Moving Next Generation Science Standards into Practice: A Middle School Ecology Unit and Teacher Professional Development Model

Barbara Nagle[1], John Howarth[1], James Short[2], Dora Kastel[2], Suzanne Wilson[3], Maia Willcox[1], Anna McPherson[2], Bianca Montrosse-Moorhead[3], Manisha Hariani[1], and Jay Holmes[2]

Lawrence Hall of Science, University of California, Berkeley[1]
American Museum of Natural History[2]
University of Connecticut[3]

Contact Barbara Nagle: bnagle@berkeley.edu

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Moving Next Generation Science Standards into Practice

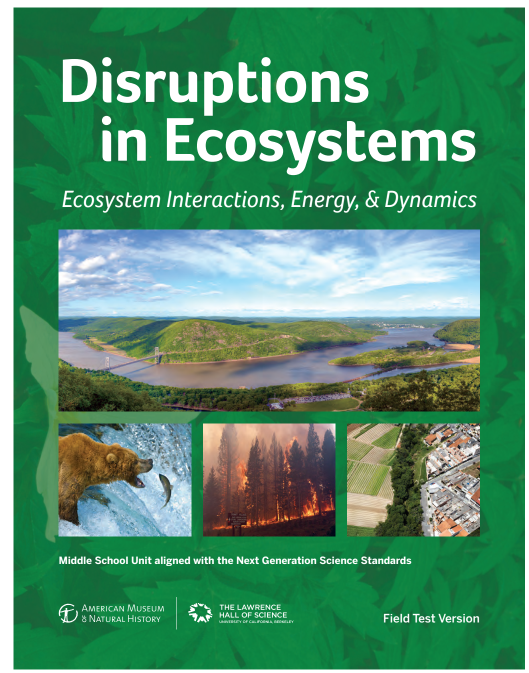
- **Four Partners:**
  - **Lead and Professional Development: American Museum of Natural History (AMNH)**
  - **Curriculum: Lawrence Hall of Science**
  - **Research: University of Connecticut**
  - **Evaluation: WestEd**
- **Four-year project began September 2014**
- **First 18 months focused on developing and testing a curriculum unit and PD model**

Project Overview

- Develop an NGSS-aligned middle school ecology curriculum unit and assessments
- Develop a professional development program to support teacher implementation
- Conduct:
  - Formative evaluation of the curriculum
  - Formative evaluation and research on the professional development
  - Development of and research on teacher measures

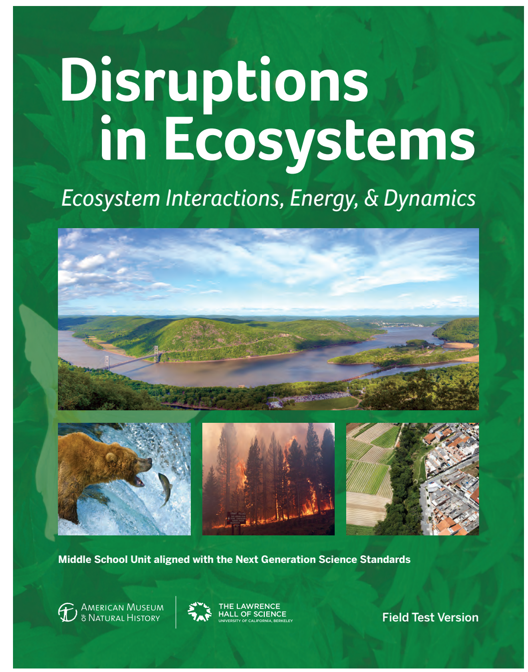
Disruptions in Ecosystems—Ecosystem Interactions, Energy, and Dynamics

- **Based on a bundle of NGSS (Table 1) and related CCSS for ELA and Mathematics (Table 3)**
  - **MS-LS2: Ecosystems: Interactions, Energy, and Dynamics**
  - **MS-ESS3: Earth and Human Activity**
  - **MS-PS1: Matter & Its Interactions**
- **Uses the BSCS 5E Instructional Model (Bybee et al, 2006; Bybee, 2013)**
  - **Engage, Explore, Explain, Elaborate, Evaluate**



