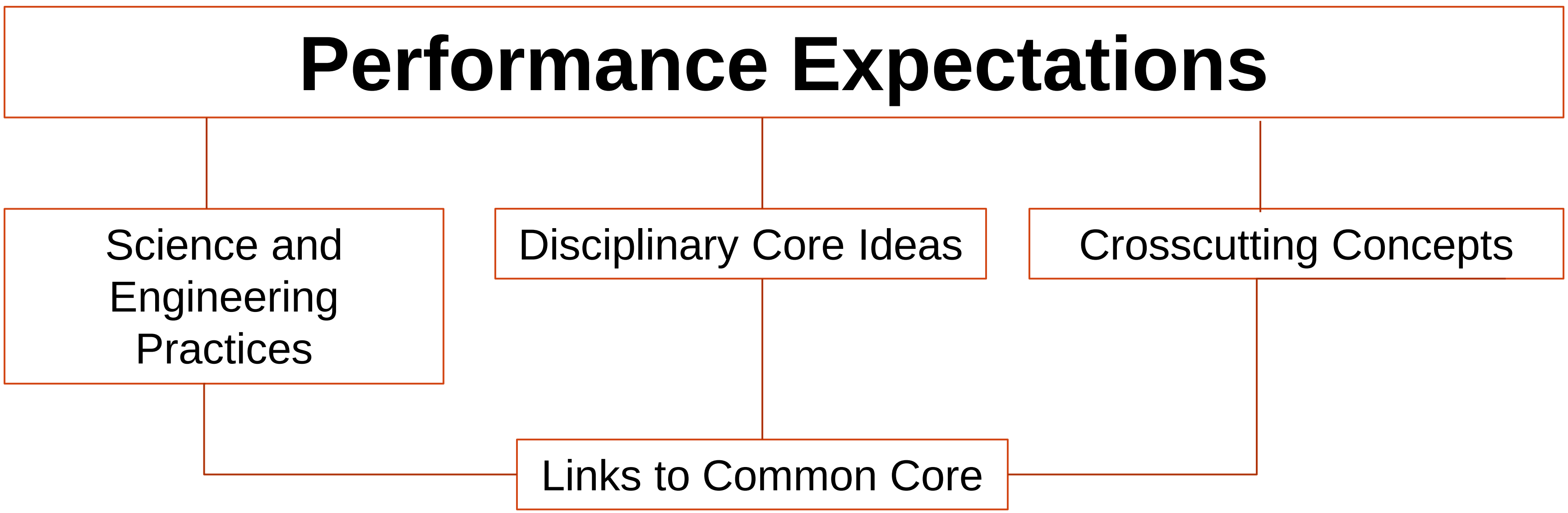
Assessing Three-Dimensional Learning in the Next Generation Science Standards

John Howarth & Maia Willcox
SEPUP
The Lawrence Hall of Science
University of California, Berkeley

SEPUP
Issue-Oriented Science

Next Generation Science Standards



Disciplinary Core Ideas

- **Physical Science**
  - Matter and its interactions
  - Motion and stability: Forces and interactions
  - Energy
  - Waves and their applications in technologies for information transfer
- **Life Science**
  - From molecules to organisms: Structures and processes
  - Ecosystems: Interactions, energy, and dynamics
  - Heredity: Inheritance and variation of traits
  - Biological evolution: Unity and diversity
- **Earth and Space Science**
  - Earth's place in the universe
  - Earth's systems
  - Earth and human activity
- **Engineering**
  - Engineering design

Crosscutting Concepts

- Cause and Effect
- Energy and Matter
- Patterns
- Scale, Proportion, and Quantity
- Stability and Change
- Structure and Function
- Systems and System Models

Science and Engineering Practices

- Analyzing and Interpreting Data
- Asking Questions and Defining Problems
- Constructing Explanations and Designing Solutions
- Developing and Using Models
- Engaging in Argument from Evidence
- Obtaining, Evaluating, and Communicating Information
- Planning and Carrying Out Investigations
- Using Mathematics and Computational Thinking

