibility of expanding the survey to different populations. The current survey results reflect the thinking of one class of students of about the same age.

Decide on a strategy for collecting further data from different age groups, professions, family members, etc. Determine if the information will be surveyed electronically or with paper and pencil and when all the survey results should be completed.

Two or three days later, compile the results of surveys from different demographics. Discuss the comparison of ages, professions, and so on, and students' ideas of the reason for discrepancies in attitudes and information. Explain that the class will return to their surveys after they have explored some of the answers to their questions on the What We Think chart.

Assessment: Formative
Use the Science Talk to assess students' ability to analyze data and engage in argument based on evidence.

ANALYZING AND INTERPRETING DATA
Analyzing data in 6–8 builds on K–5 experiences and progresses to extending quantitative analysis to investigations, distinguishing between correlation and causation, and basic statistical techniques of data and error analysis.

- Construct, analyze, and/or interpret graphical displays of data and/or large data sets to identify linear and nonlinear relationships.
- Use graphical displays (e.g., maps, charts, graphs, and/or tables) of large data sets to identify temporal and spatial relationships.
- ~~Distinguish between causal and correlational relationships in data.~~
- **Apply concepts of statistics and probability (including mean, median, mode, and variability) to analyze and characterize data, using digital tools when feasible.**
- **Consider limitations of data analysis (e.g., measurement error), and/or seek to improve precision and accuracy of data with better technological tools and methods (e.g., multiple trials).**
- **Analyze and interpret data to determine similarities and differences in findings.**
- ~~Analyze data to define an optimal operational range for a proposed object, tool, process or system that best meets criteria for success.~~

Lesson 2C: Digging into Data from Isle Royale

Teacher Background Information
The students continue their exploration into the moose/wolf relationship through a research project that is based on their questions. The introduction into population research serves as a precursor or point of reference for application and comparison to populations and relationships in their classroom ecosystem and a variety of ecosystems.

Explore the Concept
During this phase of the learning, students explore real data from the research on Isle Royale and revisit their initial models with new information. Students gather information through a variety of sources and media.

Advance Preparation
Keep the What We Think chart visible and active throughout the unit.

Each student will need graph paper and colored pencils (2 colors) to complete the graphing from the data chart. If needed, a page of graph paper for duplication is available at the end of the Handouts section of the Teacher Guide.

Become familiar with the Summary and Graph (page 2) in the 2017-18 Ecological Studies of Wolves on Isle Royale Annual Report.

https://bit.ly/3QO7sM7

Allow time for the students to carry out their observation, care and feeding of the classroom habitat. If changes or interactions have occured, be sure to discuss as a class.

Procedure
Explore the concept.
Explain to the class that scientists have had the unique opportunity to study the population of moose and wolves over fifty years on an island in Lake Superior called Isle Royale.

Show them the map of Michigan and the location of Isle Royale in Lake Superior. Ask students for their ideas of what type of data can be collected by observing the moose and wolf populations on Isle Royale. Ask students for their ideas of what differences might occur in the populations of both animals. Discuss the other organisms that make Isle Royale their habitat (birds, waterfowl, insects, plants, squirrels, beaver, fox, etc.).

Ask students to return to their groups of four and read the information page, "The Moose and Wolf Relationship on Isle Royale, Michigan," in their Student Journals. Using their Student Journals or graph paper and colored pencils, have the students

MATERIALS NEEDED
For each student:
student pages
Teacher provides:
Michigan map
graph paper
colored pencils
chart paper
markers
scrap paper
sticky notes
book: *White Fang* (optional)

LS4.D: BIODIVERSITY AND HUMANS
- 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. (secondary to MS-LS2-5)

READING SCIENCE AND TECHNICAL SUBJECTS—GRADES 6–8
Key Ideas and Details
RST.6–8.1: Cite specific textual evidence to support analysis of science and technical texts.

RST.6–8.2: Determine the central ideas or conclusions of a text; provide an accurate summary of the text distinct from prior knowledge or opinions.

