WAVE OF PLASTIC

STUDENT INQUIRY OF PLASTIC WASTE AND ITS IMPACTS ON MARINE ECOSYSTEMS

A Meaningful Watershed Educational Experience

Grades 6-8

Through a series of five lessons, Wave of Plastic helps students make sense of the core ideas related to issues of plastic pollution (particularly those relevant to the Chesapeake Bay and its watershed) by engaging in authentic disciplinary practice culminating in comprehensive, student-driven, informed action projects.

This unit has been designed to support Next Generation Science Standards, Maryland Environmental Literacy Standards, Maryland Service-Learning Graduation Requirements, and the Student Outcome of the Environmental Literacy Goal of the 2014 Chesapeake Bay Watershed Agreement (Meaningful Watershed Educational Experiences).

Wave of Plastic represents a partnership between the University of Maryland Center for Environmental Science, and Calvert and St. Mary's County Public Schools. Funding support was provided by the NOAA Bay Watershed Education and Training (B-WET).

University of Maryland Center for Environmental Science

Calvert County Public Schools

St. Mary's County Public Schools

NOAA Chesapeake Bay

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Setting the Context for Learning: Phenomena of Plastic Pollution & Marine Debris

Over the last several decades, plastics have come to dominate daily life. Their versatility, durability, and low production costs have made them a favored material for a wide variety of manufactured goods from eating utensils to medical equipment.

Some of the features that lead to the proliferation of plastics in everyday items also make them amongst the most ubiquitous environmental contaminants in the world today.

Every citizen can make a difference by making choices that reduce the use of plastics and its entry into our oceans.

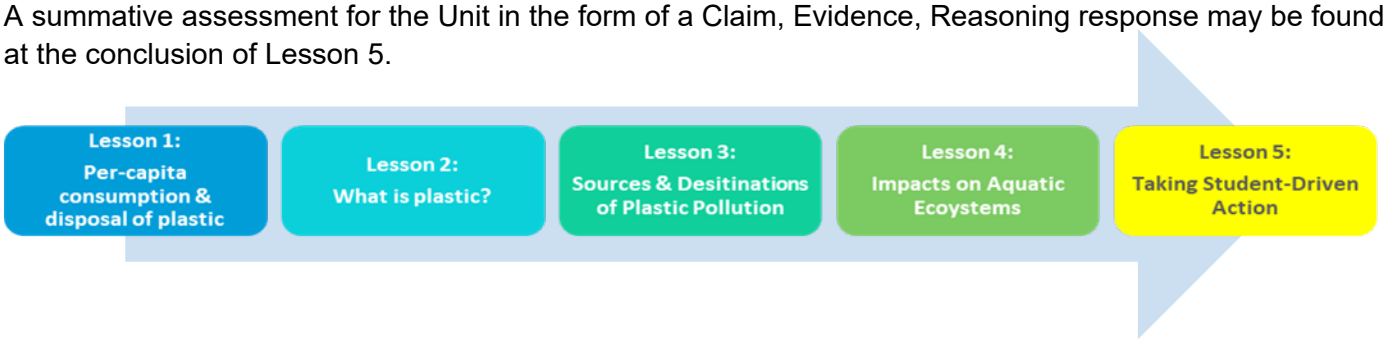
Wave of Plastic: Curricular Connections

The Wave of Plastic unit has been designed to meet Middle School NGSS Performance Expectations that are part of the scope of the curriculum for grades six (St. Mary's County Public Schools, MD) and eight (Calvert County Public Schools, MD). The lessons have been carefully developed to meet the needs of a broad range of grade level-appropriate and diverse learning needs.

Wave of Plastic helps students make sense of the core ideas related to issues of plastic pollution by engaging in authentic disciplinary practice culminating in comprehensive, student-driven, informed action projects.

In order to maximize the learning benefits for students, it is recommended that all five lessons in the unit be taught in sequence (note that some activities may extend across more than one lesson). If the unit must be abridged, it is recommended that Lessons 1, 3, and 5 be taught in order to continue to meet the requirements of the Next Generation Science Standards, the Maryland Service Learning and Environmental Literacy standards, and the Meaningful Watershed Educational Experience requirements of the Chesapeake Bay Watershed Agreement (see arrow figure below).

A summative assessment for the Unit in the form of a Claim, Evidence, Reasoning response may be found at the conclusion of Lesson 5.



