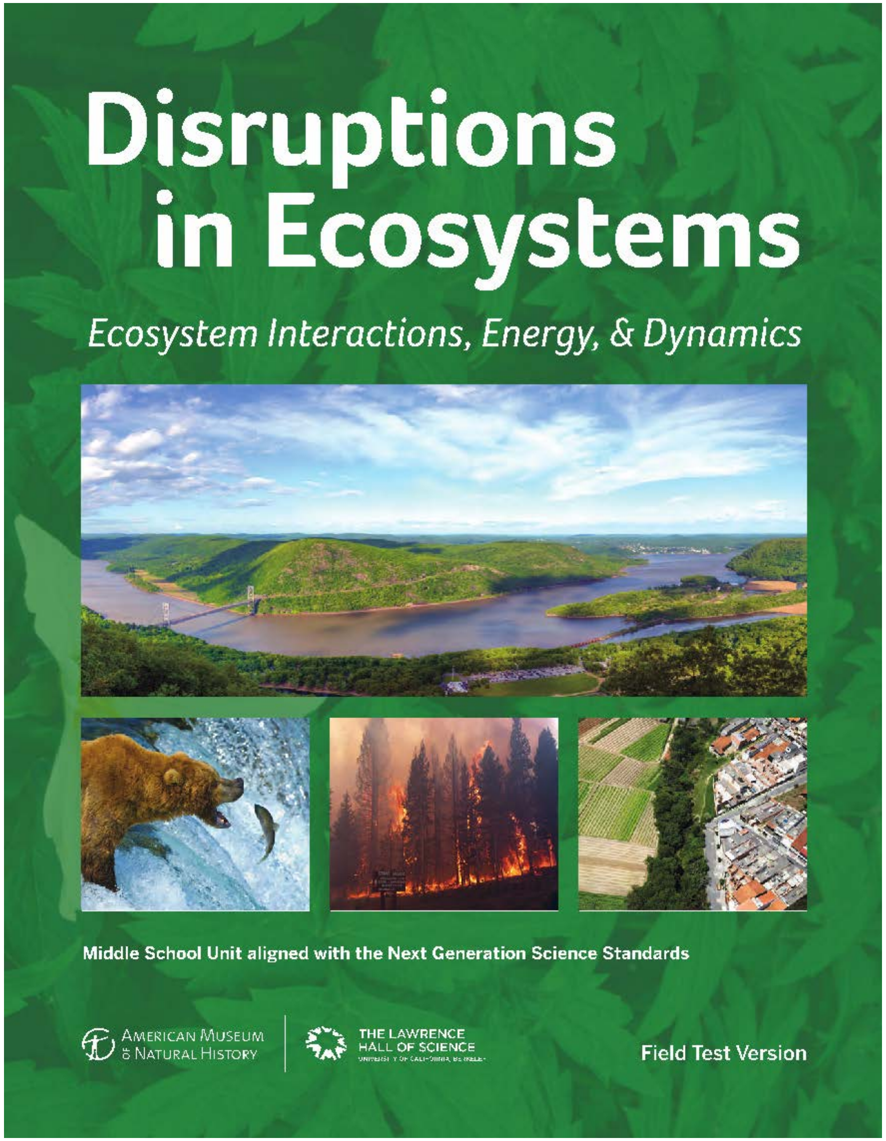

NGSS@NSTA FORUM
Friday, March 16, 2018

Disruptions in Ecosystems:
An NGSS-Designed Middle School Unit & PD Model

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The Lawrence Hall of Science
University of California, Berkeley

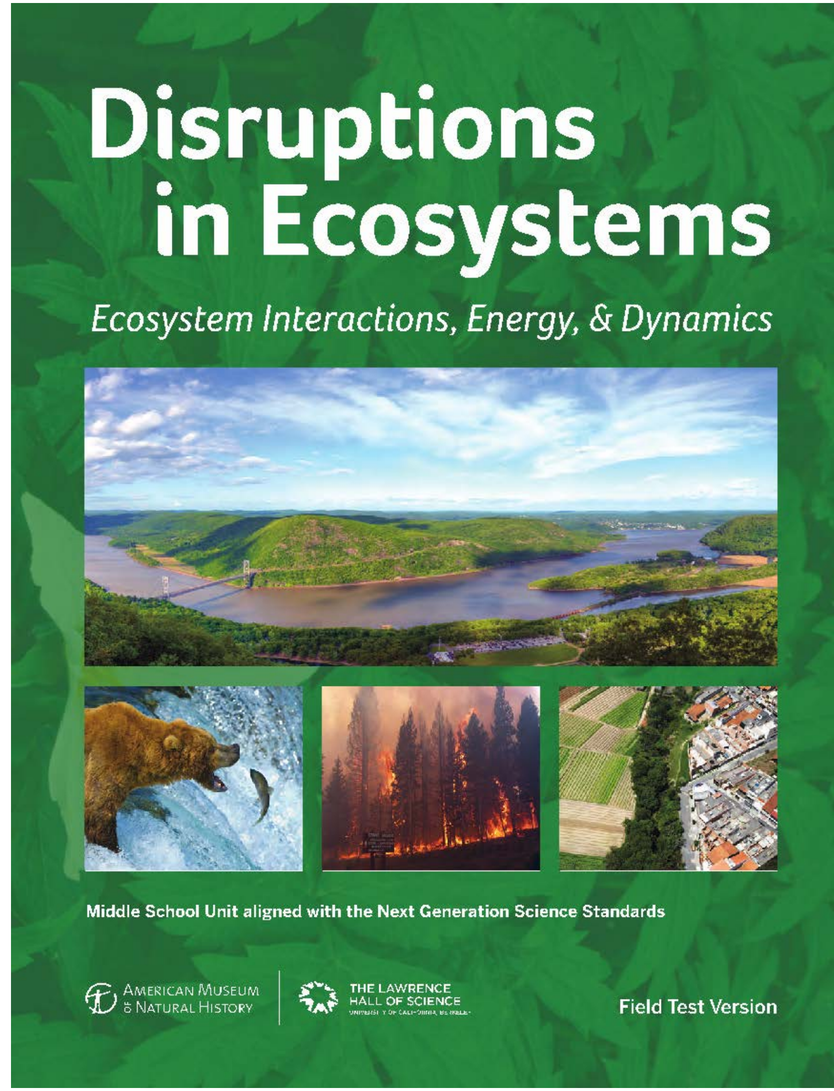
Welcome!

- Introduce yourself, share your role.
- What are some of the things you look for in instructional materials?

Overview

- Student Materials
  - *Activity 3.4*
- Teacher Materials
  - *PD Activity*
- Features in Materials to Support Student and Teacher Learning
- How can YOU use these materials?

