Designing an NGSS-aligned Middle School Ecosystems Unit Using the Five Tools and Processes

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THE LAWRENCE HALL OF SCIENCE
UNIVERSITY OF CALIFORNIA, BERKELEY

AMERICAN MUSEUM OF NATURAL HISTORY

UCONN | NEAG SCHOOL OF EDUCATION

Moving NGSS into Practice

- Four Partners:
  - Lead and PD: AMNH
  - Instructional Materials: Lawrence Hall of Science
  - Research: University of Connecticut
  - Evaluation: WestEd
- Four-year project began September 2014

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

Project Timeline

Timeframe	Milestones
September 2014 – July 2015	• Develop first field test instructional materials • Develop first field test PD model
August 2015 – February 2016	• 25 NYC teachers field test • Expert panel review
March 2016 – July 2016	• Revise materials and PD model for second field test
August 2016 – February 2017	• 25 NYC teachers field test • Second expert review
March 2017 – July 2017	• Revise materials and PD model for final field test
August 2017 – February 2018	• 25 NYC teachers field test • Further review if needed
March 2018 – August 2018	• Final revisions to materials and PD model

Curriculum Development and Design

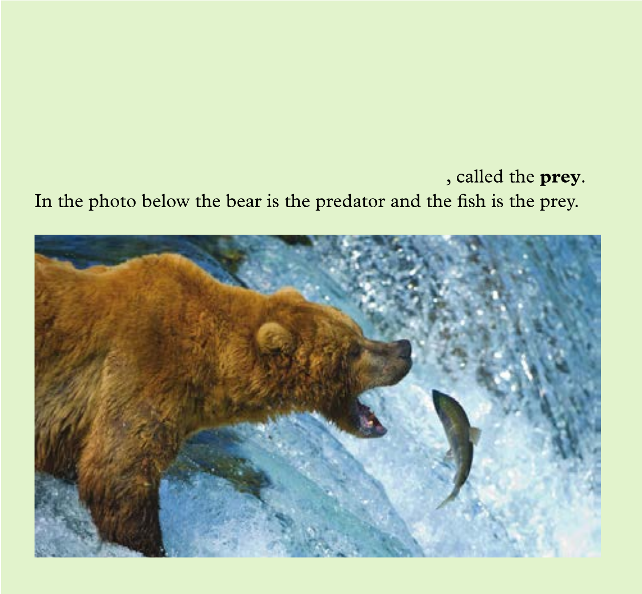
Backward design approach

- Define learning goals
- Draft assessments
- Develop learning activities

Use the *Five Tools and Processes for Translating the NGSS* (developed by AMNH, BSCS, WestEd) for initial development and planning

Use the BSCS 5E Instructional Model (Bybee et al, 2006; Bybee, 2013)

- Engage, Explore, Explain, Elaborate, Evaluate

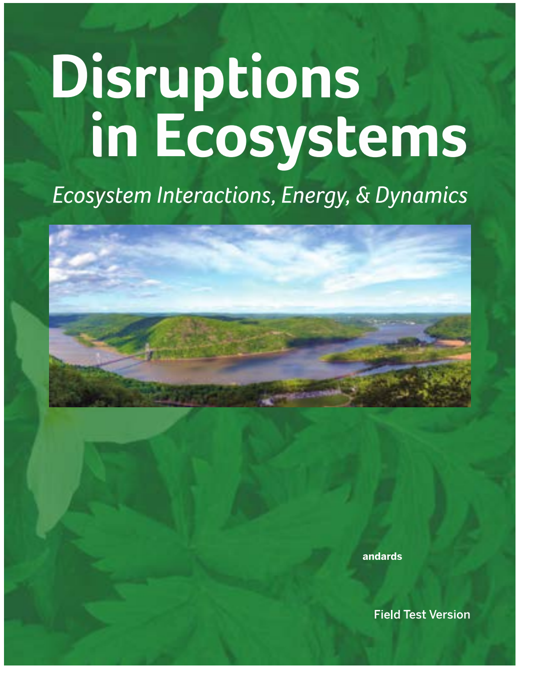


SEPUP Development Steps

1. Identify targeted learning outcomes (PEs)
2. Determine acceptable evidence of student learning to develop performance tasks
3. Develop instructional sequences to provide students opportunities to learn DCIs, CCCs, and SEPs