Disruptions in Ecosystems—Ecosystem Interactions, Energy, and Dynamics

- Educative elements for teachers related to S-CK and S-PCK
- Embedded authentic assessments of 3D learning
- Supports for
  - Literacy & CC-ELA
  - Diverse learners
  - Development of science practices



Curriculum Development and Design

Backward design approach

- Define learning goals
- Draft assessments
- Develop learning activities

Supported by use of the *Five Tools and Processes for NGSS* (developed by AMNH, BSCS, WestEd)

Types of Interactions

Predator-prey interactions, competition, and symbiosis are all interactions between living factors. A **predator-prey** interaction involves a feeding relationship between two animals. The **predator** is the animal that kills and consumes another animal, called the **prey**. In the photo below the bear is the predator and the fish is the prey.

Curriculum evaluation

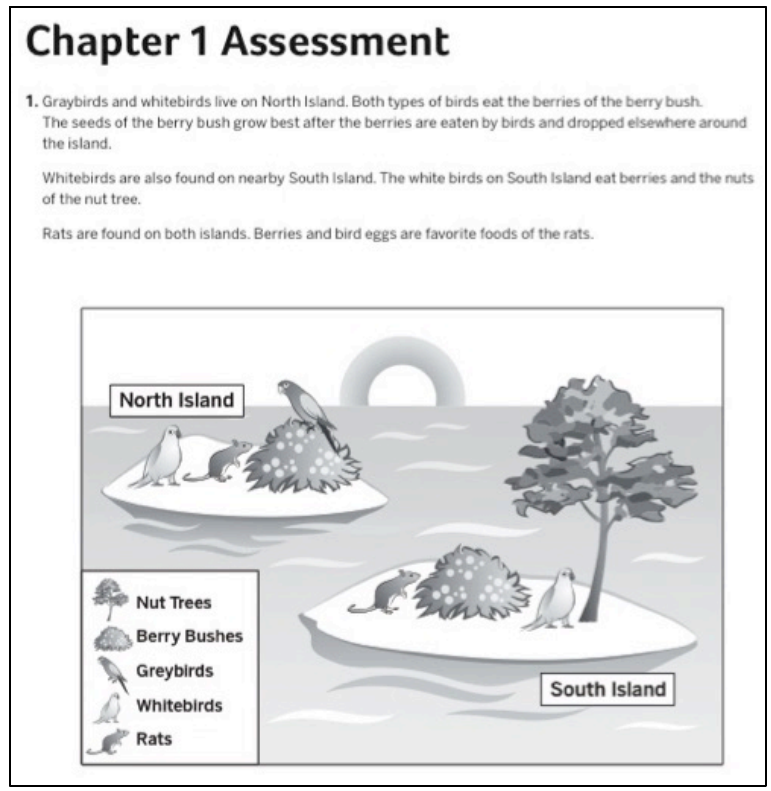
- Feedback from 2015–2016 field test by 25 NYC teachers
  - Surveys by activity, chapter, unit
  - Focus groups
  - Feedback during final PD day
  - Student work samples
- Expert panel meeting and written review
  - NGSS and 3D learning
  - 5E model
  - Educative aspects of the materials
  - Support for English language learners/diverse learners
  - Usability
  - Professional development
- The first of three iterative cycles of feedback and revision

Assessments

Assessment specifications were developed through the use of the Five Tools

Three-dimensional assessments

- Embedded in learning activities
- In a culminating Evaluate activity
- In end-of-chapter tests



Chapter 1 Assessment

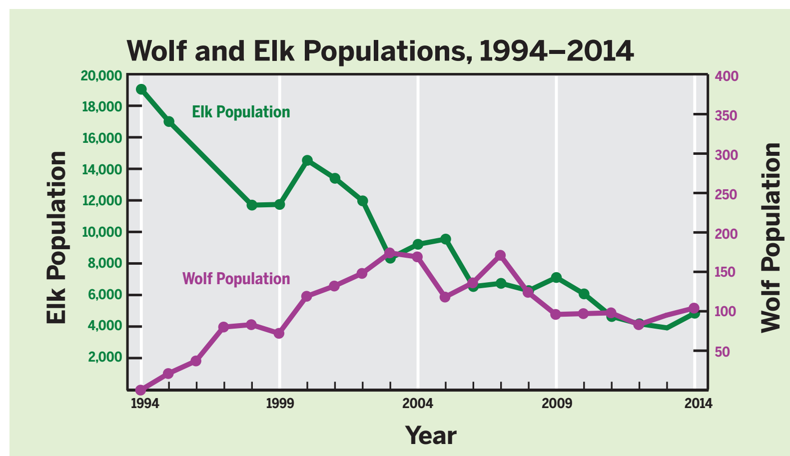
1. Graybirds and whitebirds live on North Island. Both types of birds eat the berries of the berry bush. The seeds of the berry bush grow best after the berries are eaten by birds and dropped elsewhere around the island.