- Middle School Ecosystems Unit & Assessments
- Designed using NGSS and modified Five Tools
- Developed by AMNH and Lawrence Hall of Science (SEPUP)
- Includes professional development model
- Funded by NSF (DRK12)
- 3 years of Field Testing with NYC teachers



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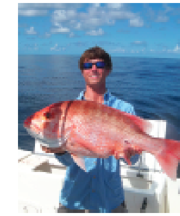
Wolves in Yellowstone 2

CHAPTER 2

Ecosystem Models 38

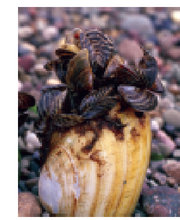
CHAPTER 3

Interactions Between Populations and Resources 68



CHAPTER 4

Zebra Mussels 94



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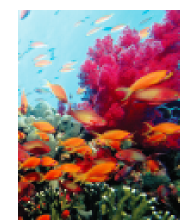
Designing Solutions 126



Activity 3.1
Engage

What factors should you consider when purchasing fish to eat?

Students begin the chapter thinking about fishing as an example of human use of natural resources. Students start considering how the health of one population might affect the ecosystem it lives in.

Activity 3.2
Explore

Can fishing limits prevent the overuse of an ecosystem?

Students explore how fishing limits can change the effect of human natural resource use, and examine how changes to the surrounding ecosystem can be a compounding factor. This allows students to investigate their initial ideas about natural resource use and about how multiple factors can affect populations.

Activity 3.3
Explain

What effect have humans had on the health of fisheries?

Students transition from analyzing their own data about a fictitious fishery to an analysis of long-term data from three real fisheries. Students use this analysis to develop an initial explanation about humans' effect on fisheries and a formal argument about the health of one fishery.

Activity 3.4
Elaborate

How do humans affect the size of dead zones?

Students expand on their understanding of human disruption of ecosystems by looking at a more complex problem: the creation and expansion of dead zones. Students use their analysis of a variety of data to inform a debate on limiting human use of fertilizers to prevent dead zones.

Activity 3.5
Evaluate

How do increases in the human population affect the resources available to organisms?

Students conclude the chapter with an investigation that examines the effects of fishing and dead zones on the Chesapeake Bay Oyster fishery. This allows for the evaluation of students' understanding of the effects of resource availability on organisms and populations of organisms as well as how increases in the human population impact the Earth's systems. This also prepares them to investigate another complex ecosystem disruption, invasive species, in the next chapter.

Student Materials

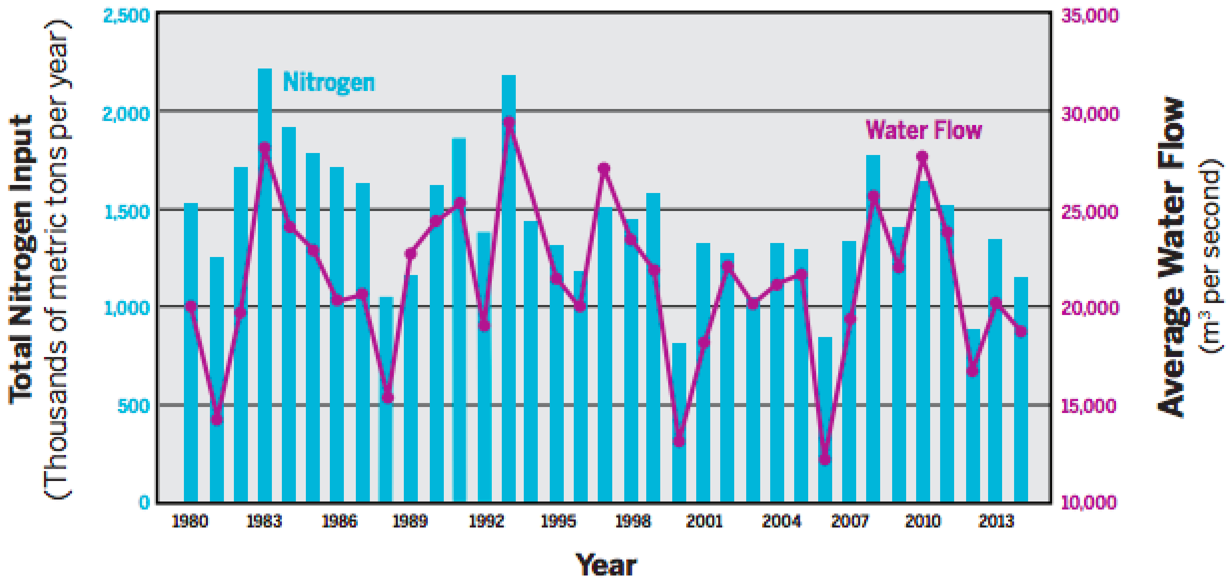
Activity 3.4

Elaborate: Dead Zones

Guiding Question

How do humans affect the size of dead zones?

Nitrogen Input and Water Flow from the Mississippi Basin to the Gulf of Mexico



This graph shows the amount of nitrogen input and water flow from the Mississippi Basin into the Gulf of Mexico from 1985 to 2014

What is the effect of water flow from the Mississippi Basin on the total nitrogen input in the Gulf of Mexico?

Student example:

Scientific Question:

"What is the effect of water flow from the Mississippi Basin on the total nitrogen input in the Gulf of Mexico?"

Scientific Explanation:

The effect of water flow from the Mississippi Basin on the total nitrogen input in the Gulf of Mexico is that when the water flow increases, the amount of nitrogen does as well. Relevant evidence that supports my claim is from the *Nitrogen Input and Water Flow from the Mississippi Basin to the Gulf of Mexico* graph on page 83. It visually describes and demonstrates how the water flow correlates with the nitrogen in terms of when the water flow increases, the nitrogen increases as well. 50% of nitrogen comes from fertilized land or treated soil, and 15% of it is from animal manure. Therefore the main source of nitrogen comes from farmlands which contain 65% of the nitrogen that is traveled into the gulf in total. Scientific concepts that are connected to the evidence are fertilizer runoffs and water flows from north to south. Because nitrogen is used in land fertilizers, after it rains, the nitrogen is drained into run off rivers that flow from north to south. Therefore, the nitrogen empties out into the Gulf of Mexico.

Student example:

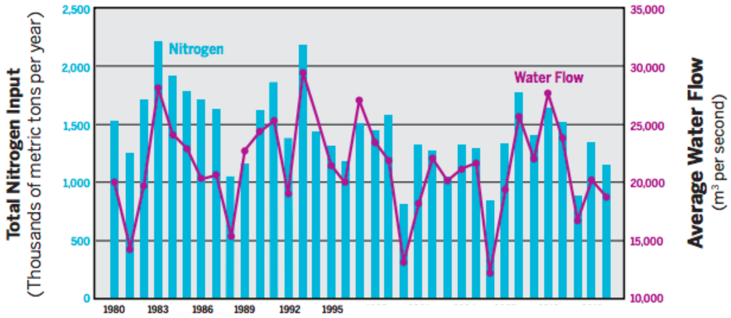
Scientific Question:

"What is the effect of water flow from the Mississippi Basin on the total nitrogen input in the Gulf of Mexico?"