Performance Expectations

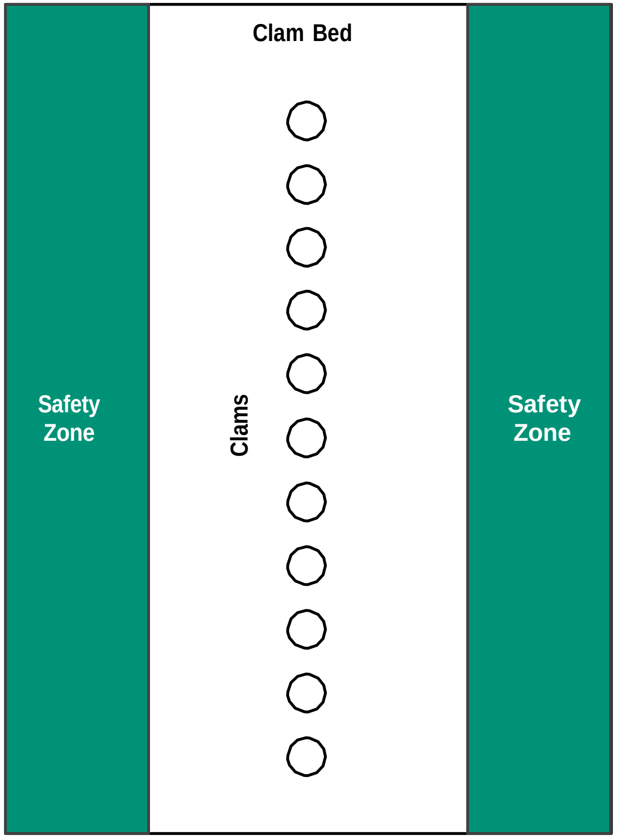
- Middle school examples:
  - **MS-LS2-1** Analyze and interpret data to provide evidence for the effects of resource availability on organisms and populations of organisms in an ecosystem.
  - **MS-LS2-2** Construct an explanation that predicts patterns of interactions among organisms across multiple ecosystems.

Clam Catch

- **The Challenge**
  - How might the introduction of a competing species, such as zebra mussels, affect a population of native clams?

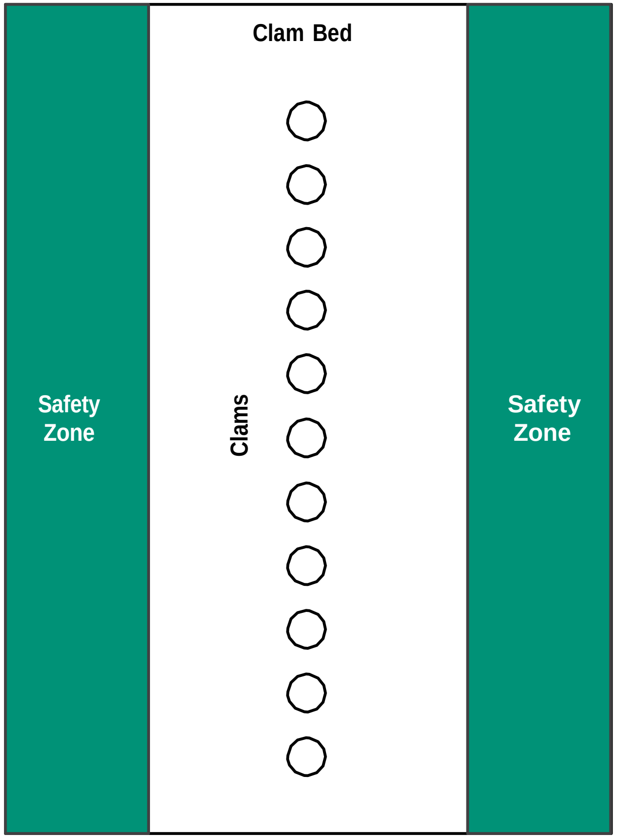
The Procedure – Part A

- Some of you will be clams, some plankton, and some recorders
- Clams stand inside the circles – one clam per circle
- Plankton stand on one side
- Plankton move quickly to the other side
- Clams try to catch the plankton
  - Tag with one hand only
  - Stay inside your circle



