



Environmental Literacy Model

Title	The Impact of Runoff on Maryland's Coastal Bays
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Audience (grade, course)	8th Grade Ecology Unit

Curriculum Anchor

Defining the Learning Objectives and Curriculum Connection

Curriculum indicators, performance expectations, and/ or student learning objectives.

NGSS:

Ecosystem Dynamics, Functioning, and Resilience

LS 2-6 Create or revise a simulation to test a solution to mitigate adverse impacts of human activity on biodiversity. (Cause and Effect)

- **Science Practices-** Using Mathematics and Computational Thinking
- **Disciplinary Core Ideas-** LS4.C: Adaptation, S4.D: Biodiversity and Humans, ETS1.B: Developing Possible Solutions
- **Crosscutting Concepts-** Cause and Effect

Human Impact Reduction Solution

LS2-7 Design, evaluate, and refine a solution for reducing the impacts of human activities on the environment and biodiversity. (Stability and Change)

- **Science Practices-** Constructing Explanations and Designing Solutions
- **Disciplinary Core Ideas-** LS2.C: Ecosystem Dynamics, Functioning, and Resilience, LS4.D: Biodiversity and Humans, ETS1.B: Developing Possible Solutions
- **Crosscutting Concepts-** Stability and Change

Human Impact on Biodiversity Solution

LS4-6 Create or revise a simulation to test a solution to mitigate adverse impacts of human activity on biodiversity. (Cause and Effect)

- **Science Practices-** Using Mathematics and Computational Thinking
- **Disciplinary Core Ideas-** LS4.C: Adaptation, LS4.D: Biodiversity and Humans, ETS1.B: Developing Possible Solutions
- **Crosscutting Concepts-** Cause and Effect

Maryland Environmental Literacy Standards.

- (1) Environmental Issue Investigation & Action. Environmentally literate students investigate environmental issues in order to develop and implement local actions that protect, sustain or restore the natural environment.
- (3) Environmental Impact of Human Activity. Environmentally literate students construct and apply understanding of the environmental impact of human activities on Earth's systems and resources.
- (5) Individual and Collective Responses to Environmental Change. Environmentally literate students construct and apply understanding of individual, collective, and societal responses to human-induced environmental change.

Student Learning Objectives:

- Students will investigate sources of runoff in the county and determine their impacts on the Coastal Bays watershed

- Students will explore the interconnectedness between human impacts on the environment and the local ecosystems.
- Students will gain critical thinking and problem solving skills through observation and investigation of a Worcester County issue.

Describing the Local Context

The life-relevant issue that will serve as the context for learning.

Humans pose the biggest threat to our nation's estuaries. Coastal counties are growing three times faster than counties elsewhere in the nation. Unfortunately, this increasing concentration of people: upsets the natural balance of estuarine ecosystems; threatens their integrity; and imposes increased pressures on vital natural resources like estuaries. This holds true for the Maryland Coastal Bays watershed which is housed in Worcester County, Maryland.

What happens on the land affects the quality of the water and health of the organisms that live in the estuary. For example, when a river or stream flows through an agricultural area, it picks up fertilizer, sediment, manure, and pesticides. As it passes through more developed areas, it can gather substances such as fertilizers or pet waste that wash off lawns, litter through storm drains, wastewater industrial facilities, sediment from construction sites, and runoff from impervious surfaces like parking lots.

In the Coastal Bays watershed, over 70% of our land is agricultural. Nutrients, such as nitrogen and phosphorus, runoff the fields, or infiltrate into groundwater, and end up in our streams, rivers, and bays. Increased amounts of these nutrients can cause detrimental effects such as eutrophication and hypoxic zones. And more than the abiotic environment will be affected by these increases. Many organisms in the watershed will be negatively impacted due to the alterations in their environment. Our local fisheries are a salient economic industry for the region, and when there is an impact on organisms in the bay, there will be domino effects throughout the watershed's food chains.

