Elaborate: The Zebra Mussel Problem: 20 Years of Data

Ecosystems are dynamic places that can change over time. The introduction of zebra mussels changed the Great Lakes and Hudson River ecosystems by altering their food webs. Over time, further changes occurred in both ecosystems. Sometimes an ecosystem can recover from a change and return to a stable state similar to before the change, or a new stable state. Other times the changes are too great.

In the last two activities, you learned how the zebra mussel affected the ecosystem in the Hudson River. The data you investigated covered a period of eight years. When scientists monitor ecosystem health, this amount of time is considered short-term. Looking at short-term data can give scientists important information about the early effects of a change. In this activity, you will look at the same factors you investigated before, but you will analyze the data in terms of long-term ecosystem health.

Scientists want to understand what happens when ecosystems, such as the Hudson River, have a new species introduced.

Guiding Question

What are the long-term effects of the zebra mussel invasion of the Hudson River?

Materials

For each pair of students:

- Computer with Internet access

For each student:

- Explanation Tool
- Argument Tool

Process & Procedure

Part A: Constructing Another Explanation of the Impact

1. In this activity you will examine long-term data for the same factors you studied in Activity 4.3. With your partner, review your predictions from activity 4.3. Decide with your partner if you want to change your prediction or keep it the same.

2. With your partner, go to the "Overview" page of the "Graph the Data" section of the website.

   http://www.amnh.org/education/hudsonriver

3. Select "Over Time" and use the map to choose the Kingston location to study.

4. In the box below the map, select "Split Date."

5. Use the pop-up calendar to set Split Date #1 to August 15, 1990. This represents average data from before the zebra mussels arrived in the Hudson River.

6. Set Split Date #2 to August 15, 2000. This will split the remaining data into two periods—one soon after the zebra mussels arrived and the other more recent.

7. Set the first parameter to "Zebra mussel" and set the second parameter to the first factor you investigated in Activity 4.3.

8. Examine the three pairs of bar graphs that are produced. Look for any patterns and record your observations.

9. Repeat Procedure Steps 6 and 7 for the second and third factors you investigated in Activity 4.3. Make sure the first parameter is always "zebra mussel."

10. With your class, watch the video clip, "Going Further."

11. Using the Explanation Tool, construct a scientific explanation about the long-term interactions between zebra mussels and the biotic or abiotic factor you chose. Use the steps below to guide you as you use the Explanation Tool.

- **Question:** Record the question "What is the long-term effect of zebra mussels on the factor you chose?"
- **Evidence:** Examine the data in the graphs you created. What pattern do you notice in the zebra mussels over time? What pattern do you notice in the factor you chose over time? Describe these patterns. Include data (with units) as evidence from the graph to support your description.
- **Science Concepts:** List any science concepts that are connected to the evidence and might help answer the question.
- **Science Reasoning:** Describe the scientific reasoning that connects the evidence and science concepts to the question you are trying to answer.
- **Claim:** Based on the evidence of patterns in the data, state a claim about the relationship between the zebra mussels and the factor you chose.

12. Complete the reading below, following your teacher's instructions to answer the "Stop to Think" question.

Long Term Changes

In 2005, 14 years after the first sighting of zebra mussels in the Hudson River, Cary Institute scientists noticed an unexpected change in the river: zooplankton had returned to the same levels as before the invasion. The scientists also observed a change in the zebra mussels they were collecting from the river. Scientists group zebra mussels by three sizes: small (less than 10 mm), medium (10–20 mm), and large (more than 20 mm). While there were still many zebra mussels in the Hudson River, they were on average much smaller. Populations of the largest—or oldest— mussels were in decline. Zebra mussels can live six or seven years, but now it seemed that most were dying after only one or two years. If there were fewer older and larger zebra mussels, it made sense that there was more zooplankton. That's because large zebra mussels feed on bigger food particles like zooplankton. Smaller zebra mussels can eat only smaller particles like phytoplankton and bacteria.

Stop to Think

What effect do you think the smaller and younger zebra mussel population might have on the rest of the food web?

These changes started to affect the rest of the food web. As zooplankton increased, so did native mussels and clams. Scientists anticipated some fish species would increase too as their food supply increased. Scientists didn't know all the factors that caused the decline in large zebra mussels, but they did know blue crabs were starting to eat the zebra mussels.

Over time, blue crabs have developed a taste for zebra mussels and are one significant factor in the decrease of zebra mussels.