The Procedure – Part A

- A clam has to catch plankton to survive
- Any clam that does not catch plankton dies and leaves the circle. You will join the plankton
- Any plankton that is caught will join the clams IF there is an available circle
- The number of clams is recorded
- The process is repeated 10 times



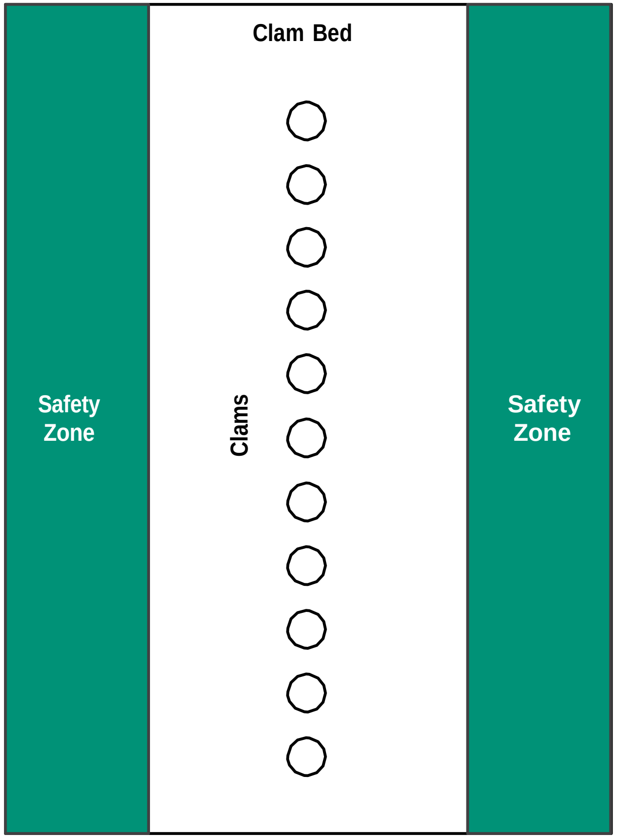
Summarizing the Data – Part A

- Was the population of clams the same from year to year?
- What prevented the population of clams from continuing to increase?
- Overall, was the population stable or unstable?

- The data can be graphed (time permitting)

Part B - Competition

- Some of you will be zebra mussels and will wear the red arm band!
- Zebra mussels are smaller than the clams and two can occupy a circle OR one zebra mussel and one clam
- Zebra mussels are voracious filter feeders. In the model they can use two hands to catch plankton.
- Same rules apply as before
- The number of clams and zebra mussels are recorded
- The process is repeated 10 times



Summarizing the Data – Part B

- Graph the populations of clams and mussels over time. (Use a line graph)
- How did the population of clams change over time?
- How did the population of zebra mussels change over time?
- What happened to the clam population after the zebra mussels were introduced?
- Why did zebra mussels have this effect on the clam population? Explain.

Extensions and Variations

- Add a mobile predator.
- Vary the initial numbers of clams, plankton, and zebra mussels.
- Discuss the strengths and limitations of this model.

Disciplinary Core Ideas

MS-LS2.A: Interdependent Relationships in Ecosystems:	Organisms, and populations of organisms, are dependent on their environmental interactions both with other living things and with nonliving factors. (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. (LS2-1)
	Growth of organisms and population increases are limited by access to resources. (LS2-1)
	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. (LS2-2)
LS2.C: Ecosystem Dynamics, Functioning, and Resilience	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. (LS2-4)

Crosscutting Concepts

Cause and Effect	Cause and effect relationships may be used to predict phenomena in natural systems. (LS2-1)
Patterns	Patterns can be used to identify cause and effect relationships. (LS2-2)
	Graphs, charts, and images can be used to identify patterns in data.
Stability and Change	Small changes in one part of a system might cause large changes in another part.