Disruptions in Ecosystems—Ecosystem Interactions, Energy, and Dynamics

- Based on a bundle of PEs and associated DCIs, SEPs, CCCs and CCSS for ELA and Mathematics
  - MS-LS2: Ecosystems: Interactions, Energy, and Dynamics
  - MS-ESS3: Earth and Human Activity
  - MS-PS1: Matter & Its Interactions
- AMNH had drafts of Tools 1 & 2 from previous work to start from



Tool 1

- Identifies & refines learning goals
- Creates a unit blueprint
- DCI, SEP, CCC, Connection to Nature of Science, Connections to Engineering, Technology and Applications of Science, and Common Core linked to the PEs
- Complete NGSS alignment plan for 5 chapters

Tool 1 Template Example – Unit Blueprint for MS-LS2 (Ecosystems: Interactions, Energy, and Dyna

Instructional Sequence 1	Instructional Sequence 2	Instructiona
Performance Expectation MS-LS2-2 ***Construct an explanation that predicts patterns of interactions among organisms across multiple ecosystems*** *Clarification Statement:* Emphasis is on predicting consistent patterns of interactions in different ecosystems in terms of the relationships among and between organisms and abiotic components of ecosystems. Examples of types of interactions could include competitive, predatory, and mutually beneficial.	**Performance Expectation MS-LS2-3** ***Develop a model to describe the cycling of matter and flow of energy among living and non-living parts of an ecosystem.*** *Clarification Statement:* Emphasis is on describing the conservation of matter and flow of energy into and out of various ecosystems and on defining the boundaries of the system. *Assessment Boundary:* Assessment does not include the use of chemical reactions to describe the processes.	**Performance Expectation I** ***Analyze and interpret data the effects of resources av populations of organisms i*** *Clarification Statement:* Em effect relationships betwee of individual organisms and in ecosystems during perio resources.
Performance Expectation MS-ESS3-4 ***Construct an argument supported by evidence for how increases in human population ~~and per-capita consumption of natural resources~~ impact Earth's systems.*** *Clarification Statement*: ~~Examples of evidence include grade-appropriate databases on human populations and the rates of consumption of food and natural resources (such as freshwater, mineral, and energy). Examples of impacts can include changes to the appearance, composition, and structure of Earth's systems as well as the rates at which they change.~~ The consequences of increases in human populations ~~and consumption of natural resources~~ are described by science, but science does not make the decisions for the actions society takes.	**Performance Expectation MS-PS1-5** ***Develop and use a model to describe how ~~the total number of atoms does not change in a chemical reaction and thus~~ mass is conserved.*** *Clarification Statement*: Emphasis is on law of conservation of matter ~~and on physical models or drawings, including digital forms that represent atoms.~~ *Assessment Boundary*: Assessment does not include the use of atomic masses, balancing symbolic equations, or intermolecular forces.	**Performance Expectation I** ***Construct an argument sup how increases in human pe ~~consumption of natural re~~ systems.*** *Clarification Statement*: ~~Exa grade-appropriate databas and the rates of consumpti resources (such as freshwa Examples of impacts can in appearance, composition, a systems as well as the rate~~ consequences of increases consumption of natural res science, but science does n the actions society takes.
	Performance Expectation MS-ESS2-1 ***Develop a model to describe the cycling of Earth's materials and the flow of energy that drives this process.***	

	Sequence 1	Sequence 2	Sequence 3	Sequence 4	Sequence 5
PEs	MS-LS-2	MS-LS2-3	MS-LS2-1	MS-LS2-4	MS-LS2-5
	MS-ESS3-4	MS-PS1-5	MS-ESS3-4	MS-LS2-1	MS-ESS3-3
		MS-ESS2-1			MS-ESS3-4
DCIs	LS2.A	LS2.B	LS2.A (3 sub bullets)	LS2.C	LS2.C
	ESS3.C	ESS2.A	ESS3.C	LS2.A (3 sub bullets)	LS4.D
		PS1.B		ESS3.C	ESS3.C (2 sub bullets
					ETS1.B
SEPs					
CCCs					
CtNoS					
Common Core					

Tool 2

- Develop assessment specifications aligned with sequences from Tool 1
- Identify and articulate evidence for student proficiency

Instructional Sequence 1

Performance Expectation MS-LS2-2

Construct an explanation that predicts patterns of interactions among organisms across multiple ecosystems

Clarification Statement: Emphasis is on predicting consistent patterns of interactions in different ecosystems in terms of the relationships among and between organisms and abiotic components of ecosystems. Examples of types of interactions could include competitive, predatory, and mutually beneficial.