   Whitebirds are also found on nearby South Island. The white birds on South Island eat berries and the nuts of the nut tree.

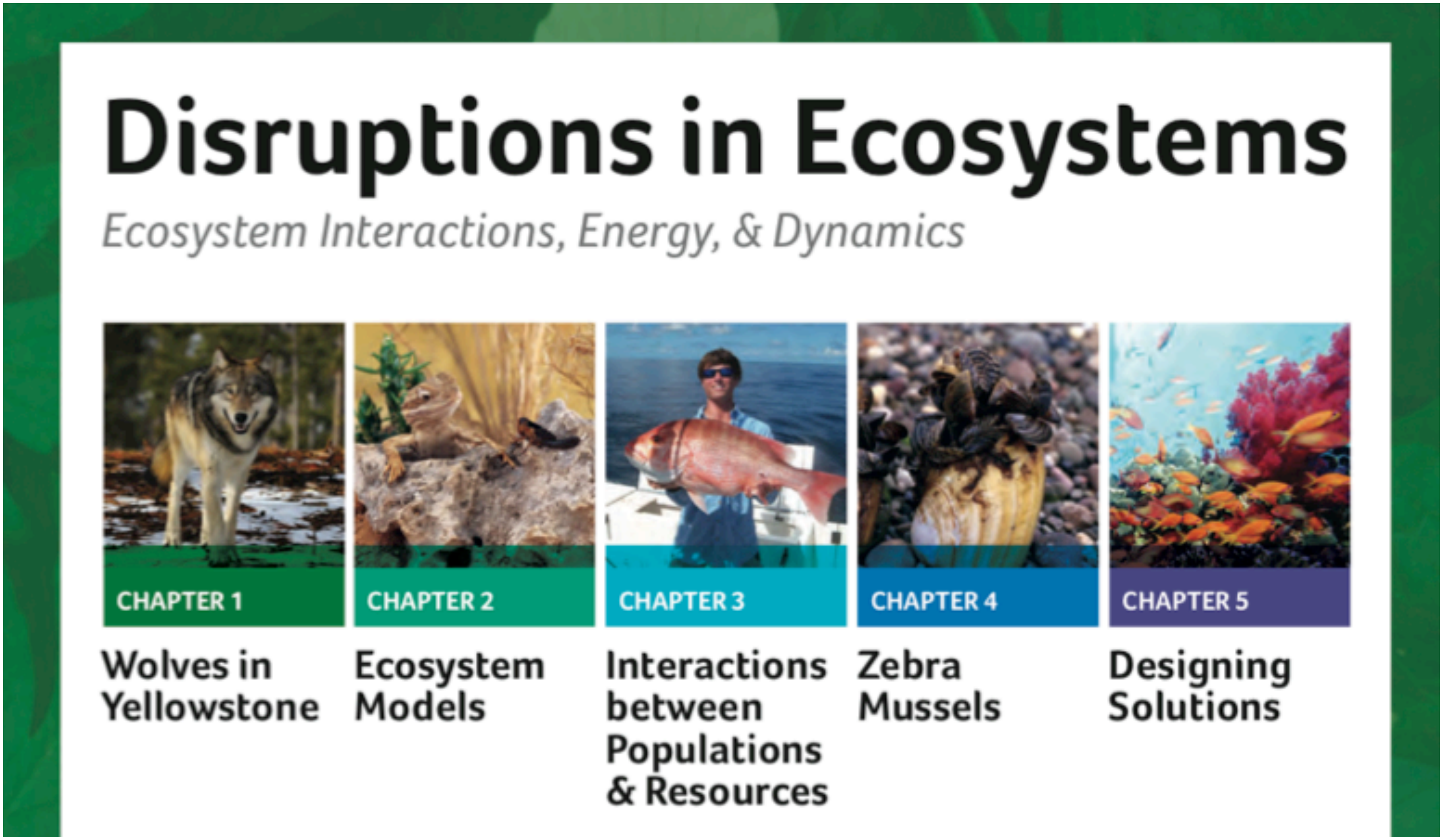
   Rats are found on both islands. Berries and bird eggs are favorite foods of the rats.