Science and Engineering Practices

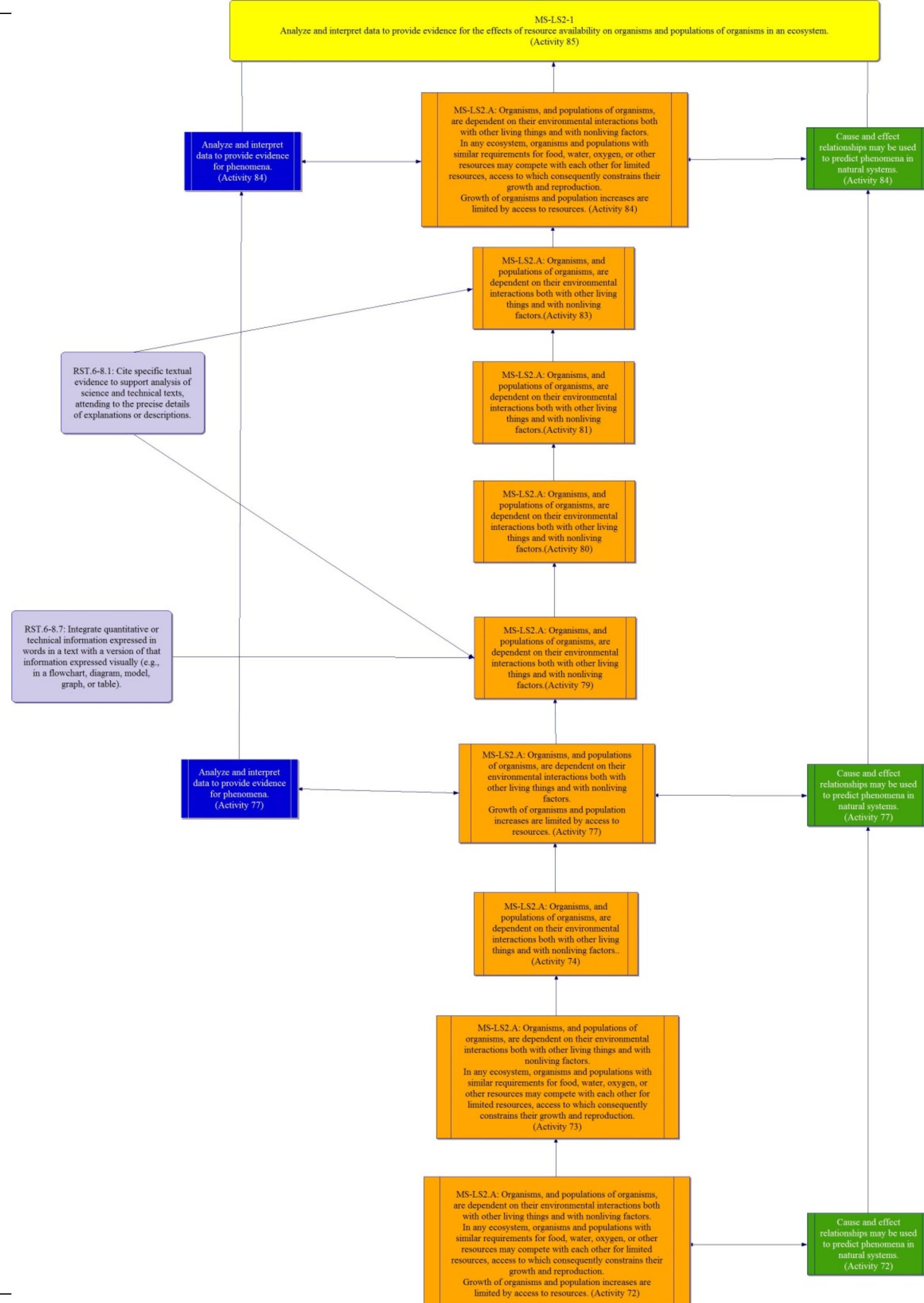
Analyzing and Interpreting Data	Analyze and interpret data to provide evidence for phenomena. (LS2-1)
	Analyze and interpret data to determine similarities and differences in findings.
Constructing Explanations and Designing Solutions	Construct an explanation that includes qualitative or quantitative relationships between variables that predict phenomena. (LS2-2)
Developing and Using Models	Develop a model to predict and/or describe phenomena. (LS2-3)
Using Mathematics and Computational Thinking	Use mathematical representations to describe and/or support scientific conclusions and design solutions.