The Maryland Coastal Bays Program has been sampling water quality in all 5 Coastal Bays for over 20 years. Their data provides an in depth look into impacts in the watershed that students can use towards background research.

Identifying the Driving Question

A broad, open-ended, life-relevant question that is based on the standards/learning objectives. Guides inquiry for the investigation(s), prompts the development of actionable claims.

How does runoff affect the Coastal Bays' water quality in Worcester County?

- What land uses surround our school and community? (ABC Activity, mapping)
- What happens when runoff flows off different types of land use? (EnviroScape)
- What type of land use is the largest cause of pollutants in our coastal bays watershed?
- What sources of runoff are impacting waterways **around** our school grounds?
- What nutrients enter our Coastal Bays from the surrounding land?
- How do pollutants from runoff affect aquatic life (in general)?
- How do pollutants from runoff affect aquatic life in my community? [water testing]

Unit [Phenomena](#) (CBF FB) - Fish Kill – discuss

Issue Investigation

Asking Questions, Defining Issues and Problems

Students define the issue, problem, or phenomenon to be investigated and develop supporting questions that are relevant for investigation.

Issue Investigation 1	Issue Investigation 2	Issue Investigation 3
<p>What are the different types of land use? (Recreational, transportation, agricultural, residential, commercial, and public buildings & institutions)</p> <ul style="list-style-type: none"> • What land uses surround our school and community? (ABC Activity, mapping) 	<p>What is the relationship between land use and runoff?</p> <ul style="list-style-type: none"> • What happens when runoff flows off different types of land use? (EnviroScape) • What type of land use is the largest cause of pollutants in our coastal bays watershed? • What sources of runoff are impacting waterways around our school grounds? 	<p>How does human use of the land impact aquatic life in the Coastal Bays system?</p> <ul style="list-style-type: none"> • What nutrients enter our Coastal Bays from the surrounding land? • How do pollutants from runoff affect aquatic life (in general)? • How do pollutants from runoff affect aquatic life in my community? [water testing]

Planning and Conducting Investigations

Students plan and conduct investigations and classroom activities (indoor and outdoor) that actively address students' supporting questions. Students collect data that will be used to inform actionable claims.

Issue Investigation 1	Issue Investigation 2	Issue Investigation 3
<ol style="list-style-type: none"> Brainstorm; <ol style="list-style-type: none"> ABC Prior Knowledge Activity- Students will apply their prior knowledge of what land is used for in Worcester County to enhance their learning. Have students go outside and observe land use around their school and document what they see. Students will use the program ArcGIS to construct a colorful Land Use Map on their iPad based on what they learnt about land use during their walk around the local school area. Then figure out what percentage of each type of land use they have. <ol style="list-style-type: none"> (self-guided) Land Use and Land Cover & Calculating Percentage of Land Use Worksheet 	<ol style="list-style-type: none"> Introduce the Brainstorming Tree <ul style="list-style-type: none"> • Runoff Thinglink • Tree PDF • Master Tree Link *Use throughout the week Brainstorm to access prior knowledge of What is runoff? <ul style="list-style-type: none"> • trunk- runoff issue • <i>roots-causes</i> • <i>treetop-impacts</i> • <i>sky-solutions</i> *Use throughout the week Classroom Activity/Demo with MD Coastal Bays Program: <ol style="list-style-type: none"> Introduction into the MD Coastal Bays Program and identify Maryland's coastal bays. EnviroScape Demo: complete stormwater runoff/watershed lesson with students. <i>(If grant money allows, each school will have their own EnviroScape.)</i> 	<ol style="list-style-type: none"> Add to brainstorming Tree (causes - roots of tree) Students will use Monitoring Estuarine Water Quality with Data in the Classroom to investigate the water quality characteristics of an estuary (water temperature, salinity and oxygen), the relationship between these parameters, and the effect that water quality has on spawning migrations of the Atlantic sturgeon. As a practice for collecting their own data. Teacher's Guide to Monitoring Estuarine WQ with Data in the Classroom Using this information, students will reflect in small groups on if those characteristics will have the same relationships in the Coastal Bays watershed. "How could these characteristics affect migrating fish populations (such as American eel and alewife) in the Coastal Bays?"

