# Yellow Rope on the Beach

## Where are yellow rope strands coming from, and how can we prevent their escape into the environment?

### Overview

Short strands of yellow rope are commonly found during beach clean-ups conducted in the Pacific Northwest. In this lesson, students will determine where this type of 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 yellow rope strands into the environment.

### Essential Questions

- *What is the original use of the yellow rope that ends up on beaches?*
- *Why is yellow rope being used, and could other materials be substituted?*
- *How is the use of yellow rope managed, and are there substitutions or processes that could prevent its 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 yellow rope strands found on PNW beaches,*
2. *Describe the life cycle of yellow rope, and*
3. *Propose solutions that would interrupt the escape of yellow rope into the natural environment.*

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***Grade Level***
4-12

***Anchoring Phenomenon***
Yellow Rope on the Beach

***Driving Question***
Where are yellow rope strands 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*

*Yellow rope (YR)*

## 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? To prevent a material from becoming marine debris item, we need to know its story.

The anchoring phenomenon of this lesson focuses on an easily described type of marine debris known as 'yellow rope' (YR) which is commonly found on beaches in the Pacific Northwest. These 6"-12" strands of three-ply polypropylene rope have been cut cleanly at both ends. Where did these strands come from, and how did they end up on the beach? To *prevent* this type of marine debris, students will research the story of YR, identify points at which the escape of YR could be prevented, and propose solutions for ways to interrupt the generation of YR marine debris.

*Oregon coast riverbank, Jan 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 coast riverbank, Jan 2021*

*Oregon beach, Feb 2019*

*Oregon beach, Jan 2019*

## Lesson Procedure

### ENGAGE

Begin the unit by helping students notice a particular type of marine debris known as yellow rope (YR).

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

In a class discussion or using *Student Worksheet #1*, solicit students' initial ideas about this marine debris is and where it may have come from. Students draw and label a possible life cycle or story about this item, which begins with the production of YR, moves on to its intended use and then 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 YR. 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 YR, its potential life cycle, and the potential hazards YR may pose to the ecosystem.

**Activity: Quantifying YR on Beaches**

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

- YR data collected by the students themselves
- Small dataset from the Central Oregon Coast
- 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 YR.

## Lesson Resources

***The Hook***

- *Video: What is This? [1:49]*

***Starting the Story***

- *Student Worksheet #1 (pdf)*

*YR collected at a 2021 SOLVE cleanup*

***Quantifying YR on Beaches***

- *Central OR Coast dataset (xls)*
- *Olympic Coast NMS data overview, Gr 4-8 (xls); complex, Gr 9-12 (xls)*

***Data Discussion Prompts***

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

***Oregon Beach Clean Up Crews***

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

**Activity: Polypropylene (PP) and Life Cycles**
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 *polypropylene* 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.

Explore selected articles to learn about the material characteristics and life cycle of polypropylene. What is the composition of polypropylene, what can this material be used for, and can it be recycled? Also, use the How It's Made video *How to Make Rope* to learn how ropes are constructed from fibers.

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

**Activity: Polypropylene Impacts on Marine Environments**
Some students may hold the misconception that YR is not harmful to the environment because it is too short entangle wildlife or is the wrong color or shape to mistaken by wildlife for food. What students may not realize is that strands of polypropylene break down over time, and the small microfibers can continue to impact ecosystems.

First, have students read about *Microfibers* to learn about definitions, sources, and impacts of small plastic debris. Then, from the *Potential Impacts of YR Marine Debris* infographic prepared by the *Ecotox and Environmental Stress Lab* at Oregon State University, students discover that smaller organisms ingest and become entangled in microfibers, and toxins and chemicals associated with plastics move through the food chain.

## EXPLAIN

In this phase, students discover how YR is connected to a particular aquaculture industry. They find out the original use of YR and how the material is handled. In addition, by watching videos and hearing from industry professionals, they can begin looking for ways to interrupt the escape of YR fragments into the environment.

### *Polypropylene Rope Life Cycle*

- *Plastics and the Plastic Life Cycle (pdf)*
- *Polypropylene articles (pdf)*
- *Video: How to Make Rope*

### *Vocabulary / Key Concepts:*

- *Polypropylene*
- *Cradle to Grave*
- *Life Cycle Assessment*

### *Adding to the Story*

- *Student Worksheet #2 (pdf)*

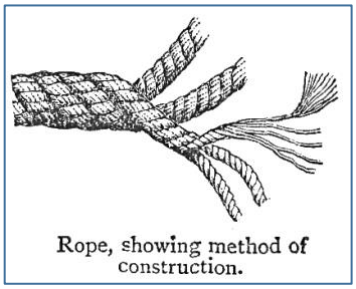


*Illustration: Chambers's Twentieth Century Dictionary of the English Language, 1908*

### *Polypropylene Impacts*

- *Article: Microfibers*
- *Potential Impacts of YR Marine Debris (pdf)*


*Location of Oregon and Washington. How might the YR story in Washington inform student understanding of the YR story in Oregon?*

**Activity: Making the Connection**
YR marine debris is connected to the oyster industry. Have students watch the video *What's Up with the Yellow Ropes?* which contains excerpts from a webinar hosted by *Surfrider Foundation Washington* and *Olympia Surfrider*. In this presentation, staff from *Twin Harbor Waterkeeper* share their experiences discovering YR on the beach, learning that it is connected to the oyster industry, and how they formed a Yellow Rope Work Group to try to solve the problem.