Performance Expectation MS-ESS3-4

Construct an argument supported by evidence for how increases in human population ~~and per-capita consumption of natural resources~~ impact Earth's systems.

Clarification Statement: ~~Examples of evidence include grade-appropriate databases on human populations and the rates of consumption of food and natural resources (such as freshwater, mineral, and energy). Examples of impacts can include changes to the appearance, composition, and structure of Earth's systems as well as the rates at which they change.~~ The consequences of increases in human populations ~~and consumption of natural resources~~ are described by science, but science does not make the decisions for the actions society takes.

Evidence of Learning Specifications

Construct an explanation that predicts:

1. consistent patterns of interactions between living and non-living parts of ecosystems
2. consistent patterns of types of interactions including competitive, predatory, and mutually beneficial

Construct an argument that:

1. is supported by empirical evidence of interactions within the ecosystem (a type of Earth system) and scientific reasoning
2. supports or refutes how increases in human population cause negative impacts on the Earth

Example: Chapter 1

Evidence of Learning Specifications

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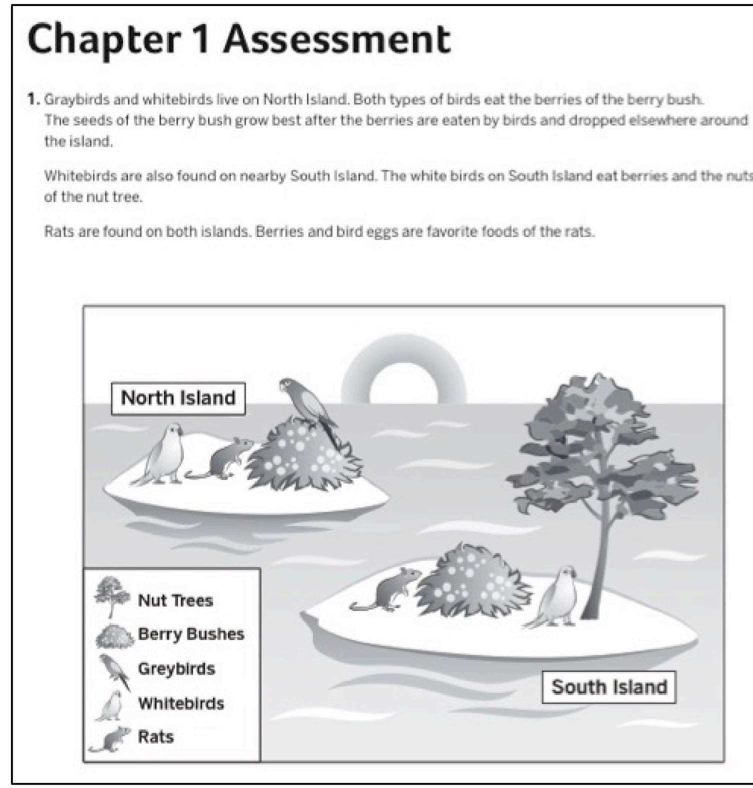
Assessments

Three-dimensional assessments

- Embedded in learning activities
- In a culminating Evaluate activity (linked to chapter phenomena & issues)
- In end-of-chapter tests



