Elaborate: Dead Zones

Humans can impact ecosystems in many ways. You have learned in previous activities about some ways that humans have affected aquatic ecosystems and fisheries. In this activity you will learn about an extreme case of human-influenced ecosystem disruption—dead zones.

In aquatic ecosystems around the world, scientists have recorded an increase in the number and size of dead zones. A **dead zone** is an area in a body of water where the water at the bottom has little or no dissolved oxygen. Scientists are concerned about the increase in dead zones because very few organisms can survive in dead zones.

One of the main causes of the increase in size and number of dead zones is fertilizer run-off. Fertilizer contains nutrients like nitrogen, which plants need to grow. Farmers apply fertilizer to plants to help them grow. If extra fertilizer is given to plants, when it rains the extra washes away into streams and rivers. This is called fertilizer run-off.

Dead zones happen when large amounts of nutrients are added to a body of water. If there is a lot of fertilizer run-off, the nutrients in the run-off help phytoplankton grow. Populations of phytoplankton increase quickly. When the plankton die and sink, they feed the bacteria (decomposers) on the bottom of the ocean. The bacteria population increases, and uses up the oxygen in the surrounding water, leaving no oxygen for other organisms. The organisms have to leave that part of the ecosystem or they die.

All of the streams and rivers in the Mississippi Watershed (the green shaded area) connect to the Mississippi river. One area that has a very large dead zone is the Gulf of Mexico, where the Mississippi river ends.

Guiding Question

How do humans affect the size of dead zones?

Materials

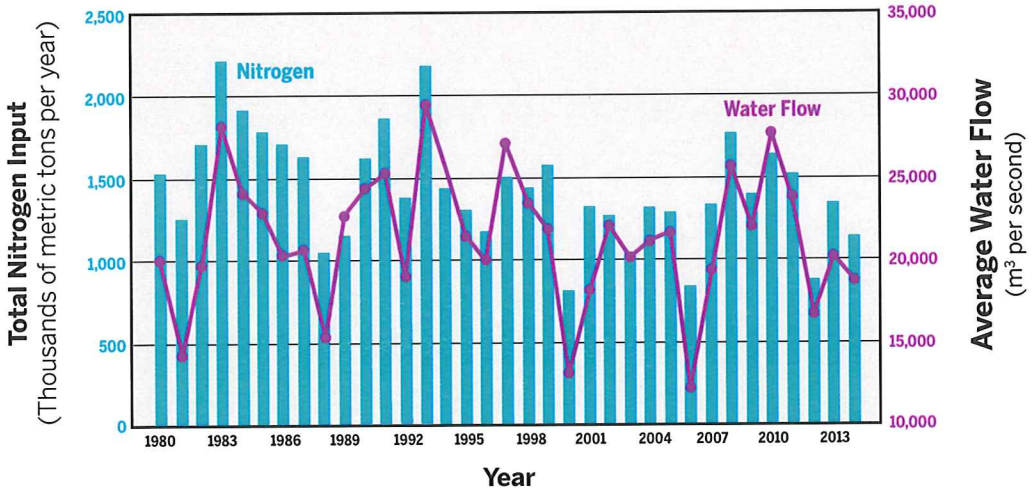
For each student:

- Explanation Tool

Process & Procedure

1. With your class, watch the video segment "The Gulf of Mexico Dead Zone."
2. Discuss the video segment with your class.
3. With your group, examine the graph below. Discuss the following:
   - What patterns do you notice?
   - What do you think explains the patterns?
   - What pattern do you expect to see in the size of the dead zones in the Gulf of Mexico? Explain why you expect to see these patterns.