Meaningful Watershed Educational Experiences (MWEEs) represent rigorous, student-centered, inquiry-based approaches to instruction designed to support student environmental literacy and stewardship.

MWEEs represent the Student Outcome of the Environmental Literacy Goal of the 2014 Chesapeake Bay Watershed Agreement, which commits school districts to support regional conservation and restoration efforts through high-quality environmental education. For more information, visit: www.BayBackpack.com.

Supporting Maryland State Department of Education (MSDE) Standards & Graduation Requirements

Next Generation Science Standards (NGSS)

Together, the 5 Wave of Plastic lessons support students' understanding of the Disciplinary Core Ideas, Scientific & Engineering Practices, and Crosscutting Concepts of the following Performance Expectations:

MS-ESS3-4: Construct an argument supported by evidence for how increases in human population and per-capita consumption of natural resources impact Earth's systems.
★ Note: All lessons provide learning experiences in support of this Performance Expectation. The final CER assessment (at the conclusion of Lesson 5) addresses it in full.

MS-PS1-3: Gather and make sense of information to describe that synthetic materials come from natural resources and impact society.
★ Note: This performance expectation is supported by Lesson 2.

MS-ESS3-3: Apply scientific principles to design a method for monitoring and minimizing a human impact on the environment.
★ Note: All lessons provide learning experiences in support of this Performance Expectation. The Student Action Project Summary assessment (at the conclusion of Lesson 5) addresses it in full.

MS-LS2-4: Construct an argument supported by empirical evidence that changes to physical or biological components of an ecosystem affect populations.
★ Note: This performance expectation is supported by Lesson 4.

Maryland Environmental Literacy Standards

Wave of Plastic supports student mastery of the following Maryland Environmental Literacy Standards:

Standard 1- Environmental Issues
Standard 5- Humans and Natural Resources
Standard 7- Environment and Society
Standard 8- Sustainability

Maryland Student Service Learning:

The Wave of Plastic Unit has been designed to meet all 7 Best Practices of Service-Learning in Maryland:

1. Meet a recognized need in the community.
2. Achieve curricular objectives through service-learning.
3. Reflect throughout the service-learning experience.
4. Develop student responsibility.
5. Establish community partnerships.
6. Plan ahead for service-learning.
7. Equip students with knowledge and skills needed for service.

Wave of Plastic Unit Standards-based Alignment

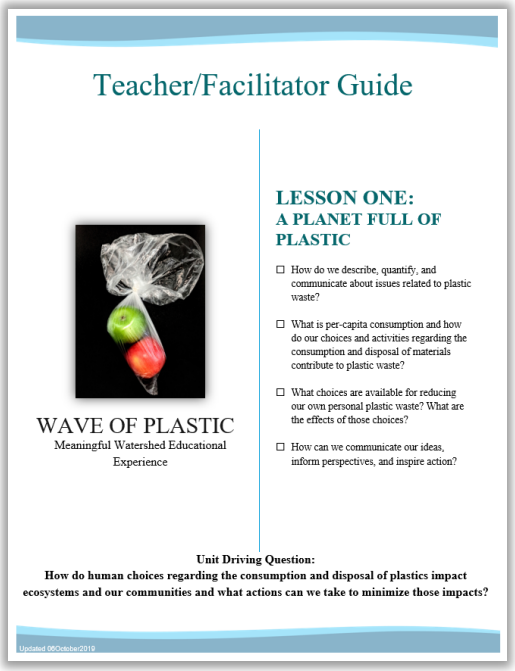
Lesson	NGSS Performance Expectations	Title	MWEE Elements	Maryland Environmental Literacy Standards
1.	☑ MS-ESS3-4 ☐ MS-PS1-3 ☐ MS-LS2-4 ☐ MS-ESS3-3	**A Planet Full of Plastic:** **Per-Capita Consumption & Disposal**	☑ Issue Definition ☑ Synthesis & Conclusions ☐Outdoor Field Experiences ☑ Student Action Projects	☑ Standard 1 – Environmental Issue (Investigation & Action) ☑ Standard 5 – Humans & Natural Resources ☑ Standard 7 – Environment & Society ☑ Standard 8 – Sustainability
2.	☑ MS-ESS3-4 ☑ MS-PS1-3 ☐ MS-LS2-4 ☐ MS-ESS3-3	**What is Plastic?**	☑ Issue Definition ☑ Synthesis & Conclusions ☐Outdoor Field Experiences ☑ Student Action Projects	
3.	☑ MS-ESS3-4 ☐ MS-PS1 ☐ MS-LS2-4 ☐ MS-ESS3-3	**From Hand, to Land, to Sea:** **Sources & Destinations of Plastic Pollution**	☑ Issue Definition ☑ Synthesis & Conclusions ☑Outdoor Field Experiences ☑ Student Action Projects	
4.	☑ MS-ESS3-4 ☐ MS-PS1-3 ☑ MS-LS2-4 ☑ MS-ESS3-3	**Impacts on Aquatic Ecosystems**	☑ Issue Definition ☑ Synthesis & Conclusions ☐Outdoor Field Experiences ☑ Student Action Projects	
5.	☑ MS-ESS3-4 ☐ MS-PS1-3 ☐ MS-LS2-4 ☑ MS-ESS3-3	**We Can Make a Difference:** **Minimizing the Effects of Plastic Waste**	☑ Issue Definition ☑ Synthesis & Conclusions ☐Outdoor Field Experiences ☑ Student Action Projects	

