Module I

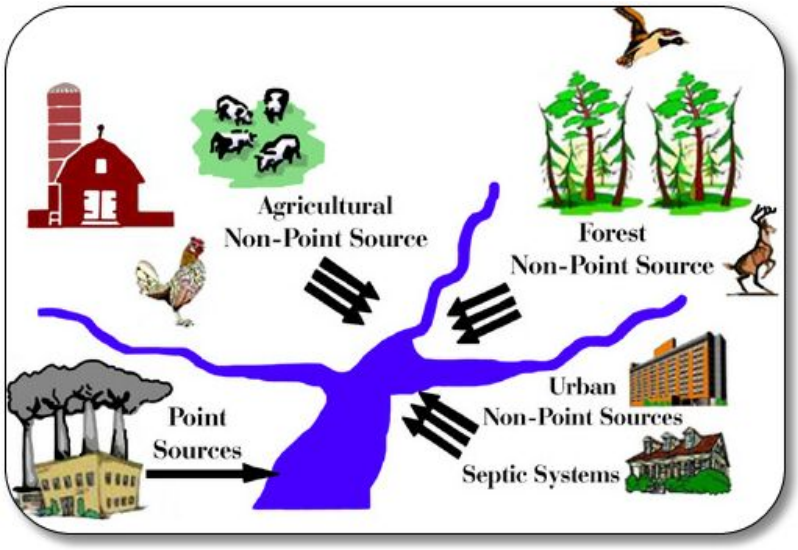
Grade Level: Middle School

Teaching Time – 4-6 class periods

Materials
Copies of Student Data Sheets 1, 2, 3 and 4

Color copies of the Chesapeake Bay watershed in Student Data Sheet 1 (consider laminating map and provide one per pair of students)

Access to computers to find their watershed address, local monitoring stations and water quality data



IV. Land Use and Water Quality

Summary

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 about point and non-point source pollutants and determine possible local sources; then they will consider ways that these can be managed or reduced to enhance water quality, just 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 of 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.

Background Information

The simplest definition of a watershed is the area of land that catches precipitation and channels this water into a marsh, stream, river, lake, or underground reservoir (groundwater). These water bodies can be contaminated by runoff that carries pollution from land surfaces anywhere within the watershed. Pollution is the presence of substances in the air, land, or water that can degrade human health and environmental quality. These substances may come from many sources, but some of the most serious pollution problems are the result of unwanted by-products—commonly called wastes—from human activities.

In the early 1970's, major steps were taken to reduce pollution from human activities, including passage of the Clear Air and Clean Water Acts, and establishment of state and federal environmental protection agencies. Many of these efforts were targeted toward large, conspicuous sources of pollution, such as factories and municipal sewage systems. Significant progress has been made in reducing pollution from these **point sources**.

Point source pollution is pollution that comes from a single, identifiable source, such as a pipe or smokestack. But many polluting substances do not originate from a single source. Rainwater, for example, may become contaminated as it moves over and through the ground, picking up pollutants from many different sources. This kind of pollution is known as **nonpoint source pollution**, and now accounts for most of the water pollution in the United States. In fact, nonpoint source pollution comes from such a wide variety of human activities that almost everyone contributes to the problem in some way, often without realizing it.

Pollutants from nonpoint sources include:

- Fertilizers and pesticides from farms and home landscapes
- Oil, grease, and toxic fluids from roads, parking areas, leaking underground storage tanks, and improper disposal of used motor vehicle lubricants
- Sediments from poorly managed construction sites, forest lands, and stream banks
- Acid drainage from abandoned mines
- Bacteria and nutrients from livestock, pet wastes, and faulty septic tanks

Because it is a serious and pervasive problem, contaminated runoff has been the focus of numerous state, local, and national efforts.

The diversity of sources and substances that result in nonpoint source pollution often make it difficult to know exactly what actions are needed to reduce or eliminate the problem. In many cases, the first priorities are to recognize when pollution is taking place, identify the polluting substances, and determine the sources of pollutants.

Environmental computer models are mathematical representations of the real world that estimate environmental events and conditions. Models simulate ecosystems that are too large or complex for real-world monitoring. These scenarios simulate how various changes can affect the Bay ecosystem, especially water quality, wildlife, and aquatic life. Data is collected 14 times a year at 22 stations located in Maryland's Chesapeake Bay main channel and 12 to 20 times a

year at 55 stations sampled in the tidal tributaries. The analyzed data provides an assessment of the water quality by evaluating the levels of nutrients, dissolved oxygen, and water clarity. Go to http://www.chesapeakebay.net/trackprogress/river or http://buoybay.noaa.gov/ to view data.