Nitrogen Input and Water Flow from the Mississippi Basin to the Gulf of Mexico



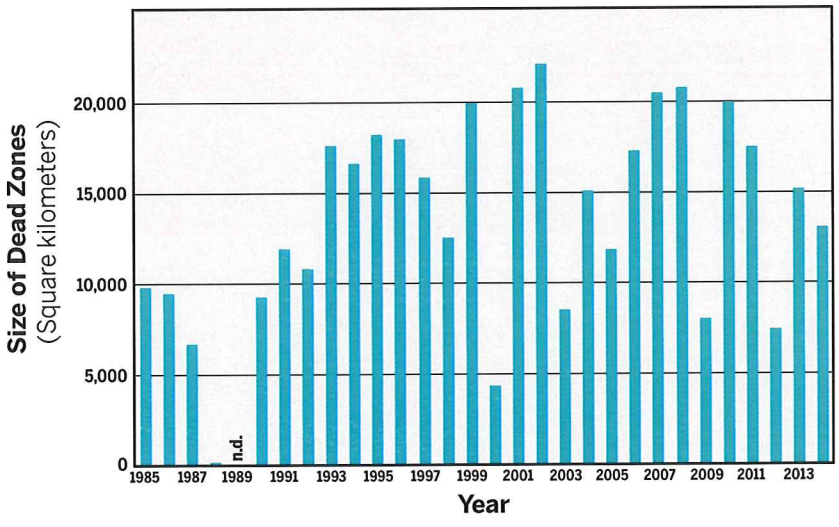
This graph shows the amount of nitrogen input and water flow from the Mississippi Basin into the Gulf of Mexico from 1985 to 2014

4. Using the Explanation Tool, construct a scientific explanation about the effect of water flow from the Mississippi Basin on the nitrogen input in the Gulf of Mexico. Use the steps below to guide you as you use the Explanation Tool.

- **Question:** Record the question "What is the effect of water flow from the Mississippi Basin on the total nitrogen input in the Gulf of Mexico?"
- **Evidence:** Examine the data in the graph and information from the introduction. What pattern do you notice in the nitrogen input and water flow data? 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.
- **Scientific 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 and on your scientific reasoning, state your claim about the effect of water flow from the Mississippi Basin on total nitrogen input in the Gulf of Mexico.

5. With your group, examine the graph below. Discuss the following:
   - **a.** What patterns do you notice?
   - **b.** Do the data in the graph match the prediction you made in Step 3 about patterns in the size of dead zones in the Gulf of Mexico?

Size of Dead Zones in the Gulf of Mexico

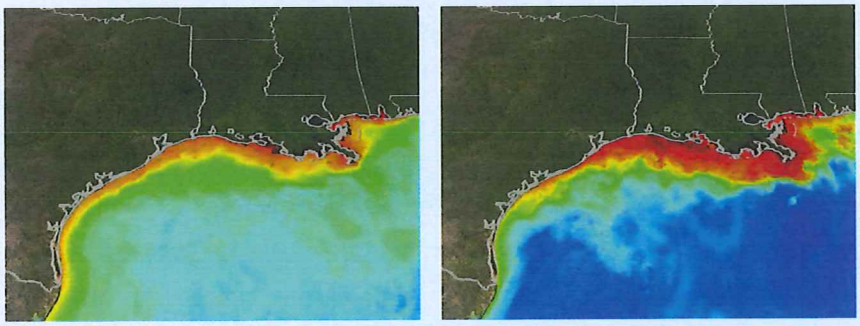


This graph shows the size of dead zones in the Gulf of Mexico between 1985 and 2014.

6. Complete the reading on the next page.

Gulf of Mexico Dead Zone

The Gulf of Mexico is one of the largest and most important areas for fisheries in the United States. The area where the Mississippi River drains into the Gulf waters is the location of the largest recorded dead zone in the United States. This dead zone reappears nearly every summer, and has been as large as 21,576 km^2 (8,400 mi^2).



These maps show the dead zone in the Gulf of Mexico in winter (left) and summer (right). The colors indicate how much plankton is present. Red represents high levels of plankton. Orange is slightly less plankton, yellow is less than orange, etc..

The Mississippi drains nearly 41% of the land in the United States, and a lot of the land is farmland where fertilizers are used. Scientists estimate that 65% of the nutrients that drain into the Gulf of Mexico come from farms and livestock production along the Mississippi.

Source of Nitrogen	% Total Nitrogen from Source
Fertilizer & treated soil	50
Animal manure	15
Other (atmosphere, ground water, erosion, runoff, etc.)	24
Factories and other buildings	11

Scientists are concerned about the effect of this increasing dead zone on the fisheries in the Gulf, especially because several of the fisheries are already considered overfished or in danger of becoming overfished.

7. With your class, debate the question "Should fertilizer use be limited to help prevent dead zones?"

Analysis

1. What are the abiotic and biotic factors that are affected in a dead zone? How do they differ from a healthy ecosystem?
2. How might an increase in the size of the dead zone in the Gulf of Mexico affect the red snapper fishery, or other fisheries in that area?
3. Draw a diagram with four panels showing the main stages in the creation of a dead zone. The panel below is an example of what the fourth panel in your diagram might look like. Include a caption for each panel that explains what is happening in the diagram.