Coherence

- Instructional materials are organized through a conceptual storyline.
- The storyline is a connection of scientific ideas (DCIs, and CCCs) that are investigated by use of scientific and engineering practices and nested in a conceptual flow that builds across time.
- In a coherent storyline, students engage in making sense of phenomena or designing solutions to problems.



Context


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

Key educative elements

(Davis and Krajcik, 2005)

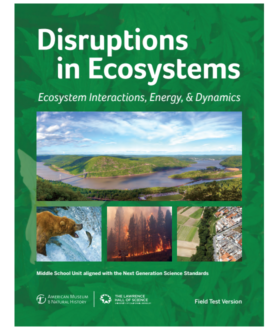
Field test 2015–2016

- Design Heuristic 2: Support for using scientific instructional representations
- Design Heuristic 4: Support for analyzing and interpreting data
- Design Heuristic 7: Support for making explanations based on evidence

Field test 2016–2017

- Design Heuristic 9: Support for development of teachers' S-CK

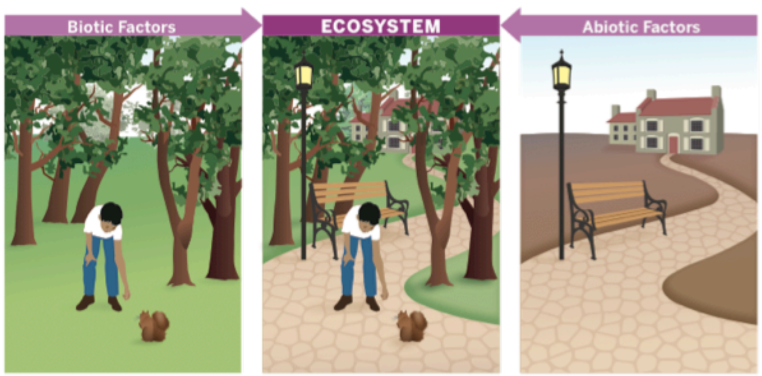
3-Dimensional Learning



Activity 1.6

Elaborate: Analyzing Patterns in Ecosystems

Organisms in an ecosystem interact with both biotic and abiotic factors. For example, squirrels living in and near a city park might be affected by biotic factors such as the availability of nuts, seeds, and berries, people who feed them, and raccoons and hawks that might eat them. Abiotic factors such as water shortages, mild or extreme weather, expansion of the parkland, or construction of homes in the area might also affect the population size.



Guiding Question

How do biotic and abiotic interactions affect populations?

Disciplinary Core Ideas

Interactions in ecosystems

Science Practices

Explanation

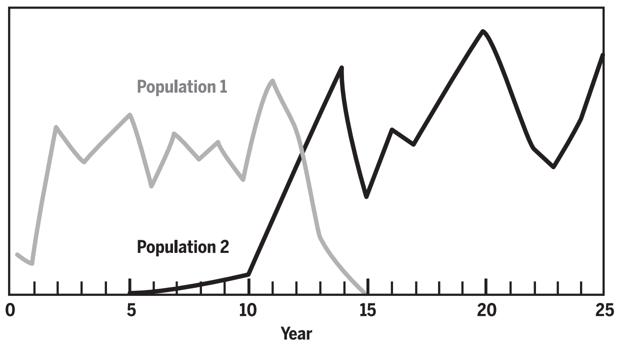
Crosscutting Concepts

Patterns

Constructing Science Explanations

5. With your group, discuss what you think might happen to the organisms on each graph over time.
6. Your teacher will assign your group to focus on one of the scenarios. Explain why you think the graph you selected matches the scenario.
7. Using the Explanation Tool, construct a scientific explanation about the patterns of interactions in your scenario. Use the list below to guide you as you use the Explanation Tool.