Scientific Explanation:

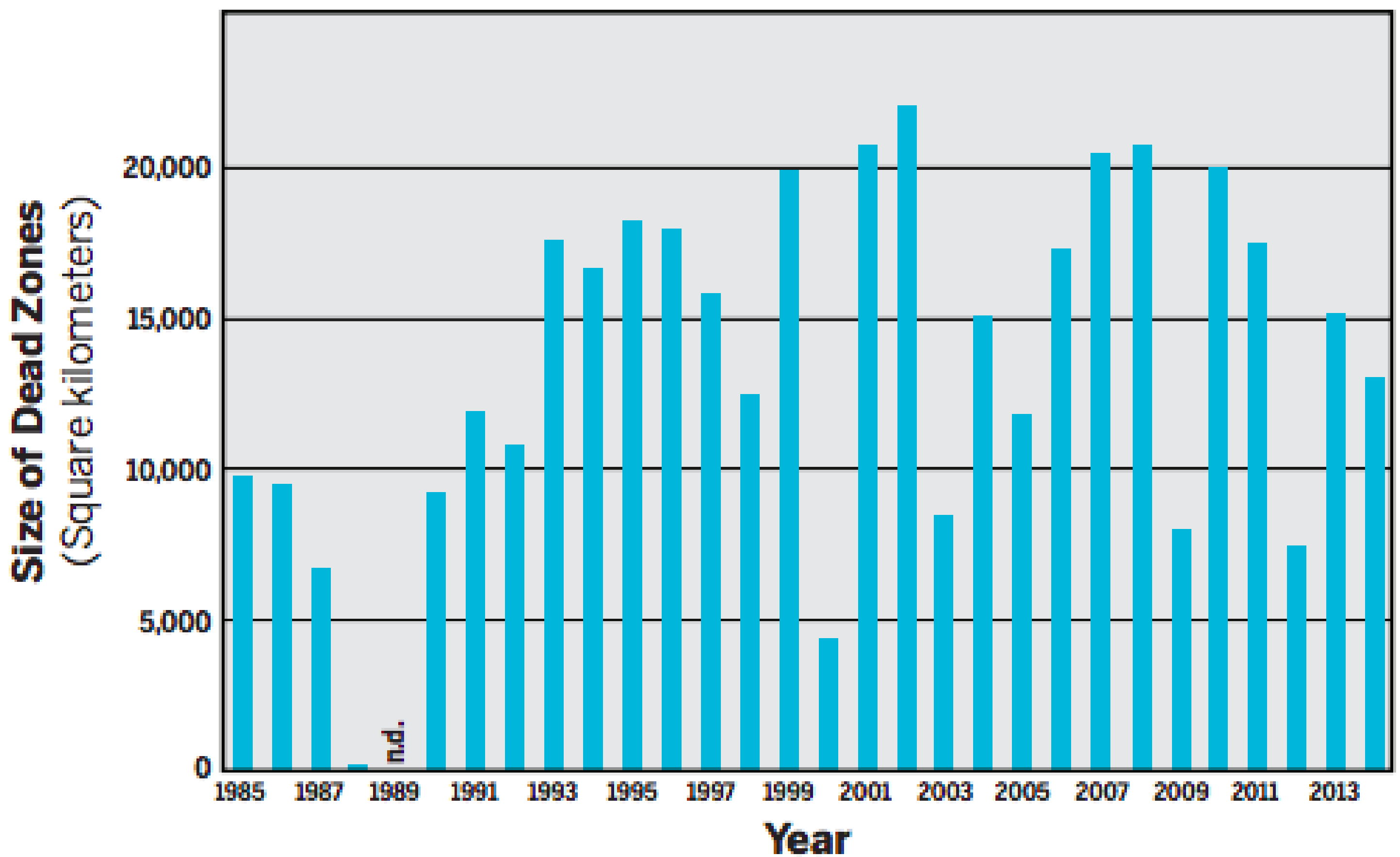
The effect of water flow from the Mississippi Basin on the total nitrogen input in the Gulf of Mexico is that when the water flow increases, the amount of nitrogen does as well. Relevant evidence that supports my claim is from the *Nitrogen Input and Water Flow from the Mississippi Basin to the Gulf of Mexico* graph on page 83. It visually describes and demonstrates how the water flow correlates with the nitrogen in terms of when the water flow increases, the nitrogen increases as well. 50% of nitrogen comes from fertilized land or treated soil, and 15% of it is from animal manure. Therefore the main source of nitrogen comes from farmlands which contain 65% of the nitrogen that is traveled into the gulf in total. Scientific concepts that are connected to the evidence are fertilizer runoffs and water flows from north to south. Because nitrogen is used in land fertilizers, after it rains, the nitrogen is drained into run off rivers that flow from north to south. Therefore, the nitrogen empties out into the Gulf of Mexico.

Nitrogen Input and Water Flow from the Mississippi Basin to the Gulf of Mexico



This graph shows the amount of nitroger
Basin into the Gulf of Mexico from 1985 t

Size of Dead Zones in the Gulf of Mexico



“Should fertilizer use be limited to help prevent dead zones?”

Teacher's Materials:
A PD Activity

Chapter 3 Overview

Activities	Science Concepts	Science Practices	Science Vocabulary	Teaching Periods
Engage **3.1 Shopping for Fish** **Guiding Question: What factors should you consider when purchasing fish to eat?** In this activity, students analyze data about purchasing fish in a grocery store. They use this data to decide what fish they would buy, and what other information they would want to have before making their decision. The class discusses the factors they think are important to consider when deciding what fish to purchase.	MS LS2.A.1 Cause & Effect Science Knowledge Describes Consequences	Analyzing & Interpreting Data	overfished	1
Explore **3.2 Gone Fishin'** **Guiding Question: Can fishing limits prevent the overuse of an ecosystem?** Students model resource consumption and overuse through a game that models fisheries. In the first game students are able to overfish the available fish populations. In the second game the fishing limits are set such that the fish populations are able to survive and increase. In the third game students model the effect of changes in ecosystem conditions.	MS LS2.A.1 Cause & Effect	Analyzing & Interpreting Data	overfished	1-2
Explain **3.3 Three Fisheries** **Guiding Question: What effect have humans had on the health of fisheries?** Students analyze data about three fisheries. They then use the data to try and identify the fisheries based on short text passages that describe each fishery, their historical and current fishing limits and practices, and key regulation dates. Students use their analysis to construct an argument about the health of a fishery.	MS LS2.A.2 MS ESS3.C.2 Consequences of Human Activity	Analyzing & Interpreting Data Engaging in Argument from Evidence	overfished	2

Assessment Overview

Embedded Formative Assessment	Activity 1 Engage	Activity 2 Explore	Activity 3 Explore	Activity 4 Explain	Activity 5 Elaborate
Disciplinary Core Ideas (DCI)					
MS LS2.A.1*	Analysis 3	P&P 4, 5, 7	P&P 7	P&P 4, Analysis 1 & 2	
MS LS2.A.2*			P&P 9		
MS LS2.A.3*					
DMS ESS3.C.2**			P&P 9	P&P 4, Analysis 2	
Science and Engineering Practices (SEP)					
Constructing Explanations and Designing Solutions			P&P 7	P&P 4	
Engaging in Argument from Evidence*			P&P 9	P&P 7	
Analyzing and Interpreting Data		P&P 4, 5, 7	P&P 2-6 Analysis 1	P&P 2 & 3	
Crosscutting Concepts (CCC)					
Cause and Effect*	Analysis 3	P&P 4, 5, 7		P&P 3 & 4 Analysis 1	
Connections to Engineering, Technology and Applications of Science**			P&P 7 & 9 Analysis 1	P&P 7	
Connections to Nature of Science**	Analysis 3			P&P 7	

