Module 2

Grade Level: Middle School

Teaching Time: 1-2 class periods

Materials:

Copies of the Student Data Sheets

Water quality parameters, data, and best practices information from previous activities.

III. Save the Oyster Reef!

Summary

Oysters are a valuable part of estuary ecosystems. They help purify the water, control erosion, and provide habitat for numerous other species. In this activity, students will investigate a hypothetical scenario in a town on the Chesapeake Bay, and devise a management plan to “Save the Oyster Reef”.

Learning Objectives

Students will be able to:

- Explain the water quality requirements for healthy oyster populations.
- Given water quality data, determine whether the water quality will allow oyster growth and spawning.
- Suggest 3 management practices that can be used to improve water quality for oyster growth and reproduction.

Background Information

Since colonial times, the Chesapeake (meaning "great shellfish Bay" in Algonquin) has lost more than 98 percent of its oysters. Gone are the days when oyster reefs posed navigational hazards to Chesapeake Bay explorers. Their reefs defined the major river channels. The reefs extended to near the water surface and often posed a navigational hazard to ships sailing up the Bay. Now, after decades of damage to reefs from harvest, increased disease, falling salinity due to the increased runoff that accompanies increased impervious surface, and increased sedimentation from runoff, a significant amount of hard bottom habitat has been lost. The oyster population in the Bay is less than 1% of what it once was. The native Eastern oyster—*Crassostrea virginica*—plays an important role in the Bay's ecosystem, as both a habitat for a variety of sessile plants and animals and free-swimming fish and shellfish, and as filter feeders because they feed upon phytoplankton (algae).

Key Words

Oyster Management – Among other strategies, restoration, monitoring efforts and the management of private and public grounds, work together to address the issue of poor water quality in the Bay with strategies to meet the criteria in all of the Bay's tributaries. Improved water quality is a critical factor in supporting a vibrant oyster resource.

Sessile – Organism permanently attached to a hard surface and not freely moving.

Water Quality Regulations - Water quality standards are provisions of state, territorial, and authorized tribal or federal law approved by EPA that describe the desired condition of a water body. These standards form a legal basis for controlling pollution entering the waters of the United States from a variety of sources (e.g., industrial facilities, wastewater treatment plants, and storm sewers). States, territories, and authorized tribes may adopt policies and provisions regarding water quality standards implementation.

Activity Procedure

Engagement

Have students read about the problem in the town of Wando from Student Data Sheet: Save the Reef!
"Something is wrong in the town of Wando on a small river in the Chesapeake Bay. The normally successful local oyster harvesters have seen a reduction in their annual oyster harvest in the last few decades and the level of oyster harvest is very low. Now the number of tourists who come to the island to eat the delicious oysters has started falling off. What's even worse is that this year, for the first time ever, local residents had to order oysters from hundreds of miles away to use in their traditional oyster roasts. Can you help the good folks of Wando decide what regulations need to be put in place to stop the decline in their local oyster reef population?"

Students have collected a lot of information in previous lessons about the value of oysters to water quality, best management practices, and the requirements of oysters in order to build and maintain healthy reef systems. They should have access to the data sheets from *Water, Water, Land Use and Water Quality*, and *Oyster Harvest Simulation* in order to discuss potential regulations that might protect and increase the oyster reefs near the town of Wando.

Exploration

Students receive information about water quality at Wando, and at a town upstream, Hamburg. They should review the parameters and look for ones that are not conducive for oyster growth. Have them keep notes in the data tables that display water quality readings for both towns on June 1, and answer the follow-up questions with evidence from previous lessons on the Student Data Sheet.

Water Quality Data on June 1

Parameter	Wando	Hamburg
Salinity	**12 ppt**	**8 ppt**
Water Temperature	**70^0 F**	**65^0F**
Dissolved oxygen	**6.9 mg/L**	**4 mg/L**
pH	**7.9**	**8.6**
Turbidity	**High**	**Very high**

1. Is the water quality in Wando adequate for healthy oysters? Yes
Evidence: All of the parameters are within the ranges for oyster growth, but if the turbidity is high over time, oyster reefs can be covered up.

2. Is the water quality in Hamburg adequate for healthy oysters? No
Evidence: High turbidity, salinity lower than 10, low dissolved oxygen. pH is high.

3. Which water quality parameters might be harmful to oysters or prevent oyster spawning?

Oysters can tolerate a large range of pH and salinity, but the low dissolved oxygen caused oyster death; very high turbidity may be causing the low dissolved oxygen, and; reducing the growth of phytoplankton (food) is critical to oysters.

Salinity - Oysters are generally happier and produce more spat at higher levels of salinity, and can live in water with levels between 2-30 ppt. The ideal salinity range for growth and development is 10 to 22 ppt.

Water Temperature - Oysters spawn at temperatures greater than $60.^0$F. Adult oysters grow well at 50^0 to 80^0F, or higher, but the most favorable temperatures are 77^0 to 79^0F.

Dissolved oxygen - Oysters and most animals that live on oyster reefs need at least 2-3 ppm DO to survive. Normal dissolved oxygen concentrations for the Bay is (about 7 milligrams dissolved oxygen/liter; mg/L) Low dissolved oxygen can result in oyster mortality. In shallow waters where nutrient pollution runs high, oxygen levels can plummet to nearly zero at night. Oysters living in these zones are far more likely to pick up the lethal Dermo disease.

pH - The Bay generally has a pH between 7.0-9.0, which is neutral to slightly basic. More acidic conditions in key parts of Chesapeake Bay reduce rates of juvenile oyster shell formation and growth. The Eastern oyster can spawn in water with a pH between 7.8 and 8.2.
Inputs of nutrients from sewage systems and agriculture promote increased phytoplankton populations in the upperpart of the Bay. As these plants grow, they absorb large amounts of carbon dioxide from the water column, thereby making waters in that region less acidic. As phytoplankton are carried toward the ocean by the Bay's currents, they are eaten by animals and bacteria. The respiration of this phytoplankton organic material results in the release of the same carbon dioxide taken up by the phytoplankton, which remains dissolved in the water making it significantly more acidic.