STABILITY AND CHANGE
- **Small changes in one part of a system might cause large changes in another part.**

ANALYZING AND INTERPRETING DATA

Analyzing data in 6–8 builds on K–5 experiences and progresses to extending quantitative analysis to investigations, distinguishing between correlation and causation, and basic statistical techniques of data and error analysis.

- Construct, analyze, and/or interpret graphical displays of data and/or large data sets to identify linear and nonlinear relationships.
- Use graphical displays (e.g., maps, charts, graphs, and/or tables) of large data sets to identify temporal and spatial relationships.
- ~~Distinguish between causal and correlational relationships in data.~~
- **Apply concepts of statistics and probability (including mean, median, mode, and variability) to analyze and characterize data, using digital tools when feasible.**
- **Consider limitations of data analysis (e.g., measurement error), and/or seek to improve precision and accuracy of data with better technological tools and methods (e.g., multiple trials).**
- **Analyze and interpret data to determine similarities and differences in findings.**
- ~~Analyze data to define an optimal operational range for a proposed object, tool, process or system that best meets criteria for success.~~

use the information chart and create graphs that show the fluctuations in moose and wolf populations over the past fifty years.

Look at the wolf and moose population data from 1959 to 2018 on the following page. Make a graph below or on graph paper that illustrates the population increases and decreases. Write questions you have about the relationship between the moose and the wolf populations on Isle Royale.

Distribute graph paper and colored pencils to each group. Facilitate the small-group activity by circulating among the students to observe and listen to their reading and discussion. To help the students make sense of the data and elaborate on their explanations, ask:

- Can someone retell what you have read so far?
- How will you organize the data on the chart into a graph? What is your dependent variable? (y-axis) What is the independent variable? (x-axis) What labels will you use?
- What do you think the graphs will tell you about the populations of moose and wolves on the island? Why do you think that?
- Tell me more about how the populations of the animals might change. What do you mean when you say…?
- What information from the reading was helpful in making sense of the data from the chart? What different factors might affect the populations of the two animals? How do you know that?
- What further questions do you have about the ecosystem on Isle Royale?

Explain the concept and define the terms.

Science Talk

Only after the students have completed the graphs and analyzed their findings, have the groups come together to share their ideas. To help the class collectively make sense of the data, ask:

- Who would like to start our sharing of data and ideas about the data?
- Did any groups have the same reasoning but a different way to explain it?
- Does anyone have a different idea?
- Do you understand what _____ is saying?
- Can anyone explain why the fluctuations in the moose and wolf populations make sense?

- How are they related? What happens to the moose population when the wolf population increases? What if the opposite happens?
- What further questions do you have about the moose and wolves on Isle Royale?

Record the students' new ideas on the What We Think chart. Add to the class list of questions for further study and research. Example questions:

- What are the weather conditions on Isle Royale?
- Do the wolves eat only the moose, or is there other prey on the island?
- What is the diet of the moose?
- What other areas on Earth support wolf and moose populations?
- How does climate change affect the moose and wolf populations on Isle Royale?
- How do scientists count the wolf and moose populations from year to year? How do they track the animals?
- What is the effect of the predator/prey relationship in a "closed system" where few animals come and go on the island?
- What other factors, besides the predator/prey relationship, affect the population of moose and wolves on the island?

Introduce the terms *species*, *population*, *community*, *biodiversity*, and *ecosystem* to the class. Ask the students to define the terms as related to organisms on Isle Royale. Only after the class is satisfied with their own definitions, have them write their definitions in the Key Terms in the Student Journal. Ask a student volunteer to use the terms in relation to the moose and wolves that make their habitats on Isle Royale.

Discuss the terms *predator* and *prey* and how the moose and wolf relate to the predator/prey relationship. Ask students to give examples of predators and prey in a variety of ecosystems.

Review the What We Think chart and ask the class where they think their research should go based on their questions about the Isle Royale phenomenon. Listen for ideas to continue to research their questions and find out what the scientists on the island are doing and learning.

