Plastic Wads on the Beach

Where are the plastic wads coming from, and how can we prevent their escape into the environment?

Overview

Plastic wads are commonly found during beach clean-ups in the U.S., and in some areas, they are listed as one of the top plastic items collected. The wads typically look like a cylinder with one end split into several arms that are spread apart. In this lesson, students will determine where this particular marine debris item is coming from, and the processes which contribute to the material becoming marine debris. Students will propose solutions to interrupt the escape of the plastic wads into the environment.

Essential Questions

- *What is the original use of the plastic wads that end up on beaches?*
- *Why is plastic being used to make the wads, and could other materials be substituted?*
- *How is the use of plastic wads managed, and are there substitutions or processes that could prevent their escape?*

Learning Goals

Students will learn the following:

- *Materials are selected for a purpose based on a cost/benefit analysis.*
- *Understanding the life cycle of a plastic item can help identify ways in which the item impacts the environment.*
- *Systemic changes in practice can reduce human impacts on ecosystems.*

Learning Objectives

Students will be able to:

1. *Identify the general source of plastic wads found on U.S. beaches,*
2. *Describe the life cycle of plastic wads, and*
3. *Propose solutions that would interrupt the escape plastic wads into the natural environment.*

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Grade Level
6-12

Anchoring Phenomenon
Plastic Wads on the Beach

Driving Question
Where are the plastic wads coming from, and how can we prevent their escape into the environment?

Standards
Next Generation Science Standards
ESS3.C: Human impacts on Earth systems
ETS1A: Defining and delimiting and engineering problem
ETS1B: Developing possible solutions
See page 8 for full NGSS

Plastic wad on the beach

Introduction

Marine debris is a complex, global, environmental problem that negatively impacts ecosystems. Persistent, solid materials that are discarded or abandoned into the marine environment can pose ingestion or entanglement hazards to wildlife, disrupt marine fishing and tourism economies, and pose hazards to human health.

Worldwide, communities are addressing the problem of marine debris by *removing* items from the ocean and beaches, as well as by creating mechanisms that *prevent* materials from becoming marine debris in the first place.

Have you ever found a piece of marine debris on the beach and wondered where it came from? In order to prevent a material from becoming marine debris item, we need to know its story.

The anchoring phenomenon of this lesson focuses plastic shotgun wads, which are an easily described type of marine debris that is commonly found on beaches in the Pacific Northwest and throughout the U.S. The empty shell may maintain a tubular shape, or the end pieces may be widely separated and splayed out like a flower or star. Where did these plastic wads come from, and how did they end up on the beach? In order to *prevent* this type of marine debris, students will research the story of plastic wads, identify points at which the escape of the plastic material could be prevented, and propose solutions for ways to interrupt the generation of this type of marine debris.

Plastic wads found on Oregon beaches, Feb 2021

Definition of Marine Debris

Marine debris is defined as any persistent solid material that is manufactured or processed and directly or indirectly, intentionally or unintentionally, disposed of or abandoned into the marine environment or the Great Lakes. - NOAA

Addressing the Problem

- *NOAA MD Prevention projects*
- *NOAA MD Removal projects*
- *Oregon Marine Debris Action Plan*

Oregon beach, Feb 2021

Oregon beach, April 2019
(Photo: Ryan Parker, Oregon State Parks)

Lesson Procedure

ENGAGE

Begin the unit by helping students notice a particular type of marine debris known as plastic wads.

- **Field option:** During a student beach or coastal river clean up, students encounter and collect plastic wads. Some marine debris data cards do not include a space for specifically recording wads, so the instructor will have to facilitate the sorting effort to help students 'see' this particular type of debris. Be aware that students may not find any wads during a single beach clean-up.
- **Classroom option:** Show students the *What is This?* video which shows a person finding a plastic wad on the beach.

In a class discussion or using Student Worksheet #1, solicit students' initial ideas about what it the plastic item is, and where it may have come from. Ask students to draw and label a possible life cycle or story about this item, which begins with the production of the wad, moves on to its intended use, and the end of life for the material. At which point(s) in the cycle might this material escape into the marine environment?

EXPLORE

In this section, students learn more about plastic wads. They explore data to find out the degree to which this material is found on beaches, and they learn more about the polymer used to make wads, its potential life cycle, and the potential hazards the plastic may pose to the ecosystem.

Activity: Quantifying Wads on Beaches

Have students explore data from beach clean-ups to assess where, when, and how many plastic wads are found on local beaches. Depending on the time available and the desired level of complexity, use any of the following datasets:

- Wad data collected by the students themselves
- Wad Watcher website from San Francisco Surfrider. Students may submit their own data to this site as well.
- Large datasets from the Olympic Coast National Marine Sanctuary in Washington state
    - Overview, for grades 4-8
    - Complex, for grades 9-12

Connect with locals who participate in beach clean-ups hosted by organizations such as SOLVE Oregon, Surfrider, or Oregon Shores Conservation Coalition and ask they have found and/or quantified plastic wads.