GUIDE TO READING THE LESSONS

Each lesson in the *Wave of Plastic* unit consists of four parts:

1. **Introduction:**
   - Students explore resources and engage in discussion to help build the foundational understandings that will support the lesson.
2. **Investigation:**
   - Students explore resources, engage in discussion, participate in investigations and activities in order to make sense of Core Ideas, Crosscutting Concepts, and Practices.
3. **Application:**
   - Students apply the understandings that they've constructed throughout the current and previous Wave of Plastic lessons through collaborative, informed actions designed to address aspects of problems related to plastic waste.
4. **Assessment:**
   - Students complete a constructed response based on the Claim, Evidence, Reasoning (CER) model to demonstrate their understandings of the NGSS core ideas, crosscutting concepts, and practices as a result of their participation in the lesson. A scoring rubric is included in each Teacher/Facilitator Guide as well as in the Student Workbooks, however teachers are invited to use the scoring system that best meets the needs of their students, school, and district.

*Each lesson begins with the NGSS Performance Expectations, the *Key Ideas* that are most relevant for the lesson, and a chart that describes each of the four parts of the lesson and lists the activities in which students will engage.


Teacher/Facilitator Guide

WAVE OF PLASTIC
Meaningful Watershed Educational Experience

LESSON ONE:
A PLANET FULL OF PLASTIC

- ☐ How do we describe, quantify, and communicate about issues related to plastic waste?
- ☐ What is per-capita consumption and how do our choices and activities regarding the consumption and disposal of materials contribute to plastic waste?
- ☐ What choices are available for reducing our own personal plastic waste? What are the effects of those choices?
- ☐ How can we communicate our ideas, inform perspectives, and inspire action?

Unit Driving Question:
How do human choices regarding the consumption and disposal of plastics impact ecosystems and our communities and what actions can we take to minimize those impacts?

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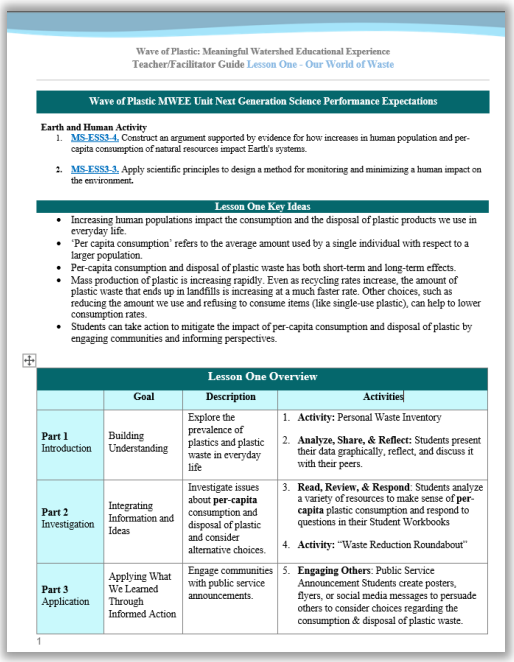
Wave of Plastic: Meaningful Watershed Educational Experience
Teacher/Facilitator Guide Lesson One - Our World of Waste

Wave of Plastic MWEE Unit Next Generation Science Performance Expectations

Earth and Human Activity

1. MS-ESS3-4, Construct an argument supported by evidence for how increases in human population and per-capita consumption of natural resources impact Earth's systems.
2. MS-ESS3-3, Apply scientific principles to design a method for monitoring and minimizing a human impact on the environment.