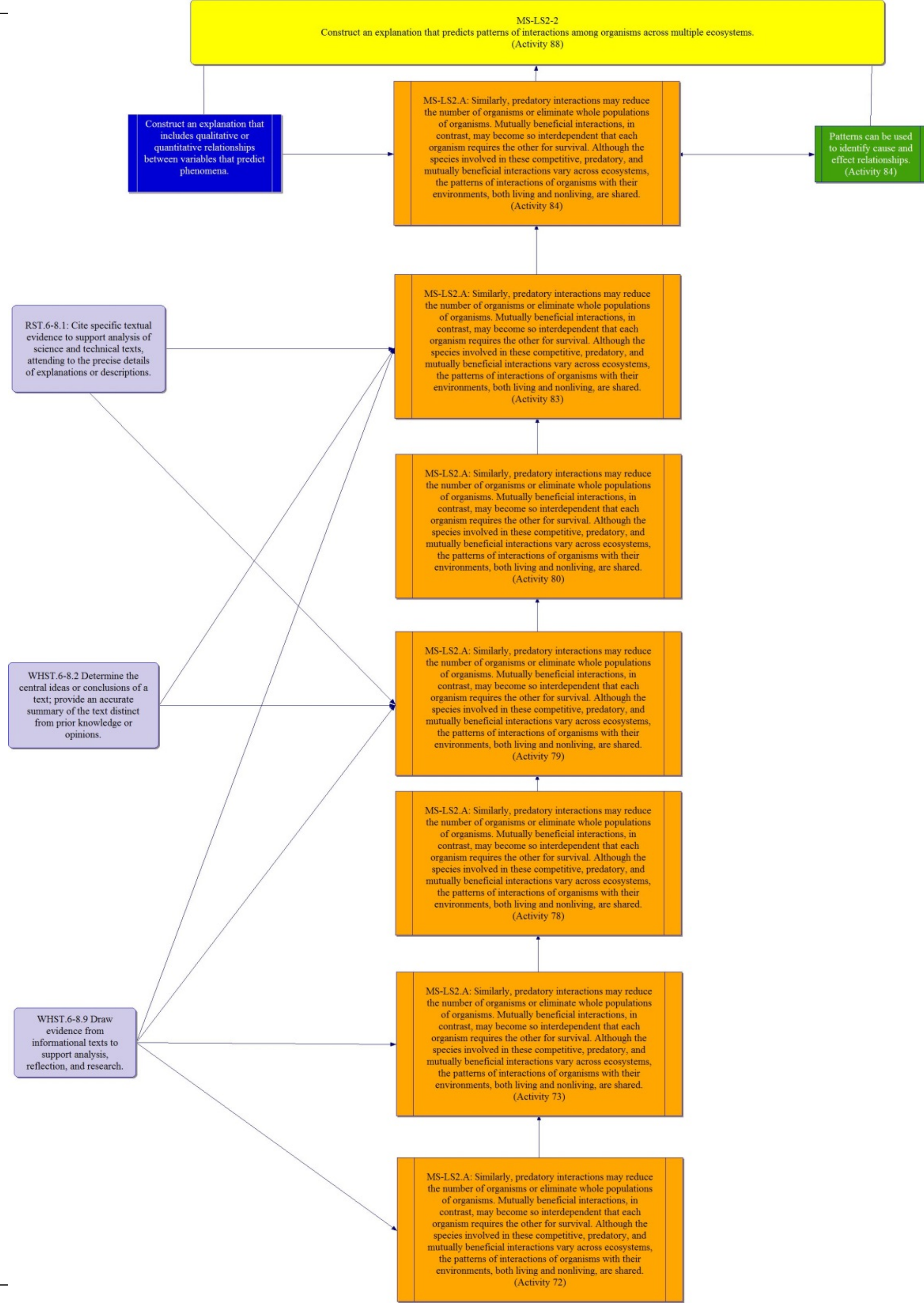
Performance Expectations

- **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.
- **MS-LS2-2** Construct an explanation that predicts patterns of interactions among organisms across multiple ecosystems.

Each performance expectation is at the end of a learning pathway, as illustrated on the next two slides).

This activity is on the learning pathways of three performance expectations and provides the opportunity for formative assessment of conceptual understanding (DCI), practices, and crosscutting concepts, along with associated common core state standards in ELA and Math.


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. (Activity 85)
Analyze and interpret data to provide evidence for phenomena. (Activity 84)
MS-LS2.A: Organisms, and populations of organisms, are dependent on their environmental interactions both with other living things and with nonliving factors. 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. Growth of organisms and population increases are limited by access to resources. (Activity 84)
Cause and effect relationships may be used to predict phenomena in natural systems. (Activity 84)
MS-LS2.A: Organisms, and populations of organisms, are dependent on their environmental interactions both with other living things and with nonliving factors.(Activity 83)
RST.6-8.1: Cite specific textual evidence to support analysis of science and technical texts, attending to the precise details of explanations or descriptions.
MS-LS2.A: Organisms, and populations of organisms, are dependent on their environmental interactions both with other living things and with nonliving factors.(Activity 81)
MS-LS2.A: Organisms, and populations of organisms, are dependent on their environmental interactions both with other living things and with nonliving factors.(Activity 80)
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).
MS-LS2.A: Organisms, and populations of organisms, are dependent on their environmental interactions both with other living things and with nonliving factors.(Activity 79)
Analyze and interpret data to provide evidence for phenomena. (Activity 77)
MS-LS2.A: Organisms, and populations of organisms, are dependent on their environmental interactions both with other living things and with nonliving factors. Growth of organisms and population increases are limited by access to resources. (Activity 77)