Assessment

Use the Activity Page, graphs, and Science Talk to assess the students' ability to analyze data and construct graphs from data on charts.

TEACHING TIP

To help students select topics for research, have them consider their questions; help them to narrow their focus on a specific question and topic. Students who enjoy a challenge may be interested in researching the inbreeding or lack of diverse genetic material that threatens the wolf population on Isle Royale.

SYSTEMS AND SYSTEM MODELS

- **A system can be described in terms of its components and their interactions.**

CAUSE AND EFFECT

- **Cause-and-effect relationships may be used to predict phenomena in natural and designed systems. (MS-ESS2-5), (MS-ESS3-4)**
- **Relationships can be classified as causal or correlational, and correlation does not necessarily imply causation. (S-ESS3-3)**

MATHEMATICS—GRADES 6–8

Expressions and Equations

3. Represent and analyze quantitative relationships between dependent and independent variables.

Statistics and Probability

1. Develop understanding of statistical variability.
2. Summarize and describe distributions.

Lesson 2D: Digging Deeper into Studies and Findings from Isle Royale

Teacher Background Information

The lesson continues with students carrying out research to answer their own questions about the interactions and interdependency of organisms on Isle Royale. The Isle Royale website has multiple articles for students to access and conduct research to answer their questions. Take this opportunity to have students conduct research, cite resources, and discuss the importance of citing the research of others.

Advance Preparation

Explore the many resources available on the Isle Royale website. The annual reports provide an in-depth account of the fluctuations in populations and how scientists have been conducting their research. Some sections of the reports have information and graphs and charts that are beyond the middle-school level, and students may need assistance if they want to interpret the more difficult information.

Become familiar with Internet resources:

Isle Royale Wolf Website - https://isleroyalewolf.org

Isle Royale Wolf Website > Annual Reports
https://bit.ly/3SrxTIT

Science Daily: Fifty Years of Wolf–Moose Research
https://bit.ly/3BVpeZP

Science Times: In Long Running Wolf-Moose Drama, Wolves Recover From Disaster - https://bit.ly/3RRMz3Q

National Parks Conservation Association: Wolves at Isle Royale
https://bit.ly/3Dvs2Oo

National Park Service: Why Relocate Wolves to Isle Royale?
https://bit.ly/3UfzByA

The Monroe News: Former national park ranger discusses predator-prey dynamic of Isle Royale wolves, moose
https://bit.ly/3Lltrcj

Access Science: Predator-prey relationship of wolves and moose on Isle Royale - https://bit.ly/3BM7DDm

Take this opportunity to turn your classroom into a magazine publication business, a newsroom, or a website for the presentation of the student findings.

MATERIALS NEEDED

For each student:
- student pages
- handout: *Moose/Wolf Relationship Product Descriptor*

For each group of 4:
- *Wolf/Moose Card Set* (wolf, moose, map)

Teacher provides:
- Michigan map
- chart paper
- markers
- scrap paper
- sticky notes
- book: *White Fang* (optional)

READING SCIENCE AND TECHNICAL SUBJECTS—GRADES 6–8

Key Ideas and Details

RST.6–8.1: Cite specific textual evidence to support analysis of science and technical texts.

RST.6–8.2: Determine the central ideas or conclusions of a text; provide an accurate summary of the text distinct from prior knowledge or opinions.

Craft and Structure

RST.6–8.4: Determine the meaning of symbols, key terms, and other domain-specific words and phrases as they are used in a specific scientific or technical context relevant to grades 6–8 texts and topics.

Integration of Knowledge and Ideas

RST.6–8.7: 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.6–8.9: Compare and contrast the information gained from experiments, simulations, video, or multimedia sources with that gained from reading a text on the same topic.

LESSON 2D

TEACHING TIP
Some topics will require more time to research than others. Some groups may finish early. Set up the presentation schedule to include one or two research presentations at the beginning or end of class as others continue to work on their projects.