Lesson One Key Ideas

- Increasing human populations impact the consumption and the disposal of plastic products we use in everyday life.
- 'Per capita consumption' refers to the average amount used by a single individual with respect to a larger population.
- Per-capita consumption and disposal of plastic waste has both short-term and long-term effects.
- Mass production of plastic is increasing rapidly. Even as recycling rates increase, the amount of plastic waste that ends up in landfills is increasing at a much faster rate. Other choices, such as reducing the amount we use and refusing to consume items (like single-use plastic), can help to lower consumption rates.
- Students can take action to mitigate the impact of per-capita consumption and disposal of plastic by engaging communities and informing perspectives.

Lesson One Overview

	Goal	Description	Activities
Part 1 Introduction	Building Understanding	Explore the prevalence of plastics and plastic waste in everyday life	1. **Activity:** Personal Waste Inventory 2. **Analyze, Share, & Reflect:** Students present their data graphically, reflect, and discuss it with their peers.
Part 2 Investigation	Integrating Information and Ideas	Investigate issues about **per-capita** consumption and disposal of plastic and consider alternative choices.	3. **Read, Review, & Respond**: Students analyze a variety of resources to make sense of **per-capita** plastic consumption and respond to questions in their Student Workbooks 4. **Activity:** "Waste Reduction Roundabout"
Part 3 Application	Applying What We Learned Through Informed Action	Engage communities with public service announcements.	5. **Engaging Others**: Public Service Announcement Students create posters, flyers, or social media messages to persuade others to consider choices regarding the consumption & disposal of plastic waste.

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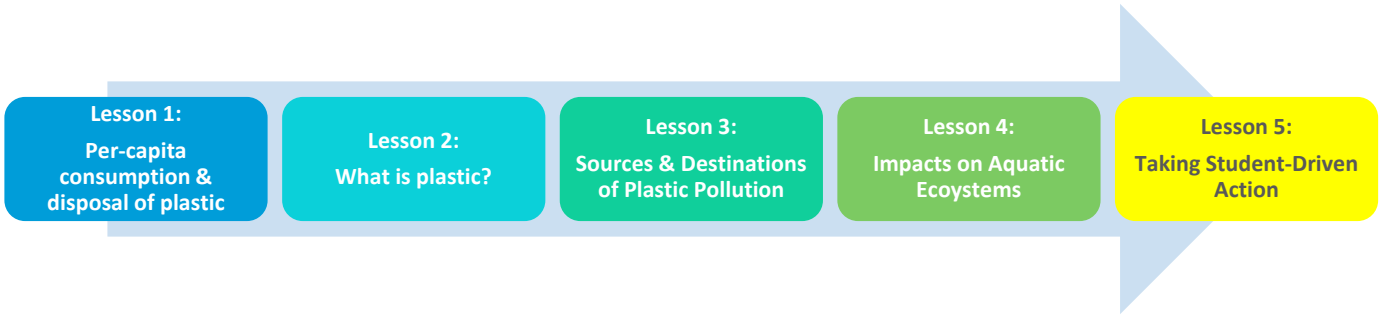
Wave of Plastic – Unit Overview