By monitoring several aspects of the Hudson River over many years, Cary Institute scientists are beginning to answer their original question: How might a zebra mussel invasion affect the Hudson River ecosystem? Early on during the invasion, zebra mussels thrived and had a huge impact on the ecosystem's food web—just as scientists had predicted. However, about 20 years later the number of zebra mussels has greatly declined. Parts of the ecosystem, such as the number of zooplankton, native mussels, and clams, have started to increase. But is this the end of the story? Or have we just seen the first two stages of an invasion that might have three, four, or more stages?

As their data sets grow, the scientists are able to track changes in the river—whether from pollution, weather, invasive species, or human activity—and to pose new questions. This broad approach puts scientists in a unique position to investigate future changes to the Hudson River ecosystem.

13. Review your Explanation Tool from Procedure Step 11. Revise or add to your student sheet as needed, based on the passage you just read.

14. Using the Argument Tool, construct a scientific argument about whether the zebra mussel has had a positive or negative effect on the Hudson River ecosystem. Use the list below to guide you as you use the Argument Tool.

■ **Question:** Record the question "Has the zebra mussel had a positive or negative effect on the Hudson River ecosystem?"

■ **Claims:** Record the two possible claims that could be made in response to the question.

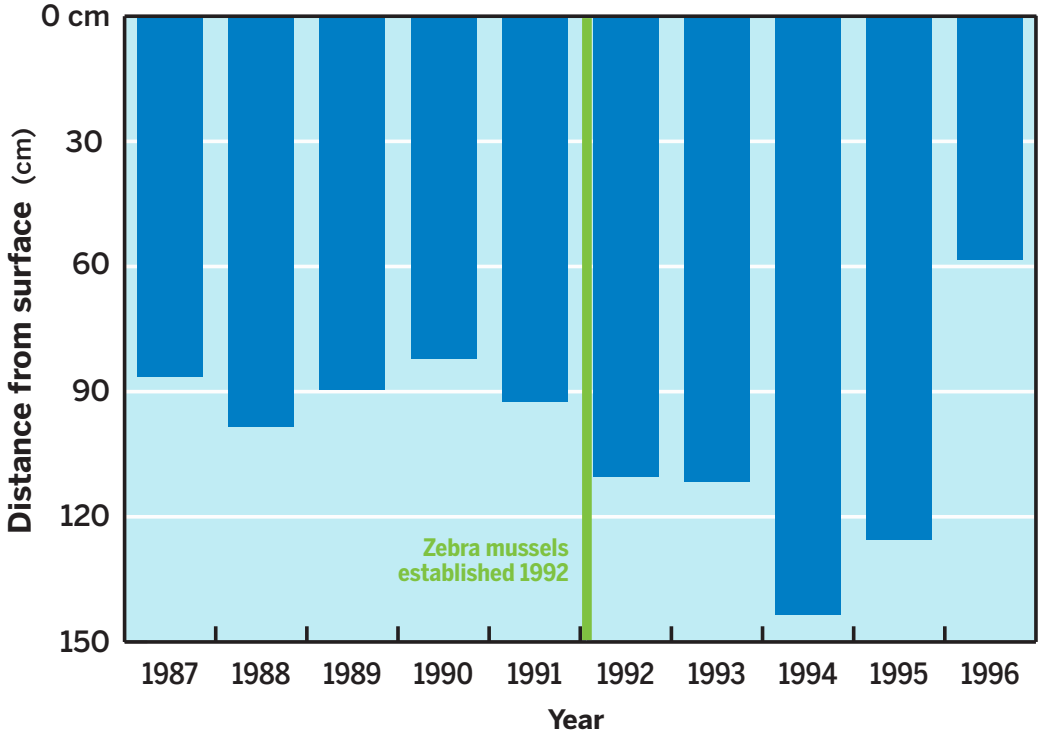
■ **Evidence:** What evidence supports each of the two claims?

■ **Science Reasoning:** For each claim, critique the quality and strength of evidence that supports the claim.

Analysis

1. Explain why it is important to monitor ecosystems over long periods of time.
2. How do the effects of zebra mussels in the Hudson River relate to stability and change in ecosystems?
3. The graph below shows water clarity over time in the Hudson River. The bars indicate how far scientists are able to see into the river from the surface of the water. What do the patterns in the data tell you about the effect of zebra mussels on water clarity?

Water Clarity Over Time in Hudson River



4. Consider the statement: "A small change to one factor can lead to large changes in an ecosystem." If the introduction of one species is considered a "small change," do you think this statement is accurate? Explain your answer.