* Primary PE and supporting elements **Secondary PE and supporting elements

Activity for Teacher Professional Learning

- Use your Assessment Chart to **locate the formative assessment opportunities** in Activity 3.4
- Revisit the *Student Materials* from Activity 3.4, and for each formative assessment opportunity, **record the code(s)** for either the DCI, CCC and/or SEP.
- **✶ Star the tasks in the student materials that are 3D** (that assess all three dimensions)
- Use your Teacher's Guide to anticipate student responses to one of the tasks. ***What will the data you collect tell you about next steps?***

Assessment Overview

Embedded Formative Assessment	Activity 1 Engage	Activity 2 Explore	Activity 3 Explore	Activity 4 Explain	Activity 5 Elaborate
Disciplinary Core Ideas (DCI)					
MS LS2.A.1*	Analysis 3	P&P 4, 5, 7	P&P 7	P&P 4, Analysis 1 & 2	
MS LS2.A.2*			P&P 9		
MS LS2.A.3*					
DMS ESS3.C.2**			P&P 9	P&P 4, Analysis 2	
Science and Engineering Practices (SEP)					
Constructing Explanations and Designing Solutions			P&P 7	P&P 4	
Engaging in Argument from Evidence*			P&P 9	P&P 7	
Analyzing and Interpreting Data		P&P 4, 5, 7	P&P 2-6 Analysis 1	P&P 2 & 3	
Crosscutting Concepts (CCC)					
Cause and Effect*	Analysis 3	P&P 4, 5, 7		P&P 3 & 4 Analysis 1	
Connections to Engineering, Technology and Applications of Science**			P&P 7 & 9 Analysis 1	P&P 7	
Connections to Nature of Science**	Analysis 3			P&P 7	

* Primary PE and supporting elements **Secondary PE and supporting elements

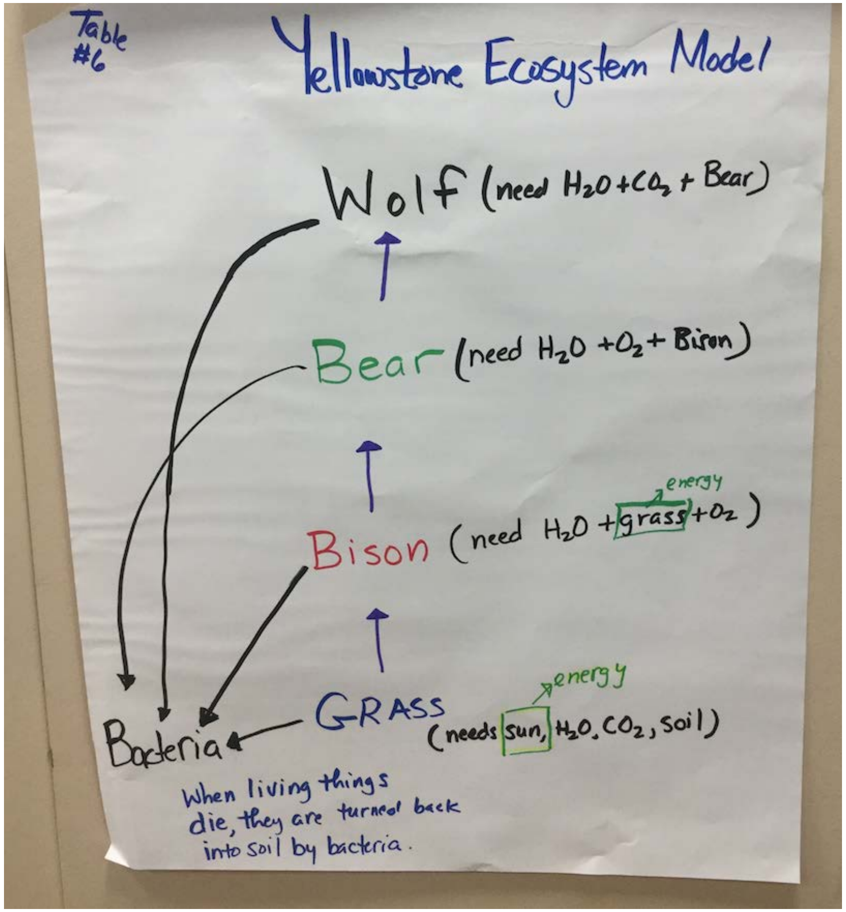
Features of the Materials that Support Student and Teacher Learning

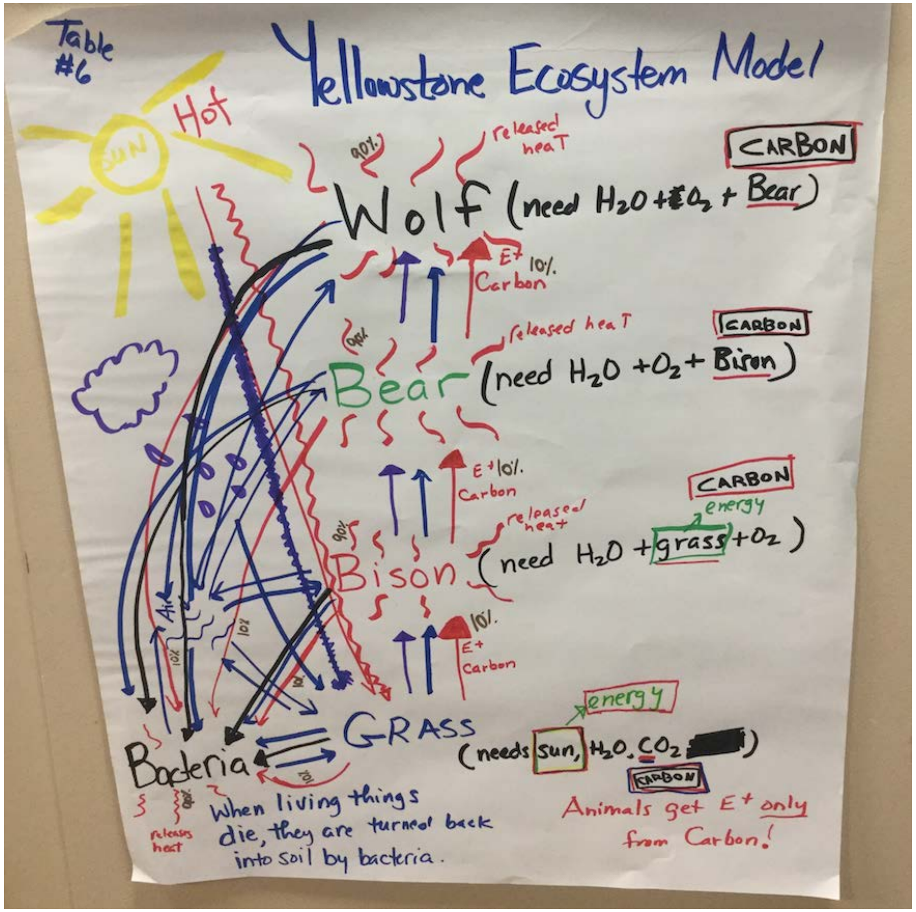
NGSS Essentials

- Three-dimensional
- Storyline and Coherence
  - Conceptual Flow & Instructional Model
  - Phenomena
- Tools that scaffold learning
- Connect to ELA/Math Standards
- System of embedded 3D assessments
  - Sample student responses
  - Rubrics for SEPs
  - Scoring Guides