Lesson	Key Ideas	Lesson Components	
1. A Planet Full of Plastic	• Increasing human populations impact the consumption and the disposal of plastic products we use in everyday life. • 'Per capita consumption' refers to the average amount used by a single individual with respect to a larger population. • Mass production of plastic is increasing rapidly. Even as recycling rates increase, the amount of plastic waste that ends up in landfills is increasing at a much faster rate. • Students can take action to mitigate the impact of per-capita consumption and disposal of plastic by engaging communities and informing perspectives.	**Introduction**	1. **Personal Waste Inventory** 2. **Analyze, Share, & Reflect**
		Investigation	3. **Read, Review, & Respond** 4. **Activity**: "Waste Reduction Roundabout"
		Application	5. Engaging Others: Public Service Announcement
		Assessment	6. **CER**
2. What is Plastic?	• Plastic is a synthetic, human-made material derived from resources found in nature. • Plastic has many properties that make it a favored material for the manufacture of a wide variety of everyday items. • Items made from plastic may be easily broken *up* into smaller pieces but not easily broken *down* by decomposers. Thus, plastic remains and accumulates in the environment. • There are many factors that influence the individual choices that people make when it comes to using plastic. We can survey our communities to understand these choices and inspire behavior change.	**Introduction**	1. **Read, Review, & Respond**
		Investigation	2. **Read, Review, & Respond** 3. **Activity**: "Make Our Own Bio-Plastics" 4. **(OPTIONAL) Activity**: "What Happens to Our Waste" 5. **Analyze, Share, & Reflect**: Updating Our Personal Waste Inventories.
		Application	6. **Engaging Others:** Community Survey
		Assessment	7. **CER**
3. From Hand, to Land, to Sea:	• Human-caused pollution plays causal roles in changing Earth's systems. • Pollution refers to any substance or energy that is foreign to an environment and/or is present in quantities that cause harm to natural systems. • There are many properties of plastic that allow it to be easily transported by wind and rain runoff across land and into waterways, where it becomes pollution. • Plastic pollution harms living things and is accumulating in the environment because of increases in per-capita consumption and because plastic persists for very long periods of time. • Sharing information visually, such as through infographics, can be an effective way to inspire behavior change.	**Introduction**	1. **Read, Review, & Respond**
		Investigation	2. **Activity:** "Plastic Waste Sort!" 3. **Read, Review, & Respond** 4. **Outdoor Field Experience**- Runoff on School Grounds 5. **Outdoor Field Experience**- School Yard Plastic Pollution Survey 6. **(OPTIONAL) Outdoor Field Experience:** "Neighborhood Plastic Pollution Survey
		Application	7. **Engaging Others**: Community Infographic
		Assessment	8. **CER**
4. Impacts on Aquatic Ecosystems	• An ecosystem is a biological community of interacting organisms and their physical environment. • Disruptions to any physical or biological component of an ecosystem can have effects and outcomes and can lead to shifts in all populations of organisms within that ecosystems. • Plastic pollution can affect individuals and populations of animals within aquatic ecosystems.	**Introduction**	1. **Read, Review, & Respond**
		Investigation	2. **Read, Review, & Respond** 3. **Activity:** "You Are What You Eat!"
		Application	4. **Engaging Others**: Personal Pledge: "I Make a Difference!"
		Assessment	5. **CER**
5. We Can Make a Difference:	• "Stewardship" refers to the responsible use and conservation of the natural environment. • Students are critical stakeholders for supporting ecosystem resiliency and stability displaying behavior that consciously seeks to minimize the negative impacts of plastic pollution on Earth's systems. • There are many ways that students can take individual and collective action to mitigate the impacts of plastic waste.	**Introduction**	1. **Analyze, Share, Reflect** 2. **Activity:** "Preparing to Take Action"
		Investigation & Application	3. **Plan, Implement, and Evaluate Action**
		Assessment	4. **Student Action Plan Summary** (MS-ESS3-3). 5. **CER** (MS-ESS3-4).

Getting Started: An Introduction to the *Wave of Plastic* Unit

Wave of Plastic: Lesson & Topic Sequence



Throughout the course of the *Wave of Plastic* Unit, students will engage in authentic disciplinary practice as they make sense of the science ideas behind issues of plastic consumption and the disposal of plastic waste.

Teachers are encouraged to use the trailer, clips, or full version of the Documentary, ***A Plastic Ocean***, to introduce the unit and engage students in the topic.

Released in 2017*, A Plastic Ocean* is a feature length documentary made possible by a group of dedicated scientists, film-makers, social entrepreneurs, scholars, environmentalists and journalists and features Dr. Michael Gonsior, an analytical/environmental chemist with the University of Maryland Center for Environmental Science. The film explores the fragile state of our oceans and examines some of the consequences of society's increasing use and disposal of plastic.

The trailer may be found at http://www.aplasticocean.movie/ . For information about using the video clips and/or the full film, contact your school district science curriculum office.

After viewing the trailer, teachers are encouraged to share the lesson and topic sequence of the Wave of Plastic Unit. The unit culminates in student-driven action projects and teachers may find it productive to keep a running class list of potential ideas for the projects from the beginning of the unit.

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Thank you for your commitment to learning, environmental literacy, stewardship, and conservation!