Developing the Practice of Modeling in an NGSS-aligned Educative Middle School Ecosystems Instructional Materials Unit

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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

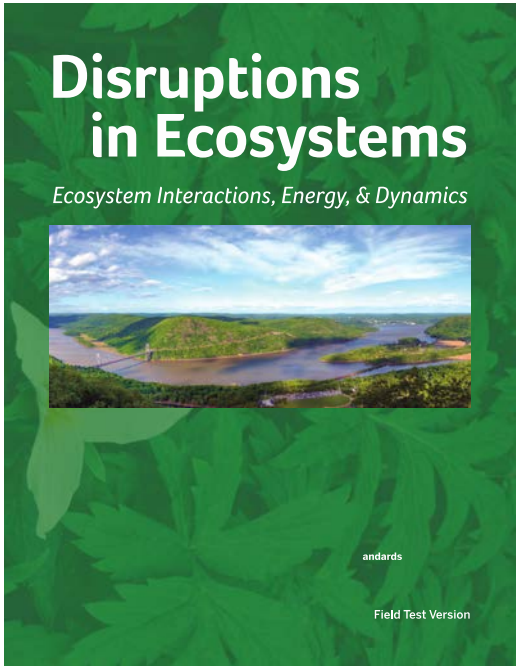
- Develop an NGSS-aligned middle school ecology curriculum unit and assessments
- Develop a professional development program to support teacher implementation
- Conduct:
  - Formative evaluation of the curriculum
  - Formative evaluation and research on the professional development
  - Development of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

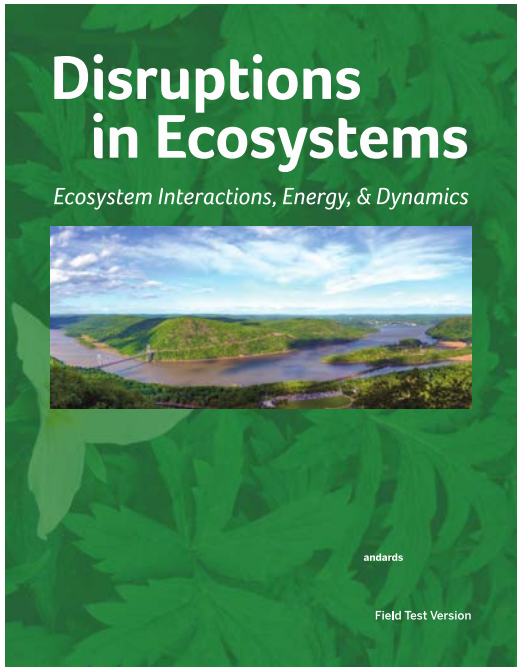
Disruptions in Ecosystems—Ecosystem Interactions, Energy, and Dynamics

- Based on a bundle of NGSS and related CCSS for ELA and Mathematics
  - 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