LS2.A: INTERDEPENDENT RELATIONSHIPS IN ECOSYSTEMS

- 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.** (MS-LS2-2)
- **Organisms, and populations of organisms, are dependent on their environmental interactions both with other living things and with nonliving factors. (MS-LS2-1)**
- **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.** (MS-LS2- 1)
- **Growth of organisms and population increases are limited by access to resources. (MS-LS2-1)**

Prepare a Research Assignment Board where students will write their topics and show their progress in completing their research.

Example:

Research Assignment Board

Students' names	Question You Are Researching	Draft Due Date	Final Draft Due Date	Presentation Date

Make copies of the handout *Moose/Wolf Relationships Product Descriptor*, found in the Handout section of the Teacher Guide.

Allow time for the students to carry out their observation, care and feeding of the classroom habitat. If changes or interactions have occured, be sure to discuss as a class.

Procedure

Elaborate on the concept.

Review the What We Think chart and discuss questions the students have concerning the study of the wolf and moose populations on Isle Royale. Discuss the different categories and have students think about a category and question they would like to know more about. Ask students how they might find out more information about the moose and wolves, the fluctuations in populations, and what scientists are doing with the data collected on the island.

Have students choose a question to research and form groups of three or four researchers. Allow time for groups to discuss their question and ideas of what they think they will find out and ideas of research resources. Distribute the *Moose/Wolf Relationships Product Descriptor* to each student. Discuss the "must haves" for all written reports and presentations and the "group choice" elements that the class and/or group feel are necessary for a complete research project. Discuss different ideas for presenting their research.

As a class, review the different categories of information on the Isle Royale website. Discuss other possibilities for research material depending on the question they are asking. Allow time for the groups to brainstorm their ideas, questions, and possible resources. Facilitate the group discussions by circulating among the students and listening to their ideas. To help groups that are stuck or struggling to develop a plan, ask:

- What question/topic has this group decided to research?
- Would it be helpful to make a list of ideas you already have and further questions that are related?
- Have you thought about the resources you can start to explore?
- Is there a way that your question/topic can be divided among the group? How can you divide the work?

After the groups have decided on a plan and chosen some of their resources, review the *Note-Taking Strategies for Informational Text and Video* in the Student Journal. Advise the students that in their research they will find information beyond their research question and to try to focus only on information that will help them answer their questions. Decide on the protocol for citing the different sources.

Set a time limit for research and decide if some of the work is to be conducted as homework and how much is accomplished in class time.

Evaluate the students' understanding of the concept.

Presenting Our Findings

Provide sufficient time for the students to present their research to the rest of the class. Have them use the *Moose/Wolf Relationship Product Descriptor* handout to help them organize their findings and presentations to the class.

After students have completed their presentations, return to the What We Think chart and revisit the questions students chose for their research. Complete the What We Did, What We Figured Out, and How Does That Help Us? columns. Ask:

- Have we answered our Driving Question(s)?
- What causes the moose and wolf populations to fluctuate over time?
- What caused the wolf population to reduce to two wolves?

At the conclusion of the lesson, if time allows, have students conduct observations of the classroom ecosystem habitat and enter their observations into the *Classroom Ecosystem Observation Log*.

Assessment

Use the Activity Page to assess the students' ability to determine central ideas, provide evidence, and evaluate information from a variety of resources.

Use the presentations to assess the students' ability to communicate information about their research project through writing and oral presentations.

OBTAINING, EVALUATING, AND COMMUNICATING INFORMATION

Obtaining, evaluating, and communicating information in 6–8 builds on K–5 experiences and progresses to evaluating the merit and validity of ideas and methods.