- **Question:** Record the question "Which graph best represents the patterns of interactions described in your scenario?"
- **Initial Thinking:** Record your thinking from Step 5 for your scenario.
- **Evidence:** Examine the data in the graph(s) that you matched with your scenario. What patterns do you notice? Describe these patterns to use them as evidence.
- **Claim:** Based on the evidence, state a claim about the patterns of interactions in your scenario. Does your claim agree with your intial thinking?
- **Science Concepts:** Apply the science concepts you have already learned to explain how the evidence supports your claim.
- **Scientific Reasoning:** Use the template provided on the Explanation Tool to describe the scientific reasoning that explains how the evidence and science concepts lead to your claim.



Competition

Learning Scaffold for Constructing Explanations

Name ________________

Explanation Tool

Question What is the scientific question you are investigating?	
Background Knowledge What do you already know related to your question?	**Initial Thoughts** Based on what you already know, what do you think the data will show?

Evidence What are the science observations or data that address your question?	**Claim** What claim can you make based on the evidence?	**Science Concepts** What science concepts are connected to the evidence and help explain the claim?

Explanation Tool
Continued

Name ________________

Does your claim agree with your initial thinking? Why or why not?

Scientific Reasoning

What relevant evidence led you to your claim? How do the science concepts relate to the evidence?

The evidence that led to my claim is (evidence). The concepts that relate to the evidence and support my claim are (science concepts). These concepts support my claim because ________ .

Explanation Tool
Continued

Name ________________

Construct a Scientific Explanation

Using the information in the boxes you have completed, write a scientific explanation that includes:

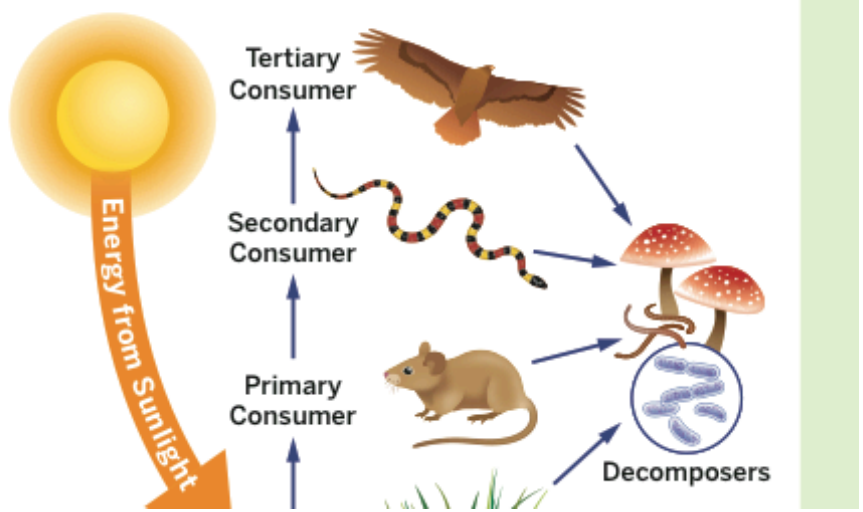
- The scientific question
- Your claim
- Relevant evidence that supports your claim
- Science concepts that support the evidence
- Scientific reasoning that links the evidence and science concepts to the claim

Scientific Explanation

Common core-aligned 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.



Findings

Strengths of the curriculum

- Support for three-dimensional learning
- Use of scaffolds for teachers and students
- Literacy strategies
- Selected educative elements
- Student engagement
- Teachers' understanding of ecosystems and pedagogy enhanced

Findings

Key areas for revision of curriculum

- Bring the NGSS dimensions more into balance and add more support for teachers
- Increase the supports for reading, writing, and classroom discourse
- Enhance the educative elements and improve format of the Teacher's Guide (challenging)
- Introduce the explanation and argumentation tools more gradually, decrease formal writing
- Reduce the length of the unit
- Revise the early chapters of the unit to better reflect the 5E model

Findings

PD Strengths

- Developed understanding of the 5E's
- Developed understanding of strategies for teaching ecology
- Developed understanding of the complexity of ecology

PD Revision

- Provide more/better support for explanation and argumentation practices.
- Spread more frequent PD sessions over a longer period of time

Next steps

- Revise curriculum to further bring out 3-dimensional learning and support teachers and students
- Field test again 2016–2017

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