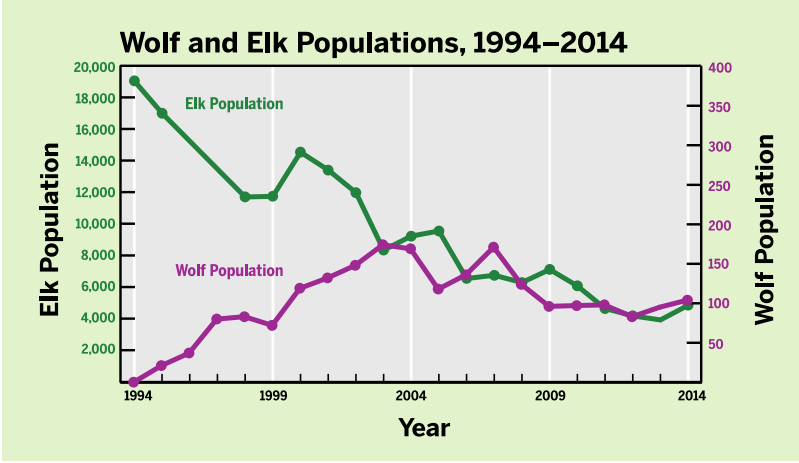
Backward design approach

- Define learning goals
- Draft assessments
- Develop learning activities

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

Coherence

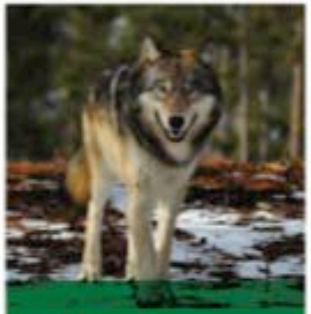
- Instructional materials are organized through a conceptual storyline.
- The storyline is a connection of scientific ideas (DCIs, and CCCs) that are investigated by use of scientific and engineering practices and nested in a conceptual flow that builds across time.
- In a coherent storyline, students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

Developing the Modeling Practice

- Focus of Chapter 2: Ecosystem Models
- Content: flow of energy and cycling of matter
- Six activities
- Context: Yellowstone National Park ecosystem
- Particular attention to common misconceptions around energy and matter

Chapter 2: Ecosystem Models
First Field Test

Activity	5E Phase	Description
A Living Model of an Ecosystem	Engage/Explore	Analyze statements on energy and matter; set up ecosystem model
Energy Flow in Ecosystems	Explain	Reading with anticipation guide
Energy Pyramid	Explore/Explain	Develop a model of an energy pyramid
Matter in Ecosystems	Explore/Explain	Ecosystem model exploration (Act 1); Reading
Fire in Yellowstone	Elaborate	Card sort with succession after fire and in a pond, with captions
Modeling Energy Flow and Matter Cycling in an Ecosystem	Evaluate	Develop a 3-d model that shows food web, cycling of matter, and flow of energy

Curriculum Evaluation – Year 1

- Feedback from 25 NYC field test teachers teachers
  - Surveys by activity, chapter, unit
  - Focus groups
  - Feedback during final PD day
  - Student work samples
- Expert panel meeting and written review

Findings – Year 1

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 – Year 1

Key areas for overall revision

- Bring the 3 dimensions more into balance and add more teacher support
- Increase the supports for reading, writing, and classroom discourse
- Enhance the educative elements
- 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 – Year 1

Chapter 2 Specific Revisions -

- Simplify and reduce overall number of models
- Better reflect 5E model
- Prevent student misconceptions by having students create initial model which is revised throughout the chapter

Chapter 2: Ecosystem Models
Second Field Test

Activity	5E Phase	Description
Ecosystem Changes	Engage	Analyze & discuss ecosystems & ecosystem disruptions; composting
Life and Death in an Ecosystem	Explore	Develop Yellowstone ecosystem model (YEM); analyze model of change in ecosystem over time
Matter in Ecosystems	Explain	Analyze scientific findings about matter in ecosystems; develop a model for cycling of matter
Energy Flow in Ecosystems	Explain	Add flow of energy to YEM; read about photosynthesis; model revision
Energy Tracking	Elaborate	Analyze existing models re energy; develop energy pyramid model; YEM revision
Modeling Energy Flow and Matter Cycling in an Ecosystem	Evaluate	Develop a 3-d model that shows food web, cycling of matter, and flow of energy

Curriculum Evaluation – Year 2

- Feedback from 25 NYC field test teachers teachers
  - Surveys by chapter and unit
  - Focus groups
  - Feedback during final PD day
  - Student work samples
- Expert review

Findings – Year 2

Feedback on Changes to Chapter 2

- More successful in developing deep understanding of matter and energy
- Teachers have better understanding of matter and energy
- Still a difficult topic!

Teacher Feedback

I learned how important it is to incorporate models in a curriculum. I learned that most students struggle to understand what is matter. I learned a great way to teach how matter and energy connect to one another. Usually students learn what is matter and what is energy but they do not connect the two. I feel this chapter really addressed that. (Stiles, 2017)

Findings – Year 2

Chapter 2 Specific Revisions -

- Deepening teacher support
- Simplifying material that students are analyzing (e.g. fewer scientific findings)
- Increasing support for analyzing materials (e.g. graphic organizer to guide analysis)

Overall Conclusions

- Fewer number of models
- Some existing model analysis helps
- Allow students to develop and revise their models over the course of several activities

Next steps

- Finish third round of revisions
- Field test again 2017 – 2018

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