- **Critically read scientific texts adapted for classroom use to determine the central ideas and/or obtain scientific and/or technical information to describe patterns in and/or evidence about the natural and designed world(s).**
- **Integrate qualitative and/or quantitative scientific and/or technical information in written text with that contained in media and visual displays to clarify claims and findings.**
- **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.**
- **Evaluate data, hypotheses, and/or conclusions in scientific and technical texts in light of competing information or accounts.**
- **Communicate scientific and/or technical information (e.g., about a proposed object, tool, process, system) in writing and/or through oral presentations.**

APPENDIX

ENGINEERING DESIGN PROCESS

The Engineering Design Process provides students with a series of steps to guide them as they solve problems and design and test products, models, and solutions. The process is cyclical, yet not necessarily in an order. Students are encouraged to evaluate as they progress through the process, revisit the mission often, and revise thinking and their plan multiple times as the process unfolds.

Engineers do not always follow the Engineering Design Process steps in order, one after another. It is very common to design something, test it, find a problem, and then go back to an earlier step to make a modification or change the design. Engineers must always keep in mind the mission or problem they are trying to solve and the limitations (cost, time, material, etc.) that are part of the solution to the problem. Two key elements in working as an engineer are teamwork and design-test-and-redesign.

Mission

- Defines the problem and what the engineers are trying to design or build.
- Describes the limitations within which the engineers must solve the problem.

Brainstorm Ideas

- Imagine, discuss, and sketch possible solutions.
- Conduct research into what has already been done.
- Discover what materials are available, time frame, and other limitations.

Plan and Design

- Draw and write a plan.
- Design your solution through drawing and manipulating materials.
- Develop a plan or steps and a schedule.

Build

- Construct your engineering device or project.
- Follow your plan.
- Adjust and test along the way.

Test and Adjust

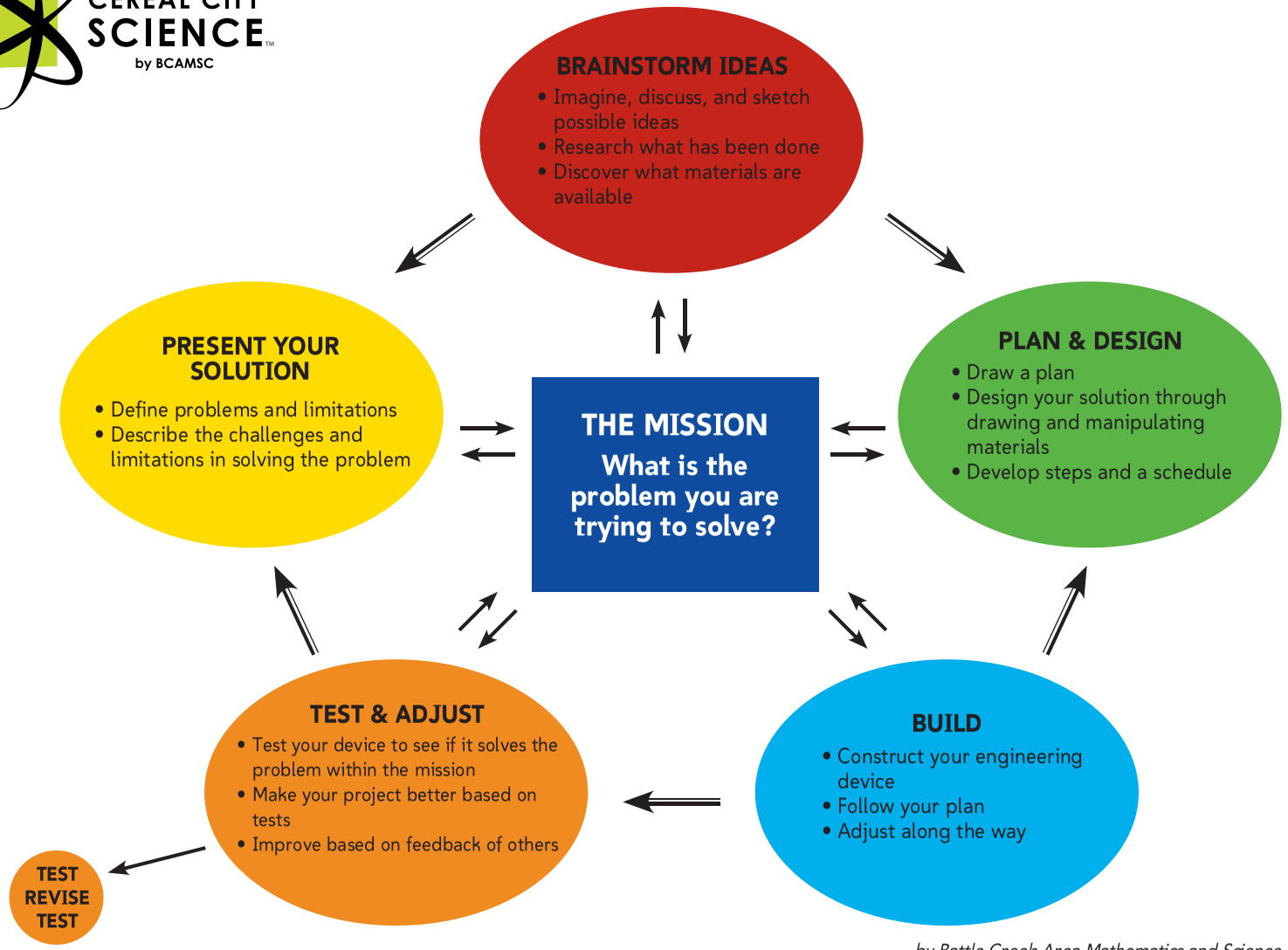
- Test your device to see if it solves the problem within the mission and limitations.
- Make your project better based on tests: Test → Revise → Test.
- Improve based on feedback of others.