**Activity: YR in Use**
Watch the video *Willapa Bay Oysters, Ep. 1* to learn about how oysters are grown and harvested. Students should identify where, when, and for what purpose YR is used in oyster farming. The best footage of how YR is used begins at 12:35.

Prompts
- What type of oyster farming uses YR? How is YR used?
- What characteristics of YR make it well-suited for its use?
- At what point(s) in the oyster farming process could YR escape?

After students have learned about polypropylene and about how YR is used in oyster farming, have students use Student Worksheet #2 to make an updated and labeled drawing of the story depicting the life cycle of YR. The life cycle should include the production, acquisition, use, reuse, and disposal of YR. In addition, the story should depict the different possible ways YR moves through the cycle; both those pieces that end up as marine debris and those that do not.

**Activity: Industry Updates**
In 2020, oyster growers, resource managers, and conservation groups in Washington began working together to actively address the YR marine debris problem. Students can gain perspectives from the oyster industry as follows:

- Explore the poster *Yellow Rope Fragments: An Industry Update* to look for more information about how YR is used, the points at where it may end up abandoned in the environment, and industry efforts to address the problem.
- Watch the recorded student webinar *YR Industry Update* to hear three oyster industry professionals share how YR is used in oyster farming and what the oyster industry is doing to reduce this type of marine debris.

Once again, have students update their YR life cycle diagram to reflect any new information.

*Finding the YR Source*
- *Video: What's Up with the Yellow Ropes? [7:38]*
- *Video: Willapa Bay Oysters, Ep.1 [25:27]*

*Discussion Prompts*
- *How are oysters grown and harvested?*
- *Are oyster farming methods all the same?*
- *How and when is YR used in oyster farming?*
- *What characteristics of YR made it well-suited for its use by oyster growers?*
- *At what point in the oyster farming process could YR escape into the marine environment?*

*Oyster shells held in place between strands of YR.*
*(photo: Westport Maritime Museum)*

*Industry Updates*
- *Poster: YR Fragments: An industry update (jpg)*
- *Video: YR Industry Update [50:44]*

**Activity: Local Industry Connection**
Have students make a list of questions they would like to ask an oyster farmer about possible solutions that might mitigate the YR problem. Connect with a local oyster grower and see if they would be willing to participate in an in person or virtual visit to the classroom, and if possible, plan a student field trip to the oyster farm.

Considerations:

- If possible, share the types of questions students will be asking with the industry representative in advance.
- Frame the interaction between all parties as a positive problem-solving partnership between industry experts and concerned students.
- Even if the local oyster famer does not practice the type of off-bottom farming that produces YR, the grower can provide an industry/career connection for students and can speak to the industry's general concerns and strategies for reducing environmental impacts associated with oyster aquaculture.

*Example Student Questions*
- *Why and when is off-bottom farming practiced?*
- *Is there a less harmful substitute for YR?*
- *When and how do YR fragments escape?*
- *What processes help keep YR from escaping?*
- *Can YR be reused or recycled?*
- *What costs and benefits are associated with addressing the YR issue?*

## ELABORATE

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

**Background: Exploring Possible Solutions**
The poster *YR Fragments: An Industry Update* summarizes many of the industry's actions taken to prevent YR fragments from ending up discarded in the marine environment, including:

- Policy – Creating Best Management Practices within the industry
  - See the Pacific Coast Shellfish Growers Association's *Marine Debris* webpage
- Removal – Hand-picking YR out of shell piles
- Substitution – Experimenting with different types of materials to replace YR
- Technology – Developing technologies to separate YR from shells
  - Watch the *Cluster Buster* story
  - Watch the *MBMM Crusher Demo* video
- Waste Management – Practicing proper disposal and recycling
  - Learn about a new effort to turn YR into crab gauges in the article *Bellingham engineers recycle ocean plastic into crabbing gear*.

*Exploring Possible Solutions*
- *Poster: YR Fragments: An industry update (jpg)*
- *Video: YR Industry Update [50:44]*
- *PCSGA Website: Marine Debris*
- *Story: Cluster Buster*
- *Video: MBMM Crusher Demo*
- *Article: Bellingham engineers recycle ocean plastic into crabbing gear (pdf)*

**Activity: Students Propose Solutions**
In this activity, students use what they have learned about the YR 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 oyster farm or connected with a local representative from the industry who would be interested hearing about and responding to student proposals.
- Alternatively, students can research the types of oyster farming practiced in Oregon and think about how to craft a proposal that would raise awareness among shellfish growers generally.

Students may describe a method to interrupt the escape of YR in Oregon that has been identified or implemented in other regions, or students may propose a related or novel idea.

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

## EVALUATE

In this section, students share solutions with oyster industry and other interested community organizations 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 for people who interact with YR.
- Implement a YR data collection system in Oregon to track changes over time.

### *Students Propose Solutions*

- *Alternative farming practices*
- *Explore replacement materials*
- *Handling YR differently*
- *Cluster Buster expansion*
- *Hand picking legacy piles*
- *Policy recommendations*
- *Recycling YR*

### *Case Study – Newport 4th grade*

- *Project summary (pdf)*


*Impact: New signage at a local oyster farm raises awareness among users.*

## 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


*photo: Westport Maritime Museum*

## Acknowledgments

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