Turbidity – Water clarity is heavily influenced by weather events, such as droughts and rain storms, and it fluctuates a great deal. When rains fall in the watershed, it runs off the ground carrying sediments into local rivers that eventually lead to the Bay. This sediment combines with other materials like decaying plant and animal waste, and sewage to form suspended solids in the water. The solids cause the water to scatter light resulting in increased turbidity. Clear waters are a reflection of a healthier Bay.

Explanation

Tell your students that now it is their turn to make a *Plan of Action* to save the oyster reefs. Divide the class into small groups of (3) to propose at least two new regulations that the officials can put into practice to slow or stop the decline in the oyster reef population. Each group should discuss potential management practices and determine which ones would make a significant difference in the water quality and improve oyster populations. They will choose the top 2 practices and write a regulation for each one. Each regulation should include the action, who is responsible to vote this into law, and who will be responsible for enforcing compliance.

Ask each student group to present an explanation of their regulations to the class through any multimedia format.

Extension

The class can compile the regulations and discuss the potential outcome. Would the people of Wando be happy with their oyster populations in 10 years? Additionally, students can participate in an oyster reef restoration project or monitor a local site on a periodic basis. http://www.cbf.org/oysters or http://oysterrecovery.org/

Students can also track water quality parameters at a local buoy. http://buoybay.noaa.gov/observations/data-graphing-tool

Evaluation

Monitor the participation of students in this group activity. Each should be contributing to the discussion and development of the regulations. Students should record their observations and evidence on the Student Data Sheet. They should provide evidence for their management decisions and prepare a short presentation to their peers outlining the reasoning for their choices. This rubric may help assess the students' presentations of their management ideas. (15 points total)

	Below Standard 1-2 points	**Approaching Standard 3-4 points**	**At Standard 5 points**	**Points**
Explanation of ideas and Information	Uses too few or irrelevant descriptions, facts, details, or examples to support their management Ideas.	Missing some key supporting ideas, conclusions, details, or explanations.	Uses relevant, well-chosen descriptions, and details; findings fully support their management ideas.	
Organization	Information is not presented in a logical order, and explanations are not clear.	Information has a logical progression but the explanations are not clear.	Information is clear, complete and presented in a logical sequence.	
Science Content	Presentation contains many inaccuracies in science content or incorrect conclusions.	Presentation has a few inaccuracies or an incorrect conclusion.	Presentation includes accurate information and good science reasoning.	
Total				

Three Dimensional Learning		How the Dimensions are Addressed
Core Disciplinary Idea(s)	**LS2.A Interdependent Relationships in Ecosystems** Organisms and populations of organisms are dependent on their environmental interactions both with other living things and with non-living factors. Growth of organisms and population increases are limited by access to resources. **ESS3.C -** Human activities have significantly altered the biosphere, sometimes damaging or destroying natural habitats.	Students have learned about the abiotic factors critical to oyster populations, they will examine water quality readings at (2) locations, and determine whether the data will limit oyster growth and reproduction. Students will examine the human activities that are responsible for poor water quality and determine courses of action to improved water quality parameters.
Science/Engineering Practice(s)	**Analyzing and Interpreting Data** Analyze and interpret data to provide evidence for phenomena. **Engaging in Argument from Evidence** Construct an oral and written argument supported by empirical evidence and scientific reasoning to support an explanation for a phenomenon or solution to a problem.	Students will analyze water quality data and determine a course of action through management plans that will improve water quality parameters for increased oyster production. In the culminating activity, students construct two regulations. A presentation to their classmates requires that they deliver sound evidence and scientific reasoning to solve the problem of poor water quality.
Cross-cutting Concepts	**Patterns** can be used to identify cause and affect relationships. **Cause and Effect** Cause and effect relationships may be used to predict phenomena in natural systems.	Students review data and information that they have collected to construct an explanation that includes relationships between the oyster population and water quality parameters. Given new data sets, they determine whether the water quality parameters will support oyster populations.

Ties to Common Core	**Speaking and Listening 8.4** Students present claims and findings emphasizing salient points in a focused, coherent manner with relevant evidence, sound and valid reasoning and well-chosen details.	A presentation of the results of their group decision about management regulations to their classmates requires that they deliver sound evidence and scientific reasoning to solve the problem of poor water quality.
Ties to MD Environmental Literacy Standards	**Standard 4. Populations, Communities, and Ecosystems** The student will use physical, chemical, biological, and ecological concepts to analyze and explain the interdependence of humans and organisms in populations, communities, and ecosystems.	The students will use chemical and biological criteria and data about oyster populations to provide evidence for the effects of water quality on ecosystem health and organism populations.

Module References

http://www.oyster-restoration.org/related-links/

http://estuaries.noaa.gov/teachers/pdf/06_oysters_tg.pdf

http://buoybay.noaa.gov/investigating-turbidity

https://www.sciencedaily.com/releases/2010/06/100610104619.htm

Maryland Environmental Literacy Standards
http://marylandpublicschools.org/programs/Documents/Environmental/MDEnvironmentalLitStandards.pdf

Additional Resources

http://www.oyster-restoration.org/related-links/