Present Your Solution

- Demonstrate how your solution solves the problem.
- Define problems and limitations.
- Describe the challenges and limitations in solving the problem.
- Describe additional revisions that could improve the device or project.

CEREAL CITY SCIENCE by BCAMSC

ENGINEERING DESIGN PROCESS



by Battle Creek Area Mathematics and Science Center
Cereal City Science
Adopted from the Carnegie Mellon Robotics Academy

CEREAL CITY SCIENCE by BCAMSC

Student Journal
MS.LS.NGSS

Stability and Change in an Ecosystem MSLNG1

A Middle School Unit supporting Next Generation Science Standards and Michigan Science Standards

Name:

Name:_____

Date:_____

ACTIVITY **1A**

Organisms in the Classroom

1. Draw and label a picture of your observation animal.

2. Write about your observations of your animal. Tell what physical characteristics and behaviors you observed.

3. Record at least three questions you have about your observation animal.

Name: _____

Date: _____

4. Record your observation of the fern plant.

5. Record your observations of the moss mat.

Name:_____

Date:_____

ACTIVITY **1B**

Putting Our Habitat Together

1. All living things need air, water, and food, and plants also need sunlight. What special needs does your organism need to survive?

2. With your group, develop and draw a model of a classroom habitat that will support the needs of your organism.

Name: _____

Date: _____

3. Write a procedure (in order) for the habitat assembly.

   Available materials: 10-gallon tank (habitat), soil, wood substrate, sticks, stones, water, spray bottle, grass seed.

Name:_____

Date:_____

1. Draw and label a model of the classroom ecosystem. Include the role of each organism.

2. Develop a model of a food web that explains the interactions among the organisms.

Name: _____

Date: _____

3. Write if you think the ecosystem is balanced or unbalanced. Explain why.

Name:_____

Date:_____

ACTIVITY **2A**

The Wolf Moose Population

1. Use the space below to develop a model of your initial ideas about the wolf and moose populations on Isle Royale. Include how they might interact and your ideas about their habitat.

2. Write a list of questions you have about the wolves, the moose, and the Isle Royale ecosystem.

Name: _____

Date: _____

3. Work with your group and use the space below to draw and label a model that explains the relationship between the moose and wolf and the changes in their population. Include the unobservable mechanisms that help explain the phenomenon. Share your individual ideas with your group to develop a group model that includes ideas from all members.