Very detailed maps of MD streams can be found at http://1.usa.gov/1Th7ZDW

One of the main goals of Chesapeake Bay restoration is to reduce the impacts of excess nutrients on the Bay, and these measures provide some of the most direct linkages to management programs that are achieving this goal. The Chesapeake Bay Program programs have agreed to reduce nitrogen, phosphorus and sediment pollution to the Bay.

Key Words

Best management practices – Structures, vegetation, or management practices designed to prevent or reduce water pollution from reaching a stream, river, or lake.

Estuary – The widening channel of a river where it nears the sea with a mixing of freshwater and salt (tidal) water.

Non-point source pollution – pollution that does not come from one specific source but comes from a large area; for example, runoff from a parking lot, a farm field, or a golf course.

Nutrient pollution – caused by excess nitrogen and phosphorus in the air and water.

Point source pollution – the contamination source can be identified. Examples include pollution from a business, factory, mine, power plant, mill, or wastewater from treatment plants that discharge into rivers.

Soil erosion - the wearing away and transport of soil by water, wind, and glaciers. Soil erosion can be a major source of turbidity, or suspended fine particles, in streams. The amount of erosion depends upon the land cover.

Tributary – A stream that flows to a larger stream or other body of water.

Watershed - The area that drains to a common waterway, such as a stream, lake, estuary, wetland, aquifer, or even the ocean.

Wetlands - Areas where water covers the soil, or is present either at or near the surface of the soil all year or at varying times during the year, including during the growing season.

Activity Procedure

Engagement

Ask students to brainstorm the types of pollution they are familiar with that occur in their own yards and neighborhoods. Write their examples on the chalkboard. Ask them if they think these types of pollution are effected in any way by rain or snow. Possible examples might include Animal/pet waste, litter, sewage, fertilizers and other chemicals, dumped oil, sediment, storm water, sticks, grass clippings.

Have students watch one or more of these videos:
What is Non-point Source Pollution - https://www.youtube.com/watch?v=phmN-IpR3xw
Sources of Water Pollution - https://www.youtube.com/watch?v=ekACmEJLK2Q
Types of Pollutants that affect Water Quality - https://www.youtube.com/watch?v=yEci6iDkXYw

Have students work in small groups to place the types of pollution into 2 categories on a piece of paper. Ask them to report out to their peers.

Point Source Pollution	Non-Point Source Pollution
Discharge from sewage plant	Fertilizers or other chemicals
Discharge from mine or factory	Soil or sediment
Wastewater from power plant or business	Storm water
	Litter, grass clippings, sticks
	Pet waste

Exploration

Surf Your Watershed! Every location on land is part of one or more watersheds, which can range in size from a few acres to millions of square miles. Most watersheds are part of larger watersheds. All watersheds in the United States have a specific name and an identifying number known as a "watershed address." Have students visit https://cfpub.epa.gov/surf/locate/index.cfm and put in their zip code to find information about their local watershed address and information on pollution and other characteristics. Consider using Google Earth or Chesapeake Bay Fieldscope (http://chesapeake.fieldscope.org/map/31). Students should complete the watershed questions in Data Sheet I.

You can see an image of the whole Chesapeake Bay watershed at http://www.chesapeakebay.net/discover/baywatershed and http://www.chesapeakebay.net/maps/map/classification_of_watersheds_based_on_2000_land_cover

Answers to Watershed Questions in Student Data Sheet 1.

1. How many states make up the Chesapeake Watershed? 7

2. You will notice that the western side of the watershed is highly forested. What major land feature corresponds to this? Appalachian Mountains

3. What major pollutants come from forested lands? Sediment and pesticides

4. The middle part of the Chesapeake Bay is dominated by 2 highly developed areas. What are they? Washington D.C and Baltimore.

5. What major pollutants come from highly developed lands? Sediment, chemicals, toxic fluids, bacteria

6. Go to http://www.chesapeakebay.net/trackprogress/river and find the river monitoring station closest to your school or home. When you click on the marker, you will see a grade and information about the major sources of water pollution in the area. Record that information below.

My River's Grade_____ Answers will vary

7. What are the major Sources of non-point pollution at this site? Answer will vary

8. What actions do you think would help to reduce these sources of non-pollution? Answers will vary.

Water quality and Pollutants: Healthy forests, streams and rivers are critical to the health of the Chesapeake Bay. Protecting forests will protect clean air and water, while lowering nutrient and sediment pollution entering the Bay. Have the students go to http://www.chesapeakebay.net/trackprogress/river (scroll down the page to River Health Report Cards) and find the river monitoring station closest to their school or home. When you click on the marker, you will see a grade and information about the major sources of water pollution in the area. Record that information in Data Sheet 1.

