Unit Introduction

Grade Level: Middle School

Timeframe (Options)
Integrated throughout year or semester

It Takes a Watershed to Raise an Oyster

Unit Overview

This learning sequence incorporates three dimensional learning from the K-12 Framework for Science Education with connections to Common Core, and the Maryland Environmental Literacy Standards. The sequence was originally conceptualized by a team of educators from the Chesapeake Bay region.

Anne Arundel Public Schools
Eric Greenlee

Somerset County Public Schools
Patricia Benner
Merrilee Perko
Pamela South

Wicomico County Public Schools
Katie Seman

Their work to design the framework for this middle school sequence and to review the final product was crucial in producing this lesson sequence.

The sequence is comprised of seven lessons, each building on the knowledge and skills of the previous one incorporating the three dimensions of learning. These dimensions are included in each lesson and the learning sequence builds toward deeper understandings and issue investigation skills. (http://www.nextgenscience.org/three-dimensions)

Dimension 1: Science and Engineering Practices (SEPs) describe behaviors that scientists engage in as they investigate and build models and theories about the natural world and the key set of engineering practices that engineers use as they design and build models and systems.

Dimension 2: Crosscutting Concepts (CCs) have application across all domains of science. As such, they are a way of linking the different domains of science. Patterns, similarity, and diversity; Cause and effect; Scale, proportion and quantity; Systems and system models; Energy and matter; Structure and function; Stability and change.

Dimension 3: Disciplinary Core Ideas (DCIs) have the power to focus K–12 science curriculum, instruction and assessments on the most important aspects of science. They must have broad importance across multiple sciences of engineering disciplines, provide a key tool for understanding or investigating, relate to the interests or life experiences of students, and be teachable over multiple grade levels to increase depth of understanding.

The lesson sequence will engage students in a local environmental issue by showing them the historical context of how the Eastern oyster populations and the Chesapeake Bay watershed have changed since the time of Captain John Smith. Students learn about water quality parameters and have opportunities to investigate the effect of land use on water quality and ultimately the oyster populations and the reef ecosystems. Finally, students are asked to learn about the effect of management practices on water quality and asked to suggest ways that these can be used to increase the health of the Chesapeake Bay ecosystem and its water supply through healthy oyster reef systems. The sequence of seven activities is divided into 2 modules building toward skills and knowledge to tackle more in-depth issue analysis in the high school sequence.

Module 1 addresses the following middle school dimensions:

Science and Engineering Practices

- Engaging in Argument from Evidence
- Obtaining, evaluating and communicating information
- Gather, read and evaluate scientific or technical information
- Developing and Using Models
- Analyzing and Interpreting Data

Crosscutting Concepts

- Patterns
- Scale, Proportion and Quantity
- Cause and Effect
- Influence of science, engineering and technology on society and the natural world.

Disciplinary Core Ideas

- LS2.A Interdependent Relationships in Ecosystems

ESS3.B Natural Hazards
ESS3.C Human Impacts on Earth Systems

Module 2 addresses the following middle school dimensions:

Science and Engineering Practices
Developing and Using Models
Analyzing and Interpreting Data
Engaging in Argument from Evidence

Crosscutting Concepts
Cause and Effect
Structure and Function
Patterns
Stability and Change

Disciplinary Core Ideas
LS1.A Structure and Function
LS2.A Interdependent Relationships in Ecosystems
LS2.C Ecosystem Dynamics
ESS3.C Human Impacts on Earth Systems
ETS1.B Developing possible solutions

Module I: Essential Questions and Learning Objectives

Lesson I. Then and Now

This activity explores the historical changes in the ecological conditions and water quality of the Chesapeake Bay. Students will confirm or refute their predictions after reading excerpts from John Smith's journal and viewing reports from the Chesapeake Bay Foundation or other sites. This activity will set the stage for students to investigate waterways near them and to look at the role of oysters in the Chesapeake Bay ecosystem.