Three-Dimensional

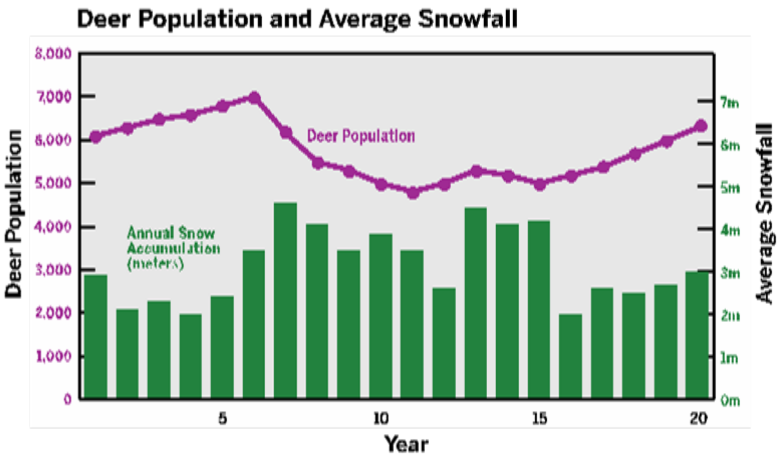
Develop, revise and use models to predict how disruptions will affect the cycling of matter and flow of energy.





Three-Dimensional

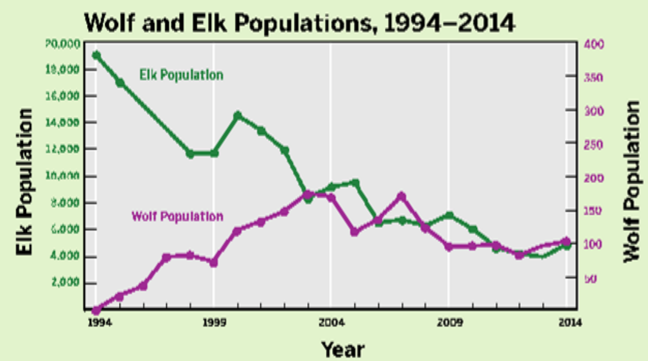
Analyze and Interpret Data to Explain How Different Patterns of Interaction Affect Populations



Guiding Question

What effects do living and non-living factors have on populations?

Wolves were reintroduced into Yellowstone in 1995. The graph below shows wolf counts for Yellowstone National Park and elk counts for Yellowstone's largest elk herd. The wolves have been counted every year since they were introduced. The elk numbers are based on counts made in and near the northern border of the park during the winter. There are no data for 1996 and 1997 because the data were not reliable due to weather conditions.



Three-Dimensional

Engaging in Argument

Guiding Question

Should wolves be reintroduced into the northeastern United States?

Controlling Deer Populations

Hunting is one way to control deer populations. White-tailed deer are one of the most commonly hunted species in the U.S., with approximately six million deer killed each year. In most cases, the dead animals are used for food.

In addition to hunting to reduce deer populations, some people have proposed reintroducing wolves into areas such as the Adirondacks in upstate New York. The Adirondacks are a mountainous area inside Adirondack Park, the largest preserve in the lower 48 states and considerably larger than Yellowstone National Park.

The park contains mountains, lakes, rivers, forests, and many types of plants and animals. The park covers about 6 million acres, of which 45% is protected public land. Much of the private land is used for agriculture, forestry, and open space. There are 105 towns and villages within the park, and over 60 million people live within a day's drive of the park.

Three-Dimensional

Designing Solutions

Humans rely upon ecosystems in many ways. They supply us with resources such as food, shelter, energy, and even the oxygen that we breathe. They also provide enjoyment and income for people. Using resources can also threaten the health of the ecosystem. In some cases a problem can become so bad that the environment will not recover by itself. In such cases, a solution is needed. The solution might involve the use of technology, the application of policies and rules, or all of these. After a solution is put in place it must be monitored to see if it is working. In this activity, you will examine several environmental issues and evaluate the sustainability of proposed solutions.

Guiding Question

How can we evaluate whether a solution to an environmental problem is a sustainable one?

Environmental Problem 1

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Environmental Problem 2

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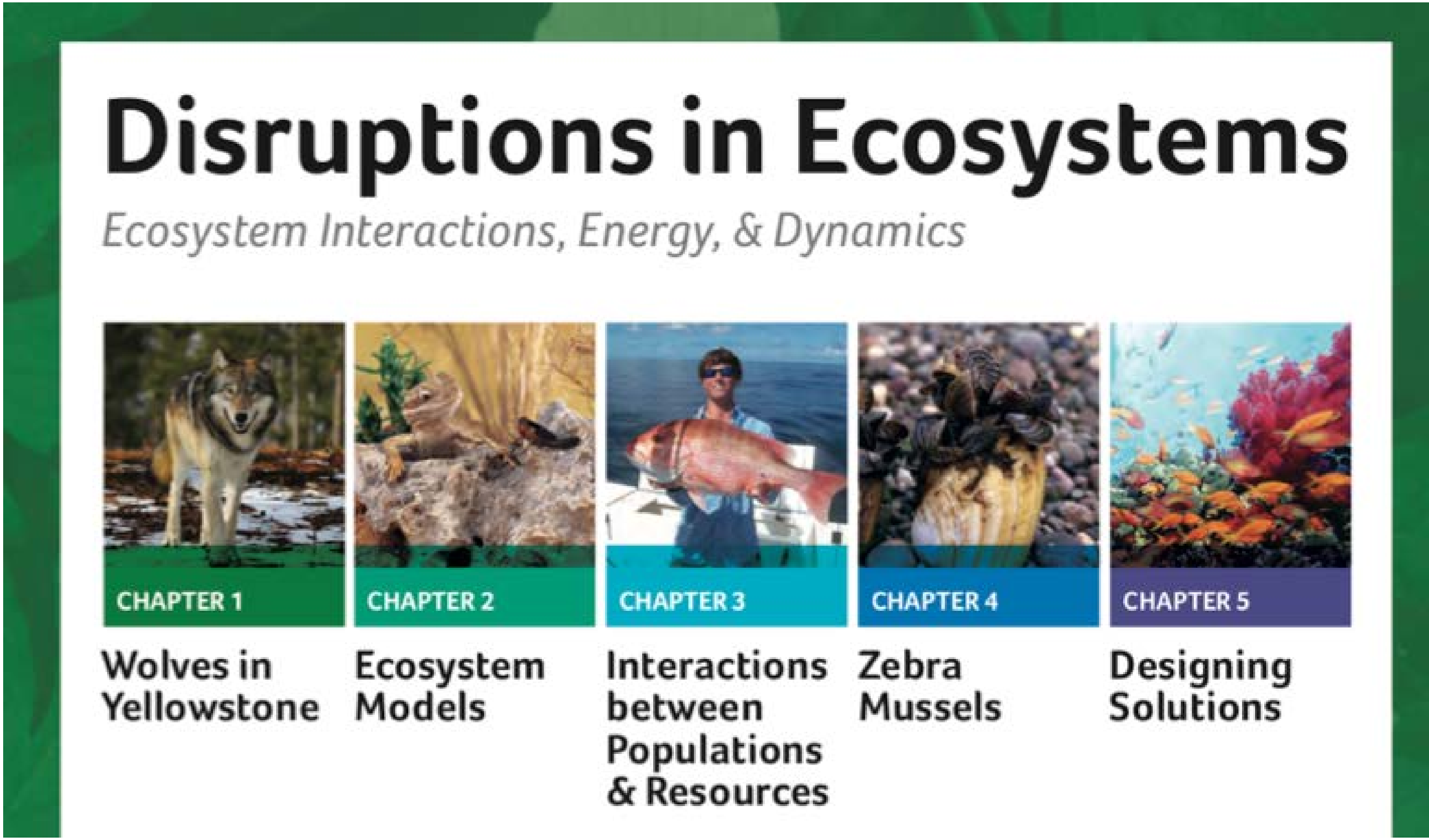
Environmental Problem 3