Before the Activity: Copy the 100-square grid onto a transparency.

- o You will want to print it so that it fits flat on the iPad screen flat. Copy one per student.

7. Students will predict how land use around their school compares to land use around our bays? (Turn and Talk)

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3. (Maps Activity/CER)

Use a land use map of Worcester County to look at the relationship between land use and runoff.

- Students should identify the main land use type surrounding our coastal bays (agriculture)

4. Predict how human use of the land impacts aquatic life in the coastal bays system. (turn and talk)

4. Students are assigned a bay to investigation:

SDMS – Isle of Wight
SHMS – Sinepuxent
PMS - Chincoteague

5. Students will research:

A. . What nutrients enter our Coastal Bays from the surrounding land?

B. What water quality testing is required to reflect health of the bays? (water temperature, salinity, pH, DO, Nitrates and Phosphates)

6. Students will decide what they should test for and why they are testing those parameters.

- a. In addition to what they find on their own students can use:

[2018 MD Coastal Bays Report Card*](#) **The 2019 and 2020 MCBP Report Card will be released in October 2021.**

[DNR Coastal Bays Water Quality Monitoring](#)

[Our Path Forward: Conservation and Management Plan for MD's Coastal Bays](#)

7. Students will use this [Rubric](#) to complete the assignment.

8. Class will share their findings and identify which water quality parameters they will be testing. (water temperature, salinity, pH, DO, Nitrates and Phosphates) .

9. Introducing Phytoplankton

- a. [The Ocean's Green Machines Video](#)

- b. Article: [What are Phytoplankton? Earth Observatory Article](#)

- c. Introductory Phytoplankton Identification lesson

[Introduction to Phytoplankton | MyNASAData](#)

- d. Phytoplankton Interactive [NASA PACE Phytoplankton Exploration](#)

10. Students will watch a refresher video on [How to use a microscope](#).
11. Students will not be able to collect their own samples. Instead they will watch a video created by partners (MCBP, Assateague State Park) collecting each of the water and phytoplankton samples. This way the students can see the sampling sites, meet scientists/educators, learn about the scientific technology and methodologies of samplings from each organization
12. Students will analyze water from their site collected by partners
 - a. students will Identify and counting phytoplankton (tally of 10 most common found)
 - [Phytoplankton ID Sheet](#)
 - [Phytoplankton Guide](#)
 - Phytoplankton are uniquely adapted to the specific depths, habitats, nutrients, and chemical conditions in which they reside. Information on diversity and taxonomic richness of a phytoplankton community can be used as an indicator of the biological condition of each of the site's sampled. Since the majority of the food web in the bays relies on phytoplankton, understanding their populations are vital to the health of the bays.
 - b. testing chemical water quality. (maybe a demo video of how to test water)
13. Students will share data with other schools [Excel Spreadsheet for Data](#)
14. Students will use data to compare water quality of the 3 bays. (Isle of Wight, Sinepuxent, Chincoteague)
 - a. Identify Potential impacts affecting each of the sampling sites (project map)
 - b. Based on data, students can order the bays from healthiest to least healthy (based on their data-discuss)
15. Students will Zoom with MCBP scientists, building their understanding of how contaminants influence aquatic life.

		16. Brainstorming Tree- add impacts

Issue Investigation con't.>

Analyzing and Interpreting Data

Students analyze data through graphs, models, and other methods to reveal patterns and relationships. Students synthesize and apply evidence from their investigations to draw conclusions that address the supporting questions.