Learning Objectives

Students will be able to:

- Explain 3 differences in the physical conditions of the Chesapeake Bay from the 1600's and today.
- Characterize relative abundance and diversity of living species near the Chesapeake Bay in 1600.
- Identify 3 characteristics of a healthy Chesapeake Bay ecosystem.

Essential Questions

How have the physical characteristics of the Chesapeake Bay changed since John Smith first sailed it in 1608?
How have habitats and abundance of animal species changed since 1608?

Lesson II. Where Am I?

This activity explores geospatial systems so that students can create waypoints and record latitude and longitude of places in a watershed as a first step in monitoring a local water way.

Learning Objectives

Students will be able to:

- Explain the concept of locating a site on Earth with 3 satellites.
- Use latitude and longitude coordinates to identify features on a map.
- Use a GPS receiver or a smart phone to locate the waypoint of a local feature on the school grounds.

Essential Questions

Where are we in the world?
What tools can be used to determine location?
Why is it important to know location in science investigations?

Lesson III. Water, Water

Students will measure water quality and its relevance to stream health by understanding water quality parameters. They will use standard water testing equipment to test and record specific characteristics of water quality and learn about the indicators of a healthy waterway. Students will also investigate how oysters can provide ecosystem services to the Bay for better water quality.

Learning Objectives

Students will be able to:

- List 3 indicators of water quality and explain how information about these are obtained.
- Give an example of how water quality indicator affect living organisms.
- Give an example of how weather events might affect a water quality indicator.

Essential Questions

What are the biotic and abiotic conditions in waterways where we are?
How can we tell if our stream is healthy?
What is the water quality where I live?

Lesson IV. Land Use and Water Quality

This activity investigates local watersheds and what land use factors influence water quality of the rivers and the Bay. Students then look at data from a local monitoring station to find the health of their stream. Using maps of land use areas in parts of the Bay, students will look at land use and compare that with local stream health. They will learn at point and non-point pollutants and determine possible local sources, then consider ways that these can be managed or reduced to enhance water quality, one step in restoring oyster populations.

Learning Objectives

Students will be able to:

- Explain the concept of a watershed in visual or verbal forms.
- Compare point and non-point sources of water pollution and give an example of each.
- Give 3 examples how land use can affect water quality.
- List 3 ways that soil erosion can be minimized in a watershed.
- Identify 4 best management practices to reduce water pollution.

Essential Questions

What land use factors influence water quality?
How does the water quality where we live compare with other areas of the state?
What management strategies can be used to improve the health of the Chesapeake Bay.

Module II. Essential Questions and Learning Objectives

Lesson I. Oysters Inside and Out

This activity explores the physical characteristics that make oysters efficient filter feeders through an investigation into oyster external and internal anatomy. They will design a water filter and test its function with dirty water, then investigate the ecosystem services that oyster reefs provide to organisms that depend on oyster reefs.

Learning Objectives

Students will be able to:

- Identify the form and function of oyster anatomy that make oysters efficient filter feeders.
- Compare oyster filter feeding anatomy with student-created filters.
- Explain the importance of oysters and oyster reef habitats to the Chesapeake Bay
- Examine and identify organisms living in the oyster reef community

Essential Questions

What role do oysters play in water quality?
How does oyster anatomy function to provide filtering of Bay water?
What organisms depend on the oyster reef ecosystem?

Lesson II. Oyster Harvest Simulation

This activity explores the historical and technological changes in the harvest of oysters through the years. It encourages students to think about how humans have affected the Bay and the Eastern oyster. During the game, dried beans represent oysters, and students test out four different types of oyster harvesting tools; nippers, hand tongs, skipjack dredges, and power dredges. After each round of "harvest", students observe and discuss how the structure of the reef has changed, and how the physical changes affect oysters and future populations.

Learning Objectives

Students will be able to:

- Explain 3 methods of oyster harvest and how method can each impacts oyster populations and oyster reef structure.

- Explain how a change in reef structure impacts oyster populations.

Essential Questions

How have harvesting techniques and oyster diseases affected oyster populations in the past?
How has more efficient harvesting techniques affected oyster reefs?