You will find additional information about the status of stream health. This site includes 12 different map views, measurement tools, and location information. http://1.usa.gov/1Th7ZDW

Consider giving the students an assignment to provide more detailed information about their local stream using the data at this site. Their maps can be printed for documentation.

Using the information from Student Data Sheet 1, Activity III, *Water, Wa*ter, ask students to complete the last column of the table on Data Sheet 2 by listing at least two potential sources of pollution from the local land uses that they identified.

Student Data Sheet 2
Water Quality and Pollutants [ANSWER KEY]

Adapted from: Michigan Technological University GK12 Global Watershed Program*, How is Water Quality Affected by Land Use?*

List at least two potential causes of each pollutant listed below.

Pollutant	Possible Sources
1. Nutrients (nitrogen and phosphorus)	1. Livestock (animal wastes) too close to stream 2. Fertilizers on crops or lawns
2. Sediment	1. Roads crossing a stream 2. Eroding Streambanks 3. Livestock too close to stream 4. ATVs driving through streams
3. Heavy water runoff	1. Poor drainage in urban areas 2. Lack of vegetation or forests in stream banks 3. Erosion from unprotected stream banks
4. Pesticides and Herbicides	1. Residential lawns and gardens 2. Golf courses and city parks 3. Crop land
5. Oil, gas, metals	1. Parking lot runoff 2. Leaking underground gas storage tanks

Students will develop their own investigative question related to the land use and pollutants that they identified in Student Data Sheet 2. They will record this on Student Data Sheet 3. Here are a few ideas and sources of information. Some sites have additional background and accompanying videos about the pollutants.

What is the trend of population growth in the Bay watershed?
http://www.chesapeakebay.net/indicators/indicator/chesapeake_bay_watershed_population

What is the trend of forest growth around the Chesapeake Bay?
http://www.chesapeakebay.net/indicators/indicator/bay_watershed_forest_cover

What are the trends of nitrogen in rivers entering Chesapeake Bay?
http://www.chesapeakebay.net/trackprogress/river

What are the trends of phosphorus in rivers entering Chesapeake Bay?
http://www.chesapeakebay.net/trackprogress/river

What are the trends of sediment in rivers entering Chesapeake Bay?
http://www.chesapeakebay.net/trackprogress/river

Review student hypotheses to make sure they are appropriate, and that students will be able to support or disprove them using the data available to them. Once approved by you, they can investigate that parameter and document their findings on Student Data Sheet 3.
After students complete their research, provide time for them to present their findings to the class.

Alternatively, your students can learn more about water quality parameters with online data in the Water Quality module of Data in the Classroom.
http://dataintheclassroom.noaa.gov/SitePages/water-quality/index#.VxpEfNQrKt8

Teachers Guide:
http://dataintheclassroom.noaa.gov/Documents/Water%20Quality%20Teacher%20Guide.pdf

Finally, the Chesapeake Watershed Project of Fieldscope is a tool with many features for student investigations. It is a citizen science initiative in which students investigate water quality issues on local and regional scales. Chesapeake Bay FieldScope is a project of National Geographic's Education Programs in collaboration with the Chesapeake Bay Foundation and the NOAA Chesapeake Bay Office. It is open and free for students and educators across the Chesapeake Bay watershed to join. There is a tutorial available to introduce you and your students to the maps and query tools available. http://chesapeake.fieldscope.org/v3/

Explanation

Putting the Chesapeake on a Pollution Diet

Students will develop a simple management plan of best practices to improve Chesapeake Bay's water quality. Some background information is provided on Data Sheet 4. This activity is

appropriate for small groups to discuss as a group to suggest management strategies that might help to reduce pollution in the Bay.

Note: This information is used in the final activity of the unit; developing a plan to restore oyster reefs and return the Bay to a healthy condition.