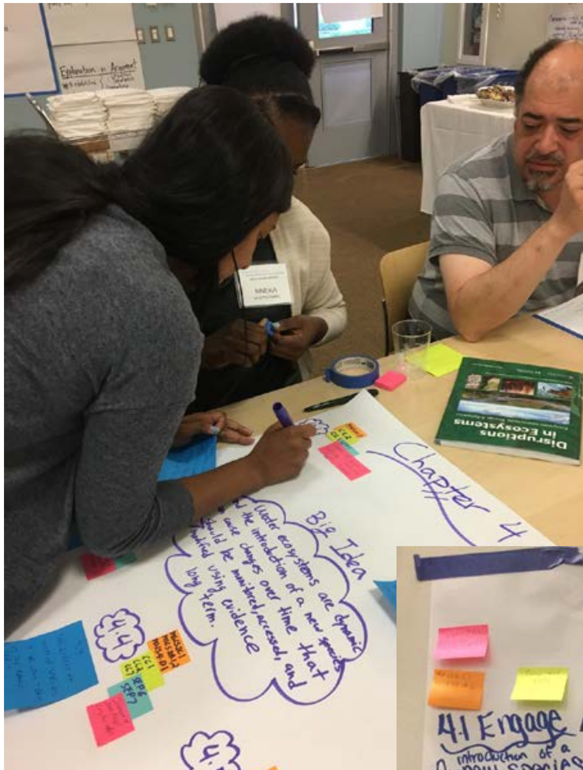
Yellowstone Lake is the largest body of water in Yellowstone National Park. It is a very large (350 km²) freshwater lake with an average depth of 42 m. More than 140 rivers and streams flow into Yellowstone Lake. The Yellowstone River is the largest outflow of water from the lake, eventually reaching the Missouri River. At the present time, no zebra mussels have been spotted in Yellowstone Lake but they have reached neighboring states. Scientists are concerned that one day they might arrive in Yellowstone.

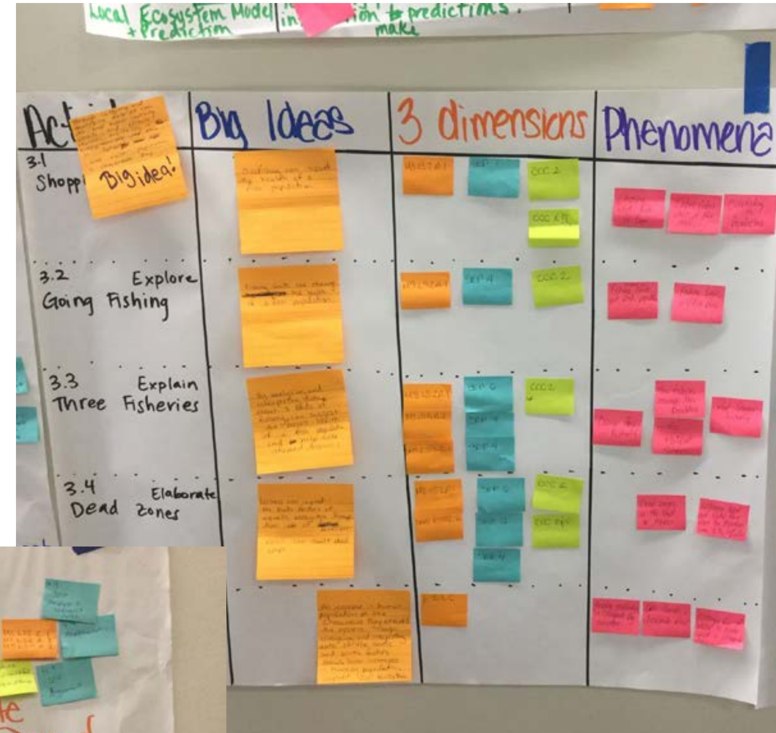
Zebra mussels are an invasive species that first appeared in the Great Lakes in the 1980's. Ever since then they have been spreading around the country. They spread easily partly because each female can lay millions of eggs. Young mussels float along the water currents. Eventually they attach themselves to hard surfaces like rocks and the bottom of boats. Colonies can become very dense with as many as 10,000 mussels per square foot. Zebra mussels also cling to native mussels and other shelled animals. These animals die because they can't feed. Zebra mussels disrupt ecosystems by eating microscopic animals and plankton. This reduces the food available for the native invertebrates and small fish. They also disrupt ecosystem services by clogging water pipes to businesses and power plants. They damage boats, docks, buoys, and other structures.