Lesson III. Save the Reef!

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

Learning Objectives

Students will be able to:
Explain the water quality requirements for healthy oyster populations.
Given stream 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.

Essential Questions

How are oysters important to Chesapeake Bay's water quality?
What aspects of water quality are important for oyster growth and reproduction?
What management strategies can improve both the water quality and the health of the Bay's oyster ecosystem?

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Resources from many federal government, informal and higher education institutions were used or adapted in the creation of these lessons.

Module 1

- Annapolis Maritime Museum, https://www.amaritime.org/
- Chesapeake Bay Foundation, http://www.cbf.org/
- Chesapeake Bay Program, http://www.chesapeakebay.net/trackprogress/river http://www.chesapeakebay.net/discover/baywatershed
- EPA, https://cfpub.epa.gov/surf/locate/index.cfm
- GPS.org, http://www.gps.gov/multimedia/tutorials/trilateration/
- Michigan Technological University GK12 Global Watershed Program, http://www.globalwatershed.mtu.edu/resources-lesson-plans.php
- NASA, (http://spaceplace.nasa.gov/gps/en/)
- National Geographic, http://www.nationalgeographic.org/lesson/ http://kids.nationalgeographic.com/kids/games/interactiveadventures/john-smith/ http://education.nationalgeographic.org/activity/introduction-gis/

- NOAA, http://oceanservice.noaa.gov/education/yos/lesson/Grades%205-8/water_quality_teacher_guide.pdf
- Penn State Public Broadcasting, http://geospatialrevolution.psu.edu
- USGS, http://ngmdb.usgs.gov/maps/TopoView/viewer/#13/43.6501/-114.2636 http://ngmdb.usgs.gov/maps/TopoView/viewer/#11/38.6346/-76.0697
- The Ward Museum, https://www.wardmuseum.org/

Module 2

- Annapolis Maritime Museum, , https://www.amaritime.org/
- Chesapeake Bay Foundation, http://www.cbf.org/oysters http://www.cbf.org/about-the-bay/more-than-just-the-bay/creatures-of-the-chesapeake/eastern-oyster http://www.cbf.org/document.doc?id=523
- Chesapeake Bay Program http://www.chesapeakebay.net/fieldguide/categories/category/aquatic_reefs_pilings http://chesapeakebay.noaa.gov/fish-facts/oysters http://buoybay.noaa.gov/observations/data-graphing-tool
- Chesapeake Bay National Estuarine Research Reserve
- NASA, https://www.nasa.gov/pdf/146846main_Cleaning_Water_Educator.pdf
- National Estuarine Research Reserve (Middle School Estuaries 101)
- Maryland Sea Grant, http://ww2.mdsg.umd.edu/interactive_lessons/oysters/anatlab/index.htm http://ww2.mdsg.umd.edu/CQ/v08n2/main2/
- Oyster Recovery Partnership, http://oysterrecovery.org/
- Oyster Restoration. http://www.oyster-restoration.org/related-links/
- TeachEngineering.org, https://www.teachengineering.org/k12engineering/designprocess#Improve
- Virginia Institute of Marine Science, http://www.vims.edu/cbnerr/_docs/education_docs/habitatcageactivity.pdf

References and Resources

- Maryland Environmental Literacy Standards http://marylandpublicschools.org/programs/Documents/Environmental/MDEnvironmentalLitStandards.pdf
- C3 Framework for Social Studies State Standards, http://www.socialstudies.org/system/files/c3/C3-Framework-for-Social-Studies.pdf
- Maryland Environmental Literacy Requirement: Origin & Development http://maeoe.org/maryland-environmental-literacy-requirement-origin-development/
- Three Dimensional Learning http://www.nextgenscience.org/three-dimensions
- Framework for K-12 Science Education https://www.nap.edu/catalog/13165/a-framework-for-k-12-science-education-practices-crosscutting-concepts
- Common Core State Standards http://www.corestandards.org/ELA-Literacy/RST/introduction/