Lesson Resources

The Hook

- *Video: What is This? [0:59]*

Starting the Story

- *Student Worksheet #1 (pdf)(doc)*

Oregon beach, Feb 2021

Quantifying Wads on Beaches

- *San Francisco Surfrider Website: Wad Watcher*
- *Olympic Coast NMS data overview, Gr 4-8 (xls); complex, Gr 9-12 (xls)*

Data Discussion Prompts

- *How many wads have been found?*
- *Where are wads found?*
- *Are there patterns in the data?*
- *What factors could explain the trends you see in the data?*
- *How might effort affect how many wads are collected?*

Oregon Beach Clean Up Crews

- *SOLVE Oregon*
- *Surfrider – Oregon Region*
- *Oregon Shores Conservation Coalition*

Activity: What is the material made of?
Plastic wads may be made from low-density polyethylene (LDPE) or high-density polyethylene (HDPE). Use the *Plastics and the Plastic and Life Cycle* resource sheet to find lessons and readings for teaching students about plastics and the life cycle assessments of plastic products.

A product made of the polymer *polyethylene* has a life cycle which can be traced from *cradle to grave*. Engineers use *life cycle assessments* to understand the environmental impacts of a product at every stage of production and use so that they can identify ways to improve recycling and reduce waste.

As they learn more about LDPE and HDPE plastics, students may use Student Worksheet #2 to make modifications to their original life cycle drawing as necessary.

Activity: Plastic Wad Impacts on Marine Environments
Wildlife may mistake plastic wads for food items. For example, to an albatross, white and red cylindrical shapes may resemble tasty squid. Use lessons from the "Impacts" section of the *Marine Debris STEAMSS lessons* to help students explore the potential impacts of plastic wads that are abandoned in marine environments.

Furthermore, plastics in the ocean eventually break down into smaller pieces, where they can continue to be ingested by smaller organisms. Furthermore, toxins and chemicals associated with plastics move through the food chain. For a short article that summarizes impacts of plastic shotgun wads on wildlife, see the *Marine Debris & Microplastics* newsletter.

EXPLAIN

In this phase, students discover the original use of plastic wads and how the material is handled. They can begin looking for ways to interrupt the escape of plastic wads into the environment.

Activity: Shotgun Wads
Plastic wads and shells come from shotguns that are used to hunt waterfowl. The Virginia Institute of Marine Science (VIMS) article *Shotgun Wads* provides a simple description of the issue, including the difference between wads and shells. Both wads and shells are found as marine debris in Oregon, although wads are found in greater numbers than shells.

Why is plastic used in the construction of shotgun wads? Before plastic became popular, shotgun wads were made of biodegradable fibrous materials. Students can explore hunter perspectives of the perceived costs and benefits of different wad

Plastic Life Cycle

- *Plastics and the Plastic Life Cycle (pdf)*

Vocabulary / Key Concepts:

- *Polyethylene*
- *LDPE and HDPE*
- *Cradle to Grave*
- *Life Cycle Assessment*

Adding to the Story

- *Student Worksheet #2 (pdf)(doc)*

Shotgun shells (top) and wads (bottom) collected from an Oregon beach, Feb 2019 (Photo: Ryan Parker, Oregon State Parks)

Plastic Wad Impacts

- *MD STEAMSS lessons – Impacts*
- *Article: Marine Debris & Microplastics*

Shotgun Wads

- *Article: Shotgun Wads*

materials by viewing the *Plastic vs Fibre Wad* video and exploring a detailed *Plastic Wad and Fibre Wad Compared* article. Students could also interview family members or other community members who hunt to learn about how shotguns work and the experiences that older hunters may have had using different types of wad materials.

Using *Student Worksheet #3*, students explain how shotgun cartridges operate, how plastic wads escape into the environment, and user perspectives on the performance of wads made of plastic versus those made of biodegradable materials.

After students have learned about plastic wads and about how they are used in shotguns, ask them to create an updated labeled drawing of the story depicting the life cycle of plastic wads. The life cycle should include the production, acquisition, use, reuse, and disposal of plastic shotgun wads. In addition, the story should depict the different possible ways wads move through the cycle; both those pieces that end up as marine debris and those that do not.

Activity: Addressing Shotgun Wad Debris in GFNMS

How are communities currently addressing the problem of plastic shotgun wad debris? In San Francisco Bay, the Greater Farallones National Marine Sanctuary (GFNMS) has been working to reduce this particular type of marine debris. After reading the NOAA article *No Silver Bullet* and *Shotgun Wads in our Waterways* from the Greater Farallones Association, students can discuss some of the approaches used to solve the problem.

Case Study: NZ Students Solve a Mystery

After students in New Zealand discovered plastic shotgun wads on local beach clean ups, they did some sleuthing to try to figure out where the wads were coming from. They partnered with Fish and Game officials who had information about how shotguns work and where they are used locally, and a scientist who used a modeling tool to track movements of ocean debris. As a result, they identified a gun club upriver as a major source of the plastic wads. The students shared the information and their solutions with the gun club, which was unaware of the issue and is now taking steps to reduce this type of plastic waste. Students can access this story through two articles: *Students Solved the Mystery of the Shotgun Wads* and *Shooters Urged to Adopt Environmental-Friendly Ammunition*.