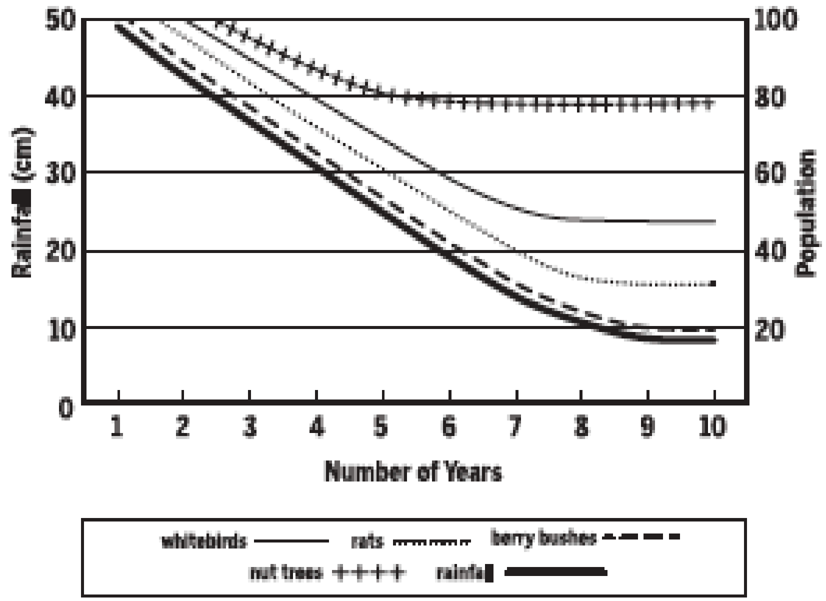
Chapter 1 Assessment

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.

1c. The graph below shows how the populations on the South Island changed during the same 10-year period of decreasing rain. Nut trees do not need a lot of rain. Construct a complete scientific explanation that answers the question, "Why did the population of whitebirds decrease to about half of what it was before?"



Your explanation should include the following:

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

Tools 3, 4 & 5

- SEPUP included many of the features of Tools 3 & 4 in the development process
  - 5E Model
  - Conceptual Flow/Storyline
  - Guiding Questions
- SEPUP's team uses a process similar to Tool 5 to plan assessment development

Chapter 4 Phenomena/Storyline

Unit Theme: Disruptions in Ecosystems

Chapter 4 Phenomena: Invasion of the Zebra Mussel in the Hudson River Ecosystem

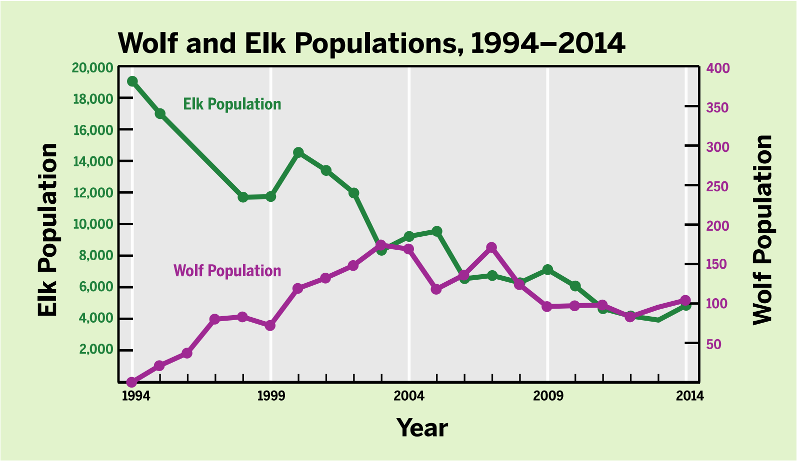
Engage	Explore	Explain	Elaborate	Evaluate
How might the introduction of the zebra mussel affect the health of the Great Lakes and Hudson River ecosystems?	What biotic and abiotic factors are affected when a new species is introduced to an ecosystem?	How did the zebra mussel initially affect the health and biodiversity of the Hudson River ecosystem?	What are the long-term effects of the zebra mussel invasion of the Hudson River?	Has the quagga mussel had a positive or negative effect on the Lake Michigan ecosystem?