Issue Investigation 1	Issue Investigation 2	Issue Investigation 3
<ol style="list-style-type: none">1. Students will analyze land use maps to identify how the land in Worcester County is used.2. Students should interpret the land use map and identify agriculture as the predominant type of land use.	<ol style="list-style-type: none">1. EnviroScope: Students will use modeling as a means of experimentation and problem solving. They will understand the limits of modeling as they learn to identify, characterize, and then correct a source of water pollution. They will develop a better understanding of what causes water pollution and the importance of keeping water quality safe for humans and the environment, especially wetlands.2. Students will use a land use map of Worcester County to look at the relationship between land use and runoff.	<ol style="list-style-type: none">1. Students will analyze water from their site collected by partners by counting and identifying phytoplankton and testing water quality.2. Students will share data with other schools Excel Spreadsheet for Data3. Students will use data to compare water quality of the 3 bays. (Isle of Wight, Sinepuxent, Chincoteague)<ol style="list-style-type: none">a. Identify Potential impacts affecting each of the sampling sites (project map)b. Based on data, students can order the bays from healthiest to least healthy (based on their data-discuss)4. Students will Zoom with MCBP scientists, building their understanding of how nutrients influence aquatic life.

Constructing and Communicating a Claim

Students draw on the conclusions from their investigations to make a claim about the driving question and communicate these evidence-based claims to internal and/or external audiences.

Issue Investigation 1	Issue Investigation 2	Issue Investigation 3
<p>Students will apply their new knowledge of land use to determine the primary uses of land in the area surrounding their school.</p>	<p>Students will use their new understanding that 1) runoff goes downhill in the watershed to the nearest waterway, 2) land use in our area includes a lot of agriculture, and 3) runoff interacts with the land and picks up pollutants along the way to conclude that pollutants in runoff from agricultural lands has a high impact on waterways in our area.</p>	<p>Students will compare their data to the data from the other two bays using their knowledge of how nutrients affect aquatic life in their bay.</p> <p>Students will use Zoom to communicate with MCBP scientists, expanding their knowledge of how nutrients affect aquatic life.</p>

Stewardship and Civic Action

Identifying Solutions

Students identify and explore solutions that directly address the problem, challenge, or opportunity reflected in their claim. Students use decision making processes to identify the solution(s) to implement.

Students (in groups) develop solutions based on their research and conclusions, present them to their classes, and vote on the most viable option(s) to suggest to Worcester County for implementation.

Students will:

1. Identify through brainstorming solutions to reducing runoff along the coastal bays.
2. Add their ideas in the sky above their brain storming tree.
3. Investigate a potential solution in groups to determine its cost and efficacy.
4. Present their findings to the class.
5. The class will vote on the most viable options for a presentation to the Worcester county community.

Designing a Plan and Taking Informed Action

Students design a plan for implementing solutions through informed action in their classrooms, schools, and/or communities. The plans should include criteria for determining the extent to which the action successfully addresses the problem, challenge, or opportunity reflected in the claim. Students implement their plans.

Students will create a public service campaign. The purpose of the campaign is to develop community awareness of nutrient loading from runoff and to share ways to mitigate nonpoint source pollution in our coastal bays. This plan of action is to get community involvement in protecting and restoring the health of the Coastal Bays.

Action Plans could include:

- Option 1: Students record PSA for local radio station(s) Ocean 98.1
- Option 2: Students create a presentation using Arcgis Story Maps and use it to present their findings to the town council(s) and/or County Council (in person or virtually)
- Option 3: Students create posters for their schools to spread the word about how everyone can help decrease pollution from runoff in our coastal bays
- Option 4: Students can recognize those community members already implementing mitigating practices.
- Option 5: Students bring local farmers into their school for a small farmer's market where their classmates can learn about best management practices farmers are employing that contribute to the health of the soil and the watershed. Best management practices can minimize runoff and mitigate water pollution.

Evaluating Action

Students reflect on the action and determine the extent to which it successfully addresses the problem, challenge, or opportunity reflected in the claim. Students communicate their findings and share proposals for sustaining or extending the action.

- Survey the student body to see the impact of the shared knowledge had on the student body/staff.
- Teachers and peers provide feedback to students.
- Students will present their Action Plans to stakeholders.