Extension

Challenge students to use Google Earth to identify different land uses in their watershed and then create a presentation using screen shots of their findings. Additional information about this assignment is at Michigan Technological University GK-12 Global Watershed Program. http://www.globalwatershed.mtu.edu/docs/watershed_connections/Watershed_Connections_Lesson_4_Water_Quality_and_Land_Use.pdf

Alternatively, students can make a 3-D model of their watershed. Divide students into small groups. Have each group begin by molding clay to represent landforms in a plastic or metal tray. Next, ask students to form the watershed by gradually leveling the clay so that it leads to the mouth of their river. Then, have them form river channels and coat with blue enamel paint and color the land with tempera paint. Finally, have students place construction paper figures on the model to simulate users of a river system. Let the model dry overnight. Try out the watershed models with a small amount of water from a spray bottle at the "head" of the waterway. Use the models to discuss the local watershed. (http://nationalgeographic.org/activity/in-your-watershed/)

Students should be able to explain:

- *Where are its boundaries?*
- *What are the main sources of pollution in our watershed?*
- *Who is impacted?*
- *How can we ensure the watershed is a clean resource for the community?*

Alternatively, have students investigate this site from Project WET, "Explore Watersheds." http://www.discoverwater.org/explore-watersheds/

Evaluation

Checking for Understanding: Students will complete Data Sheets 1, 2, 3 and 4 documenting their work and evaluated for completeness.

Three Dimensional Learning		How the Dimensions are Addressed
Core Disciplinary Idea(s)	**MS-ESS3.C Human Impacts on Earth Systems –** Human activities in agriculture, industry and everyday life have had major effects on land, vegetation, streams oceans, air, and even outer space. Individuals and communities are doing things to help protect Earth's resources and environments.	Students investigate local watersheds and land use factors that influence water quality, then look at data from a local monitoring station to find the health of their stream. This activity uses knowledge developed in the previous activities.
Science/Engineering Practice(s)	**Obtaining, evaluating, and communicating information** in 6-8 builds on K–5 experiences and progresses to using appropriate and sufficient evidence and scientific reasoning to defend and critique claims and explanations about the natural and designed world. **Analyzing and Interpreting Data-** Analyzing data in 6-8 builds on K-5 experiences and progresses to extending quantitative analysis to investigations. Analyze and interpret data to provide evidence for phenomena.	Students gather information about management practices and complete a plan to reduce pollutants and increase the health of the Chesapeake Bay. Students will review online data from reliable sources about the status of pollutants in their local stream and determine its relative grade.
Cross-cutting Concepts	**Cause and Effect** – Use cause and effect relationships to predict phenomena in natural or designed systems. Patterns in rates of change and other numerical relationships to identify cause and effect relationships. **Systems and system models** – A system can be described in terms of its components and their interactions.	Students will use online data, maps, and interactive websites to investigate the effects of land use on pollutants. They will see patterns in land use and stream health due to different pollutants. Students use maps and interactive websites to explore the components of the Chesapeake Bay watershed.

Ties to Common Core	**CCSS.ELA-LITERACY.RST.6-8.3** Follow precisely a multistep procedure when carrying out experiments, taking measurements, or performing technical tasks.	Students will develop their own investigative question related to the land use and pollutants and follow instructions to look for relevant data and record their findings and develop conclusions.
Ties to MD Environmental Literacy Standards	**Standard 5. Humans and Natural Resources** – The student will use concepts from chemistry, physics, biology, and ecology to interpret both positive and negative impacts of human activities on earth's natural systems and resources.	Students investigate the effect of land use and the corresponding pollution to waterways in the Chesapeake Bay. They will use information about their local stream to develop a best practices management plan.

Module References

http://www.chesapeakebay.net/maps/map/classification_of_watersheds_based_on_2000_land_cover
http://www.chesapeakebay.net/trackprogress/river
http://buoybay.noaa.gov/
http://1.usa.gov/1Th7ZDW
http://www.chesapeakebay.net/track/guides
http://www.globalwatershed.mtu.edu/docs/watershed_connections/Watershed_Connections_Lesson_4_Water_Quality_and_Land_Use.pdf
http://www.chesapeakebay.net/blog/post/epa_establishes_chesapeake_bay_pollution_diet
http://www.chesapeakebay.net/data/downloads/cbp_water_quality_database_1984_present
http://www.chesapeakebay.net/maps/map/chesapeake_bay_watershed_model_phase_5_modeling_segments
Maryland Environmental Literacy Standards
http://marylandpublicschools.org/programs/Documents/Environmental/MDEnvironmentalLitStandards.pdf

Additional Resources

http://estuaries.noaa.gov/ScienceData/Default.aspx?ID=289

http://education.nationalgeographic.org/programs/chesapeake-water-quality/

http://www.mde.state.md.us/programs/water/tmdl/water%20quality%20standards/pages/programs/waterprograms/tmdl/wqstandards/faqs.aspx

https://www.epa.gov/nutrient-policy-data/chesapeake-bay