Perspectives on Wad Materials

- *Video: Plastic vs Fibre Wad [6:45]*
- *Article: Plastic Wad and Fibre Wad Compared*
- *Student Worksheet #3 (pdf)(doc)*

Fibre is the same word as fiber. The only difference between them is in their spellings. Fiber is preferred in American spelling; fibre is the preferred spelling in British English.

Addressing Shotgun Wad Debris in Greater Farallones NMS

- *Article: No Silver Bullet*
- *Article: Shotgun Wads in our Waterways*

Discussion Questions

How common is it to find plastic shotgun wads in GFNMS marine debris beach clean ups?

What did studies reveal about hunter views on plastic wad debris?

What marine debris reduction strategies is the GFNMS using?

NZ Students Solve a Mystery

- *Article: Students Solved the Mystery of the Shotgun Wads*
- *Article: Shooters Urged to Adopt Environmental-friendly Ammunition*

Activity: Biodegradable Wads

Some groups are working on creating alternatives to plastic shotgun wads. One article titled *Are Paper Shotgun Shells Ripe for a Revival?* predicts a possible return to the natural materials which comprised shells and wads in the past. In addition, some engineers are creating wads that look and behave like plastic but are made of biodegradable materials. Students can learn more by exploring the VIMS *Biodegradable Wads* project and *Fact Sheet*.

Activity: Local Industry Connection

To help students devise solutions, they can engage with community members who are involved in the plastic wad life cycle. Students use *Student Worksheet #4*, to identify people who use, sell, manufacture, or manage the material. Ask students to make a list of questions they would like to ask these local experts about their ideas for solutions for the plastic wad debris problem. See if an industry member would be willing to participate in an in person or virtual visit to the classroom. If possible, plan a student field trip to a site where shotguns are used for recreation.

ELABORATE

Students identify ways to interrupt the escape of plastic wads, including cost/benefit analysis of potential solutions.

Exploring Possible Solutions

What kinds of solutions already exist out there in the world?

- Removal – Participating in clean ups of ranges and beaches
- Substitution – Experimenting with different types of materials to replace plastic wads; bringing alternatives to market
- Technology – Developing technologies to physically prevent plastic wads from escaping beyond collection
- Education – Creating outreach messages to help create awareness and encourage actions to reduce plastic wads debris
- Policy – Developing and sharing rules and best practices
- Waste Management – Developing procedures to make disposal and recycling of plastic wads easier and to improve compliance among users

Activity: Students Propose Solutions

In this activity, students use what they have learned about plastic wads issue to propose a possible solution for the problem.

Audience:

- The students may create proposals with a specific audience in mind. For example, the class may have already visited a local shooting site or have connected with a local representative from the industry who would be interested hearing about and responding to student proposals.

Biodegradable Shotgun Wads

- *Article: Are Paper Shotgun Shells Ripe for a Revival?*
- *Article: Biodegradable Wads*
- *VIMS: Fact Sheet*

Local Industry Connections

- *Student Worksheet #4 (pdf)(doc)*

Example Student Questions

- *Why are plastic wads used?*
- *Could shotgun wads be made of less harmful materials?*
- *What processes help keep plastic wads from being left in the environment?*
- *How do Oregon hunters become aware about the problems of plastic wad debris?*
- *Can plastic wads be reused or recycled?*
- *What costs and benefits are associated with addressing the plastic wad issue?*

- Alternatively, students develop outreach messages to raise awareness among shotgun users in general.
- Align with an organization that already interacts with users and suggest ways they could incorporate waste reduction practices and messages into their outreach materials.

Students may describe a method to interrupt the local escape of plastic wads that has been identified or implemented in other regions, or the student may propose a related or novel idea.

Have students redraw the life cycle of plastic wads to include their solution(s).

EVALUATE

In this section, students share solutions with stakeholders to get their feedback, and then revise their proposals as necessary. Ideally, industry members and students can come up with a Next Step that they can work on together to move forward with making the solution a reality.

For example:

- Design and share a prototype of a solution.
- Share identified best practices with decision-makers to encourage their adoption in new areas.
- Identify a shovel-ready project for the Oregon Marine Debris Action Plan.
- Develop outreach messages to share solutions to industry and policy makers
- Implement data collection system for plastic wads in Oregon to track changes over time

Students Propose Solutions

- *Explore and test replacement materials*
- *Support availability and competitive pricing of biodegradable options*
- *Encourage users to pick up and dispose of plastic wads*
- *Policy recommendations*
- *Recycling plastic wads*

Next Generation Science Standards

Performance Expectation(s):

MS-ESS3-3 - Apply scientific principles to design a method for monitoring and minimizing a human impact on the environment.
HS-ESS3-4 – Evaluate or refine a technological solution that reduces impacts of human activities on natural systems.

Science & Engineering Practices:

Asking questions and defining problems
Constructing explanations and designing solutions

Disciplinary Core Ideas:

ESS3.C: Human impacts on Earth systems
ETS1A: Defining and delimiting and engineering problem
ETS1B: Developing possible solutions

Crosscutting Concepts:

Cause and Effect
Stability and Change

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