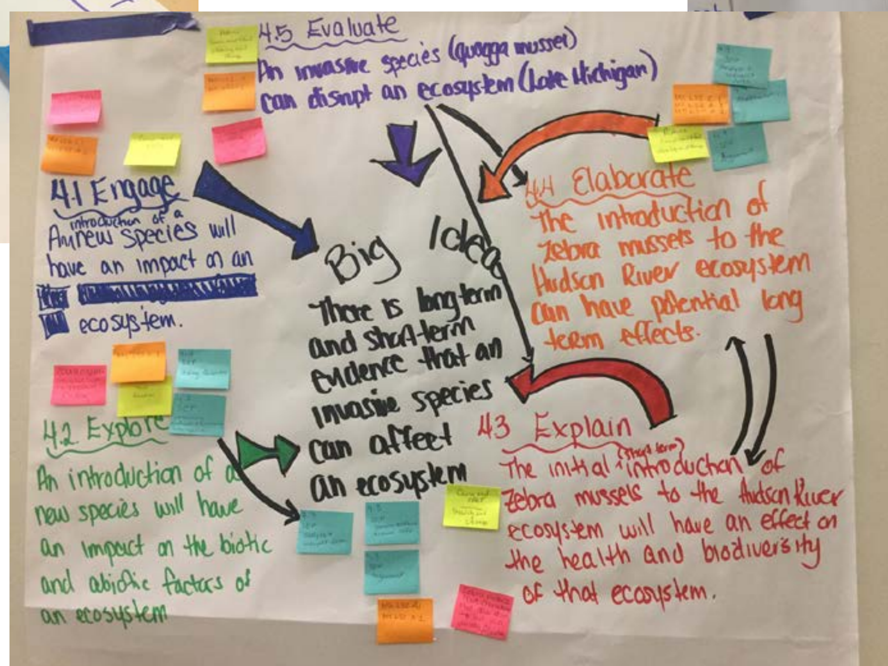
Coherence


Disruptions in Ecosystems
Ecosystem Interactions, Energy, & Dynamics
CHAPTER 1
Wolves in Yellowstone
CHAPTER 2
Ecosystem Models
CHAPTER 3
Interactions between Populations & Resources
CHAPTER 4
Zebra Mussels
CHAPTER 5
Designing Solutions

Coherence: A Professional Learning Activity

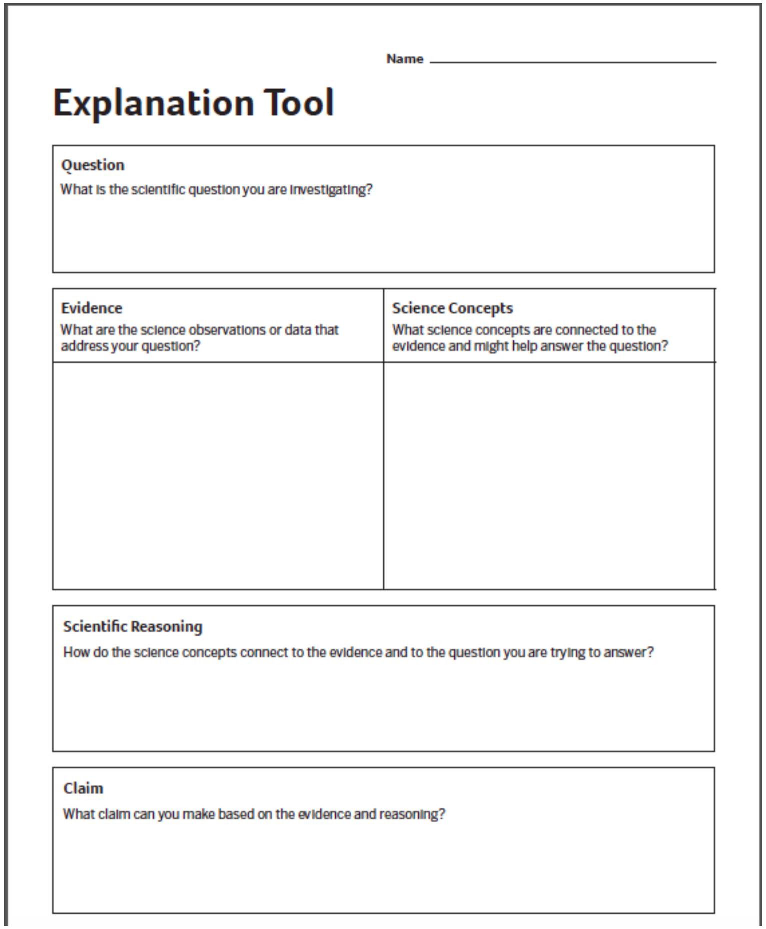






Tools and Scaffolds: SEPs

Learning Scaffold for Constructing Explanations



Name

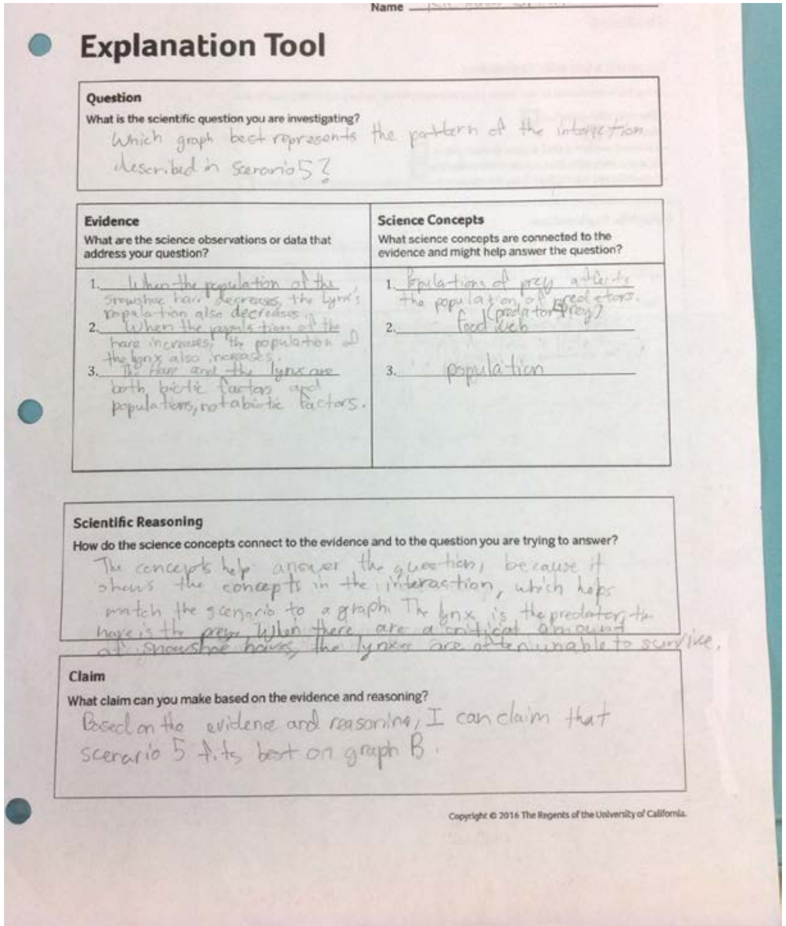
Explanation Tool

Question
What is the scientific question you are investigating?

Evidence What are the science observations or data that address your question?	**Science Concepts** What science concepts are connected to the evidence and might help answer the question?

Scientific Reasoning
How do the science concepts connect to the evidence and to the question you are trying to answer?

Claim
What claim can you make based on the evidence and reasoning?