Cause and effect relationships may be used to predict phenomena in natural systems. (Activity 77)
MS-LS2.A: Organisms, and populations of organisms, are dependent on their environmental interactions both with other living things and with nonliving factors.. (Activity 74)
MS-LS2.A: Organisms, and populations of organisms, are dependent on their environmental interactions both with other living things and with nonliving factors. 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. (Activity 73)
MS-LS2.A: Organisms, and populations of organisms, are dependent on their environmental interactions both with other living things and with nonliving factors. 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. Growth of organisms and population increases are limited by access to resources. (Activity 72)
Cause and effect relationships may be used to predict phenomena in natural systems. (Activity 72)


MS-LS2-2 Construct an explanation that predicts patterns of interactions among organisms across multiple ecosystems. (Activity 88)
Construct an explanation that includes qualitative or quantitative relationships between variables that predict phenomena.
MS-LS2.A: 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. (Activity 84)
Patterns can be used to identify cause and effect relationships. (Activity 84)
RST.6-8.1: Cite specific textual evidence to support analysis of science and technical texts, attending to the precise details of explanations or descriptions.
MS-LS2.A: 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. (Activity 83)
MS-LS2.A: 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. (Activity 80)
WHST.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.
MS-LS2.A: 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. (Activity 79)
MS-LS2.A: 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. (Activity 78)
WHST.6-8.9 Draw evidence from informational texts to support analysis, reflection, and research.
MS-LS2.A: 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. (Activity 73)
MS-LS2.A: 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. (Activity 72)

Contact Information

- John Howarth
  - john_howarth@berkeley.edu

- Maia Willcox
  - mwillcox@berkeley.edu

This slide show and activity will be available at sepuplhs.org/news