After Tools 1 & 2…

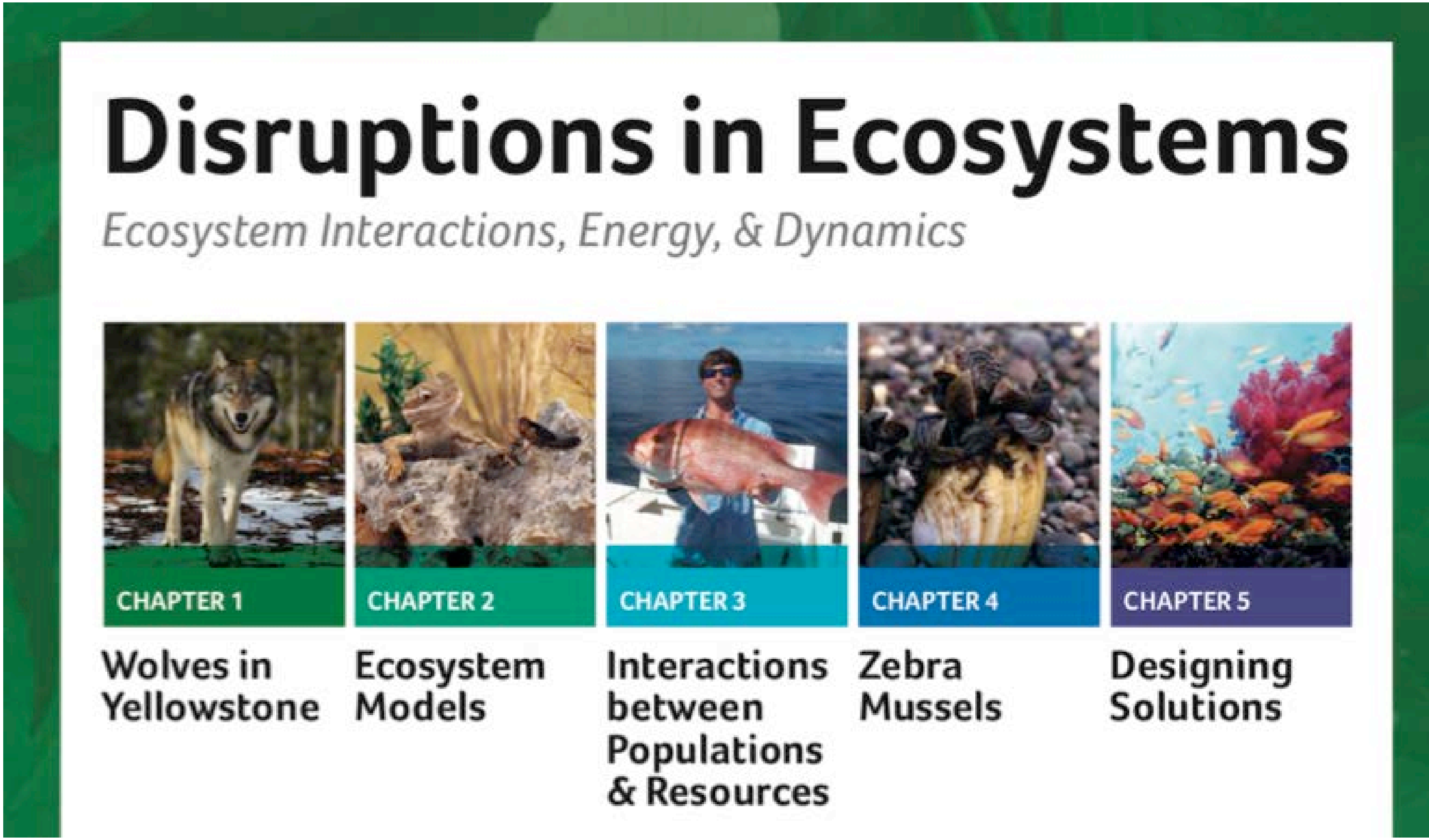
- Lots of revisiting and some revising of the tools as we initially develop the materials
- Selection of phenomena, with some revision during the development process
- Continued revision of all curricular pieces (instructional materials, assessments, etc) after each round of field testing (currently on second round of revisions)

Outcomes

- 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.

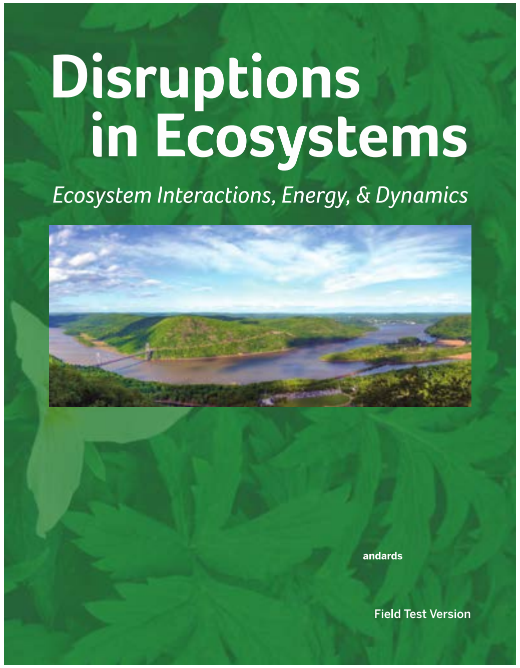


Instructional Materials



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



Final Products (2018)

- Student Book
- Educative Teacher’s Guide
- Assessments (embedded, end of chapter, & external)
- Professional Development Model

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