Name:_____

Date:_____

Digging Into Data From Isle Royale

The Moose and Wolf Relationship on Isle Royale, Michigan

Isle Royale, Michigan is an island located in the northwest portion of Lake Superior. It is approximately 80 km (50 miles) from Michigan's shore and 35 km (22 miles) from the Canadian shore. Moose first arrived on the island in about the year 1900 when they swam across Lake Superior from Minnesota, 43.5 km (27 miles). They enjoyed a predator-free environment and the moose population thrived. In 1949, the area experienced a particularly cold winter and a small ice bridge formed between Ontario, Canada and Isle Royale. A pair of wolves crossed the ice bridge and a predator was introduced to the island.

Since 1959, scientists have studied the moose and wolf populations to better understand how the moose and wolf interact and the predator/prey relationship. Isle Royale provides a somewhat "closed ecosystem" for scientists to study. The island is protected and the moose and wolves can be studied without human activity or intervention. There is little migration of other animals onto and off of the island.

When the research first began, many researchers believed that the population of the moose and wolf would eventually reach an equilibrium, or stabilize. The study has not yet shown a trend in moose and wolf counts and the numbers tend to increase and decrease unpredictably.

Moose and wolves are not the only animals on the island. Beavers, snowshoe hares, red fox, mice, squirrels, birds, waterfowl, and an abundance of insects are part of the biotic makeup of the Isle Royale community. The moose is the main or preferred diet of the wolf but they have been observed hunting and eating the snowshoe hares and beavers. The beavers compete with the moose for the same vegetation as a food source, affecting both moose and beaver populations.

The climate on Isle Royale also plays a role in the moose/wolf relationship. The recent summers on Isle Royale have been warming up. The warmer climate in recent years has produced more insects, especially ticks. Ticks consume the blood of mammals and cause sores, hair loss, and disease. Harsh winters and abundant snowfall make it difficult for the moose and wolf alike. Hunting and foraging are more difficult in the extreme cold and deep snow for both animals.

2C ACTIVITY
Digging Into Data From Isle Royale

Name: _____

Date: _____

Look at the wolf and moose population data from 1959 to 2018 on the following page. Make a graph below or on graph paper that illustrates the population increases and decreases. Write questions you have about the relationship between the moose and the wolf populations on Isle Royale.

Name:_____

Date:_____

ACTIVITY **2C**

Digging Into Data From Isle Royale

Wolf and Moose Population Data 1959 to 2019

Year	Estimated Wolf Population	Estimated Moose Population
1959	20	538
1962	23	579
1965	28	634
1968	22	848
1971	20	1183
1974	31	1203
1977	34	949
1980	50	788
1983	23	830
1986	20	1014
1989	12	1260
1992	12	1697
1995	16	2117
1998	14	925
2001	19	1120
2004	29	750
2007	21	385
2010	19	510
2013	8	975
2016	2	1300
2019	15	2060

Name: _____

Date: _____

TOOL FOR PRE-READING NOTES

Title of chapter or article:	
List the titles and subtitles of the reading.	
List any bolded terms in the article.	
Write down the main ideas or questions you will focus on during the reading.	
Write any information you learned from pictures and graphs or charts in the article.	
What question(s) do you think this reading is attempting to answer?	

Name: _____

Date: _____

ACTIVITY **2D**

Digging Deeper Into Studies and Findings From Isle Royale

NOTE-TAKING TOOL FOR READING IN SCIENCE

Title of chapter or article:	
Read the first selected section to get a good idea of the material, then go back and reread to take notes: • Write the main idea or concept of the selection in your own words. • Write the meaning of key terms in your own words. • Review and compare your notes with a partner.	
Continue to read the next selected section. Write the main idea or concept of the selection in your own words. • Write the meaning of key terms in your own words. • Review and compare your notes with a partner.	
Compare and combine the pre-reading notes with the notes from the reading. • How did the reading answer the question? • How did the reading cover the main idea? • Write the meaning of unfamiliar terms in your own words.	
List questions or concepts that are unclear in the reading.	

K E Y T E R M S

Name: _____

Date: _____