Name

Explanation Tool

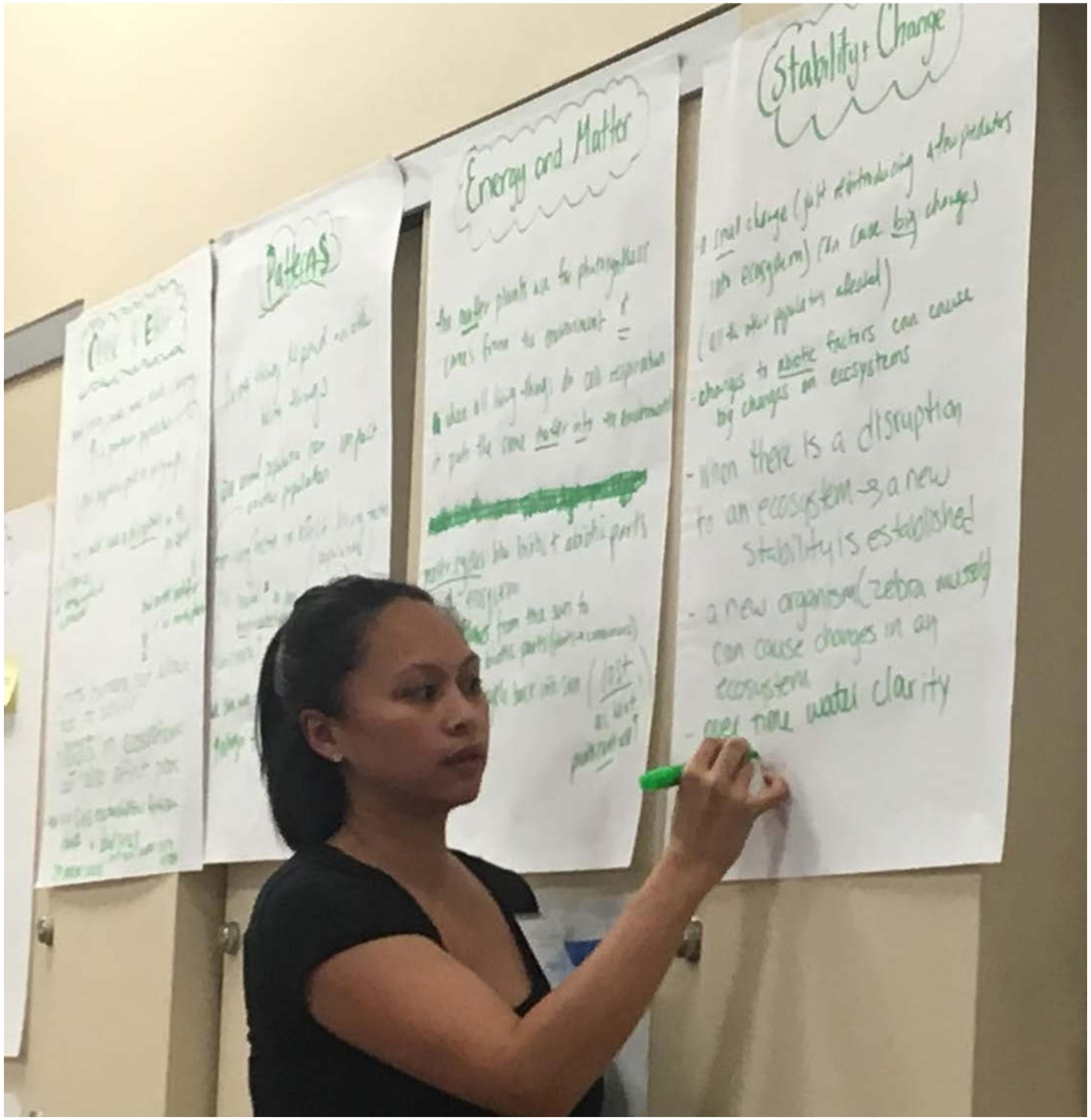
Question
What is the scientific question you are investigating?
Which graph best represents the pattern of the interaction described in Scenario 5?

Evidence What are the science observations or data that address your question?	**Science Concepts** What science concepts are connected to the evidence and might help answer the question?
1. When the population of the snowshoe hair decreases, the lynx's population also decreases.	1. Populations of prey affects the population of predators. (predator/prey)
2. When the population of the hare increases, the population of the lynx also increases.	2. food web
3. The hare and the lynx are both biotic factors and populations, not abiotic factors.	3. population

Scientific Reasoning
How do the science concepts connect to the evidence and to the question you are trying to answer?
The concepts help answer the question, because it shows the concepts in the interaction, which helps match the scenario to a graph. The lynx is the predator, the hare is the prey. When there are a critical amount of snowshoe hares, the lynxes are often unable to survive.

Claim
What claim can you make based on the evidence and reasoning?
Based on the evidence and reasoning, I can claim that scenario 5 fits best on graph B.

Tools and Scaffolds: CCCs



Tools and Scaffolds: Literacy Strategies

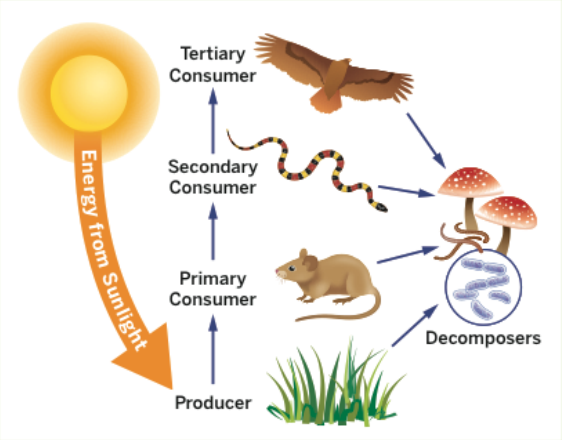
Anticipation Guide: Energy in Ecosystems

Before	After	Statement
______	______	1. Light from the Sun is one of many energy sources for plants. Other energy sources include soil, water, and air.
______	______	2. Plants need only soil, water, and sunlight to make their own food.
______	______	3. If all the plants in the Yellowstone ecosystem died from a disease, the coyotes in the area would always survive because they could eat rabbits.
______	______	4. Heat given off by animals can be used by plants to make food.
______	______	5. In a food chain, most of the energy stored in organisms is lost to the non-living environment.
______	______	6. Energy flows in one direction within ecosystems, from plants to animals.

Energy Flows to Producers, Consumers, and Decomposers

In an ecosystem, there are also organisms that get food by eating dead or decaying plants or animals, or plant and animal wastes. These organisms are called **decomposers**. Decomposers include worms, fungi, and bacteria. At each level of a food chain, some energy also flows to decomposers when organisms die. Figure 3, "The Role of Decomposers," shows a food chain with the decomposers added.

Figure 3.
The Role of Decomposers



Energy flows in just one direction in an ecosystem, from the producers to the consumers and decomposers. At each level of a food chain, organisms use some of their energy for their own survival and growth. When these organisms are eaten, energy stored in the organisms moves to the next level.

Energy is Lost to the Environment

But much of the energy an organism gets from its food is released to the environment as heat. At each level of the food web, about 10%

Disruptions in Ecosystems: Three layers of assessment

- **Frequent formative assessment**
  - Written and/or Discussion

- **“Evaluate” activity** (authentic performance task)
  - Assessments of “knowledge in use”

- **Summative chapter assessments**
  - Designed to assess competencies in different contexts than the ones specifically addressed in the unit

How might you use this unit in your:

- classroom
- school
- district

Questions?

***Slides*: http://bit.ly/NSTA18ecosystems**

***Unit*: https://www.nextgenscience.org/resources/examples-quality-ngss-design**

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